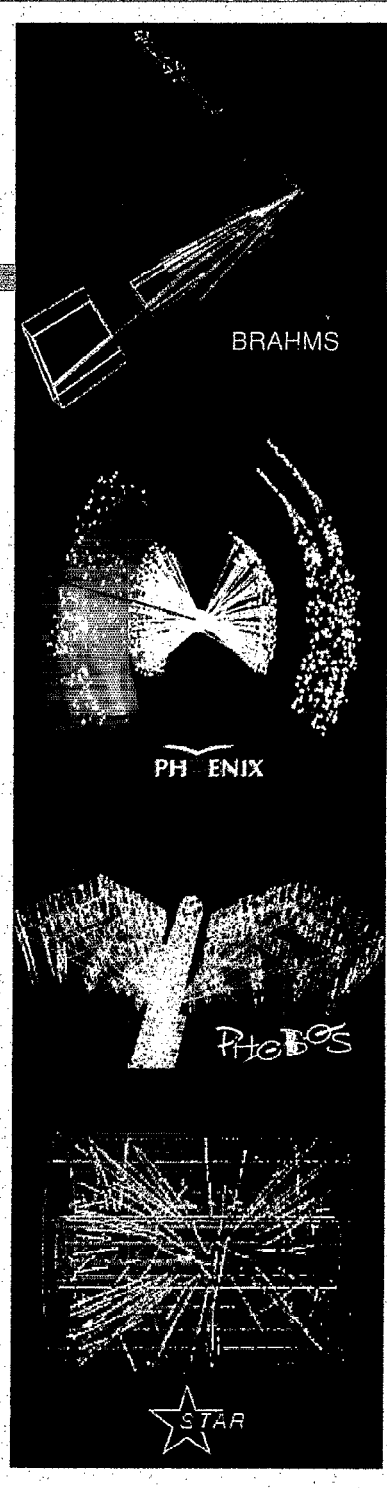
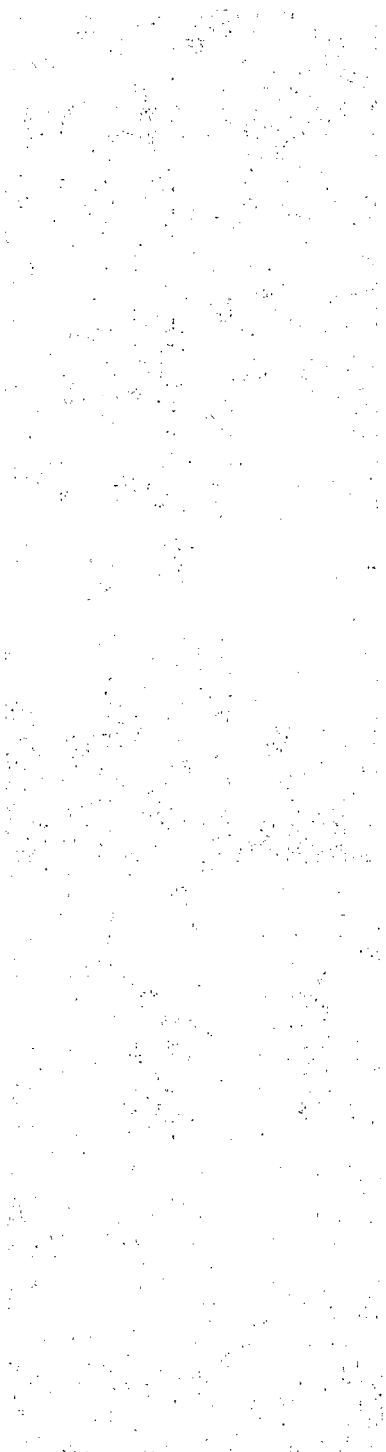
BNL 34518
Sixteenth Edition
Informal Report

BROOKHAVEN NATIONAL LABORATORY
Upton, Long Island, New York 11973-5000



C-AD EXPERIMENTS

1999 ♦ 2000 ♦ 2001 ♦ 2002



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Sixteenth Edition
Informal Report

C-AD Experiments – 1999 - 2002

P. Lo Presti

March 2001

Collider-Accelerator Department
Experimental Support and Facilities Division

Brookhaven National Laboratory
Brookhaven Science Associates
Upton, New York 11973-5000
United States of America

Under Contract No. DE-AC02-98CH10886 with the
United States Department of Energy

This publication can be located at the following web site:
http://server.c-ad.bnl.gov/esfd/eps.htm

Our cover was designed by Peggy Harvey of the C-AD Main Control Room.
"Thank you Peggy for an elegant design."

On October 1, 1999 the Relativistic Heavy Ion Collider (RHIC) Project and the Alternating Gradient Synchrotron (AGS) Department combined to form the Collider-Accelerator Department (C-AD) with former AGS Chair Derek Lowenstein as the new C-AD Chair.

This transition marks the beginning of a new era of accelerator operation and physics here at BNL since the C-AD combines the new skills developed during the 10 year period of RHIC construction with the experience of both the RHIC and AGS groups in operating state-of-the-art facilities.

Along with this transition come major new experiments for the Collider-Accelerator Department:

BRAHMS

PHENIX

PHOBOS

PP2PP

RHIC-SPIN

and

STAR

C-AD Experiments – 2000 and 2001

Table of Contents

This is the *16th edition*. Please forward suggestions and changes for future editions to:

Division Head, ES&F Division
Brookhaven National Laboratory
Building 911B
Upton, New York 11973-5000 U.S.A.

AGS as run schedule, FY1999

Normal Running
Cycle on Demand
Facility Commissioning

By: W. Meng/H. Huang, Date: 1 Oct 99

FY99

Beam	Exp #	Experiment Spokespersons or Activity	AGS Beam/Mode Charged Hours	Approved Hours
		AGS Startup		
		BLIP	2741	
		RHIC/AGS Studies		
		RHIC Test Run		
		RHIC Commissioning	565	
A1	852	Cason/Chung/Seth	6466	6109
A2	865	Zeller	7733	6500
A3	941	Huang/Majka	442	400
A3	947	Vazquez	161	300
B1	925	Makdisi/Yokosawa	426	384
B1	948	Stephenson	178	200
B1	943	Dietrich/Hartouni	244	300
B2		Test Beam		
C1	850	Carroll/Heppelman	4788	4000
C4	787	Bryman/Littenberg/Smith	15321	15500
C6	913	Sadler/Spinka/Tippens	795	700
C6	914	Kycia/Kruglov/Nelkens	639	700
C6	927	Kycia/Nelkens	83	80
C6	PHOBOS	Steadman	58	72
C8	931	Dehmelt/Hungerford/Zeps	408	800
D6	906	Chiem/Fukuda/Rusek	1829	1600
D6	930	Tamura	429	1040
U	938	Bauer/Haines/Hastings/Walanabe	67	
U	939	Hanson/King	69	
U	933	Hartouni/Morris	225	200
U	945	Cooper/Morgan		32
U	945A	Greene/Sommer	48	24
U	945B	Greene	7	
V1	821	Hughes/Morse/Roberts	1920	2100
AGS	950	Imai/Fields	109	24

Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
1 8 15 22 29	6 13 20 27	3 10 17 24	1 8 15 22 29	5 12 19 26	2 9 16 23	2 9 16 23 30	6 13 20 27	4 11 18 25	1 8 15 22 29	6 13 20 27	3 10 17 24 31	7 14 21 28	5 12 19 26
	p (SEB)				p (FEB)	pp	S	Fe		Au	p (FEB)	S	

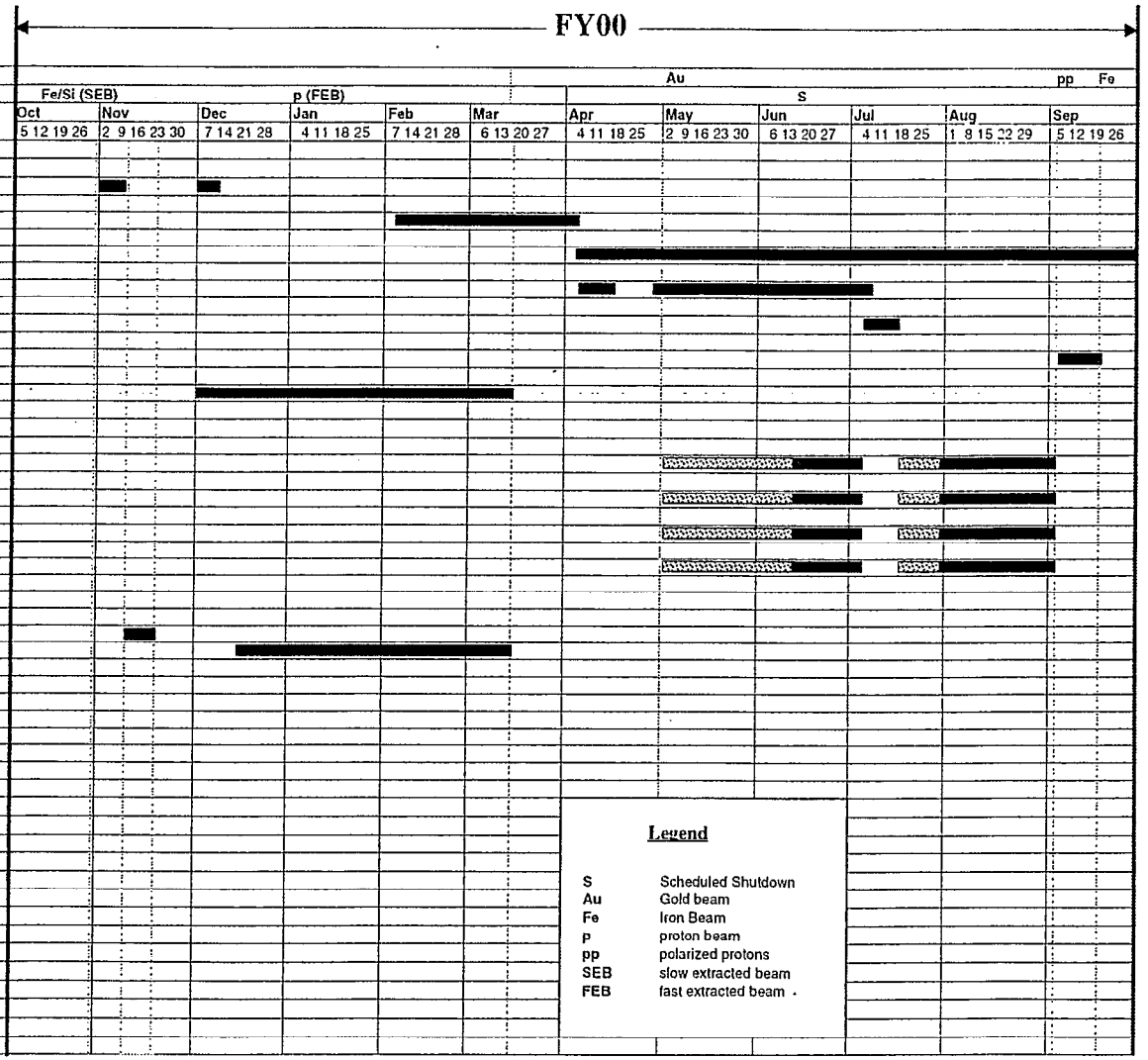
Legend

S	Scheduled Shutdown
p	proton beam (25 GeV/c)
pp	polarized protons
SEB	slow extracted beam
FEB	fast extracted beam

C-A as run schedule, FY2000

Normal Running
Standby

By: Y. Makdisi. Date: 30 Sep 00
corrected 10/12/01



Beam	Exp #	Experiment Spokespersons or Activity	Charged Hours	Approved Hours
		AGS Startup		
		RHIC Cryo Startup/Systems Tests		
		RHIC Cryo ON		
		RHIC Startup (with beam)		
		RHIC Pause for Experiments		
		RHIC Polarized Proton Development	338	
		BLIP	2000	
RHIC Experiments				
6:00	STAR	Harris/Hallman	308	
8:00	PHENIX	Zajc	300	
10:00	PHOBOS	Busza	326	
2:00	BRAHMS	Videbaek	299	
AGS Experiments				
A3	947	Vazquez	335	300
V1	821	Hughes/Morse/Roberts	3232	2100
Unscheduled RHIC Experiments				
2:00	PP2PP	Guryn		
6:00	STAR	RHIC Spin		
8:00	PHENIX	RHIC Spin		
2:00	PP2PP	RHIC Spin		
Unscheduled AGS Experiments				
A3	951	McDonald	0	3600
B5	940	Molzon	4	4000
C1	938	Bauer/Haines/Hastings/Watanabe	67	
C3	926	Bryman/Littenberg/Zeller	0	8000
C4	949	Bryman/Kettell/Sugimoto	0	6000
C6	927	Kycia/Nefkens	83	2280
C6	953	Nefkens/Manley/Spinka	0	450
C8	931	Dehnhard/Hungerford/Zeps	408	1408
D6	930	Tamura	428	1428
U	955	Hartouni/Morris	0	
V	952	Cushman	0	

Legend

S	Scheduled Shutdown
Au	Gold beam
Fe	Iron Beam
p	proton beam
pp	polarized protons
SEB	slow extracted beam
FEB	fast extracted beam

II

http://server.c-ad.bnl.gov/esfd

- Normal running
- Concurrent with RHIC operations
- Schedule to be determined
- Engineering/Commissiioning
- Standby
- AGS pulse on demand

C-A as run schedule, FY2001

By: T. Satogata Date: 31 Oct 01

FY01

Beam	Exp #	Experiment Spokesperson or Activity	Charged Hours	Approved Hours
		AGS Startup		
		RHIC Cryo Startup/RHIC Systems Tests/warmup		
		RHIC Cryo on		
		BLIP	2795	
		RHIC Studies		
RHIC Experiments				
6:00	STAR	Harris	934	
8:00	PHENIX	Zajc	907	
10:00	PHOBOS	Busza	914	
2:00	BRAHMS	Videbaek	926	
AGS Experiments				
A3	951	McDonald	199	3600
A3	957	Vazquez	146	150
C7	956	Bauer/Haines/Hastings/Watanabe	102	-
C4	949	Bryman/Kettell/Sugimoto	642	6000
C8	931	Dehnhard/Hungerford/Quinn/Zeps	842	1406
D6	930	Tamura	851	1428
V1	952(tests)	Cushman	56	
V1	821	Hughes/Morse/Roberts	4025	2100
U	955	Hartouni/Morris	62	-
Unscheduled AGS Experiments				
A3	960	Vazquez	0	150
B5	940	McIzon	4	4000
C3	926	Bryman/Littenberg/Zeller	0	8000
C6	953	Manley/Spinka/Nefkens	0	450
C6	927(tests)	Nefkens/Comfort	83	2 weeks
C6	958	Comfort/Sadler	0	400
C6	927	Nefkens/Comfort	83	2280
V1	952	Cushman	0	

RHIC Beam/Mode	S									Au-Au					
AGS Beam/Mode			Fe(SEB)			p (FEB)								p (SEB	pp
Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct			
3 9 17 24 31	7 14 21 28	5 12 19 26	2 9 16 23 30	6 13 20 27	6 13 20 27	3 10 17 24	1 8 15 22 29	5 12 19 26	3 9 17 24 31	7 14 21 28	4 11 18 25	2 9 16 23 30			

50% of time ~~> 20% of time

Legend

S	Scheduled Shutdown
Fe	Iron beam
Au	Gold beam
p	proton beam
pp	polarized protons
FEB	fast extracted beam

http://server.c-ad.bnl.gov/esfd

Normal running
Concurrent with RHIC operations
Schedule to be determined
Engineering/Commissioning
Standby

C-A Run Plan, FY2002

In progress, subject to funding and other issues

By: K. Drees/ P. Pile Date: 18 Dec 01
hours as of 13 Nov 01

FY02

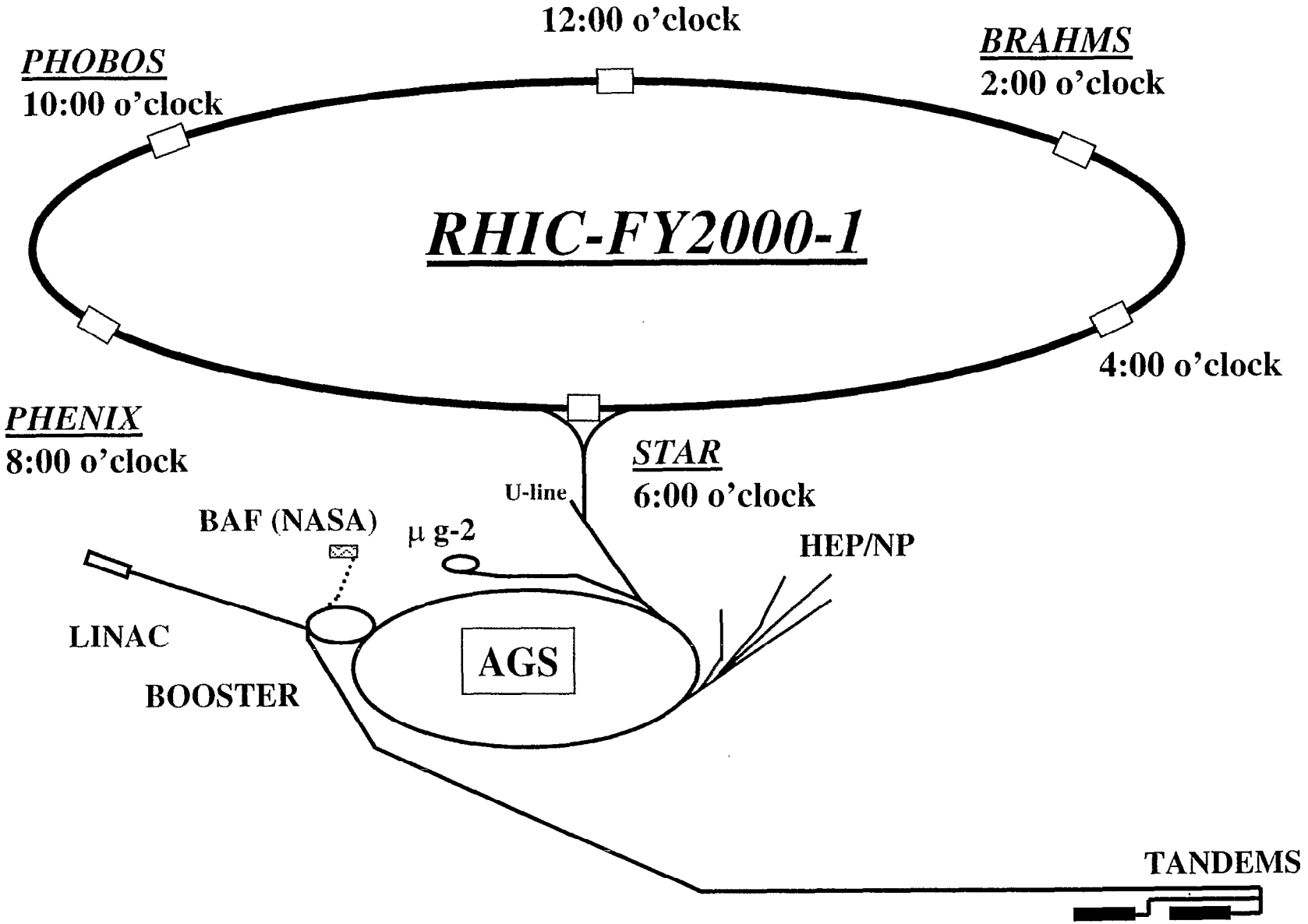
Beam	Exp #	Experiment Spokesperson or Activity	Charged Hours	Approved Hours
		AGS Startup		
		RHIC Cryo Startup/RHIC Systems Tests/warmup		
		RHIC Cryo on		
		BLIP	3104	
		RHIC Studies (AsRequired)		
		AGS pp studies		
		BAF		
RHIC Experiments				
6:00	STAR	Harris	1021	
8:00	PHENIX	Zajc	1002	
10:00	PHOBOS	Busza	1020	
2:00	BRAHMS	Videbaek	1025	
2:00	BRAHMS	RHIC Spin		
6:00	STAR	RHIC Spin		
8:00	PHENIX	RHIC Spin		
2:00	PP2PP	Guryn		
AGS Experiments				
A3	960	Vazquez	0	150
C4	949	Bryman/Kettel/Sugimoto	732	6000
C7	956	Bauer/Haines/Hastings/Watanabe	90	-
C8	931	Dehnhard/Hungerford/Quinn/Zeps	842	1408
D6	930	Tamura	940	1428
Unscheduled AGS Experiments				
A3	951	McDonald	165	3600
B5	940	Molzon	4	4000
C3	926	Bryman/Littenberg/Zeller	224	8000
C6	927(tests)	Nefkens/Comfort		
C6	953	Manley/Spinka/Nefkens	0	450
C6	958	Comfort/Sadler	0	400
C6/C2	927	Nefkens/Comfort	83	2280
D6	964	Imai/Nakazawa/Tamura	0	1400
V1	952	Cushman	56	
V1	962	Hughes/Roberts/Morris	0	2000
Proposed AGS Experiments				
U	945C	Greene	0	
U	963	Hartouni/Morris	0	1 week
LOI AGS Experiments				
V1	EDM	Miller/Semertzidis		

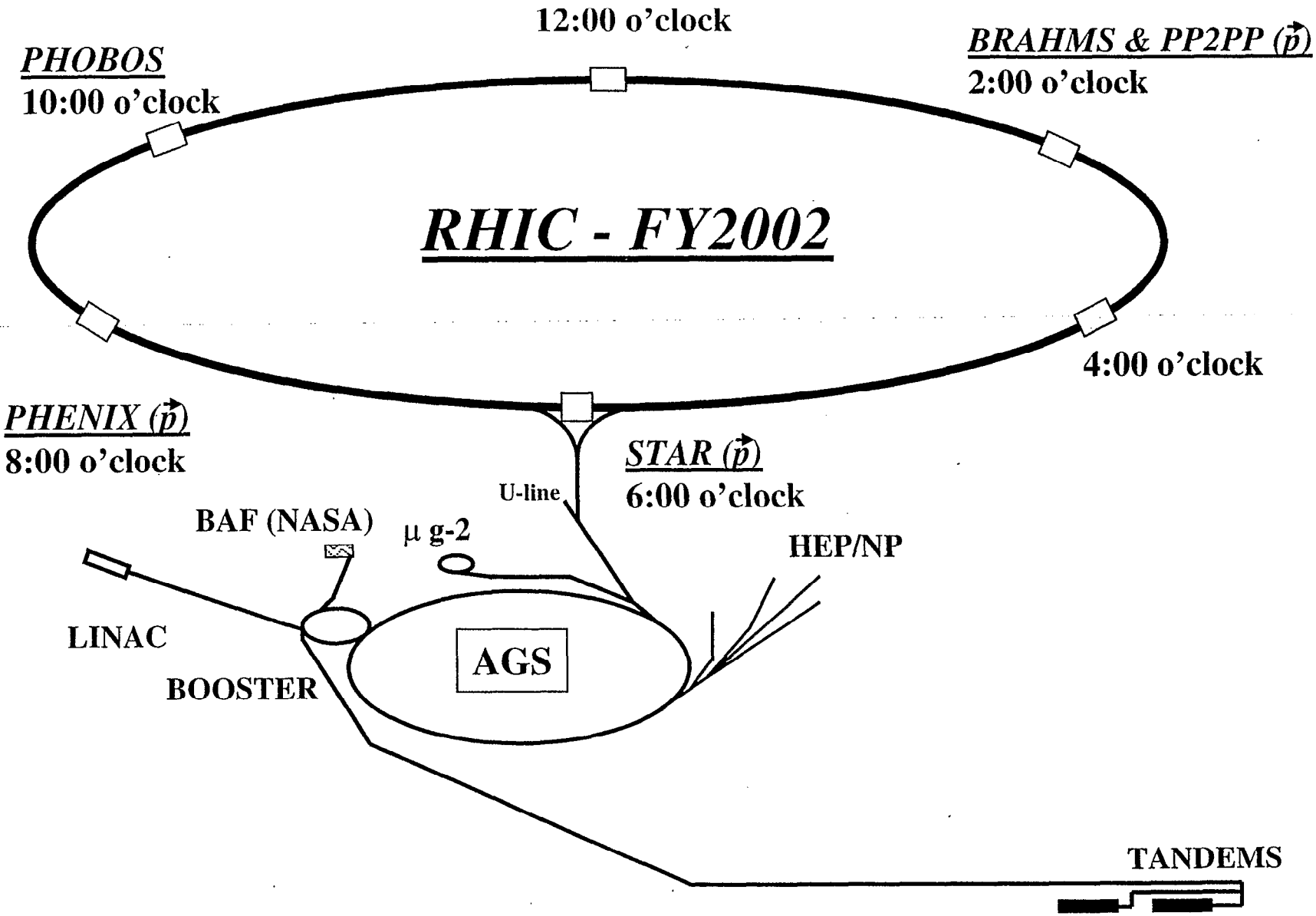
RHIC Beam/Mode	Au		S	pp								S
AGS Beam Mode	p(S		pp				p(SEB		p (FEB) Fe		S	

Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
4 11 18 25	2 9 16 23 30	6 13 20 27	4 11 18 25	1 8 15 22 29	5 12 19 26	5 12 19 26	2 9 16 23 30	7 14 21 28	4 11 18 25	2 9 16 23 30	6 13 20 27	3 9 17 24 3

Legend

S	Scheduled Shutdown
Fe	Iron beam
Au	Gold beam
Fe	Iron beam
Au	Gold beam
p	proton beam
pp	polarized protons
FEB	fast extracted beam


12:00 o'clock
PHOBOS
10:00 o'clock
BRAHMS
2:00 o'clock
RHIC-FY2000-1
4:00 o'clock
PHENIX
8:00 o'clock
STAR
6:00 o'clock
U-line
BAF (NASA)
μ g-2
HEP/NP
LINAC
AGS
BOOSTER
TANDEMS


12:00 o'clock
PHOBOS
10:00 o'clock
BRAHMS & PP2PP (p)
2:00 o'clock
RHIC - FY2002
4:00 o'clock
PHENIX (p)
8:00 o'clock
STAR (p)
6:00 o'clock
U-line
BAF (NASA)
μ g-2
HEP/NP
LINAC
AGS
BOOSTER
TANDEMS

AGS Experimental Area

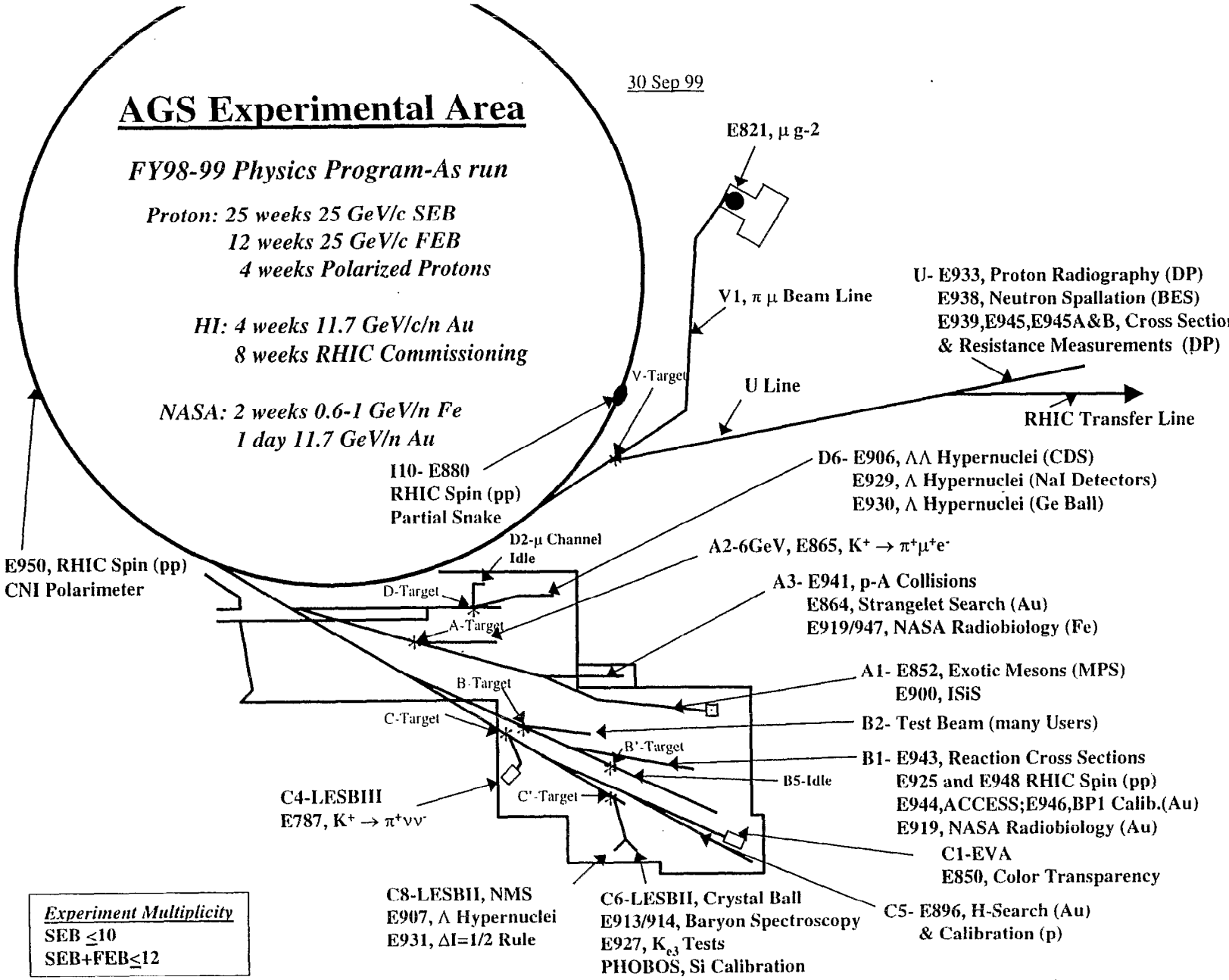
30 Sep 99

FY98-99 Physics Program-As run

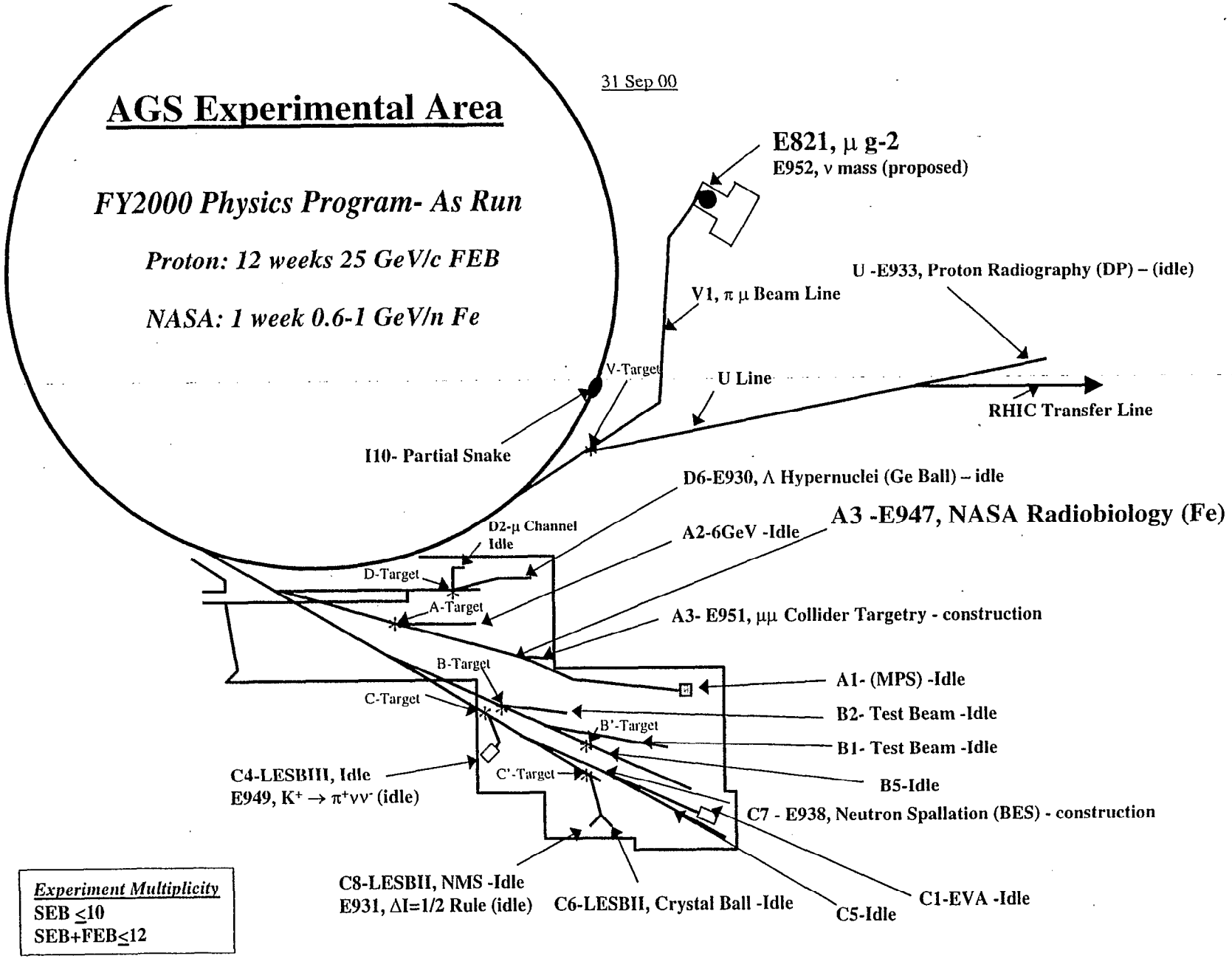
Proton: 25 weeks 25 GeV/c SEB
12 weeks 25 GeV/c FEB
4 weeks Polarized Protons

HI: 4 weeks 11.7 GeV/c/n Au
8 weeks RHIC Commissioning

NASA: 2 weeks 0.6-1 GeV/n Fe
1 day 11.7 GeV/n Au



Experiment Multiplicity
SEB ≤10
SEB+FEB≤12


AGS Experimental Area
31 Sep 00
FY2000 Physics Program- As Run
Proton: 12 weeks 25 GeV/c FEB
NASA: 1 week 0.6-1 GeV/n Fe
E821, μ g-2
E952, ν mass (proposed)
U -E933, Proton Radiography (DP) – (idle)
V1, π μ Beam Line
V-Target
U Line
RHIC Transfer Line
I10- Partial Snake
D6-E930, Λ Hypernuclei (Ge Ball) – idle
A3 -E947, NASA Radiobiology (Fe)
D2-μ Channel
Idle
A2-6GeV -Idle
D-Target
A-Target
A3- E951, μμ Collider Targetry - construction
B-Target
A1- (MPS) -Idle
C-Target
B2- Test Beam -Idle
B'-Target
B1- Test Beam -Idle
C4-LESBIII, Idle
E949, K+ → π+νν- (idle)
C'-Target
B5-Idle
C7 - E938, Neutron Spallation (BES) - construction
C8-LESBII, NMS -Idle
E931, ΔI=1/2 Rule (idle)
C6-LESBII, Crystal Ball -Idle
C5-Idle
C1-EVA -Idle
Experiment Multiplicity
SEB ≤10
SEB+FEB≤12

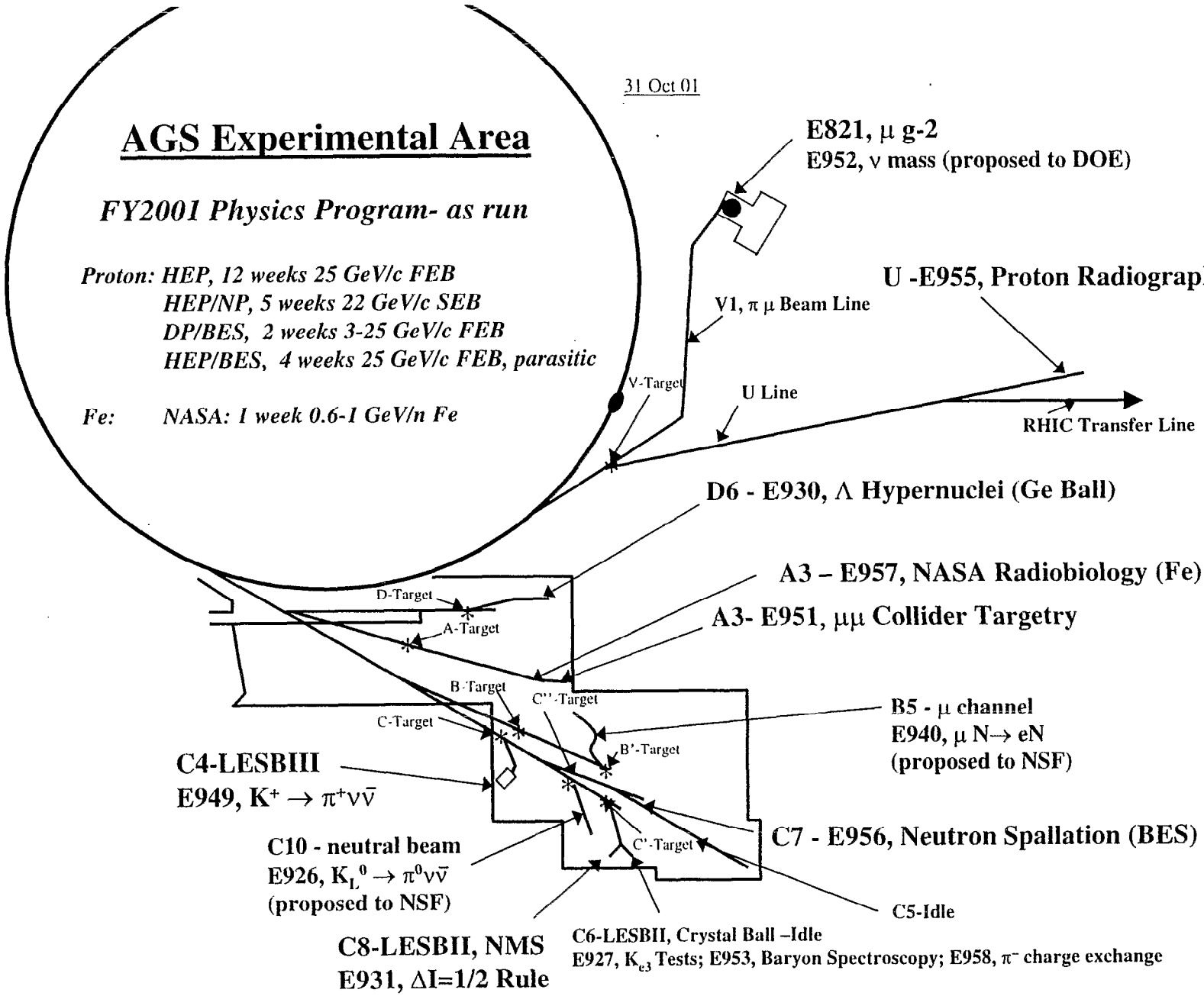
31 Oct 01

AGS Experimental Area

FY2001 Physics Program- as run

Proton: HEP, 12 weeks 25 GeV/c FEB
HEP/NP, 5 weeks 22 GeV/c SEB
DP/BES, 2 weeks 3-25 GeV/c FEB
HEP/BES, 4 weeks 25 GeV/c FEB, parasitic

Fe: NASA: 1 week 0.6-1 GeV/n Fe



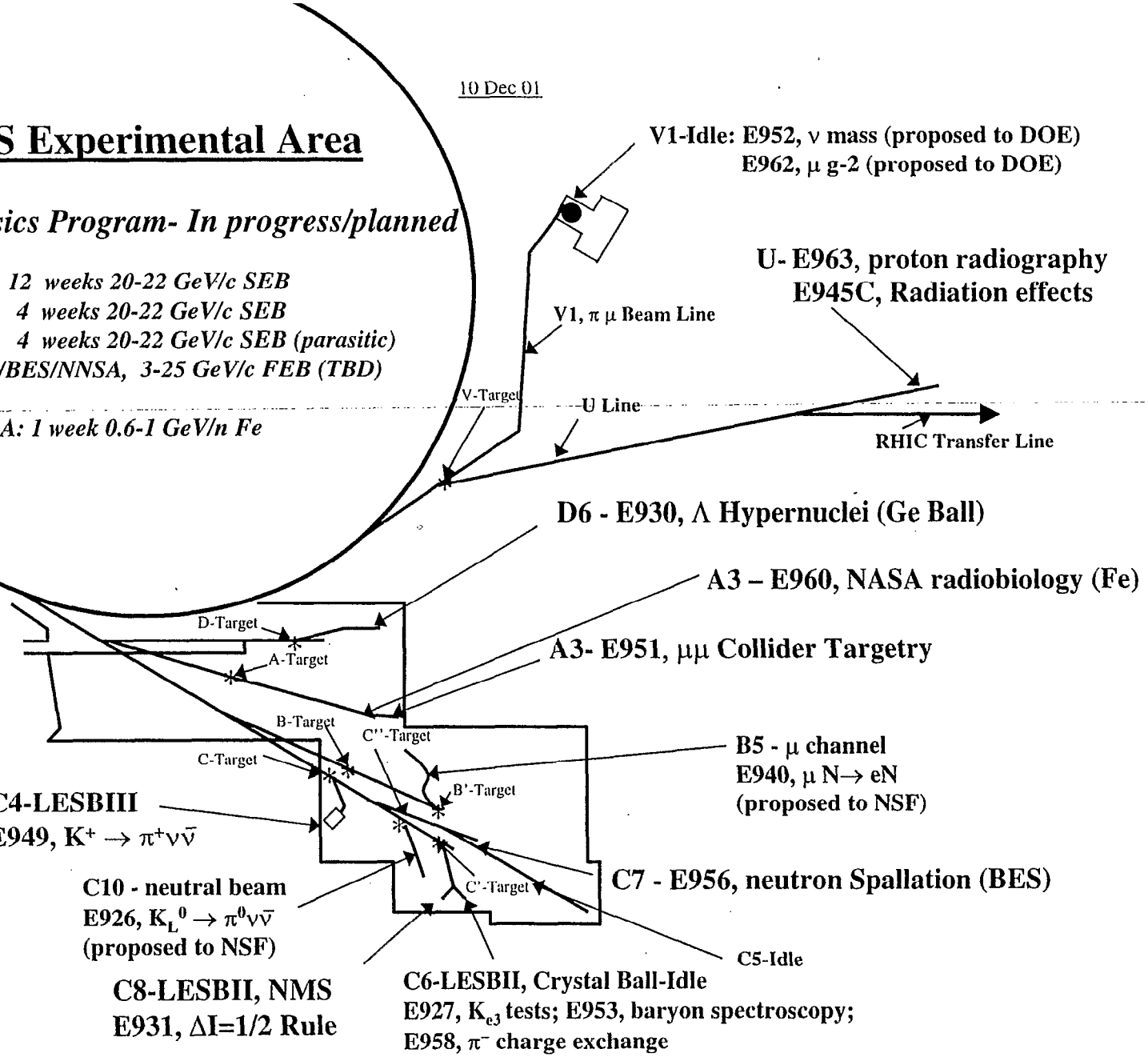
10 Dec 01

AGS Experimental Area

FY2002 Physics Program- In progress/planned

Proton: HEP, 12 weeks 20-22 GeV/c SEB
NP, 4 weeks 20-22 GeV/c SEB
NP, 4 weeks 20-22 GeV/c SEB (parasitic)
HEP/BES/NNSA, 3-25 GeV/c FEB (TBD)

Fe: NASA: 1 week 0.6-1 GeV/n Fe



Summary Of Experiments

Two outstanding questions of fundamental science:

What happened during the first ~ microseconds of the early universe?

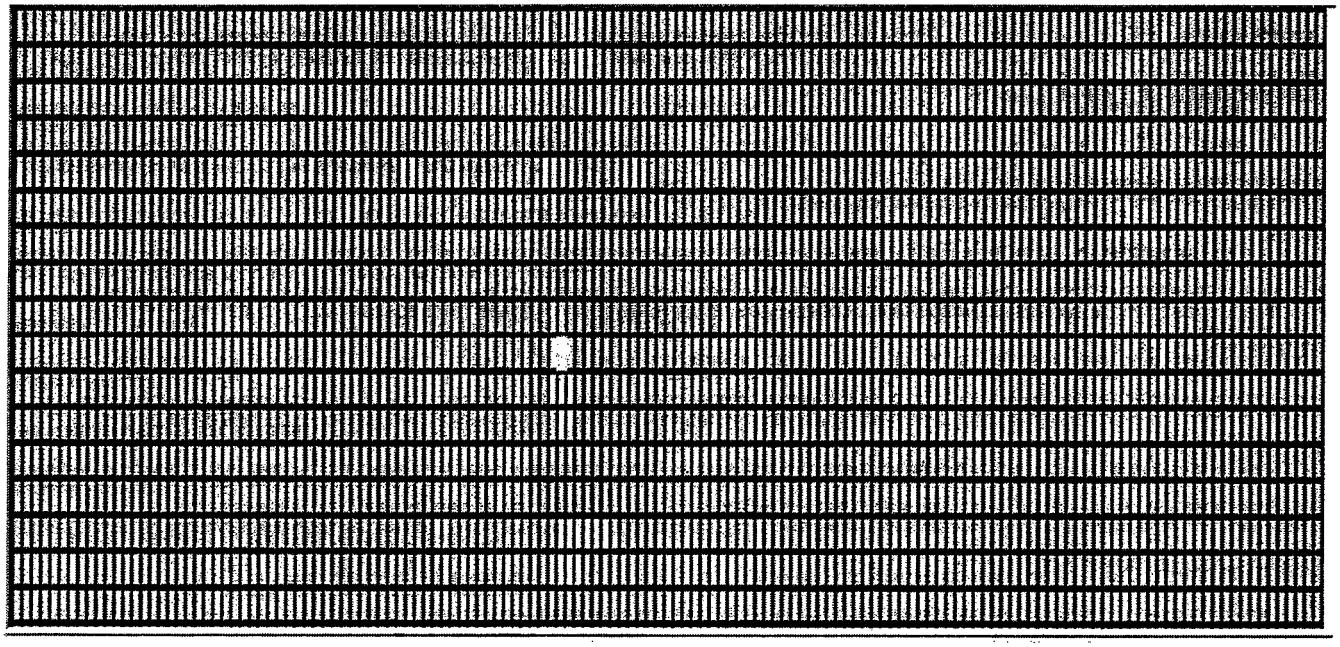
and

How does the proton get its spin?

These questions will be addressed by the RHIC detectors

BRAHMS
PHENIX
PHOBOS
STAR

The detectors will study the collisions of



At approximately 23:00 on June 15, 2000 detection was made of the first collisions.

Beam: 2:00 o'clock
Status: In Progress
Hours Charged: 299

EXPERIMENT - BRAHMS

SPOKESMEN: F. VIDEBAEK AND J. J. GAARDHOJE

- **Brookhaven National Laboratory** - D. Beavis, C. Chasman, R. Debbe, J. H. Lee, E. McBreen, K. Olchanski, J. W. Olness, R. Scheetz, F. Videbaek
- **Fysisk Institutt** – K. Fanebust, R. Gruner, D. Roehrich
- **Jagellonian University** - K. Grotowski, T. Kozik, Z. Majka, Z. Sosin, P. Staszel
- **Johns Hopkins University** - E. J. Kim, Y. K. Lee
- **New York University** – Y. Blyakhman, B. Budick
- **Niels Bohr Inst. for Astronomy, Physics and Geophysics University** – J. G. Bearden, J. P. Bondorf, H. Boggild, J. J. Gaardhoje, A. G. Hansen, O. Hansen, A. Holm, C. Holm, H. Heiselberg, B. Svane Nielsen
- **Texas A&M University** – C. Cibor, K. Hagel, M. Murray, J. Natowitz, R. Wada
- **University Bucharest** – C. Besliu, D. Argintaru, R. Zaharia, F. Constantin, D. Felea, A. Jipa, I. S. Zgura
- **University Kansas** – H. Ito, S. J. Sanders
- **University of Lund** – B. L^Aorstad, J. Schmidt-Sorensen
- **University Oslo** – G. Lovhoiden, A. K. Holme, T. S. Tveter

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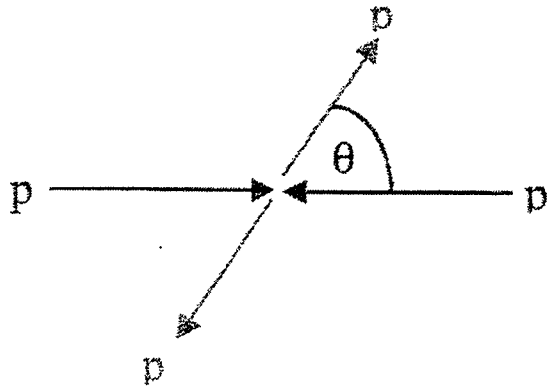
BRAHMS, the **B**road **RA**nge **H**adron **M**agnetic **S**pectrometers experiment at RHIC is designed to measure charged hadrons over a wide range of rapidity and transverse momentum to study the reaction mechanisms of the relativistic heavy ion reactions at RHIC and the properties of the highly excited nuclear matter formed in these reaction.

ELASTIC SCATTERING (BASIC FACTS)

1. **Elastic scattering process:** In State = Out State, pp → pp



2. **Kinematic variables:**

   a) t = four momentum transferred squared

   $$t = (p_{out} - p_{in})^2 = -2p^2(1-\cos\theta)$$

   $$t \cong -p^2\theta^2 \quad \text{for small angles } (\ 80\ \mu\text{rad} < \theta < 13\ \text{mrad}\ )$$

   t – gives the scattering angle in the CMS

   b) $s = 4(p^2 + m^2) \cong 4p^2$ $\qquad$ $\sqrt{s}$ = Total CMS Energy

Beam: 2:00 o'clock
Status: FY 2001
Hours Charged: 0

EXPERIMENT – PP2PP

SPOKESMAN: W. GURYN

- **Brookhaven National Laboratory** – R. Chrien, R. Gill, W. Guryn, D. Lynn, A. Rusek, M.Sakitt, S. Tepikian
- **Ecole Polytechnique** – J. Bourotte, M. Haguenauer
- **Institute des Science Nucleaires** – M. Buenerd
- **Institute for High Energy Physics – A. Ufimtsev**
- **Moscow Engineering Physics Institute** - A. A. Bogdanov, V. A. Kaplin, A. Karakash, S. B. Nurushev, M. F. Runtzo, M. N. Strikhanov
- **State University of New York at Stony Brook** – M. Rijssenbeek, C. Tang
- **Tomsk Nuclear Physics institute** – G. N. Dudkin, I. V. Glavanakov, Y. F. Krechetov, G. A. Naumenko, A. P. Potylitskin, G. M. Radutsky
- **University di Genova and Sezione** – M. Conte
- **University Iowa** – N. Akchurin, C. Newsom, Y. Onel
- **University Padova** – M. Pusterla
- **University Texas** – K. De, A. Vartapetian
- **University di Trieste and Sezione** – R. Giacomich, A. Penzo, P. Schiavon

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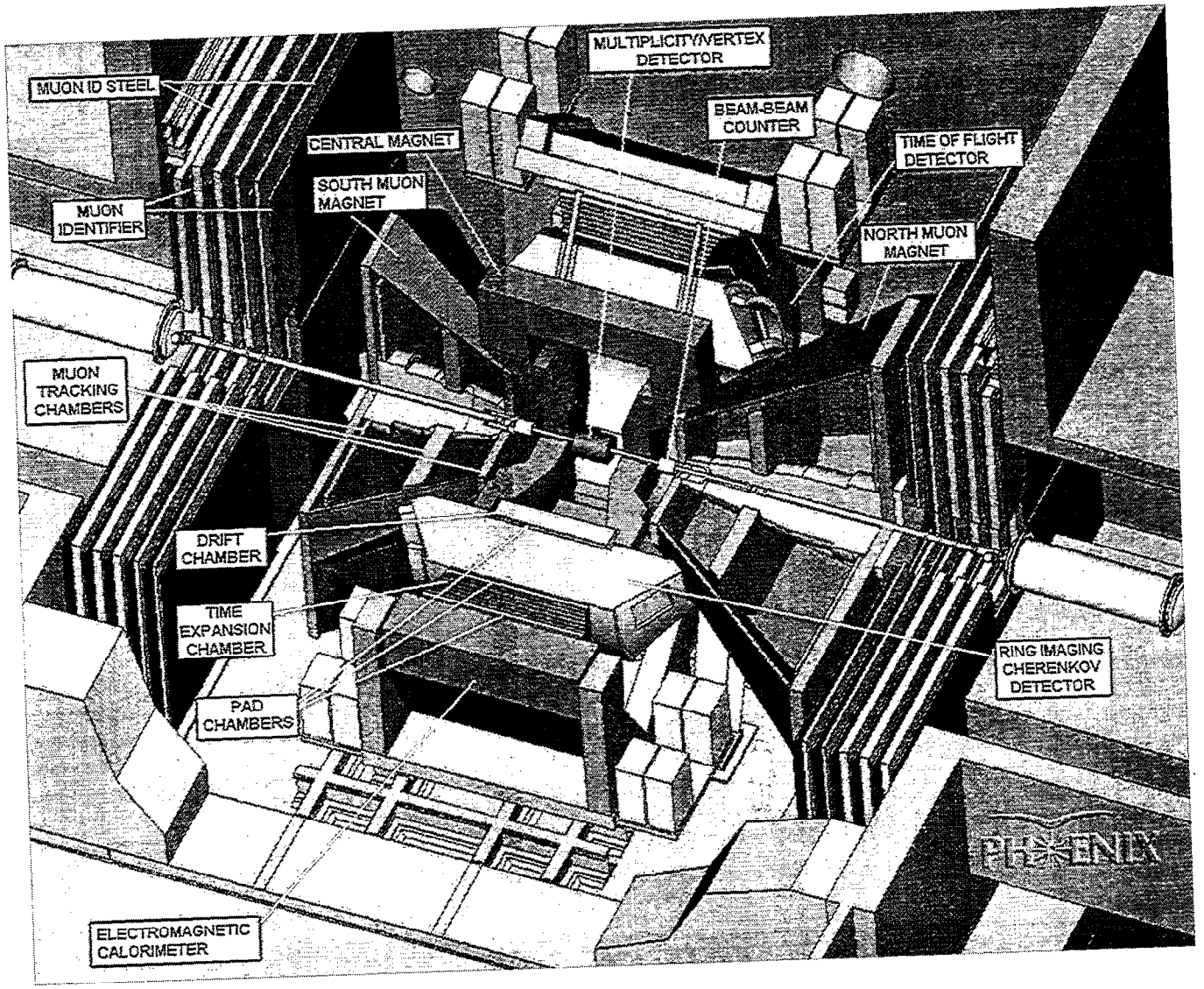
This is an experiment to study proton-proton (pp) elastic scattering experiment at RHIC. Using both polarized and unpolarized beams, the experiment will study pp elastic scattering from $\sqrt{s}$ = 60 GeV to $\sqrt{s}$ = 500 GeV in two kinematical regions.


MULTIPLICITY/VERTEX DETECTOR
MUON ID STEEL
BEAM-BEAM COUNTER
CENTRAL MAGNET
TIME OF FLIGHT DETECTOR
SOUTH MUON MAGNET
MUON IDENTIFIER
NORTH MUON MAGNET
MUON TRACKING CHAMBERS
DRIFT CHAMBER
TIME EXPANSION CHAMBER
RING IMAGING CHERENKOV DETECTOR
PAD CHAMBERS
PHENIX
ELECTROMAGNETIC CALORIMETER

Beam: 8:00 o'clock
Status: In Progress
Hours Charged: 300

EXPERIMENT – PHENIX

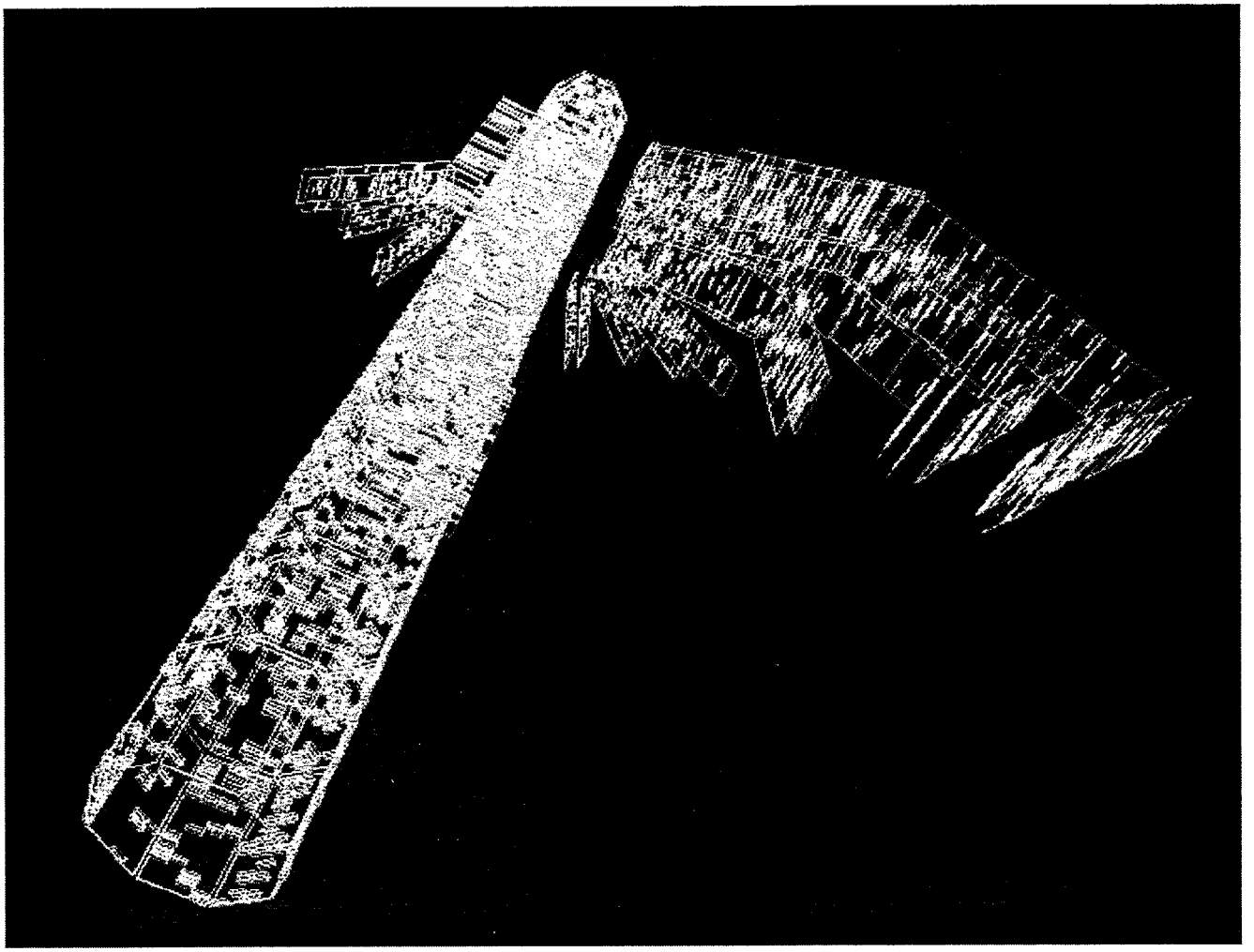
SPOKESMAN: W. A. ZAJC

The PHENIX collaboration consists of over 430 physicists and engineers from 43 participating institutions in 11 countries (Brazil, Canada, China, Germany, India, Israwl, Japan, Korea, Russia, Sweden and the U.S.A.) A comparable number of support personnel also work on PHENIX.

PHENIX is a very large detector system, which is designed to detect, identify, and measure the momentum of each of the many different kinds of particles produced at RHIC. PHENIX comprises three electromagnets, four instrumented spectrometers or arms, and inner detector systems.

PHENIX looks deep into the source of RHIC physics to learn about the earliest times of quark gluon plasma formation in heavy-ion collisions, and uncover the secrets of the spin structure of the proton in polarized proton collisions.

The design of the detectors and readout has been optimized across a very broad dynamic range from A-A collisions (low rate, large events, high occupancy) to $\vec{p}$ - $\vec{p}$ collisions (high rate, small events, low occupany). This result of this optimization is a detector with the ability to measure both large cross section hadronic phenomena and rare processes.



Gold-Gold Ion Collisions at PHOBOS

The figure shows the response of our Silicon Detectors to particles produced in collisions of two gold ions. The green points show where the particles hit the silicon.

Beam: 10:00 o'clock
Status: In Progress
Hours Charged: 326

EXPERIMENT – PHOBOS

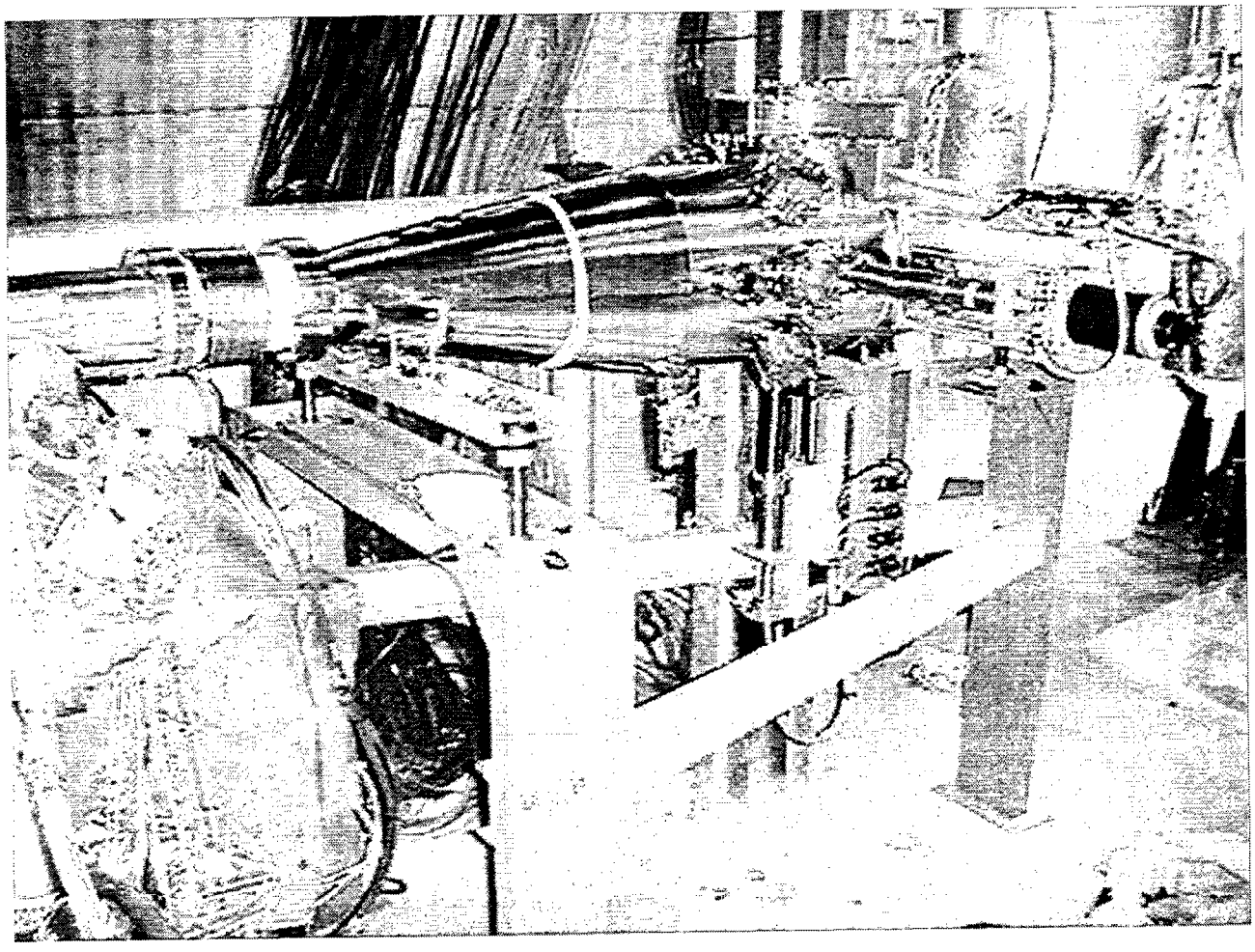
SPOKESMAN: W. BUSZA

The PHOBOS collaboration consists of over 100 physicists and engineers. A comparable number of support personnel also work on PHENIX.

- **Argonne National Laboratory**
- **Brookhaven National Laboratory**
- **Institute of Nuclear Physics – Krakow, Poland**
- **Jagiellonian University – Krakow, Poland**
- **Massachusetts Inst. of Technology**
- **National Central University – Taiwan**
- **University of Rochester**
- **University of Illinois – Chicago**
- **University of Maryland**

PHOBOS consists of many silicon detectors surrounding the interacton region. With these detectors physicists will be able to count the total number of produced particles and study the angular distributions of all the products. With this array they will be on the look out for unusual events, fluctuations I the umber of particles and angular distribution. Physicists know from other branches of physics that a characteristic for phase transitions are fluctuations in physical observables. In order to obtain more detailed information about these events the PHOBOS detector has two high quality magnetic spectrometers which study, in detail, 1% of the produce particles.

The PHOBOS detector is able to measure quantities such as the temperature, suze, and density of the fireball produced in the collision. It studies the ratios of the various particles produced. With this information it should be possible to both detect and study a phase transition that might occur between Quark-Gluon Plasma (QGP) and ordinary nuclear matter.



First Polarimeter Chamber Installed in Blue Ring

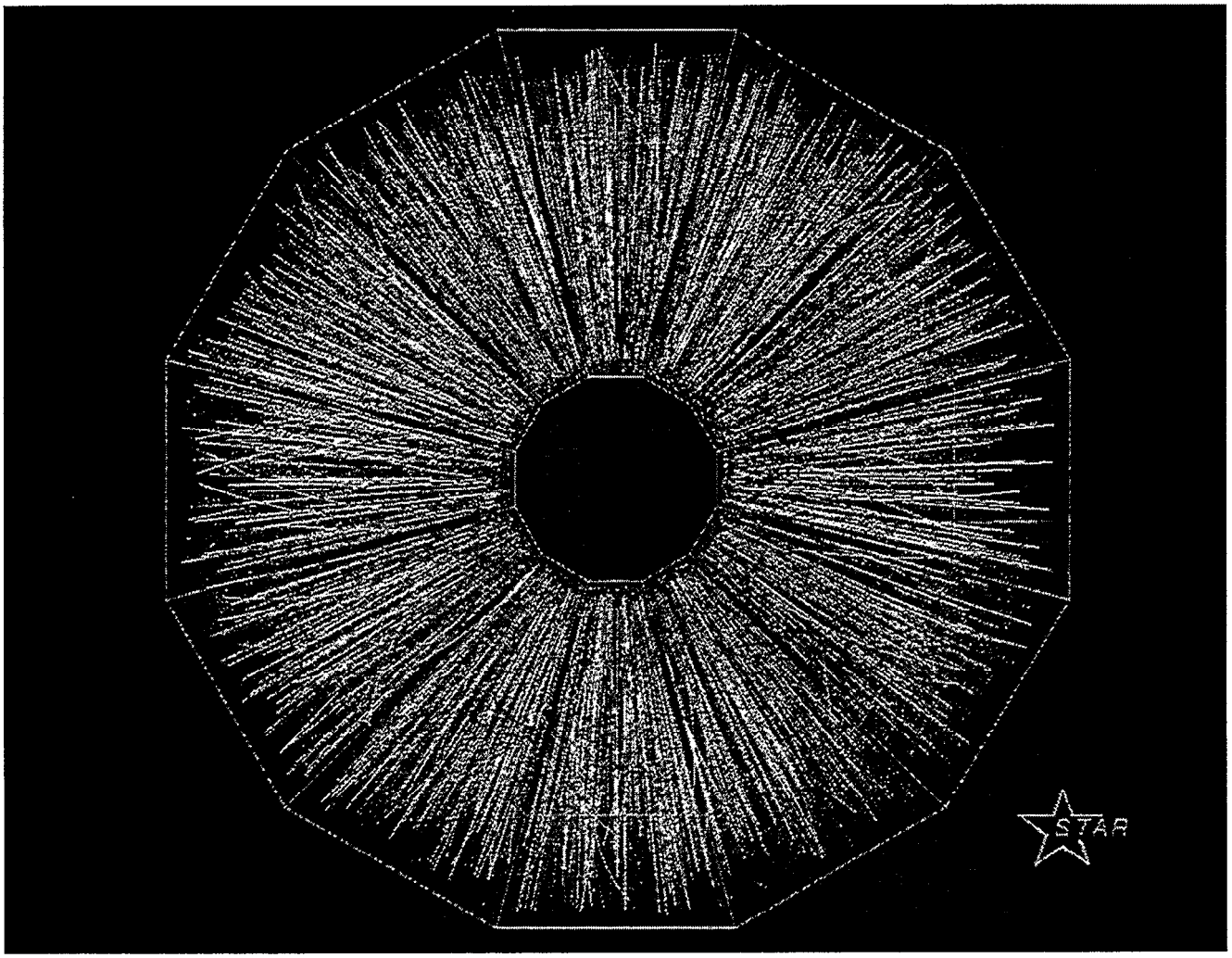
EXPERIMENT – RHIC SPIN

SPOKESMEN: K. IMAI, J. M. MOSS

The RHIC SPIN collaboration consists of over 100 physicists and engineers. A comparable number of support personnel also work on PHENIX.

- **Bombay Research Institute - India**
- **Brookhaven National Laboratory**
- **Chinese Instituate of Atomic Energy - Beijing**
- **Chung-ang University – Seoul, Korea**
- **Columbia University**
- **Institute of High Energy Physics – Protvino, Russia**
- **Institute of Modern Physics – Protvino, Russia**
- **Institute for Physical and Chemical Research – Wako, Japan**
- **Iowa State University**
- **Joint Inst. for Nuclear Research – Dubna, Russia**
- **Korea University**
- **Kurchatov Inst. of Atmoic Energy – Moscow, Russia**
- **Kyoto University - Japan**
- **Lawrence Livermore Natl. Laboratory**
- **Los Alamos Natl. Laboratory**
- **Louisiana University**
- **New Mexico State University**
- **Oak Ridge Natl. Laboratory**
- **Peking University**
- **Petersburg Nuclear Physics Institute – St. Petersburg, Russia**
- **Seoul National University**
- **Soong-Sil University – Seoul, Korea**
- **Tokyo Institute of Technology**
- **University of California - Riverside**
- **University of Sao Paulo – Brazil**
- **University of Tenneseee**
- **Vanderbilt University**
- **Yonsei University – Seoul, Korea**

The RIKEN BNL collaboration for Spin Physics fabricated and installed Siberian Snakes an dSpin Rotators in the RHIC main rings to accelerate polarized protons up to 250 GeV and upgraded the PHENIX detector by installing new mouon arms to enhance the acceptance of single and di-muons. This making it feasible to study the polarized quark and anti-quark structure function by way of the Drell-Yan processes and vector boson productions, and investigate gluon polarization via heavy quark production and gluon Compton scattering.



End view of a collision of two 30-billion-electron-volt gold beams in the STAR detctor at RHIC.

The beams travel in opposite directions at nearly the speed of light before colliding.

Beam: 6:00 o'clock
Status: In Progress
Hours Charged: 308

EXPERIMENT – STAR

SPOKESMAN: J. W. HARRIS

The STAR collaboration consists of hundreds of physicists and engineers. A comparable number of support personnel also work on PHENIX.

- **Argonne National Laboratory**
- **Brookhaven National Laboratory**
- **Carnegie Mellon University**
- **City College of New York**
- **Creighton University**
- **Indian Institute of Tech. - Bombay**
- **Indiana University**
- **Institute of High Energy Physics – Beijing**
- **Institute of High Energy Physics – Protvino**
- **Institute of Fisica da Universidade de Sao Paulo**
- **Institute of Particle Physics – Wuhan**
- **Institute of Physics - Bhubaneswar**
- **Institute de Recherches Subatomiques (IReS) de Strasbourg**
- **Jammu University**
- **Kent State University**
- **Laboratory of High Energy Physics - Dubna**
- **Lawrence Berkeley Laboratory**
- **Max-Planck-Institute fuer Physics**
- **Michigan State University**
- **Moscow Engineering Physics Institute**
- **Ohio State University**
- **Panjab University**
- **Particle Physics Laboratory - Dubna**
- **Pennsylvania State University**
- **Purdue University**
- **Rice University**
- **Space Sciences Laboratory**
- **SUBATECH, Nantes**
- **Texas A&M University**
- **University of Birmingham**
- **University of California – Davis**
- **University of California – Los Angeles**
- **University of Frankfurt**
- **University of Rajasthan**
- **University of Texas - Austin**
- **University of Washington**
- **Variable Energy Cyclotron Center - Calcutta**
- **Warsaw University of Technology**
- **Wayne State University**
- **Yale University**

The Solenoidal Tracker At RHIC (STAR) experiment is designed to search for signatures of quark-gluon plasma (QGP) formation and to investigate the behavior of strongly interacting matter at high energy density. The experimental emphasis in the STAR heavy ion program is on the correlation of many observables on an event-by-event basis, and the hard scattering of partons as a penetrating probe of high density nuclear matter.

A second focus of the STAR experimental program is to study the spin-dependent parton distributions of the proton, using beams of transverse and longitudinally polarized protons. A specific goal is to measure the polarization of gluons in the proton, using the QCD "Compton" process ($qg \rightarrow q\gamma$) as a probe.

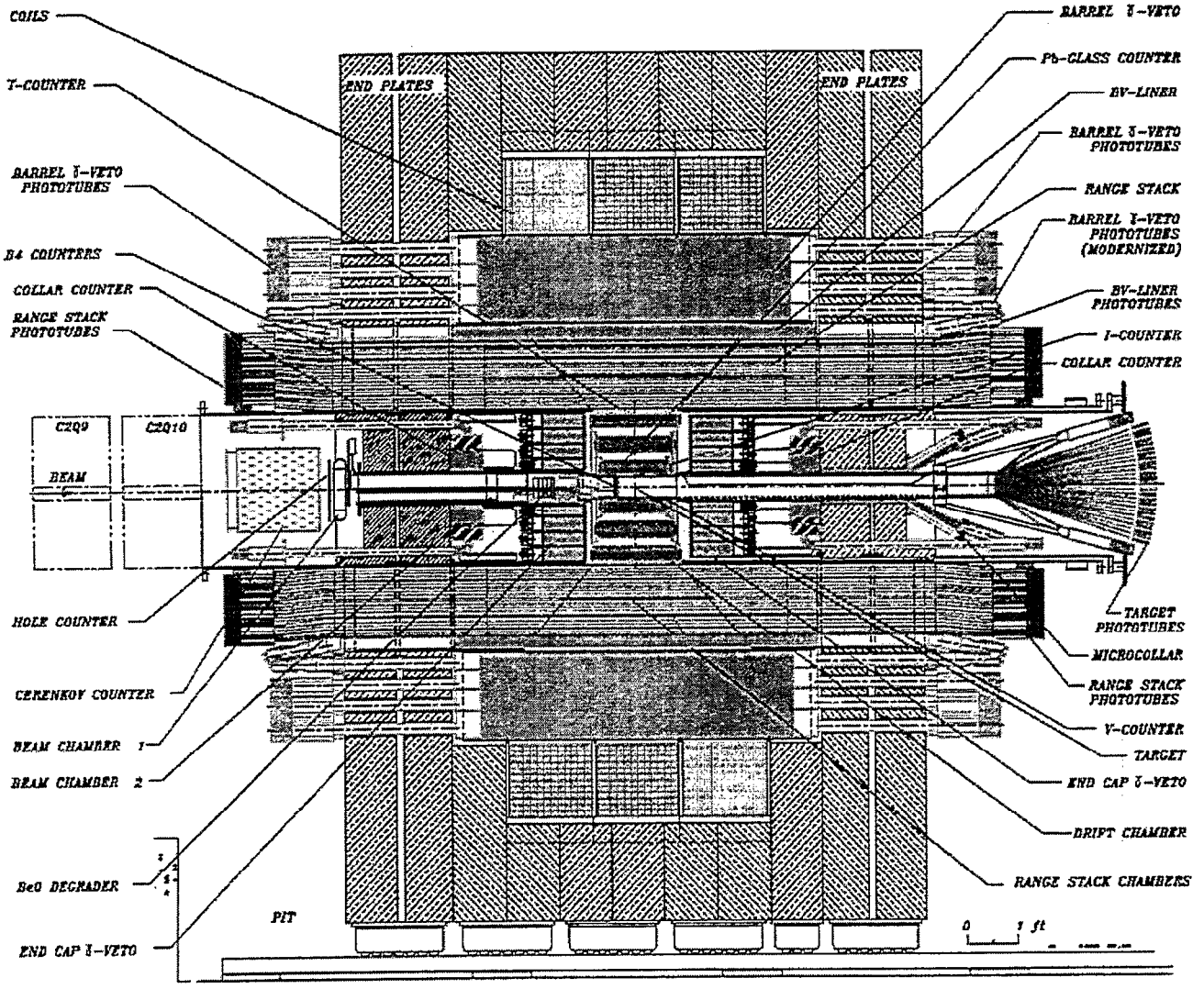
The STAR detection system consists of a Time Projection Chamber (TPC) and a Silicon Vertex Tracker (SVT) inside a solenoidal magnet, enabling tracking, momentum analysis, particle identification by dE/dx, and location of primary and secondary vertices with full azimuthal coverage ($\Delta\Phi = 2\pi$, $|\eta| < 1$). A Central Trigger Barrel (CTB) of scintilllators surrounding the TPC, and Zero Degree Calorimeters (ZDCs) located at ± 18 meters from the interaction point provide a collision geometry trigger, and the ability to selectively veto events according to the number of spectator neutrons going forward. A set of Forward Trigger Detectors (FTDs) designed to detect interactions by measuring the forward going charged particle multiplicity will be installed prior to the polarized proton run in 2001.

Forward Time Projection Chambers on either side of the interaction vertex provide additional tracking coverage in the acceptance $\Delta\Phi = 2\pi$, $2.5 < |\eta| < 4$. In addition, a Ring Imaging Cerenkov (RICH) detector covering approximately 1 square meter, and a 41 element patch TOF detector substituted for one of the CTB scintillators provide inclusive particle identification for high pt particles beyond the range where dE/dx measurement in the STAR TPC is possible.

A Barrel Electromagnetic Calorimeter (BEMC) ($\Delta\phi = 2\pi$, $|\eta| < 1$) as well as an Endcap Electromagnetic Calorimeter (EEMC) ($\Delta\Phi = 2\pi$, $1 < \eta < 2$) on one end of the STAR detector will be used to measure neutral transverse energy, direct photon production, and jet cross sections. The detectors are under construction, with the installation of the first BEMC modules having begun. The installation of the first half of the EEMC is expected in the summer of 2002.

Additional detector components that will be added in 2002 include a Silicon Strip Detector (SSD) and a Photon Multiplicity Detector (PMD). The SSD will comprise a fourth layer of silicon tracking outside the existing three layers of silicon drift detectors which are part of the STAR SVT. It will be used to improve tracking efficiency and background rejection for secondary vertices from hyperon decays and to improve the standalone tracking capability of the silicon vertex tracker for low momentum particles. The Photon Multiplicity Detector is a fine-grained array of detector cells based on gaseous shower counting. It will be used to detect photon showers in the forward acceptance of STAR.

E787 DETECTOR



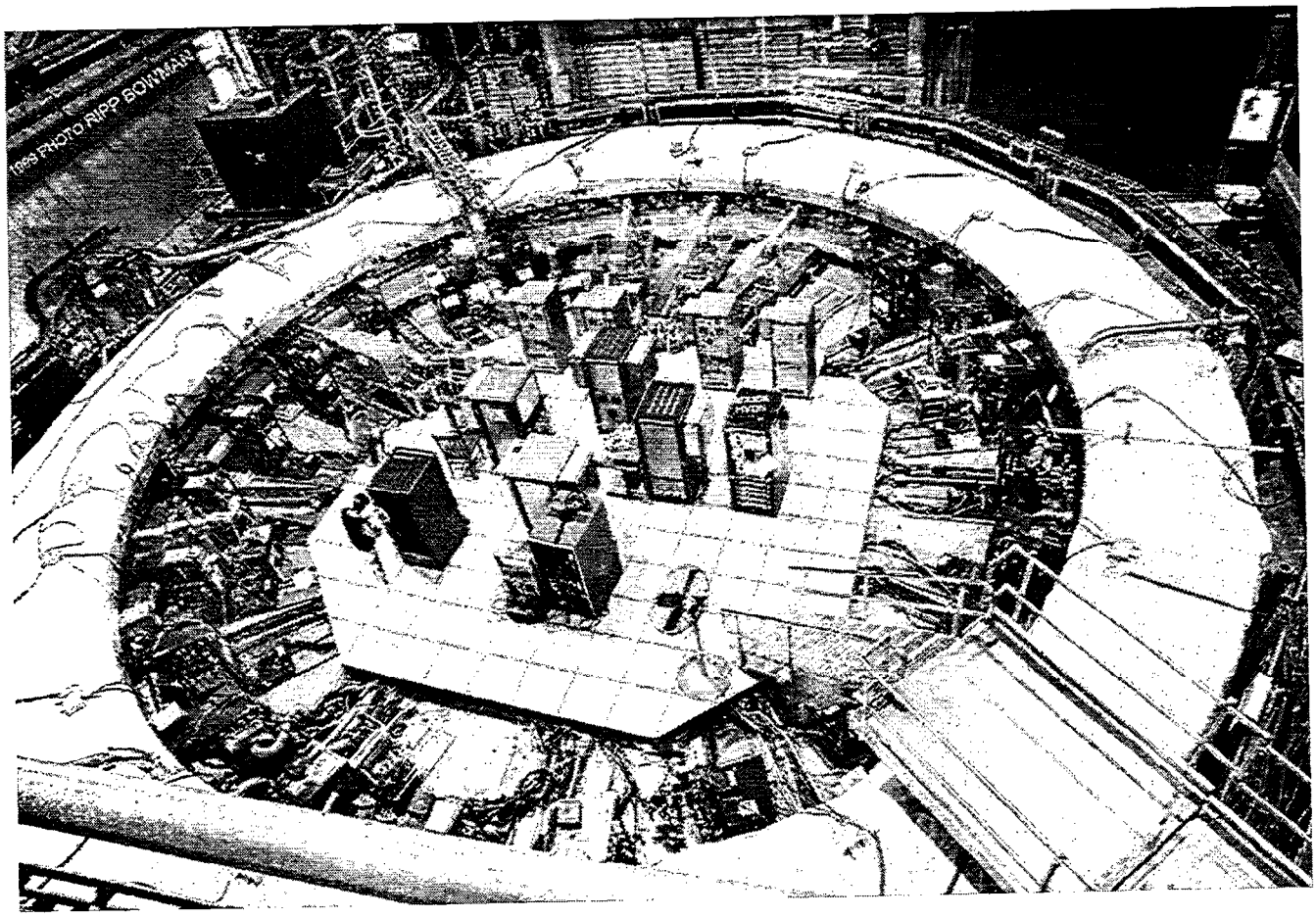
Beam: C4
Status: Completed FY99
Hours Charged/Approved: 15321/15500

EXPERIMENT 787 - A STUDY OF THE DECAY $K^+ \to \pi^+ \nu \bar{\nu}$

SPOKESMEN: D. A. BRYMAN, L. S. LITTENBERG, A. J. S. SMITH

- **Brookhaven National Laboratory**
  S. Adler, M. S. Atiya, I-H. Chiang, M. Diwan, J. S. Frank, J. S. Haggerty, V. Jain, S. Kettell, T. F. Kycia, K. K. Li, L. S. Littenberg, C. F. Ng, R. C. Strand, C. Witzig
- **Fukui University**
  M. Miyajima, Y. Tamagawa
- **KEK-National Laboratory for High Energy Physics**
  M. Aoki, T. Inagaki, S. Kabe, M. Kobayashi, T. K. Komatsubara, Y. Kuno, M. Kuriki, T. Morimoto, N. Muramatsu, H. Okuno, K. Omata, A. Otomo, T. Sato, T. Shinkawa, S. Sugimoto, K. Ukai, Y. Yoshimura
- **Osaka University** - T. Nakano
- **Princeton University**
  A. Bazanko, P. D. Meyers, D. R. Relyea, F. C. Shoemaker, A. J. S. Smith, J. R. Stone
- **TRIUMF**
  P. Bergbusch, E. W. Blackmore, D. A. Bryman, S.Chen, A. Konaka, J. A. Macdonald, J. Mildenberger, T. Numao, J-M. Poutissou, R. Poutissou, G. Redlinger
- **University of Alberta**
  P. Kitching, S. Ng, R. Soluk

Experiment 787 was a search for reactions of the type $K^+ \to \pi^+ XX'$, where X is a weakly interacting light neutral particle. The experiment was sensitive to such decays at the 10^{-10} level. The prime candidate was $K^+ \to \pi^+ \nu\bar{\nu}$ which provided a uniquely stringent test of the Standard Model and its parameters because it is the only experimentally accessible process that is dominated by an unambiguously calculable higher order weak interaction. Two body decays $K^+ \to \pi^+ X$ were also searched for to place constraints on the existence of a variety of hypothetical particles such as axions, familons, hyperphotons and supersymmetric neutrals predicted by extensions to the SM. Several other rare decays including $K^+ \to \pi^+ \gamma\gamma$, $K^+ \to \pi^+ \mu^+ \mu^-$, $\pi^0 \to \nu \bar{\nu}$ -, and $\pi^0 \to \gamma XX$ were also investigated. The former two, $K^+ \to \pi^+ \gamma\gamma$ and $K^+ \to \pi^+ \mu^+ \mu^-$, were discovered by this experiment. A candidate for $K^+ \to \pi^+ \nu\bar{\nu}$ was observed by E787.


1998 PHOTO RIPP BOWMAN

Beam: V1
Status: In Process
Hours Charged/Approved: 3232/2100

EXPERIMENT 821 - A NEW PRECISION MEASUREMENT OF THE MUON G-2 AT THE LEVEL OF 0.35 PPM

SPOKESMEN: V.W. HUGHES, W. M. MORSE, B. L. ROBERTS

- **Boston University** - R.M. Carey, W. Earle, E. Efstathiadis, M. Hare, E.S. Hazen, F. Krienen, J.P. Miller, J. Pale, O. Rind, B.L. Roberts, L.R. Sulak, A. Trofimov
- **Brookhaven National Laboratory** - J. Benante, H.N. Brown, G. Bunce, G.T. Danby, R. Larsen, Y. Y. Lee, W. Meng, J. Mi, W.M. Morse, C. Ozben, C. Pai, R. Prigl, R. Sanders, Y. K. Semertzidis, L. Snydstrup, T. Tallerico, M. Tanaka, D. Warburton
- **Budker Institue for Nuclear Physics** - V.P. Druzhinin, G.V. Fedotovich, B.I. Khazin, I. Logashenko, N. Ryskulov, S. Serednyakov, Yu.M. Shatunov, E. Solodov
- **Cornell University** - Y. Orlov
- **Fairfield University** - D. Winn
- **Max Planck Institut fur Physik** - U. Haeberlen
- **National Laboratory for High Energy Physics (KEK)** - A.Yamamoto
- **Tokyo Institute of Technology** - M. Iwasaki, M. Kawamura
- **Yale University** - H. Deng, S.K. Dhawan, F.J.M. Farley, M. Grosse-Perkekamp, V.W. Hughes, D. Kawall, W. Liu, J. Pretz, S. I. Redin, A. Steinmetz
- **University of Heidelberg** - A. Grossmann, K. Jungmann, D. von Walter, G. zu Putlitz
- **University of Illinois** - P. Debevec, W. Deninger, F. Gray, D.W. Hertzog, C. J. G. Onderwater, C. Polly, S. Sedykh, M. Sossong, D. Urner
- **University of Minnesota** - P. Cushman, L. Duong, S. Giron, J. Kindem, I. Kronkvist, R. McNabb, D. Miller, C. Timmermans, D. Zimmerman

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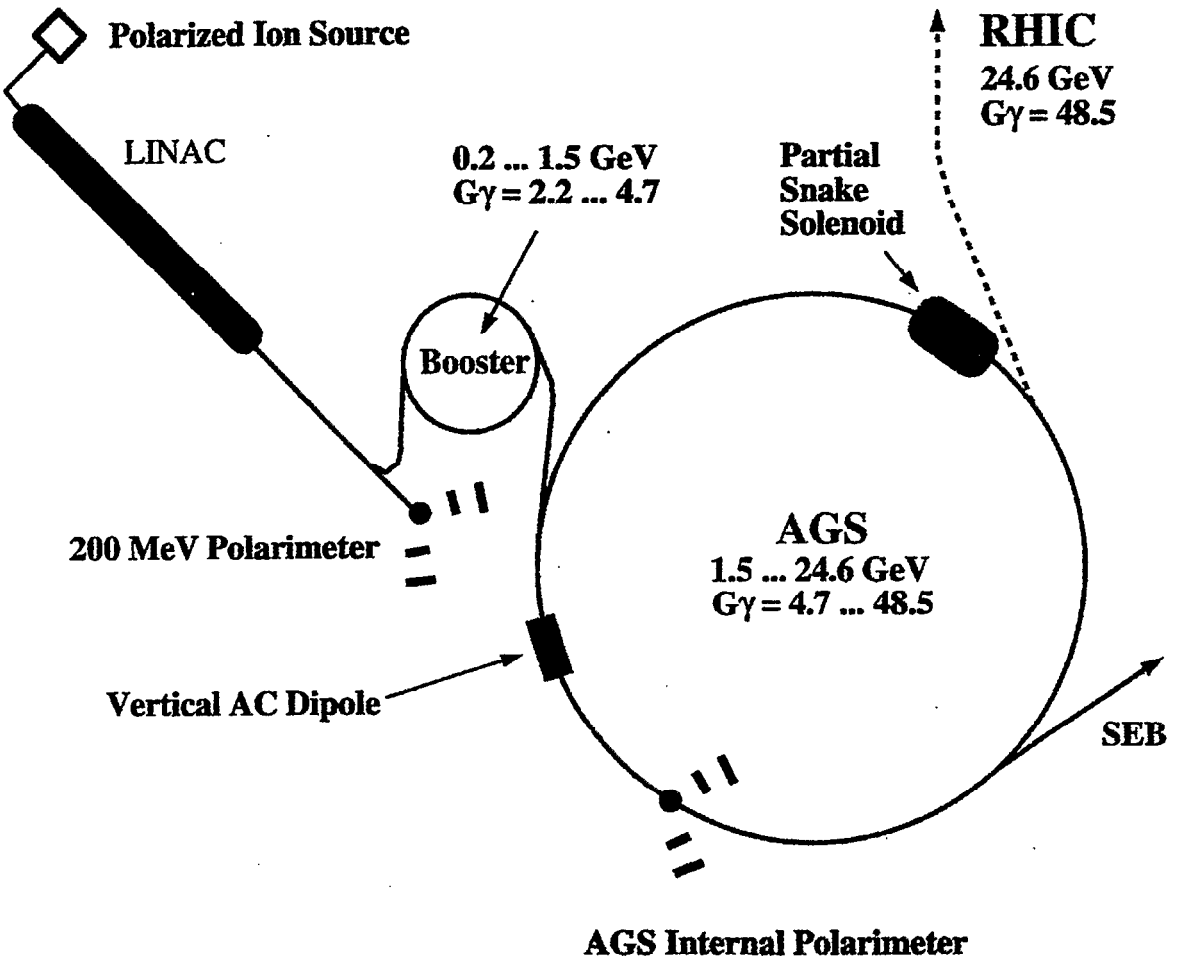
The anomalous gyromagnetic ratio of the muon (g-2) will be measured to 0.35 ppm or a factor of 20 times better than it is currently known. The predicted contribution to (g-2) from the first and second order $W^{\pm}$ and Z^0 radiative corrections is predicted to be 1.3 ppm, so this experiment will provide a direct test of the electroweak radiative corrections, and hence of the renormalizability of the Glashow-Weinberg-Salam theory. Since a_μ is sensitive to a wide range of non-standard model effects there is a window in which to search for new physics. W or muon substructure, super-symmetry and the existence of new gauge bosons are several possibilities. A 14 m diameter superferric muon storage ring is now operational. Data collection began in FY 1997.

Polarized Proton Experiments in the AGS with a Partial Siberian Snake (E880)

(ANL,BNL,INDIANA,TRIUMF,KEK,RIKEN,IHEP)



Beam: AGS Internal Beam
Status: Completed
Hours Charged/Approved: 729/320

EXPERIMENT 880 - THE EFFECTS OF A PARTIAL SIBERIAN SNAKE ON POLARIZATION AT THE AGS

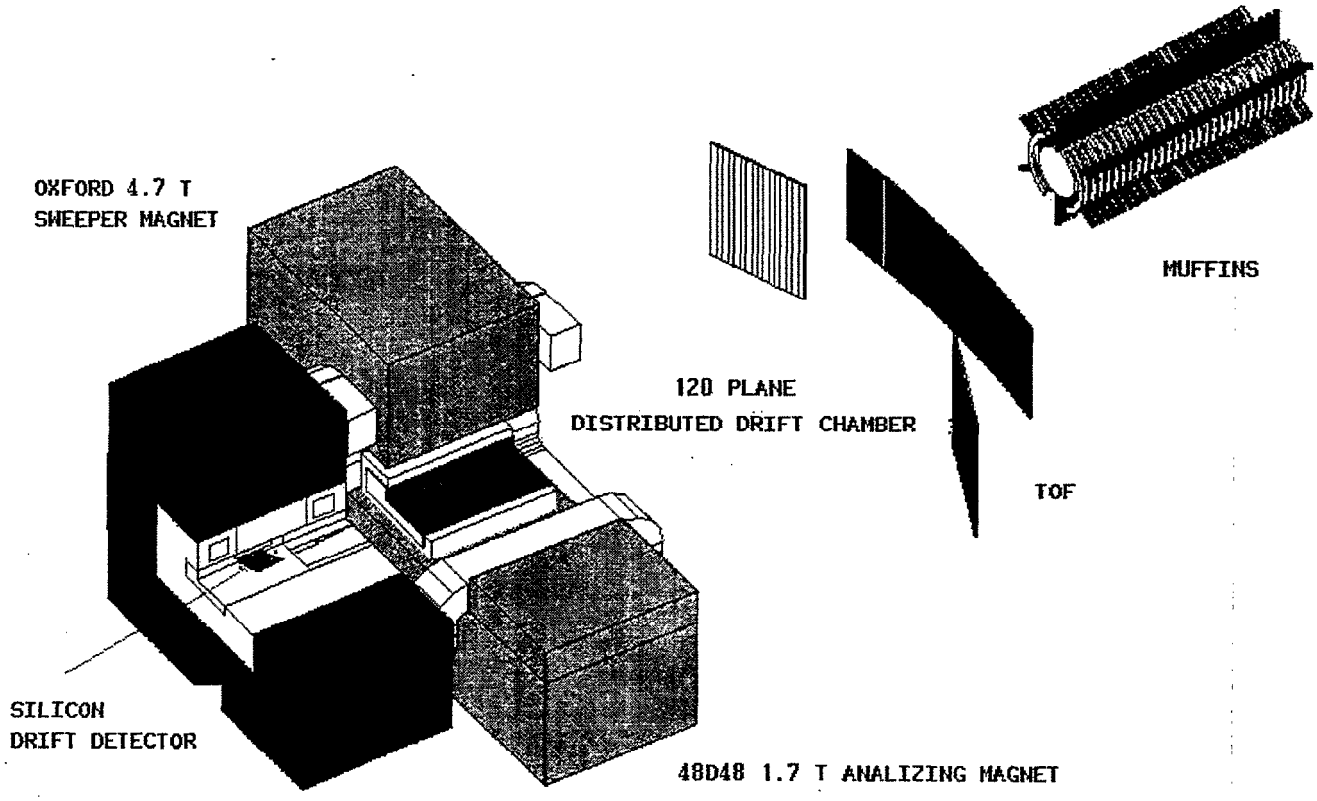
SPOKESMEN: S. Y. LEE AND T. ROSER

- **Argonne National Laboratory** - C. Allgower, M. Bai,[1] K. Krueger, H. Spinka, L. Teng, D. G. Underwood, A. Yokosawa
- **Brookhaven National Laboratory** - L. Ahrens, J. Alessi, K. Brown, G. Bunce, P. Cameron, E. D. Courant, J. W. Glenn, H. Huang, P. Ingrassia, Y. Y. Lee, A. Luccio, Y. I. Makdisi, L. Ratner, K. Reece, T. Roser, J. F. Skelly, A. Soukas, M. Syphers, S. Tepikian, R. E. Thern, N. Tsoupas, W. van Asselt, N. Williams
- **Fermilab** - V. Bharadwaj, S. Hseuh
- **Indiana University IUCF** - P. Chu, D. Jeon, S.Y. Lee
- **Institute for High Energy Physics, Serpukhov** - A. Ufimtsev
- **KEK** - S. Hiramatsu, Y. Mori, H. Sato, K. Yokoya
- **Riken** - T. Katayama, M. Okamura, T. Tominaka
- **TRIUMF** - U. Wienands[2]

This group has built a 4.7 Tesla-meter room temperature solenoid which was installed in a 10-foot long AGS straight section. AGS polarized proton beam time was used to perform *partial snake experiments*. These experiments tested successfully the idea of using a partial snake to correct all de-polarizing imperfection resonances. Intrinsic depolarizing resonances are successfully overcome by using an AC vertical dipole to generate coherent betatron oscillation.

(1) Also at Indiana University
(2) Present address: SLAC

BNL–AGS E896 EXPERIMENTAL LAYOUT



Beam: C5
Status: Completed FY98
Hours Charged/Approved: 899/1000

EXPERIMENT 896 - A PROPOSAL TO THE BNL AGS: To Search for a Short-Lived H_0 DiBaryon, Short-Lived Strange Matter, and to Investigate Hyperon Production in 11.6 A GeV/c AuAu Collision

SPOKESMEN: H. CRAWFORD AND T. HALLMAN

- **Brookhaven National Laboratory** - W. Christie, R. Debbe, T. Hallman, T. Ljubicic, R. Longacre, D. Lynn, J. Mitchell, E. Mogavero, A. Saulys
- **Carnegie-Mellon University** - C. Brown, M. Kaplan, Z. Milosevich, D. Russ
- **CERN** - P. Sonderegger
- **Johns Hopkins University** - L. Madansky
- **Lawrence Berkeley Laboratory** - L. Greiner, P. Lindstrom, J. Marx, I. Sakrejda
- **NASA-Goddard Space Flight Center** - J. W. Mitchell
- **Ohio State University** - T. Humanic, I. Kotov, G. LoCurto, E. Sugarbaker
- **Rice University** - B. Bonner, K. Kainz, W. Llope, G. Mutchler, E. Platner, P. Yepes
- **Space Science Laboratory** - M. Bennett, H. Crawford, M. Cronqvist, J. Engelage, M. Flores, L. Greiner, E. Judd, G.Visser
- **Wayne State University** - R. Bellwied, M. Nachaet, S. Nehmeh, S. Pandey, J. Sheen, J. Takahashi, K. Wilson
- **Yale University** - G. Kunde, S. Kumar, F. Rotondo, N. Smirnoff
- **University of California-Los Angeles** - H. Huang, G. Igo, S. Kelly, S. Trentalage
- **University of Catania** - S. Albergo, D. Boemi, Z. Caccia, S. Costa, A. Insolia, C. Nociforo, R. Potenza, G. Russo, A. Tricoma, C. Tuve
- **University of Michigan** - R. Welsh
- **University of Texas-Austin** - G. Hoffman, P. Jensen, S. Paganis, P. Riley, J. Schambach, J. Tang

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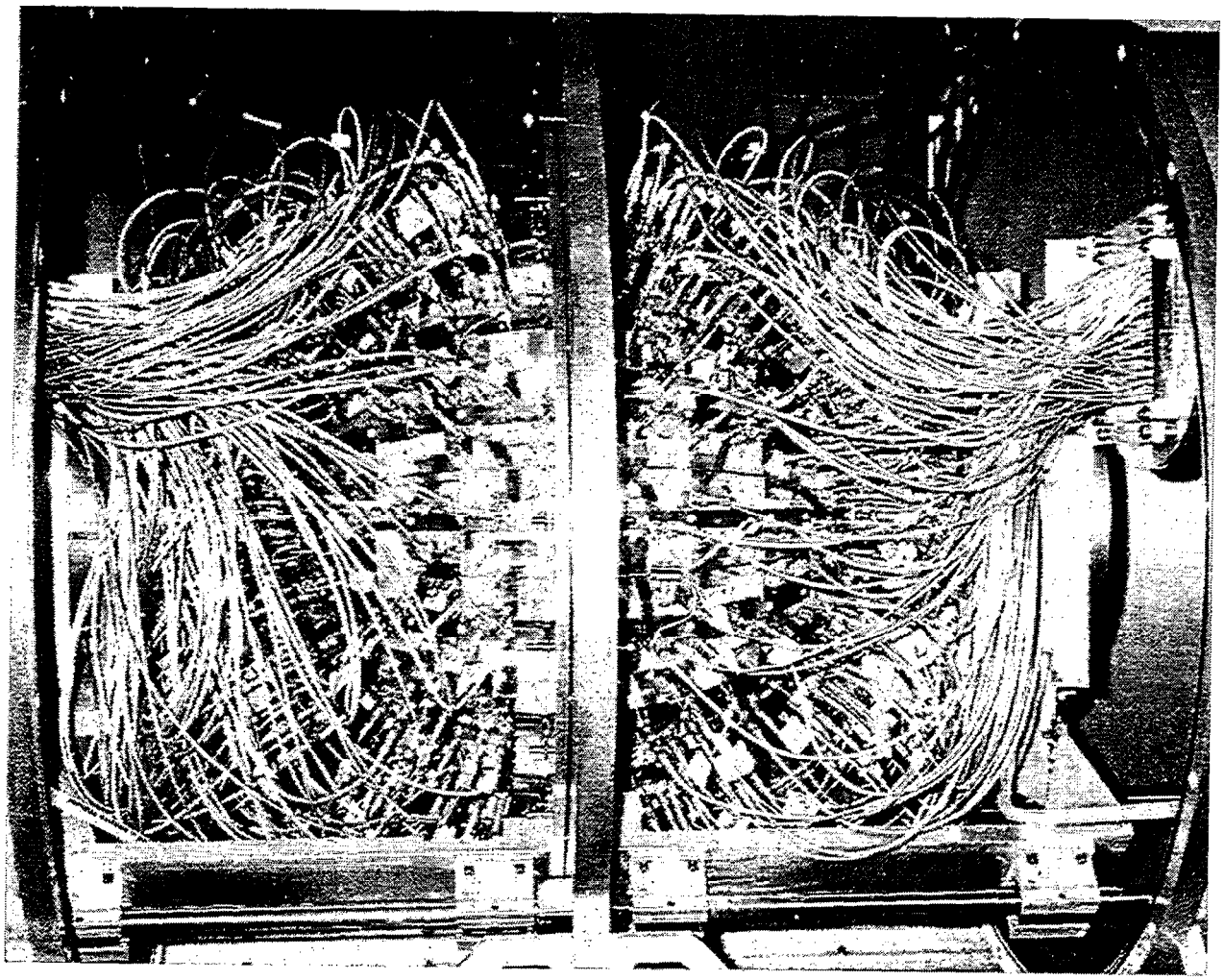
The experiment is a search for the H^0 dibaryon and for new states of nuclear matter produced in nucleus-nucleus (AuAu) collisions at the AGS. The experiment enhances the existing AA program by extending the search into regions of shorter lifetime and complements the existing double-strangeness-exchange program by offering access to a new, more probable doorway channel, the coalescence of two Λ's into a bound di-Λ. The detector is a capable of unambiguously identifying the topological signature of unstable particle decays as well as the rigidity of each particle produced, affording a sensitive search for new metastable states and investigation of the properties of known strange particles such as the Λ polarization and the $\Lambda\Lambda$ potential.



Full View of the ISiS Detector

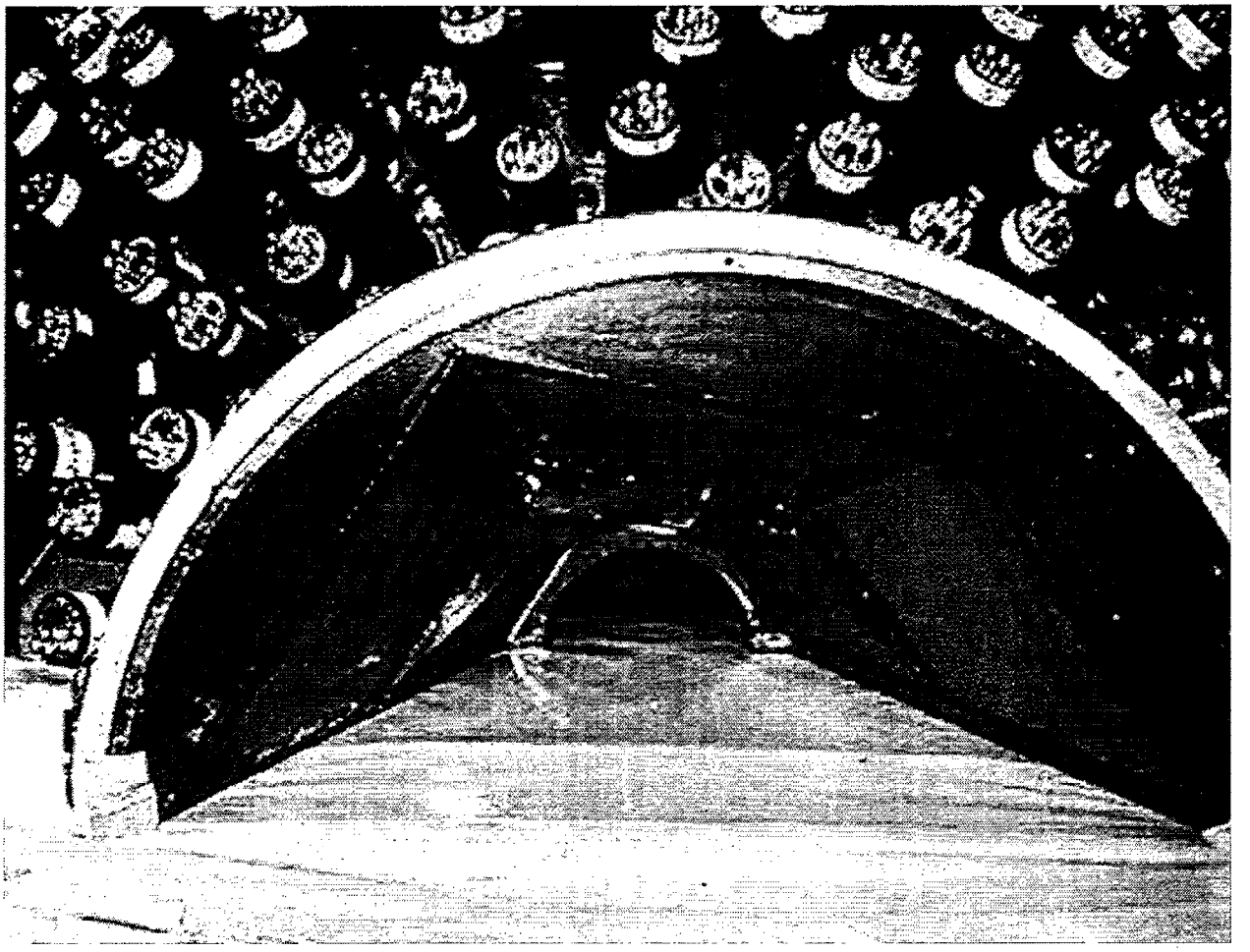
Beam: A1
Status: Completed FY 1998
Hours Charged/Approved: 1545

EXPERIMENT 900 - ENERGY DISSIPATION AND MULTIFRAGMENTATION IN H + A REACTIONS BETWEEN 2 AND 24 GEV/C

SPOKESMEN: K. KWIATKOWSKI AND V. E. VIOLA

- **Argonne National Laboratory** - B. Back
- **Brookhaven National Laboratory** - S. Gushue, L. P. Remsberg
- **Indiana University** - W-Ch. Hsi, K. Kwiatkowski, T. Lefort, V. E. Viola, N. R. Yoder
- **Los Alamos National Laboratory** - D. S. Bracken, K. B. Morley
- **Simon Fraser University** - R. Korteling
- **Texas A&M University** - F. Gimeno-Nogues, E. Ramakrishnan, D. Rowland, S. J. Yennello
- **Warsaw University** - L. Pienkowski
- **University of Maryland** - H. Breuer

This experiment had exclusive studies of target fragmentation in 2 - 24 GeV/c hadron (p, $\bar{p}$ and π^-)-induced reactions. Measurements were performed with the Indiana Silicon Sphere 4π detector array, capable of identifying H and He isotopes and Z = 3 - 20 fragments for target rapidity ejectiles over a wide dynamic range. The primary physics objectives were twofold: (1) to improve the understanding of energy dissipation phenomena for central collisions in the h + A reaction at relativistic energies, and (2) to examine the decay modes of hot nuclear matter excited by simple hadron probes. The bombarding energy regime was chosen to overlap the region in which previous inclusive measurements at AGS had been interpreted in terms of a liquid-gas phase transition in hot finite nuclei. It is in this energy region that the excitation of Δ, N* and higher resonances provide an effective means of dissipating projectile energy into internal excitation energy of the target nucleus. Thus, these data placed fresh constraints on the new generation of transport codes, as well as current models of mulifragmentation. During the 1996 proton cycle, studies were successfully completed on the p + ^{197}Au system at 6.0, 10.0, 12.0 and 14.6 GeV/c and π^- + ^{197}Au at 5.0, 9.2 and 11.0 GeV/c. These measurements demonstrated an independence of energy deposition on projectile momentum and type for these reactions. In 1998 it measured the 7 GeV/c $\bar{p}$ + ^{197} Au reaction to search for enhanced energy deposition with antiproton beams.



Beam: C6
Status: Completed FY 1999
Hours Charged/Approved: 795

EXPERIMENT 913 - BARYON SPECTROSCOPY WITH THE CRYSTAL BALL

SPOKESMAN: M. E. SADLER, H. SPINKA, W. B. TIPPENS

- **Abilene Christian University** - R. Bagga, B. Draper, J. Huddleston, D. Isenhower, Z. Mulkey, M. Sadler
- **Argonne National Laboratory** - T. Kasprzyk, H. Spinka
- **Arizona State University** - J. Comfort, K. Craig, A. Ramirez
- **Brookhaven National Laboratory** - T. Kycia
- **George Washington University** - W. J. Briscoe, A. Shafi
- **Kent State University** - D. M. Manley
- **Petersburg Nuclear Physics Institute-Gatchina** - V. Abaev, V. Bekrenev, S. Kruglov, A. Kulbardis, I. Lopatin, A. Starostin
- **Rudjer Boskovic Institute** -I. Šlaus, I. Supek
- **Valparaiso University** - A. Gibson, D. Grosnick, D.D. Koetke, R. Manweiler, P. Nord, S. Stanislaus
- **University of California-Los Angeles** - M. Clajus, S. McDonald, A. Marusic, B.M.K. Nefkens, M. Pulver, W. B. Tippens
- **University of Colorado** - J. Patterson, J. Peterson
- **Universit at Karlsruhe** - H. Staudenmaier
- **University of Regina** - N. Knecht, G. Lolos, Z. Papandreou

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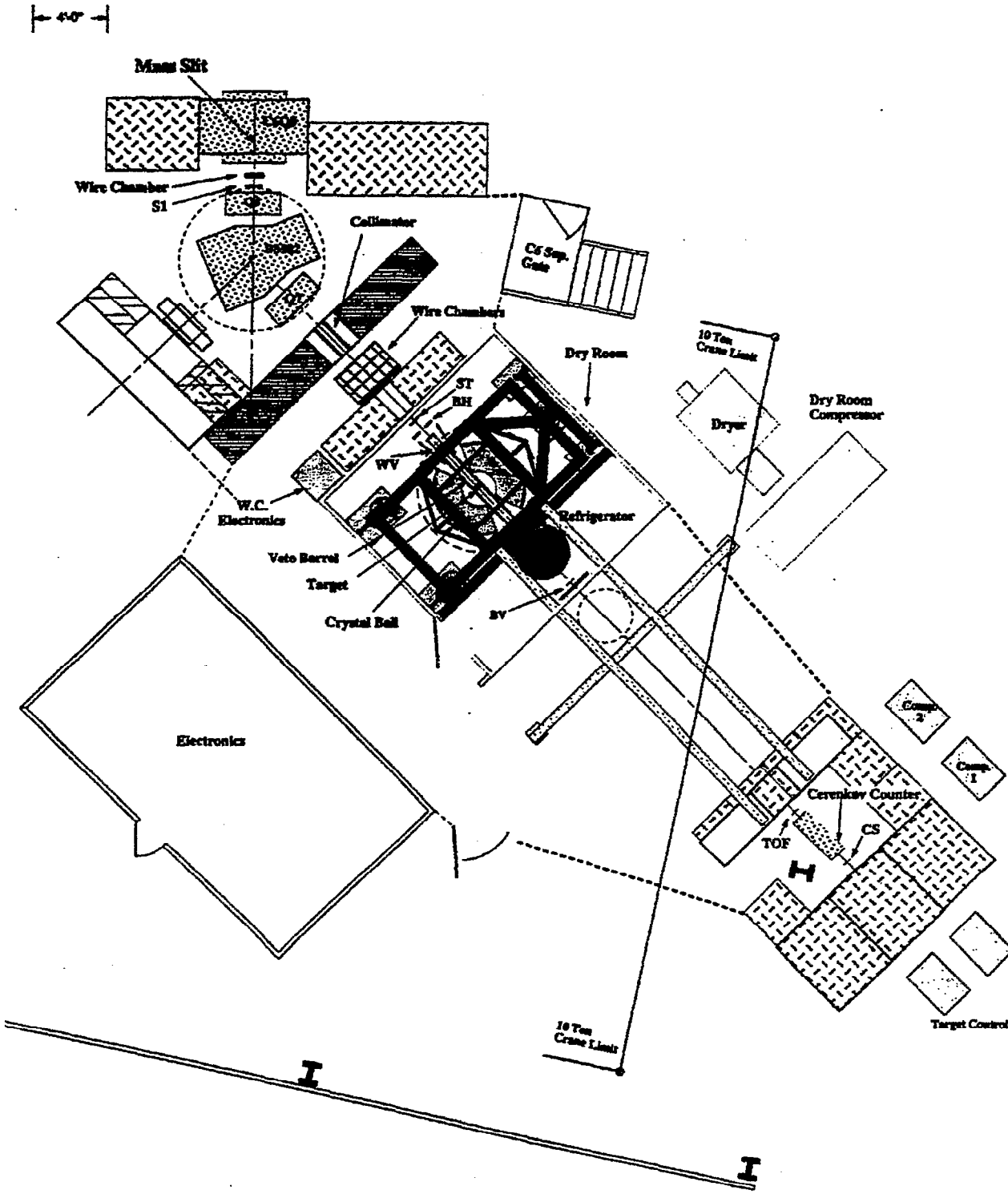
This was a comprehensive experimental program in baryon spectroscopy using the SLAC Crystal Ball detector to make precision measurements of total and differential cross sections for neutral final states in $\pi^- p$ interactions using pion beams in the momentum range 0.4 - 1.9 GeV/c. The angular distributions of all the neutral final states such as γn, π° were measured simultaneously. The purpose was to improve the mass, width, and neutral branching fractions for the N^* resonances in this energy region. The Crystal Ball detector is a nearly 4π multi-photon spectrometer, which is used to analyze events by reconstructing the invariant mass and, in conjunction with the measured beam momentum, the missing mass of the produced γ rays. The Crystal Ball was located in the C6 beam line during this phase of the experiment. The beam momentum was limited to $\leq$ 750 MeV/c.


4'-0"
Mass Slit
Wire Chamber
S1
Collimator
Cs Sep. Gate
Wire Chambers
Dry Room
10 Ton Crane Limit
Dryer
Dry Room Compressor
ST
BH
WV
W.C. Electronics
Refrigerator
Veto Barrel
Target
Crystal Ball
BV
Electronics
Comp. 2
Comp. 1
Cerenkov Counter
TOF
CS
H
Target Control
10 Ton Crane Limit
I
I

EXPERIMENT 914 - NEUTRAL HYPERON SPECTROSCOPY

SPOKESMAN: B.M.K. NEFKENS, T. KYCIA, S. P. KRUGLOV

- **Abilene Christian University** - R. Bagga, B. Draper, J. Huddleston, D. Isenhower, Z. Mulkey, M. Sadler
- **Argonne National Laboratory** - T. Kasprzyk, H. Spinka
- **Arizona State University** - J. Comfort, K. Craig, A. Ramirez
- **Brookhaven National Laboratory** - T. Kycia
- **George Washington University** - W. J. Briscoe, A. Shafi
- **Kent State University** - D. M. Manley
- **Petersburg Nuclear Physics Institute-Gatchina** - V. Abaev, V. Bekrenev, S. Kruglov, A. Kulbardis, I. Lopatin, A. Starostin
- **Rudjer Boskovic Institute** -I. Šlaus, I. Supek
- **Valparaiso University** - A. Gibson, D. Grosnick, D.D. Koetke, R. Manweiler, P. Nord, S. Stanislaus
- **University of California-Los Angeles** - M. Clajus, S. McDonald, A. Marusic, B.M.K. Nefkens, M. Pulver, W. B. Tippens
- **University of Colorado** - J. Patterson, J. Peterson
- **Universit at Karlsruhe** - H. Staudenmaier
- **University of Regina** - N. Knecht, G. Lolos, Z. Papandreou

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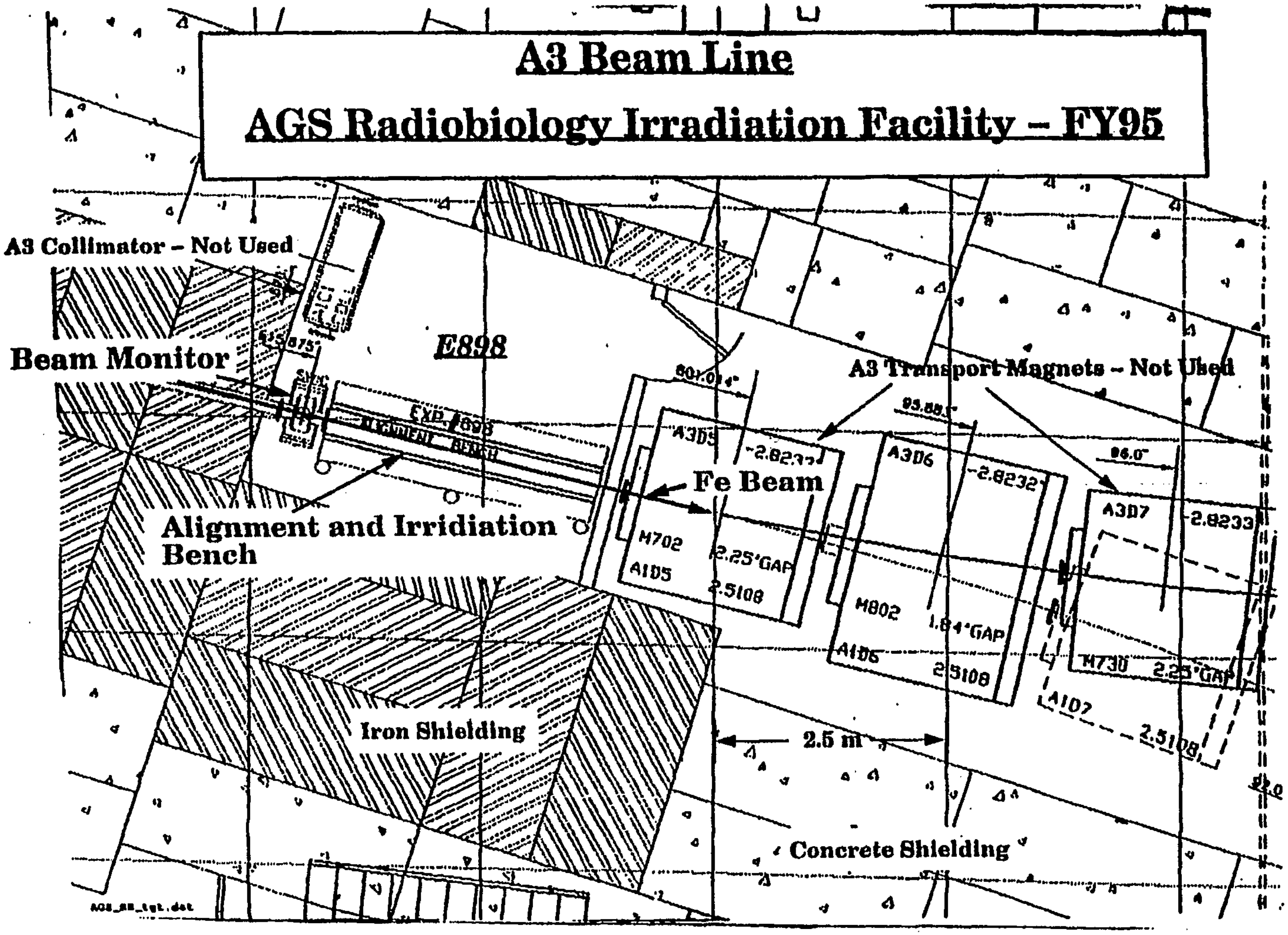
This experiment investigated the spectrum of Λ^* and Σ^* resonances via their neutral decays in the reactions:

$K^- P \rightarrow \Lambda\gamma$	600-1800 MeV/c (p_{lab})
$K^- P \rightarrow \Lambda\pi^0$	"
$K^- P \rightarrow \Lambda 2\pi^0$	"
$K^- P \rightarrow \Lambda\eta$	720-1800 MeV/c (p_{lab})
$K^- P \rightarrow \Sigma^0\gamma$	600-1800 MeV/c (p_{lab})
$K^- P \rightarrow \Sigma^0\pi^0$	"
$K^- P \rightarrow \Sigma^0 2\pi^0$	"
$K^- P \rightarrow \Sigma^0\eta$	890-1800 MeV/c (p_{lab})

Measurements of total and differential cross sections of these reactions were made simultaneously over the full angular range, using the Crystal Ball multi photon spectrometer and a LH2 target. The Crystal Ball has a 94% solid angle coverage and good energy and angular resolution. This phase of the experiment was conducted in the C6 beam line with a maximum momentum of 750 MeV/c.


A3 Beam Line
AGS Radiobiology Irradiation Facility – FY95
A3 Collimator – Not Used
Beam Monitor
E898
A3 Transport Magnets – Not Used
Fe Beam
Alignment and Irridiation Bench
A3D5
A3D6
A3D7
M702
M802
H730
A1D5
A1D6
A1D7
2.25"GAP
1.84"GAP
2.5108
2.5 m
Iron Shielding
Concrete Shielding

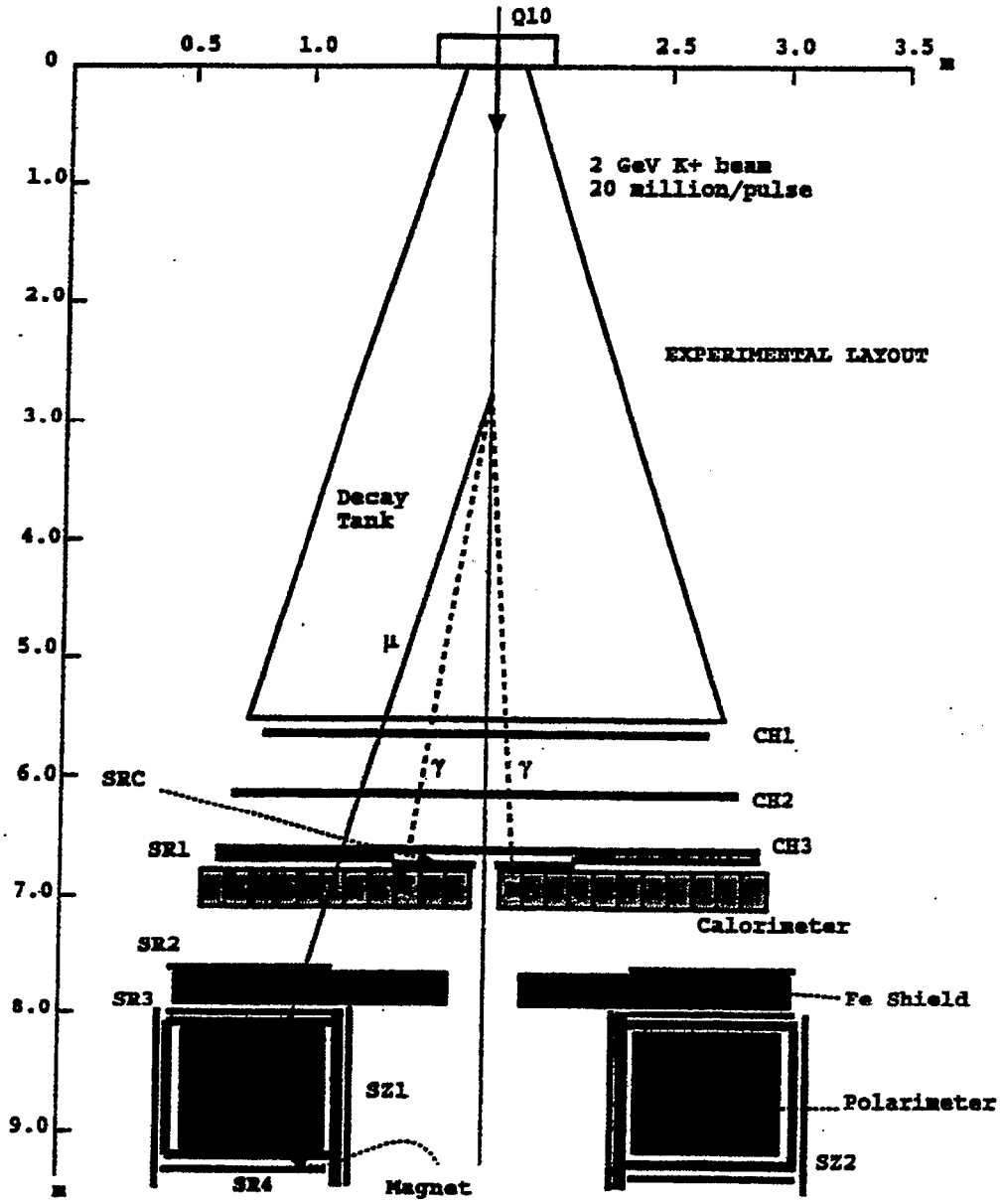
Beam: A3
Status: Completed FY 1998
Hours Charged/Approved: 319/300

EXPERMENT 919 - A STUDY OF THE GENETIC AND EPIGENETIC EFFECTS PRODUCED BY HIGH ENERGY HEAVY IONS

SPOKESMEN: M. VAZQUEZ

- **Alabama Agr. and Mechanical University** - P. Kale
- **Brookhaven National Laboratory** - J. Bullis, J. Gatley, B. Sutherland, M. Vazquez
- **Case Western Reserve University** - H. Evans
- **Colorado State University** - T. Borak, G. Mariano, C. A. Waldren
- **Columbia University** - T. K. Hei
- **Georgetown University medical Center** - T. Jorgensen
- **Lawrence Berkeley National Laboratory** - P. Cooper, A. Kronenberg, J. Miller
- **Loma Linda University** - G. Nelson
- **Los Alamos National Laboratory** - D. J. Chen
- **NASA Johnson Space Center** - T. C-h Yang
- **Natl. Inst. Of Radiological Sciences, Japan** - Y. Furusawa
- **Pacific Northwest National Laboratory** - N. F. Metting
- **USAF Armstrong Laboratory** - A. Cox
- **Washington State University** - A. Brooks
- **University of California** - L. H. Lutze-Mann, W. Morgan
- **University of Maryland Baltimore** - E. Balcer-Kubiczek, B. Rabin
- **University of Texas** - M. Natarajan

This was a NASA effort in the AGS to study the genetic and epigentic effects produced by high-energy heavy ions. There were two runs labeled BNL-3, 4 for the period of October 1, 1996 to September 31, 1998. Each run provided approximately 150 hours of 1GeV/nucleon Fe ions.



Schematic of the experiment. A typical $K^+ \rightarrow \mu^+\pi^0\nu$ event is superimposed.

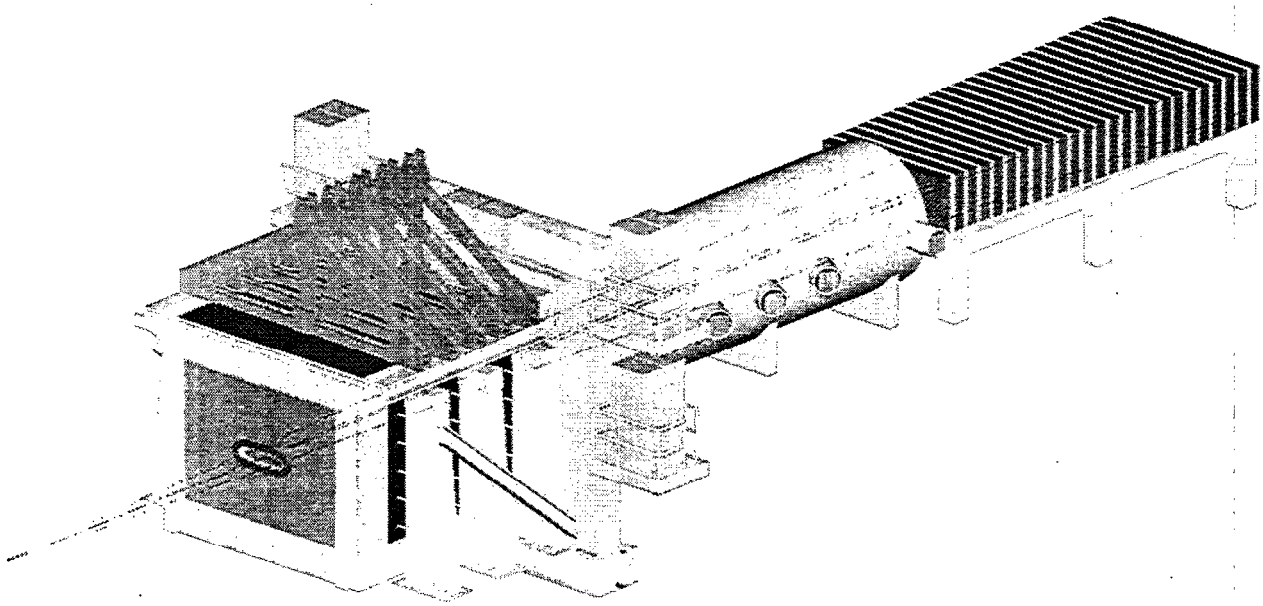
Beam: D6
Status: Withdrawn 9/21/2000
Hours Charged/Approved: 0

EXPERIMENT 923 - SEARCH FOR T VIOLATING MUON POLARIZATION IN $K^+ \rightarrow \mu^+ \pi^0 \nu_\mu$ DECAY

SPOKESMEN: M. V. DIWAN, HONG MA, V. ISSAKOV

- **Brookhaven National Laboratory** - A. S. Carroll, M. V. Diwan, J. Frank, A. Gordeev, S. Kettell, L. Leipuner, L. Littenberg, H. Ma, V. Polychronakas
- **Institute for Nuclear Research, Moscow, Russia** - G. Atoyan, Y. Andreev, V. Issakov, O. Karavichev, T. Karavisheva, A. Poblaguev, A. Proskuryakov
- **Institute for High Energy Physics, Protvino, Russia** - V. Semenov
- **Louisiana Tech University** - M. Elaasar, D. Greenwood, K. Johnston
- **Yale University** - R. Adair, R. Larsen

This experiment proposed a new search for the time reversal violating polarization of the muon normal to the decay plan of the $K^+ \rightarrow \mu^+ \pi^\circ \nu_\mu$ decay. The experiment will be performed with in-flight decays in an intense (2 x 10^7 K^+ per sec) 2 GeV/c separated kaon beam in an existing beam line at the AGS. The center piece of the detector will be a new polarimeter which will consist of 128 carbon wedges, with active detector elements (either scintillator or wire chambers) between the wedges, arranged in a cylindrical manner around the kaon beam. More than 10^9 events are expected to be analyzed to obtain sensitivity to the T-violating polarization of ± 0.0007 to $\mathrm{Im}\xi$, an improvement by approximately 40 over the previous best limit.



Layout of the $K_L^0 \rightarrow \pi^0 \nu\bar{\nu}$ experiment

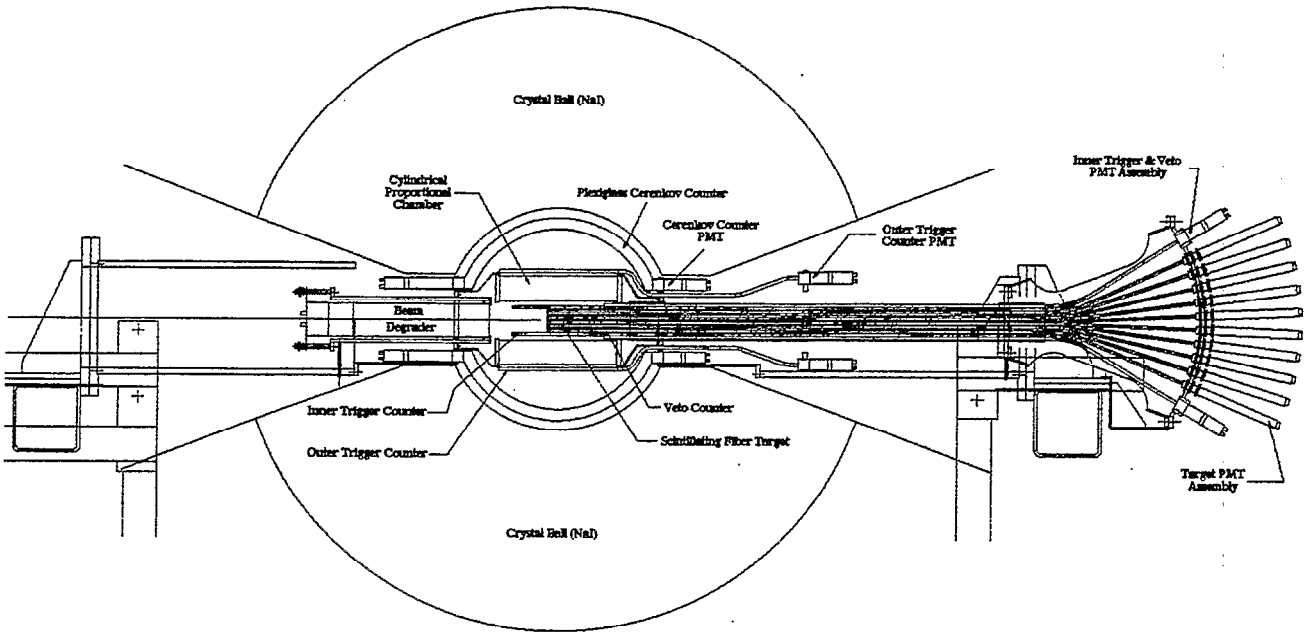
Beam: B5
Status: NSF Funding Requested
Hours Charged/Approved: 0/8000

EXPERIMENT 926 - MEASUREMENT OF $K^{\circ}_{L} \rightarrow \pi^{o} \nu \bar{\nu}$ (KOPIO)

SPOKESMEN: D. BRYMAN, L. LITTENBERG, M. ZELLER

- **Brookhaven National Laboratory** - I-H. Chiang, J. W. Glenn, V. Jain, D. Lazarus, K. Li, L. Littenberg, G. Redlinger, R. Strand, C. Woody
- **INR-Moscow** – G. Atoyan, M. Grigoriev, V. Issakov, A. Ivashkin, M. Khabibullin, A. Khotjanzev, Y. Kudenko, O. Mineev, A. Poblauev
- **Kyoto University** - T. Nomura, N. Sasao
- **Thomas Jefferson National Accelerator Facility** - M. Ito
- **TRIUMF** - E. Blackmore, D. Bryman, P. Gumplinger, M. Hasinoff, A. Konaka, J. Macdonald, T. Numao, R. Poutissou, G. Smith
- **Virginia Polytechnic Institute** - M. Blecher, M. Pitt, B. Vogelaar
- **Yale University** - S. Dhawan, H. Kaspar, S. Pislak, M. Zeller
- **University of British Columbia** - M. Hasinoff
- **University Cincinnati** – K.Kineshita
- **University of New Mexico** - B. Bassalleck, N. Bruner, D. E. Fields, J. Lowe, T. L. Thomas
- **University Virginia** – D. Pocanic
- **University Zurich** – P. Tru

This experiment will be a measurement of the branching ratio for the rare decay $K_L \rightarrow \pi^0 \nu\bar{\nu}$. The method employs kaon time-of-flight and full kinematic reconstruction of the π^0 to suppress backgrounds to a level well below an anticipated signal in the range of $3 \pm 2 \times 10^{-11}$.


Crystal Ball (NaI)
Cylindrical Proportional Chamber
Plexiglass Cerenkov Counter
Cerenkov Counter PMT
Outer Trigger Counter PMT
Inner Trigger & Veto PMT Assembly
Beam Degrader
Inner Trigger Counter
Outer Trigger Counter
Veto Counter
Scintillating Fiber Target
Target PMT Assembly
Crystal Ball (NaI)

Beam: C6
Status: Approved for Tests FY 2002
Hours Charged/Approved: 83/2280

Experiment 927 – Measurement of the K_{e3}^{+} Decay Rate and Spectrum

SPOKESMAN: B. M. K. NEFKENS

- **University of California at Los Angeles** - M. Clajus, S. C. McDonald, A. Maru[]i[], A. M. K. Nefkens, W. B. Tippens
- **Joint Inst. for Nuclear Research - Dubna** – A. Efendiev
- **Abilene Christian University** - L. D. Isenhower, M. E. Sadler
- **Argonne National Laboratory** - H. M. Spinka
- **Arizona State University** - J. R. Comfort, K. Craig
- **Rudjr Bošković Inst., Zagreb, Croatia** - M. Batinić, I. Šlaus, I. Supek, A. Švarc
- **University of Colorado** – R. J. Peterson
- **George Washington University** – C. Bennhold, W. J. Briscoe
- **University of Karlsruhe, Germany** – H. M. Staudenmaier
- **Kent State University** – D. M. Manley
- **St. Petersburg Nuclear Physics Inst., Gatchina** – A. B. Starostin
- **University of Regina, Canada** – G. J. Lolos, Z. Papandreou
- **Valparaiso University** – J. Alyea, D. Grosnick, D. D. Koetke, R.W. Manweiler, S.Stanislaus

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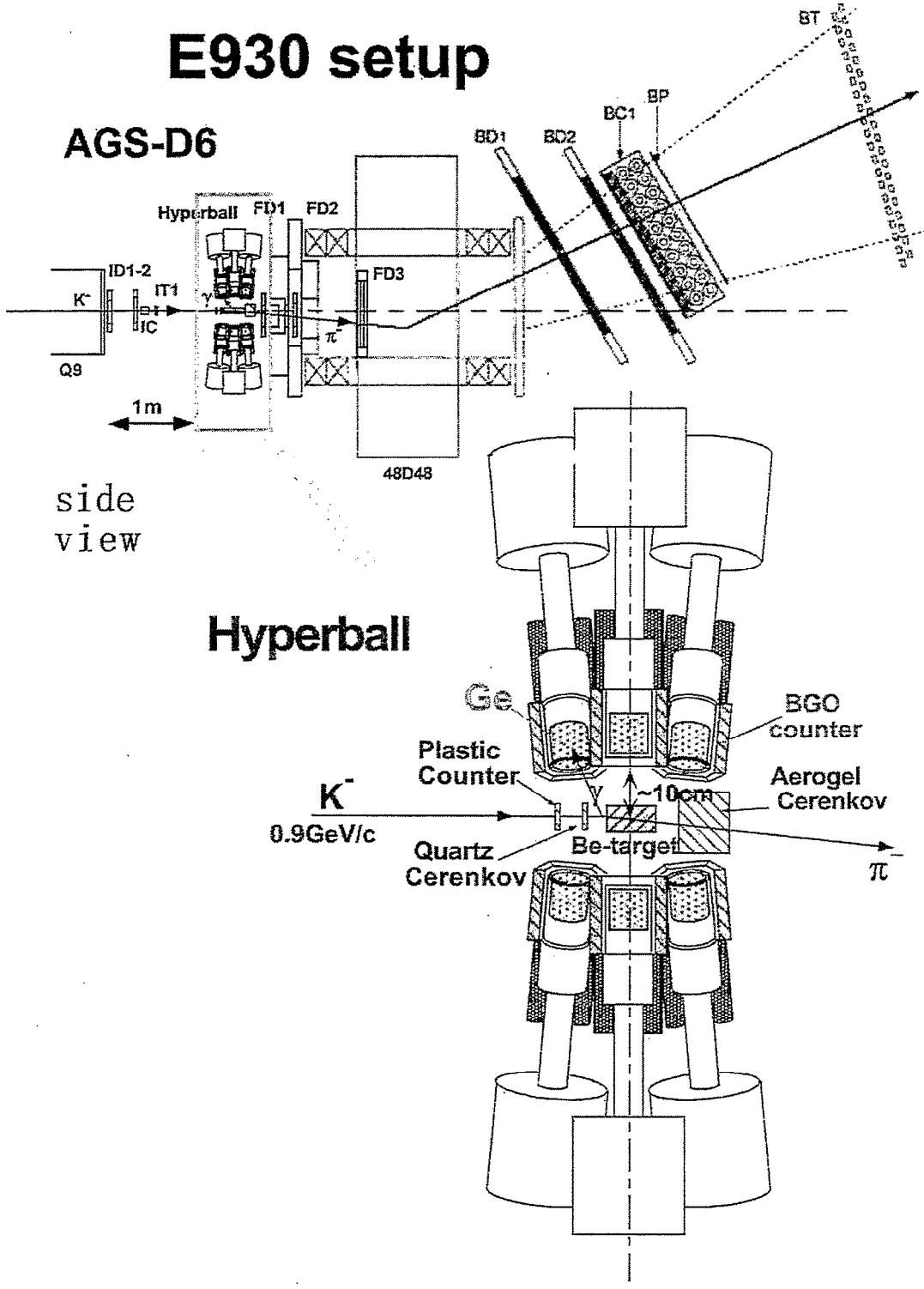
The goal of this experiment was to measure the K_{e3}^{+} decay rate to better than 0.7%. This translates into an absolute determination of V_{us} to better than 0.35%, not including the error in the theoretical evaluation of the small correction for the finite quark masses. Combined with the relatively well known values for V_{ud} and V_{ub}, this provided the most stringent test of the unitarity of the CKM matrix. Among several reasons that such a test is of interest is the proposed existence of supersymmetry (SUSY) particles which are predicted to cause a small deviation from the unitarity relation.


E930 setup
AGS-D6
BT
BP
BC1
BD1
BD2
Hyperball
FD1
FD2
FD3
ID1-2
IT1
IC
K⁻
γ
π⁻
Q9
1m
48D48
side
view
Hyperball
Ge
BGO
counter
Plastic
Counter
Aerogel
Cerenkov
K⁻
0.9GeV/c
γ
~10cm
Quartz
Cerenkov
Be-target
π⁻

Beam: D6
Status: In Progress
Hours Charged/Approved: 428/1428

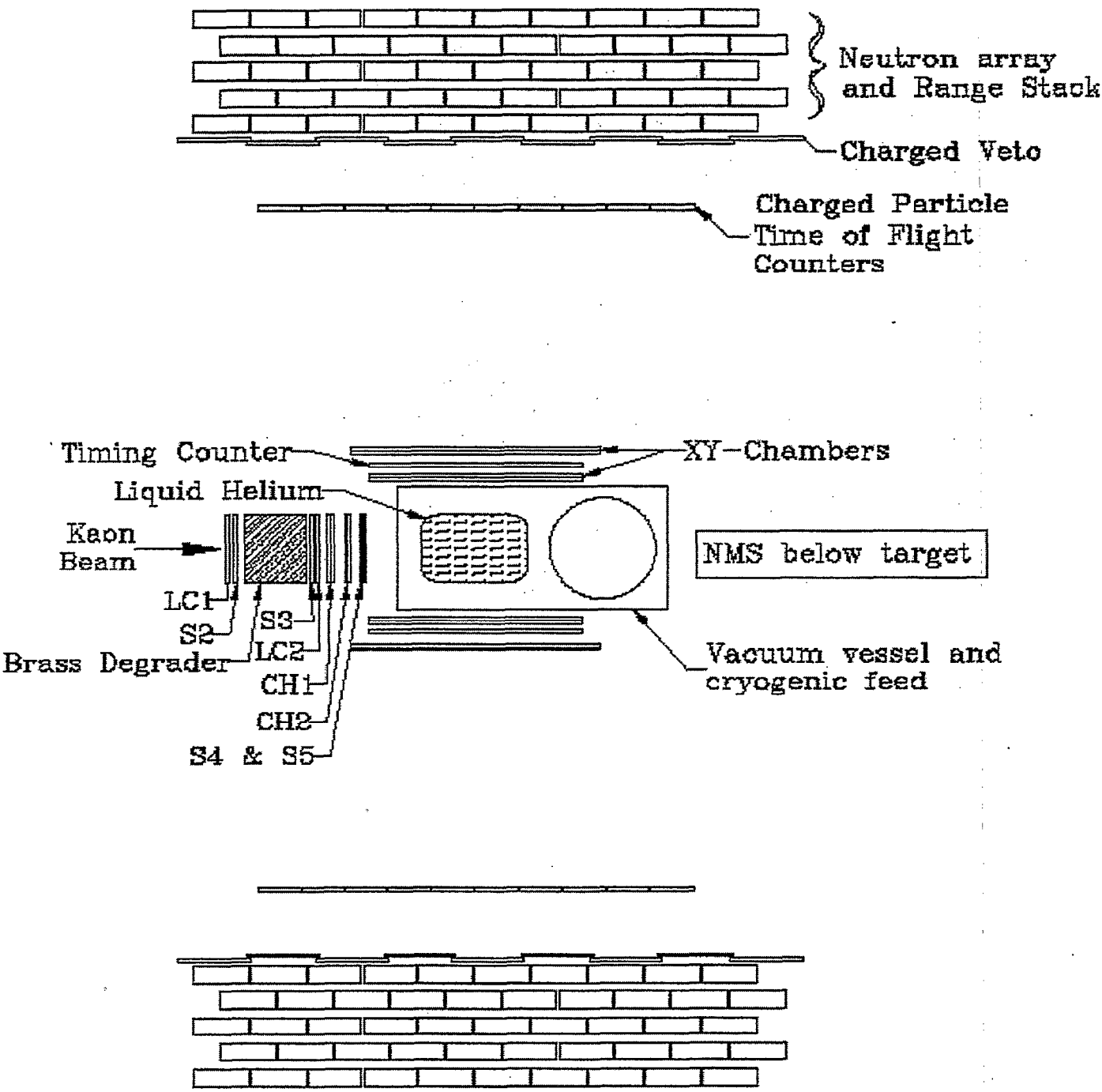
EXPERIMENT 930 - HIGH-RESOLUTION γ SPECTROSCOPY OF HYPERNUCLEI USING LARGE-ACCEPTANCE GERMANIUM DETECTOR

SPOKESMAN: H. TAMURA

- **Brookhaven National Laboratory** – D.E. Alburger, R.E. Chrien, H. Hotchi, M. May, P. Pile, A. Rusek, R. Sutter
- **Carnegie Mellon University** – P. Eugenio, G.B. Franklin, P. Khaustov, B.P. Quinn, R.A. Schumacher
- **China Institute of Atomic Energy** – S.H. Zhou
- **Hampton University** – L. Gran, L. Tang, L. Yuan, X.F. Zhu
- **Kyoto University** – H. Akikawa, K. Imai
- **North Carolina A&T University** - R. Sawafta
- **Osaka University** - S. Ajimura
- **Tohoku University** – Y. Miura, J.Sasao, H. Tamura, M. Ukai
- **University Freiburg** – J. Franz, H.Schmitt
- **University of Tokyo** - K. Tanida

The experimenters propose a high-resolution γ-ray spectroscopy measurement of several light Λ hypernuclei employing Hyperball, a large-acceptance germanium detector array for hypernuclear studies constructed in Japan. Λ hypernuclei are produced by the (K^-, π^-) reaction and their γ transitions are detected in coincidence. They will use K^- beam at D6 beam line together with the E813 spectrometer. The aim is to determine all the terms of ΛN spin-dependent interactions, namely, spin-spin, spin-orbit, and tensor forces between Λ and nucleon, through detailed level structures of ${}^{9}_{\Lambda}$Be, ${}^{16}_{\Lambda}$O, ${}^{7}_{\Lambda}$Li, and ${}^{12}_{\Lambda}$C hypernuclei.

Date for ^{9}Be target were taken in 1998 and the two transitions in ${}^{9}_{\Lambda}$Be, E2($5/2^+ \rightarrow 1/2^+$) and E2($3/2^+ \rightarrow 1/2^+$), were separately observed at 3.05 MeV. Their energy difference was measured t be only 31± 2 keV, which confirmed a very small but finite size of the sin-orbit force ($\propto l_{\Lambda N} S_{\Lambda}$) in the ΛN interaction.



E931 Schematic Plan View

Beam: C8
Status: In Progress
Hours Charged/Approved: 408/1408

EXPERIMENT 931 - STUDY OF THE $\Delta I = \frac{1}{2}$ RULE IN THE WEAK DECAY OF S-SHELL HYPERNUCLEI

SPOKESMAN: D. DEHNHARD, E. HUNGERFORD, V. ZEPS

- **Arizona State University** - J. R. Comfort, C. Gauland
- **Brookhaven National Laboratory** - R. E. Chrien, M. May, P. H. Pile, A. Rusek, R. Sutter
- **Carnegie-Mellon University** - G. B. Franklin, B. Quinn
- **CEBAF** - L. Tang
- **Christopher Newport College** - J. Gerald
- **George Washington University** - W. Briscoe
- **Los Alamos National Laboratory** - J. Amann, D. Boudrie, C. Edwards, B. F. Gibson, C. Morris, J. O'Donnell, J-C. Peng, A. Thiessen
- **Louisiana Tech University** - M. Barakat, K. Johnston
- **North Carolina A&T** - R. Sawafta
- **R. Boskovic Institute** - I. Supek
- **Tohoku University** - O. Hashimoto
- **University of California at Los Angeles** - B. Nefkens, W. B. Tippens
- **University of Colorado** - G. A. Peterson
- **University of Houston** - M. Ahmed, X. Cui, A. Empl, E. V. Hungerford, A. Lan, B. Mayes, L. Pinsky
- **University of Kentucky** - V. Zeps
- **University of Maryland** - P. G. Roos
- **University of Minnesota** - D. Dehnhard
- **University of Texas at Austin** - G. Glass, C. Fred Moore, H. Ward
- **University of Zagreb** - D. Androic, M. Furic, T. Petkovic, M. Planinic

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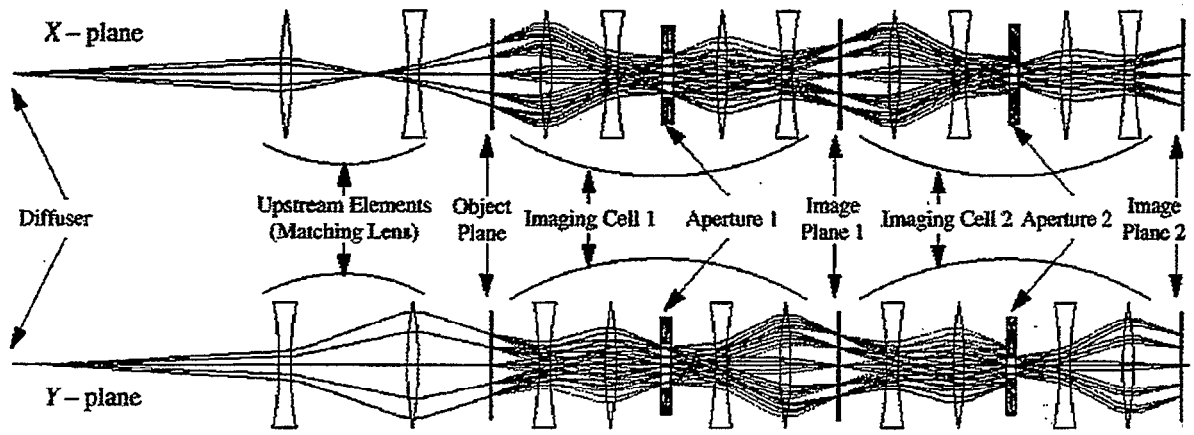
This experiment addresses an unresolved, fundamental question of "why" and "when" to apply the $\Delta I = \frac{1}{2}$ rule to the weak decay of strange hadrons. An opportunity now exists to determine if this apparently universal rule applies to the non-mesonic weak decay of a Λ, by studying particle emission from the weak decay of ${}^{4}_{\Lambda}\mathrm{He}$. The experiment will use the NMS spectrometer and the LESBII beam line.



E933 Schematic

Schematic of the Proton Radiography magnetic lens system showing both the *X* and *Y* views. The beam is first prepared with a diffuser and matching lens to meet optics requirements. It then passes through the object being radiographed. The transmitted beam passes through an iris, or aperture located in the middle of the 4-quadrupole –I magnetic lens cell and is focused on the first detector. It then enters the second identical –I lens cell, which this time has a smaller diameter iris, and is focused on a second detector. Together, the two detectors provide the information needed to reconstruct both the density profile and material composition of the object.

Beam: U
Status: Completed FY 1999
Hours Charged/Approved: 225/200

EXPERIMENT 933 - PROTON RADIOGRAPHY

CONTACT PERSONS: C. MORRIS, E. HARTUNI

- **Bechtal Nevada** - R. Thompson, R. Liljestrand
- **Lawrence Livermore National Laboratory** - E. Ables, M. B. Aufderheide, R. M. Bionta, P. D. Barnes Jr., T. E.Cowan, D. Fujino, E. P. Hartouni, H-S. Park, R. A. Soltz, K. A.VanBibber, D. M. Wright
- **Los Alamos National Laboratory** - J. F. Amann, R. L. Boudrie, G. E. Hogan, N. S. P. King, A. R. Mathews, J. B. McClelland, K. B. Morley, C. L. Morris, C.T. Mottershead, K. H.Mueller, J. S. Sarracino, G. J. Yates, H. J. Ziock, J. D. Zumbro

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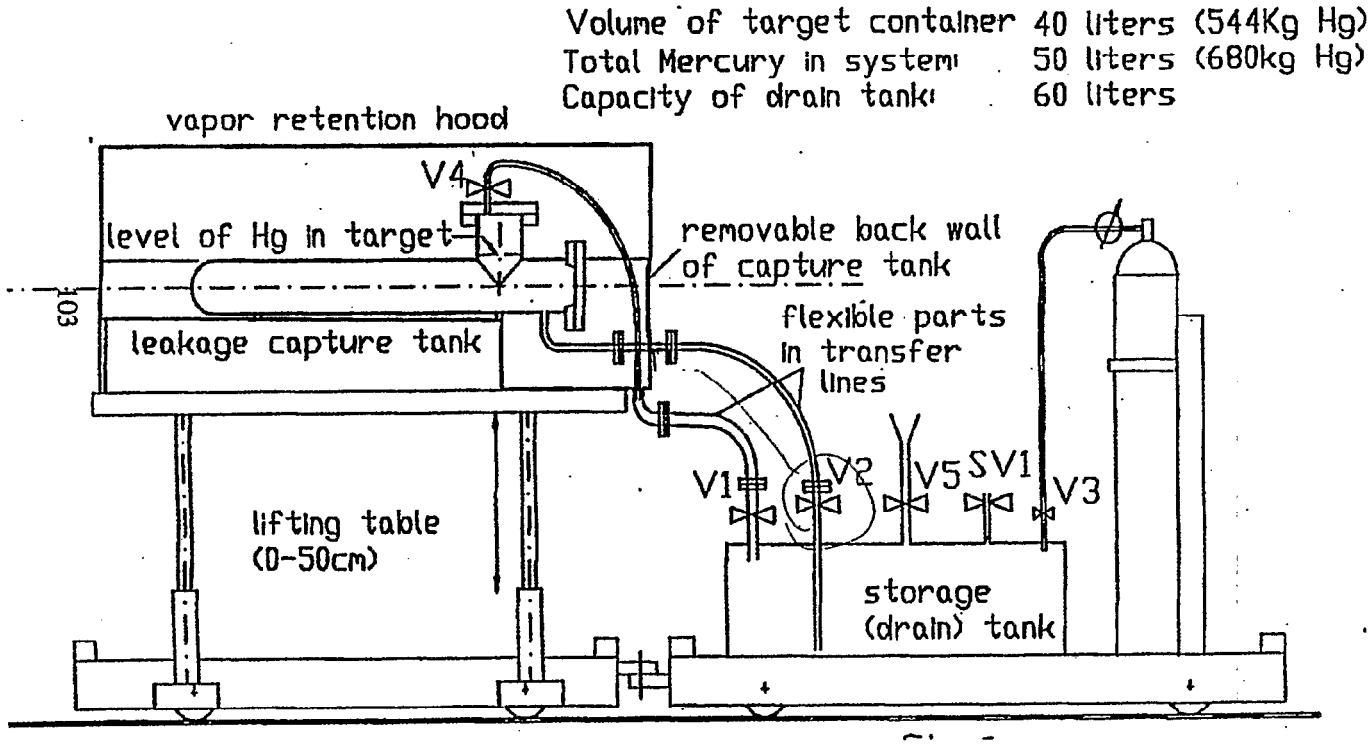
Proton radiography was investigated as a promising new technology for hydrodynamic testing in support of a science based stockpile stewardship program. It gave the potential to outperform traditional X-ray Techniques in meeting the full range of requirements that are being developed by a DOE-DP charted tri-lab working group. This group was established to identify technical approaches by which an advanced hydrodynamic testing capability could certify the stockpile in the absence of underground testing.

BNL-AGS Target Test Experiment

Schematic section along beam center line



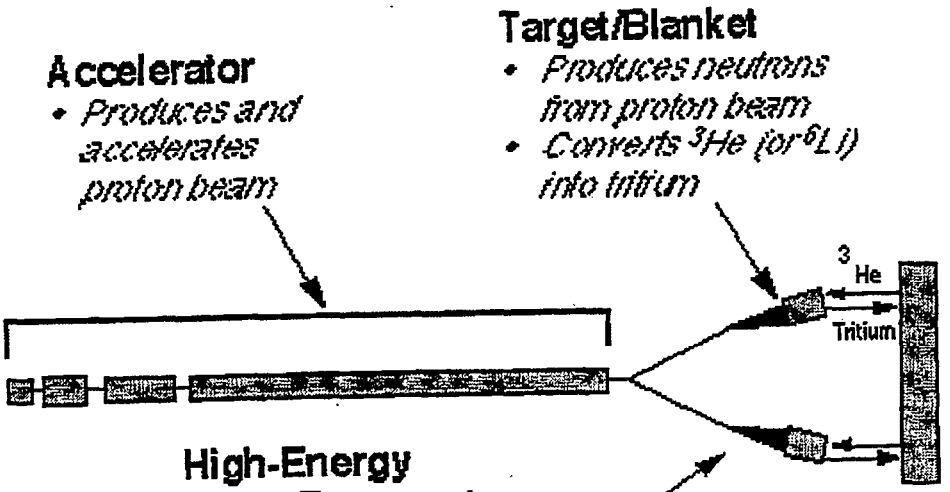
EXPERIMENT 938 - SPALLATION NEUTRON TARGET STUDIES AT THE AGS

SPOKESMEN: G. BAUER, J. HAINES, J. B. HASTINGS, N. WATANABE

- **Argonne National Laboratory** - J. M. Carpenter
- **Brookhaven National Laboratory** - J. B. Hastings
- **Forschungszentrum Jülich** - H. Conrad
- **High Energy Accelerator Research Organization (KEK)** - H. Ikeda
- **Japan Atomic Energy Research Institute** - N. Watanabe
- **Los Alamos National Laboratory** - G. Russell
- **Oak Ridge National Laboratory** - J. Haines
- **Paul Scherrer Institute** - G. Bauer

There is a worldwide effort in planning and designing the next generation neutron source; the focus is on spallation source with average power of up to 5 MW and single pulse energies of 100 kjoules. The design issues center around the heavy metal target; liquid mercury is the current first choice. The AGS is a unique resource to study in detail neutron production, pressure wave mitigation and other issues in target design. It is the **only** proton source in the world with the energy per pulse equal to the proposed future sources.

This experiment measured the neutron production and energy deposition in liquid mercury as a function of incident proton energy. The pressure wave behavior under peak power loading was measured and mitigation measures evaluated. Finally, the performance of a liquid mercury target in conjunction with a lead reflector and moderators were measured to study the complete system performance. The total proton fluence required at a given proton energy was minimal (typically a few time 10^{14}) for the first two measurement periods.


Accelerator
• Produces and accelerates proton beam
Target/Blanket
• Produces neutrons from proton beam
• Converts ^{3}He (or ^{6}Li) into tritium
^{3}He
Tritium
High-Energy Beam Transport
• Proton beam delivery to Target/Blanket
• Expands and shapes beam
Tritium Processing
• Continuous tritium extraction
• Purification to weapons grade tritium

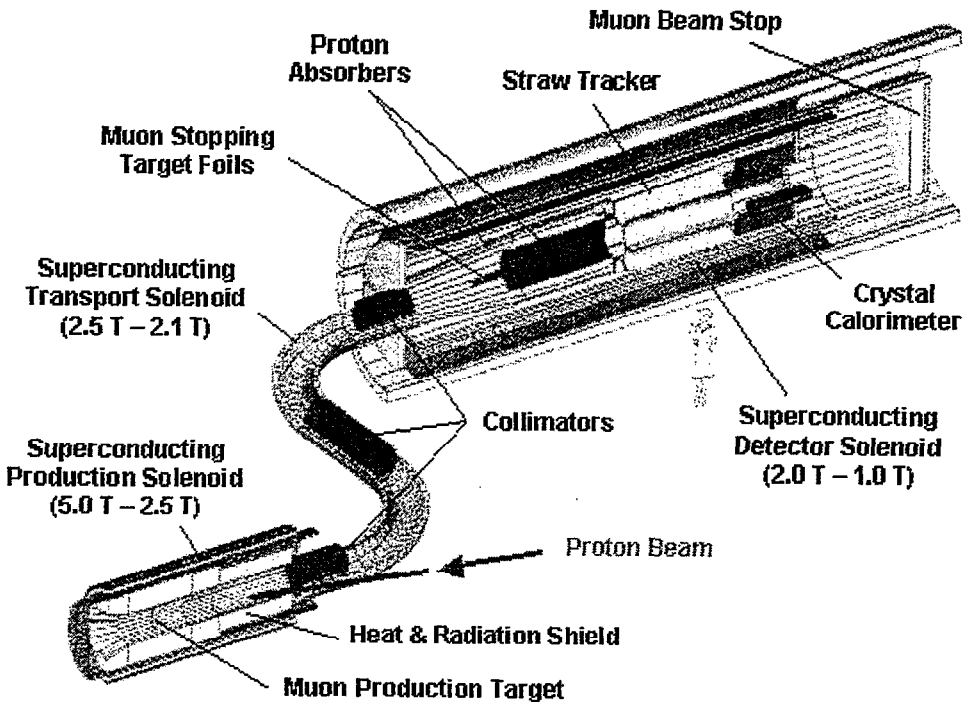
Beam: U
Status: Completed FY 1999
Hours Charged: 69

EXPERIMENT 939 - EXPERIMENTS FOR THE DOE ACCELERATOR PRODUCTION OF TRITIUM (APT) PROJECT

SPOKESMEN: N. S. P. KING AND A. L. HANSON

- **Bechtel Nevada** - R. Thompson, R. Liljestrand
- **Brookhaven National Laboratory** - G. Greene, A. L. Hanson, L. Snead, M.Todosow
- **CEA** - J. Frehaut
- **Lawrence Livermore National Laboratory** - G. Henry, D. Slaughter
- **LNS-CNRS** - S. Leray
- **Los Alamos National Laboratory**
  K. Alrick, F. Cverna, N. S. P. King, G. L. Morgan, L. Waters, J. Ullmann
- **U. S. Department of Energy** - T. Ward

The purpose of this experiment was to advance the R&D work for the accelerator production of tritium as a part of a national program now underway in this subject. Using fast extracted protons, thin aluminum foils were exposed to proton beams of 800, 1200, 1600 and 2000 MeV to measure the production cross sections for the $^{27}Al(p)^{24}Na$ and $^{27}Al(p)^{22}Na$ reations. These cross-sections were used to help normalize data from other measurements.


Muon Beam Stop
Proton Absorbers
Straw Tracker
Muon Stopping Target Foils
Superconducting Transport Solenoid (2.5 T – 2.1 T)
Crystal Calorimeter
Collimators
Superconducting Detector Solenoid (2.0 T – 1.0 T)
Superconducting Production Solenoid (5.0 T – 2.5 T)
Proton Beam
Heat & Radiation Shield
Muon Production Target

Beam: C4
Status: NSF Funding Requested
Hours Charged/Approved: 4/4000

EXPERIMENT 940 - A SEARCH FOR $\mu^- N \rightarrow e^- N$ WITH SENSITIVITY BELOW 10^{-16} MUON-ELECTRON CONVERSION (MECO)

SPOKESMAN: W. MOLZON

- **Institute for Nuclear Research** - R. M. Djikibaev, V. M. Lobashev, A. N. Toropin
- **New York University** - A. Mincer, P. Nemethy, J. Sculli
- **Purdue Univeristy** - S. Carabello, D. Koltick
- **University of California at Irvine** - M. Bachman, G. Kagel, R. Lee, T. J. Liu, W. Molzon, M. Overlin
- **University of Houston** - A. Empl, E. V. Hungerford, K. J. Lan, B. W. Mayes, L. S. Pinsky, J Wilson, M. Youn
- **University of Pennsylvania** - W. D. Wales

This experiment proposes to search for the process $\mu^- N \rightarrow e^- N$ with a significantly improved sensitivity with respect to past and proposed future searches. Interest is in searching for violations of additive quantum numbers associated with each type of lepton. Violation of these quantum numbers is commonly referred to as lepton flavor violation (LFV). The process will provide direct evidence of muon and electron number violation.

The experiment will be conducted in a new μ beam line produced using a pulsed proton beam. The proton energy will be chosen in the range 8-20 GeV to optimize the μ flux per unit time and minimize operating costs of the experiment. The expected sensitivity, normalized to the kinematically similar process of μ capture on the nucleus, is one event for a branching fraction of 2×10^{-17}.

Beam: U
Status: Completed FY 1999
Hours Charged/Approved: 48/32

EXPERIMENT 945 - PHYSICS BENCHMARK MEASUREMENT OF ENERGY DEPOSITION IN AN APT TARGET/BLANKET PROTOTYPE

SPOKESMEN: R. COOPER AND G. MORGAN

- **Bechtel Nevada** - R. Cooper, J. Langenbrunner, R. Liljestrand, A. Whiteson
- **Brookhaven National Laboratory** - A. L. Hanson
- **General Atomics** - M. Madlener, T. Torres
- **Lawrence Livermore National Laboratory** - D. Slaughter
- **Los Alamos National Laboratory** - P. Ferlguson, N. King, G.Morgan, E. Pitcher, L. Waters, K. Woloshun

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In order to finalize the design of the APT target/blanket, a code validation experiment needed to be performed which measured the energy deposition from a proton beam, as a function of position, in a prototype target/blanket. The measured distribution of the deposited energy was compared with the distribution calculated by the MCMPX transport code. This validation is needed to understand uncertainties in the calculations, which were used to optimize the target/blanket design and maximize the tritium production rate.

This experiment used proton beams with two energies, 1.2 and 1.6 GeV, and with the line operating at maximum current, with approximately 5 x 10^{12} protons per spill.

Beam: U
Status: Completed FY 1999
Hours Charged/Approved: 48/24

EXPERIMENT 945A – MEASUREMENT OF RADIATION DAMAGE IN METALS AT LIQUID HELIUM TEMPERATURE BY RESISTIVITY CHANGE

SPOKESMEN: G.A. GREEN AND W. F. SOMMER

- **Brookhaven National Laboratory** – B.S. Bowerman, C. C. Finfrock, G.A. Greene, A. L. Hanson, C. L. Snead
- **Los Alamos National Laboratory** – M. R. James, W. F. Sommer, L. S. Waters

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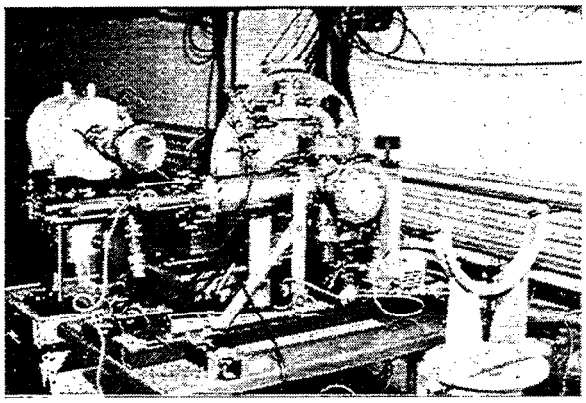
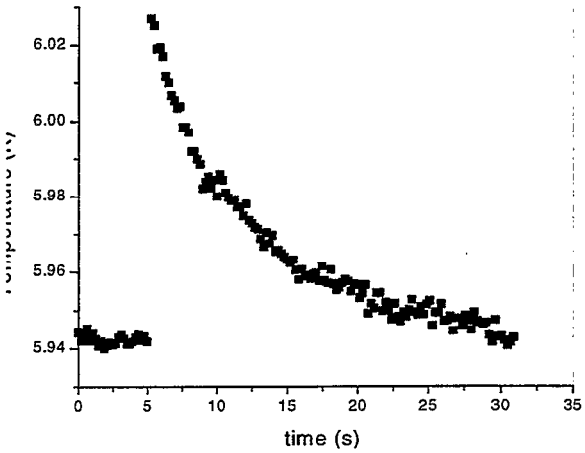
An experiment for code validation purposes is needed to measure resistivity changes in several pure metals after defects have been introduced at liquid-helium temperature by exposure to energetic protons. This data is needed to quantify the uncertainties in the calculations used to predict radiation damage to spallation targets under proton irradiation. Wire samples will be tested in a cryostate that were used for similar studies at BNL.

This experiment was installed in the U-line across from the UGE2 entrance, and was directly upsteam from E945, the LANL energy deposition experiment. Experiments were conducted at four proton energies: 0.8, 1.2, 1.6 and 2.0 GeV, and with the beam line operating at maxim current, with approximately 5 x 10^{12} proton per spill. It was desirable to have at least two measurements at each energy. A tight beam profile was required for this experiment to minimize heating of the sample holder. The beam was focused to give a spot diameter at the target location of no larger than 1.0 cm full-width at half-height.





Photograph of the Energy Deposition Vacuum-Cryostat Apparatus in the Beam Line Along With a Typical Thermal Spike of the Instrumented Copper Target

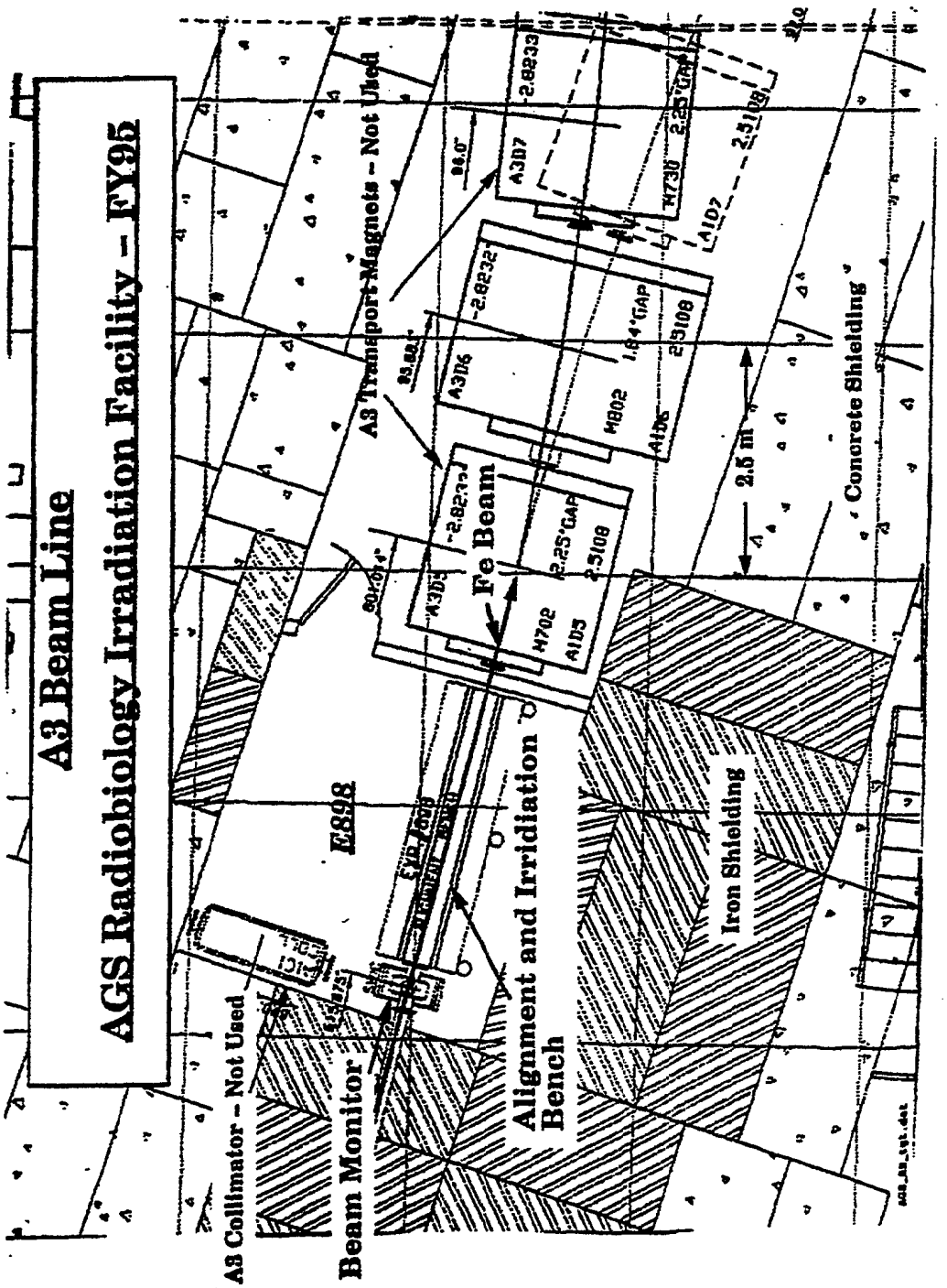
Beam: U
Status: Completed FY 1999
Hours Charged: 7

EXPERIMENT 945B – THERMAL EFFECTS OF SECONDARY RADIATION FROM SPALLATION TARGETS ON MAGNET MATERIALS AT LIQUID HELIUM TEMPERATURE

SPOKESMAN: G.A.GREEN

- **Brookhaven National Laboratory** – C. C. Finfrock, G.A. Greene, D. A. Harder
- **Los Alamos National Laboratory** – P. Walstrom

This experiment was installed in the U-line blockhouse downstream of the UGE2 entrance and directly along side Experiment 933, off-axis of the primary beam transport. A vacuum cryostat with an instrumented OFHC copper target was pumped down to 10^{-9} Torr and cooled to about 6 K by liquid helium. A series of experiments were conducted with 24 GeV/c protons in single-pulse extraction mode at an intensity of 5×10^{10} protons per bunch onto the E-933 tungsten object. The E-945B copper target was intended to provide a temperature signal in response to the energy deposited by the scattered radiation from the E-933 target, similar to the energy deposition that a superconducting magnet downstream from such a target would experience. After calibration of the copper target by measuring the thermal spikes due to the energy deposition from well characterized electric pulses (15 mK/mJ), the thermal response of the copper target was measured due to the energy deposition from the scattered charged particles and photons from the spallation target. The temperature instrumentation on the copper target was capable of temperature measurement precision of 10^{-3} K and accuracy of 3×10^{-3} K, making possible the measurement of energy deposition per unit mass in the copper target as low as 2 mJ/kg. A photograph of the cryostat assembly is shown, on opposite page, along with an example of a temperature spike (0.085 K) due to the deposition of 5.6 mJ into the copper target.


A3 Beam Line
AGS Radiobiology Irradiation Facility – FY95
A3 Transport Magnets – Not Used
Fe Beam
E898
Alignment and Irridiation Bench
Beam Monitor
A3 Collimator – Not Used
Iron Shielding
Concrete Shielding
2.5 m

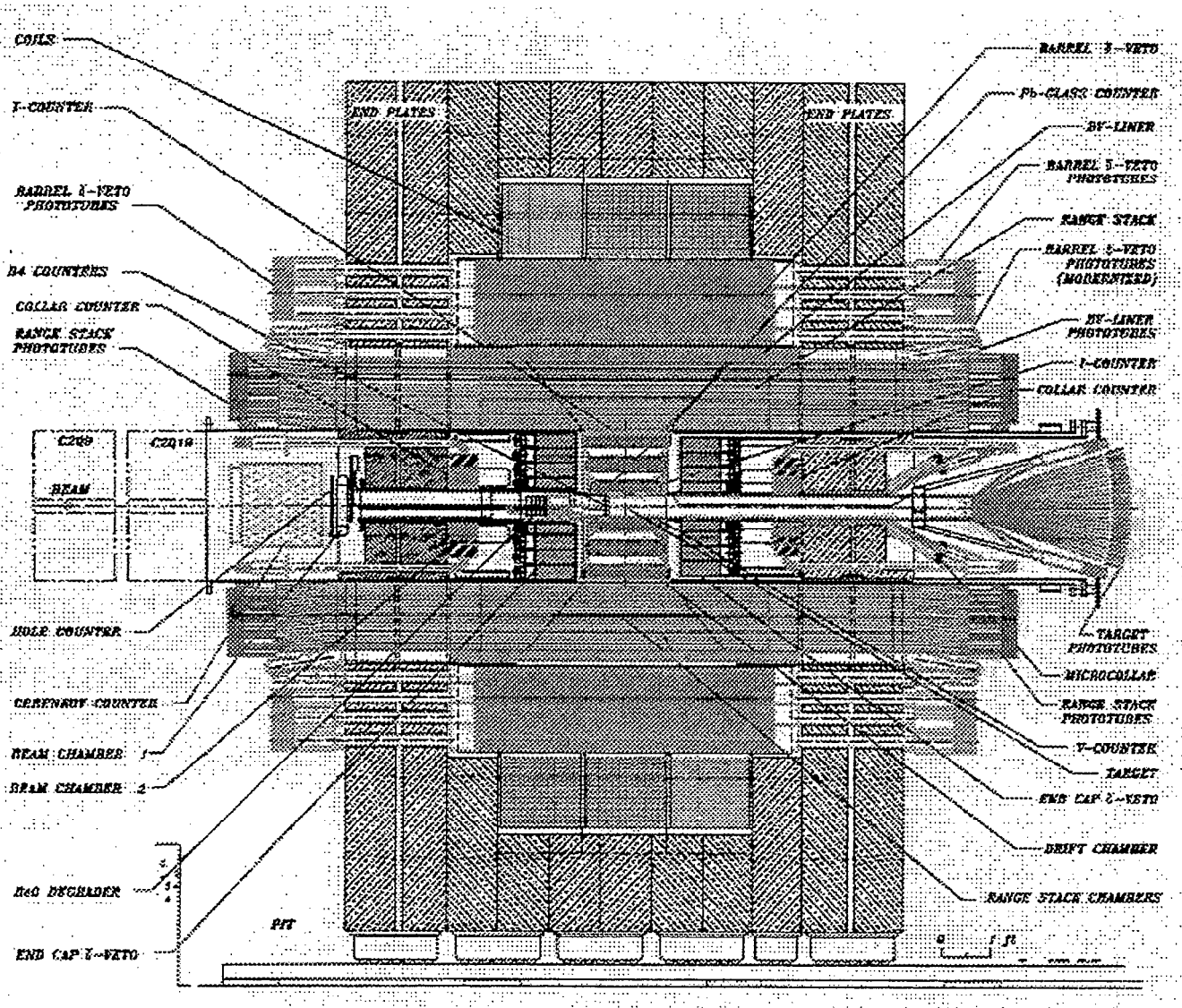
Beam: A3
Status: Scheduled FY 2000
Hours Charged/Approved: 335/300

EXPERIMENT 947 – NASA – RADIOBIOLOGY TESTING

SPOKESMEN: M. VAZQUEZ

- **Alabama A&M University** - P. Kale
- **Brookhaven National Laboratory** - B. Sutherland, M. Vazquez
- **Case Western Reserve University** – H. Evans
- **Colorado University** – J. Bedford, C. Waldren
- **Columbia University** – T. K. Hei
- **John Hopkins Medical Inst.** – J. Dicello
- **Lawrence Berkeley Laboratory** – H. Barcellos-Hoff, J.Miller, P. Cooper, A. Kronenberg
- **Los Alamos National Laboratory** – D. J.Chen
- **Pacific Northwest National Laboratory** – N. Metting
- **Texas A&M University** – R. R. Sinden
- **University of Maryland** - B.Rabin
- **Washington State University** – A. L. Brooks

This is a continuing program of experiments in radiobiology, funded by the National Aeronautics and Space Agency (NASA) as part of their space-related research efforts in the life sciences.



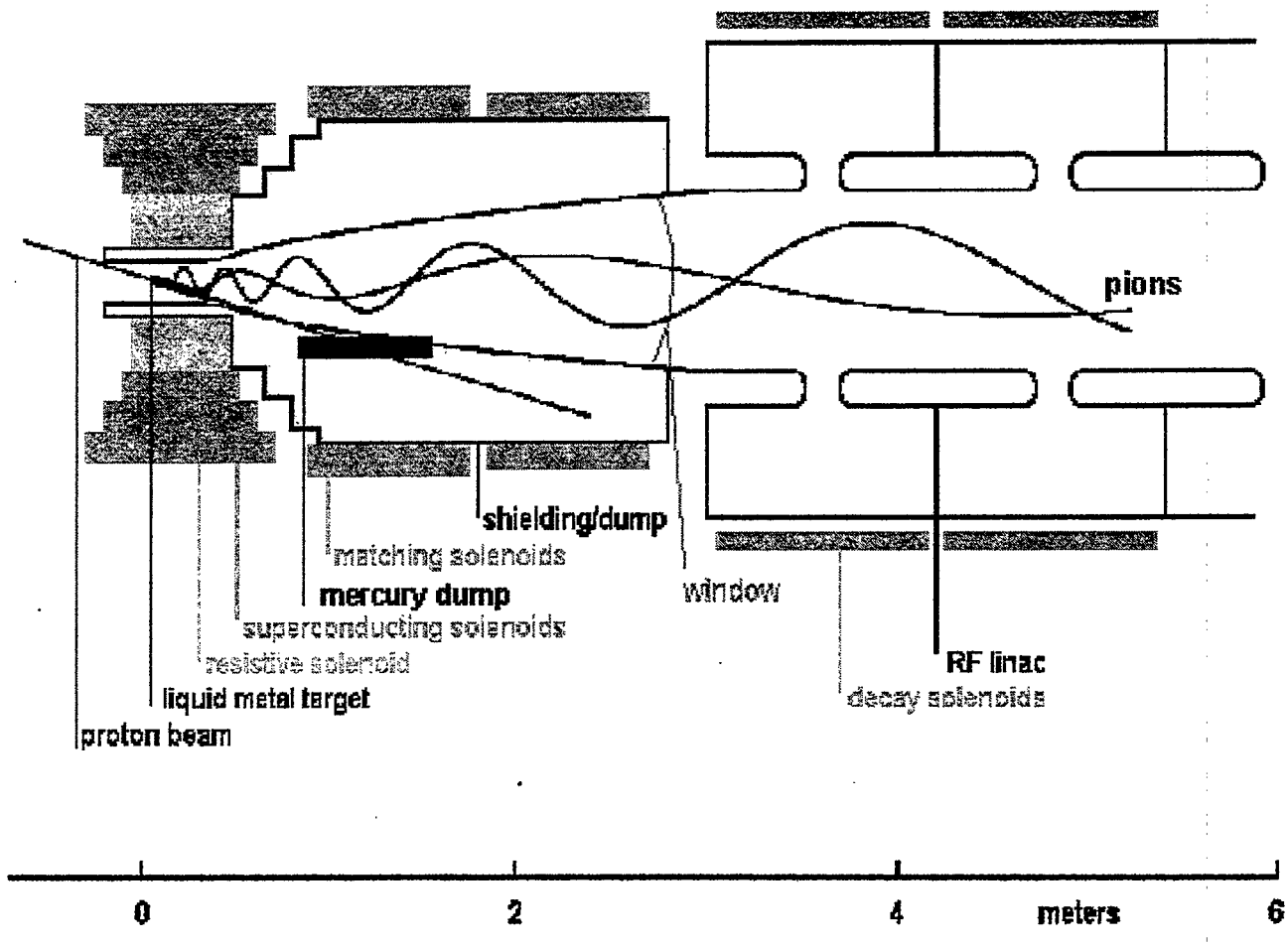
The new detector.

EXPERIMENT 949 - AN EXPERIMENT TO MEASURE THE BRANCHING RATIO $B(K^+ \rightarrow \pi^+ \nu \bar{\nu})$

SPOKESMEN: D. BRYMAN, S. KETTELL, S. SUGIMOTO

- **Brookhaven National Laboratory** – B. Bhuyan, I-H. Chiang, M. V. Diwan, J.S. Frank, J. S. Haggerty, D.E. Jaffe, S. H. Kettell, K.K. Li, L.S. Littengerg, G. Redlinger, R.C. Strand, B. Viren
- **Centre for Subatomic Research-U. Alberta** - P. Kitching
- **FERMI National Laboratory** – P.S. Cooper, E. Ramberg, R.S. Tschirhart
- **Fukui University** - M. Miyajima, J. Nishide, T. Shimoyama, Y. Tamagawa
- **Inst. High Energy Physics** – A. Kozjevnikov, L. Landsberg, V. Mukhin, V. Obraztsov, S. Petrenko, V. Rykalin, V. Victorov
- **Inst. Nuclear Research** – A.P. Ivashkin, M.M. Khabibullin, A.N. Khotjantsev, Y.G. Kudenko, A.S. Levchenko, O.V. Mineev, N.V. Yershov
- **KEK** - T. Inagaki, S. Kabe, M. Kobayashi, T.K. Komatsubara, K. Omata, T. Sato, S. Sugimoto, T. Tsuneimi, T. Yasuno, Y. Yoshimura, T. Yoshioka
- **Kyoto University** – T. Fujiwara, T. Nomura
- **National Defense Academy of Japan** – T. Shinkawa
- **Osaka Univrsity** - M. Nomachi
- **Research Center for Nuclear Physics, Osaka University** – T. Nakano, N. Muramatsu
- **TRIUMF** - P. C. Bergbusch, E. W. Blackmore, S. Chen, J. Hu, A. Konaka, J. A. Macdonald, J. Mildenberger, T. Numao, J-M. Poutissou, R. Poutissou
- **University British Columbia** – D.A. Bryman, X. Li
- **University New Mexico** – B. Bassalleck, B. Lewis, J. Lowe
- **Yeshiva University** - M. Pommot-Maia

A new, more precise measurement of the $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ branching ratio is proposed in this experiment. Improvements to the E787 apparatus and running mode will be made to reach a sensitivity of (8-14) x 10^{-12}, an order of magnitude below the Standard Model prediction. This should result in a determination of $|V_{td}|$ to better than 27%.



Muon Collider Targetry and Phase Rotation

Beam: A3

Beam: A3
Status: In Progress
Hours Charged/Approved: 24/3600

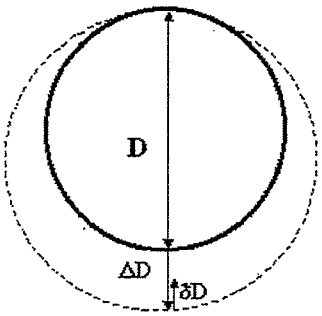
EXPERIMENT 951 – AN R&D PROGRAM FOR TARGETRY AND CAPTURE AT A MUON-COLLIDER SOURCE

SPOKESPERSON: K. T. MCDONALD

- **Argonne National Laboratory** – A. Hassanein, J. H. Norem, C. Reed, D. L. Smith
- **Brookhaven National Laboratory** – J. Alessi, R. C. Fernow, J.C. Gallardo, J. Hastings, S. A. Kahn, B. J. King, H.G. Kirk, V. LoDestro, R. B. Palmer, T. Roser, Y. Torun, H. Wang, R. Weggel, Y. Zhao
- **CERN** – C. Johnson,
- **Fermi National Laboratory** – P. Lebrun, N. V. Mokhov, A. van Ginneken
- **Lawrence Berkeley National Laboratory** – J. Corlett, Y. Fukui, M. A. Green, R. M. Scanlan,
- **Oak Ridge National Laboratory** – D. D. Earl, T. A. Gabriel, J. R. Haines,
- **Joseph Henry Laboratories, Princeton U.** – C. Lu, K. T. McDonald, E. J. Prebys
- **SUNY Stony Brook** – Y. Torun

The proposed R&D program plans to investigate targetry issues for a muon-collider source consisting of the initial studies of liquid (and solid) target materials with a proton beam at the AGS. Studies of a liquid-metal jet entering a 20-T magnet at the Natl. high Magnetic Field Lab (NHMFL) in Florida as well as studies of a full-scale liquid-metal jet in a beam of 10^{14} protons per pulse, but without magnetic field will be done. It is also planned to study a liquid-metal jet + proton beam + 20-T pulsed solenoid magnet and studies of a 70MHz rf cavity downstream of the target in the proton beam, but without a magnet around the rf cavity. Characterization of the pion yield downstream of the target + rf cavity and simulation of the performance of liquid-metal targets; thermal shock, eddy currents will be studied.

Conceptual Details and Numerical Scale



Forward-going decay muons orbit a larger diameter by ΔD

CM

$\nu_\mu \longleftarrow \pi \longrightarrow \mu$

$q = 29.7\ \text{MeV/c}$

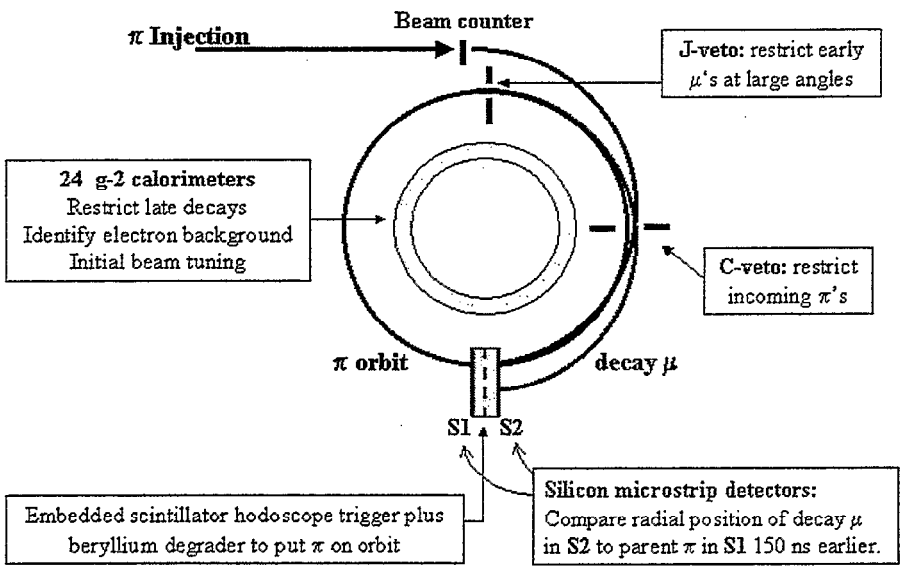
$$\frac{\Delta D}{D} = \frac{p_\mu - p_\pi}{p_\pi} = \frac{0.7\ \text{MeV/c}}{3\ \text{GeV/c}} = \frac{3.26\ \text{mm}}{14\ \text{m}}$$

Non-zero neutrino mass shrinks ΔD by

$$\frac{\delta D}{D} = \frac{-m_\nu^2}{2\,q\,m_\pi}$$

Corresponding to 0.04 mm for current limit

E952: NuMass
20 keV/c^2 Direct Muon Neutrino Mass Limit
The 14 m diameter g-2 Storage Ring becomes a one-turn Spectrometer observing $\pi \rightarrow \mu\nu$ decay in flight



Beam: V1
Status: Approved
Hours Charged/Approved:

EXPERIMENT 952 – AN IMPROVED LIMIT ON THE MUON NEUTRINO MASS FROM PION DECAY IN FLIGHT

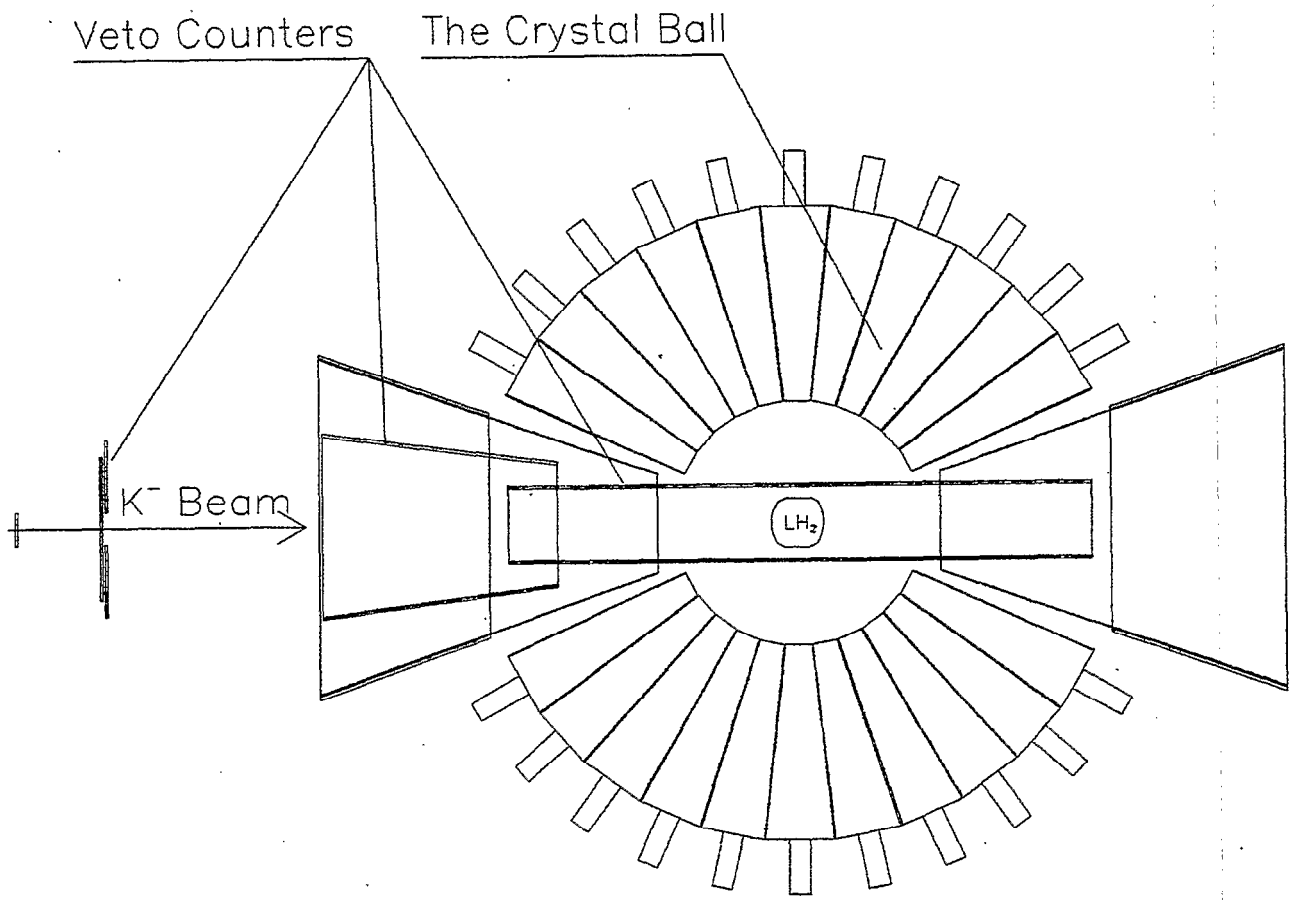
SPOKESPERSON: P. B. CUSHMAN

- **Boston University** – R.M. Carey, J.P. Miller, O. Rind, B.L. Roberts
- **Brookhaven National Laboratory** – H. Brown, G. Bunce, J.W. Glenn, Y.Y. Lee, W. Meng, W.M. Morse, C. Ozben, R. Prigl, Y.K. Semertzidis
- **New York University** – P. Nemethy
- **Newman Laboratory, Cornell University** – Y. Orlov
- **Physik Inst. der Universität Heidelberg** – K. Jungmann, G. zu Putlitz
- **University Illinois** – P.T. Debevec, D.W. Hertzog, C.J.G. Onderwater
- **University of Minnesota** – P. B. Cushman, A. Heering, I. Kronkvist
- **Yale University** – F.J.M. Farley, V.W. Hughes

The g-2 Storage Ring is a unique facility for precision measurements that test the standard model. This experiment hopes to improve the muon neutrino mass limit by a factor of 20 (from 170 keV down to 8 keV) which will be the largest factor improvement made in any neutrino species mass within the last 20 years. It utilizes the storage ring as an extremely uniform spectrometer to compare the parent pion and daughter muon momenta from the $\pi \rightarrow \mu\nu$ decay in flight. The experiment avoids multiple scattering limitations by transforming the momentum measurement into a position measurement; the edge of the μ radial distribution referenced on an event-by-event basis to the parent π depends on the mass of the recoiling ν.

In order to put pions on orbit in the ring, 5.2 cm of beryllium degrades the pion energy. Silicon micro-strip detectors on either side of the degrader record the position of the particle exiting through S1 and then entering the other side through S2 one cycle later. Because of the excellent magnetic field uniformity (better than 1 ppm), pions which do not decay end up back at the same position on the detector from which they started, no matter what their initial momentum and angle, whereas the daughter muons will cover a range of positions. The resulting radial distribution, referenced on a particle-by-particle basis to the parent pion, will consist of a large narrow peak at zero for undecayed pions and a broad distribution representing the decay products. The fact that the pions return to the origin makes the experiment relatively insensitive to the initial pion distribution. The width of the undecayed pion peak provides an in situ calibration of the orbital parameters and magnetic field uniformity.

Since the muons which decay in the forward direction actually have a higher momentum than the parent pion, they will traverse a larger diameter circle. Muons that are produced in the forward direction at a point halfway around the ring will therefore have the maximum radial displacement from the parent pion initial impact point when they return to the detector. In fact, they represent the maximum displacement of any daughter muon with any decay angle. Thus, the radial distribution of the decay muons referenced on a particle-by-particle basis to the radial position of their parent pions has a well-defined edge. If the neutrino has mass, this will reduce the energy of the forward-going muon and shrink the edge of the decay muon distribution by an amount which is sensitive to the square of the neutrino mass, but relatively insensitive to the uncertainty in the pion mass.


Veto Counters
The Crystal Ball
K⁻ Beam
LH₂

Beam: C6
Status: Scheduled FY 2002
Hours Charged/Approved: 0/450

EXPERIMENT 953 – NEUTRAL HYPERON SPECTROSCOPY WITH THE CRYSTAL BALL

SPOKESPERSON: D. M. MANLEY, B.M.K. NEFKENS, H. SPINKA

- **Abilene Christian University** – L. D. Isenhower
- **Argonne National Laboratory** – H. M. Spinka
- **Arizona State University** – J. R. Comfort
- **George Washington University** – W. J. Briscoe
- **Kent State University** – D.M. Manley
- **Petersburg Nuclear Physics Institute** – V.V. Abaev, V.S. Bekrenev, N.G. Kozlenko, S.P. Kruglov, A.A. Kulbardis, I.V. Lopatin
- **Rudjer Boškovic Institute** – I. Šlaus, I. Supek, A. Švarc
- **University of California** – B.M.K. Nefkins, S.N. Prakhov, J.W. Price, A.B. Starostin, W.B. Tippens
- **University Colorado** – R.J. Peterson
- **University Karlsruhe** – H.M. Staudenmaier
- **University Maryland** – D.C. Peaslee
- **University Uppsala** – H. Calen, S. Kullander, A. Kupsc, B. Morosov
- **Valparaiso University** – D. Grosnick, D.D. Koetke, R.W. Manweiler, T.D.S. Stanislaus

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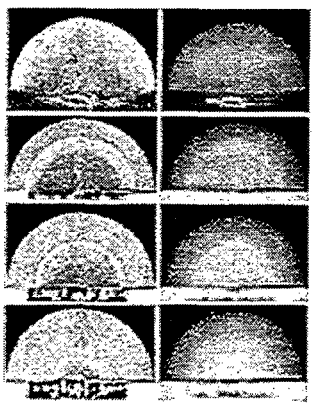
The spectroscopy of hyperons is a fundamental testing ground for nonperturbative QCD models, but ne that has been poorly studied. This proposal plans to perform measurements of absolute differential cross sectons for $K^-p\to\gamma\Lambda$, $K^-p\to\gamma\Sigma^0$, $K^-p\to\pi^0\Lambda$, $K^-p\to\pi^0\Sigma^0$, $K^-p\to K_s^0 n$, and $K^-p\to\eta\Lambda$ in the momentum rante 500-750 MeV/c. These measurements will complete the program originally approved as Phase A of AGS E914.



This photo shows a detonation wave at four different times in a high-explosive assembly. These exposures correspond to 0.99, 1.90, 2.50, and 3.25 msec (top to bottom) after detonation. The detonation wave is clearly evident in the radiographs as it propagates from the detonator to the outer surface of the explosive materials. The images were recorded on a phosphor image plate that allows one image per shot. An active camera system has now been installed and used to capture up to six frames in the time of a single high-explosive detonation. Future detector development is expected to provide the ability to take thousands of frames during the explosion to produce a "motion picture" of the event.

Beam: U
Status: Completed FY 2001
Hours Charged: 65

EXPERIMENT 955 – PROTON RADIOGRAPHY AT THE AGS IN THE U-LINE

SPOKESPERSENS: C. L. MORRIS, E. P. HARTOUNI

- **Bechtal Nevada** – R. T. Thompson, R. P. Liljestrand, D. V. Morgan, A. Whiteson
- **Brookhaven National Laboratory** – G. Green, A. Hanson, J. Scaduto
- **Lawrence Livermore National Laboratory** – E. Ables, M. B. Aufderheide, P. D. Barnes Jr., E. P. Hartouni, H-S. Park, R. A. Soltz, L. Wiley, D. M. Wrigth
- **Los Alamos National Laboratory** – K. R. Alrick, K. L. Buescher, D. J. Clark, C. J. Espinoza, J. J. Gomez, N. T. Gray, G. W. Hart, M. Y. Hockaday, G. E. Hogan, N. S.P. King, A. R. Mathews, J.B. McClelland, K. B. Morley, C. L. Morris, C. T. Mottershead, K. H. Mueller, M. M. Murrag, P. D. Pazuchanics, J.S. Sarracino, A. Saunders, M. D. Wilke, J. D. Zumbro

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Since experiment 933 was originally proposed, several additional questions have arisen about using protons for advanced radiography. This experiment program will include measurements on a wide range of step wedges to validate the separation of Coulomb and nuclear scattering using different collimators to demonstrate material ID. These measurements will be made using both active detectors (cameras) and image plates (to ensure sufficient range). Data will be taken with the full range of available collimators for completeness. Domonstrations of material ID on classified thick objects will also be done. Background characterizaton and mitigation for the active cameras will be done. Sources and shielding techniques to reduce the star background in the CCD cameras will be studied. Data will be taken at a number of angles on suitable test objects aimed at providing input to help define the number of axis needed for an AHF. These data will probablybe taken on both image plates and with active cameras, with a greater emphasis on the active camera data in order to most efficiently use the beam time.

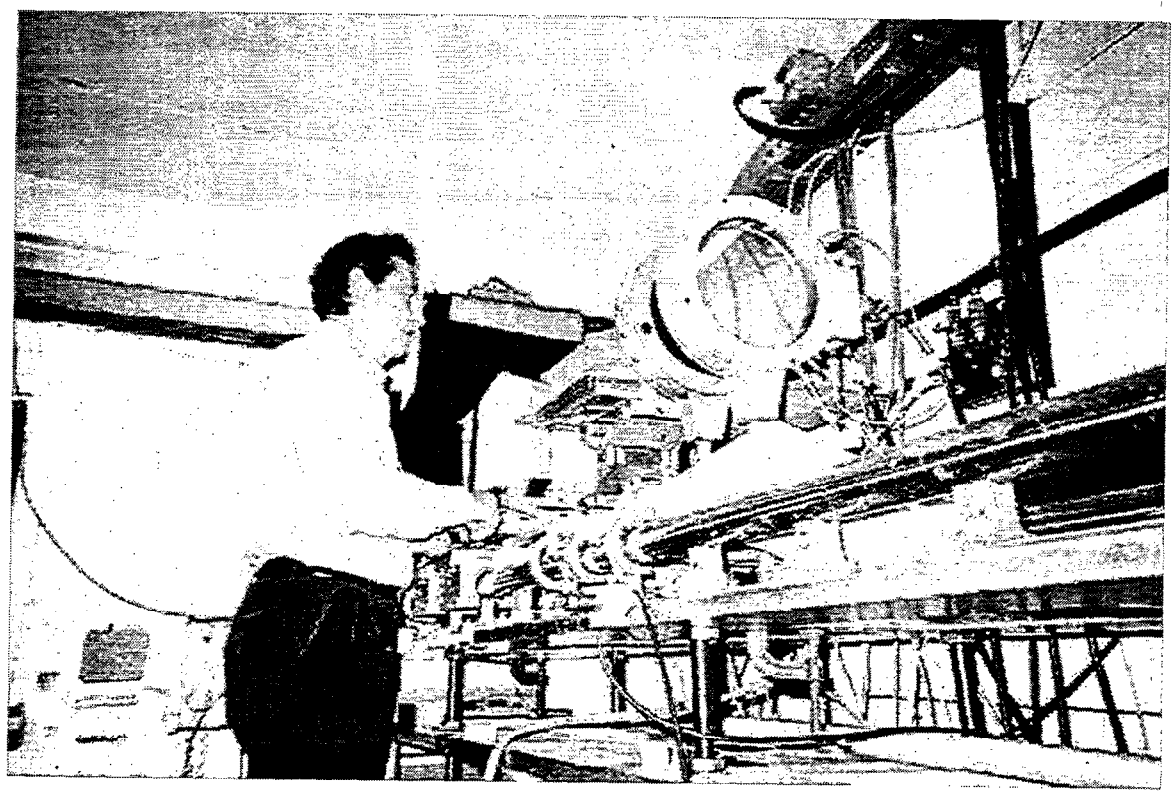
Beam: C7
Status: In Progress
Hours Charged/Approved:

EXPERIMENT 956 – SPALLATION NEUTRON STUDIES AT THE AGS

SPOKESPERSENS: J. B.HASTINGS, G. BAUER, N.WATANABE

- **Argonne National Laboratory** – J.M. Carpenter
- **Brookhaven National Laboratory** – J. B.Hastings
- **Forschungszentrum Centre - Julich** – H. Conrad
- **Japan Atomic Energy Research Inst.** – N. Watanabe
- **Los Alamos National Laboratory** – G. Russell
- **Oak Ridge National Laboratory** – J. Haines
- **Paul Scherrer Inst.** – G. Bauer

There is a worldwide effort in the planning, design and construction of the next generation neutron sources. The focus is on spallation sources with average powers of up to 5 MW and single pulse energies of 100 kjoules. The critical design issues center around the heavy metal target. All of the present design studies are considering liquid mercury as a first choice. The AGS is a unique resource to study in detail neutron production, pressure wave mitigation and other important issues in target design. It is the only proton source in the world with the energy per pulse equal to the proposed future sources. The initial studies on a Hg target system have confirmed the unique role of the AGS. We propose to continue the measurements of the presusre wave behaviour under peak power loading and evaluate proposed mitigation measures. Another critical area is advanced moderator performance as well as materials studies for moderator containment. To carry out these studies it is important to develop a solid target that is passively safer as a neutron source. This target will be tested and then used in the second and third years of the program. We will study a novel moderator (methane pellet bed) and slab moderator configurations. These efforts will complete the establishment of a spallation neutron test facility capable of the full range of R&D from the target through the moderator and up to and including advance detector development.



Dr. Mauro Belli setting up a sample to be exposed to iron ions

Beam: A3
Status: Completed FY 2001
Hours Charged/Approved: 143/150

EXPERIMENT 957 – NASA RADIOBIOLOGY

SPOKESPERSON: M. VAZQUEZ

- **Brookhaven National Laboratory** - R. Setlow, B. Sutherland, M. Vazquez
- **Case Western Reserve University** – H. Evans
- **Colorado University** – J. Bedford, C. Waldren
- **Columbia University** – T. K. Hei
- **Human Nutrition Research Center on Aging** – J. Joseph
- **John Hopkins Medical Inst.** – J. Dicello, D. Huso
- **Lawrence Berkeley Laboratory** – H. Barcellos-Hoff, J.Miller, P. Cooper, A. Kronenberg, B. Rydberg
- **Loma Linda University** – L. Green, G. Nelson
- **NASA Headquarters** – W. Schimmerling
- **NASA Johnson Space Center** – F. Cuccinota
- **National Inst. of Health, Rome Italy** – F. Antonelli, M. Belli, G. Simone
- **NSCORTLBNL-CSU** – J. Kinnison, D. Stephens
- **New York University Medical Center** – F. Burns
- **Prairie View A&M University** – R. Wilkins
- **Texas A&M University** – L. Braby, J. Lupton
- **University California – San Fran.** – B. Fouladi, J. Murnane
- **University "Federico II", Napoli** – M. Durante
- **University of Maryland** - B.Rabin
- **University Pennsylvania** – J. Gerwitz
- **University of Rome, Thor Vergara** – V. Bidoli, M. Cosolino, L. Narici, W.Sanita
- **University of Texas Health Sciences** – M. Natarajan
- **University Tokyo** – A. Sima

During the Winter of 2000 a series of radiobiologial and physics experiments were performed using BNL's AGS to accelerate iron ion beams. These experiments were part of the seventh consecutive run sponsored by NASA's Space Radiation Program (SRHP) heavy ion radiobiology research program at BNL.

The AGS provided iron beams with an enery of 1 GeV/nucleon (1.046 GeV/nucleon, LET: 148 keV/μm), for biology and physics experiments. The dose/rates used were as low as 10 cGy/min and as high as 15 Gy/min. The spill rate employed was 30 spills/min with a duration of 500-600 msec/spill. The spill fluence was (particles/spill) 1 x 10^8 (max) and 1.5 x 10^5 (min). The intensities (particles/cm^2/sec on target) used during the run were 1 x 10^8 (max) and 400 (min). A 7.5cm diameter beam spot was employed as a nominal spot for the majority of the exposures. For larger samples (animals), an elliptical spot was used (up to 9cm).

Radiobiological experiments employed cells, tissues, and intact specimens, which required a complex coordination and planning of their respective logistic support. Biological studies used human, mouse, rat and hamster cell lines, human-hamster hybrid cell lines, tumor cell lines and intact specimens (rodents and fish). Physics experiments involved the exposure of solid state detectors and spacecraft materials.

Beam: C6
Status: Scheduled FY 2002
Hours Charged/Approved: 0/450

EXPERIMENT 958 – PION CHARGE-EXCHANGE CROSS-SECTIONS AT LOW ENERGIES

SPOKESPERSENS: M.E. SADLER, J.COMFORT

- **Abilene Christian University** – L. D. Isenhower
- **Argonne National Laboratory** – H. M. Spinka
- **Arizona State University** – J. R. Comfort, K.Craig, T. Ramirez
- **George Washington University** – W. J. Briscoe, A. Shafi
- **Karlsruhe University** – H. Staudenmeier
- **Kent State University** – D. M. Manley, J. Olmsted
- **Petersburg Nuclear Physics Institute** – V.V. Abaev, V.S. Bekrenev, N.G. Kozlenko, S.P. Kruglov, A.A. Kulbardis
- **Rudjer Boškovic Institute** –I. Supek
- **University of California** – B.M.K. Nefkins, N. Phaisangitisakul, S.N. Prakhov, J.W. Price, A.B. Starostin
- **University Colorado** – R.J. Peterson
- **University Karlsruhe** – H.M. Staudenmaier
- **University Maryland** – D.C. Peaslee
- **University Regina** – N. Knecht, G. Lolos, Z. Papandreou
- **University Uppsala** – H. Calen, A. Kupsc, T. Johanson, U.Wiedner
- **Valparaiso University** – D. Groznick, D. D. Koetke, R.Manweiler, S. Stanislaus

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The experiment will measure the cross-section angular distributions for the $\pi^-p \rightarrow \pi^0 n$ reaction with the Crystal Ball spectrometer for momenta between 50-180 MeV/c. The motivations for this is to provide accurate data to explore isospin invariance in the πN system, to supercede existing data that does not agree well with partial-wave analysis (PWAs) and to complement differential cross-section and analyzing power date for $\pi^+p \rightarrow \pi^+p$ and $\pi^-p \rightarrow \pi^0 n$. By providing high-quality results for the charge-exchange reaction, the amplitudes for πN interactions can be defined more precisely and enable more reliable extractions of the up-down quark mass difference and the sigma term.

Beam: A3

Beam: A3
Status: Schedule FY 2002
Hours Charged/Approved: 0/150

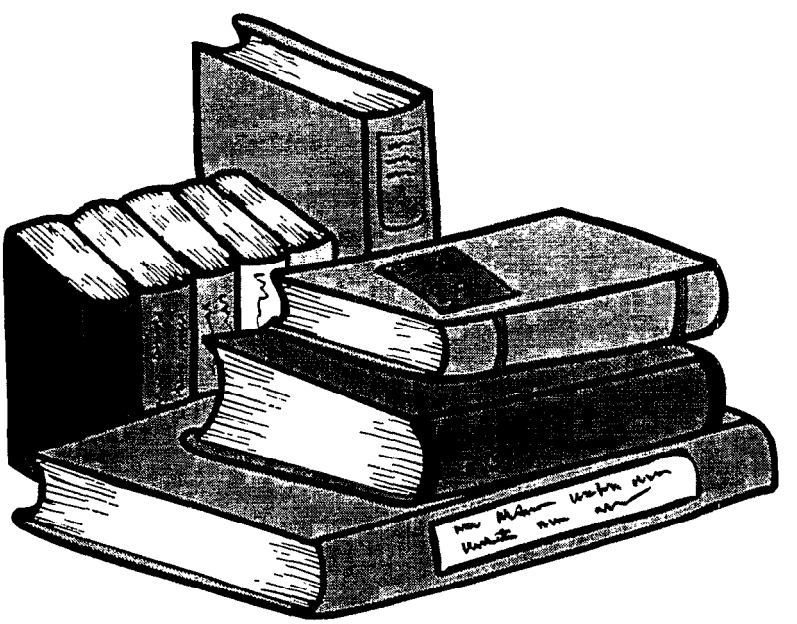
EXPERIMENT 960 – NASA RADIOBIOLOGY

SPOKESPERSON: M. VAZQUEZ

- **Alabama A&M University** - P. Kale
- **Brookhaven National Laboratory** - B. Sutherland, M. Vazquez
- **Case Western Reserve University** – H. Evans
- **Colorado University** – J. Bedford, C. Waldren
- **Columbia University** – T. K. Hei
- **John Hopkins Medical Inst.** – J. Dicello
- **Lawrence Berkeley Laboratory** – H. Barcellos-Hoff, J.Miller, P. Cooper, A. Kronenberg
- **Los Alamos National Laboratory** – D. J.Chen
- **Pacific Northwest National Laboratory** – N. Metting
- **Texas A&M University** – R. R. Sinden
- **University of Maryland** - B.Rabin
- **Washington State University** – A. L. Brooks

This is a continuing program of experiments in radiobiology, funded by the National Aeronautics and Space Agency (NASA) as part of their space-related research efforts in the life sciences.

List of Publications for C-AD Experiments



Publications - AGS Experiments 1982 - 2001

This listing was originally prepared using the SLAC data base SPIRES; we now rely on the experimenters themselves to supply us with information. It is easy to miss publications in such a wide search and we apologize for any left out or misidentified. Please let us know about these as well as keeping us posted on your recent publications of C-AD experiments.

BRAHMS

F. Videbaek, *The BRAHMS experiment at RHIC*, Nucl. Phys. A566 (1994)(Quark Matter '93).

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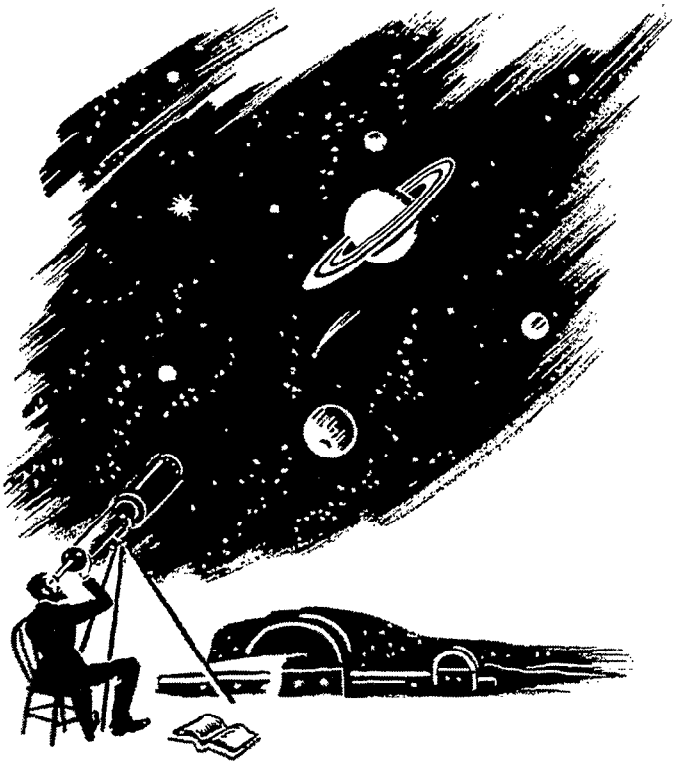
C-AD Experimenters



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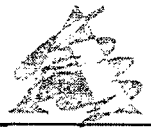

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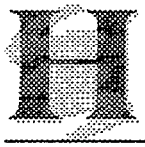

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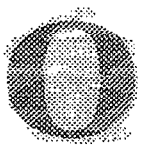

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