Overview of non-RHIC programs

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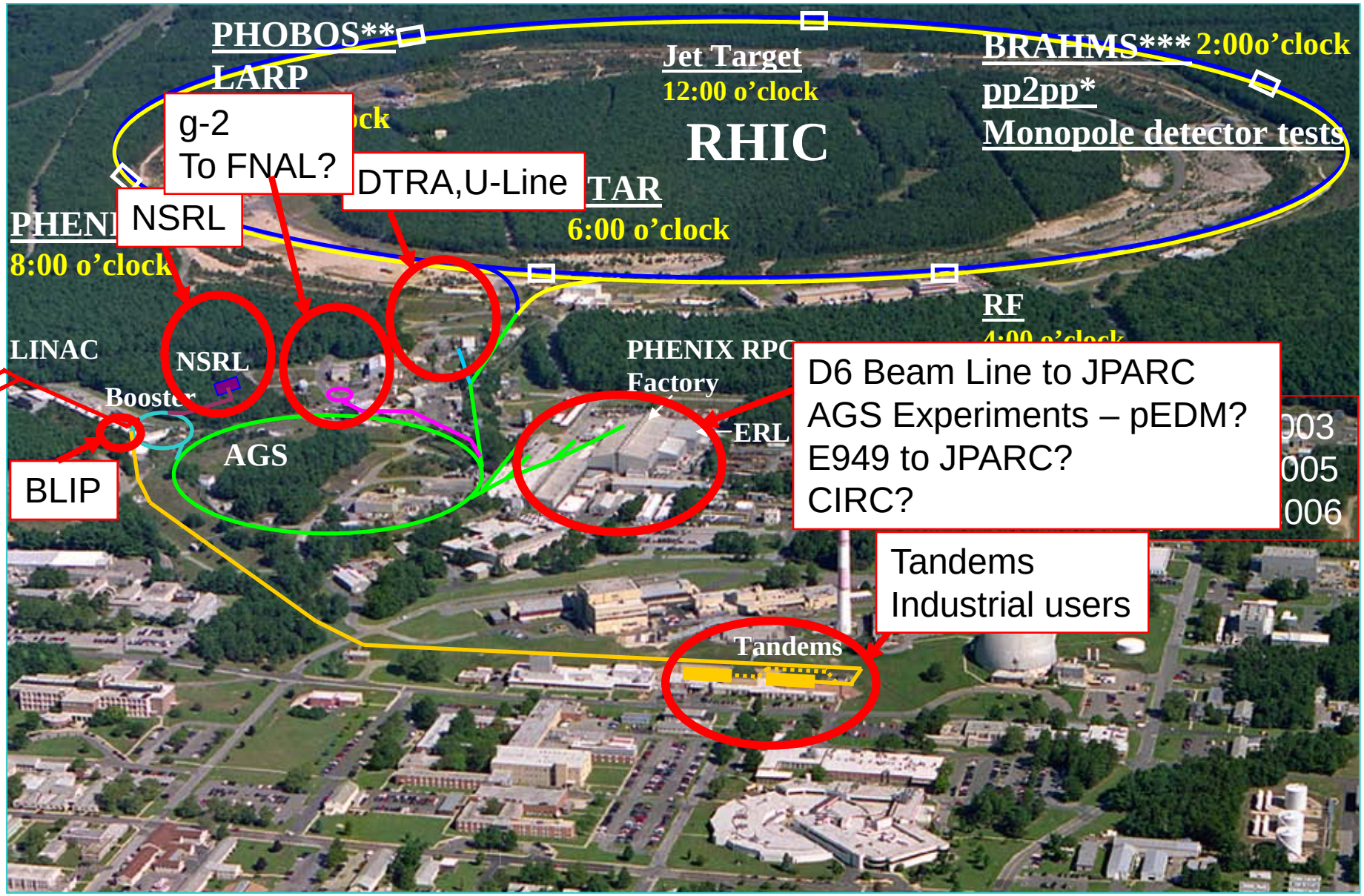
RHIC Retreat - 2009
Mystic, CT
15 July 2009

The C-AD Accelerator Complex - 2009



Other Programs in 2010

- **Tandem**
  - Continues to support industrial users
  - Should be last full year of operation as the HI injector for RHIC and NSRL
- **LINAC**
  - BLIP - Jan-June dedicated run planned, subject to 29-30 July Isotope Planning Meeting
- **Booster**
  - NSRL
    - 21 Sept until ~ Thanksgiving, stand-alone running (scheduled)
    - March-June run concurrent with RHIC operations (to be scheduled)
- **AGS**
  - U-line: Expect a follow-up to E973, the proton interrogation experiment, to run following the end of RHIC Run10

Other Programs > 2010

- **Tandem**
  - Continued support for industrial users only if financially self-sufficient
- **LINAC**
  - BLIP: likely to continue
- **Booster**
  - NSRL operations continues with about 6 months per year
- **AGS**
  - U-line: possibly DTRA or NNSA experiments
  - SEB floor: possibility pEDM experiment

Tandem Business Plan (A. McNerney)

EBIS will replace the Tandem van de Graaff as the heavy ion injector for RHIC and NSRL in FY 2011

- Business Plan options:

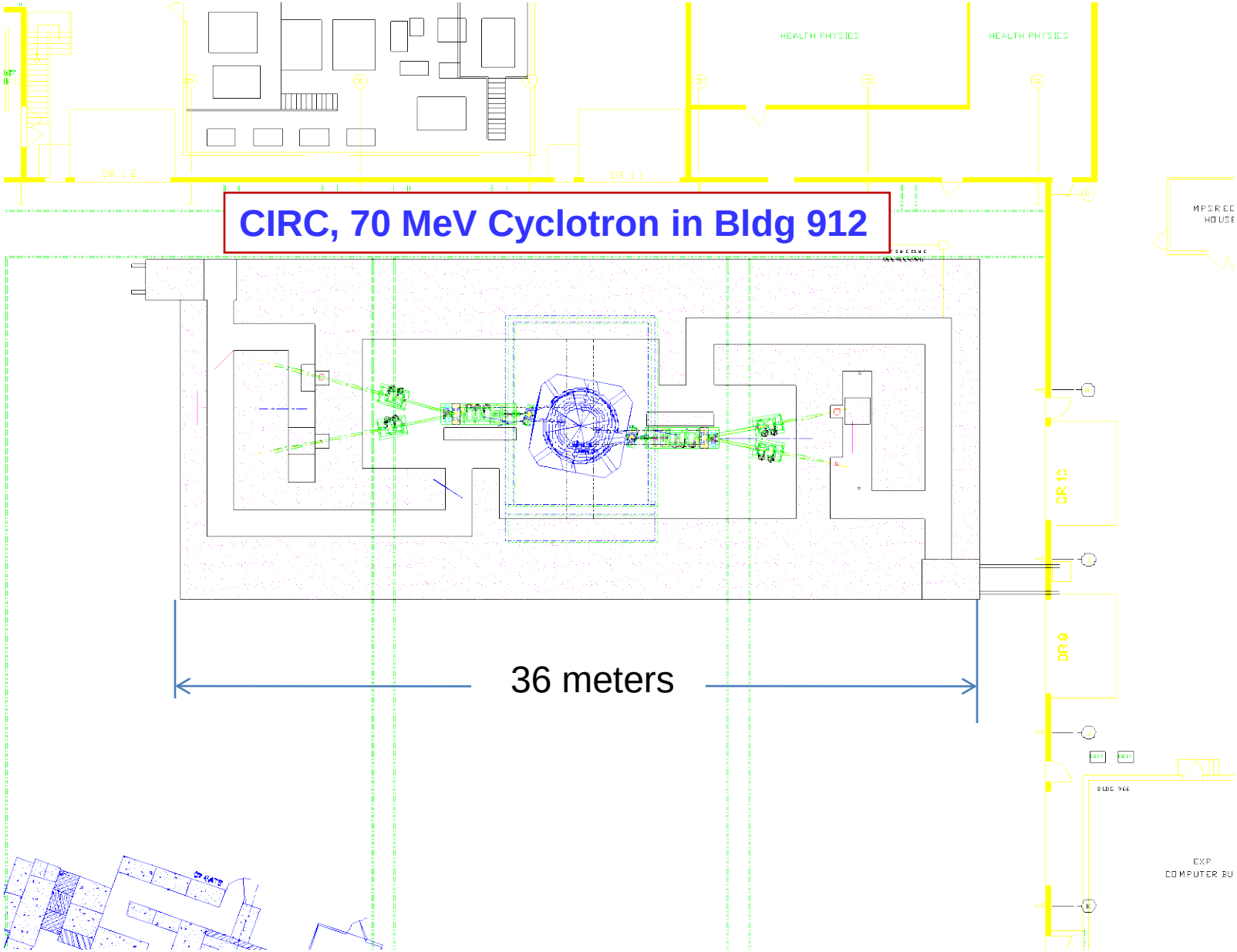
1. Continue Tandem Operations as a Stand Alone User Facility
   - Maintain current technical capabilities , and with improved availability, reduced staff and efficient schedule, achieve sustainable program of 1200 operating hours as a minimum
   - Develop new programs (e.g., micro-beams, accelerator mass spectrometry) with external support. Collaboration effort with external Users, the CFN, Biology and/or Medical Departments.

2. Cease Tandem Operations
   - Excess Facility – Requires Annual Surveillance and Maintenance (~$35K)
   - Decommission and Reclaim Space (~$15M)
   - Transfer to EM for future D&D

BLIP/CIRC Future

- CIRC (Cyclotron Isotope Research Center)
  - 70 MeV cyclotron for BNL to replace BLIP
  - CDR submitted to DOE NE in 2000,
  - ESAAB (Energy Systems Acquisition Advisory Board) favorable review in 2001
  - CD0 in 2001 (DOE NE)
  - Lots of intervening activity
  - Latest proposed CIRC location – bldg 912 near the MPS facility
  - No decision from DOE as to when or if CIRC will be built
- Isotope Production/BLIP is now under DOE NP management (since 2009)
  - An Isotopes Subcommittee was established in the Fall of 2008 by the Nuclear Science Advisory Committee (NSAC) to address charges from the Office of Nuclear Physics of the DOE Office of Science
    - This committee has had 5 meetings
    - Report is due to NSAC in July 2009 with NSAC discussion scheduled for 27 July
  - DOE is actively soliciting academic cyclotrons to participate in the isotope production network
- **<u>BLIP/CIRC future should finally be decided soon</u>**

CIRC, 70 MeV Cyclotron in Bldg 912



NSRL Facility

Motivation

- United States plans to maintain human presence in space:
  - International Space Station
  - Return to the moon
  - On to Mars

- Humans are at risk due to radiation in space:
  - Galactic Cosmic Rays (GCR)
    - High energy protons and highly charged and energetic atomic nuclei (HZE)
    - Shielding not particularly effective
    - Biological effects poorly understood
    - **most significant space radiation hazard**

  - Solar wind/Solar Particle Events(SPE)
    - Early warning and shielding helps

- **NSRL is NASA's main tool to enable characterization and mitigation of risks from radiation for deep space missions**

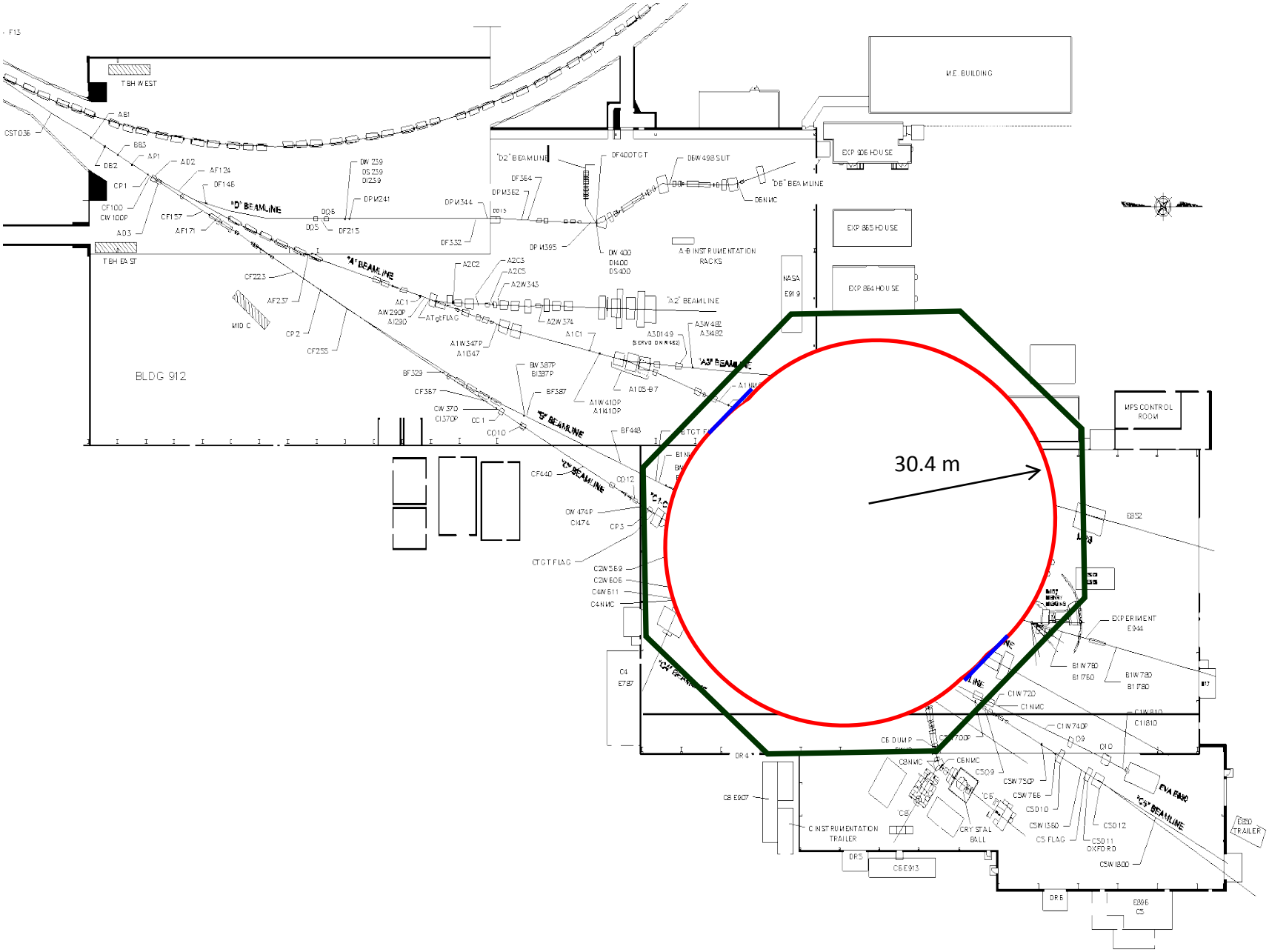
→ NSRL should be with us for a long while

NSRL Future

- Expect continued operation for the foreseeable future ~ 6 month a year
- The new large beam capability (60x60 cm beam) that was added this year will be exploited
- The new EBIS (to which they contributed $$'s) is eagerly awaited, promising new beams and ease of operation concurrent with all RHIC operating modes
- A. Dilmanian (BNL Medical) plans to submit a proposal this month to a private foundation called The Ben and Catherine Ivy Foundation to treat rabbits and dogs with spontaneous glioma brain tumors using interlaced carbon microbeams, a technique he developed at NSRL. Could lead to off hours treatment for up to 15 animals per NSRL year and perhaps ultimately to human subjects
- A second Booster beam line and/or a beam line off the AGS have been discussed as possibilities for the future but are not a part of present planning

d(p)EDM proposal, a history

- **dEDM First proposed in Sept 2004 with 10^{-27} e·cm sensitivity**
  - rejected by BNL PAC, cost/scientific competitiveness were cited as issues
- **LOI's submitted in Sept 2006 and March 2007 – with 10^{-29} e·cm sensitivity**
  - encouragement given by PAC to explore the feasibility of developing the LOI into a proposal (2006) and encouragement to develop a proposal (2007)
- **Proposal submitted in April 2008**
  - Again encouraged, "..beautiful experiment on paper and potentially one with large physics impact…the path to realizing such an experiment in the current funding environment is tortuous…technical risks are too high…critical to define as soon as possible a detailed compelling staged R&D approach…strengthen collaboration…etc.."
- **Spring 2009, shifted emphasis to proton EDM** rather than deuteron
  - Reduced technical risks and cost
  - Floor space becomes an issue
- **Preliminary (friendly) Technical Review June 2009 at C-AD**
- **Technical, R&D Plan, systematic errors etc, Review by experts from outside BNL planned for Sept 2009**
- ***If the experiment goes forward will require very significant effort from C-AD***


30.4 m
BLDG 912
M.E. BUILDING
EXP 906 HOUSE
EXP 865 HOUSE
EXP 864 HOUSE
MPS CONTROL ROOM
EXPERIMENT E944
"D" BEAMLINE
"A" BEAMLINE
"A2" BEAMLINE
"A3" BEAMLINE
"B" BEAMLINE
"C" BEAMLINE
"C4" BEAMLINE
"C5" BEAMLINE
"D2" BEAMLINE
"D6" BEAMLINE
A-B INSTRUMENTATION RACKS
C INSTRUMENTATION TRAILER
CRYSTAL BALL
TBH WEST
TBH EAST
MID C
NASA E919
E852
E850 TRAILER
E896 C5
C6 E913
C4 E787
C8 E907
DR4
DR5
DR6

Summary

- **Coming up during Run10**
  - BLIP, concurrent with RHIC with stand-alone running, Jan-Jun
  - NSRL, 21 Sep-Thanksgiving, March through mid-June
  - Probable DTRA follow-up experiment at end of Run10

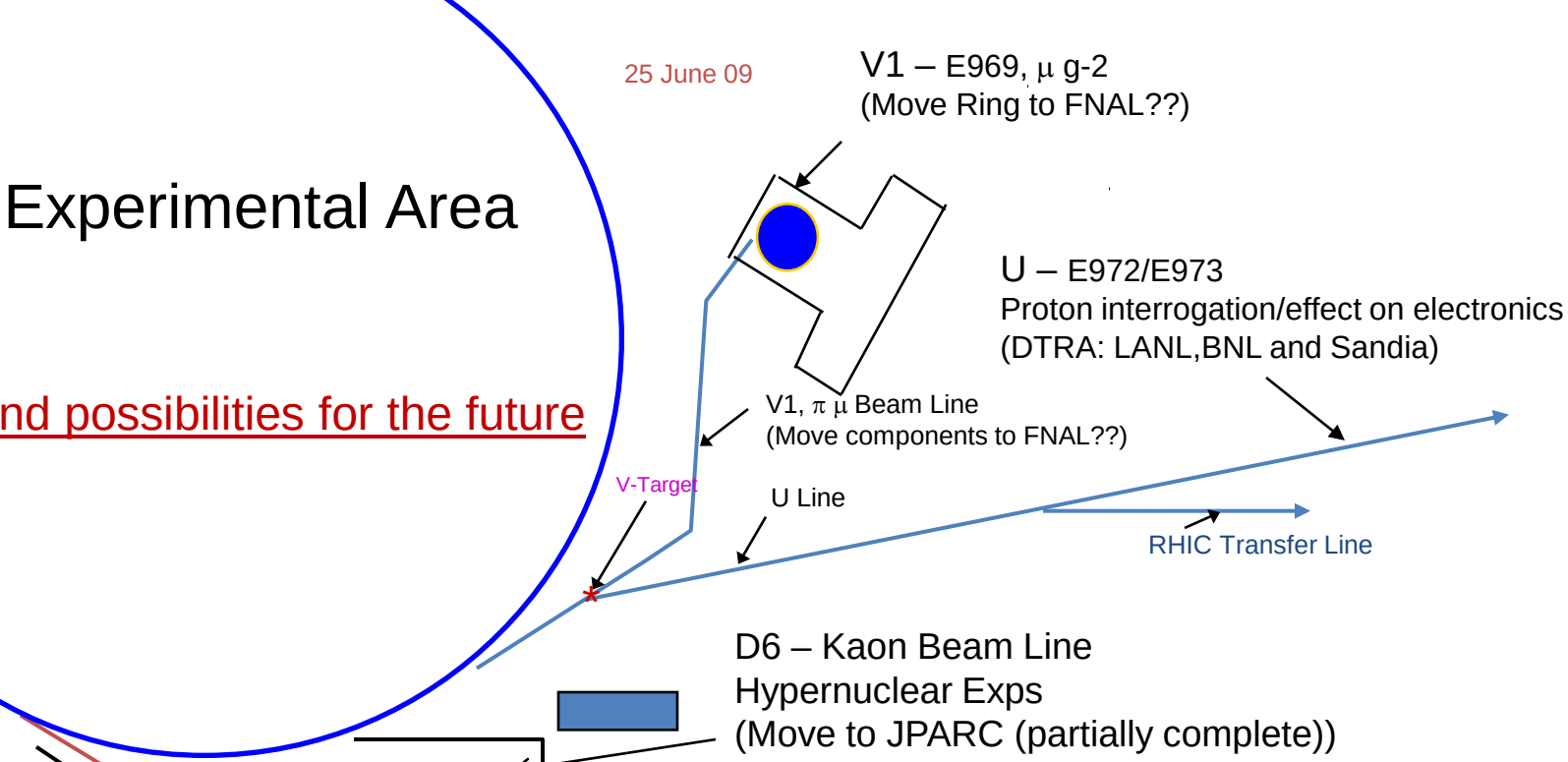
- **Future**
  - NSRL in the EBIS era will continue
  - AGS Fixed Target Possibilities
    - DTRA and/or NNSA in U-Line
    - NASA (new high energy beam line and facility, NASA is considering this to supplement NSRL Galactic Cosmic Ray simulation)
    - Muon g-2, final chapter will not be at AGS, possible move to FNAL
    - Proton edm (new beam line and storage ring – technical reviews etc in progress, CD0 not likely for a while)

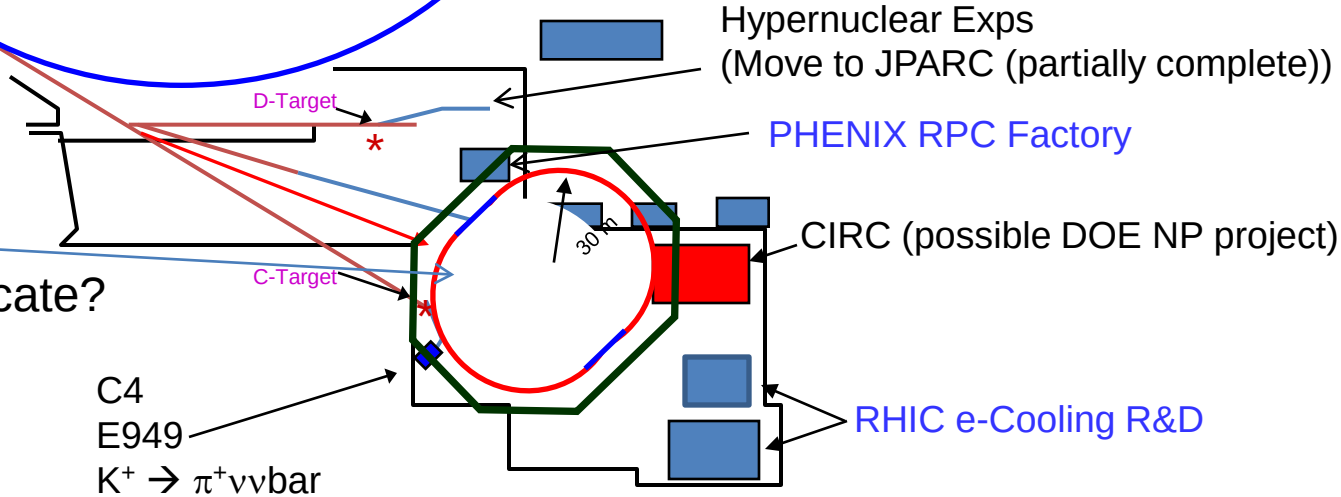
Supplemental Info

AGS Experimental Area

2009 and possibilities for the future

25 June 09



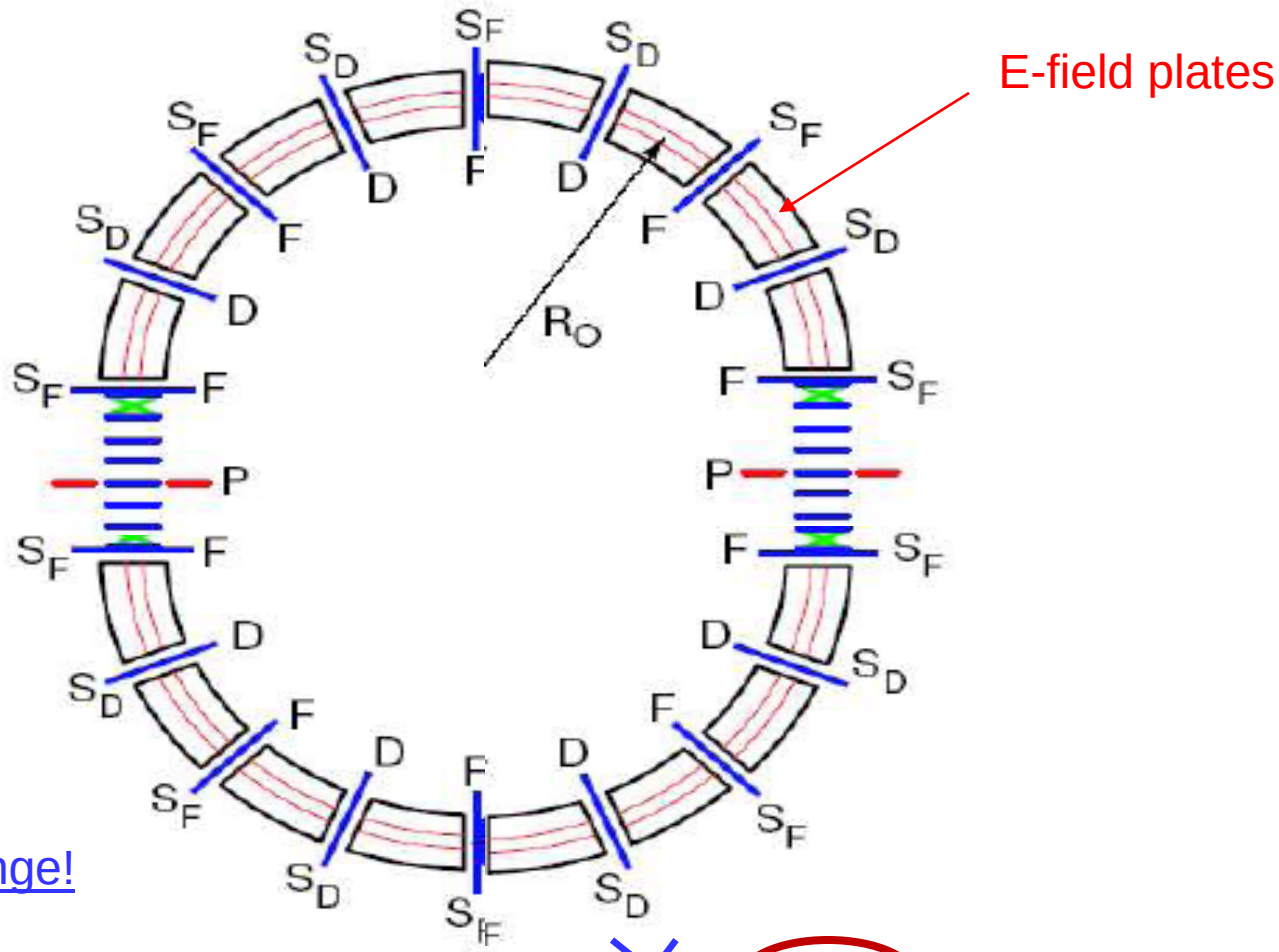


p EDM
Where to locate?

C4
E949
$K^+ \rightarrow \pi^+ \nu\nu bar$
(Move to JPARC??)

Proton EDM lattice

Bunches with opposite polarization (for polarimeter systematic error cancellations)



A challenge!

- Radial E-field of 17MV/m (no dipole B-field). R_0~~25m~~ ~30m
- Magnetic quadrupoles (FODO)
- Magnetic sextupoles (S_F, S_D for Spin Coherence Time)
- P: Polarimeter

Ring parameters

The parameters of the proton beam from the Booster (the AGS will be used as a transfer line only) into the EDM ring are:
Polarization state: vertical, polarization as high as possible (we will assume ~90%)
Intensity: 2×10^{10} in two bunches (opposite polarization vertically) every 500s-1000s.
Emittance (95%, un-normalized):
3-mm-mrad horizontally and
10-mm-mrad vertically.
Beam momentum: 0.7GeV/c (kinetic energy: 232 MeV)
Full momentum spread: $(dp/p)_{max}=10^{-3}$, or $(dp/p)_{rms}=2.5\times10^{-4}$
Running time per year: 10^{7} s.
The total energy of the beam is 1J, and the instantaneous current is 3mA. The required beam vacuum is 10^{-9} Torr.

Good match to operations concurrent with RHIC

- Low beam intensity so no AGS intensity related rehabilitation issues or risk to operation of AGS for RHIC injection

- In addition to numerous technical difficulties, room to build a ring on the AGS building 912 experimental floor an issue.

The Accelerators and non-RHIC programs (cont')

AGS

- Primary mission: HI and polarized proton injector for RHIC

- Past utilization **outside RHIC operations** for dedicated experiments
  - 2000: g-2 experiment, NASA
  - 2001: g-2 experiment, NASA, BES,NNSA and HEP slow beam experiments
  - 2002: NP and HEP slow beam experiments, NASA, NNSA
  - 2003: NASA
  - 2004: HEP and US Atlas tests
  - 2005: NASA
  - 2006-8: none
  - 2009: DTRA experiments

- Utilization **concurrent with RHIC** operations for fixed target experiments
  - 2001-2002: NP and HEP slow beam experiments
  - 2003-present: none
  - Possible Future-new pedm experiment, NASA galactic cosmic ray facility
  - **Issues**:
    - Operations cost
    - Risk to RHIC injector chain if high proton intensity
    - Legacy radiation damage (Cost)

NSRL time-line

- 1988: NASA begins discussion with BNL about possible use of the Booster for space radiation studies
- 1998: Conceptual Design Report finalized, construction authorized
- Built collaboratively by NASA and DOE, at BNL with construction and operations funds from NASA
- NSRL Construction: 1999 – 2002
- 2002-early 2003: NSRL commissioned
- Mid-2003-present: NSRL fully operational
- 2008: getting ready for 3rd run in 2008, begins at end of this month

NSRL Operations

- Operates about 6 months out of a year, mostly Monday-Friday 0600 to 1800 hrs

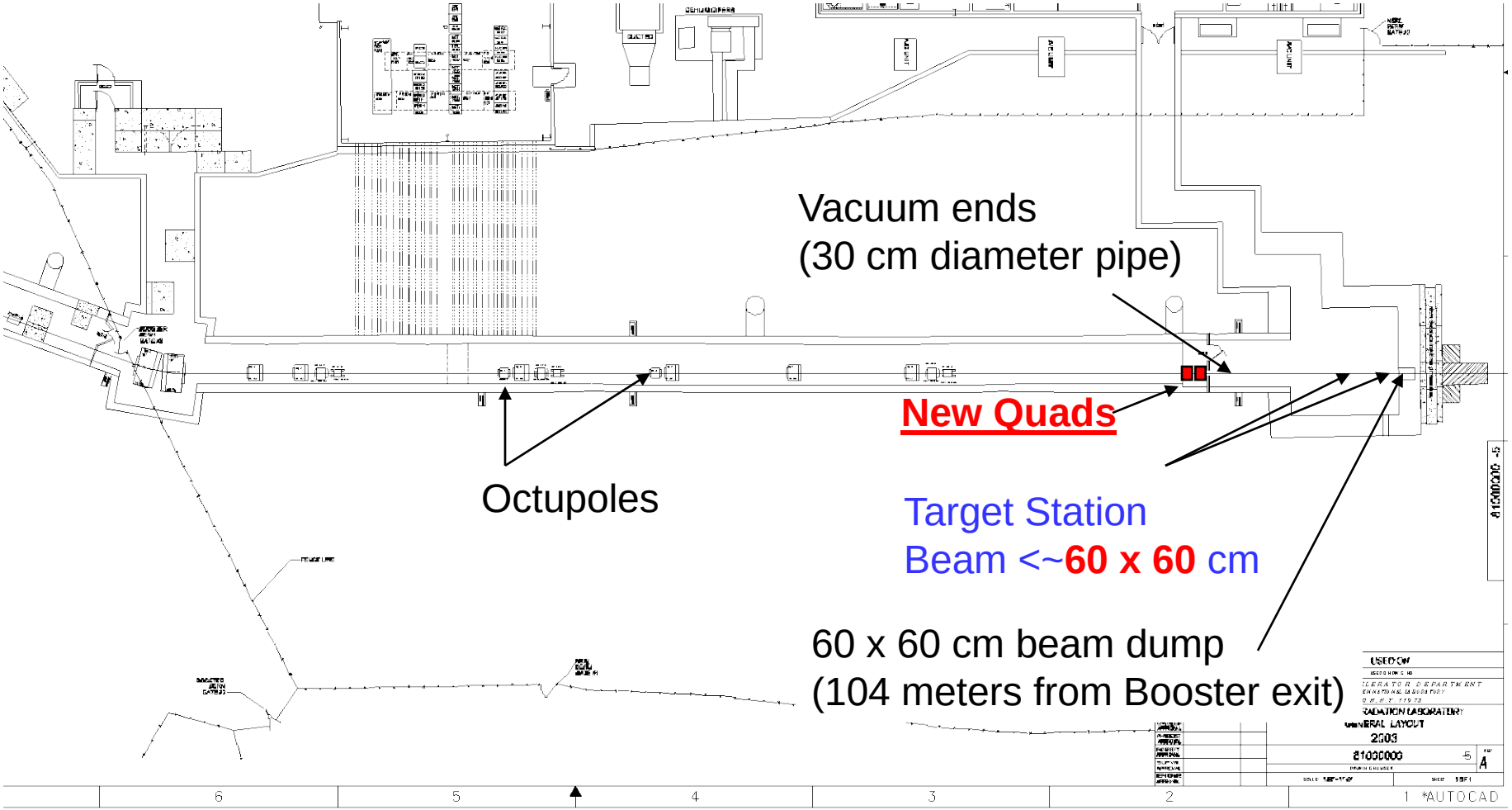
- Operates concurrent with RHIC operations 3-4 months a year
  - RHIC has priority, NSRL off during intensive RHIC HI setup and RHIC HI injection (~1 hr every 4-6 hrs). The new EBIS ion source in 2010 will solve this problem.
  - No interruptions during RHIC proton operations, operates with Booster pulse-to-pulse modulation

Solar Particle Event Simulator with Large Beam

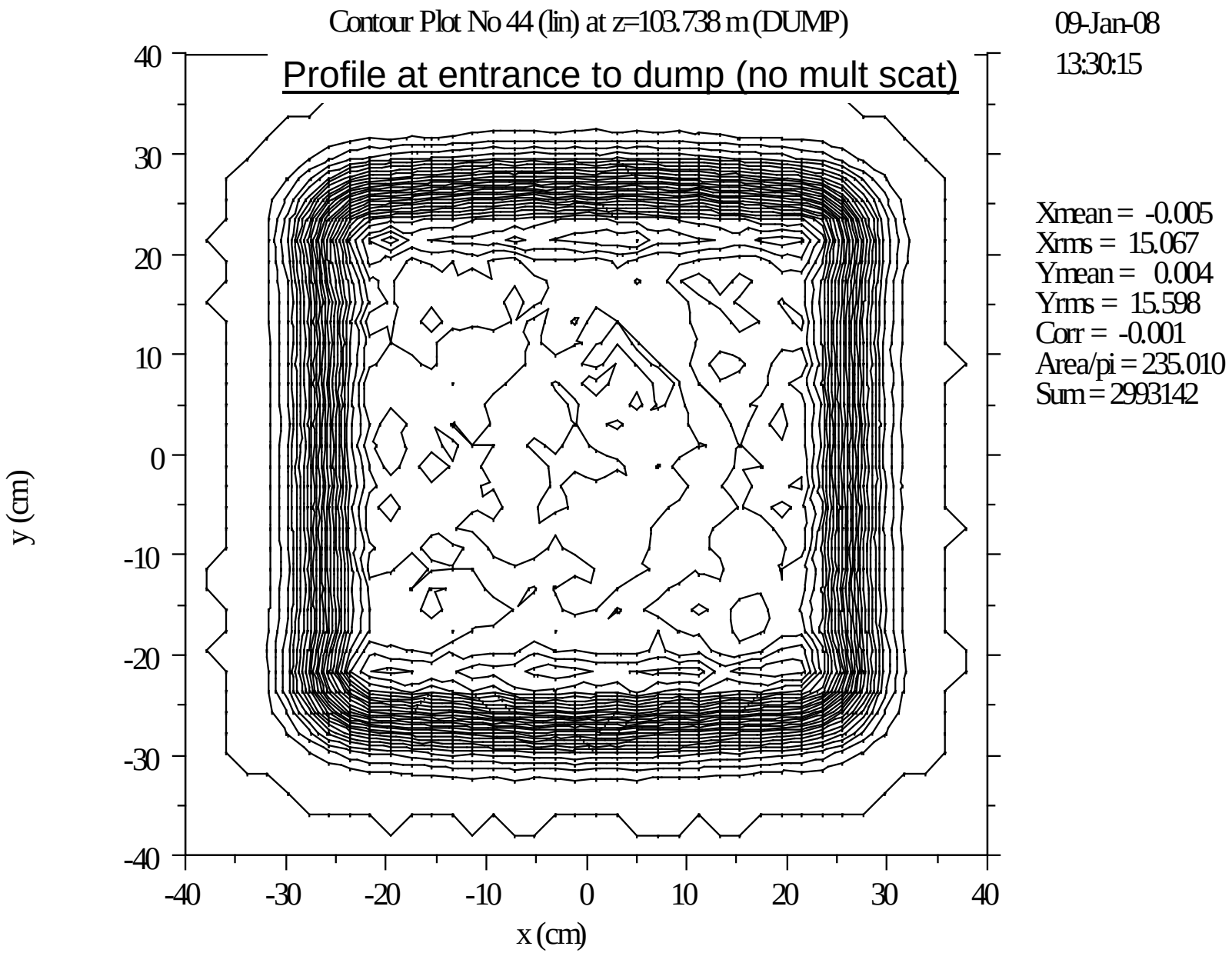
- Adds two 12Q16 quads to allow beam expansion at vacuum exit window
- Allows for target at Dump (104 meters from Booster extraction)
- Beam size limited by beam dump entrance size and dosimetry support rails to ~ 60 x 60 cm (activation issue), optics capable of delivering larger beam size
- Proton energies to 3 GeV, ions to ~ 1.1 GeV/n

NEW FOR SPRING 2009 – Solar Particle Event Simulator

Solar Particle Event Simulator with Large Beam

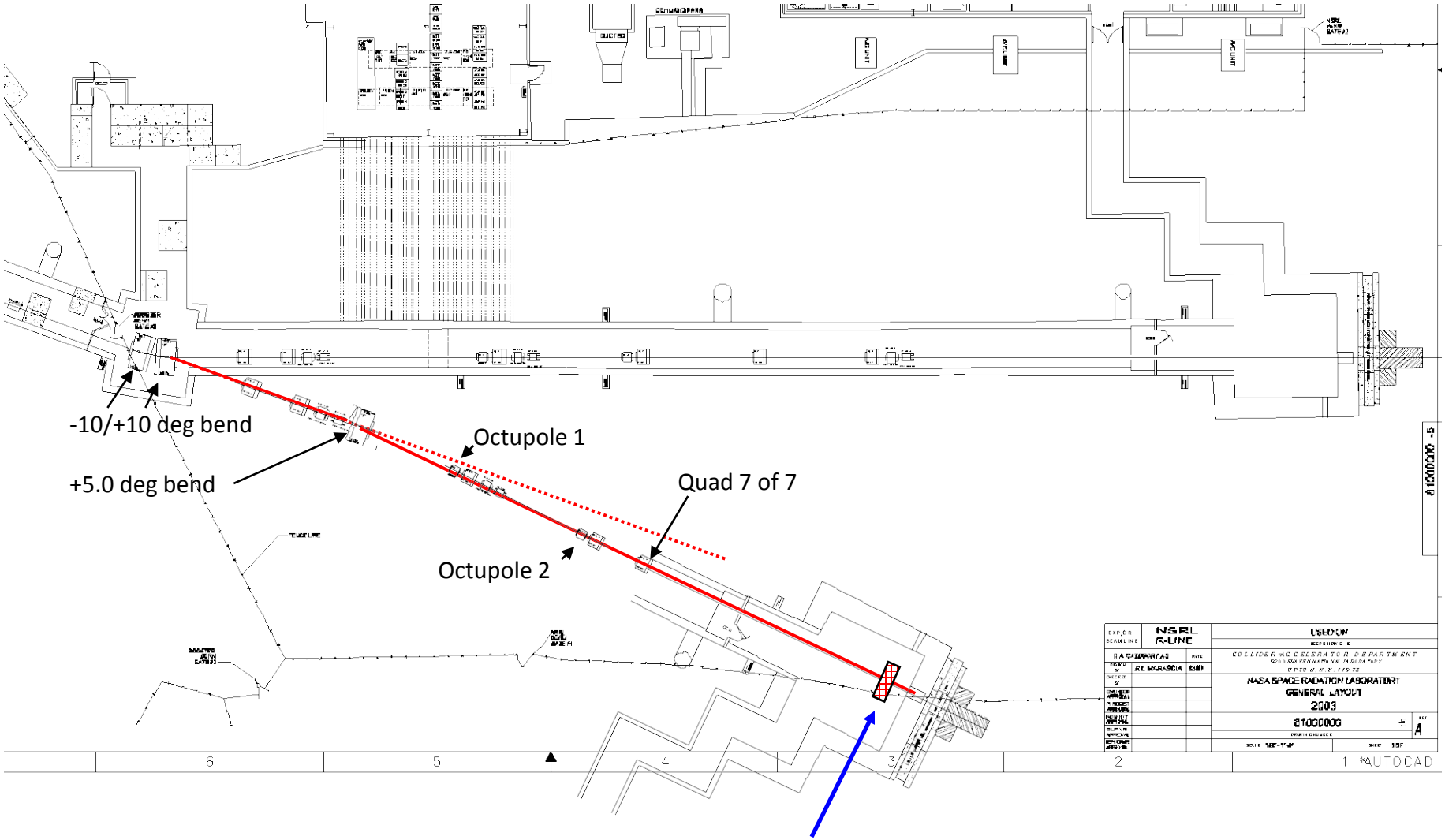


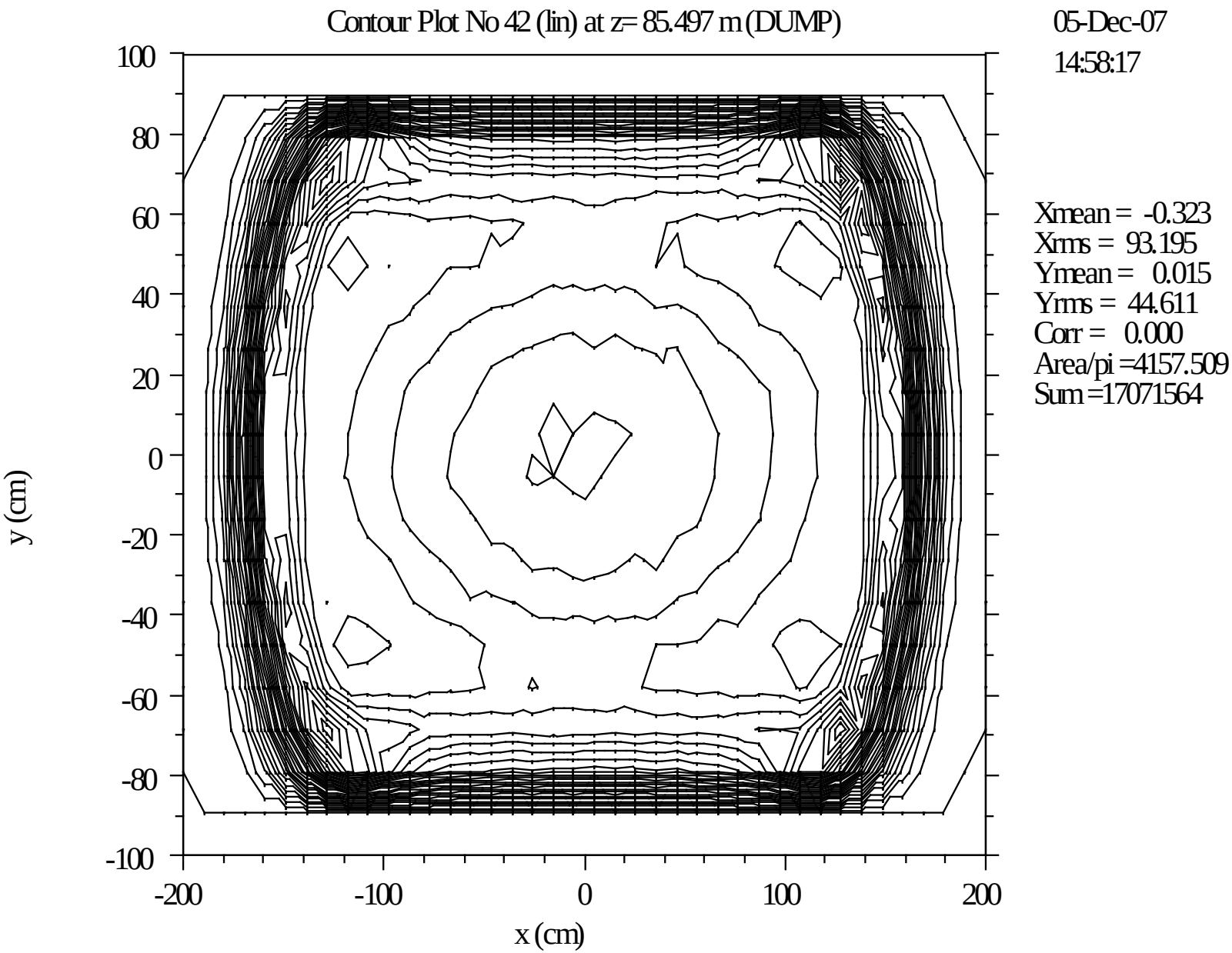
EXAMPLE LARGE BEAM



Another Possible upgrade

NSRL-II 2008 Version-1



New Experiment Facility
'OR' with present facility

EXAMPLE VERY LARGE BEAM, ~3 meters x 1.5 meters NSRL-II 2008-1