Status of the Facility for Rare Isotope Beams

Rare Isotope Accelerator (RIA)

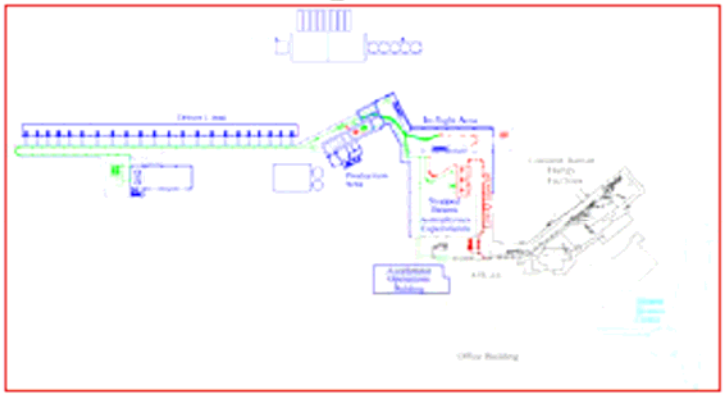
RIA

Connecting nuclei with the universe

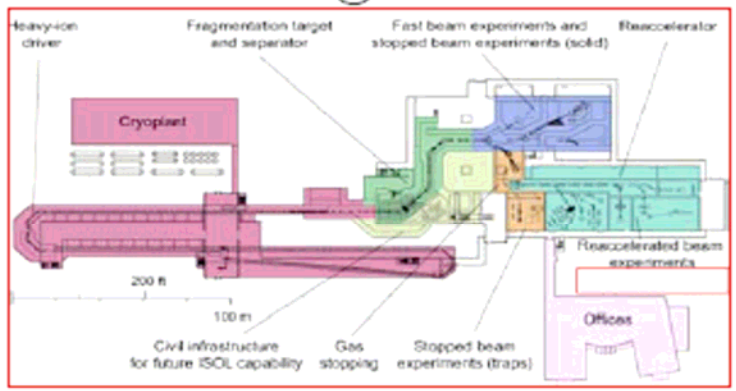
Rare Isotope Accelerator (RIA)

FRIB: Facility for Rare Isotope Beams

AEBL @ ANL



ISF @ MSU



History of the Project: ISOL

LALP 91-51

The IsoSpin Laboratory

ISL

Research Opportunities with Radioactive Nuclear Beams

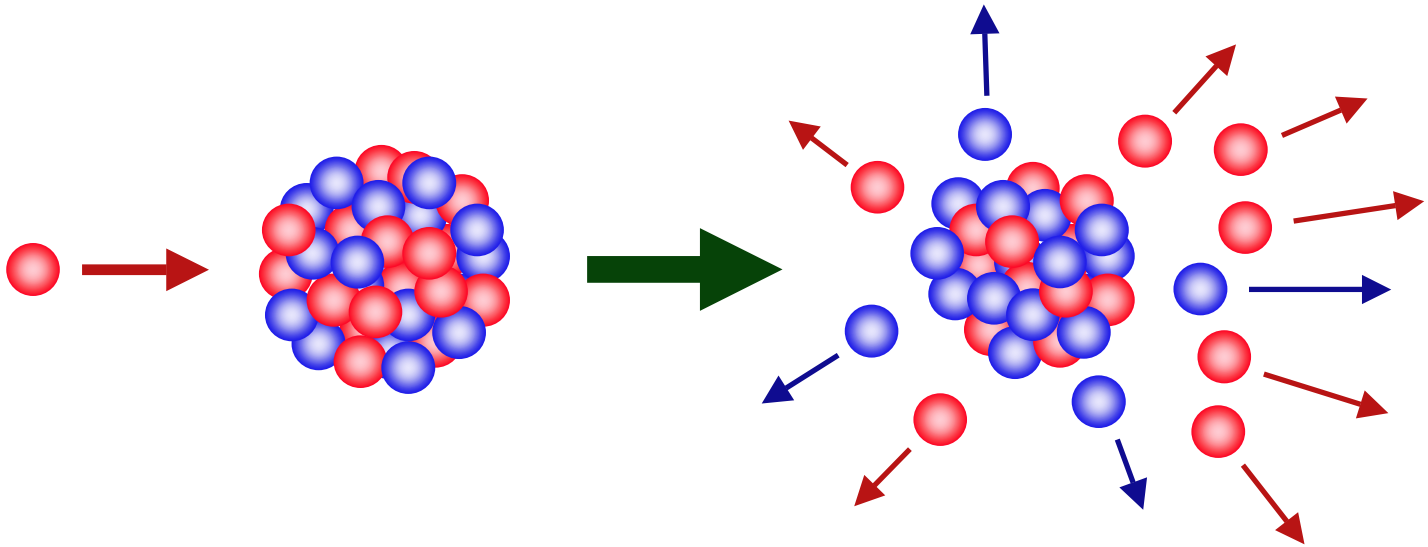
1991

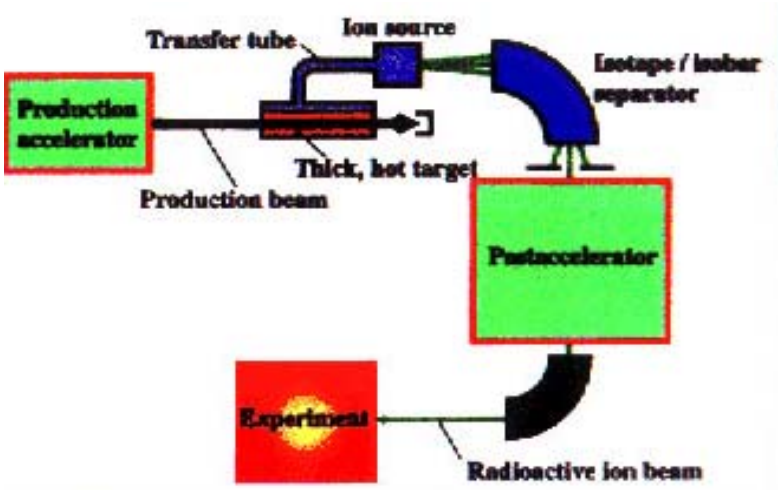
OVERVIEW OF RESEARCH OPPORTUNITIES WITH RADIOACTIVE NUCLEAR BEAMS

An Update--1995

Prepared by the ISL Steering Committee February 1995

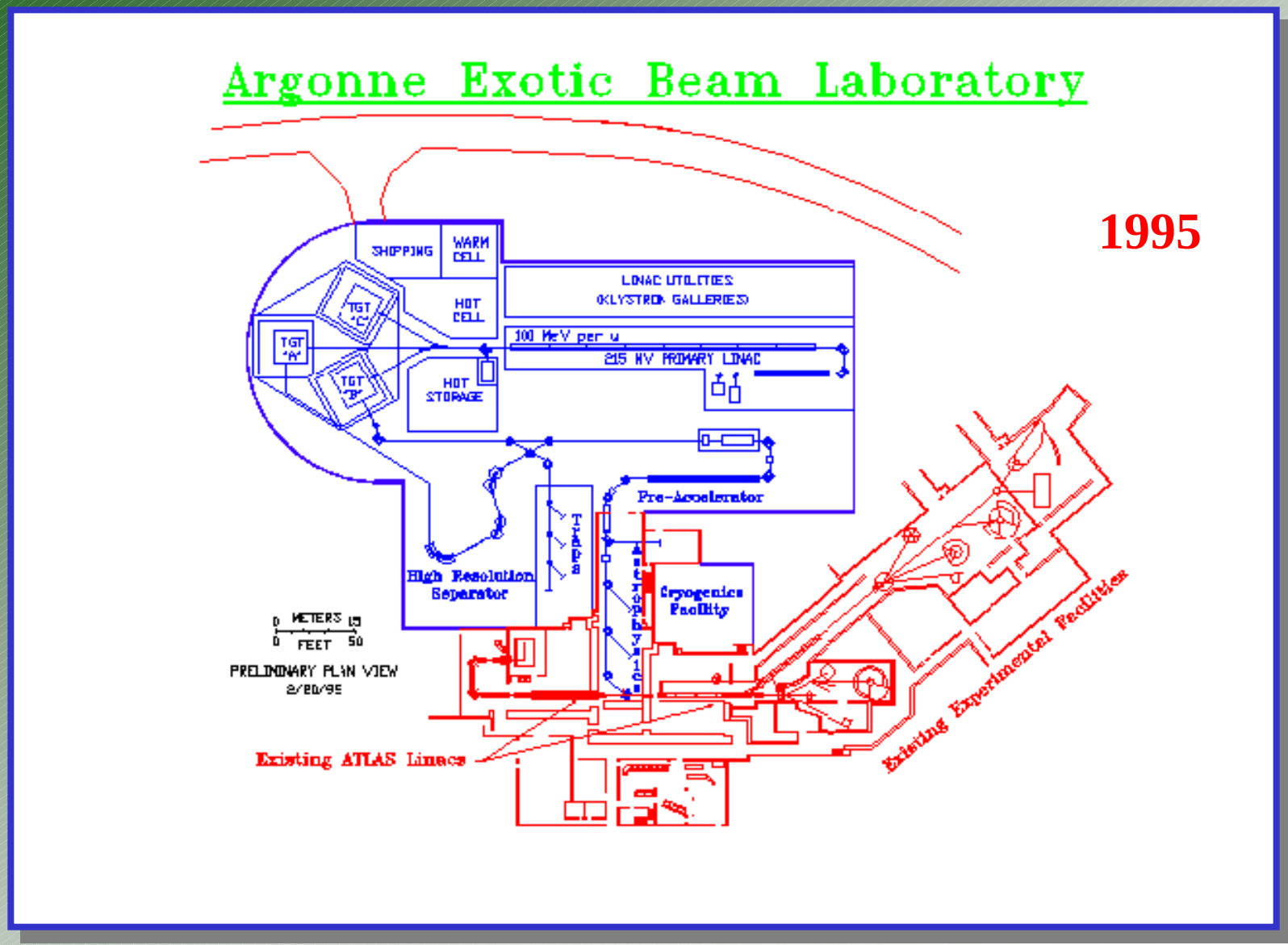
Isotope Separation On-Line (ISOL)



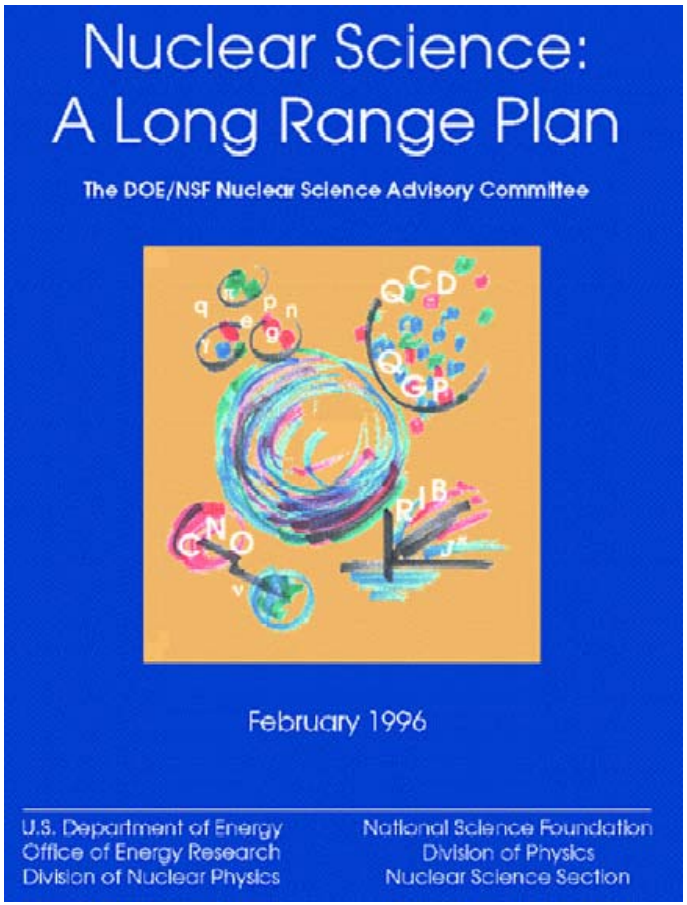


Random removal of protons and neutrons from heavy target nuclei by energetic light projectiles (pre-equilibrium and equilibrium emissions).

The Advanced ISOL Facility at ATLAS



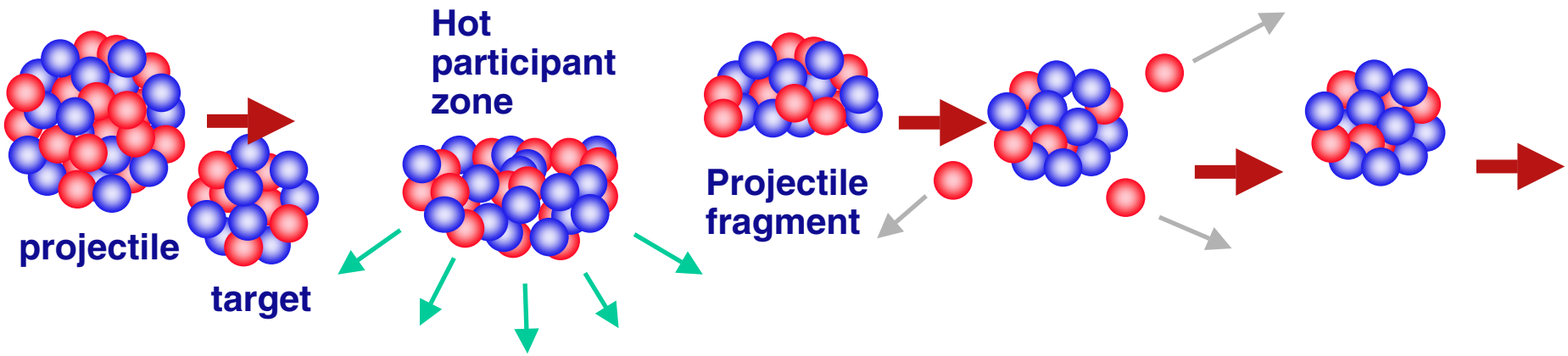
NSAC Long Range Plan 1996



3. The scientific opportunities made available by world-class radioactive beams are extremely compelling and merit very high priority. The U.S. is well-positioned for a leadership role in this important area; accordingly

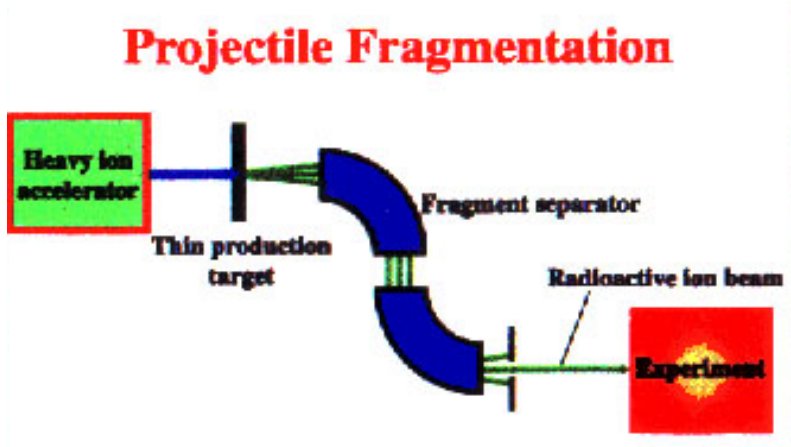
- We strongly recommend the immediate upgrade of the MSU facility to provide intense beams of radioactive nuclei via fragmentation.
- We strongly recommend development of a cost-effective plan for a next generation ISOL-type facility and its construction when RHIC construction is substantially complete.

Projectile Fragmentation

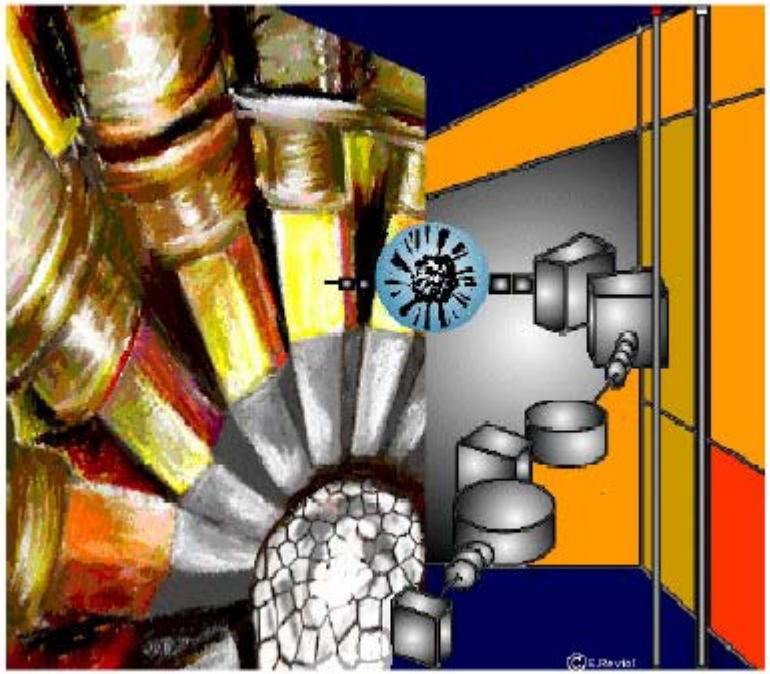


Random removal of protons and neutrons from heavy projectile in peripheral collisions

Cooling by evaporation.



Experimental Equipment



Experimental Equipment for an Advanced ISOL Facility, Lawrence Berkeley National Laboratory

July 22-25, 1998

More Reports

Scientific Opportunities

with an

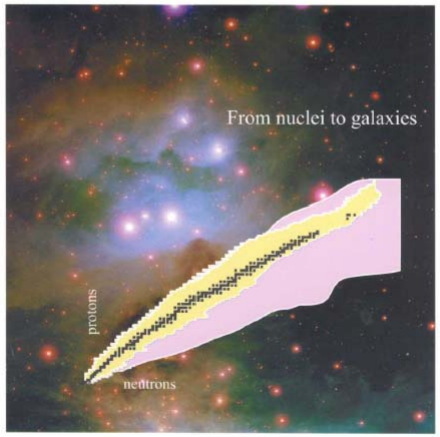
Advanced ISOL Facility

NOVEMBER 1997

1997

The OECD Megascience Forum

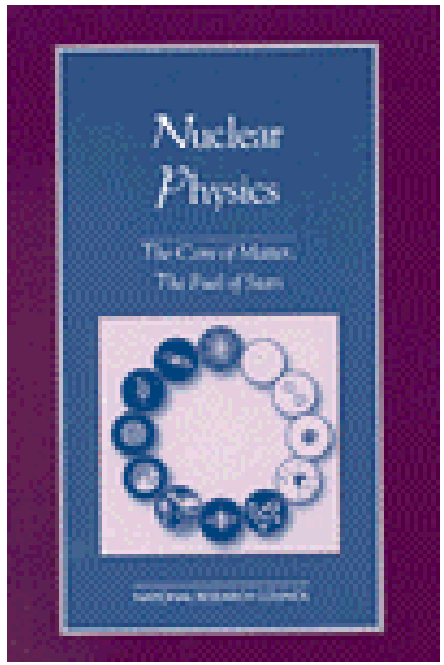
Report from the Working Group
on
Nuclear Physics



ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

OECD OCDE PARIS

1998



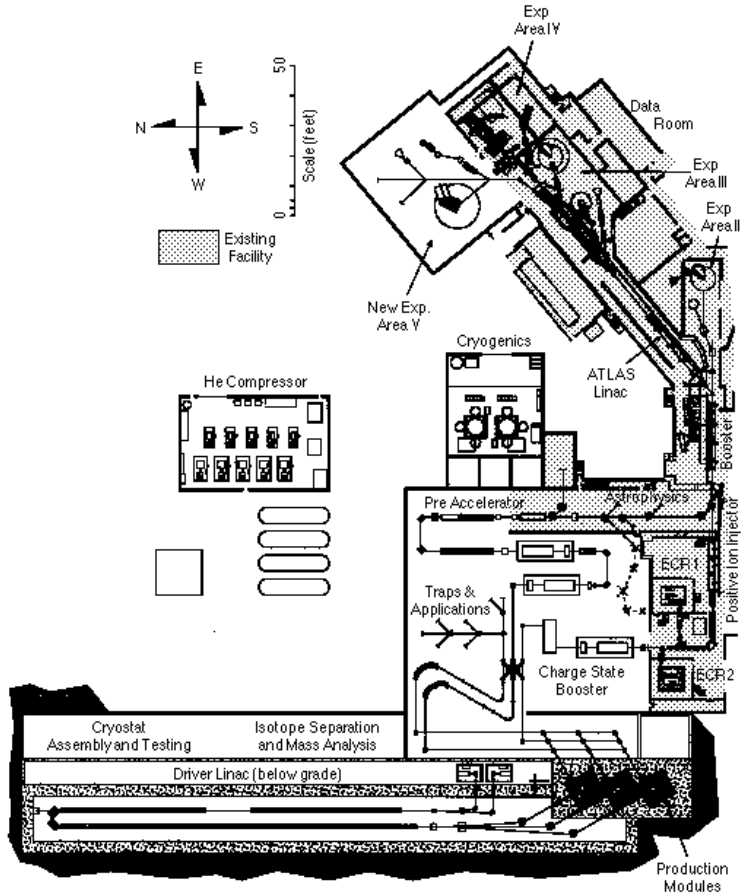
1999

Argonne ISOL Facility

Report to Users
ATLAS FACILITY

March 1999

Edited by: Irshad Ahmad and David Hofman



Layout of the Proposed Argonne ISOL Facility

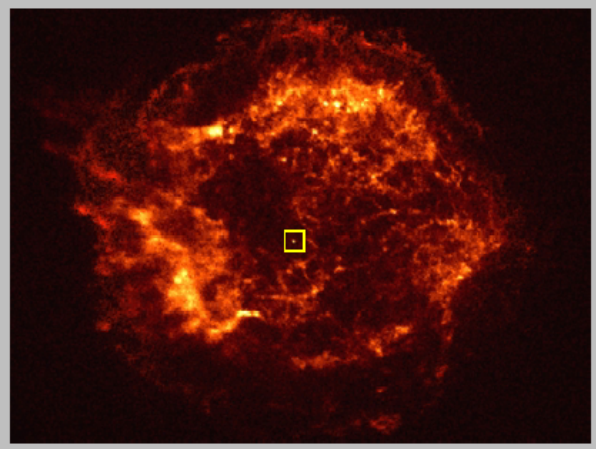
Support from Astrophysics

OPPORTUNITIES

IN

NUCLEAR ASTROPHYSICS

ORIGIN OF THE ELEMENTS



1999

New Concept: RIA

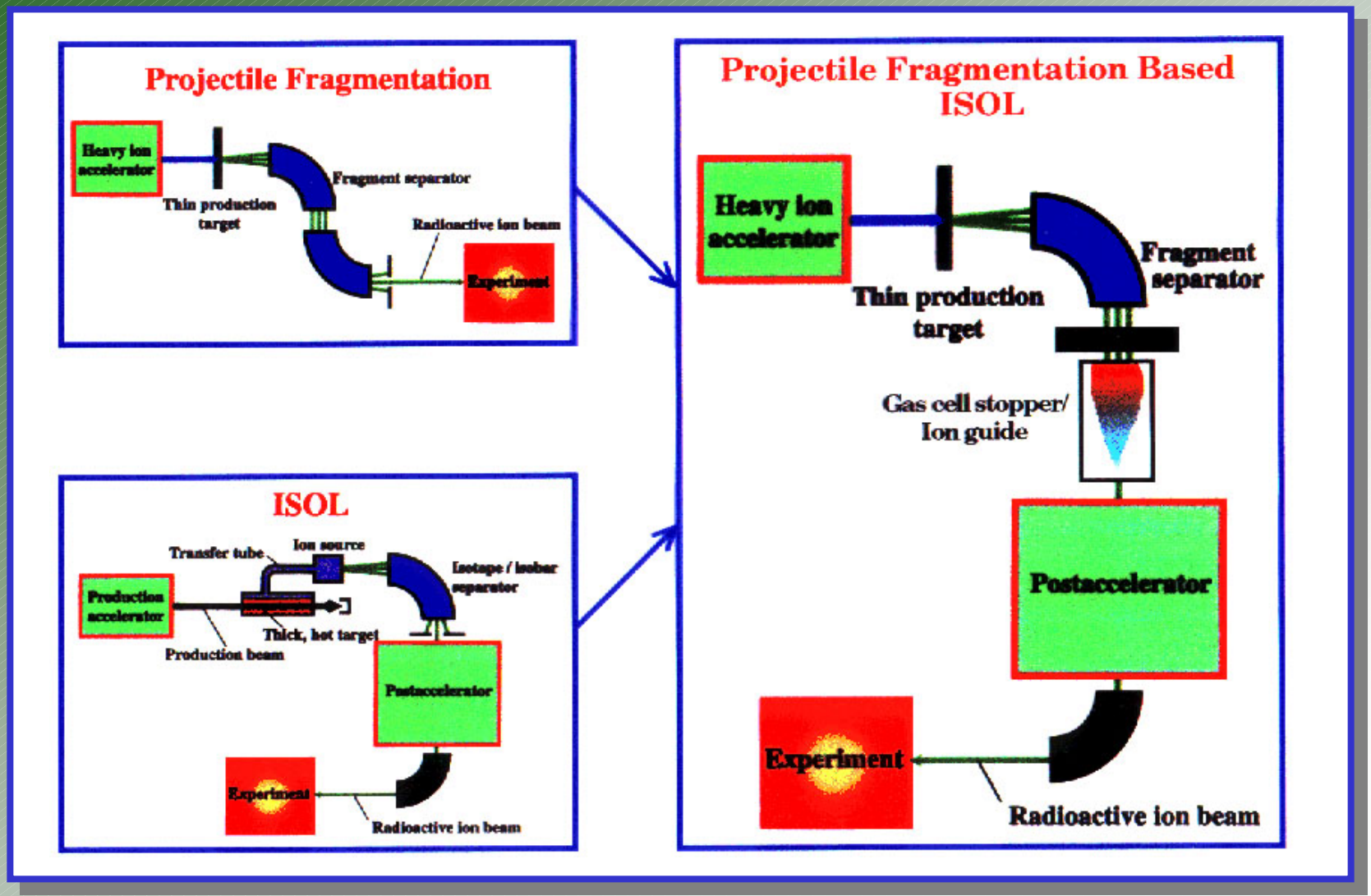
ISOL Task Force Report to NSAC

November 22, 1999

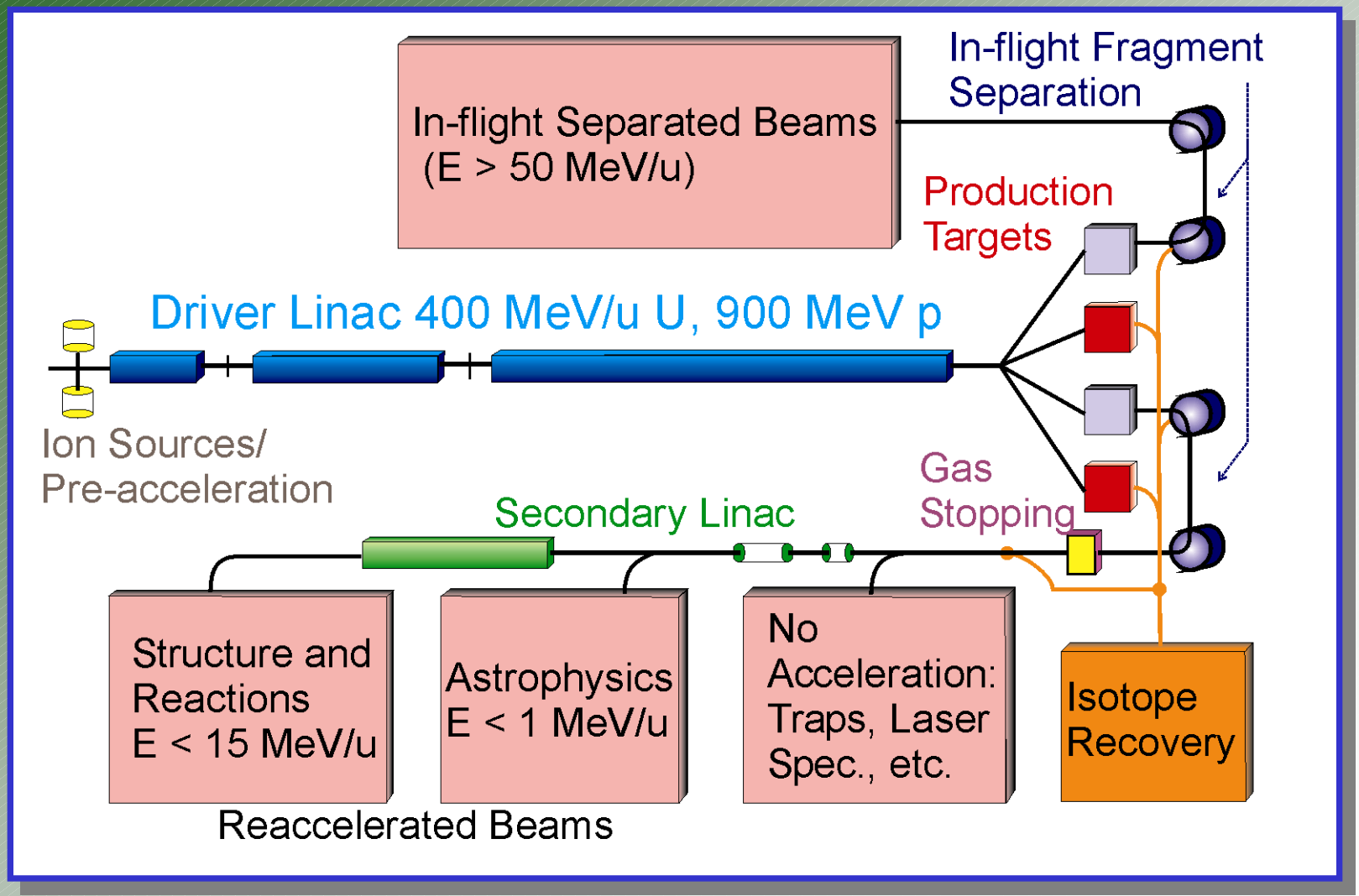
Opportunity: Rare-Isotope Accelerator (RIA) Facility

We have unanimously concluded that the coming decade presents an important opportunity to construct a world-leading facility for the study of short-lived isotopes, which we call the Rare-Isotope Accelerator (RIA) facility. Such a facility will enable a program of experiments with the potential to revolutionize our understanding of the production of nuclei in stellar environments, to advance our knowledge of the structure of nuclei far from stability, and to make stringent tests of the standard model of elementary particles and their interactions.

RIA Concept

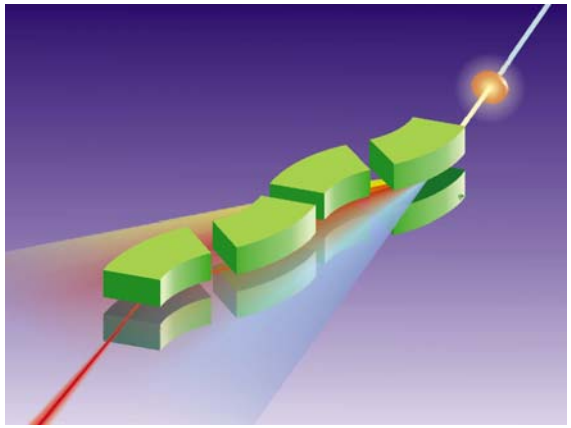


Rare Isotope Accelerator (RIA)



More "White" Papers

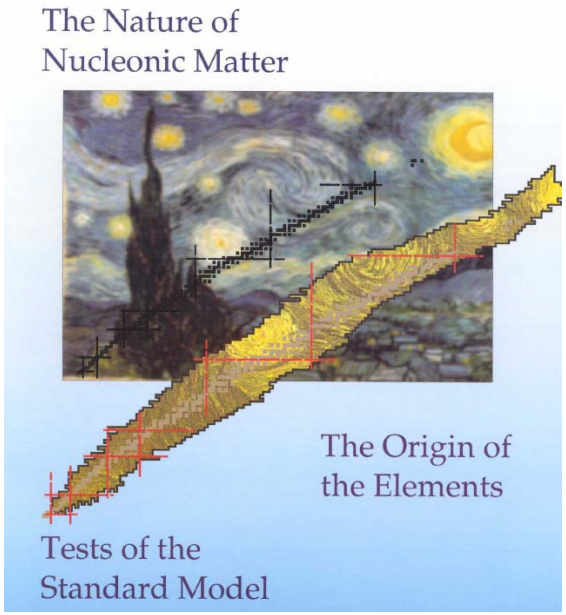
Scientific Opportunities with Fast Fragmentation Beams from RIA



National Superconducting Cyclotron Laboratory
Michigan State University

March 2000

RIA Physics White Paper



HOME

RIA Applications Workshop 2000

Summary of the RIA Applications Workshop

October 30-31, 2000
Los Alamos National Laboratory

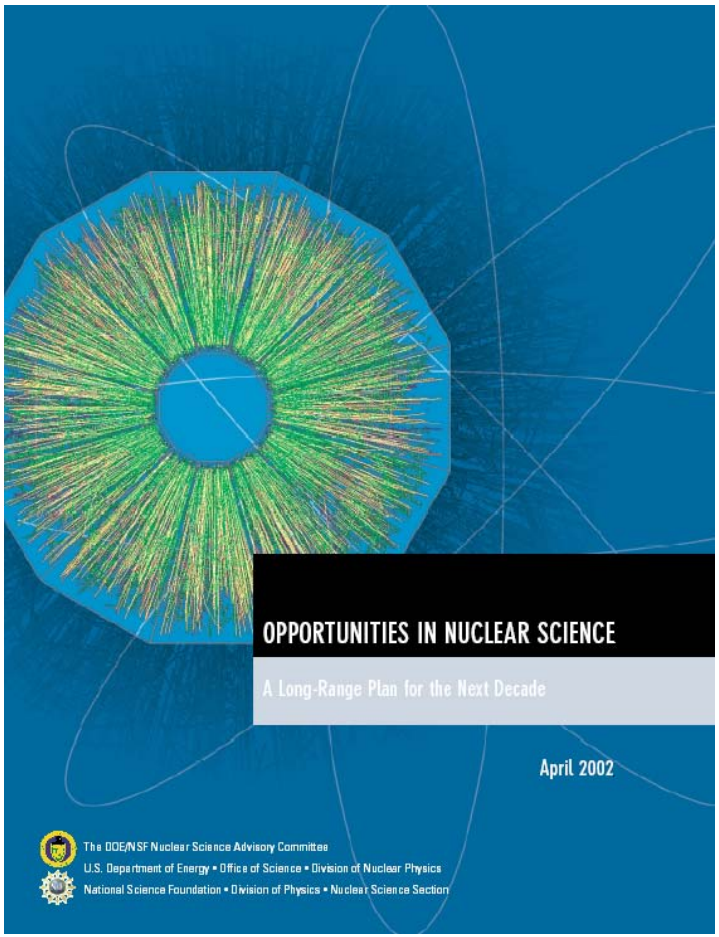
Nuclear Structure and Astrophysics Town Meeting

Draft 2.0

Oakland, CA

November 9-12, 2000

NSAC Long Range Plan 2002



RECOMMENDATION 1

- *Increase support for facility operations—especially our unique new facilities, RHIC, CEBAF, and NSCL—which will greatly enhance the impact of the nation's nuclear science program.*

RECOMMENDATION 2

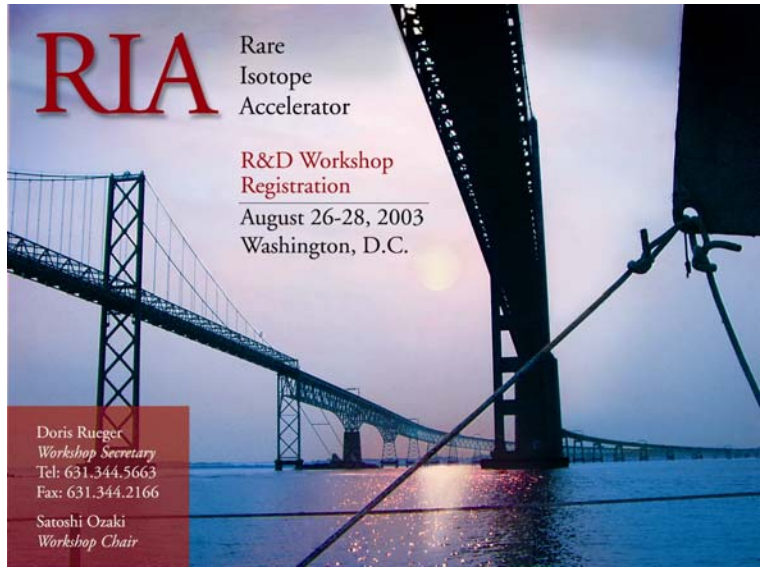
The Rare Isotope Accelerator (RIA) is our highest priority for major new construction. RIA will be the world-leading facility for research in nuclear structure and nuclear astrophysics.

More Workshops and Meetings

The Intellectual Challenges of RIA

A White Paper from the RIA Users Community

Nov 19, 2002



RIA Workshop on the Experimental Equipment for RIA

March 18-22, 2003 ▪ Oak Ridge, Tennessee

DOE 20-Year Science Facility Plan

November 10, 2003

Energy Secretary Spencer Abraham Announces Department of Energy 20-Year Science Facility Plan

Sets Priorities for 28 New, Major Science Research Facilities

WASHINGTON, DC – In a speech at the National Press Club today, U.S. Energy Secretary Spencer Abraham outlined the Department of

RIA

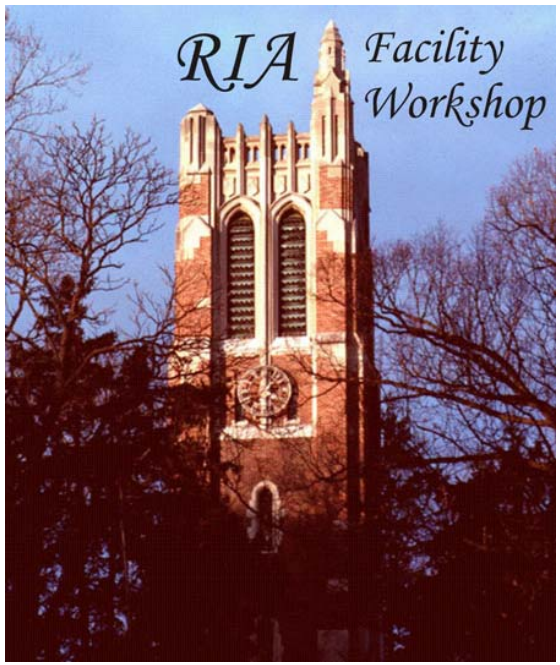
Rare Isotope Accelerator

http://www.sc.doe.gov/Sub/Facilities_for_future/20-Year-Outlook-screen.pdf

More Reports and Workshops

February 23, 2004 Report of the NSAC Subcommittee on

Comparison of the Rare Isotope Accelerator (RIA) and the Gesellschaft für Schwerionenforschung (GSI) Future Facility



MSU

March 9-13, 2004

RIA Theory Group

Blue Book, 2005

Ode to Nature: IV, Copyright Julio Mateo, 1985
Used by permission from the artist. www.mateo.net

More NSAC Reviews

February 23, 2004

"Comparison of the Rare Isotope Accelerator (RIA) and the Gesellschaft für Schwerionenforschung (GSI) Future Facility"

We reaffirm a very strong science case associated with study of rare isotopes. … RIA and the GSI future facility were designed for quite different purposes and each has unique capabilities.

June23, 2005

"Guidance for Implementing the 2002 Long Range Plan"

RIA remains the highest priority of our field for major new onstruction.

The subcommittee continues to be guided by the 2002 LRP, following the recommendation that RIA can proceed only with a significant influx of new funding

Rare Isotope Science Assessment Committee

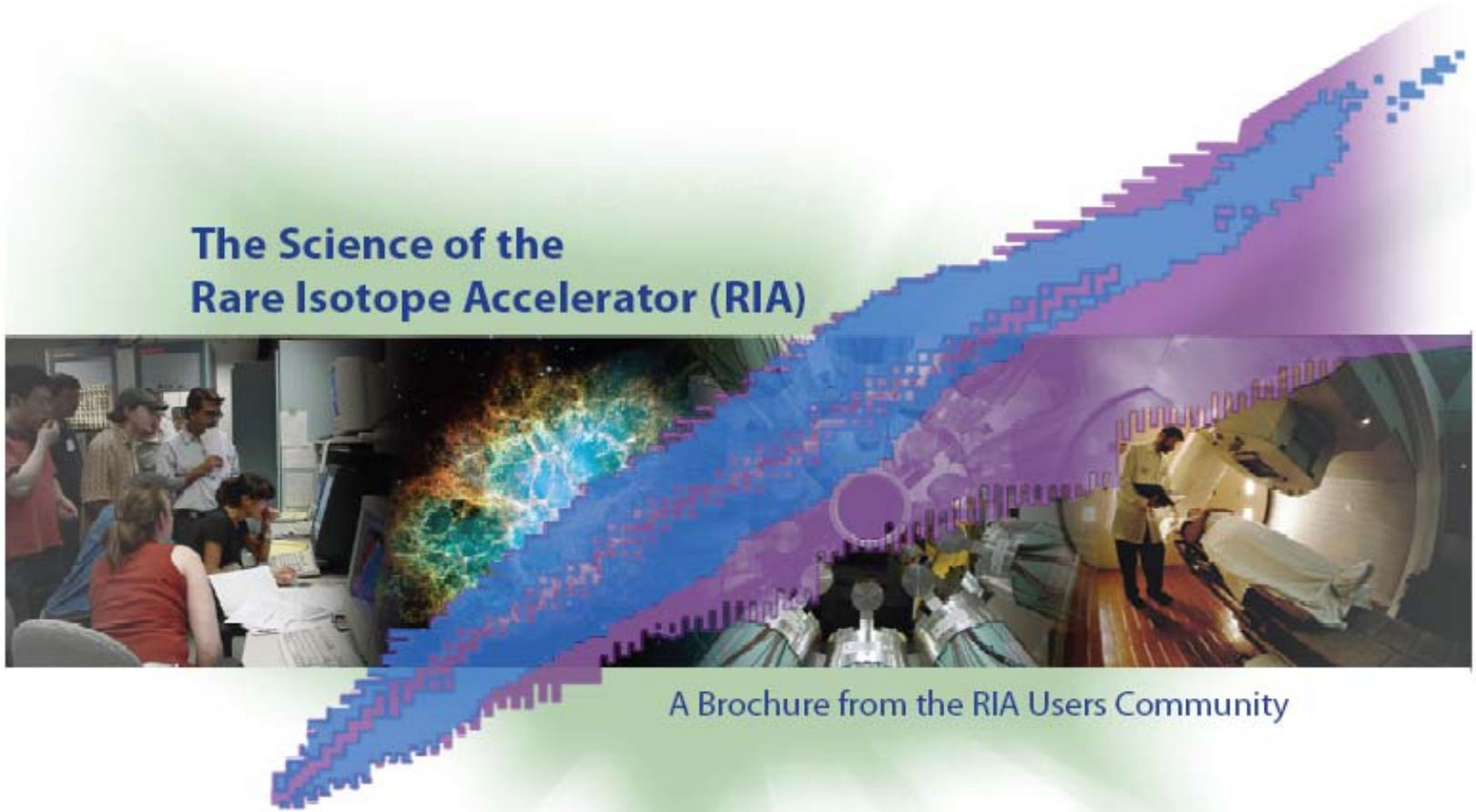
BOARD ON PHYSICS AND ASTRONOMY

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

Statement of Task:
In particular, the committee will address the following questions:

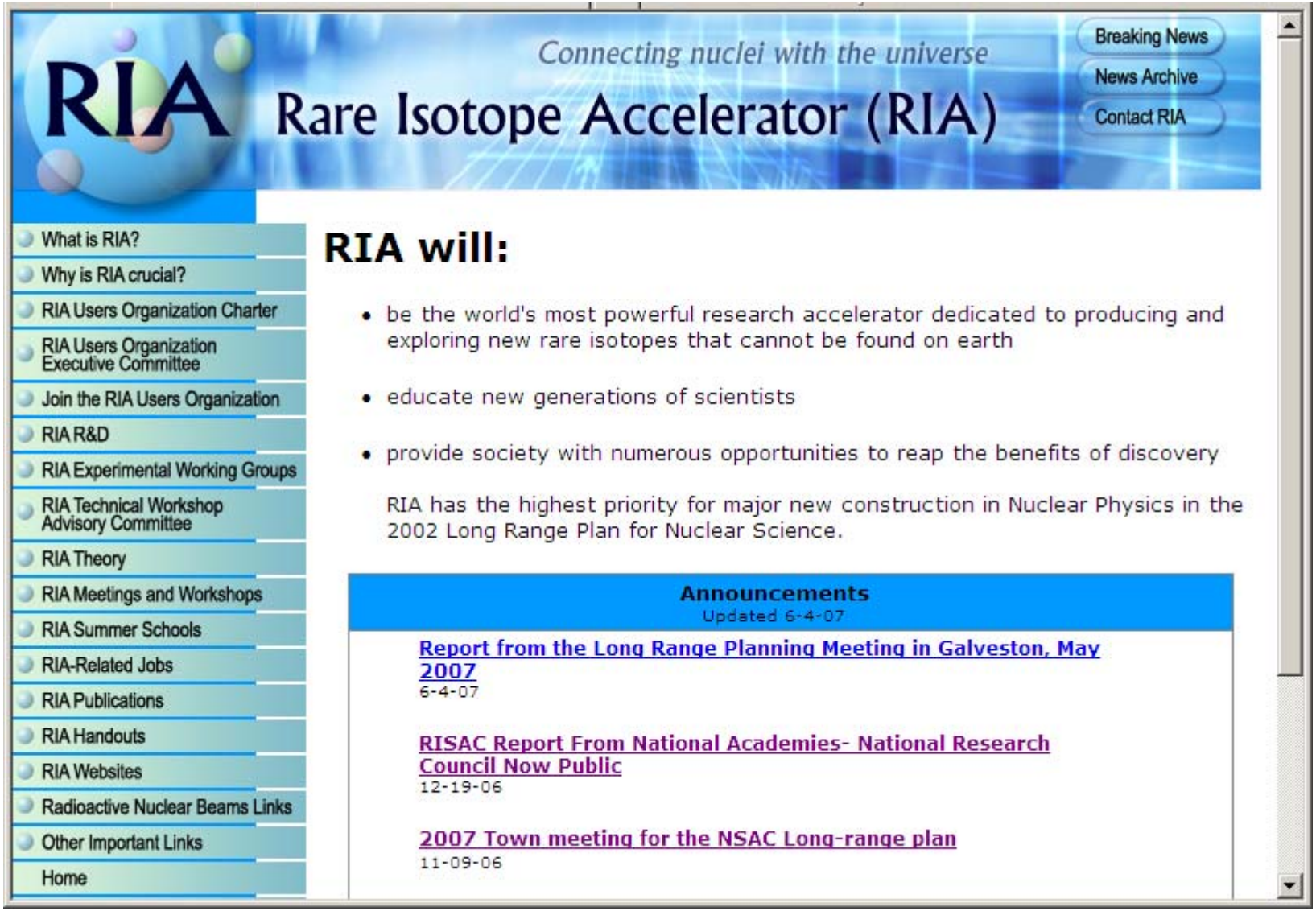
- What science should be addressed by a rare isotope facility and what is its importance in the overall context of research in nuclear physics and physics in general?
- What are the **capabilities of other facilities**, existing and planned, domestic and abroad, to address the science agenda? What scientific role could be played by a domestic rare-isotope facility that is complementary to existing and planned facilities at home and elsewhere?
- What are the **benefits to other fields of science and to society** of establishing such a facility in the United States?

RIA Users Group Brochure



2006

RIA Users Group Website



RIA Users Organization Charter

1. *Definition and Purpose:*

The RIA Users' Organization is a group whose members are interested in the Rare Isotope Accelerator (RIA) for the purpose of conducting scientific research and developing new technology. The purposes of this association are:

(a) To work towards the realization and timely construction of RIA

(b) To articulate and promote the scientific case for RIA and its significance to society

(c) To promote and enhance the RIA research and development effort and other RIA related activities to maximize its scientific potential

(d) To act as an advocate for the needs of the RIA users

Organization of RIA Users Groups

http://www.orau.org/ria/

http://www.orau.org/ria/RIATG/

http://www.ariaweb.org/

Experimental Working Groups

http://groups.nscl.msu.edu/dariti/

DARITI Working Group

Decay spectroscopy At RIA: Into Terra Incognita

http://radware.phy.ornl.gov/greta/join.html

http://mare.tamu.edu/ria/separators.html

RIA Separator Working Group for the E/A=10MeV Experimental Area

http://www.nscl.msu.edu/~zegers/RIA/spectrometer.html

RIA Spectrograph working group

http://nuchem.chem.rochester.edu/SHIRIA/

SHIRIA Work Group

Studies of Heavy-Ion Reactions at RIA

RISAC Report

- Nuclear structure and nuclear astrophysics constitute a vital component of the nuclear science portfolio in the United States.
- Failure to pursue a U.S.-FRIB would likely lead to a forfeiture of U.S. leadership in nuclear-structure-related physics and would curtail the training of future U.S. nuclear scientists.
- A U.S. facility for rare-isotope beams of the kind described to the committee would be complementary to existing and planned international efforts, particularly if based on a heavy-ion linear accelerator. With such a facility, the United States would be a partner among equals in the exploration of the world-leading scientific thrusts listed above.
- The science addressed by a rare-isotope facility, most likely based on a heavy-ion driver using a linear accelerator, should be a high priority for the United States. The facility for rare-isotope beams envisaged for the United States would provide capabilities unmatched elsewhere that would help to provide answers to the key science topics outlined above.

Long Range Plan Town Meetings

Nuclear Astrophysics and Study of Nuclei

Town Meeting ,Chicago, January 2007

The highest priority in low-energy nuclear physics be the construction of a heavy-ion linac based rare isotope facility, including the capabilities for stopped, re-accelerated and in-flight beams to realize the scientific potential defined by the community and endorsed by the National Academies of Sciences in their recent RISAC report.

NSAC LRP Recommendation May 2007

- We recommend completion of the 12 GeV Upgrade at Jefferson Lab. The Upgrade will enable new insights into the structure of the nucleon, the transition between the hadronic and quark/gluon descriptions of nuclei, and the nature of confinement.
- We recommend construction of the Facility for Rare Isotope Beams, FRIB, a world-leading facility for the study of nuclear structure, reactions and astrophysics. Experiments with the new isotopes produced at FRIB will lead to a comprehensive description of nuclei, elucidate the origin of the elements in the cosmos, provide an understanding of matter in the crust of neutron stars, and establish the scientific foundation for innovative applications of nuclear science to society.

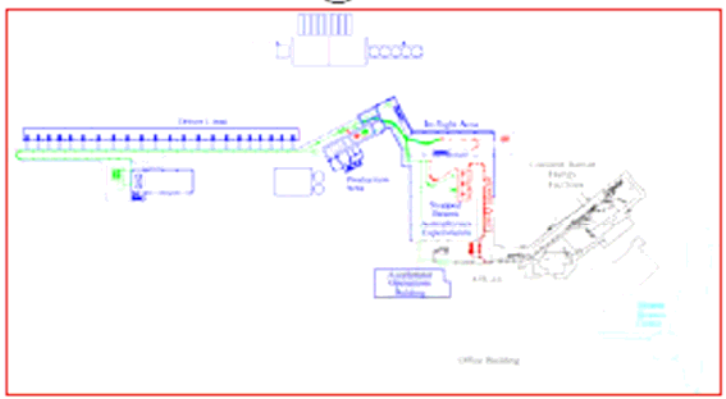
RIB Task Force Report: August 2007

"We recommend that DOE and NSF proceed with solicitation of proposals for a FRIB based on the 200 MeV, 400 kW superconducting heavy-ion driver linac at the earliest opportunity."

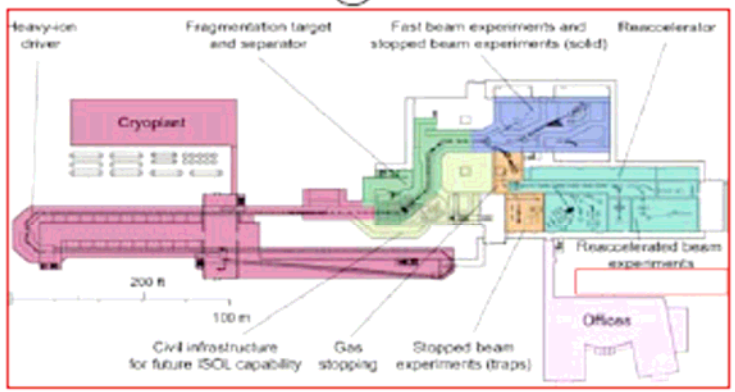
Current Status of Two Options

FRIB: Facility for Rare Isotope Beams

AEBL @ ANL



ISF @ MSU



Argonne Exotic Beam Laboratory

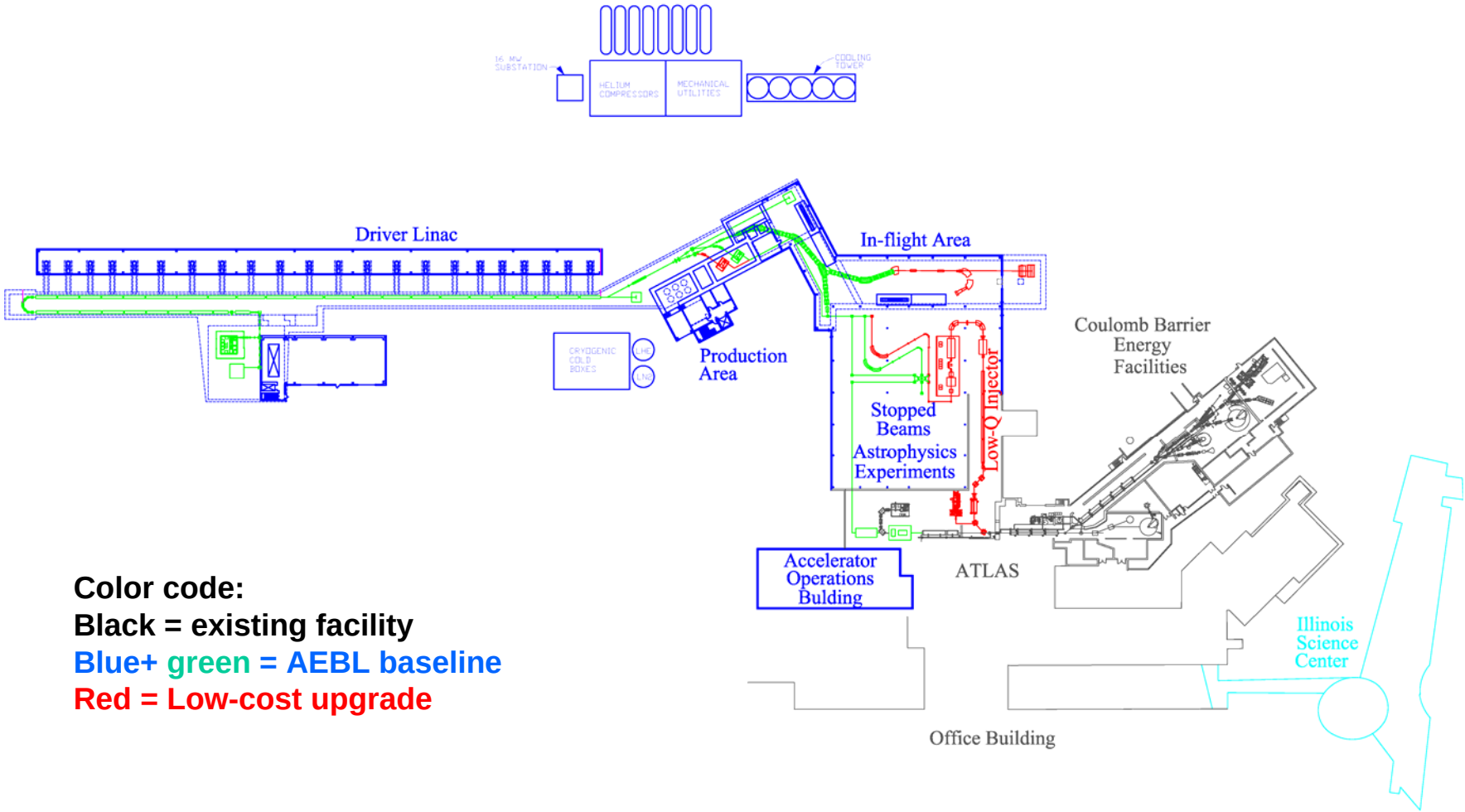
Isotope Science Facility

Argonne Exotic Beam Laboratory

- Complements the major investments in Europe and Japan in fast-beam fragmentation facilities by focusing on unique reaccelerated exotic beams. The facility will provide the full capabilities of stopped, reaccelerated and in-flight beams.
- 200 MeV/u superconducting linac driver will provide higher yields of all isotopes.
- With reaccelerated beams based on gas-stopping and ISOL, vastly exceeds the capabilities of all reaccelerated beam facilities.

ANL slides adapted from D. Geesaman,
2nd ANL-FNAL Collaboration Meeting, May 18, 2007

AEBL Layout



Color code:
Black = existing facility
Blue+ green = AEBL baseline
Red = Low-cost upgrade

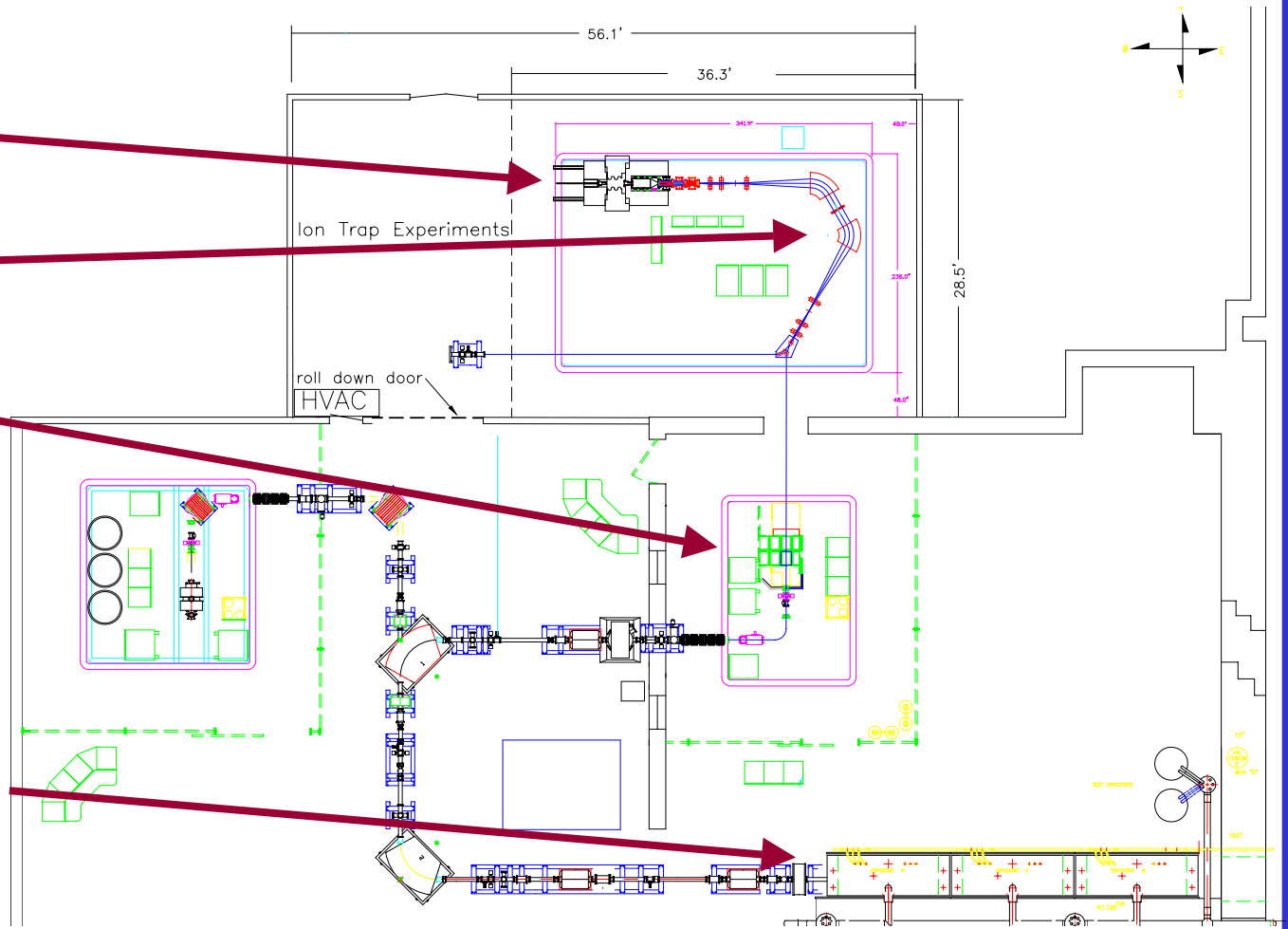
CARIBU

Gas Catcher

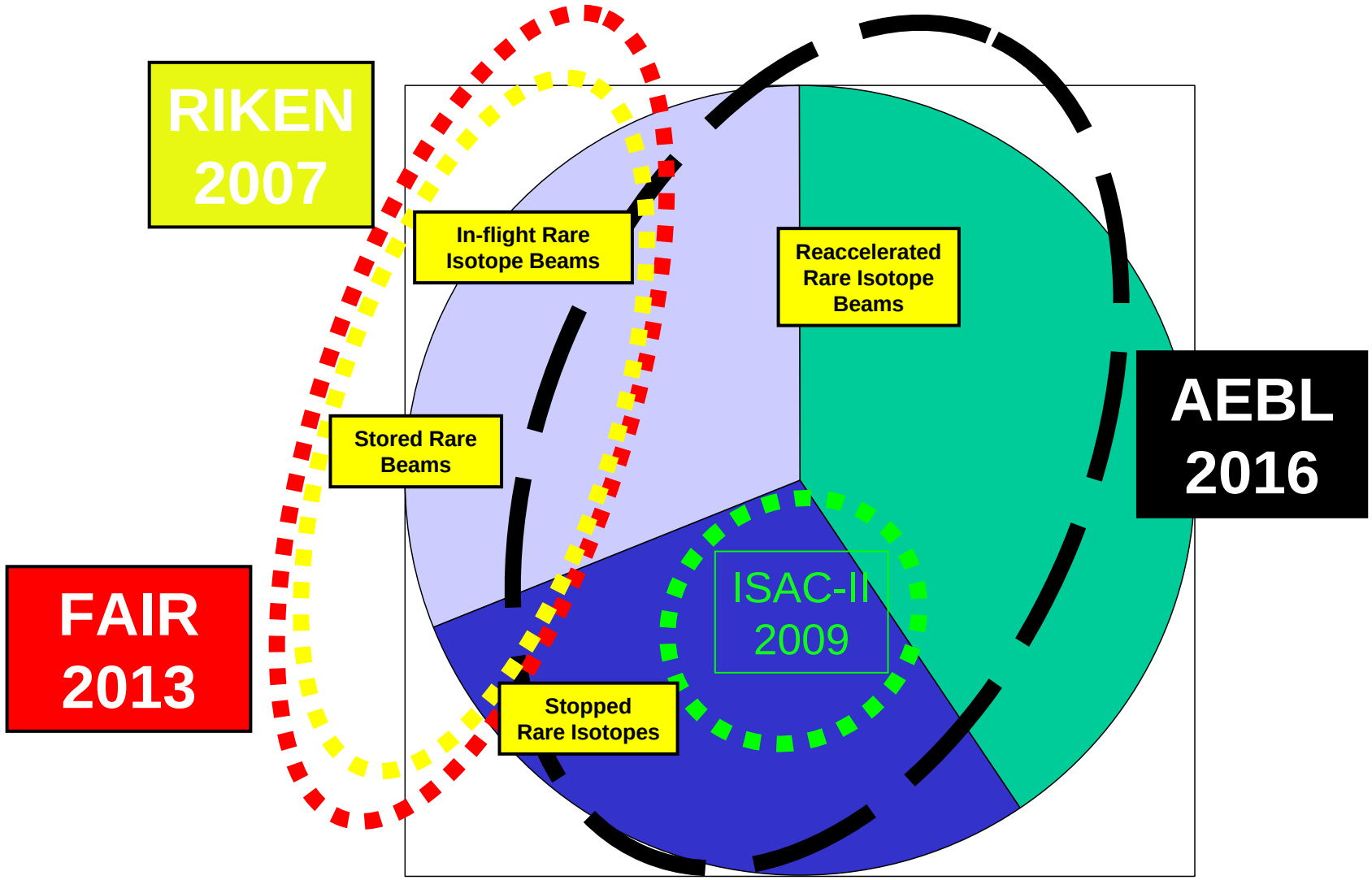
High Resolution Isotope Separator

Charge Breeding in ECR Source

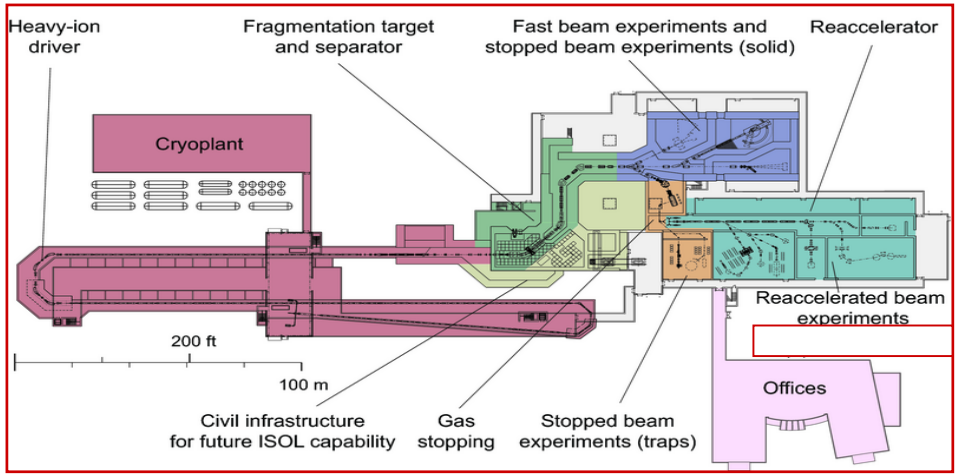
Post-acceleration of weak beams



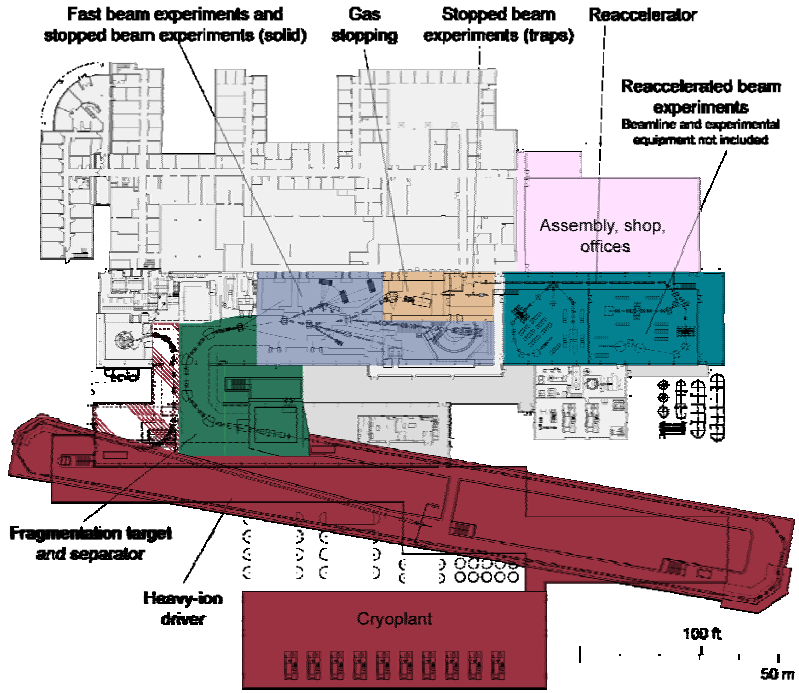
International Context



Two Options for ISF at MSU



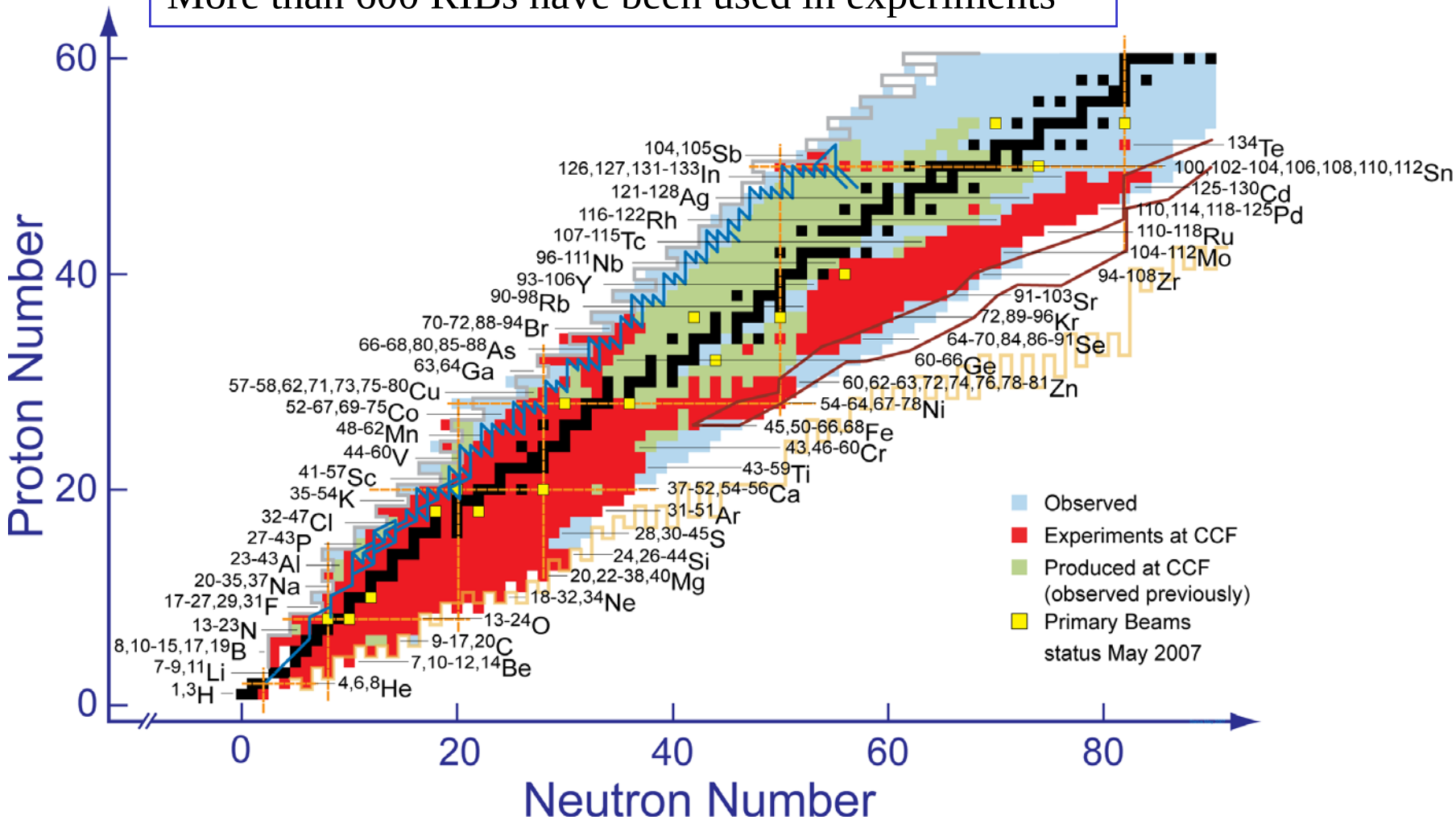
New South Campus Facility allows unconstrained optimization



Upgrade at NSCL site: constrained by space available, but less costly by ~ $100 M; will need further optimization…

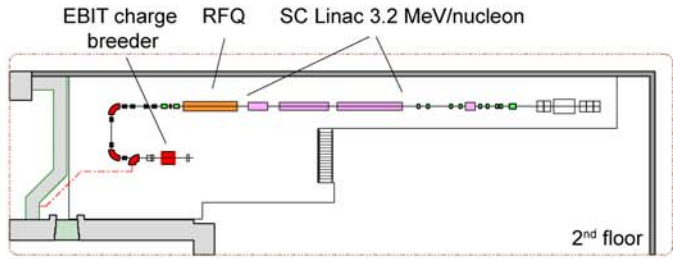
Rare Isotope Beams Produced at NSCL

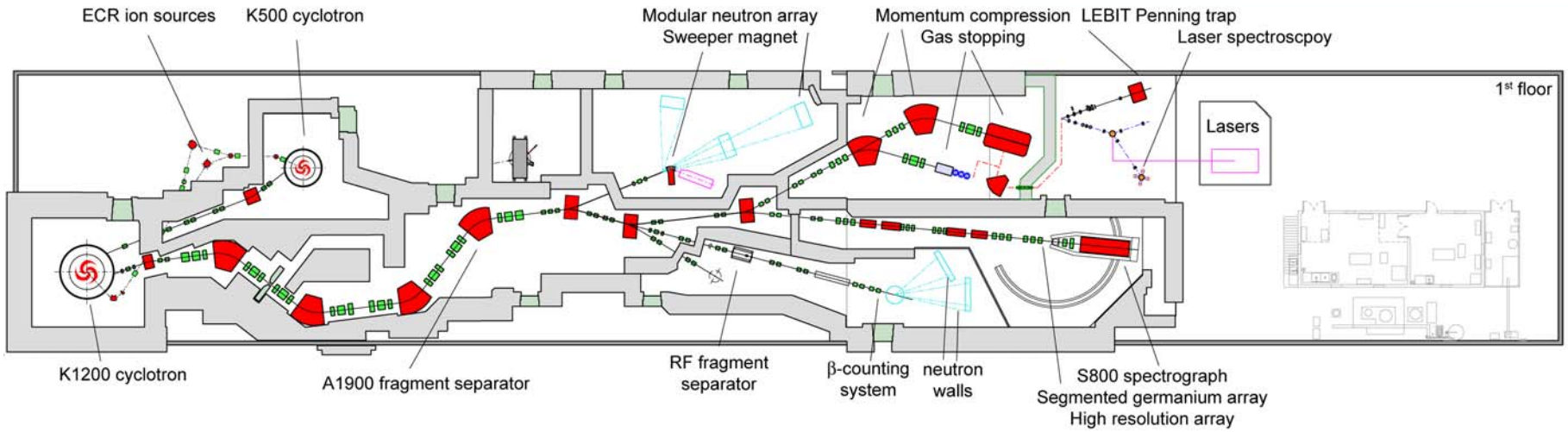
More than 900 RIBs have been made
More than 600 RIBs have been used in experiments



NSCL Facility Plan

- The NSCL is currently developing an innovative facility for efficiently stopping and accelerating rare isotopes produced and separated in flight
  - Ongoing design and construction of gas stopper, EBIT charge breeder, RFQ, 3.2 MeV/nucleon SC linac
- World unique capability by 2010
  - Detectors for science program at conceptual stage e.g., $^{30}P(p,\gamma)^{31}S$; (p,p) excitation functions, (p,α) reactions …





Advantages of ISF at NSCL

- NSCL is a world-leading rare-isotope research facility
  - One of three nuclear-science flagship facilities in the US
    - RHIC at BNL, CEBAF at JLab, NSCL at MSU
    - Competes well with the world-leading laboratories GSI, GANIL, RIKEN
- One of the few university-based national user facilities
  - Big Science in an open academic environment offers unique synergy between cutting edge research and education
  - MSU educates more than 10% of the nation's nuclear science PhD's; its nuclear science graduate program is ranked #2 (behind MIT)
- Excellent prospects for the near-term (5-10 years) future
  - Significant risk investment into reaccelerator project by MSU to remain world-leading
- An upgrade with a 200 MeV/nucleon driver linac would ensure continued world-leadership for the coming decades
  - Builds on existing strength and experience in operating the premier rare isotope user facility in the U.S.
  - Continued hands-on education of nuclear science work-force via cost-effective synergy of education and research

Future Plans

Solicitation for Facility for Rare Isotope Beams

(December 2007)

- Funding Opportunity Announcement for U.S. Facility for Rare Isotope Beams is anticipated in FY 2008
- Contents of draft FOA are confidential
- Anticipate making a single award in FY 2008
- There is no FY 2008 funding associated with the award - identifies a site that can proceed with facility establishment. Future funding depends on Appropriation.
- A web site will be available that will manage questions related to the FRIB FOA process

- Conceptual Design Report (CDR) funding requested for FY 2009-2010
- Preliminary Engineering and Design (PED) funding requested for FY 2011-2013
- Construction starts in FY 2013

FOA expected within the next two weeks…..