



National Superconducting Cyclotron Laboratory

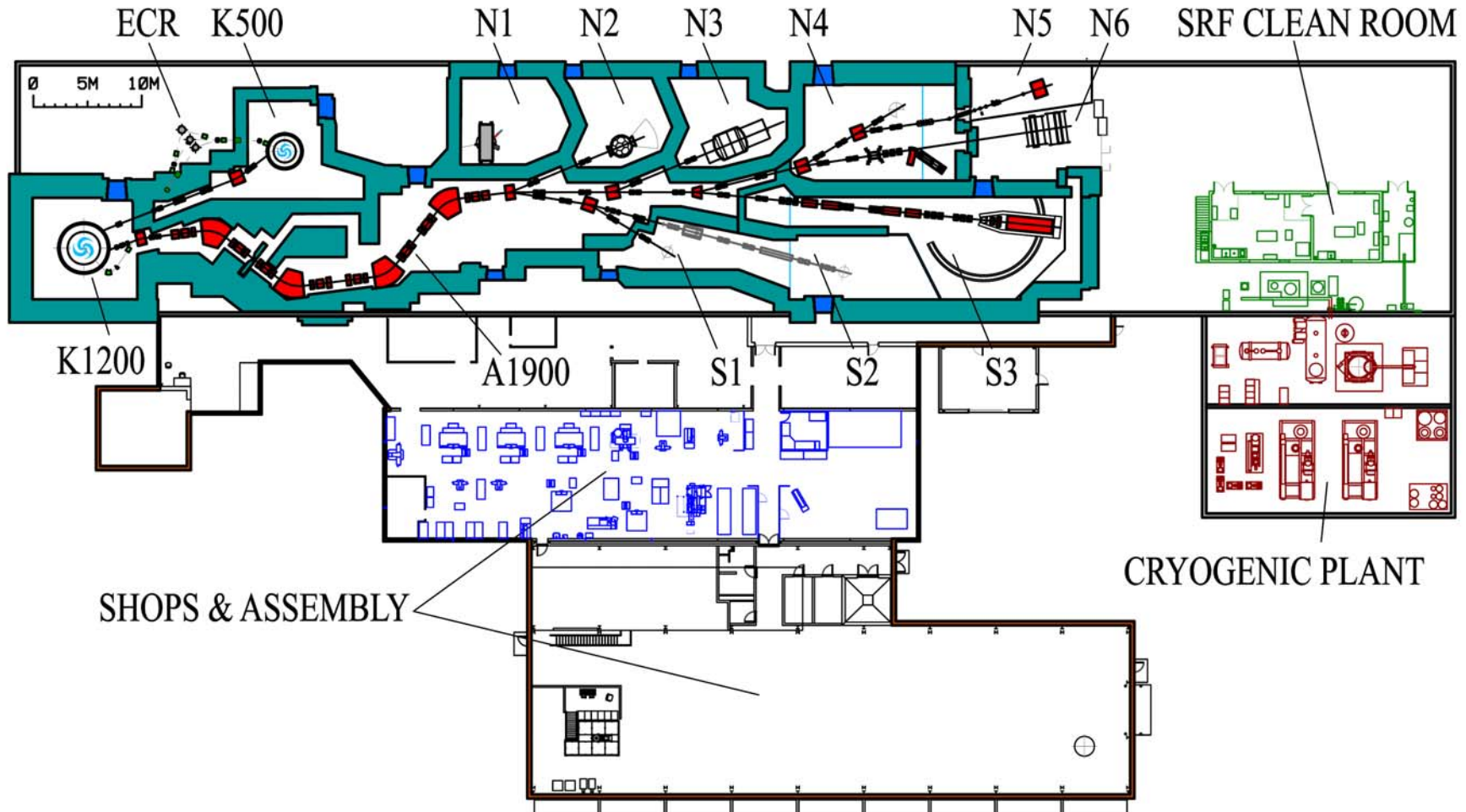
Forefront national user facility for rare isotope research and education in nuclear science, astro-nuclear physics, accelerator physics, and societal applications

280 employees, incl. 41 undergraduate and 52 graduate students, 24 faculty (+ 3 open faculty positions)

New CCF user group formed in 2001: 700 registered members (439 from 101 US institutions, 261 from 113 foreign institutions and 35 countries) as of Feb. 17, 2006

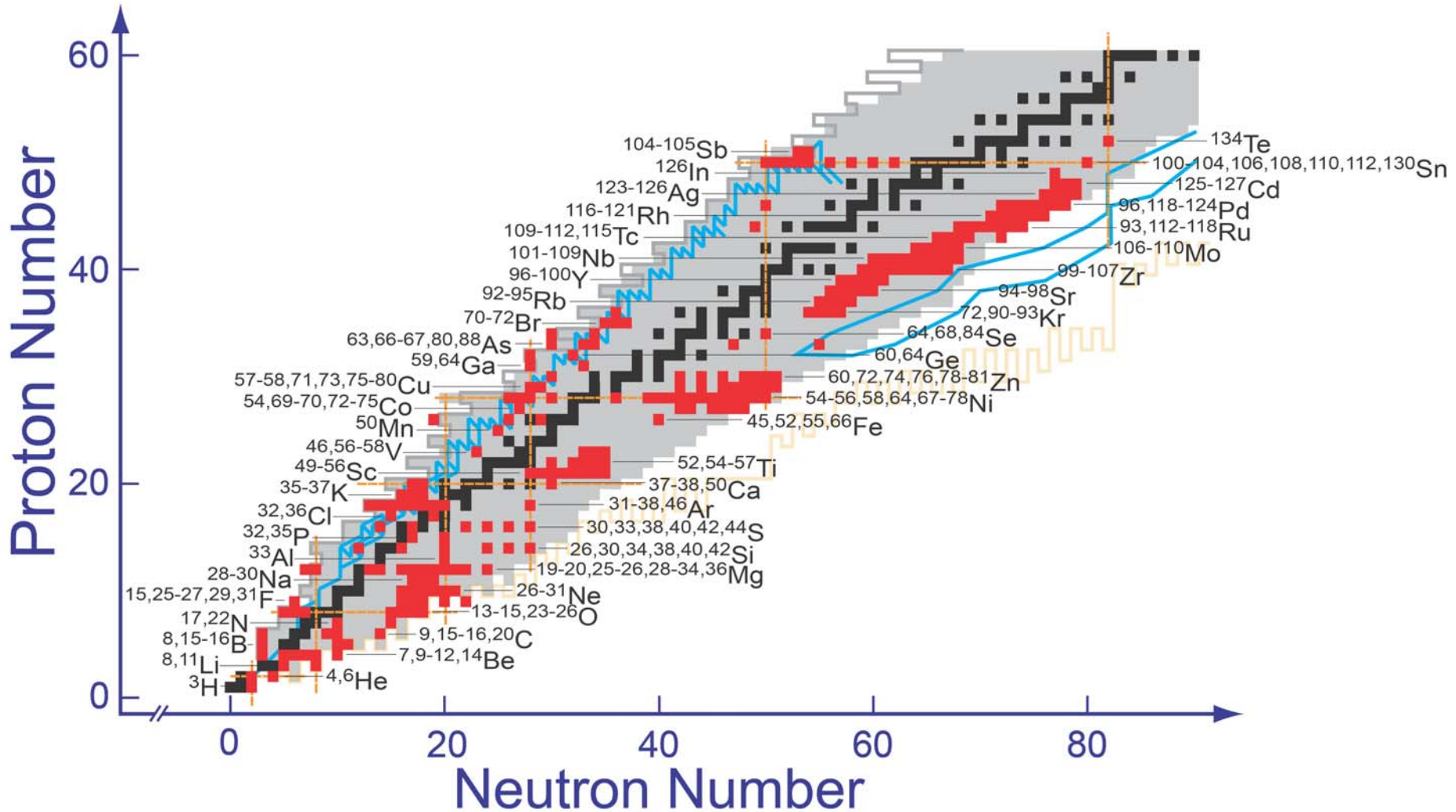


State-of-the-art apparatus: A1900 fragment separator, 4π -Array, 92-inch chamber, S800 magnetic spectrograph, large aperture sweeper magnet spectrograph, large area ($2 \times 2 \text{ m}^2$) position sensitive neutron detectors, segmented Ge and Si-strip-CsI arrays, β -NMR and β -counting station, Gas cell (1 bar He) for stopping rare isotopes, 9.4 Tesla Penning Trap, ...



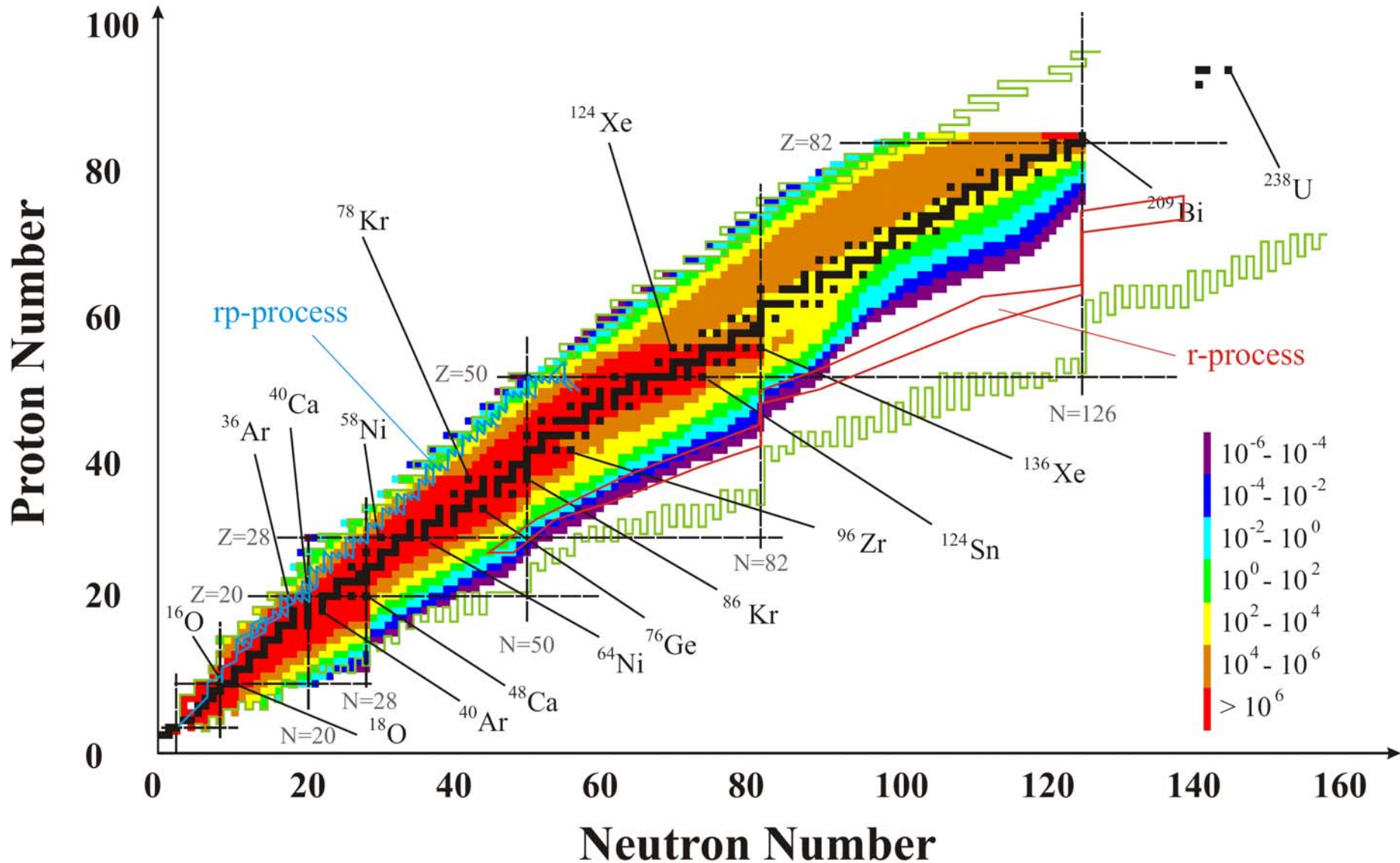
Beams Produced with CCF/A1900

2001 through 2005: 503 invited talks by NSCL users and staff, 426 papers in refereed journals, including 68 in Physical Review Letters



NSCL Scientific Reach Projection

Set of driver beams indicated



JINA is an important aspect of the NSCL's intellectual fabric

[Link to observational astronomy via Tim Beers \(Department of Physics and Astronomy\)](#)

Properties of Nuclei far from Stability: Paul Mantica, David Morrissey*, Andreas Stolz², Michael Thoennessen

Information about Wave Functions: Alexandra Gade¹, Thomas Glasmacher, Brad Sherrill*, Kris Starosta

Precision Measurements, Fundamental Studies: Georg Bollen, David Morrissey*

Nucleus-Nucleus Collisions and EOS: Bill Lynch, Betty Tsang², Gary Westfall*

Nuclear Theory: Filomena Nunes¹, Wolfgang Bauer, [Alex Brown](#), Pawel Danielewicz, Thomas Duguet¹, Vladimir Zelevinsky

[Astro-Nuclear Physics \(JINA\):](#) [Sam Austin**](#), Edward Brown, Bill Lynch, Paul Mantica, [Hendrik Schatz](#), Brad Sherrill*, [Remco Zegers](#)¹

Accelerator Physics and Beam Dynamics: Terry Grimm³, Felix Marti³, Stan Schriber¹, Richard York

Electronics, RF and control systems: John Vincent

* University Distinguished Professor (** University Distinguished Professor Emeritus)

1 NSCL faculty

2 NSCL CA-faculty

3 CA-staff with adjunct faculty appointment

- Production of nuclei with unusual ratios of protons to neutrons and the measurement of their properties

What are the limits of nuclear existence? What are the properties of nuclei with extreme ratios of protons and neutrons (neutron skins and halos)? Modification of shell structure, new doubly magic nuclei: ^{48}Ni , ^{78}Ni , ^{100}Sn , ^{132}Sn ...

- Exploration of the nuclear processes that are responsible for the chemical evolution of the universe through the ongoing synthesis of most elements in the cosmos – led by JINA

Where are most of the nuclei heavier than iron made? How do supernovae explode? Are Type 1a SN good standard candles?

- Exploration of the isospin dependent properties of hot nuclear matter and how they affect supernovae and neutron star properties – important connection to JINA

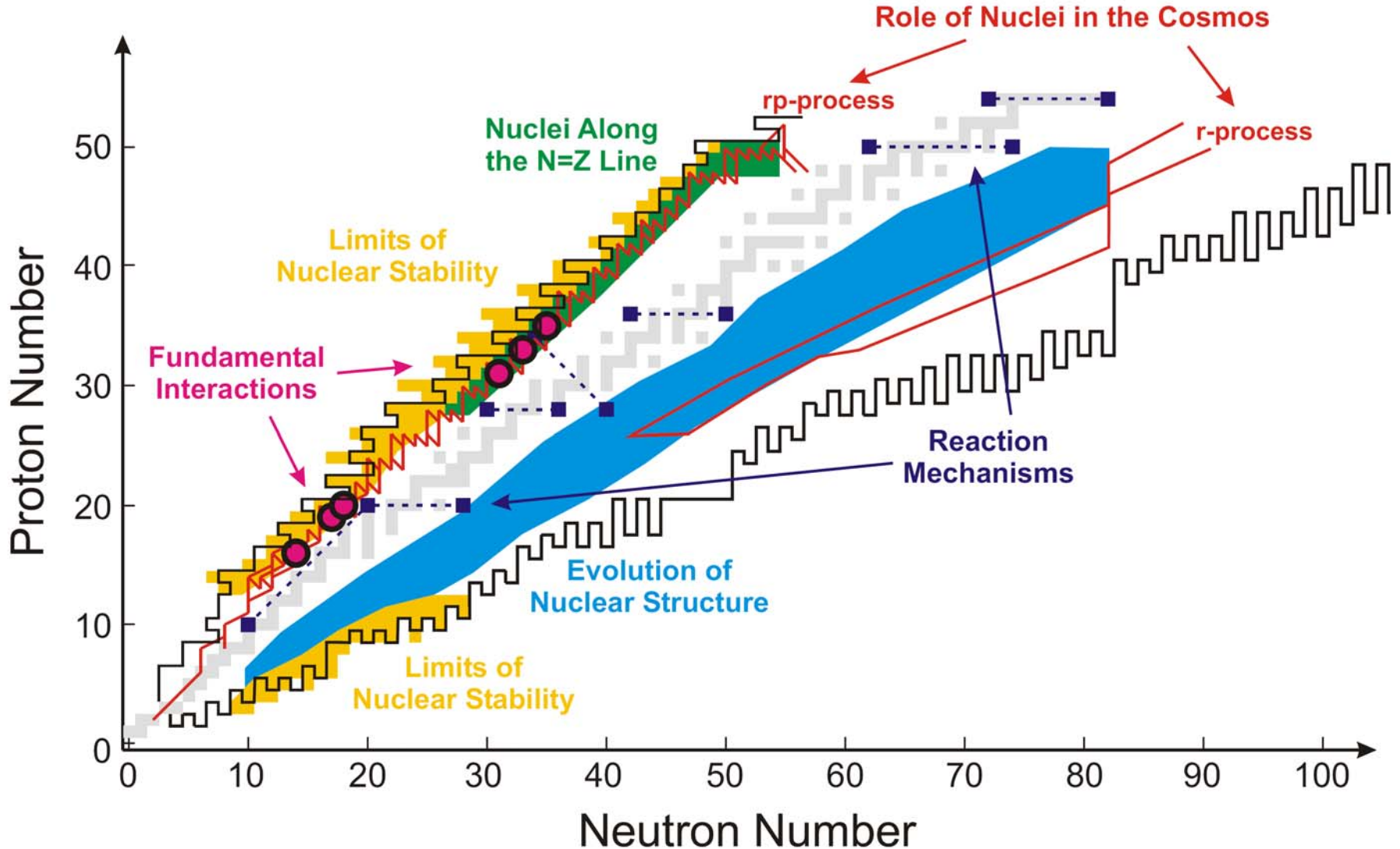
What is the equation of state (EOS) of neutron-rich nuclear matter?

- Exploration and tests of novel superconducting accelerator and beam transport concepts and the dynamics of high-intensity beams

Aligned with 3 of the 5 key questions identified in the 2002 NSAC LRP: What is the structure of the nucleon? What is the structure of nucleonic matter? What are the properties of hot nuclear matter? What is the nuclear microphysics of the Universe? What will be the new Standard Model?

Scientific Program

With CCF running well, the 5-year perspective is superb – especially for the astro-nuclear research activities led by JINA



Weekly meeting to discuss JINA science and administration

- JINA has become the primary intellectual driver for the astro-nuclear research program at the NSCL providing important intellectual cross fertilization
 - The NSCL is a major tool for JINA science, main contributions to MRC2, MRC3
 - JINA is a collaborator on many experiments (equipment, manpower, expertise)
 - JINA initiates and facilitates collaborations with other groups (VISTARS, ...)

NSCL program

JINA program

Nucleosynthesis

- AGB stars (@WMU)

- r-process (@NSCL)

Supernovae

- weak interactions (@NSCL, RCNP)
- SN modeling (@NSCL, P&A)

Neutron Stars

- rp-process (@NSCL, P&A)
- EOS (@NSCL)

MRC 1

Stellar processes

- hydrostatic burning
- s-process

MRC 2

Supernovae

- p-process
- core collapse supernovae
- type Ia supernovae

MRC 3

Neutron Stars and Novae

- surface burning
- EOS



JINA Provides the Intellectual Framework for Astro-Nuclear Research at NSCL



- Efficient communication with other JINA sites – experimental and theoretical collaborations across field boundaries
- Fruitful ties into the larger JINA framework – problems are addressed by a broad arsenal of scientific tools, including stable beam experiments, model calculations, theoretical nuclear physics, and astronomy efforts (example r-/s-process effort)
- JINA workshops enhance and drive experimental and theoretical agenda
- Enhanced intellectual cross-links through visitor program, JINA seminars, workshops & schools at NSCL
- JINA facilitates dissemination and increases impact of NSCL results (rp-process database, public outreach)

JINA Provides Close Ties to Observational Astronomy and Theoretical Astrophysics

- JINA was instrumental for creation of a faculty position bridging nuclear physics and astronomy (Ed Brown)
 - Close scientific collaborations with T. Beers and E. Brown and between students and postdocs
 - One of the compelling reasons to establish the new High-Performance Computing Center at MSU
- Many joint JINA activities (outreach, workshops, ...)
- Joint supervision of graduate students and postdocs
- Joint searches for postdocs
- Access to SEGUE (Sloan Digital Sky Survey Extension), Soar, observational data
- Joint lunch time seminar series (open to NSCL and Physics & Astronomy)



JINA Provides Unique Training Opportunities for NSCL Students and Postdocs



- Research stays at other JINA institutions allow in-depth collaboration to enhance research and education experience
 - Grad student Montes stayed several times at VISTARS (Virtuelles Institut der Struktur der Kerne und nuklearer Astrophysik: GSI, U. Mainz, U. Frankfurt)
 - Clarisse Tur will be at LANL for several months
- JINA nuclear astrophysics club educates students and postdocs through informal discussions with seminar speakers and visitors
- Interactions with JINA seminar speakers and visitors
 - Facilitated by JINA nuclear astrophysics club
- JINA schools & workshops – can be tailored to student's needs
 - Small r-process school trained student to interpret ^{78}Ni measurement
- Connection to other JINA students and postdocs through conferences, workshops, visits
 - Collaboration of NSCL postdoc Jorge Pereira and U. Chicago student Ivo Seitenzahl
- Undergraduate research opportunities (4-5 undergraduates at any time from MSU and abroad)

Mutually beneficial – enhanced impact of NSCL and JINA outreach



Narrated by Linda Hunt
<http://wkar.org/nucleusfactory/>





From ART to SCIENCE: Igniting Stellar Imaginations

The Joint Institute for Nuclear Astrophysics (JINA) invites you and your class to participate in an outreach program promoting "ART to SCIENCE."

JINA would like to introduce children to the wonders of the physical universe and thereby ignite stellar imaginations.

JINA provides books for the children and covers the costs of art supplies, and then the children create art for us on the theme "made of star stuff."

Elementary art classes near ND or MSU may participate.

Contact JINA Outreach for details.
www.JINAweb.org

- TV and radio interviews (WKAR, KTEP, ...)
- Nucleus Factory (WKAR-TV Documentary – also available on DVD)
- Community Outreach: open house (500 visitors in 3 hours), small-group tours (2000 persons/year), From Art to Science ...



NSCL/MSU Contributions to JINA

- 1/3 of 20% cost share contribution
 - Administrative support
 - Access to computing infrastructure at NSCL
 - Access to new high performance computing center
 - Office and meeting space
 - Facility usage and technical support for PAC approved JINA experiments
 - Technical and administrative support for outreach
- The NSCL recognizes the important role played by JINA and provides an excellent environment for JINA to reach its full potential

- Committed to provide a CA position in support JINA nuclear astrophysics program
- Support for new outreach person (new position to be filled – offer has been made)
- New technical developments will open the door to new scientific opportunities for JINA
 - RFFS
 - New S2 area (n-detector)
 - Support of EOS related experiments
 - R&D for low-energy reaccelerated beam capability
- Possibility to add another outstanding faculty in nuclear astrophysics