Physics with Exotic Nuclei and Exotic Atoms at Relativistic Energies

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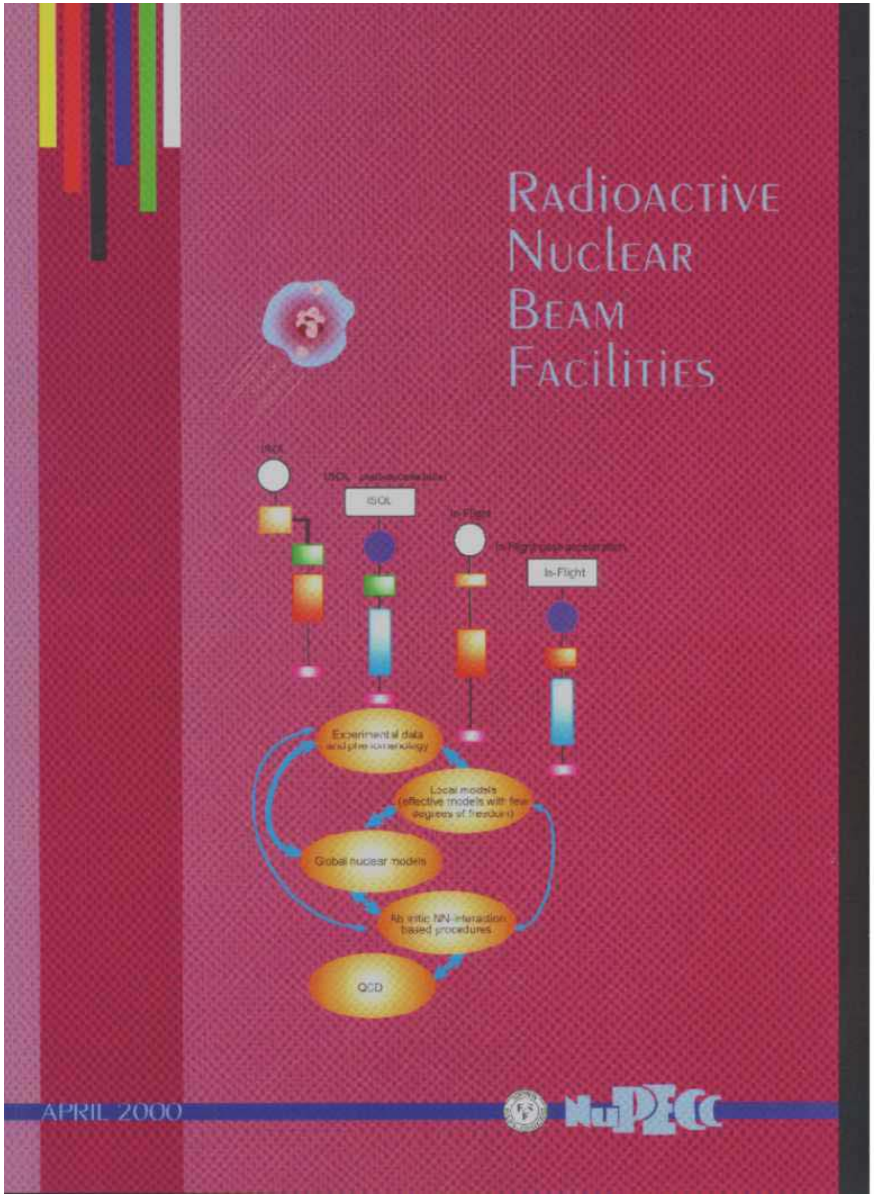
- Introduction √
- Momentum Measurements, Ion Optics, Spectrometers √
- Atomic Interaction of Heavy Ions √
- Exotic Atoms √
- Production and Separation of Exotic Nuclei √
- Halo and Skin Nuclei √
- Precision Experiments with Stored Ions √
- Discovery of a New Type of Radioactivity √
- **Next-Generation In-Flight Facility**

The Next-Generation Facilities for Exotic Nuclear Beams in Europe



The European option

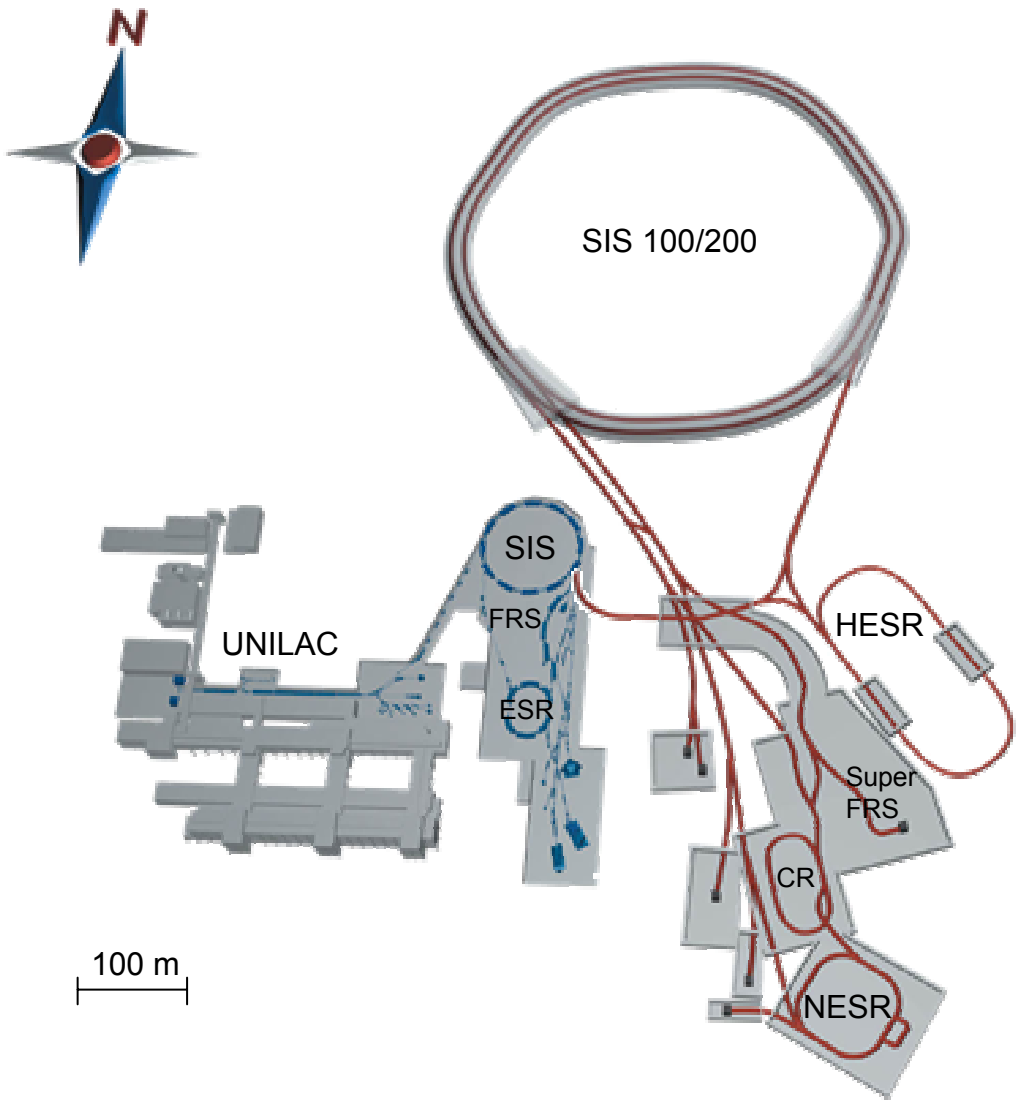
1. **In- Flight**
   R3B
2. **ISOL**
   EURISOL

B. Jonson

International Accelerator Facility for beams of Ions and Antiprotons

GSI

The Next-Generation International Accelerator at GSI



Gain Factors

- Primary beam intensity: Factor **100 – 1000**
- Secondary beam intensities for radioactive nuclei: up to factor **10,000**
- Beam energy: Factor **20**

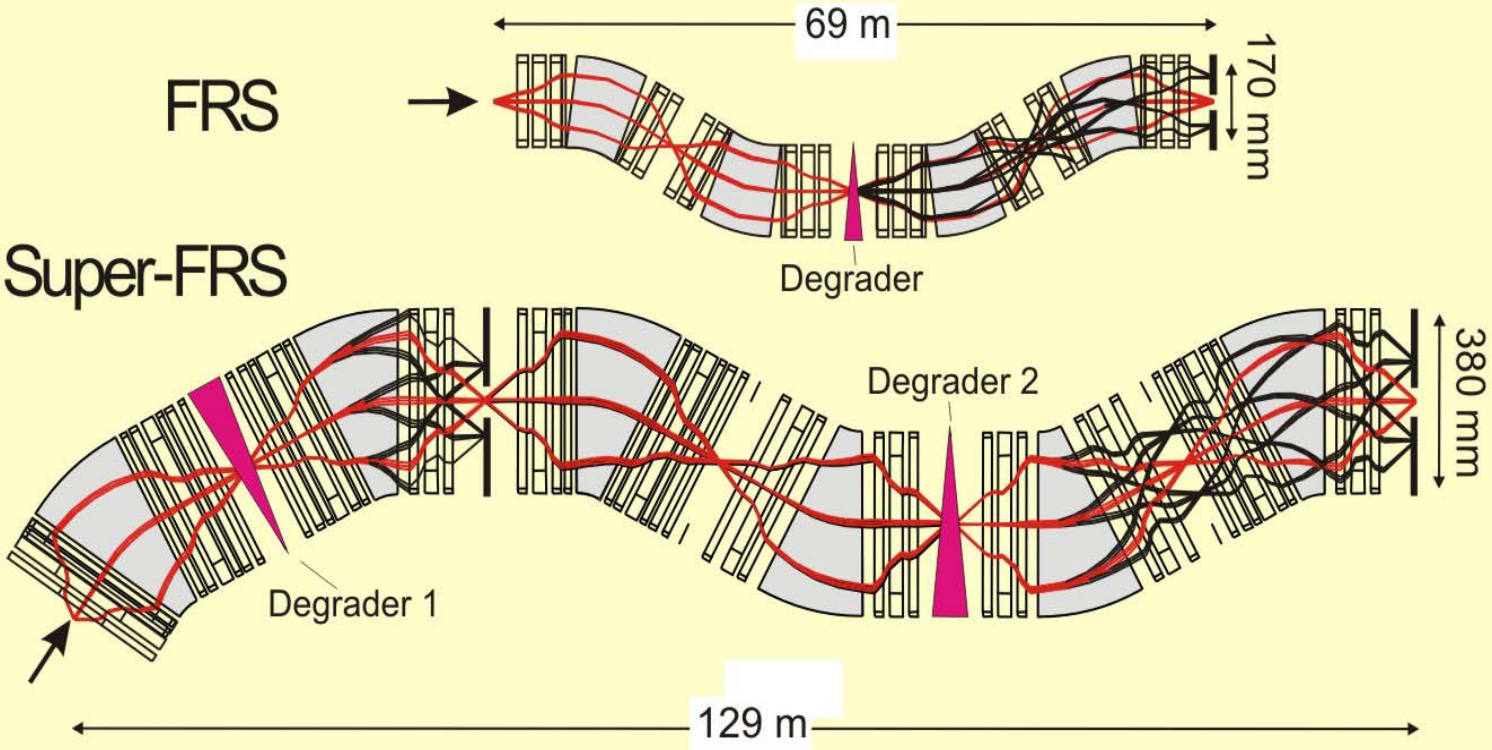
Special Properties

- Intense, fast **cooled** energetic beams of exotic nuclei
- **Cooled** antiproton beams up to15 GeV
- Internal targets for high-luminosity in-ring experiments

New Technologies

- Fast cycling superconducting magnets
- Electron cooling at high ion intensities and energies
- Fast stochastic cooling

Comparison of the FRS and the Super-FRS



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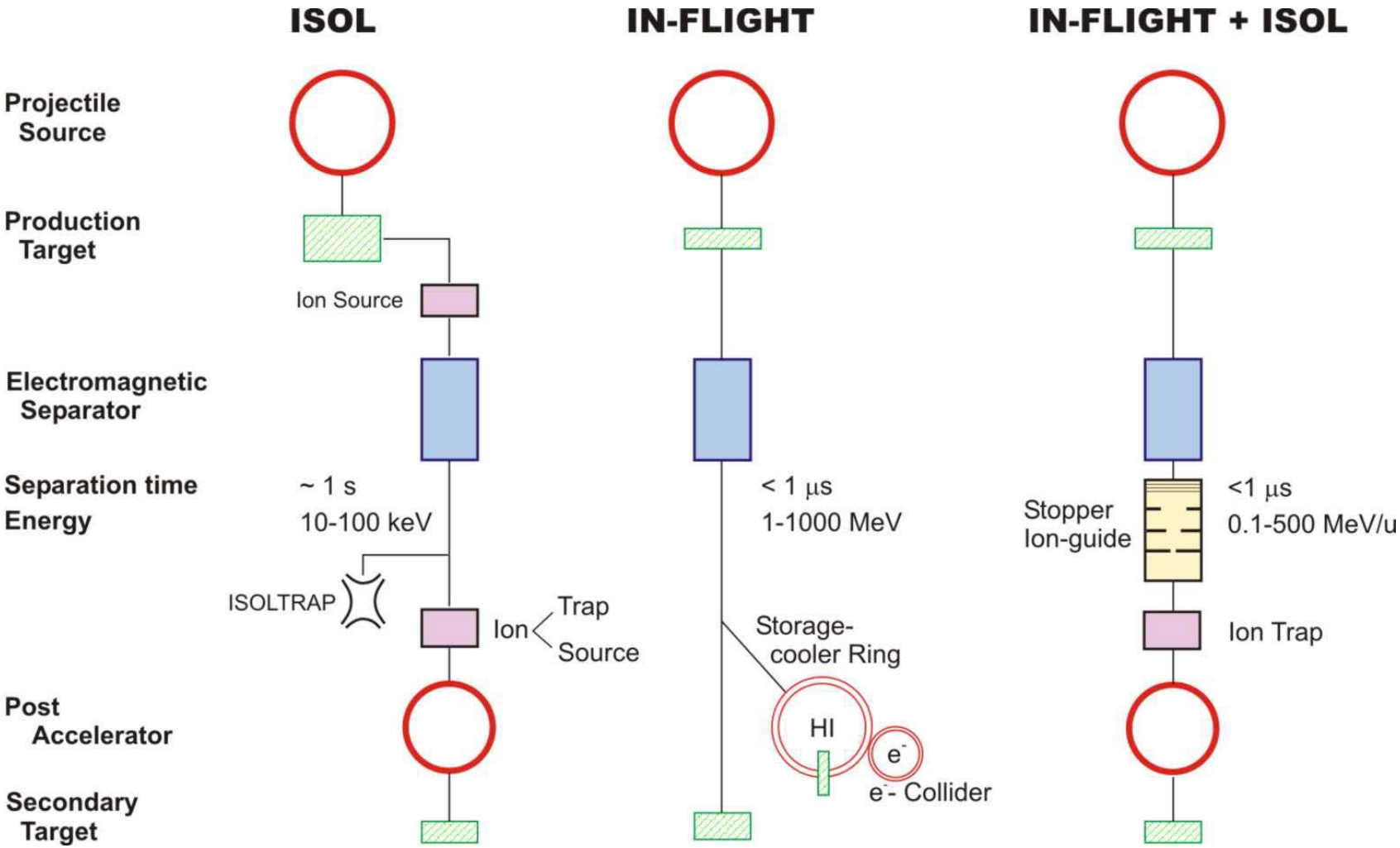
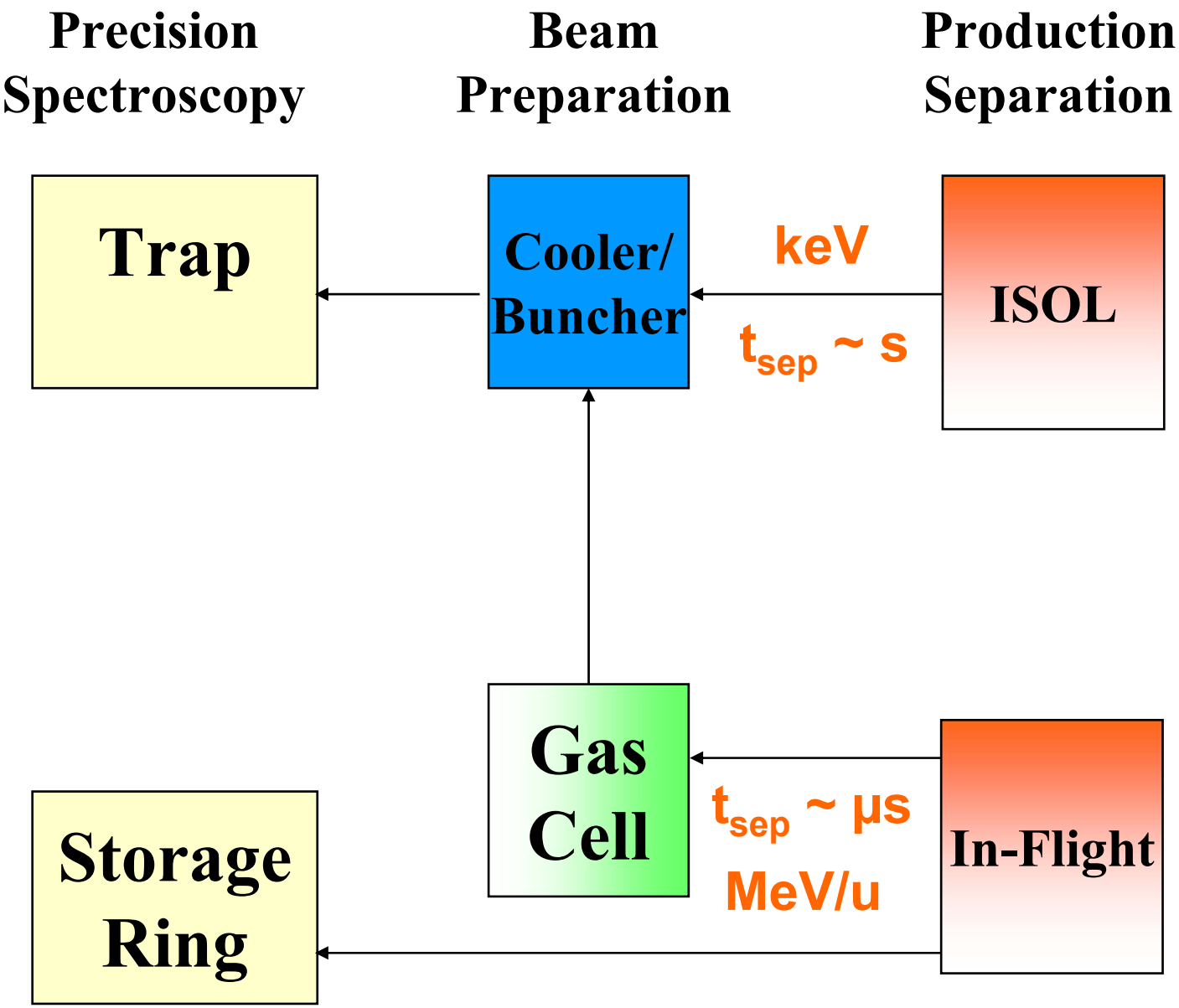
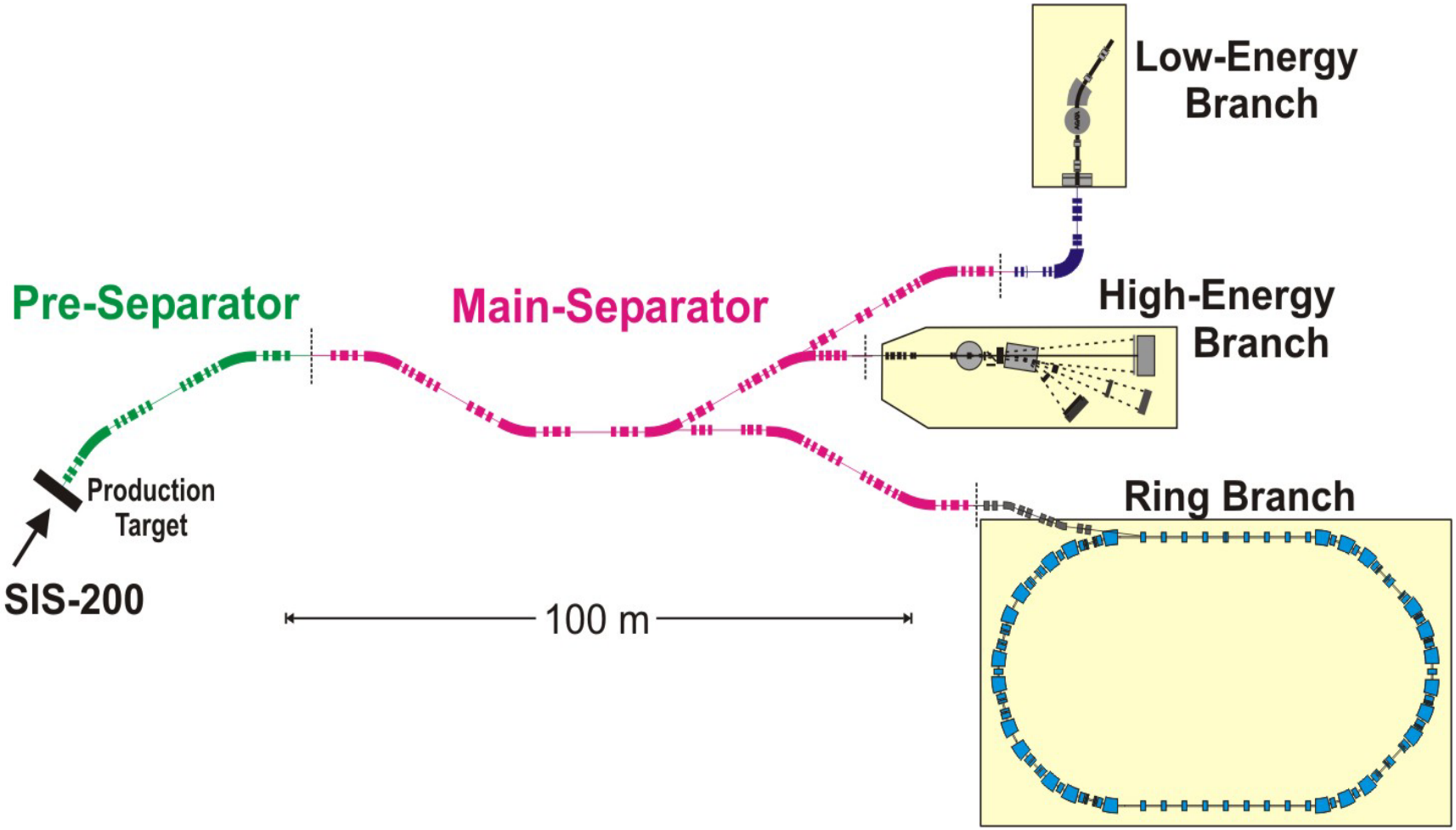
Scheme of Modern Rare Isotope Facilities



Experiments with Stored Exotic Nuclei



Super-FRS a Large-Acceptance High-Resolution Spectrometer for Exotic Nuclei



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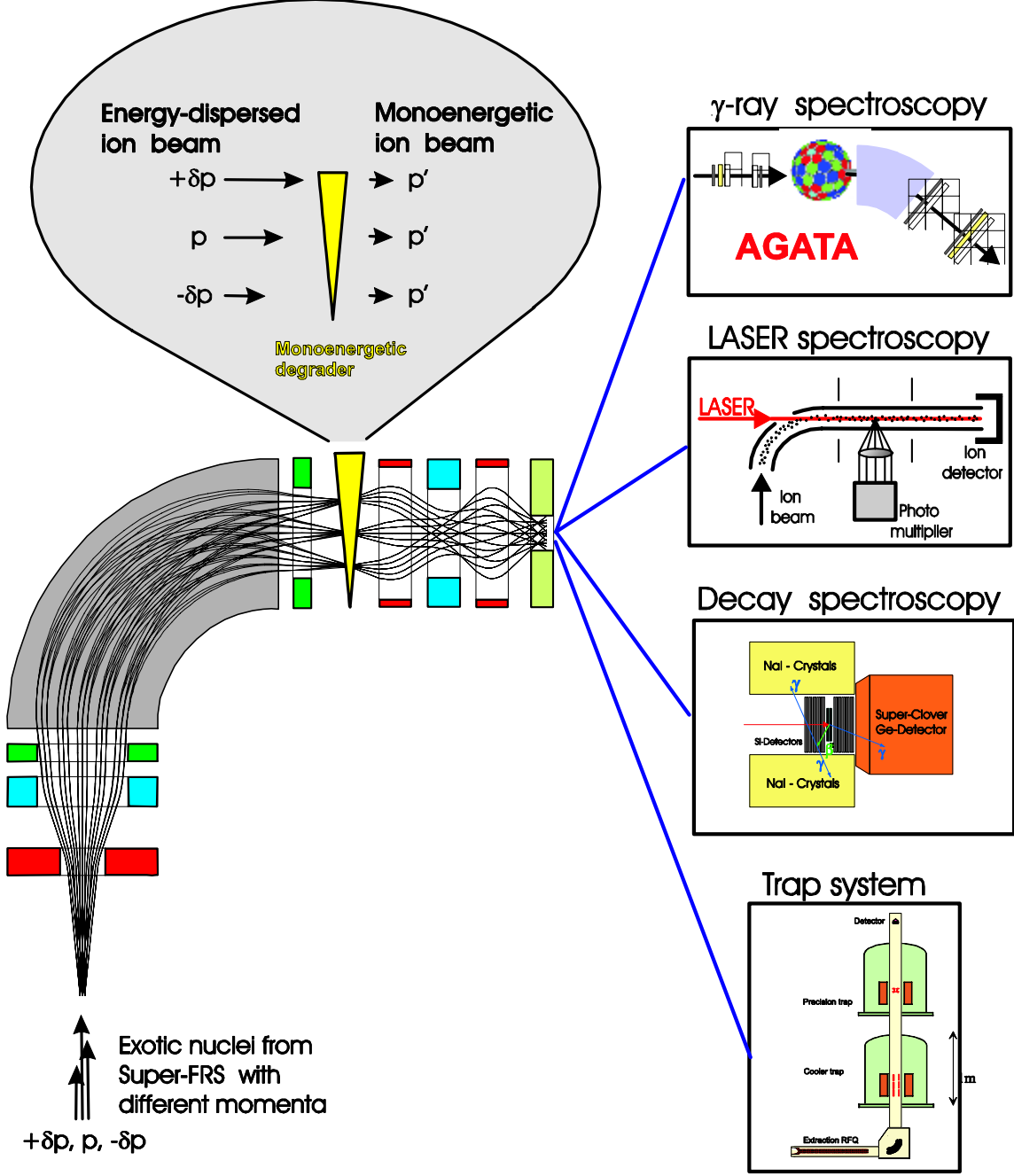
Experiments with Low-energy and Stopped beams

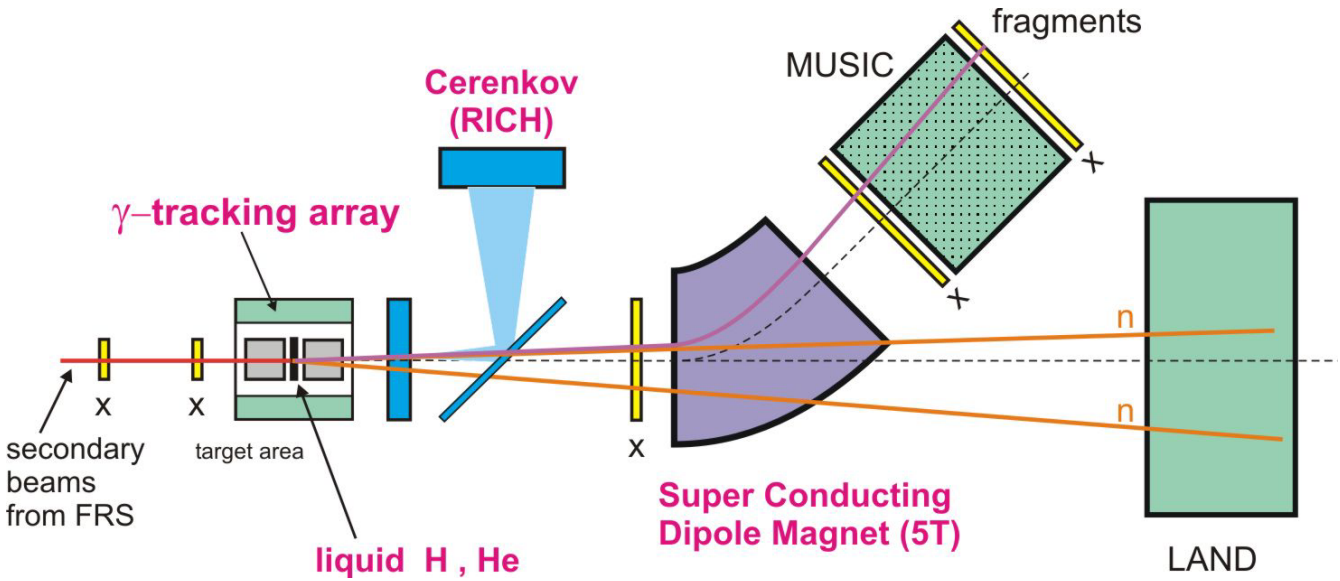
- Decay spectroscopy
- Reactions near the Coulomb barrier
- Laser spectroscopy
- Ion traps



C. Scheidenberger

R^{3}B: A next-generation experimental setup for Reaction studies with Relativistic Radioactive Beams

T. Aumann



★ **Electromagnetic excitations** ➤ single-particle structure ➤ astrophysical S-factor ➤ soft modes ➤ giant resonances ➤ B(E2)

★ **Knockout / quasi-free scattering** ➤ single-particle structure, spectral functions ➤ unbound states, spectroscopy beyond dripline

★ **Charge exchange (p,n)** ➤ GT strength ➤ spin dipole resonance ➤ neutron skin

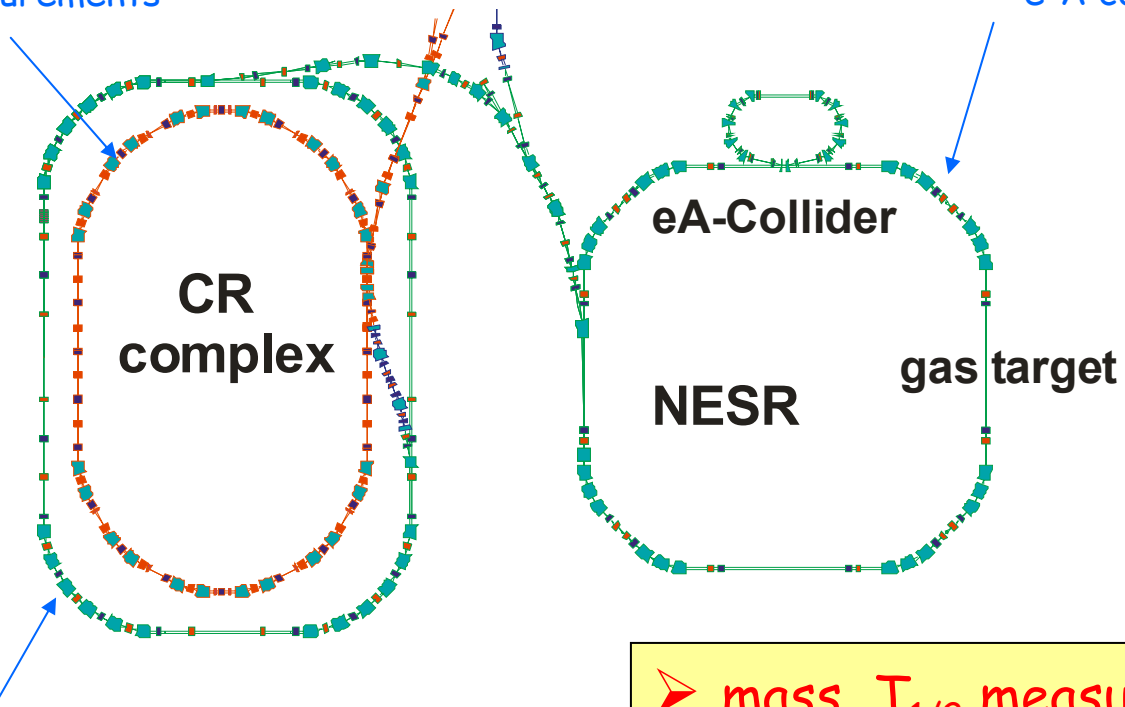
★ **Other reactions: Fission, Fragmentation, Multifragmentation, Spallation**

Super-FRS ring branch: stored fragment beams in CR/NESR

bunched fragment beam
from Super-FRS (740 AMeV,50 ns)

- efficient injection into CR
- stochastic pre-cooling in CR
- ToF mass measurements

- electron cooling in NESR
- Schottky mass measurements
- reactions at internal target
- e-A collisions

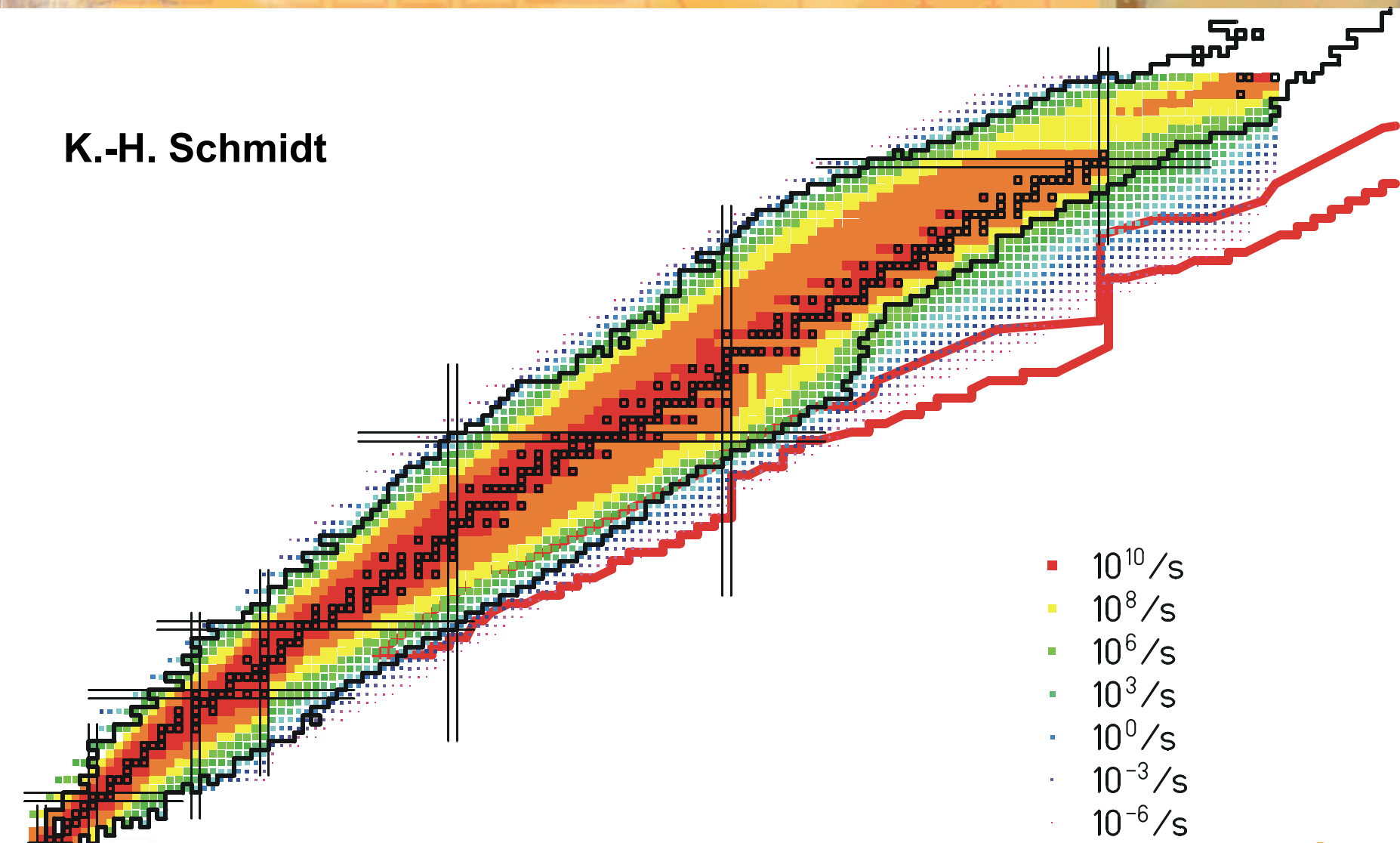


- deceleration to 200-400 A MeV

- mass, $T_{1/2}$ measurements
- transfer reactions
- p and a scattering
- charge-exchange reactions
- knockout reactions
- electron scattering

The Super-FRS Nuclei is an Ideal Tool to Study the r-Process

K.-H. Schmidt



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