The Super-FRS Project at GSI

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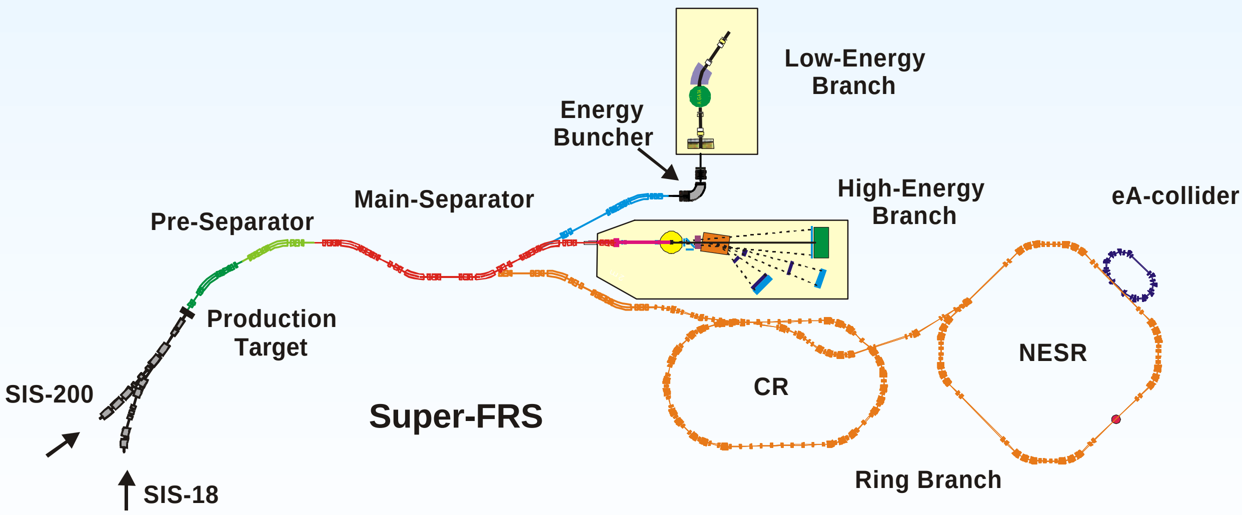
for the Super-FRS working group

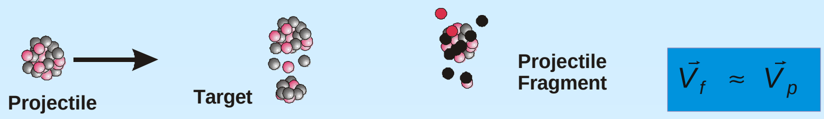
CERN, 30.10.2002

- FRS facility
- The concept of the new facility
- The Super-FRS and its branches
- Summary



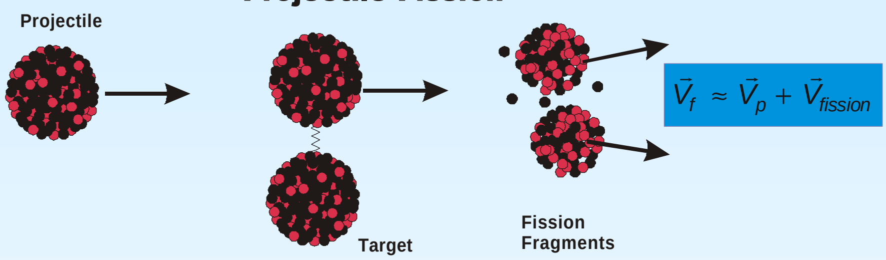
Projectile Fragmentation and Projectile Fission

Projectile Fragmentation

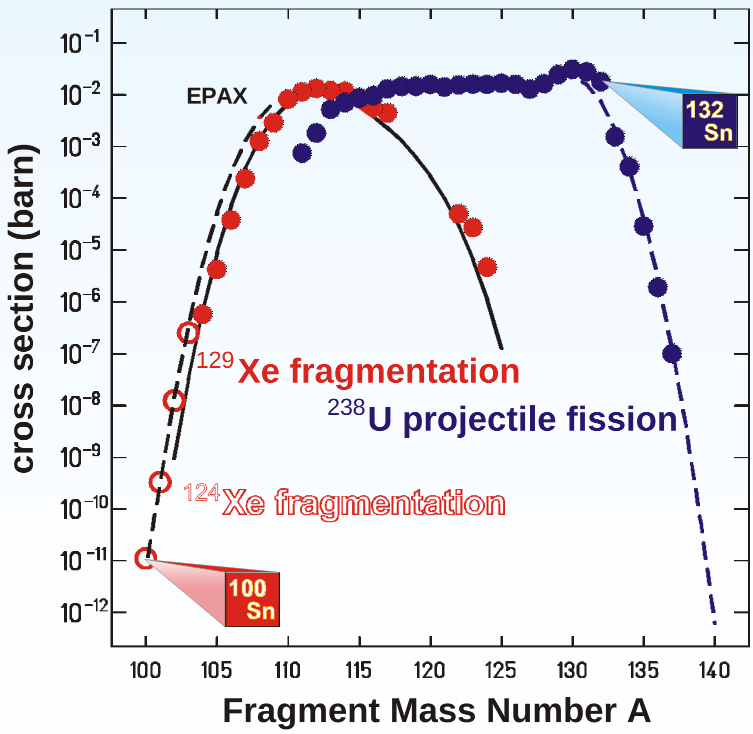


Nucleon-Nucleon-Collissions (Abrasion Ablation)

Projectile Fission

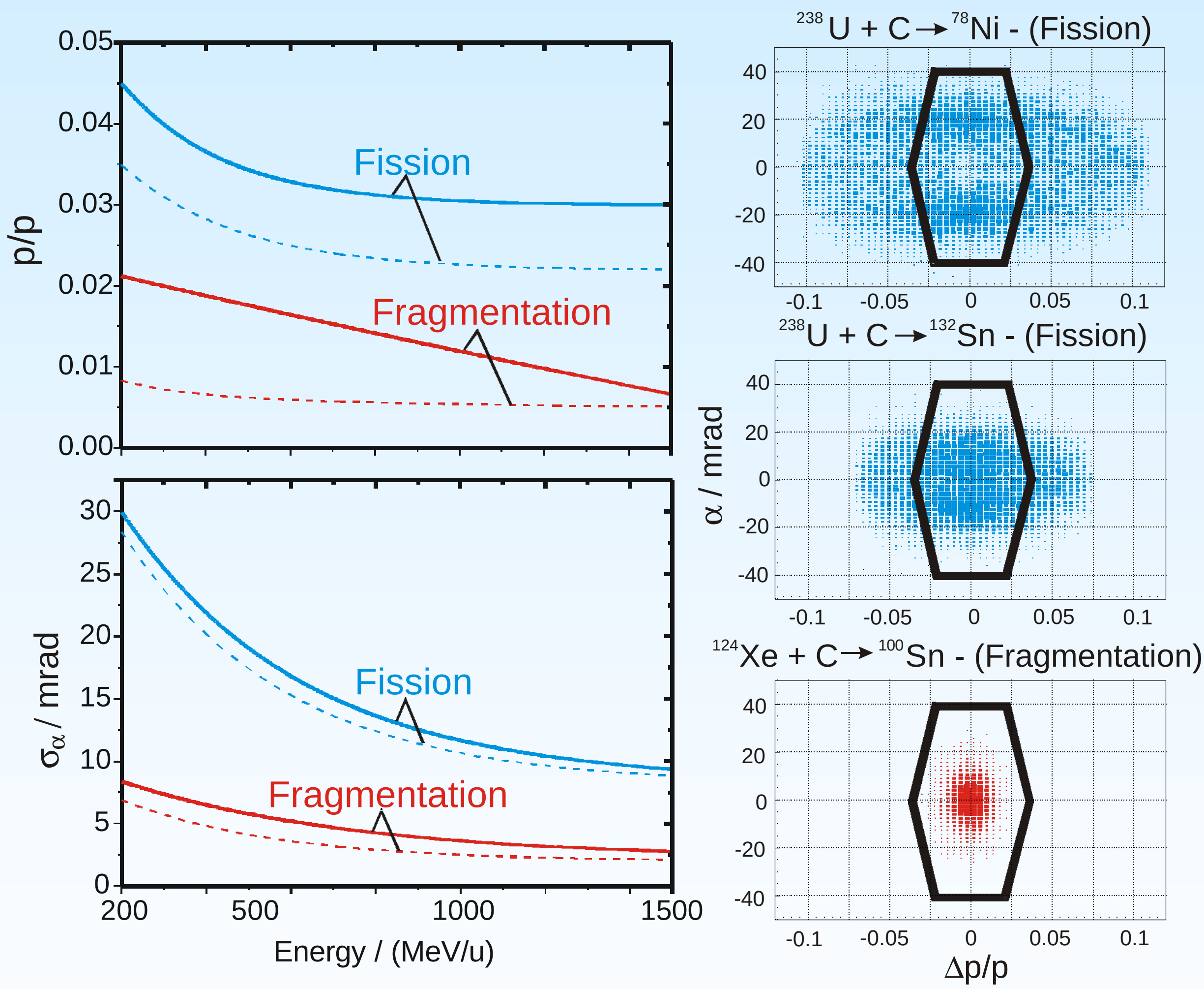


Coulomb Excitation in Peripheral Collisions

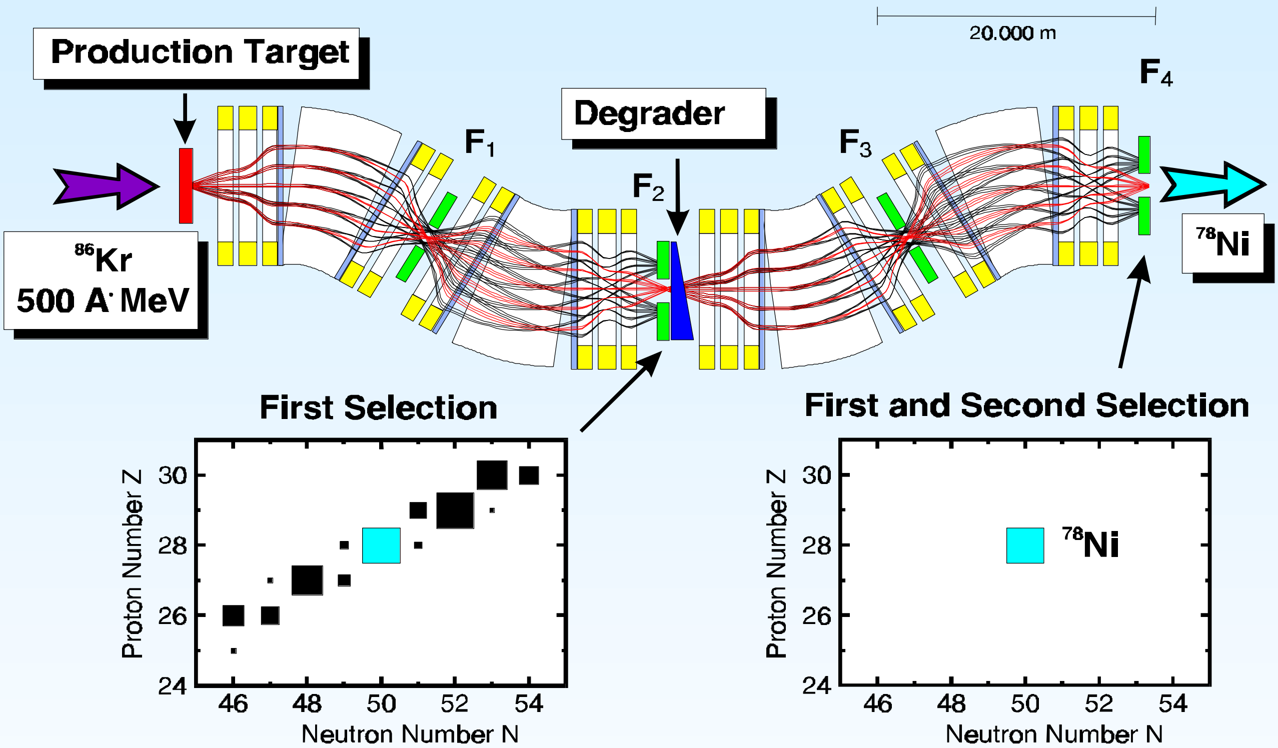


K.Sümmerer

Kinematics of Exotic Nuclei produced in Projectile Fragmentation and Projectile Fission



Bρ-ΔE-Bρ Separation Method



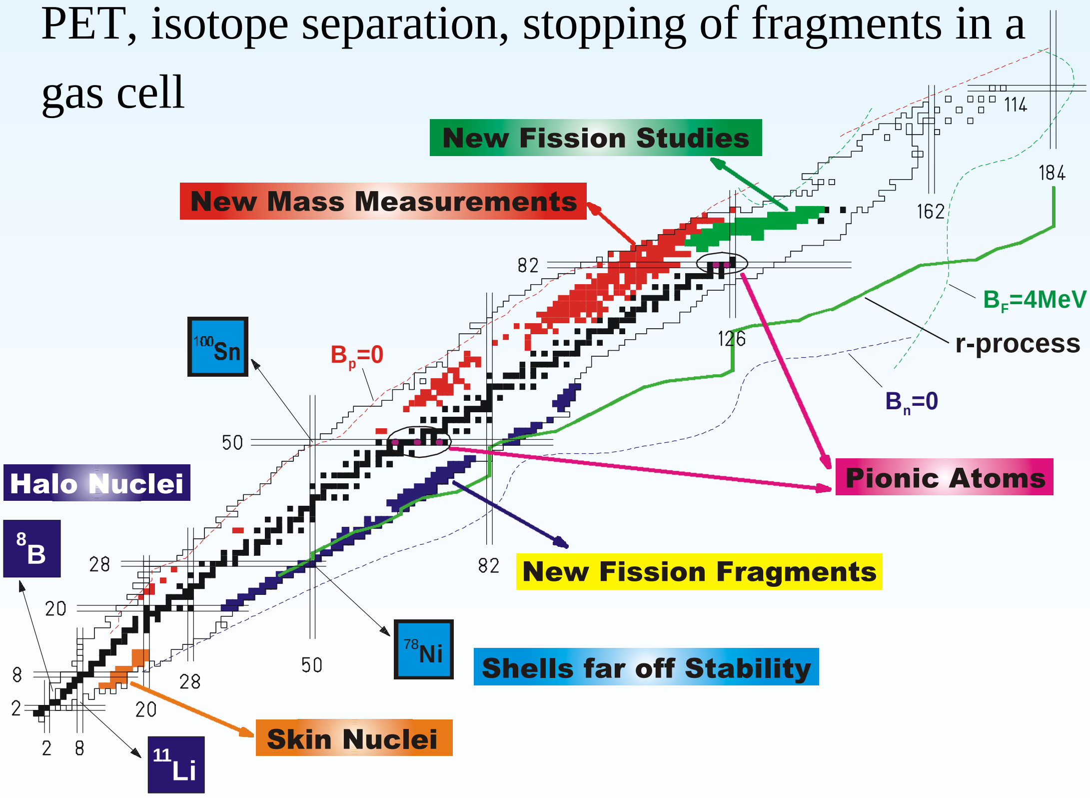
Experiments with the FRS

- **Nuclear structure and reactions**

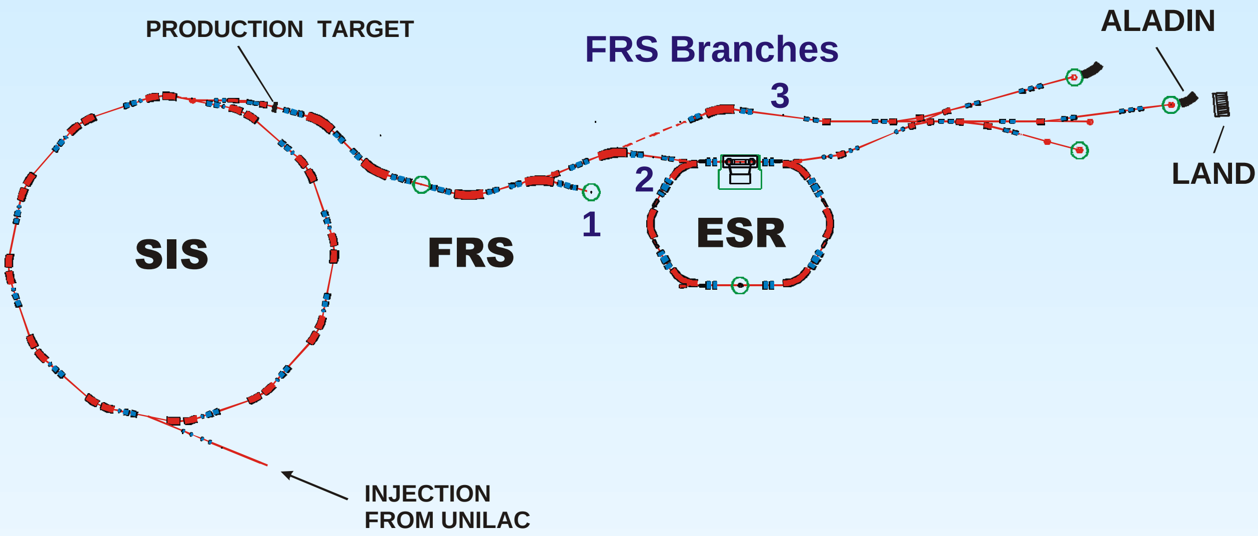
  Explore the properties of dripline nuclei, search for new structures and shells, study hadronic atoms
- **Nuclear astrophysics and applications**

  Exotic nuclei are the key to understand the formation of elements in the universe
- **Atomic interactions of heavy ions with matter**

  Basic atomic collision studies and applications PET, isotope separation, stopping of fragments in a gas cell



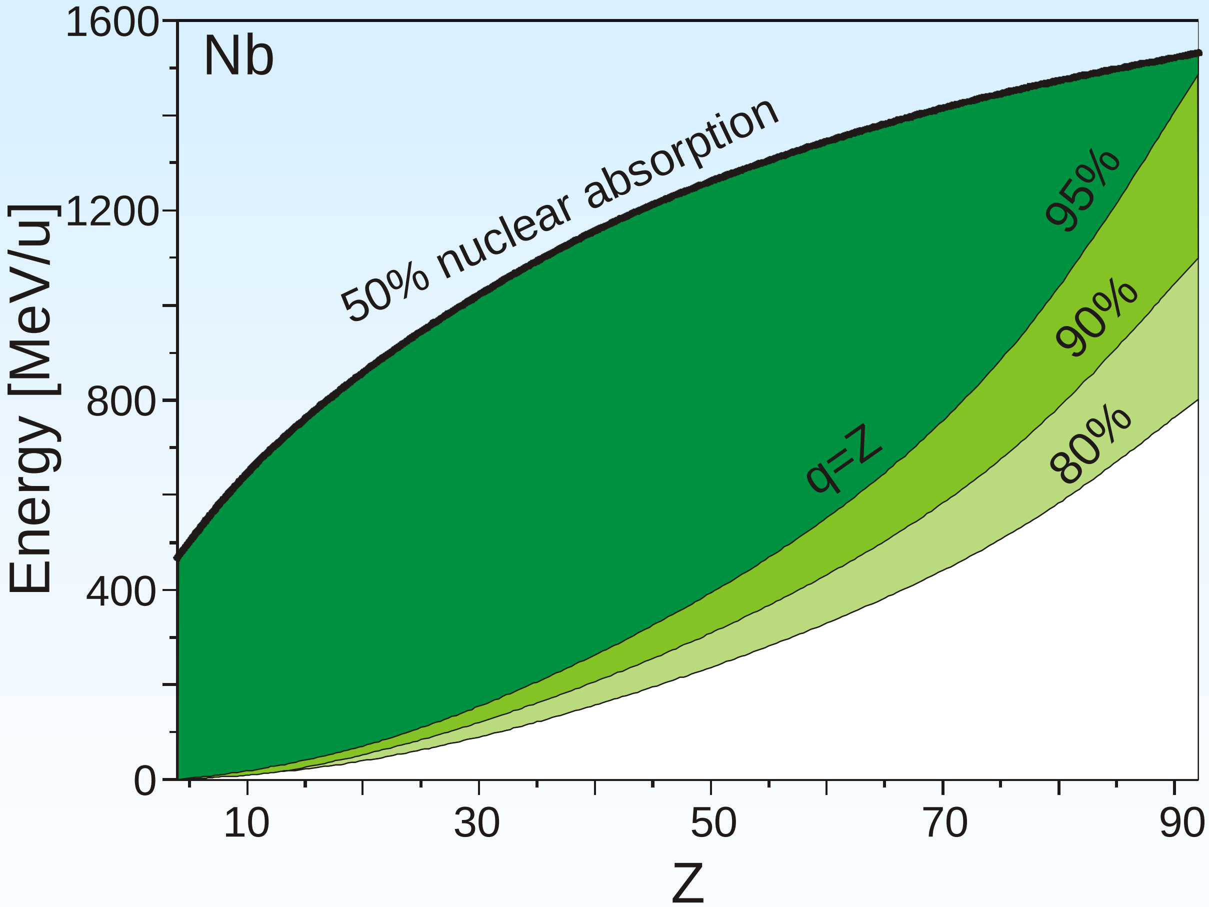
The Present Secondary Beam Facility at GSI



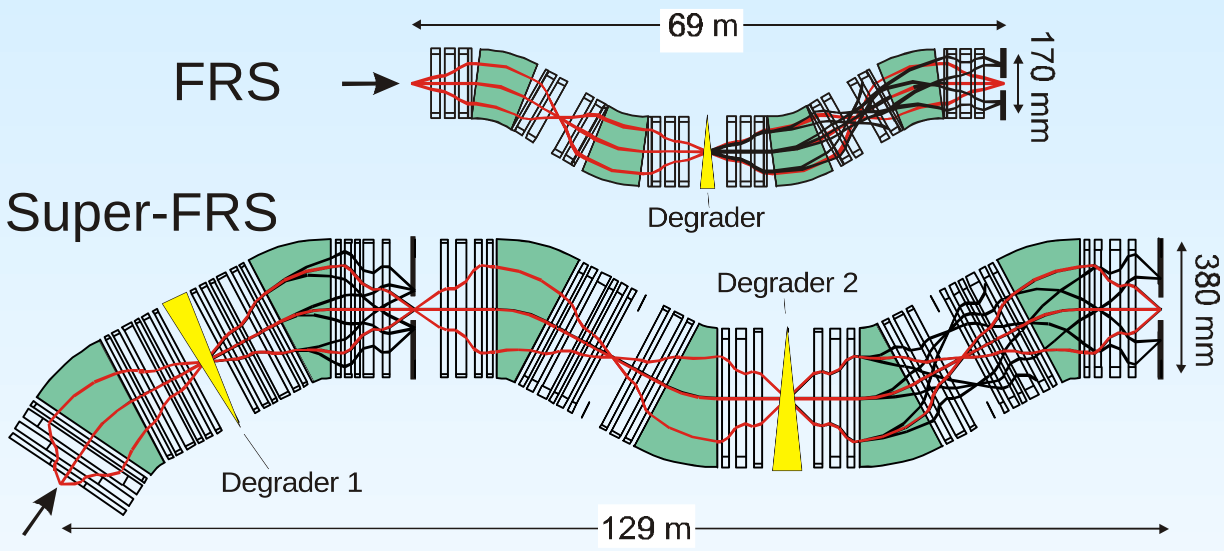
Limitations of the facility:

- Low primary beam intensity (e.g. 10^9 ^{238}U /s)
- Low transmission for projectile fission fragments (4-10% at the FRS)
- Low transmission for fragments into the storage ring and to the experimental areas
- Limited maximum magnetic rigidity

The Energy-Z Operating Domain for In-Flight Separation

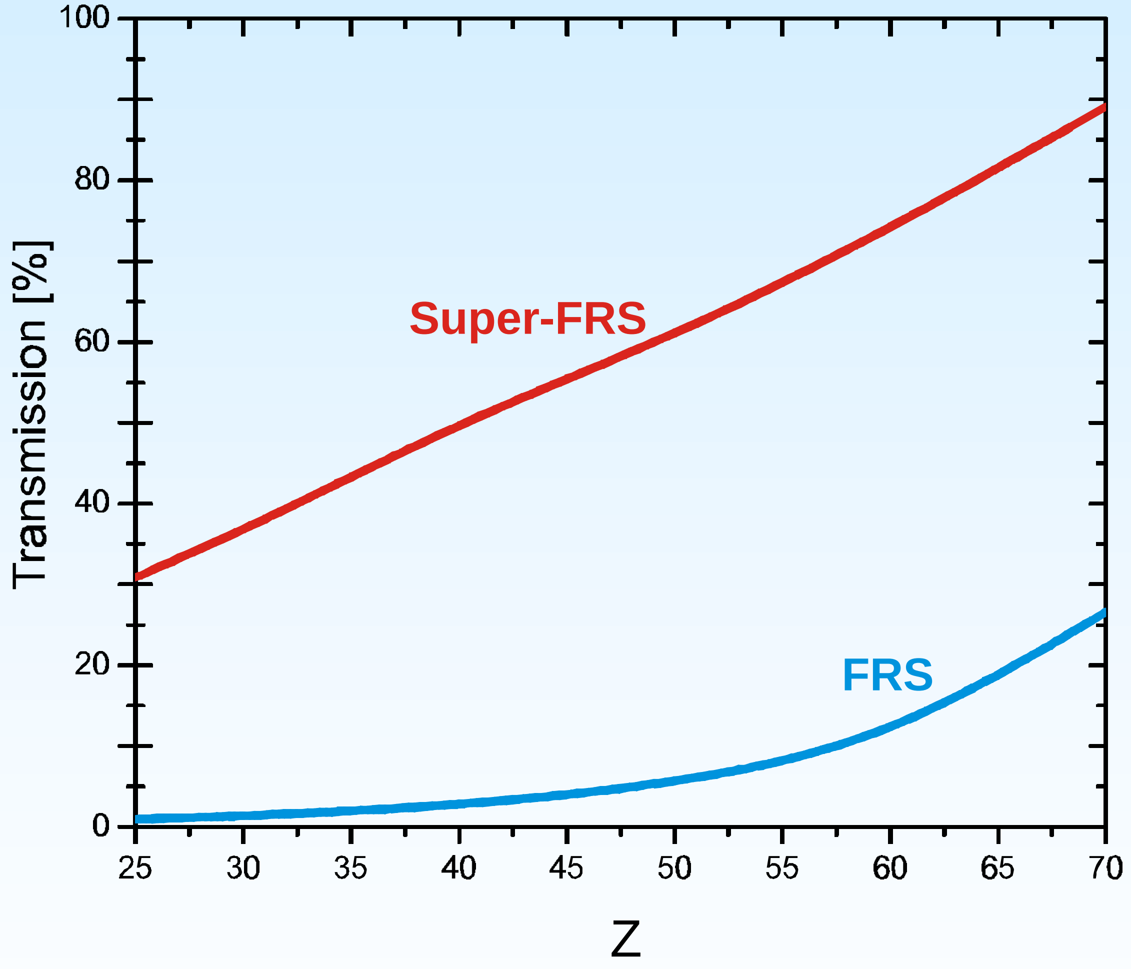


Comparison of the FRS and the Super-FRS

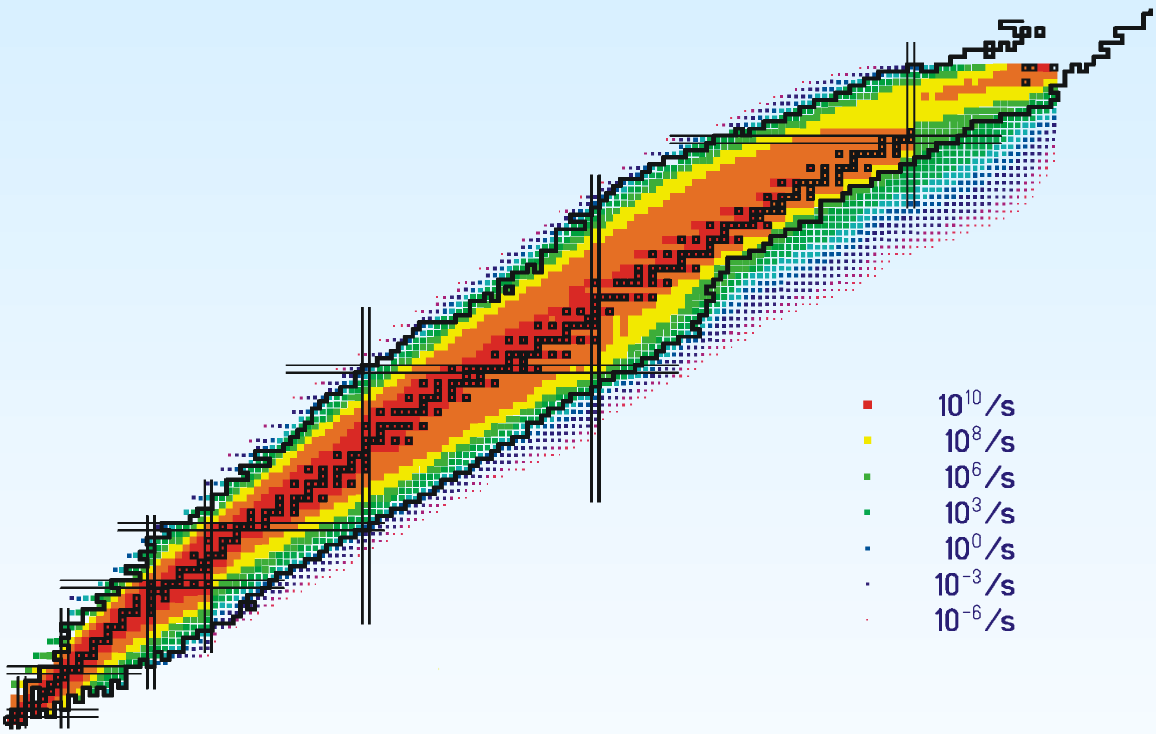


	$B\rho_{max}$	$\Delta p/p$	$\Delta\Phi_x$	$\Delta\Phi_y$	resolving power
FRS	18 Tm	1.0 %	± 13 mrad	± 13 mrad	1500
Super-FRS	**20 Tm**	**2.5 %**	**± 40 mrad**	**± 20 mrad**	**1500**

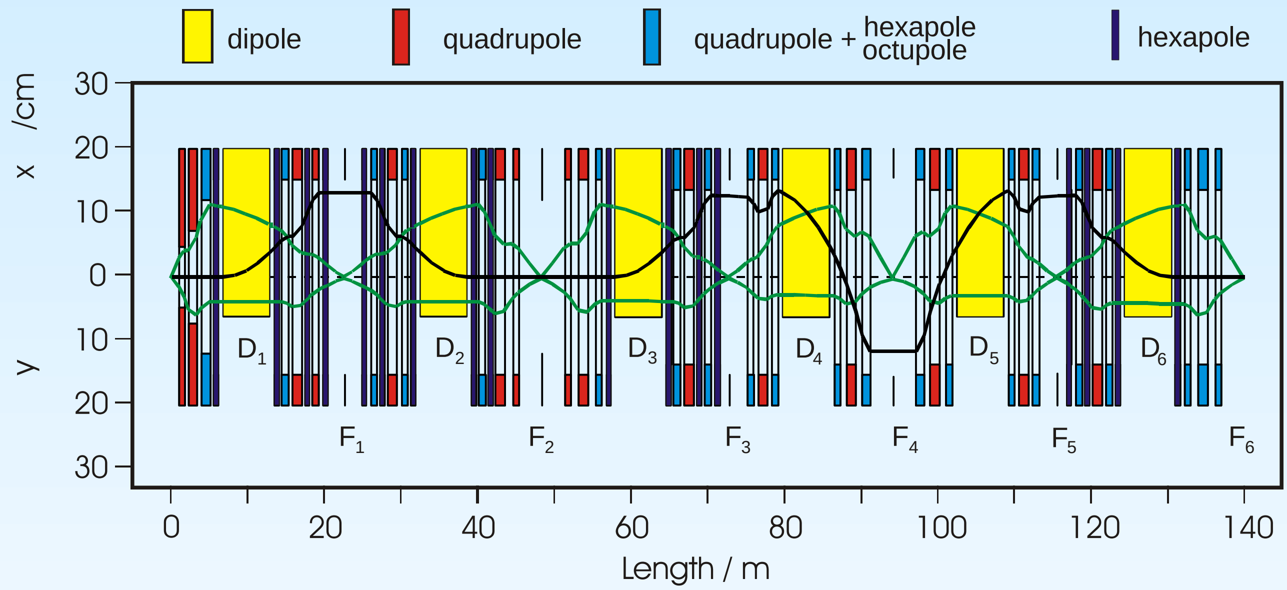
Transmission Gain for Fission Products



Rates for Exotic Nuclei at the Super-FRS

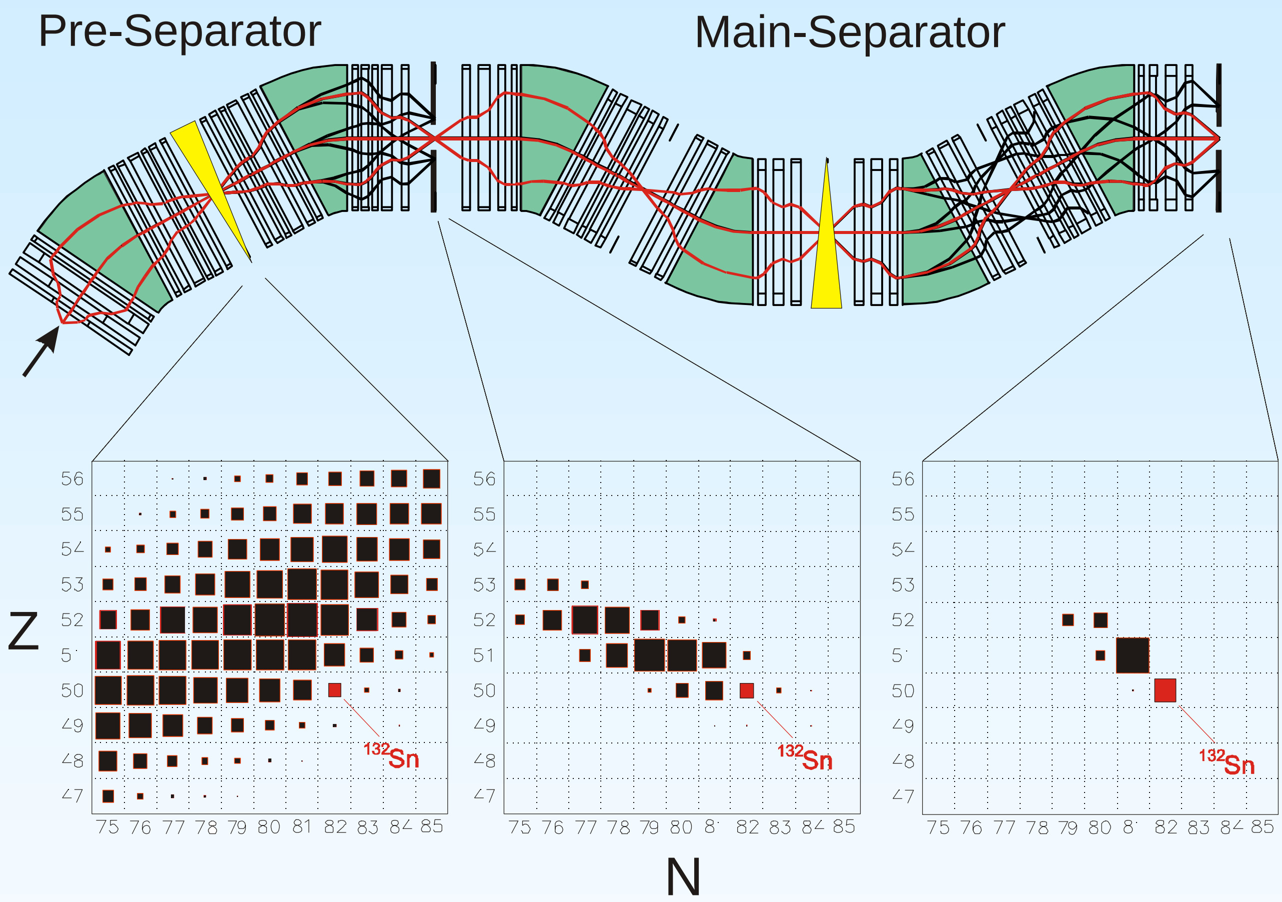


Ion-Optical Design of the Super-FRS



	at F1	at F2	at F4	at F6
(x,x)	-3.28	2.00	1.46	1.60
(x,a)	0	0	0	0
(x,p)	5.05	0	-4.48	0
(a,x)	0.25	-0.59	-0.68	-0.66
(a,p)	0	0	0	0
(y,y)	-2.55	1.90	2.84	1.94
(y,b)	0	0	0	0
(b,y)	0.12	-0.21	-0.36	-0.67

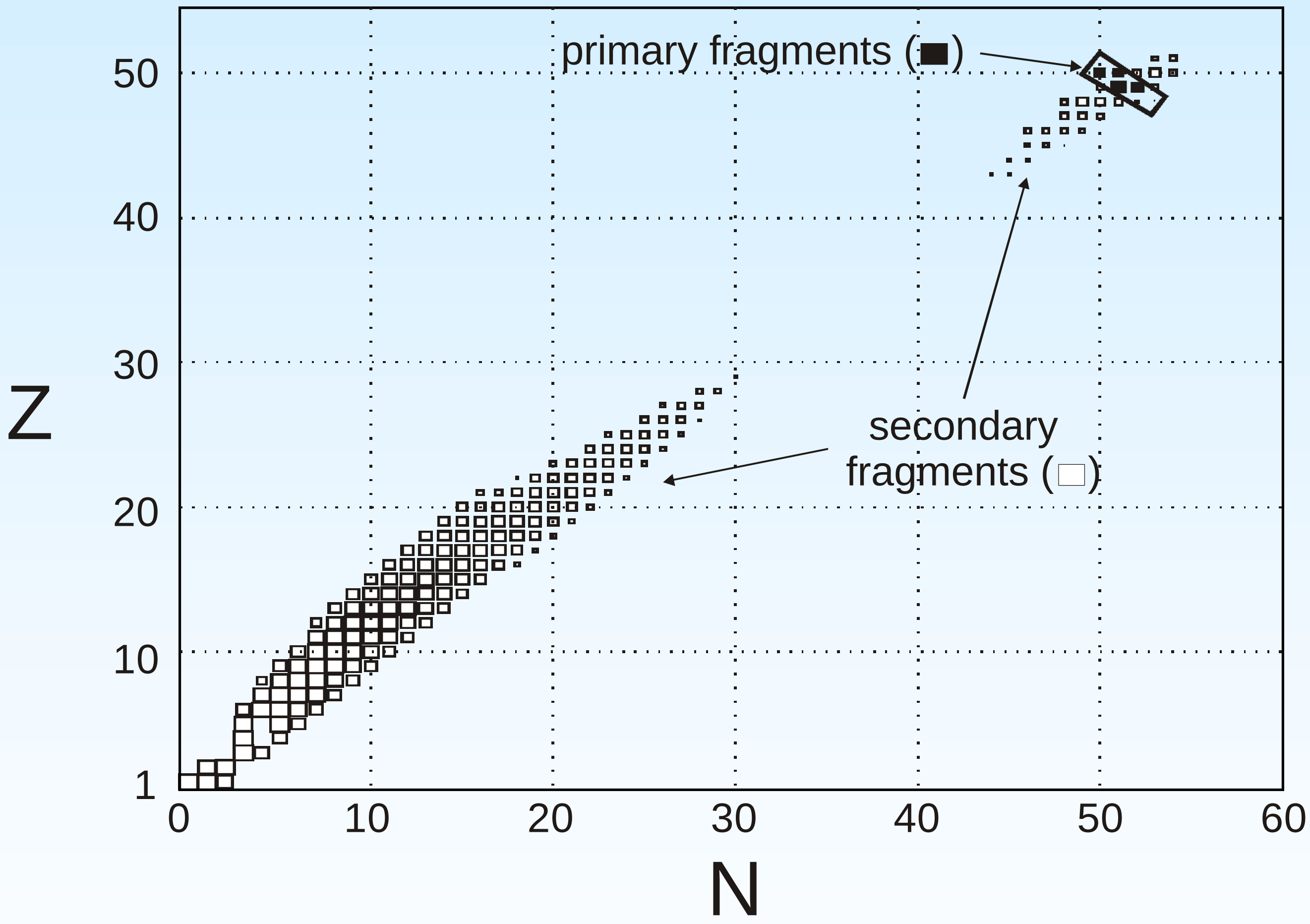
Separation performance using two degrader stages



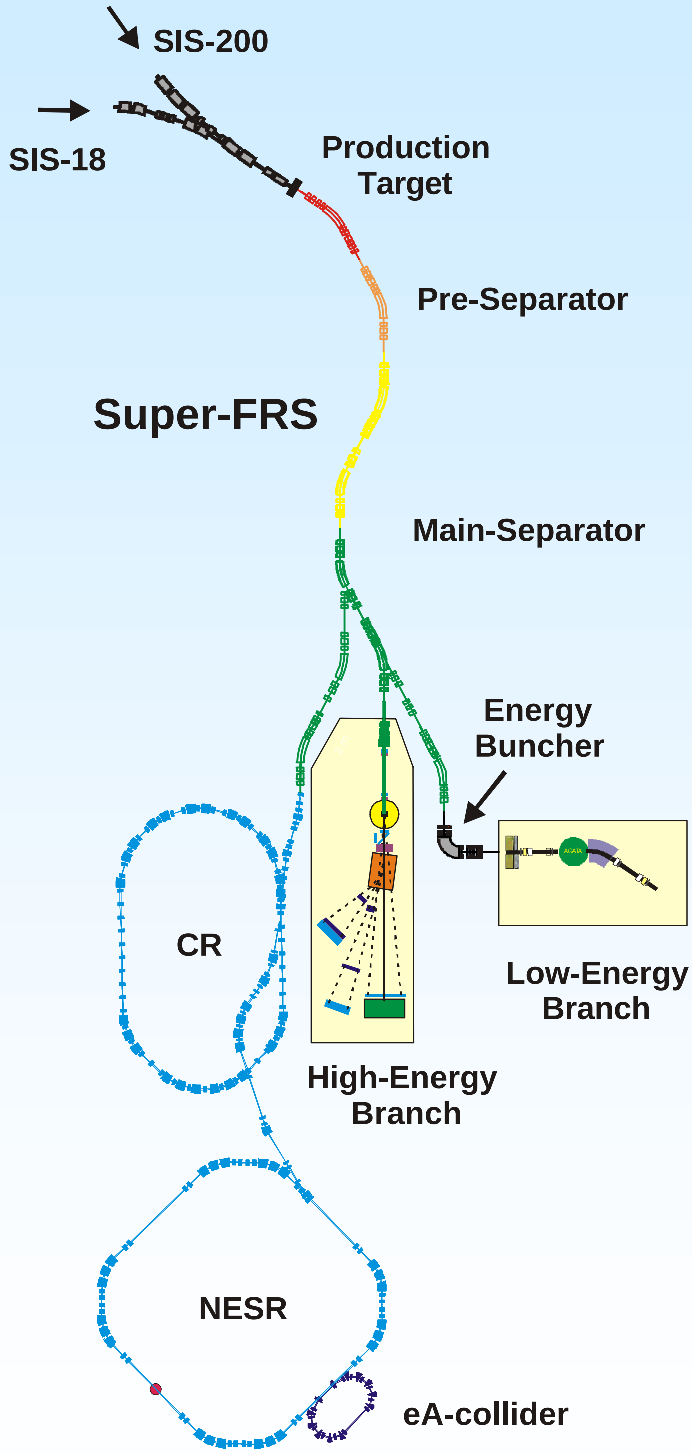
Features of two degrader stages

- Reduction of contaminants from fragments produced in the degrader
- Optimization of the fragment rate on detectors in the main-separator
- Introduction of another separation cut in the A-Z plane
- Possible usage of pre- and main-separator for secondary reaction studies

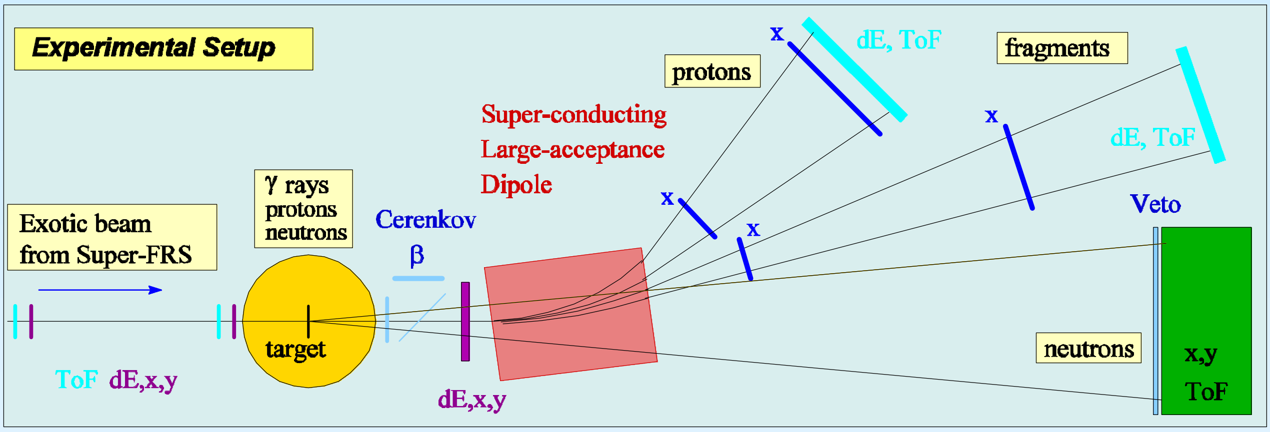
Separation Characteristics for ^{100}Sn with 1 and 2 Degrader Stages



The Super-FRS and it's Facility

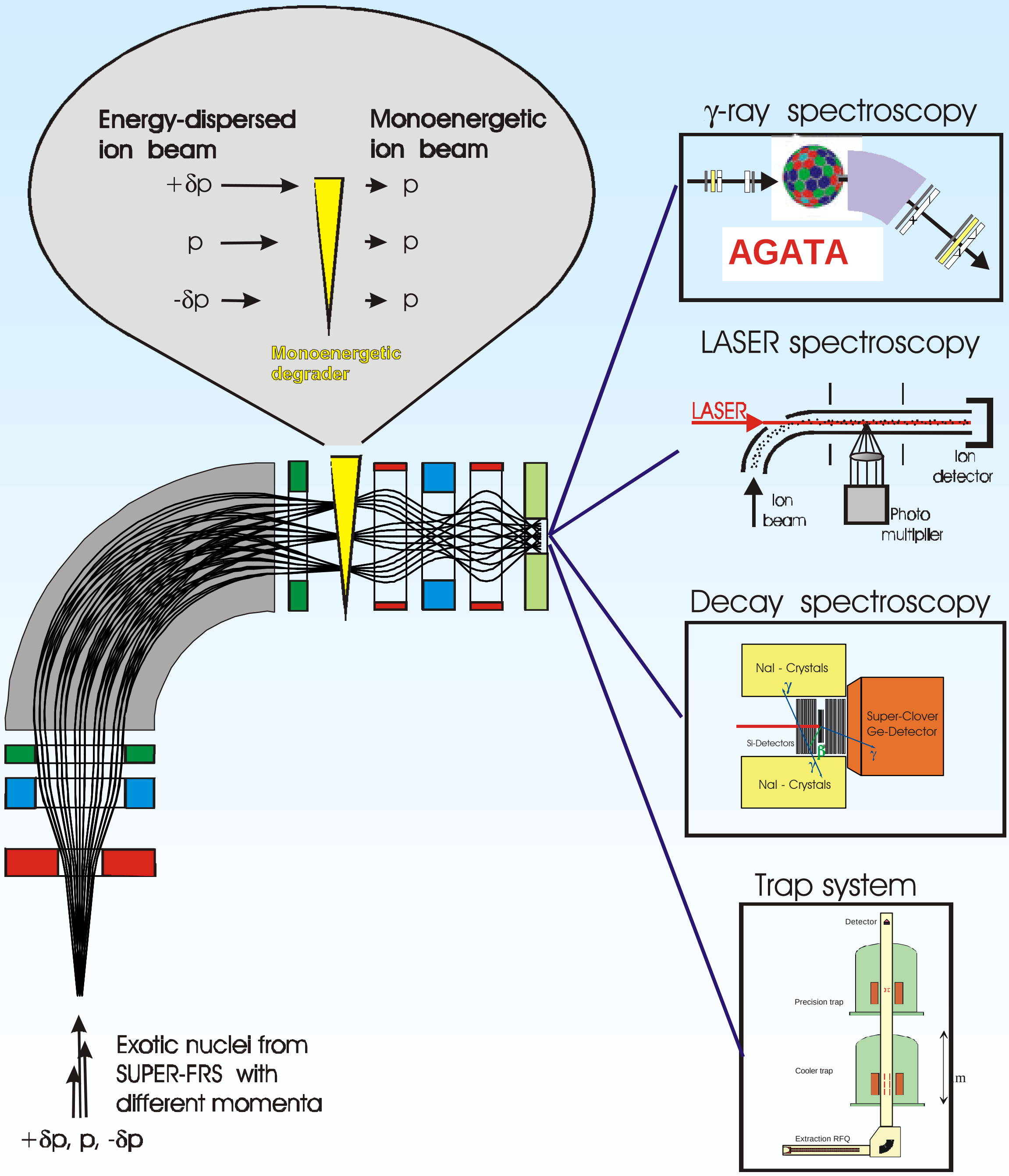


The High-Energy Branch

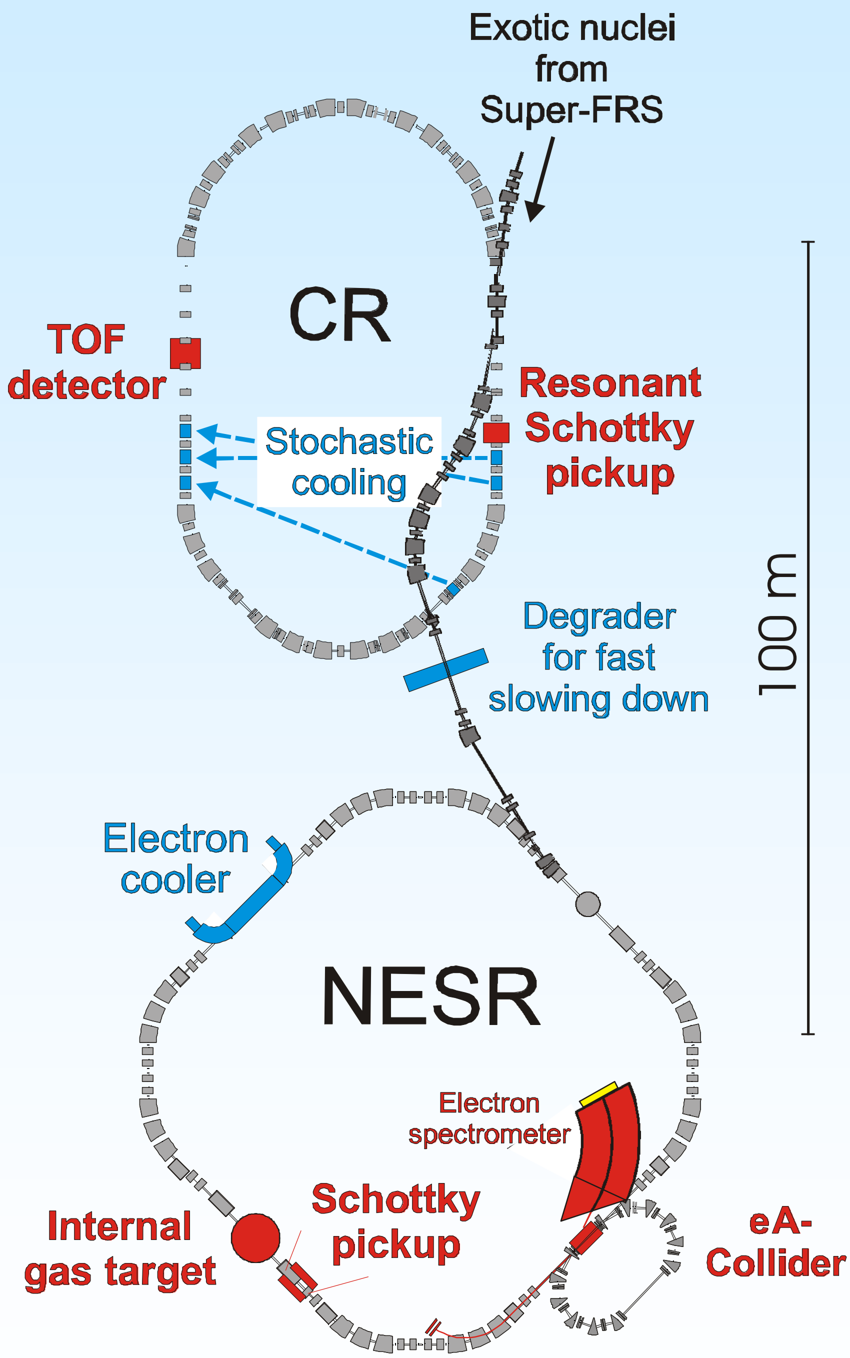


Reaction	Physics goals	Ions/s
Knockout	Unbound states, properties beyond the driplines Single particle structure	1-10 0.1-10
Electromagnetic Excitation	Single particle structure Soft dipole modes Giant dipole resonance Giant quadrupole strength B(E2), evolution of shell structure Astrophysics, rp-process, (p,γ) S-factor	0.1-10 1-10 100 10^3 1-10 10^3
Fission	Shell structure, dynamical properties	10^3
Fragmentation	γ spectroscopy, high spin	10
Multifragmentation	EOS, phase transitions	10^3
(p,n)	Spin-dipole exc., neutron skin, GT strength	10^3 -10^4
Quasi-free scattering	Single particle structure	10
Spallation	Reaction theory (applications, e.g. hybrid reactors)	10^4

Instrumentation of the Low-Energy Branch



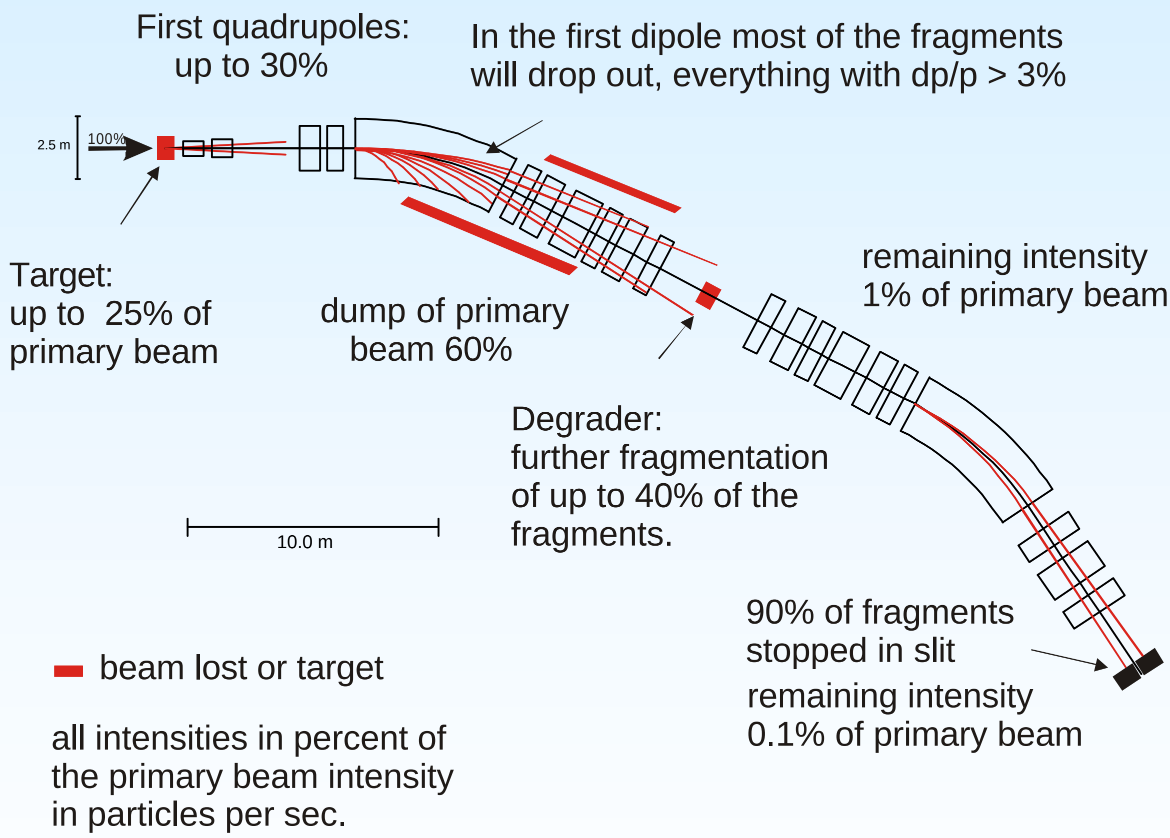
Instrumentation for Experiments with Stored Beams



Summary

- Large momentum and angular acceptance
- Super-FRS consists of three branches feeding caves for different types of experiments
- High secondary-beam transmission to all experimental areas and into the CR/NESR
- Increase of secondary beam intensities of more than 10000 compared to now
- Super-FRS needs more than one separation stage to provide sufficient background reduction
- Unambigious fragment identification (q=Z)
  - Higher separation quality
  - Higher sensitivity and selectivity
  - Physics with single exotic atoms

Intensity distribution in the preseparator of Super-FRS



The GSI Upgrade