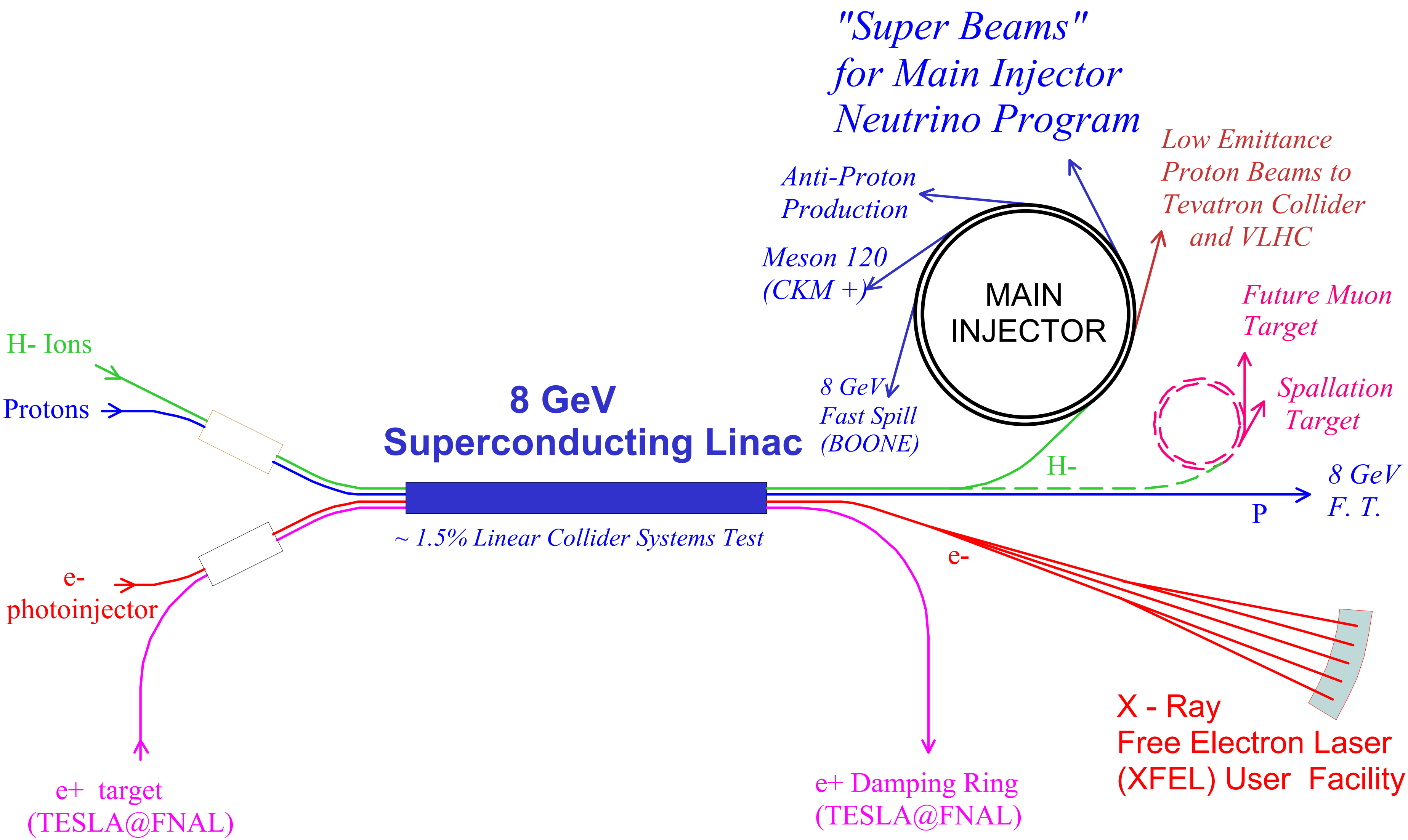
GSI Future Project as a Model for a Diverse User Facility at a Multi-Mission SCRF Linac

- Joel asked me to say something about the "other" capabilities of the Proton Driver/ Multi-Mission Superconducting Linac

- The GSI Future Project is a very successful model for a multi-mission facility.

(It is somewhat familiar to me from being on a GSI external review committee, and also from GSI's involvement in the Heavy-Ion Fusion project)

Multi-Mission 8 GeV Injector Linac



Draft of the 8 GeV SCRF Linac Design Study now Available:

http://tdserver1.fnal.gov/project/8GevLinac/DesignStudy

The TESLA / XFEL / GSI DECISION

~~**TeV-Energy Superconducting Linear Accelerator (TESLA)**, which under the supervision of the *Deutsches Elektronen-Synchrotron* (DESY) is being planned as a global cooperation project. The investment costs total Euro **3.45 billion**. TESLA will provide answers to fundamentally important questions in elementary particle physics and cosmology.~~

TESLA X-ray Free Electron Laser (TESLA X-FEL), proposed as part of the international TESLA project supervised by DESY. According to the current plans, the investment costs for the X-FEL amount to Euro **673 million**. Owing to the high luminosity and time resolution of the X-FEL, a completely new quality of experiments can be expected for many areas of research in the natural, life, geo- and material sciences.

International Accelerator Facility for Beams of Ions and Antiprotons, proposed by the *Gesellschaft für Schwerionenforschung* in Darmstadt **(GSI).** The investment costs total Euro **675 million**. The proposed facility opens up new avenues in basic and applied research, above all in the fields of nuclear, hadron, atomic and plasma physics.

http://www.wissenschaftsrat.de/presse/pm_2002.htm

The TESLA XFEL

http://tesla.desy.de/new_pages/tdr_update/start.html

GSI Future Facility

Walter F. Henning

March 2003, LEAP03

- Introduction
- Facility Layout and Characteristics
- Scientific Areas and Goals
- Research with Antiprotons
- Summary

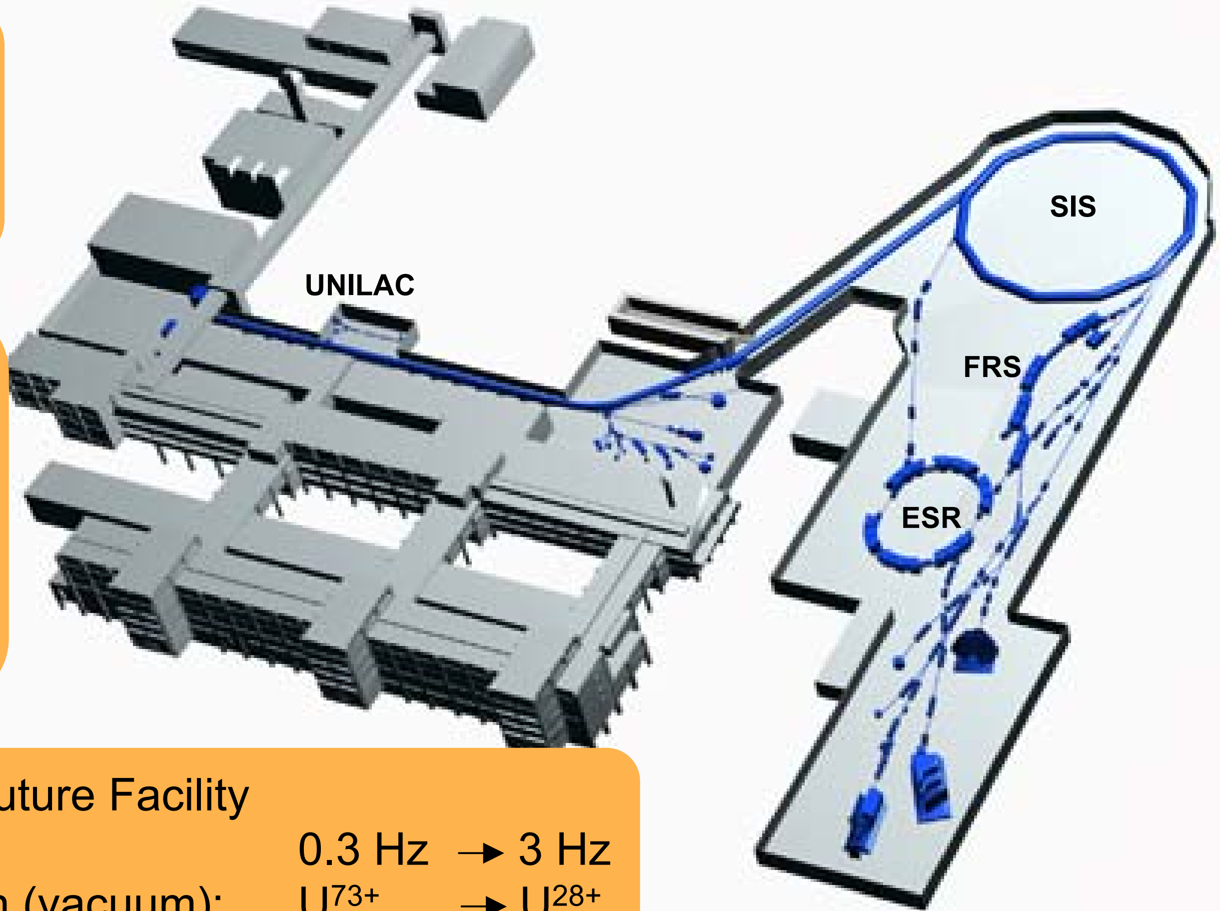
Present GSI Facility

Accelerator Parameters

Energies:
Unilac < 20 MeV/u
SIS 1-2 GeV/u
ESR < 0.8 GeV/u

3 Injectors

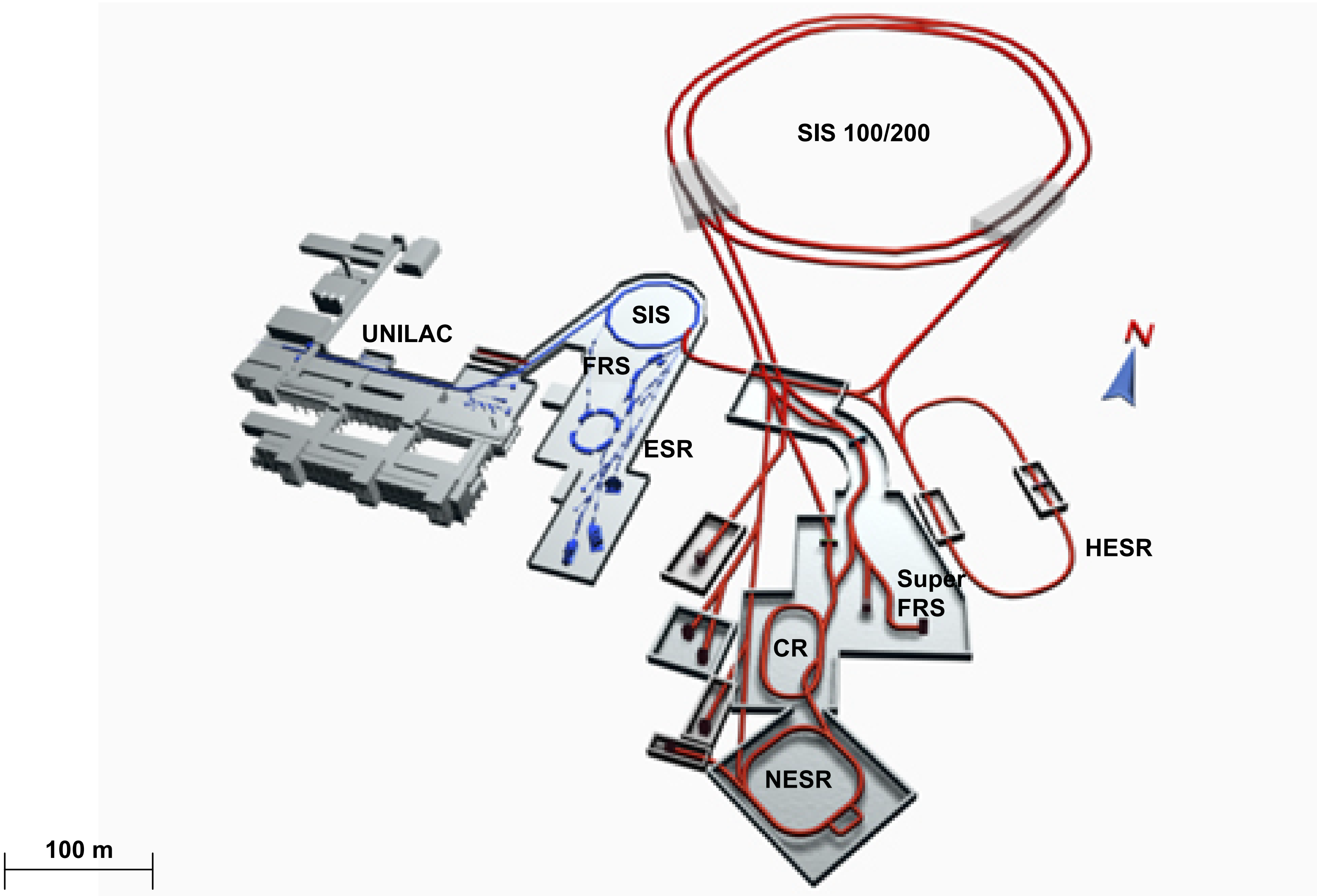
HSI:	8 mA Ar^{1+}
	18 mA Ar^{10+}
	15 mA U^{4+}
	2,5 mA U^{28+}
	0,5 mA U^{73+}



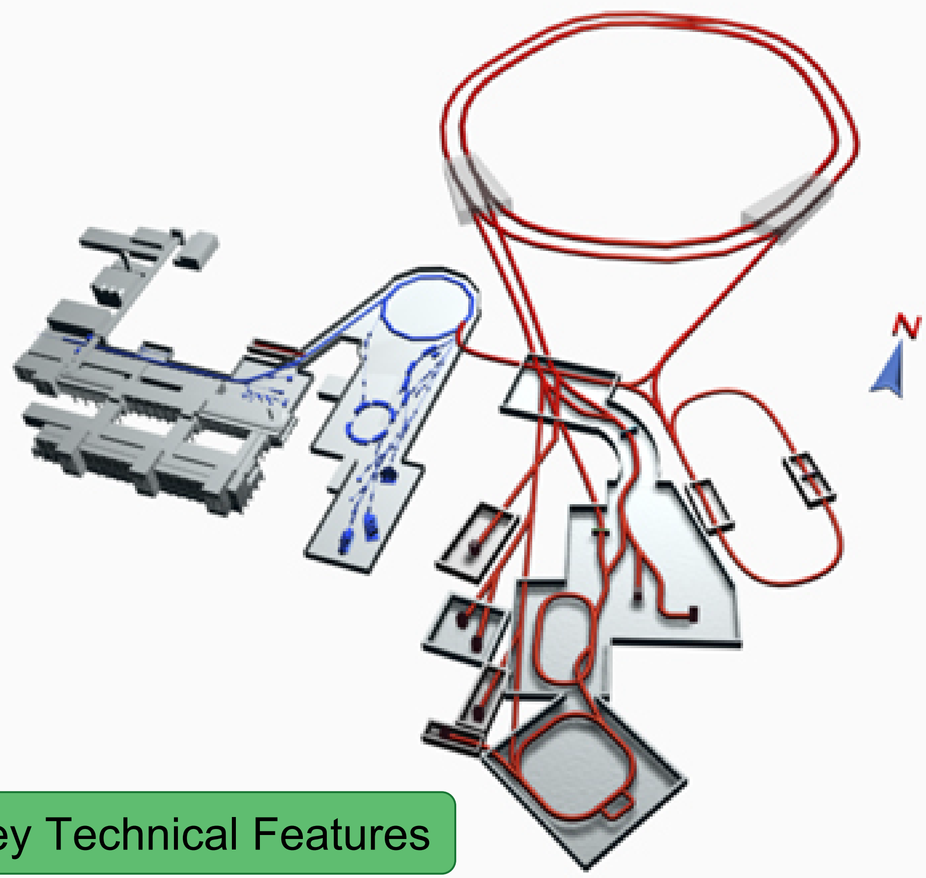
Upgrade towards the Future Facility

Freqency (power):	0.3 Hz	→ 3 Hz
Space charge reduction (vacuum):	U^{73+}	→ U^{28+}

GSI Future Facility



GSI Facility Characteristics



Primary Beams

- 10^{12}/s; 1.5 GeV/u; $^{238}U^{28+}$
- Factor 100-1000 over present in intensity
- 2(4)x10^{13}/s 30 GeV protons
- 10^{10}/s $^{238}U^{73+}$ up to 25 (- 35) GeV/u

Secondary Beams

- Broad range of radioactive beams up to 1.5 - 2 GeV/u; up to factor 10 000 in intensity over present
- Antiprotons 3 (0) - 30 GeV

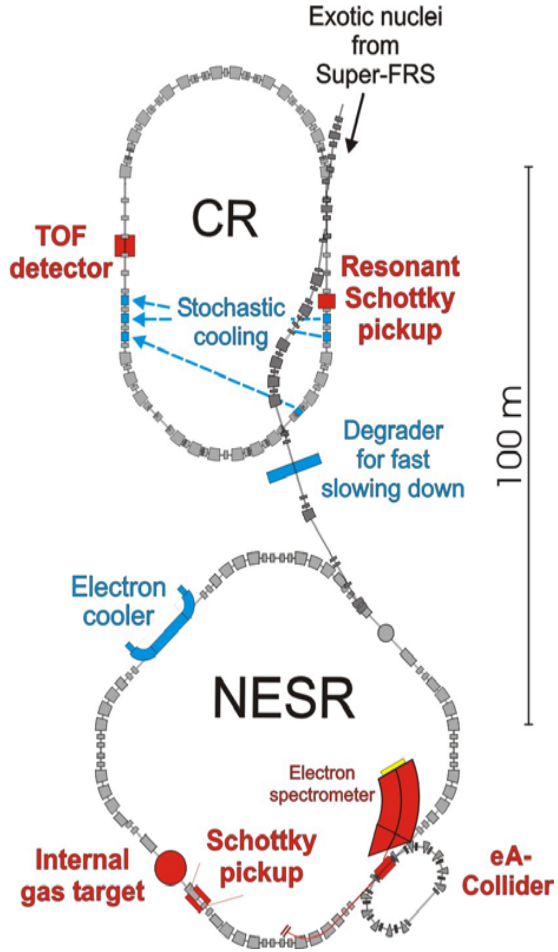
Storage and Cooler Rings

- Radioactive beams
- e – A collider
- 10^{11} stored and cooled 0.8 - 14.5 GeV antiprotons

Key Technical Features

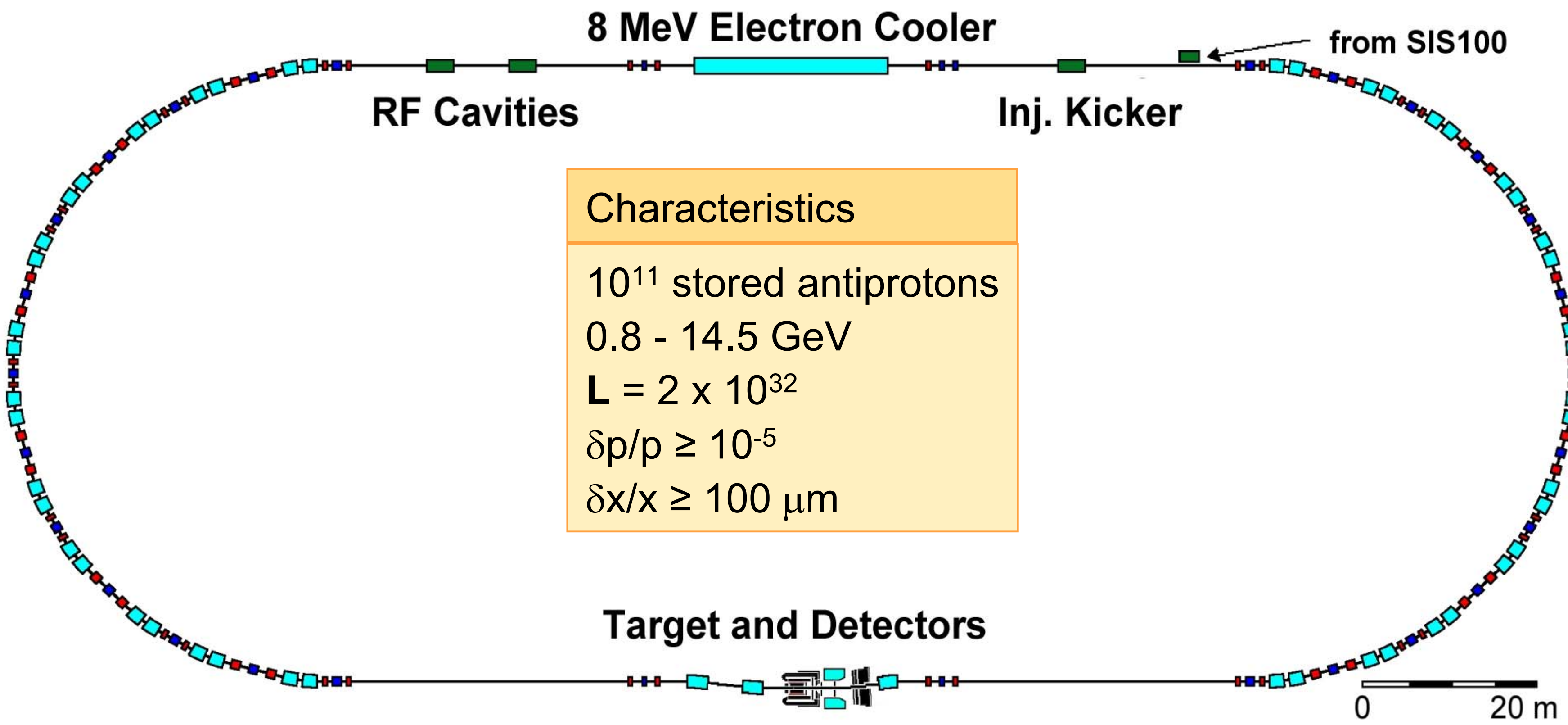
- Cooled beams
- Rapidly cycling superconducting magnets

Storage Rings



➡ Collector (CR) and Storage Rings (NESR) for Ions and Antiprotons

HESR - High Energy Storage Ring



Characteristics

10^{11} stored antiprotons

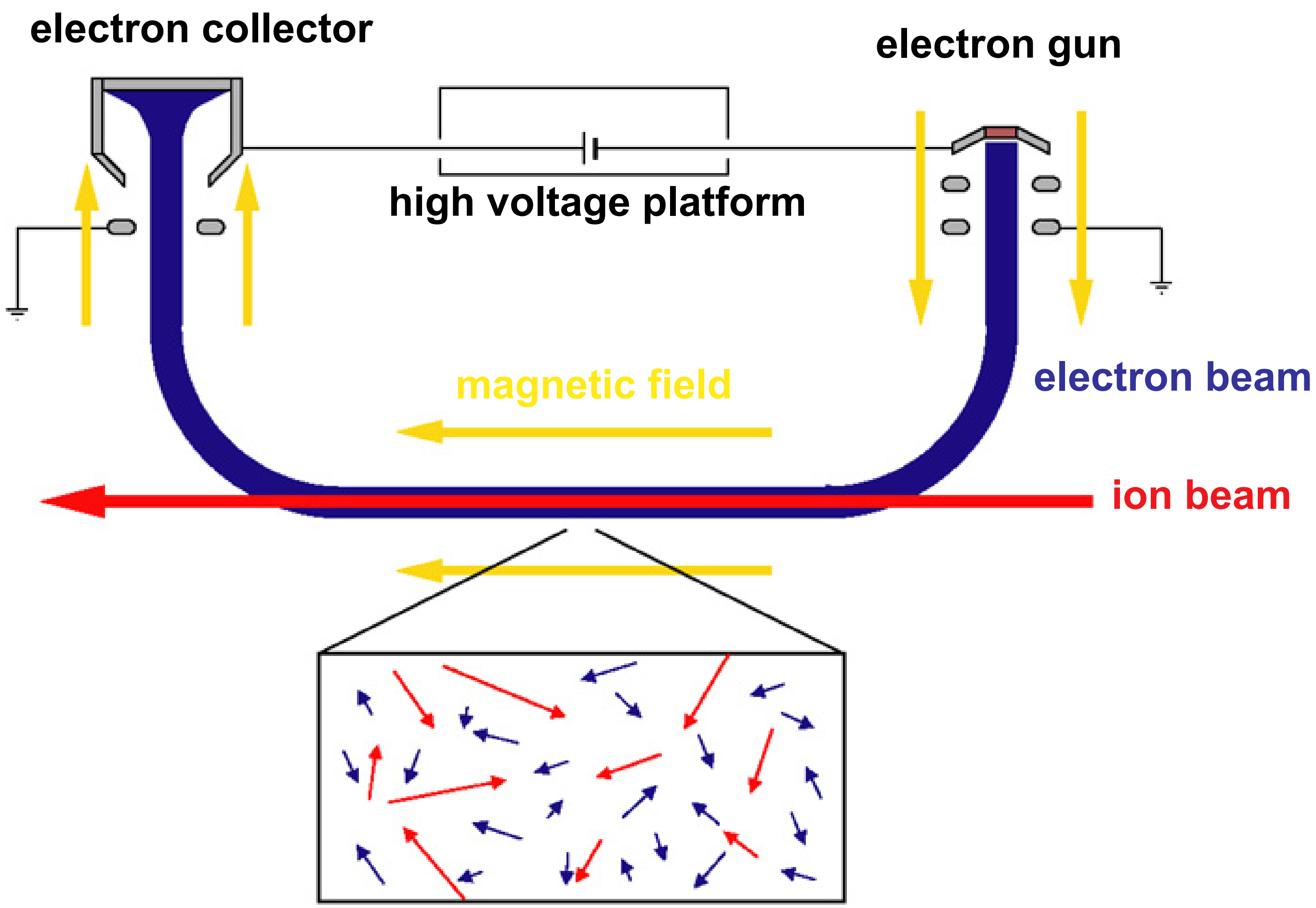
0.8 - 14.5 GeV

L = 2×10^{32}

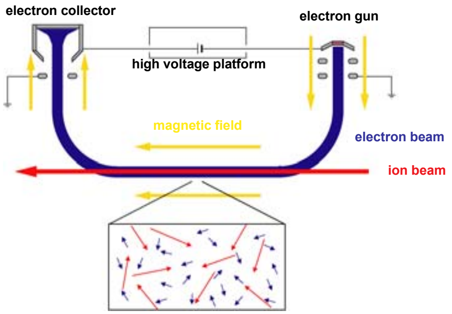
$\delta p/p \geq 10^{-5}$

$\delta x/x \geq 100\ \mu m$

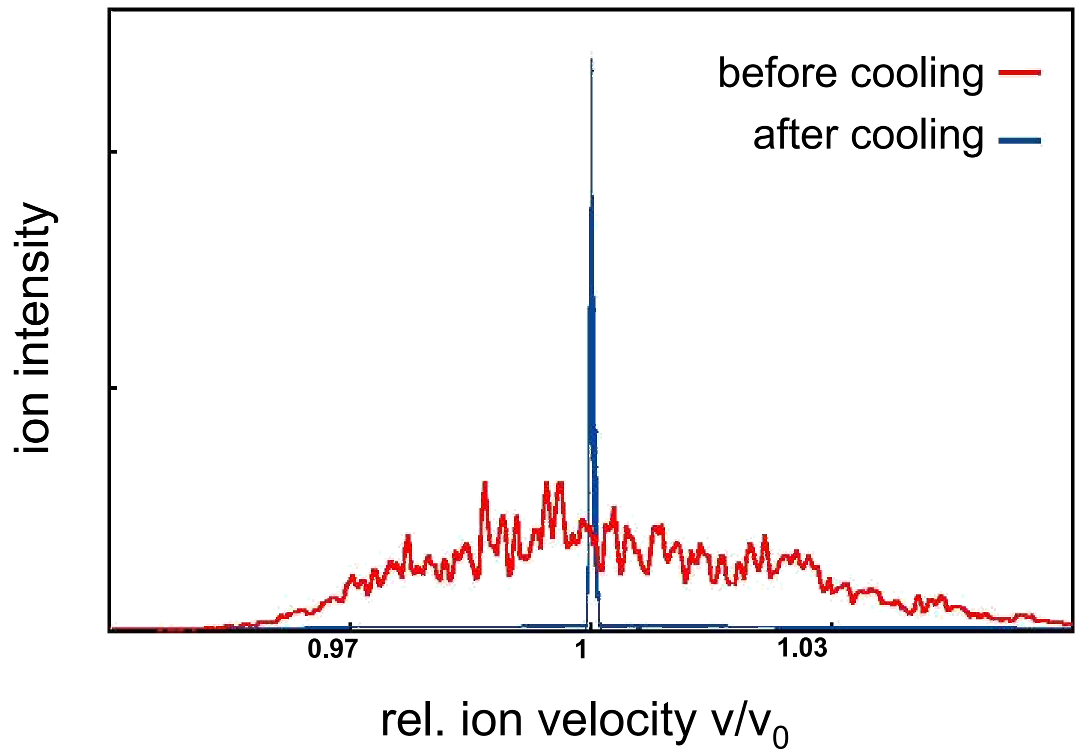
Storage Rings: Cooled Ion Beams

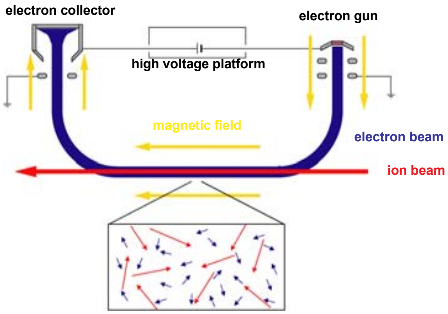


Storage Rings: Cooled Ion Beams

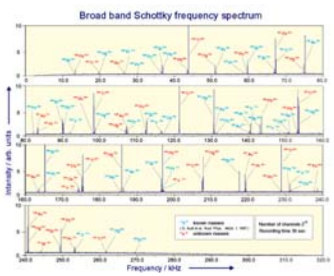


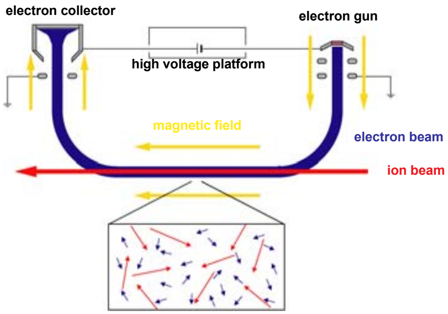
Storage Rings: Cooled Ion Beams

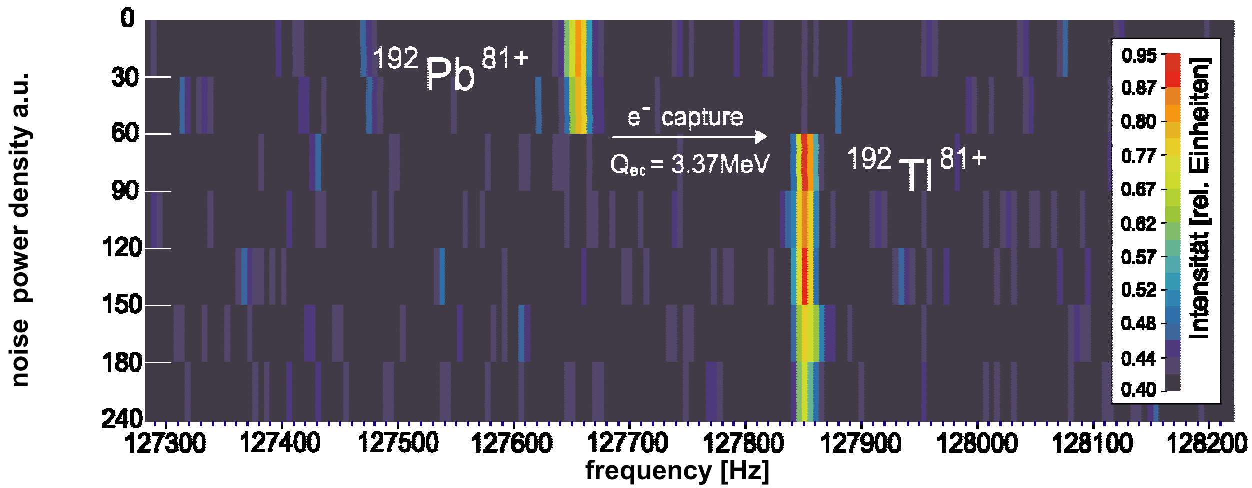


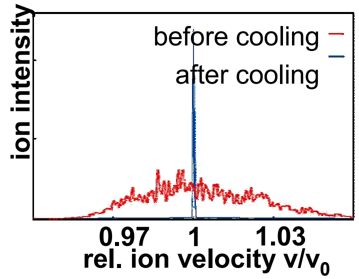


Storage Rings: Cooled Ion Beams





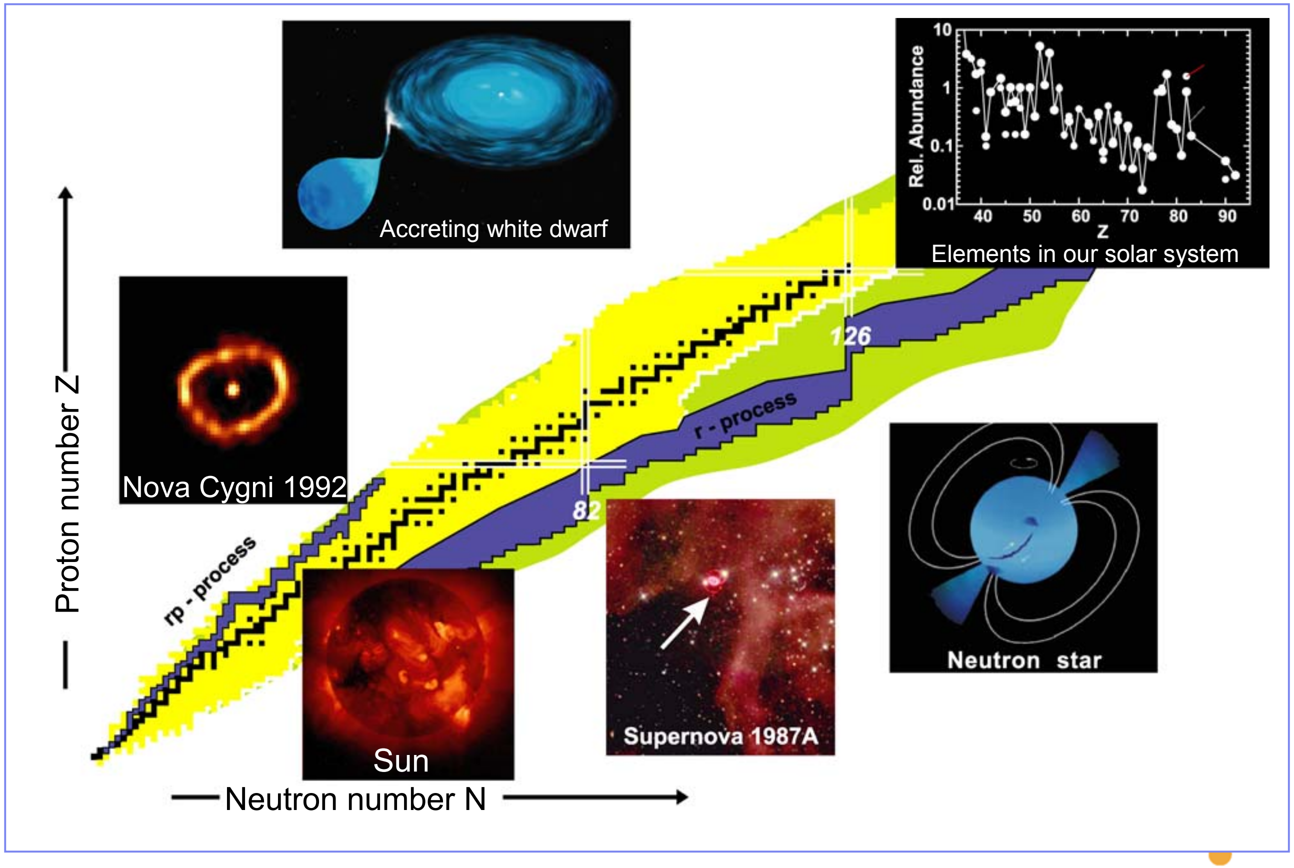




Summary of Research Areas at the GSI Future Facility

Structure and Dynamics of Nuclei - Radioactive Beams

Nucleonic matter
Nuclear astrophysics
Fundamental symmetries



HIGH ENERGY DENSITY PLASMAS

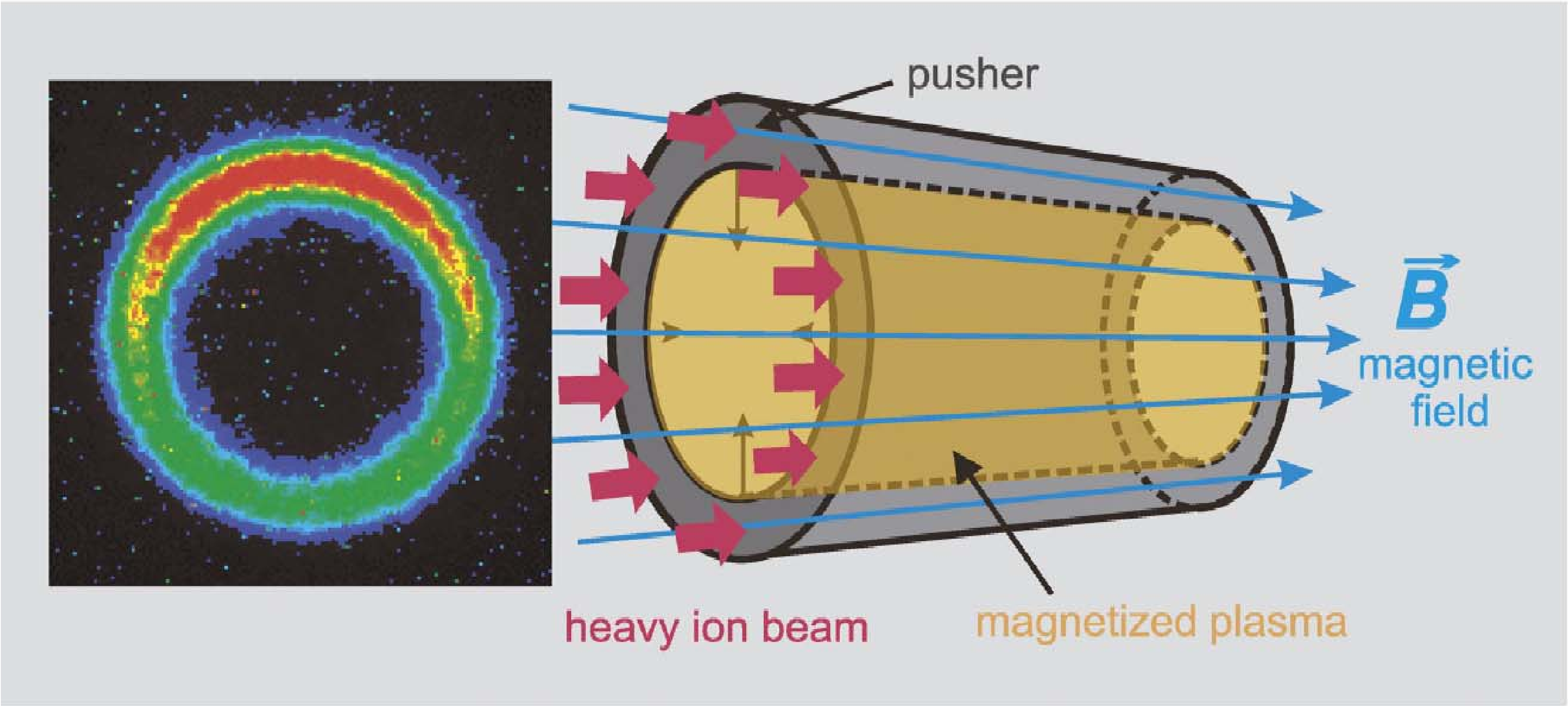
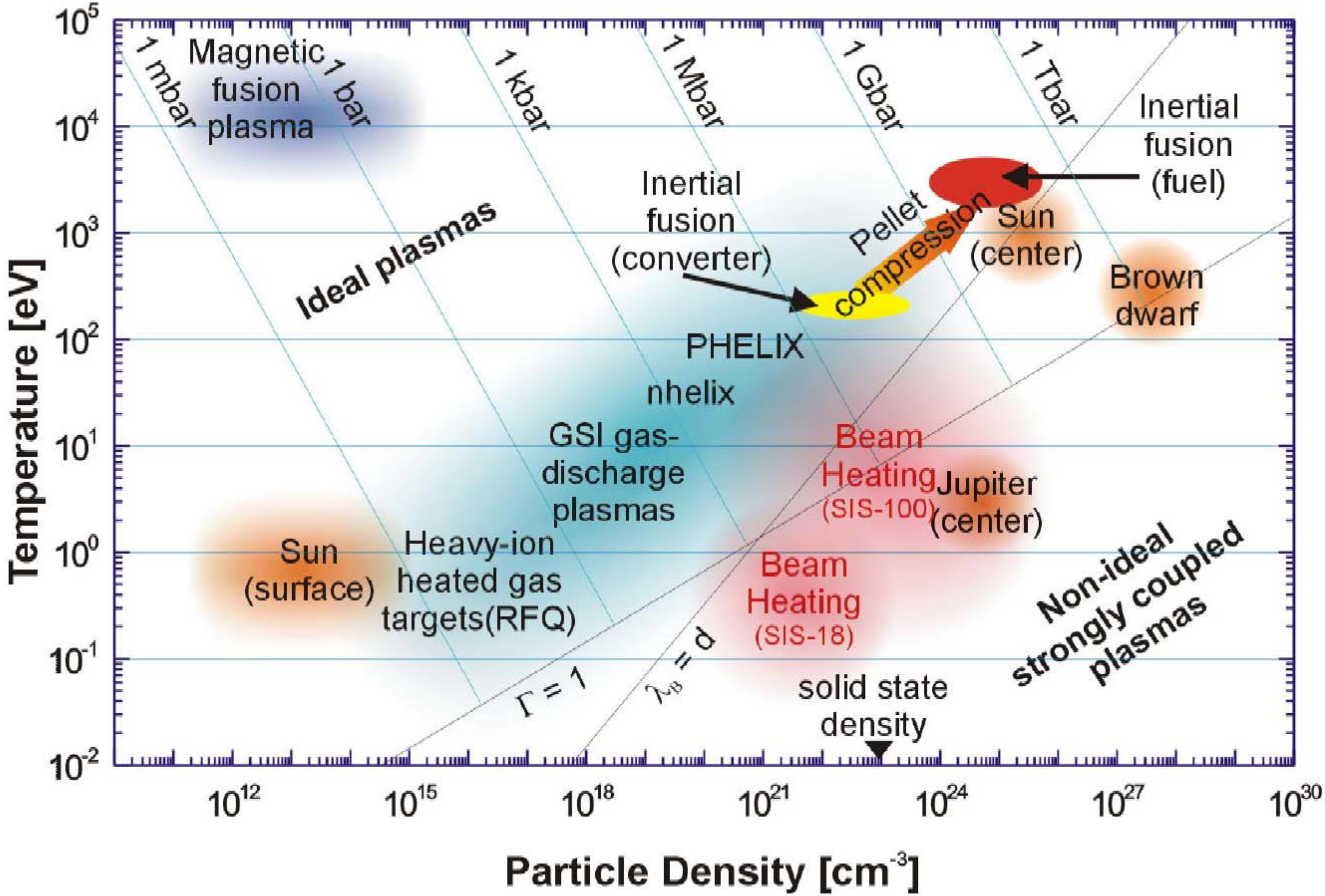


Figure 1.12: The principle of magnetized targets for heavy-ion beam experiments. The focus of the ion beam is of annular shape. An example of such a ring-focus, which was already achieved with the GSI plasma lens, is shown in the left part of the figure. Highest plasma parameters are obtained, where the annular beam heats the outer line material in the annular focus region only and the inner cold portion of target is accelerated inward by the beam heated material. At magnetic field strengths of about 30 T, one expects, due to the effect of magneto-thermal insulation, plasma temperatures in the keV region to be reached.



Magnetic fusion plasma
1 mbar
1 bar
1 kbar
1 Mbar
1 Gbar
1 Tbar
Inertial fusion (fuel)
Inertial fusion (converter)
Pellet compression
Sun (center)
Brown dwarf
Ideal plasmas
PHELIX
nhelix
GSI gas-discharge plasmas
Beam Heating (SIS-100)
Jupiter (center)
Sun (surface)
Heavy-ion heated gas targets(RFQ)
Beam Heating (SIS-18)
Non-ideal strongly coupled plasmas
Γ = 1
λ_B = d
solid state density
Temperature [eV]
Particle Density [cm^-3]

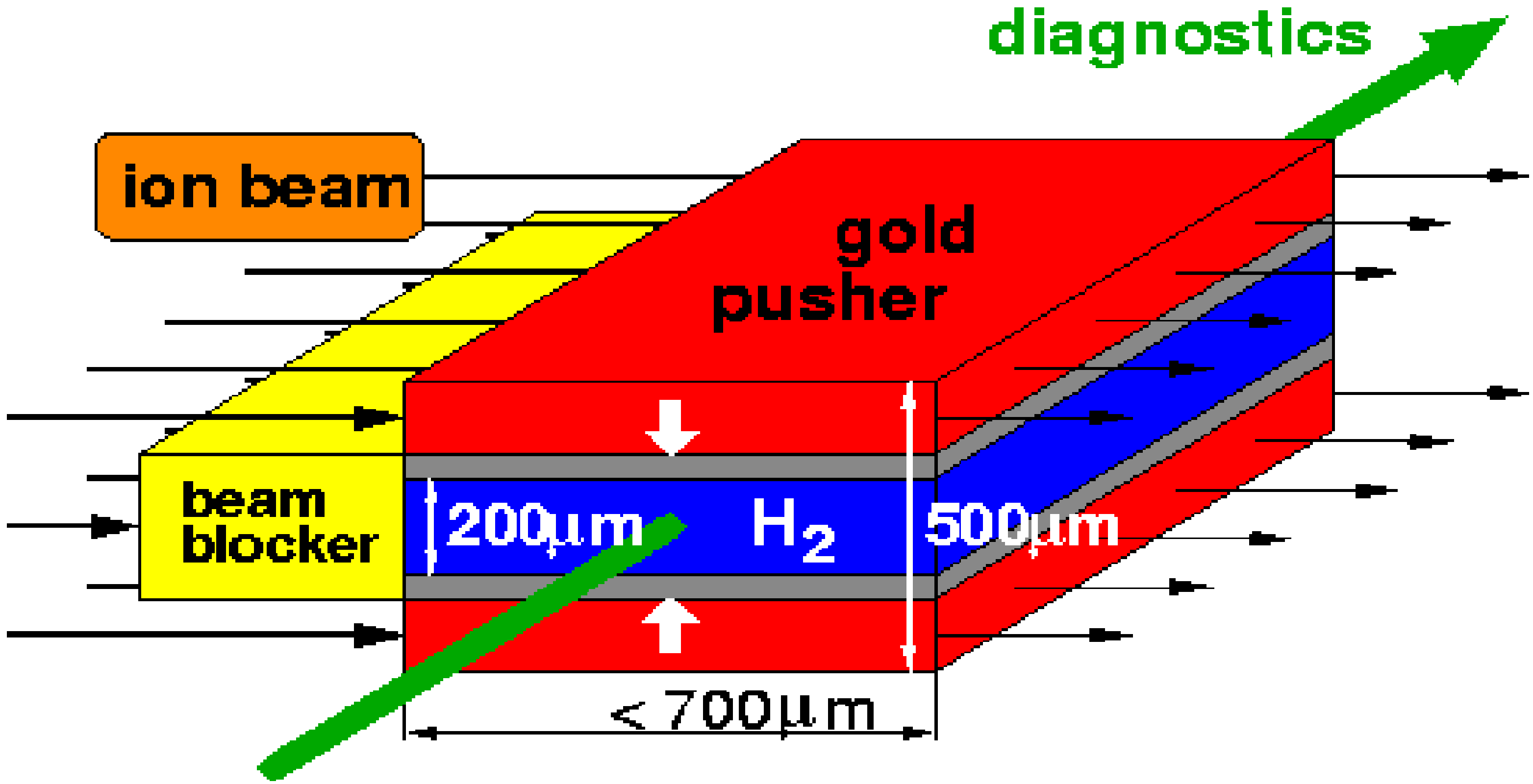
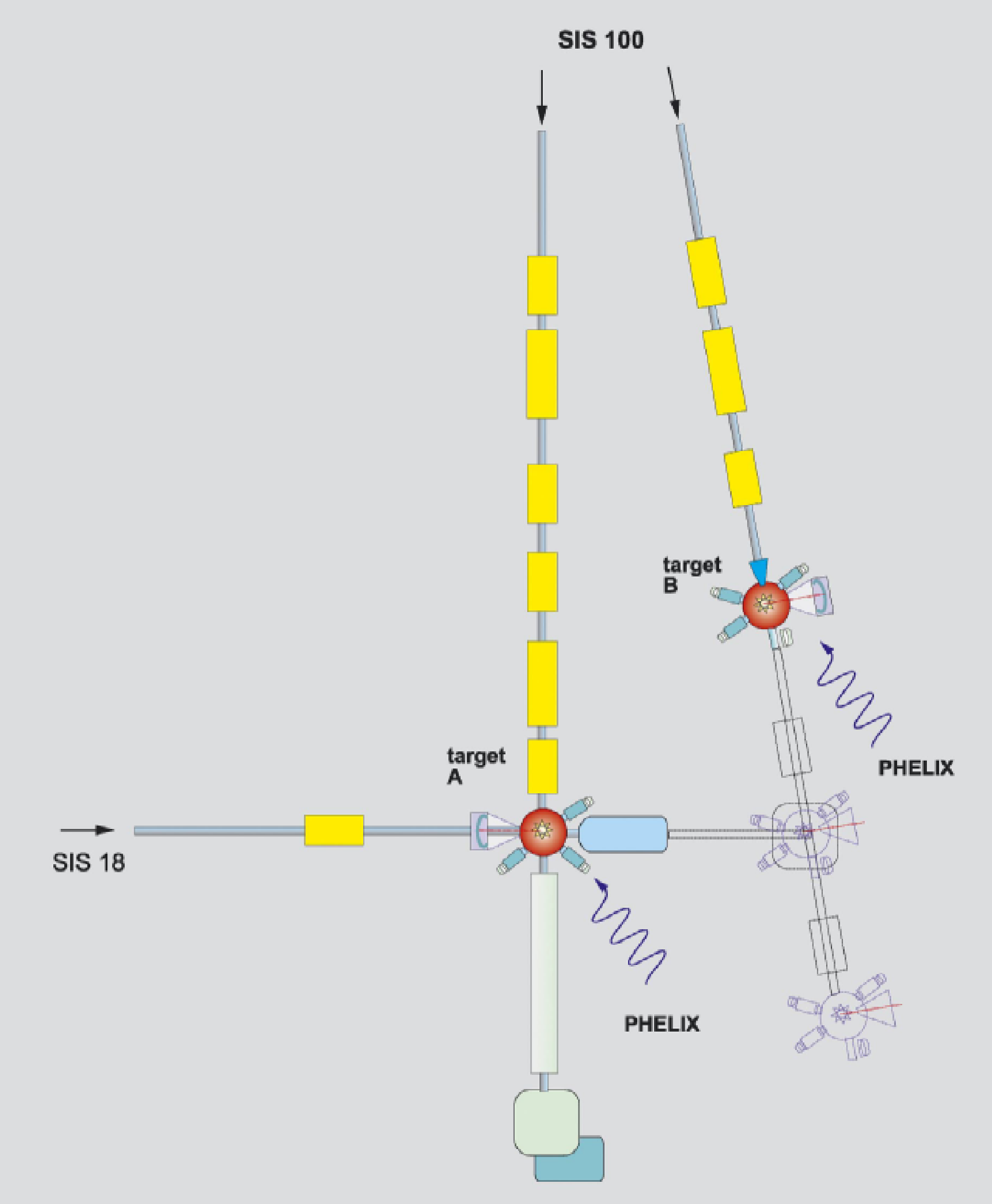


Figure 4.10: Proposed planar compression experiment.

Beam + Material = ultra-high density

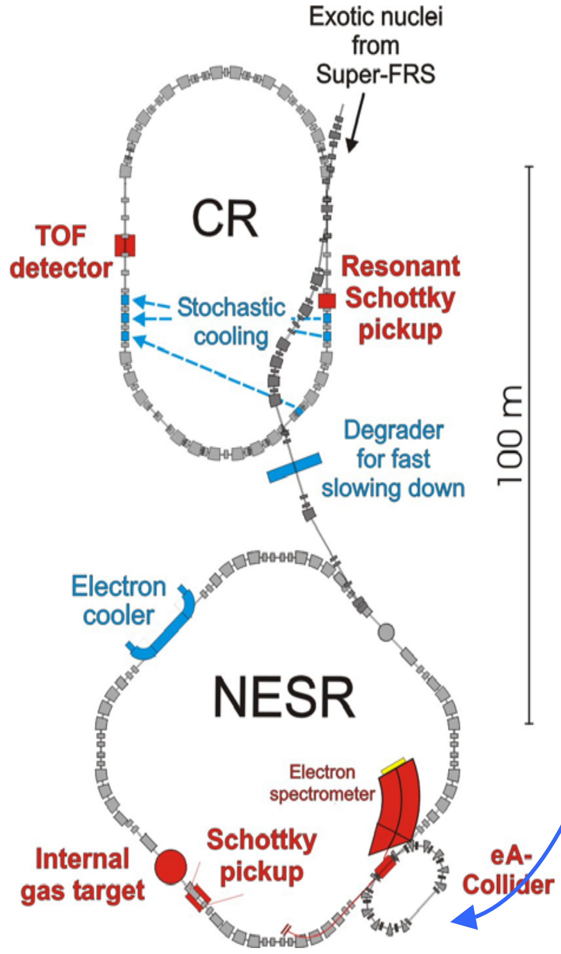


PHELIX

Petawatt High-Energy Laser for Ion eXperiments

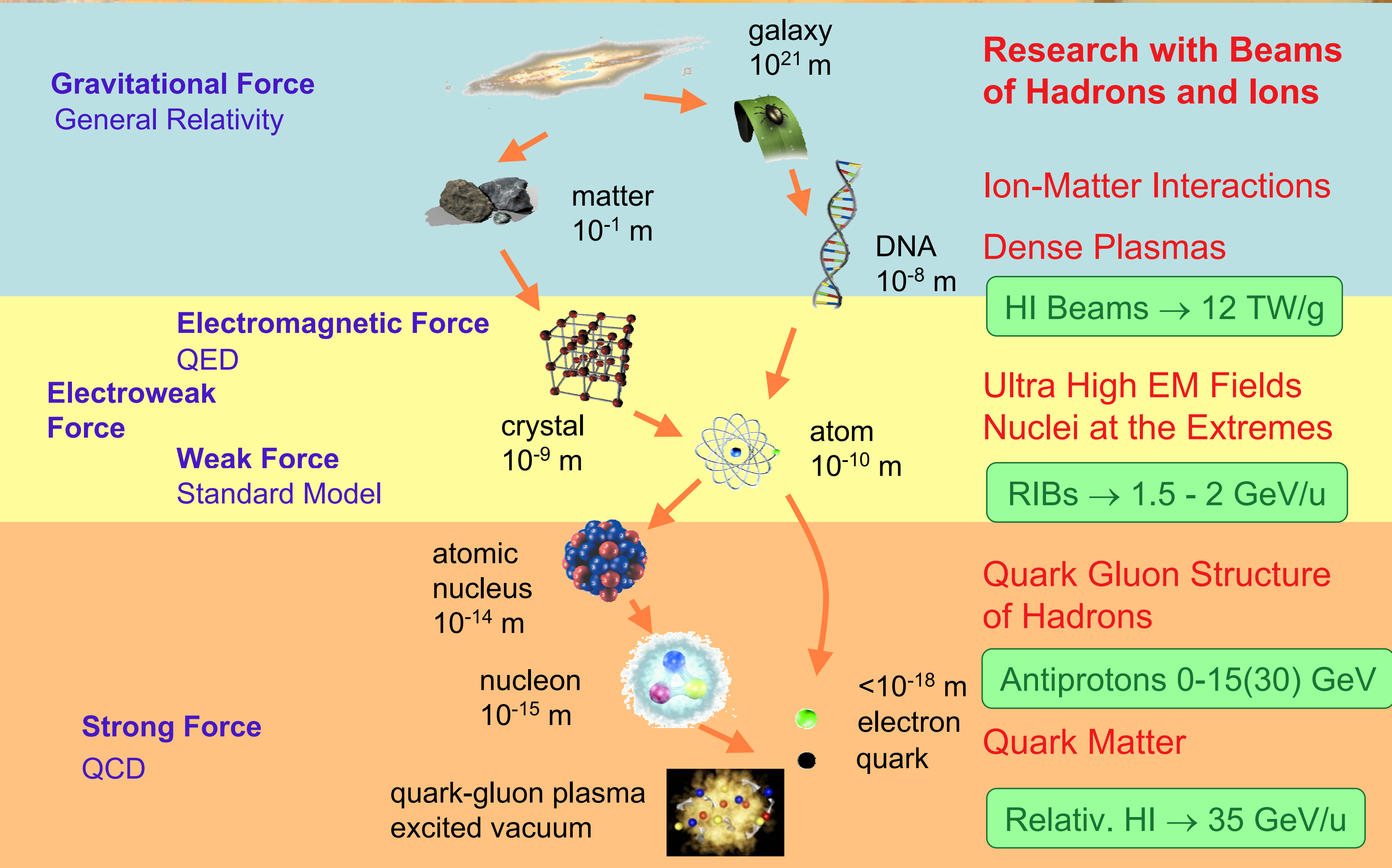
Laser beams
+ Particle Beams
+ Superconducting Low Beta Quads
= ?

Storage Rings



Positron-Antiproton Scattering (~1 GeV c.m.)
▪ Structure Functions etc. ▪ CPT Invariance

Structure of Matter

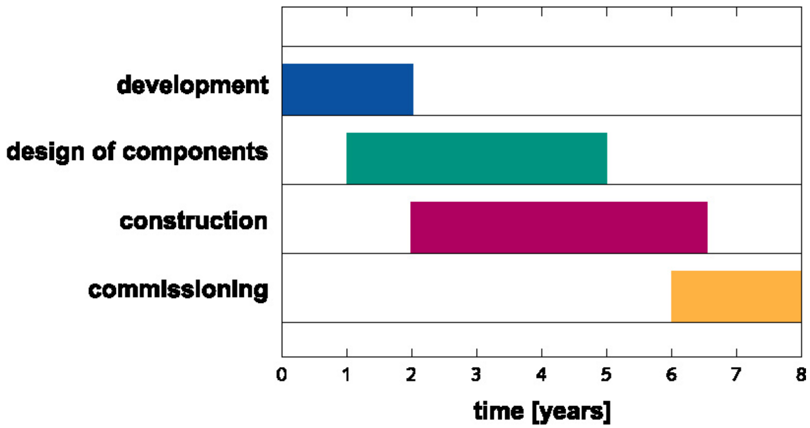


Users, Costs and Schedules

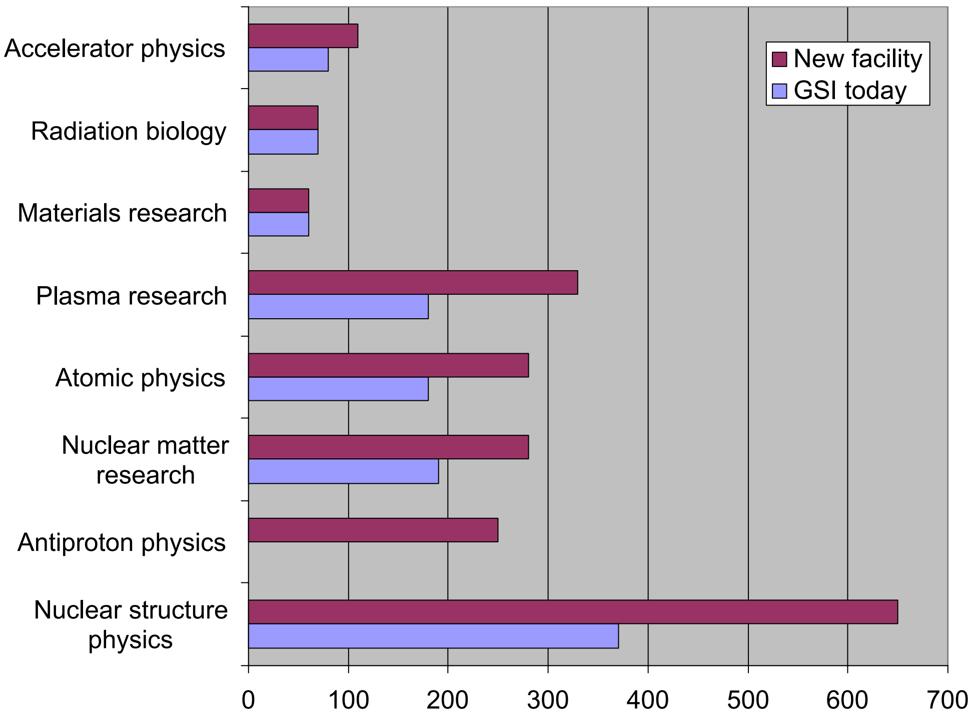
COSTS

Building and infrastructure:	225 Mio. €
Accelerator:	265 Mio. €
Experimental stations / detectors:	185 Mio. €
Total:	675 Mio. €

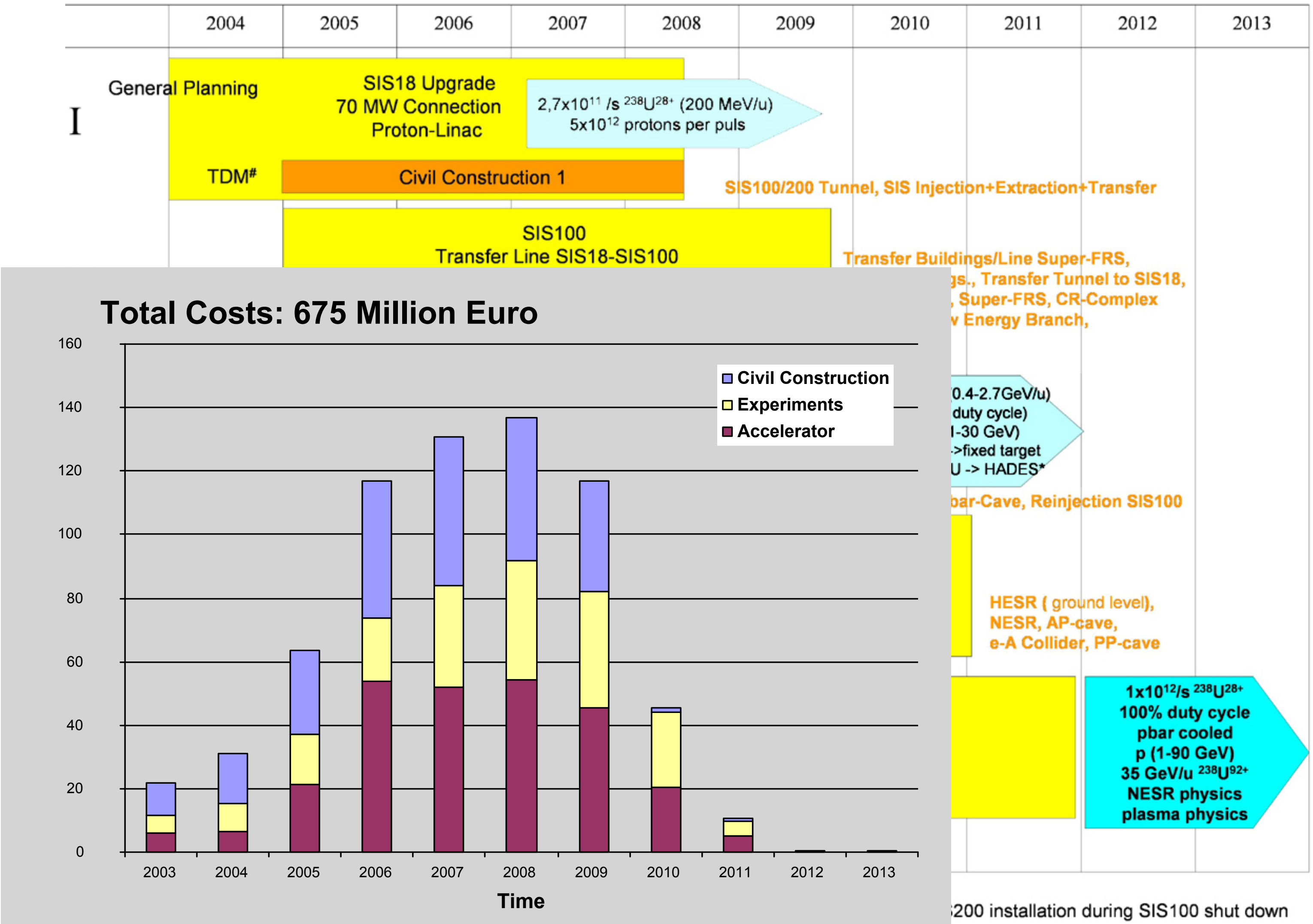
SCHEDULE



Users interest



Concept for Staged Construction of the International Facility for Beams of Ions and Antiprotons



Major Milestones of the GSI Future Facility

1996 - 1999	Workshops and Working Groups
2001	Conceptual Design Report
2001	Review of Project by the Science Council (Wissenschaftsrat) of the German Government
2002	Recommendation for Realization by the Wissenschaftsrat
2001 - 2002	Workshops and Formation of the Proto-Collaborations
2003	Cabinet Decision of the Federal Government to Fund the Project (with: a) staging and b) 25% external contributions)

Activities in Connection with the GSI Plans

Working Groups on Long-Term Perspectives of GSI

Deep-inelastic electron-nucleon and electron-nucleus scattering at $\sqrt{s}$ = 20 – 30 GeV
Conveners: V. Metag (GSI), D. v. Harrach (Mainz), A. Schäfer (Frankfurt)

X-ray spectroscopy and radiation physics
Conveners: J. Kluge (GSI), H. Backe (Mainz), G. Soff (Dresden)

Nuclear collisions at maximum baryon density
Conveners: P. Braun-Munzinger (GSI), R. Stock (Frankfurt), J. P. Blaizot (Saclay)

Physics with secondary beams
Conveners: U. Lynen (GSI), D. Frekers (Münster), J. Wambach (Darmstadt)

Nuclear structure with radioactive beams
Conveners: G. Münzenberg (GSI), D. Habs (LMU München), H. Lenske (Gießen), P. Ring (TU München)

Plasma physics with heavy ion beams
Conveners: R. Bock (GSI), D.H.H. Hoffmann (Erlangen), J. Meyer-ter-Vehn (IPP München)

Accelerator studies (electron-nucleon/nucleus collider)
Conveners: K. Blasche (GSI), J. Maidment (DESY), B. Autin (CERN), N. S. Dikansky (Novosibirsk)

Accelerator studies (high intensity option)
Convener: D. Böhne (GSI)

Short Pulse/High Power Lasers
Convener: J. Kluge (GSI)

Letter of Intent: "Construction of a GLUE/CHARM Factory at GSI"

Editorial Board: B. Franzke (GSI)
P. Kienle (Munich)
H. Koch (Bochum)
W. Kühn (Giessen)
V. Metag (Giessen)
U. Wiedner (CERN & Uppsala)

Contributions from W. Cassing (Giessen), S. Paul (Munich), J. Pochodzalla (Heidelberg), M. Soyeur (Saclay) and J. Wambach (Darmstadt) and many members of the Hadron Working Group for GSI.

25 Workshops on science and technical aspects of the GSI future facility

Evaluation of the German Wissenschaftsrat

“Stellungnahme zu neun Großgeräten der naturwissenschaftlichen Grundlagenforschung und zur Weiterentwicklung der Investitionsplanung von Großgeräten“