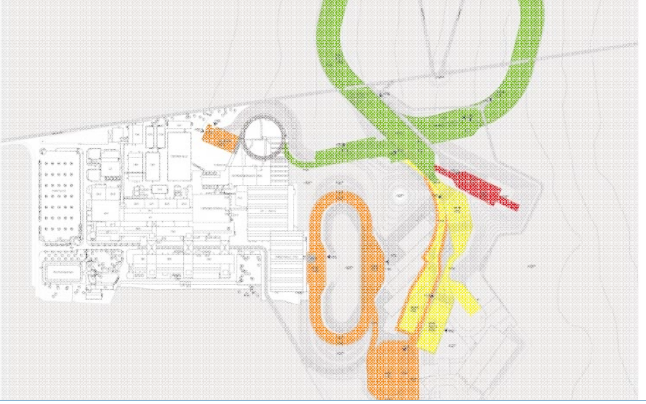
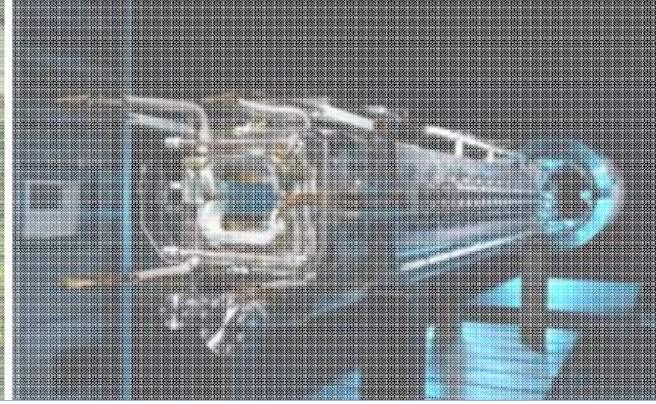




Status of the FAIR Project

Boris Sharkov

FAIR Scientific Director (des.)

@ Peking 22.02.2010

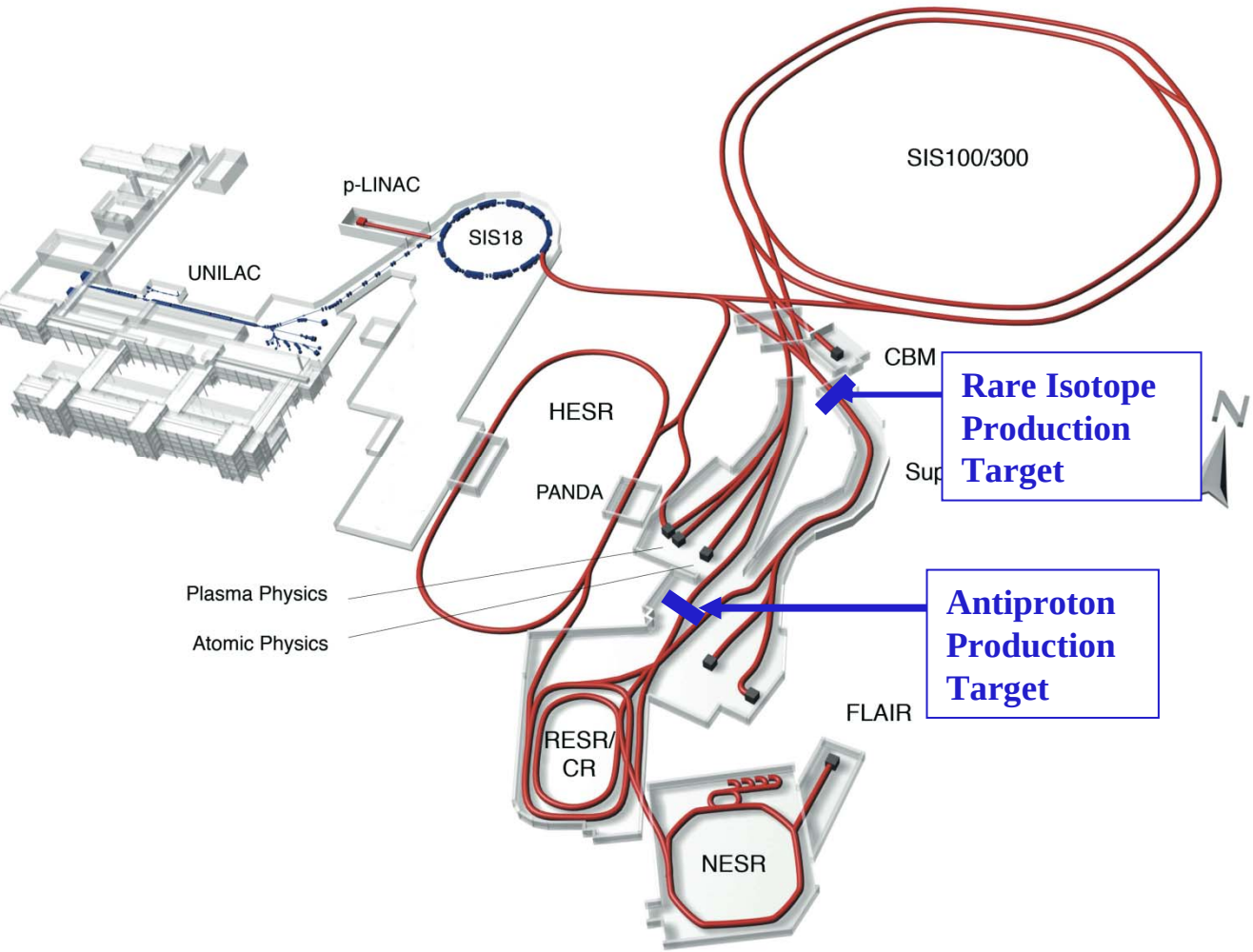
Austria China Finland France Germany Greece India Italy Poland Romania Russia Slovakia Slovenia Spain Sweden U K Saudi Arabia

FAIR

International FAIR Project: *the Intensity Frontier*

Key Technologies

- Beam cooling
- Rapidly cycling superconducting magnets
- Narrow bunching of beams



Primary Beams

- **All elements** up to Uranium
- Factor 100-**1000** over present intensity
- **50ns bunching**

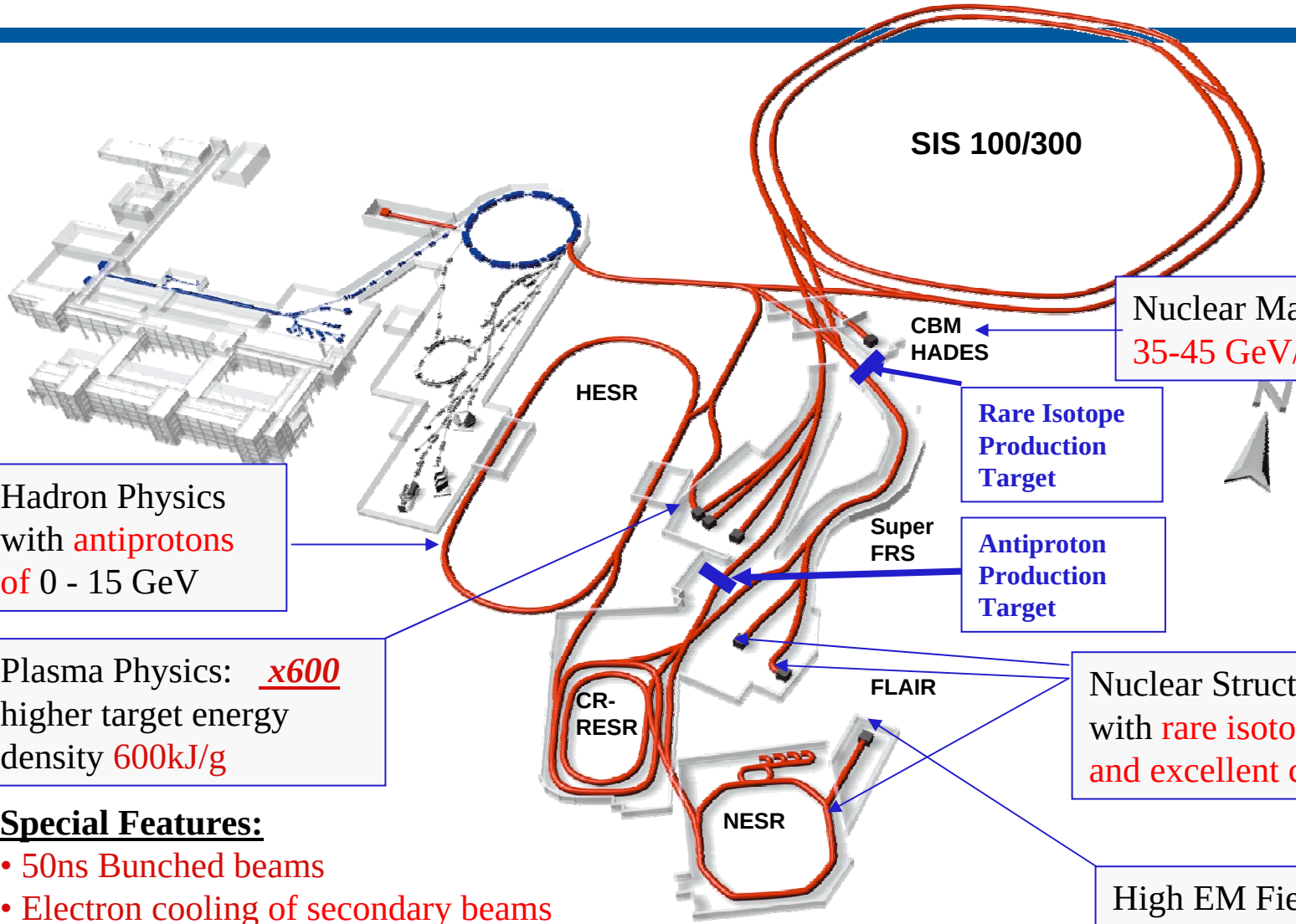
Secondary Beams

- **Rare isotope beams** up to a factor **of 10 000** in intensity over present
- Low and high energy **antiprotons**

Storage and Cooler Rings

- Rare isotope beams
- **e$^-$**– Rare Isotope collider
- **10^{11}** stored and cooled antiprotons for **Antimatter** creation

Research Communities at FAIR



Nuclear Matter Physics with 35-45 GeV/u HI beams, ***x1000***

Rare Isotope Production Target

Antiproton Production Target

Hadron Physics with antiprotons of 0 - 15 GeV

Plasma Physics: ***x600*** higher target energy density 600kJ/g

Nuclear Structure & Astrophysics with rare isotope beams, ***x10 000*** and excellent cooling

Special Features:

- 50ns Bunched beams
- Electron cooling of secondary beams
- SC magnets fast ramping
- Parallel operation

High EM Field (HI)
Fundamental Studies (HI & p)
Applications (HI)

Rationale for new Modularized Start Version (WP) in 2009

- a detailed cost estimate for CC presented by architects
- a new cost estimate in 2009 for the **accelerator** complex
- Detailed list of site related construction costs was worked out
- firm commitments of FAIR Member States

- Germany and State of Hesse announced to cover "site-dependent" construction costs outside FAIR project budget + 110 M€ !

Bundesministerium für Bildung und Forschung

HESSEN Hessisches Ministerium für Wissenschaft und Kunst

Freiheit Einheit Demokratie

HAUSANSCHRIFT Hannoversche Straße 28-30, 10115 Berlin
POSTANSCHRIFT 11055 Berlin

TEL 030 / 18 57-50 50
FAX 030 / 18 57-55 51
E-MAIL presse@bmbf.bund.de
HOMEPAGE www.bmbf.de

Presse-mitteilung

03. September 2009
216/2009

Konjunkturpaket II unterstützt Spitzenforschung in Darmstadt

Staatssekretär Storm und hessische Ministerin Kühne-Hörmann feiern Richtfest für Testinghalle für das internationale Zukunftsprojekt FAIR

Das GSI Helmholtzzentrum ist gut gerüstet für das internationale Zukunftsprojekt FAIR

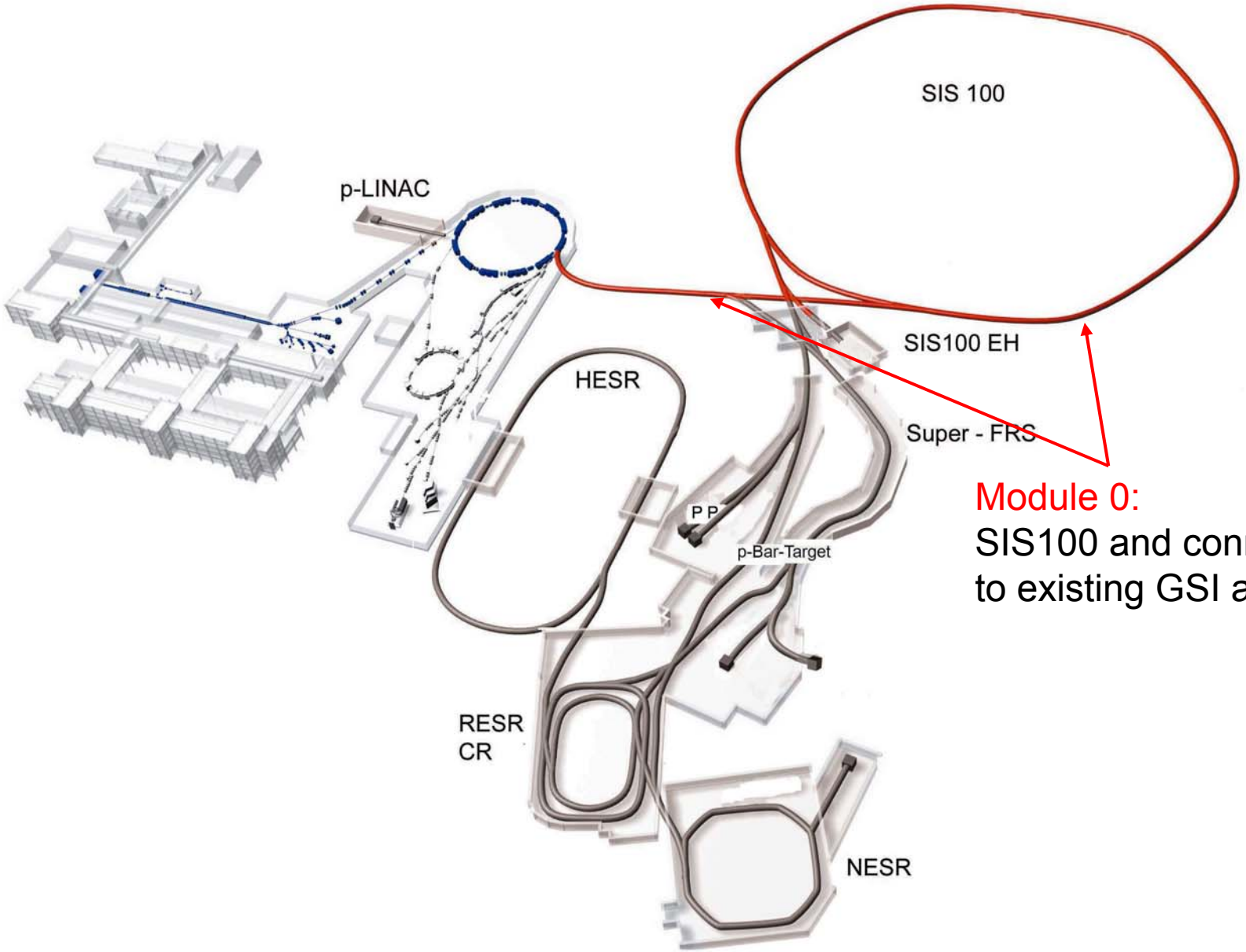
Development of Project Staging

2003	**Recommendation by WissenschaftsRat – FAIR Realisation in three stages**						
2005	**Entire Facility** **Baseline Technical Report**						
2007	**Phase A**						**Phase B** SIS300
2009	**Module 0** SIS100	**Module 1** expt areas CBM/HADES and APPA	**Module 2** Super-FRS fixed target area NuSTAR	**Module 3** pbar facility, incl. CR for PANDA, options for NuSTAR	**Module 4** LEB for NuSTAR, NESR for NuSTAR and APPA, FLAIR for APPA	**Module 5** RESR nominal intensity for PANDA & parallel operation with NuSTAR and APPA	**Module 6** SIS300

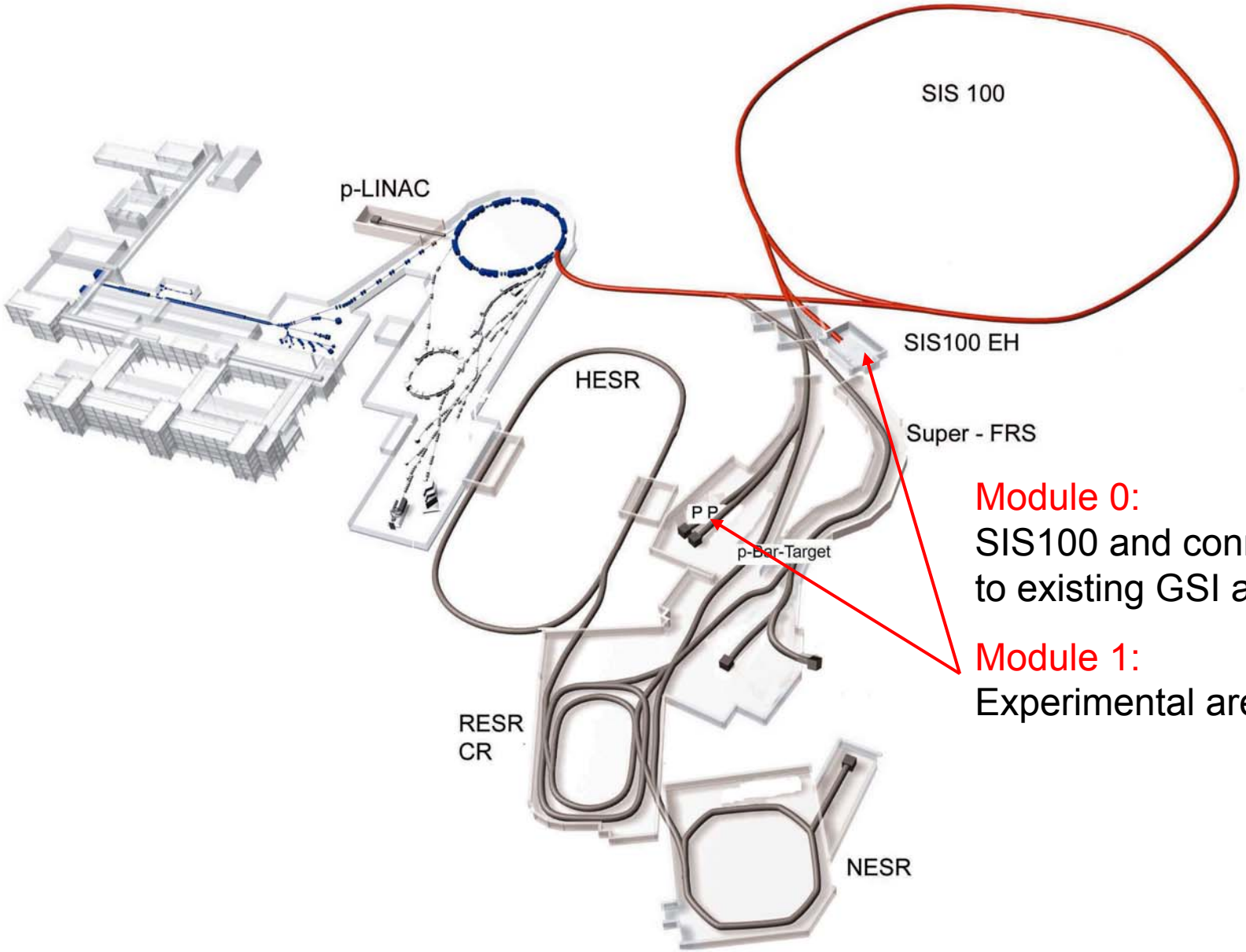
Modularized Start Version

Basic Criteria :

Outstanding research opportunities should be offered to *all four* scientific pillars of FAIR by the Modularized Start Version

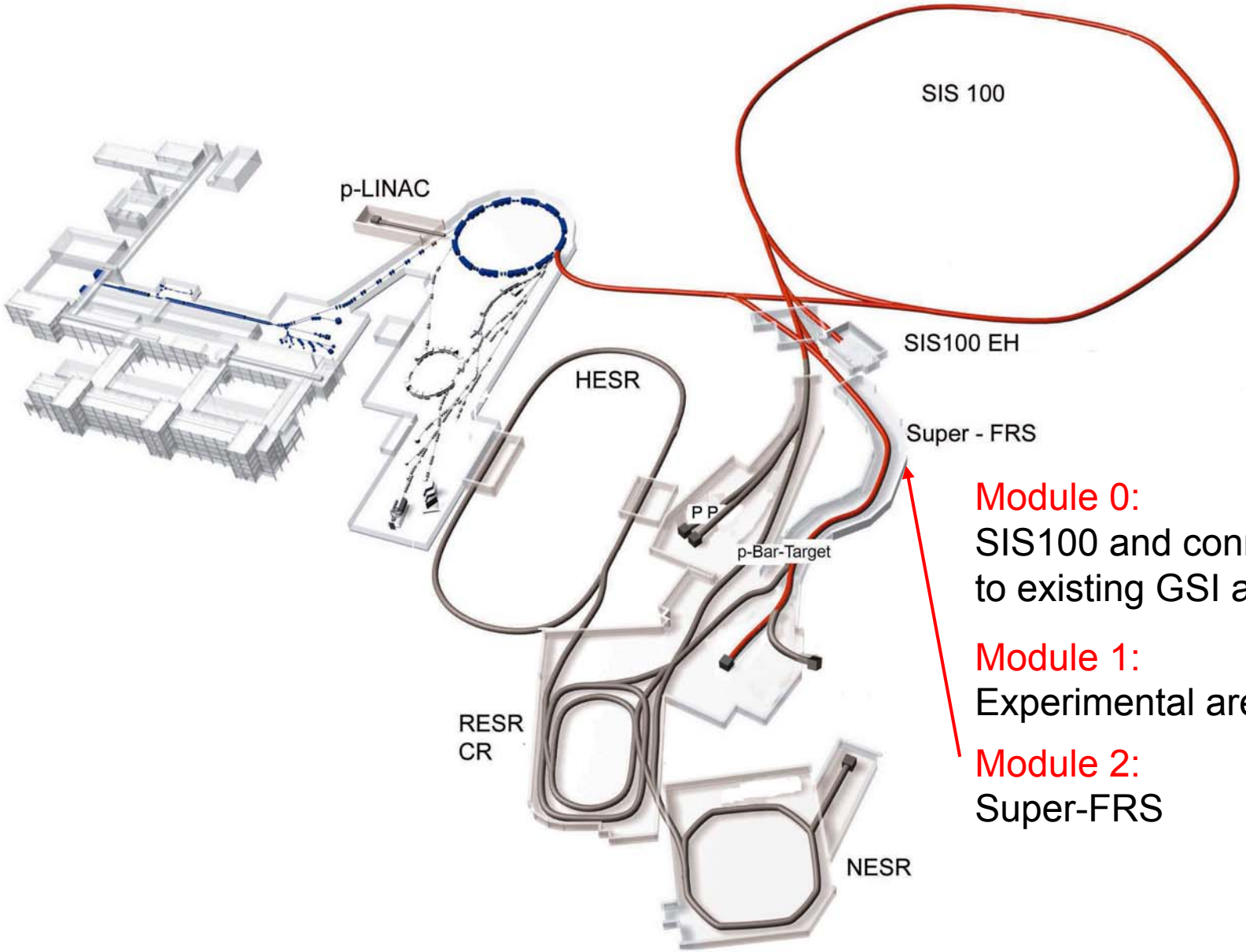


Module 0:
SIS100 and connection to existing GSI accel.



Module 0:
SIS100 and connection to existing GSI accel.

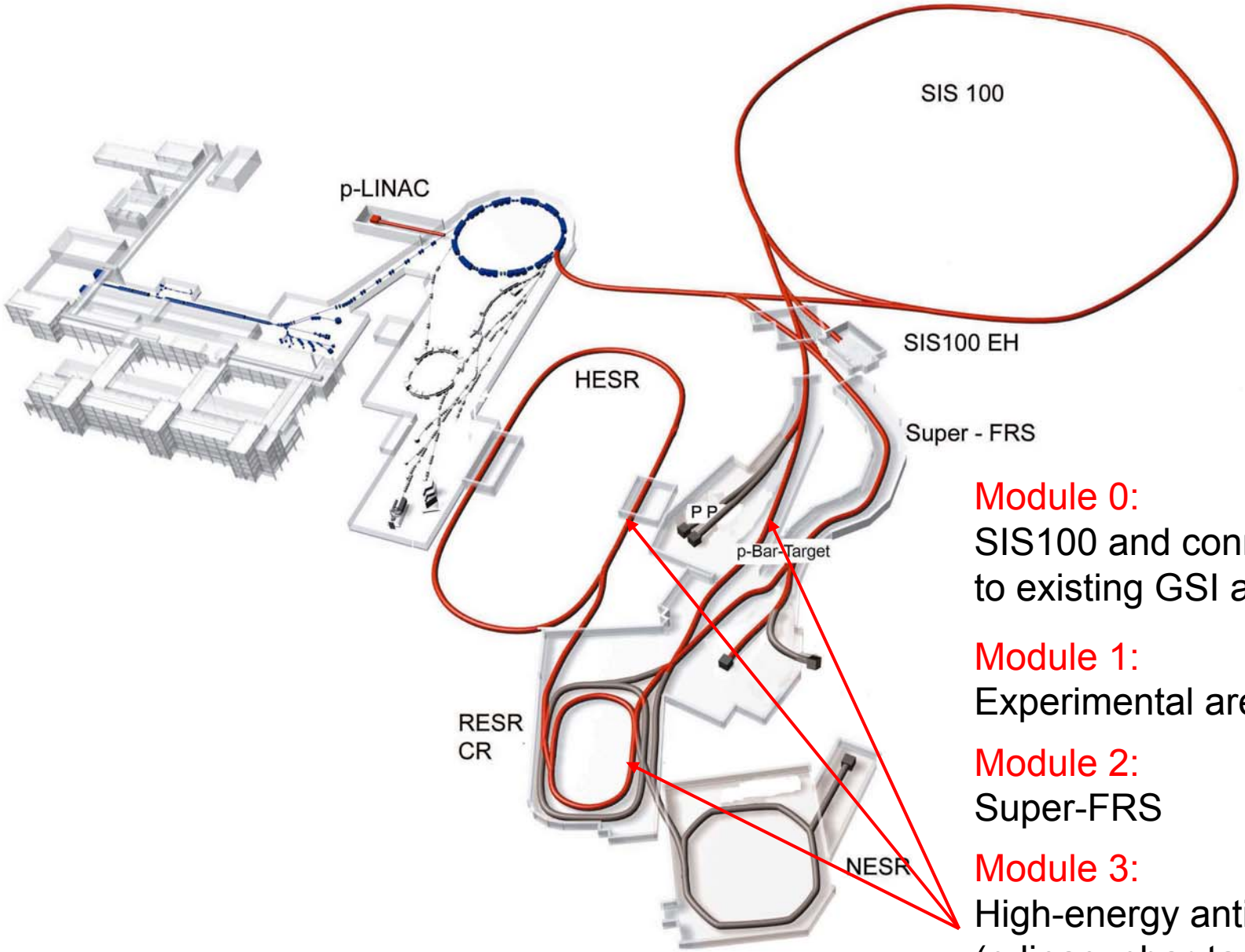
Module 1:
Experimental areas



Module 0:
SIS100 and connection to existing GSI accel.

Module 1:
Experimental areas

Module 2:
Super-FRS

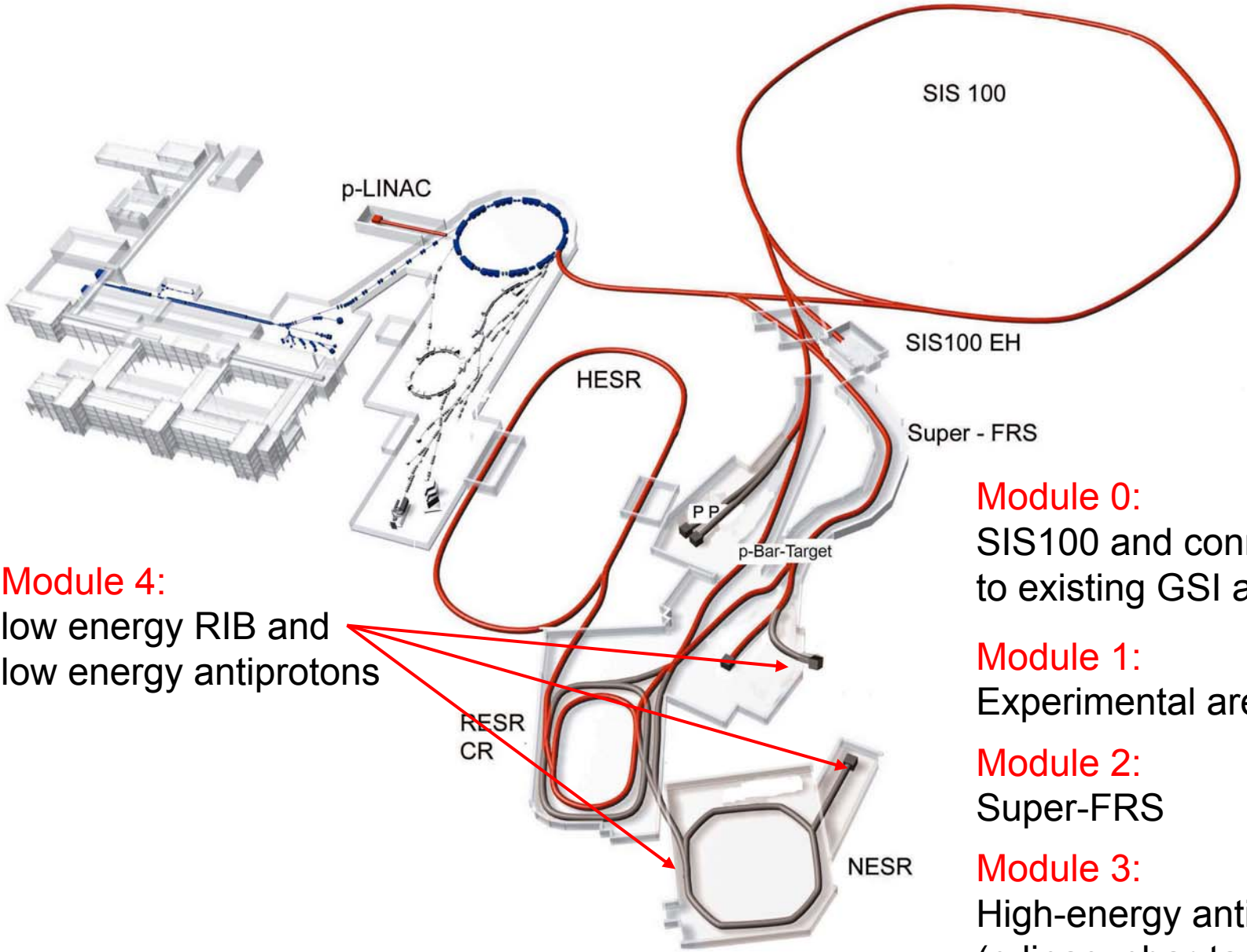


Module 0:
SIS100 and connection to existing GSI accel.

Module 1:
Experimental areas

Module 2:
Super-FRS

Module 3:
High-energy antiprotons (p-linac, pbar-target, CR, HESR)



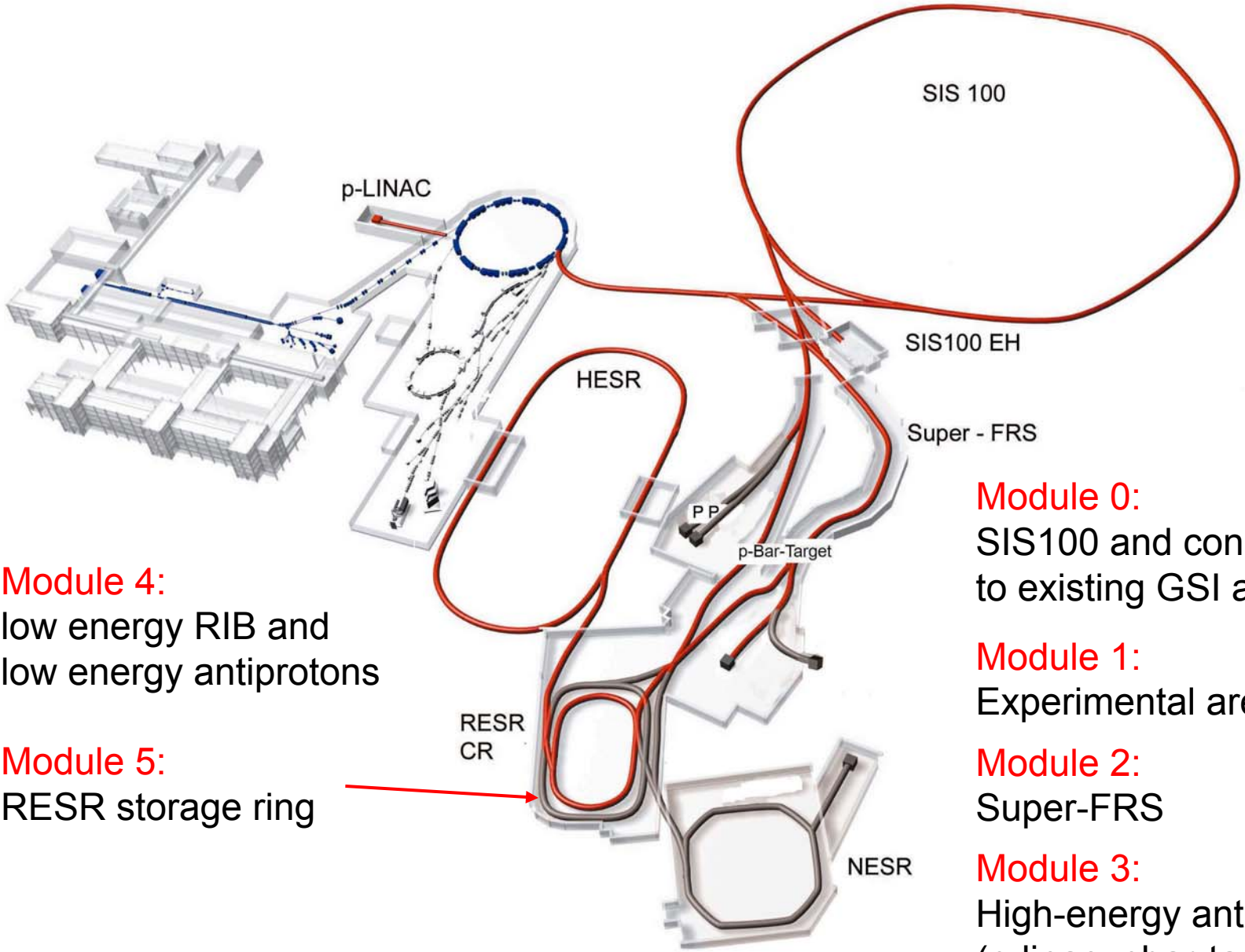
Module 4:
low energy RIB and
low energy antiprotons

Module 0:
SIS100 and connection to existing GSI accel.

Module 1:
Experimental areas

Module 2:
Super-FRS

Module 3:
High-energy antiprotons (p-linac, pbar-target, CR, HESR)



Module 4:
low energy RIB and
low energy antiprotons

Module 5:
RESR storage ring

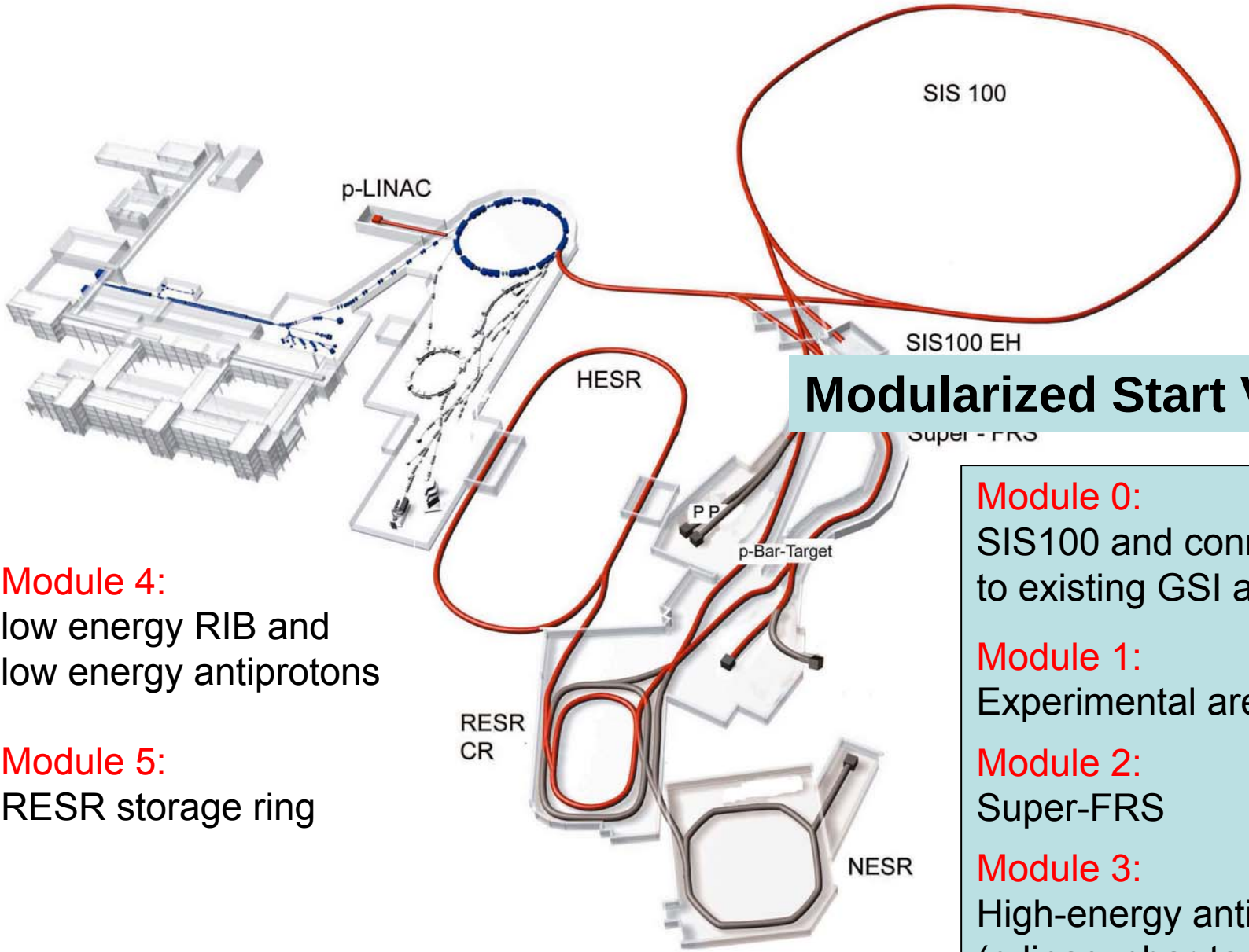
Module 0:
SIS100 and connection to existing GSI accel.

Module 1:
Experimental areas

Module 2:
Super-FRS

Module 3:
High-energy antiprotons (p-linac, pbar-target, CR, HESR)

Modularized Start Version



Module 4:
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Module 5:
RESR storage ring

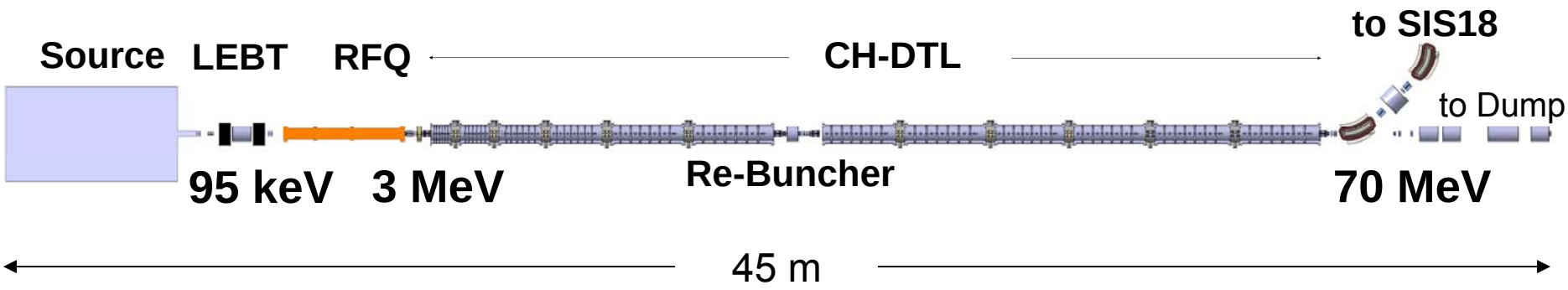
Module 0:
SIS100 and connection to existing GSI accel.

Module 1:
Experimental areas

Module 2:
Super-FRS

Module 3:
High-energy antiprotons (p-linac, pbar-target, CR, HESR)

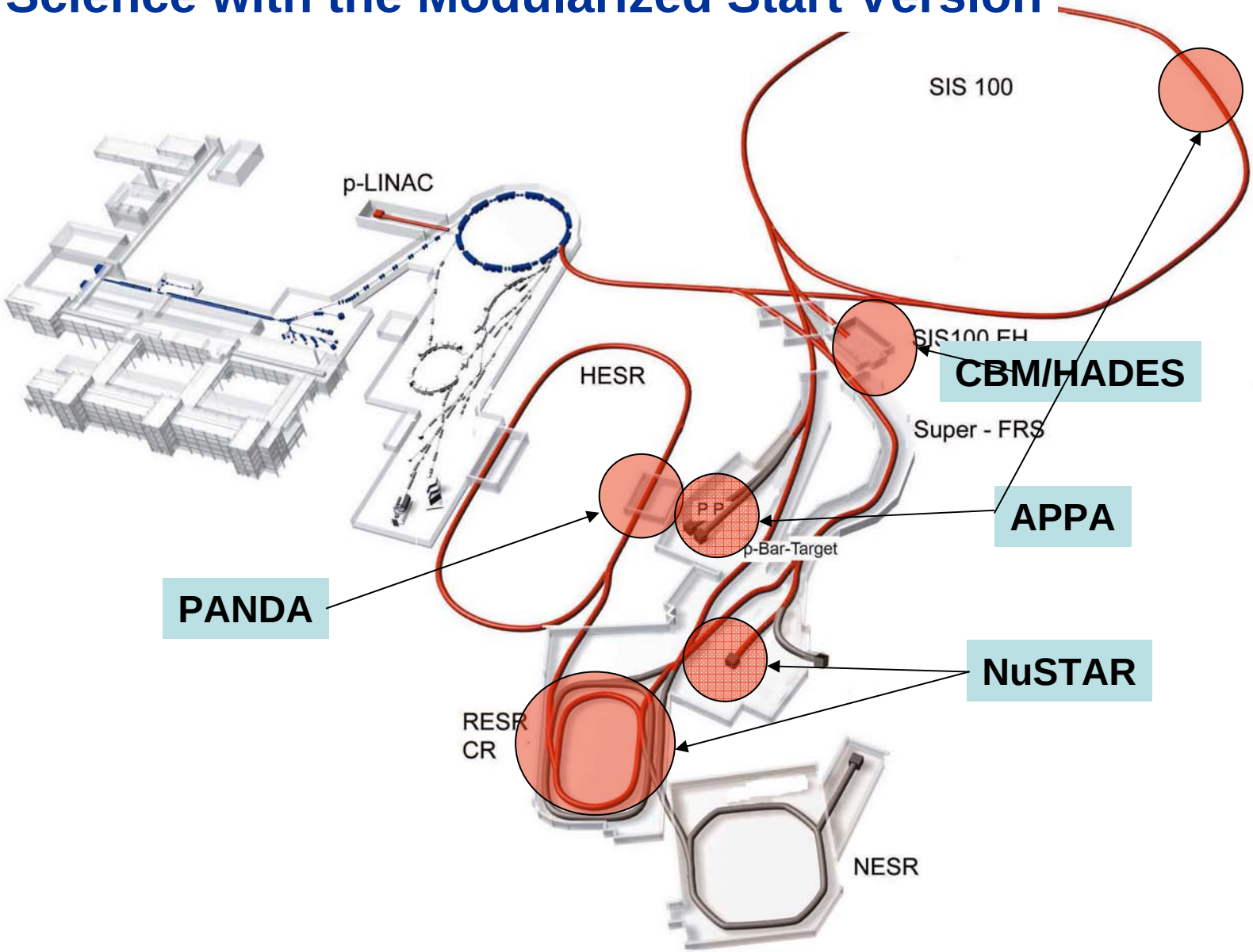
70 MeV Proton Linac



Beam energy	70 MeV
Beam current (op.)	35 mA
Beam current (des.)	*70 mA*
Beam pulse length	36 µs
Repetition rate	4 Hz
Rf-frequency	325.224 MHz
Tot. hor emit (norm.)	2.1 / *4.2* µm
Tot. mom. spread	≤ ± 10^{-3}
Linac length	≈ 35 m

French Participation Total Invest : 1.7 M€

Science with the Modularized Start Version



Outstanding research opportunities are offered to all four scientific pillars of FAIR by the Modularized Start Version

Atomic, Plasmaphysics and Applied Physics (APPA)

Plasma-physics

- 246 scientists
- 55 institutions
- 16 countries

BIOMAT

- 110 scientists
- 28 institutions
- 12 countries

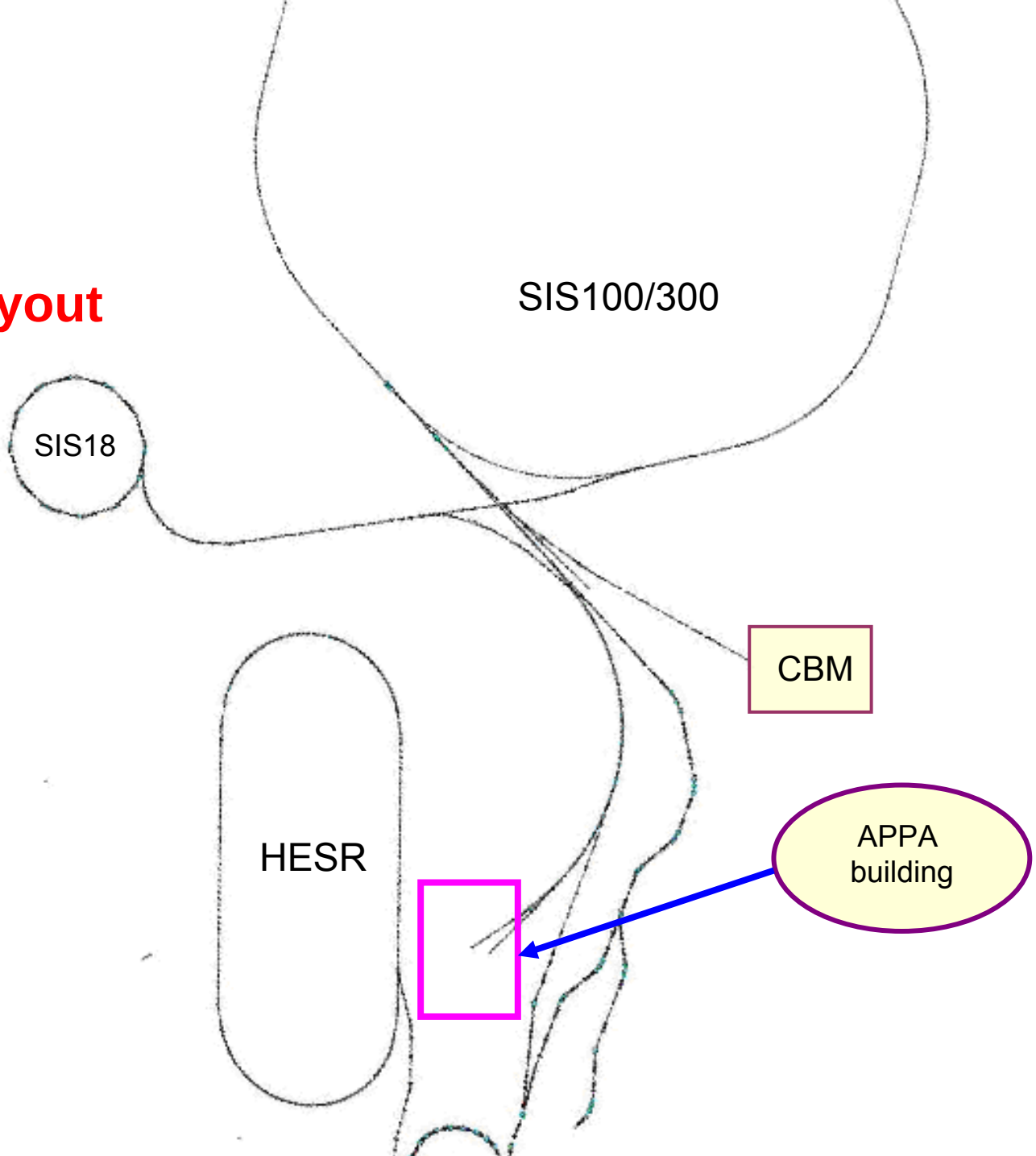
SPARC

- 284 scientists
- 83 institutions
- 26 countries

FLAIR

- 144 scientists
- 49 institutions
- 15 countries

MSV Layout



APPA Hall

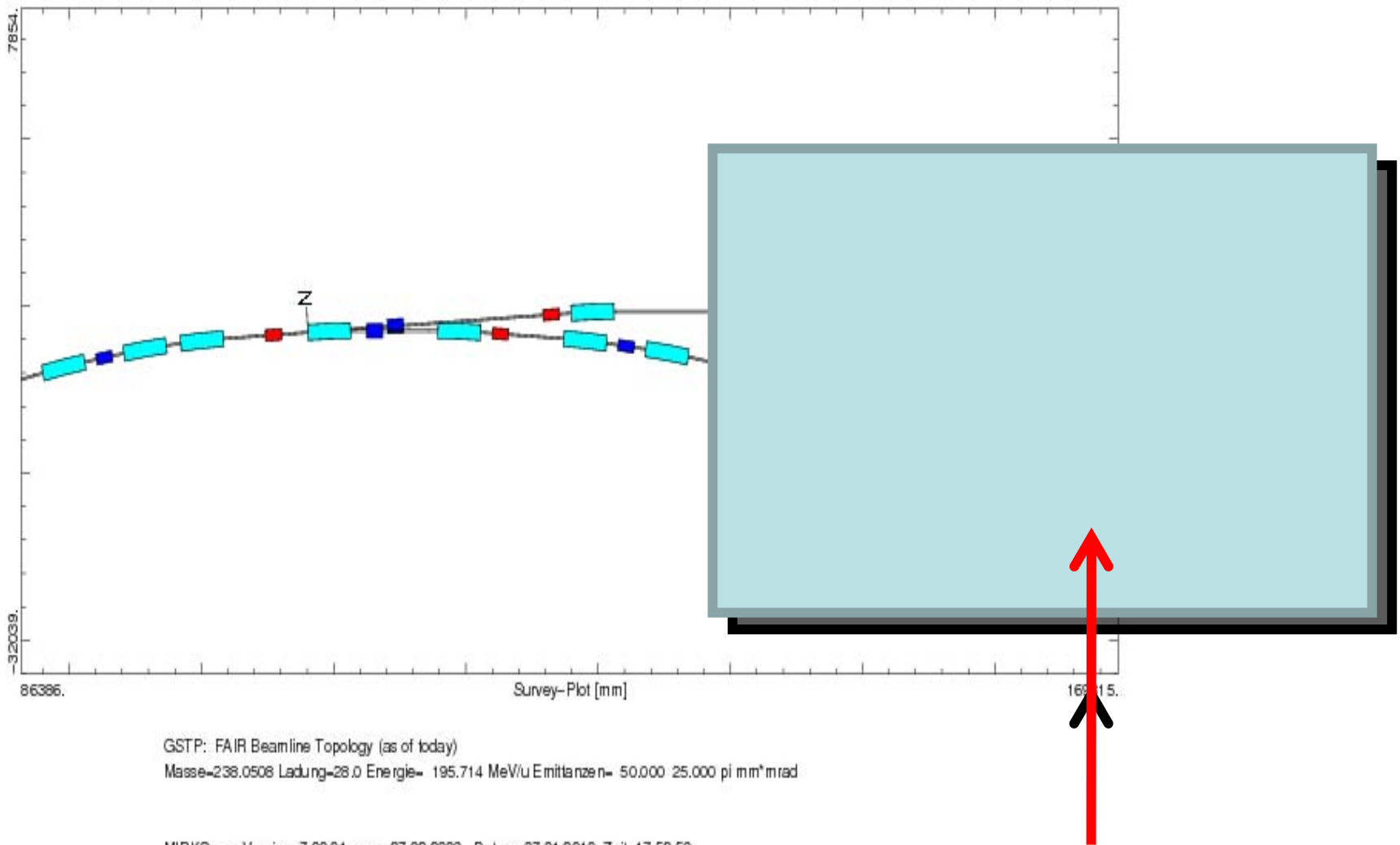
- Between HESR and Antiproton target
- Geologically not optimal, but only place where proton beamline can be added
- Financing through cost savings in SIS construction, CBM cave and antiproton target

Next steps:

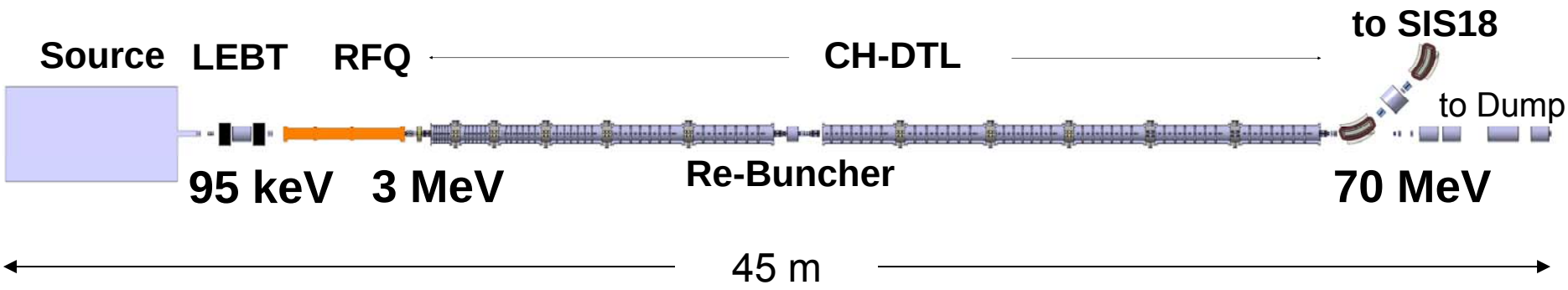
- new realistic space requirements needed for approval by BMBF (expt. areas and other needed space) (to be finished in February)
- then detailed planning will start (later to be checked by HBM) (to be finished in summer)

currently limiting factor for the entire construction approval procedure !

Beamline to the APPA hall



Proton Linac Overview



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Tot. mom. spread	≤ ± 10^{-3}
Linac length	≈ 35 m

French Participation Total Invest : 1.7 M€

Perspectives of HED-experiments at FAIR

Up to **200 times** the beam power and **100 times** higher energy density in the target will be available at FAIR

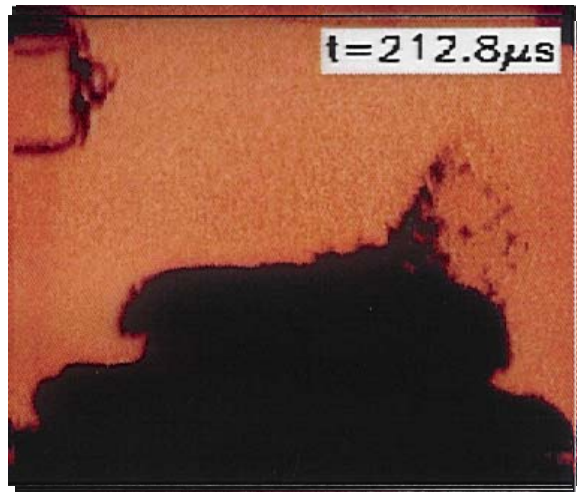
Ion beam U $^{28+}$	SIS-18	SIS-100	
Energy/ion	400MeV/u	0.4-27 GeV/u	
Number of ions	4.10^{9} ions	5.10^{11} ions	X100
Full energy	0.06 kJ	6 kJ	
Beam duration	130 ns	50 ns	
Beam power	0.5 GW	0.1TW	X200
	Lead Target		
Specific energy	1 kJ/g	100 kJ/g	X100
Specific power	5 GW/g	1 TW/g	X200
WDM temperature	~ 1 eV	10-20 eV	

only available at FAIR

Plasma Physics with highly Bunched Beams

Bulk matter at very high pressures, densities, and temperatures

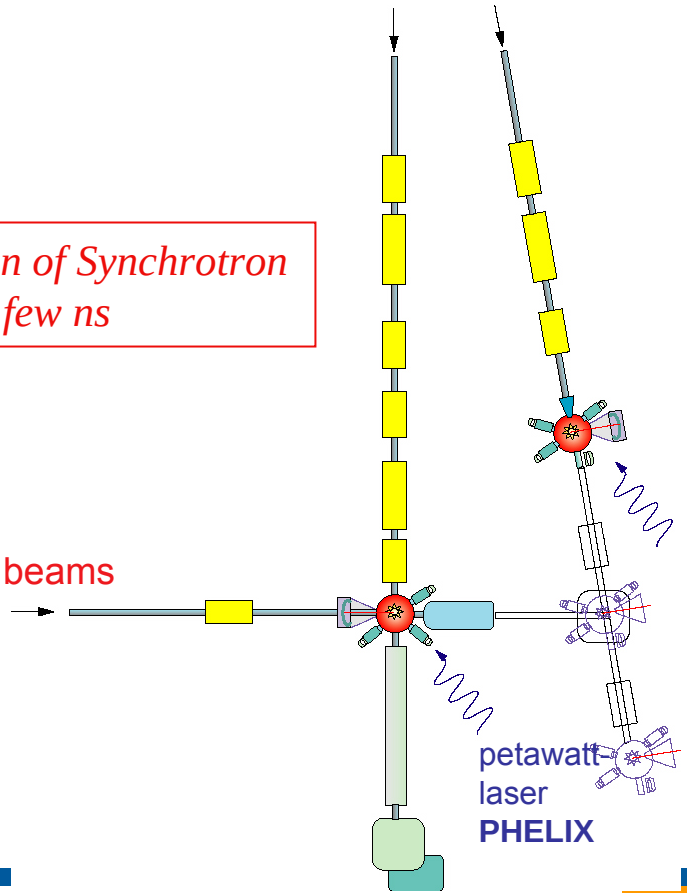
ΔE Energy loss of heavy ions in hot plasma is larger than in cold matter



Today:
30mm Xenon Crystal
10^{10} Ne^{10+} -Ions **=>>**

highly bunched beams
from **SIS 100**

Synchronization of Synchrotron and Laser to a few ns



Expected Beam Parameters

SIS 100 (FAIR)

N = 2 x 10^{12} Uran

E_0 = 1 GeV/u

E_{tot} = 80 kJ

τ = 50 ns

Range in solid Pb ≈1.55 cm

beam radius ≈ 0.05 cm

E_s = 600 kJ/g

P_s = 12 TW/g

The CBM Collaboration: 55 institutions, 450 members

Croatia:
RBI, Zagreb
Split Univ.

China:
CCNU Wuhan
Tsinghua Univ.
USTC Hefei

Czech Republic:
CAS, Rez
Techn. Univ.Prague

France:
IPHC Strasbourg

Hungaria:
KFKI Budapest
Budapest Univ.

Norway:
Univ. Bergen

India:
Aligarh Muslim Univ.
Panjab Univ.
Rajasthan Univ.
Univ. of Jammu
Univ. of Kashmir
Univ. of Calcutta
B.H. Univ. Varanasi
VECC Kolkata
SAHA Kolkata
IOP Bhubaneswar
IIT Kharagpur
Gauhati Univ.

Korea:
Korea Univ. Seoul
Pusan Nat. Univ.

Germany:
Univ. Heidelberg, P.I.
Univ. Heidelberg, KIP
Univ. Heidelberg, ZITI
Univ. Frankfurt IKF
Univ. Frankfurt, FIAS
Univ. Münster
FZ Dresden
GSI Darmstadt
Univ. Wuppertal

Poland:
Jag. Univ. Krakow
Warsaw Univ.
Silesia Univ. Katowice
AGH Krakow

Portugal:
LIP Coimbra

Romania:
NIPNE Bucharest
Univ. Bucharest

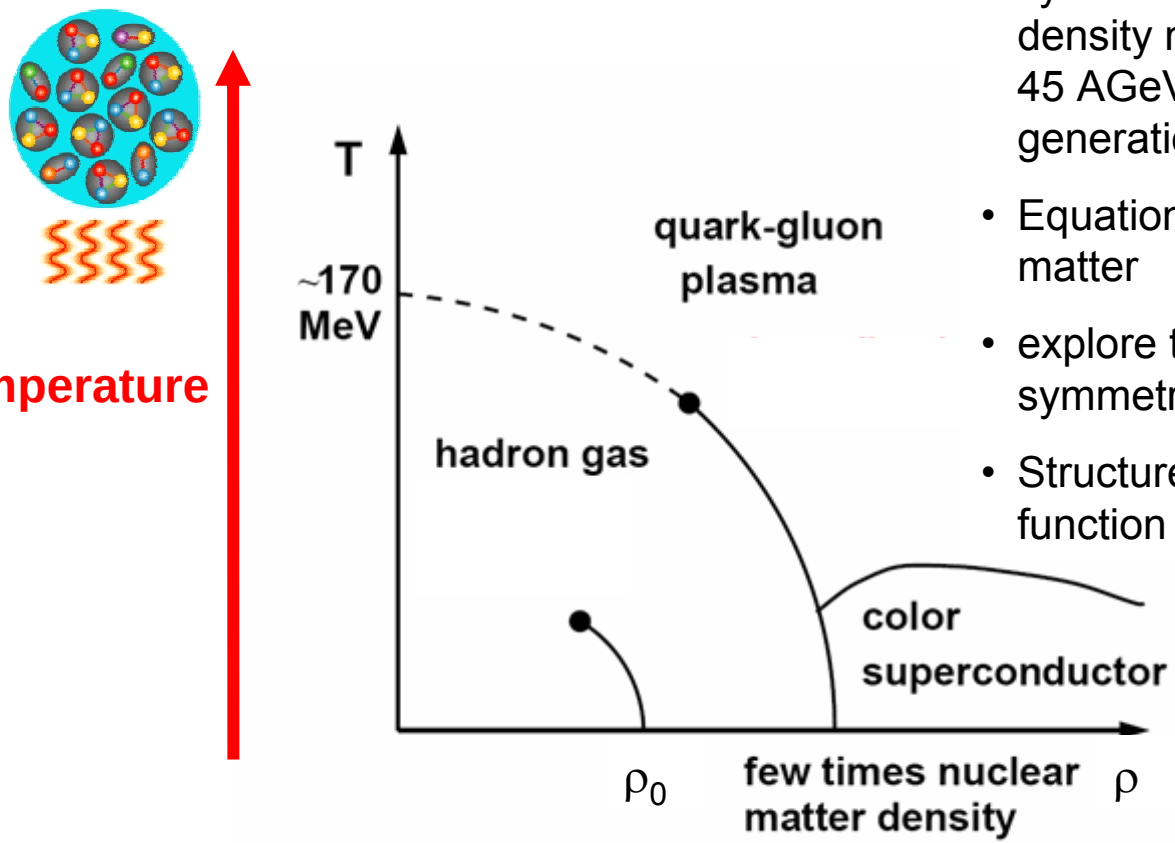
Russia:
IHEP Protvino
INR Troitzk
ITEP Moscow
KRI, St. Petersburg
Kurchatov Inst., Moscow
LHEP, JINR Dubna
LIT, JINR Dubna
MEPHI Moscow
Obninsk State Univ.
PNPI Gatchina
SINP MSU, Moscow
St. Petersburg P. Univ.

Ukraine:
T. Shevchenko Univ. Kiev
Kiev Inst. Nucl. Research

14st CBM Collaboration meeting
5-9 Oct. 2009, Split, Croatia

Phasediagram of strongly interacting matter

Fundamental questions of QCD

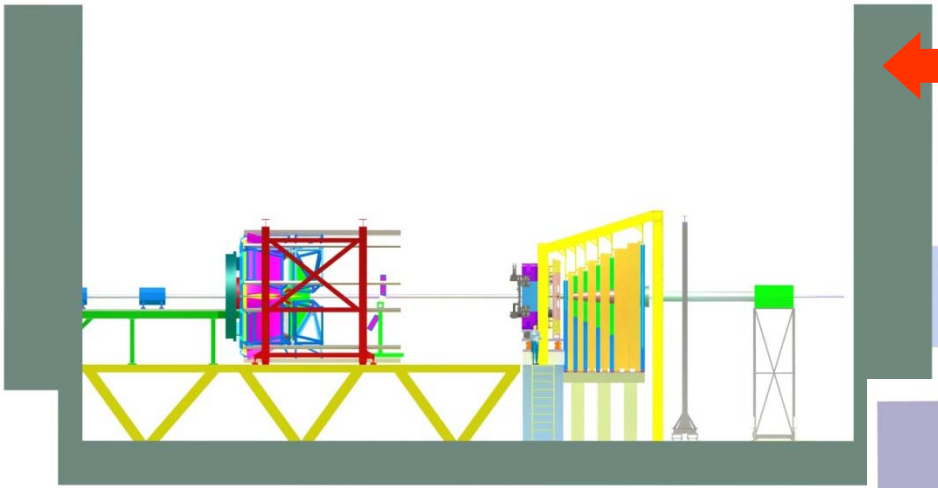


CBM and HADES at SIS 100 and SIS 300

- systematic exploration of high baryon density matter in A+A collisions from 2 – 45 AGeV beam energy with 2nd generation experiments
- Equation of state of strongly interacting matter
- explore the QCD phase diagram, chiral symmetry restauration
- Structure of strongly interacting matter as function of T and ρ_B?

Experimental equipment (FAIR Modules 0,1)

- HADES: existing setup at SIS18
- CBM: New instrument with ultra radiation-hard and high-rate detectors, free-streaming electronics, online event selection

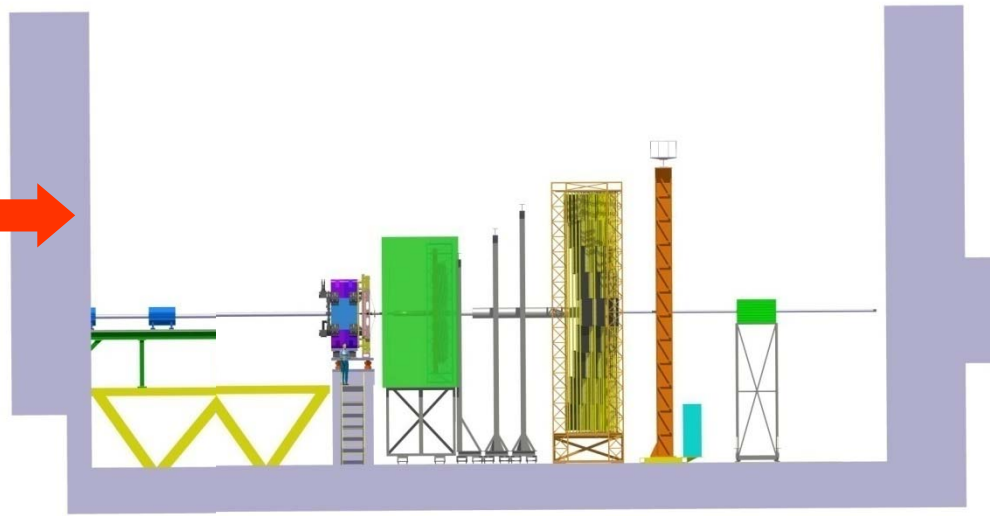


Cave with HADES and a CBM start version

- **e+e- measurement (HADES-RICH)**
- **Hadron/Multistrange states**
  CBM magnet +STS
- **μ+μ-: Muon chambers**

Cave with CBM full version

Open charm: MVD
Dilepton study: MuCh/RICH
Hadrons: STS/TOF
Centrality selection: PSD



Nuclear STructure, Astrophysics and Reactions

> 800 members from 37 countries and 146 institutions

Layout and Design parameters for the Super-FRS

The In-Flight Rare-Isotope Beam Facility 0 - 1500 AMeV

Superconducting FRagment Separator
High-Energy Reaction Setup
Multi-Storage Rings (CR, NESR, eA)
Energy-Bunched Stopped Beams

Key characteristics

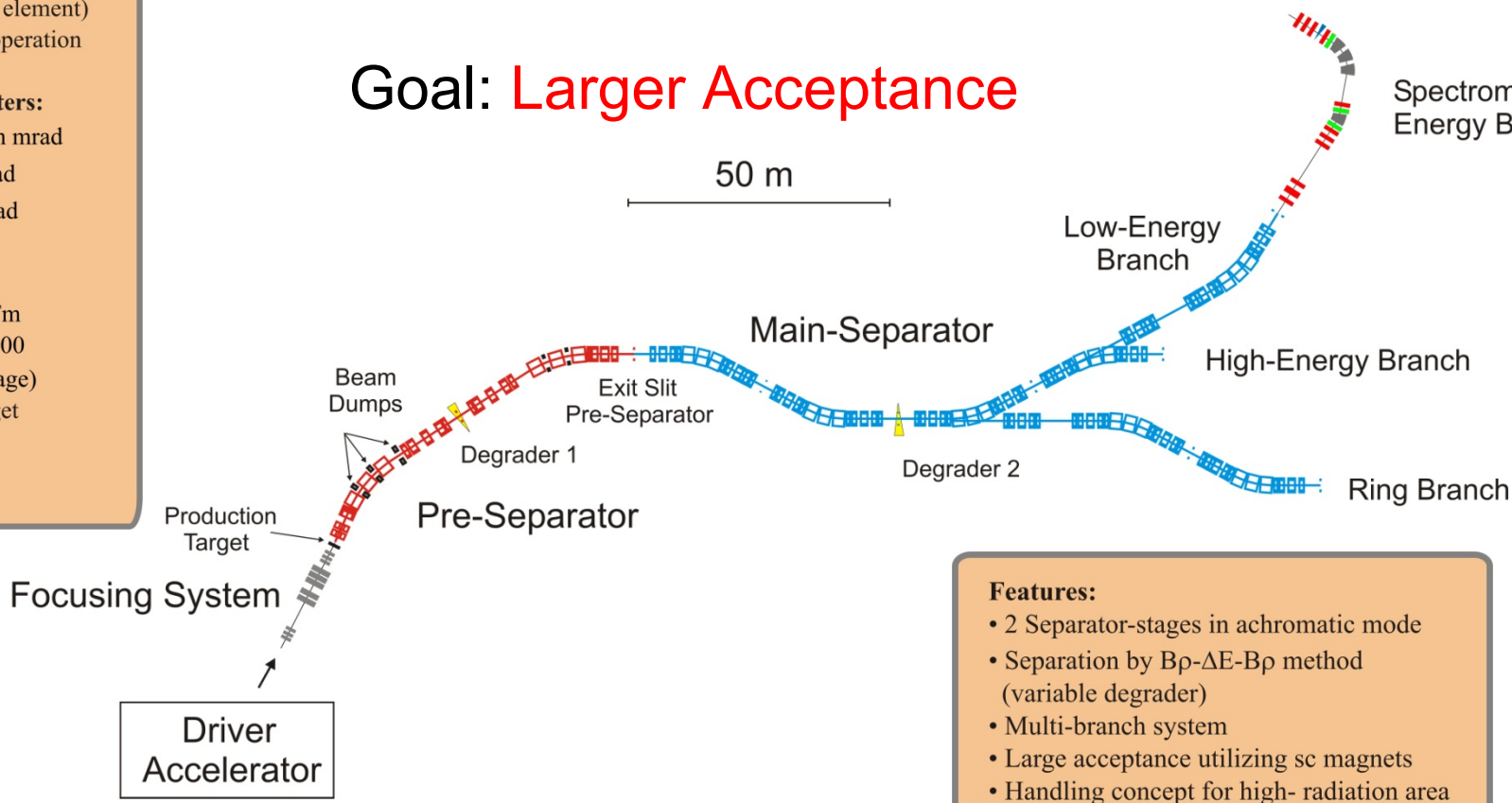
Projectile:
- Elements p - U
- Energy up to 1.5 GeV/u
- Intensity up to 10^{12} /s (depending on element)
- DC or pulsed operation

Design Parameters:

$\varepsilon_x=\varepsilon_y$ = 40 π mm mrad
Φ_x = ± 40 mrad
Φ_y = ± 20 mrad
$\Delta P/P$ = ± 2.5 %

Bρ = 2 - 20 Tm
R_{ion} = 750 / 1500
(first / second stage)
Spot size on target
σ_x = 1.0 mm
σ_y = 2.0 mm

Goal: Larger Acceptance

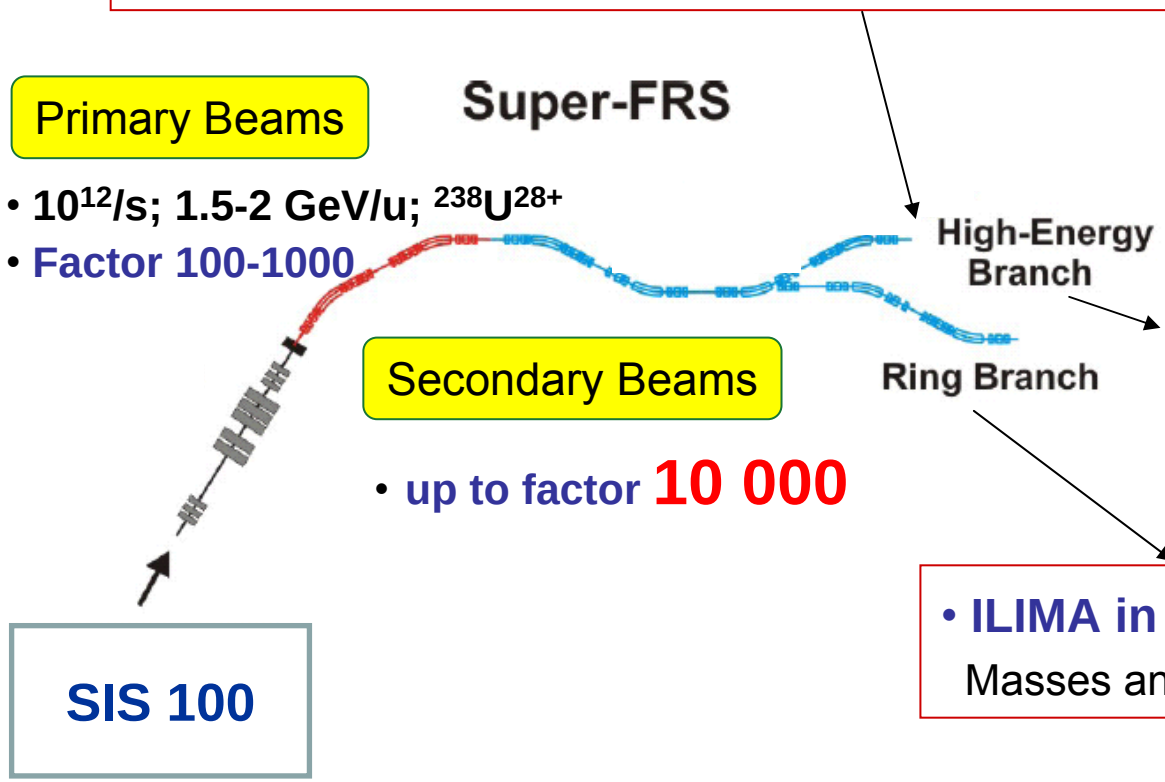


Features:
- 2 Separator-stages in achromatic mode
- Separation by Bρ-ΔE-Bρ method (variable degrader)
- Multi-branch system
- Large acceptance utilizing sc magnets
- Handling concept for high- radiation area

NuSTAR Experiments in Modularized Start Version

Accommodate LEB experiments at available Super-FRS branch

- **HISPEC:** In-Flight Spectroscopy
- **DESPEC:** Decay Spectroscopy
- **MATS:** Penning trap system (Masses, Trap Assisted Spectroscopy)
- **LASPEC:** LASER Spectroscopy (Spins, Moments, isotope shifts)

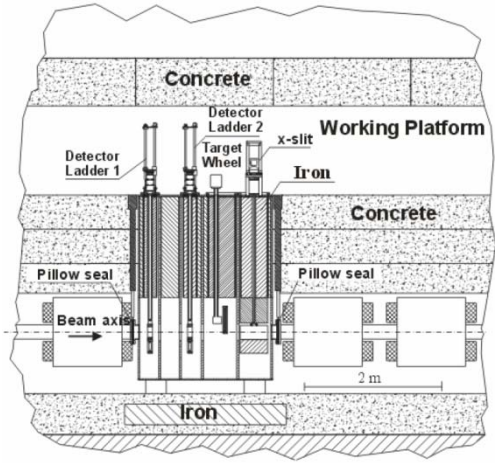


- **R^{3}B**: (full capability)
  Reactions with Relativistic Radioactive Beams in complete kinematics

- **ILIMA in CR**:
  Masses and Half-lives for short-lived ions

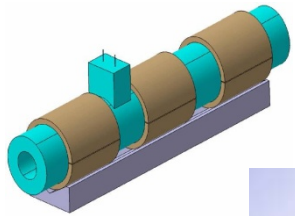
Technical Challenges

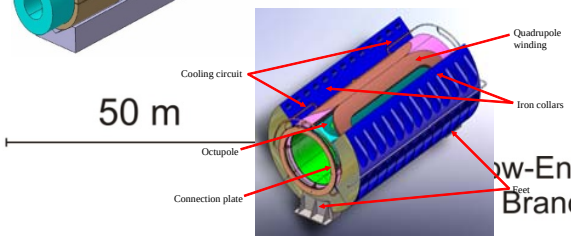
Remote Handling



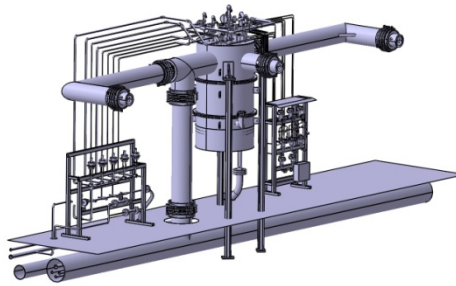
Target & Beam Catcher

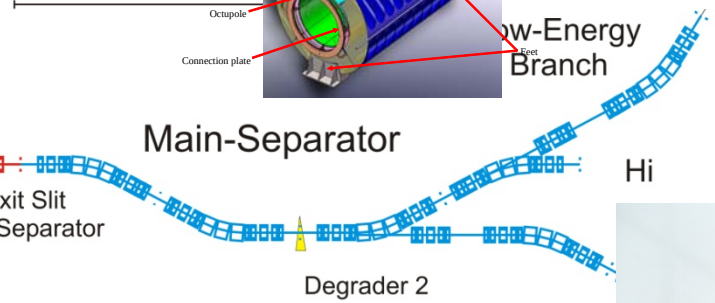
SC Multiplets





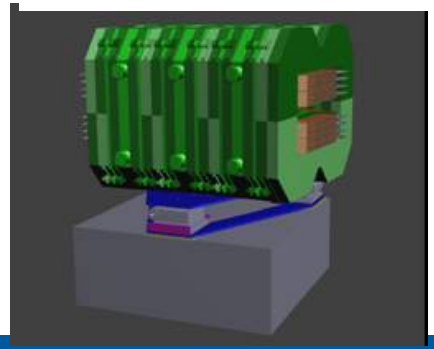
Cryogenics

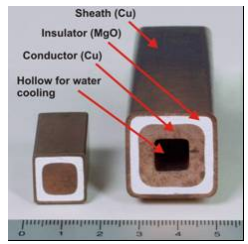




SC Dipoles

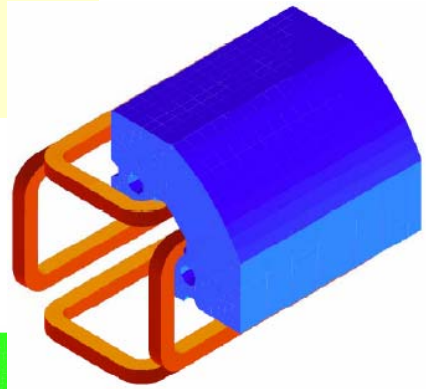
Radiation Reistant Magnets



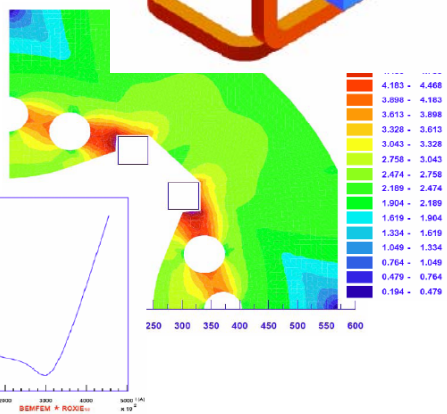


Super Conducting Muliplet Design (Consortium by France/Spain)

Proposal by **CIEMAT/Spain**
- superferric type (field shaping)
- less cold iron
- operation current at 450 A



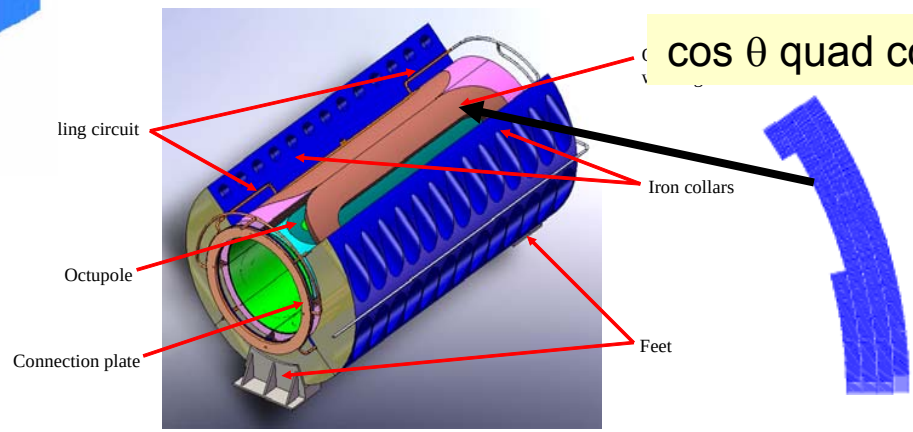
- New parameters
  - Iron mass: 4430 kg
  - Coil SC area: 666 mm^2 (Cu/Sc=2.4)
  - Inductance: 11.9 H/m
  - Stored energy: 1181 kJ/m
  - 51.7x53 mm coil, 1.18x1.88 mm wire
  - 444 Amps, 1026 turns
  - Quality up to 5 T/m (r=190 mm):
    - B6: -1 to 3 units of 10^{-4}
    - B10: -2 to 2 units of 10^{-4}
    - B14: -1 units of 10^{-4}
    - B18: -0.2 units of 10^{-4}
  - Peak field in coil: 4.85 T
  - Max. percentage on load line: 60.9%

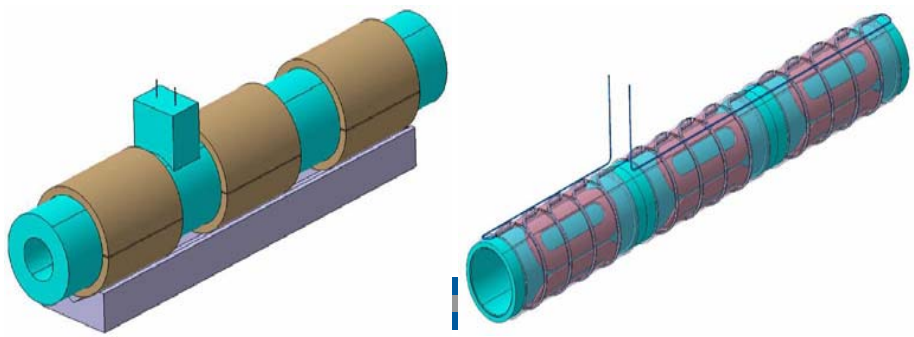


- Both collaborators provided a conceptual design report
- Review by MAC
- →start of pre-series multiplet

Proposal by **CEA/France**
- cos θ solution
- no helium vessel, indirect cooling
- high current (~800 A), strong forces
- field quality sensitive to coil placement

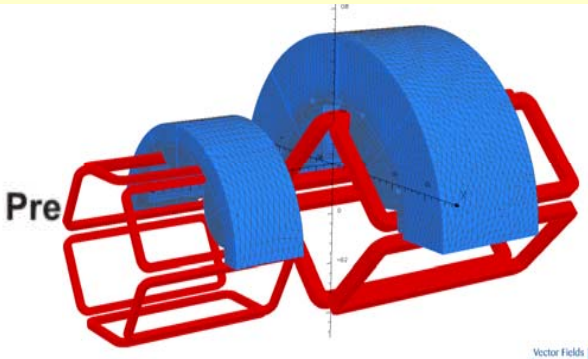
cos θ quad coil

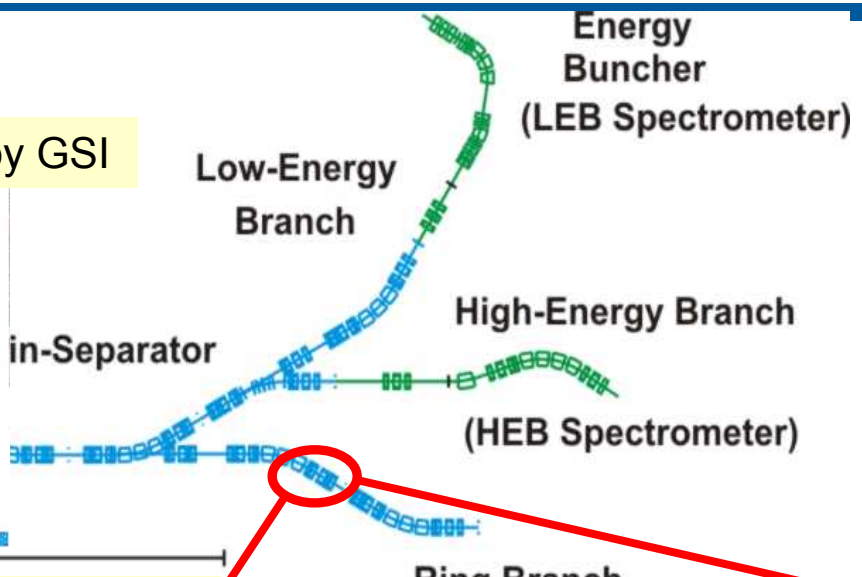




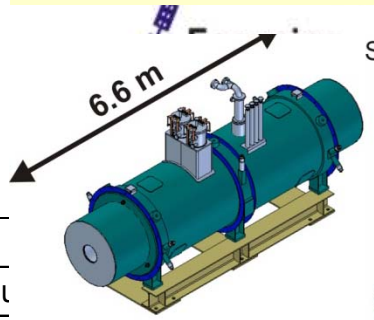
Superconducting Multiplets for the Super-FRS

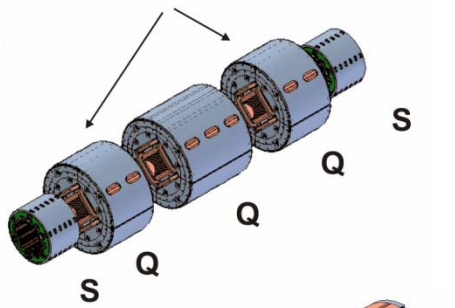
First 'superferric' magnet design by GSI

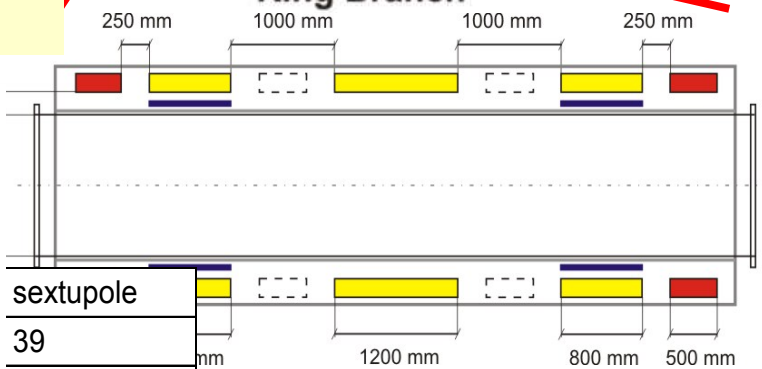




Conceptual design by Toshiba Corporation

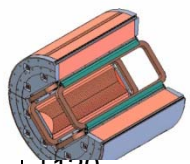






				sextupole
Nu				39
Ef				0.5
Gr				4-40 T/m^2
Gr				±8·10^{-4}
Us				±190
Useable vertical aperture	mm	±120	±120	±120
Embedded octupole (B''')	T/m^3	105		

Effective length (quads) 0.8 / 1.2 m
Aperture (warm) ± 190 mm
Pole radius 240 mm
Field gradient 1.0 - 10.0 T/m



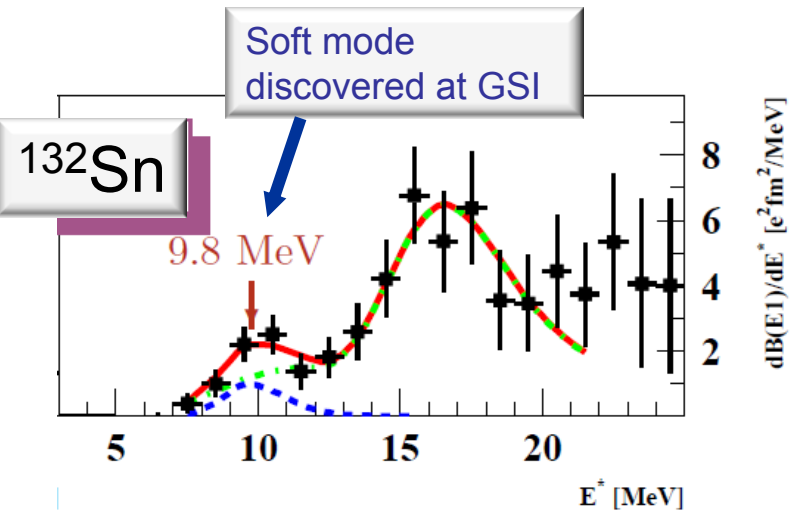
- Warm bore diameter of 38 cm
- Quadrupole triplet + separated sextupoles + y-steering magnet
- Octupole correction coils are embedded
- SC coils, iron-dominated ? cold iron ?

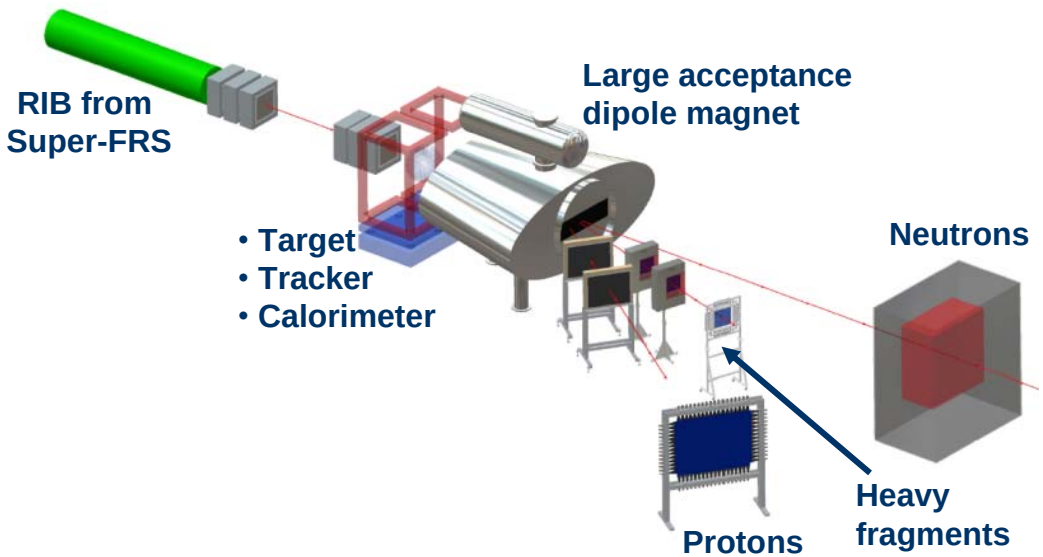
NuSTAR Experiments in Modularized Start Version

R^3B: Reaction studies at the highest energies in complete kinematics

- Few body correlations (halo nuclei, open quantum systems)
- Dipole response (Pygmy resonance, n-skins, neutron matter, EOS)
- Single-particle structure (shell-evolution, r-process path)
- Fission & fragmentation dynamics (large scale collective motion, symmetry energy, EOS)
- (gamma,n) reactions (r-process path)

- **R^3B will have its full capability for rates > 1pps**
- **High energies (> 1AGeV) ➔ world-wide unique experiments**



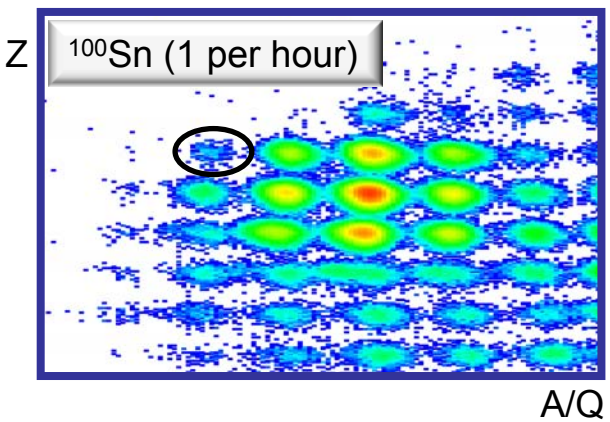


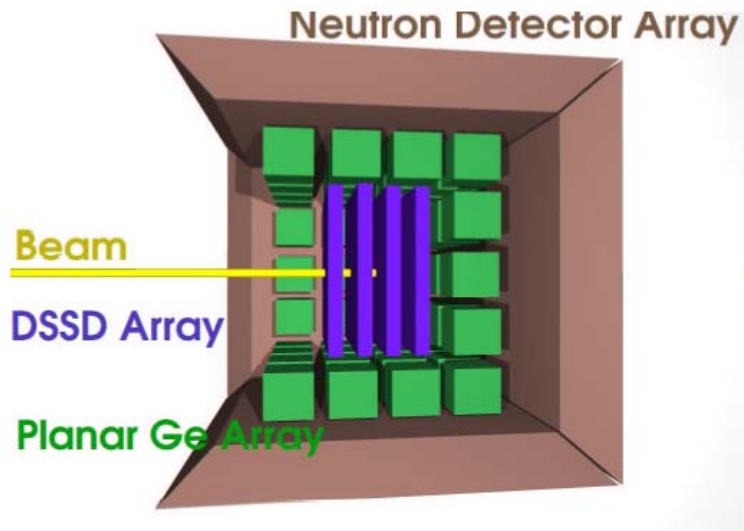
NuSTAR Experiments in Modularized Start Version

DESPEC: decay spectroscopy using gamma-ray spectroscopy and neutron detection following isomeric or beta-decay of very exotic nuclei

- Gamow Teller strength (short range correlations, nucleosynthesis, supernovae)
- Structure along the proton drip-line (proton radioactivity, rp-process)
- Structure of r-process nuclei (shell evolution, r-process path)
- g-factors and lifetimes of isomers (evolution of shells and collectivity, nuclear shapes)

- **Experiments possible with stopped beams & production rates down to 1 isotope per hour**
- **farthest reach towards the drip lines**





NuSTAR Experiments in Modularized Start Version

HISPEC: high resolution in-flight gamma-spectroscopy

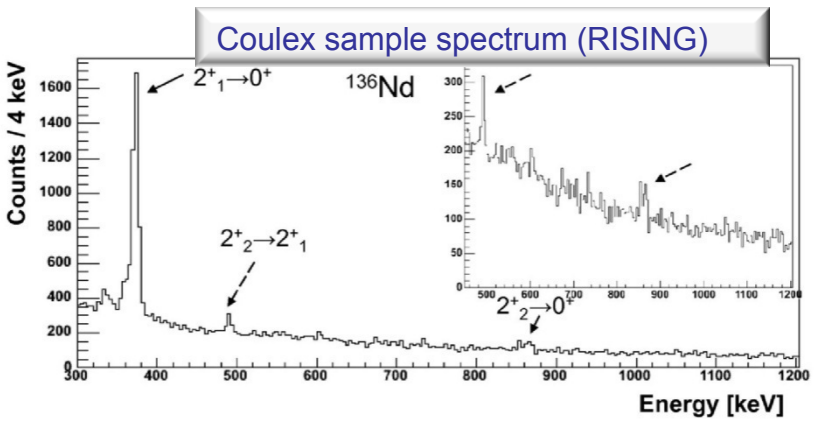
- Excited states in exotic nuclei
  - Inelastic excitation (EM, hadronic), secondary fragmentation, knock-out
- Lifetimes and g-factors of short-lived excited states

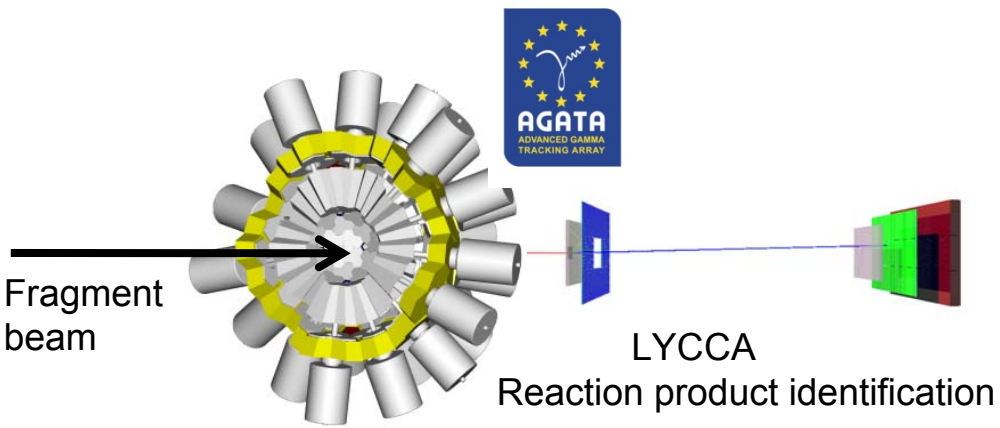
(evolution of shells and collectivity)

(phase-/shape-transitions & shape coexistence)

(isospin symmetry, pn-pairing)

- **Experiments possible with medium-energy beams (50-100 AMeV)**
- **Broad program for nuclei with A up to ~100**





NuSTAR Experiments in Modularized Start Version

MATS and LASPEC: **ground state properties using high-precision techniques**

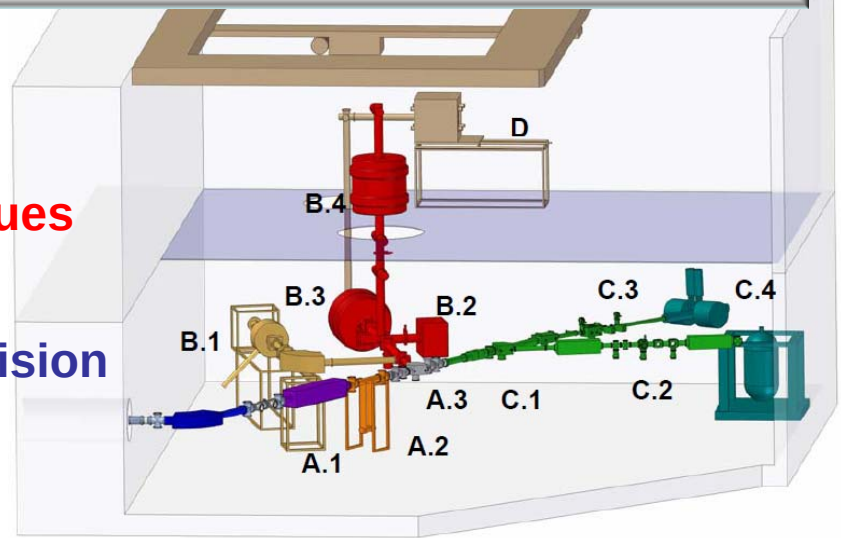
- Penning trap system (MATS)
  - High-precision masses for highly charged ions
  - Trap-assisted and in-trap spectroscopy
- Laser spectroscopy (LASPEC)
  - Ground state spins, moments, isotope shifts from laser spectroscopy

    (evolution of shells and nuclear shapes)

    (nuclear astrophysics input: masses, EC rates, GT strength)

    (test of fundamental symmetries: CKM unitarity, CVC)

- **Stopping in and extraction from gas-cell**
- **charge breeding & non-destructive techniques**
- **half-life limit ~10ms**
- **Access to refractory elements, highest precision**



NuSTAR Experiments in Modularized Start Version

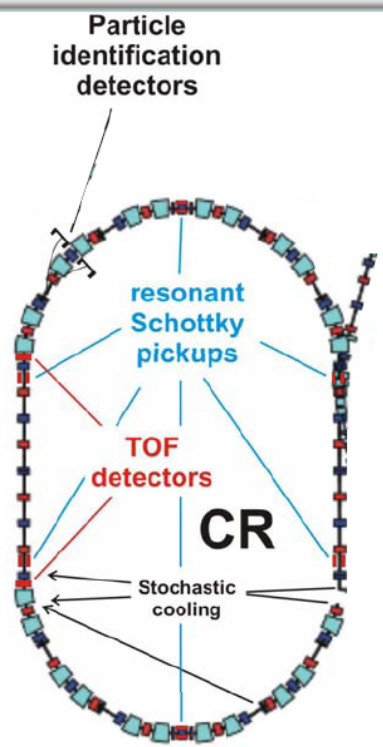
ILIMA in CR: mass measurements of nuclei with half-lives in the ms region

- Masses of very exotic nuclei using isochronous mode & TOF technique
- Half-lives via detection of decay products with particle detectors
- Study of isomeric states

(shell evolution, effective interaction)

(nuclear astrophysics input: masses, half-lives)

- **Masses with precision ~50 keV**
- **Many masses at same time**
- **access to nuclei with half-lives shorter than cooling times**



Summary: NuSTAR Collaboration

Module 0-3: Unique research opportunities to study Nuclear Structure and Dynamics and Nuclear Astrophysics

R3B	full program, reactions at relativistic energies, complete kinematics
ILIMA	unique measurements of masses and half-lives in the CR
HISPEC,DESPEC	in-beam (50-100 AMeV) & decay spectroscopy
MATS, LASPEC	precision ground state properties

Modules 4 and 5: Additional Research Opportunities

ILIMA	cooled beams, unique decay modes, isomeric beams in NESR
EXL	elastic and inelastic scattering on internal H, He target in NESR
HISPEC	energy buncher: access to heavier nuclei, low-energy beams
MATS, LASPEC	energy buncher: faster extraction, cleaner beams

The Collaboration

At present 410 physicists from 53 institutions in 16 countries

Basel, Beijing, Bochum, IIT Bombay, Bonn, Brescia, IFIN Bucharest, Catania, IIT Chicago, Cracow, IFJ PAN Cracow, Cracow UT, Edinburgh, Erlangen, Ferrara, Frankfurt, Genova, Giessen, Glasgow, GSI, FZ Jülich, JINR Dubna, Katowice, KVI Groningen, Lanzhou, LNF, Lund, Mainz, Minsk, ITEP Moscow, MPEI Moscow,TU München, Münster, Northwestern, BINP Novosibirsk, IPN Orsay, Pavia, IHEP Protvino, PNPI St.Petersburg, KTH Stockholm, Stockholm, Dep. A. Avogadro Torino, Dep. Fis. Sperimentale Torino, Torino Politecnico, Trieste, TSL Uppsala, Tübingen, Uppsala, Valencia, SINS Warsaw, TU Warsaw, AAS Wien

High precision beams of Antiprotons

..allow in collisions with protons and nuclei the formation of

- pairs of sub-nuclear particles and their antiparticles
- high precision measurements of sub-nuclear masses and lifetimes

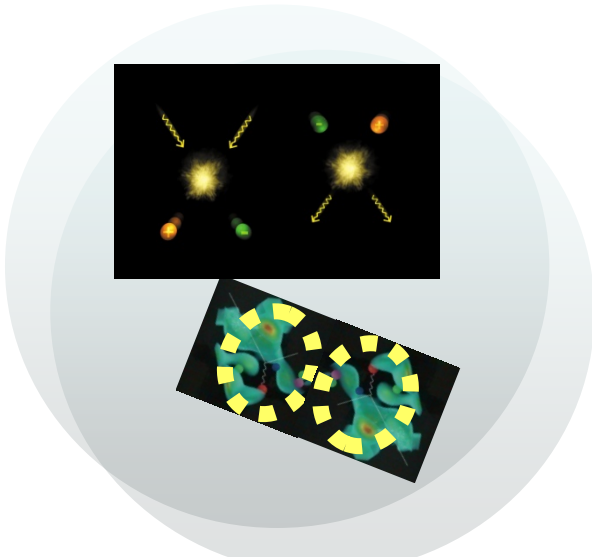
..allow at zero velocity the production of ***antihydrogen atoms and molecules***, the antimatter of hydrogen, and studies of, e.g.,

- gravity acting on ***antimatter***
- validity of our physics laws for ***antimatter***

=> At FAIR: 100 times more abundant than at CERN

Scientific program (Highlights)

- Charmonium (ccbar)/open charm (c+other non c-quark) spectroscopy
- Non-pertubative QCD dynamics
- Nucleon Structure via electro-magnetic processes



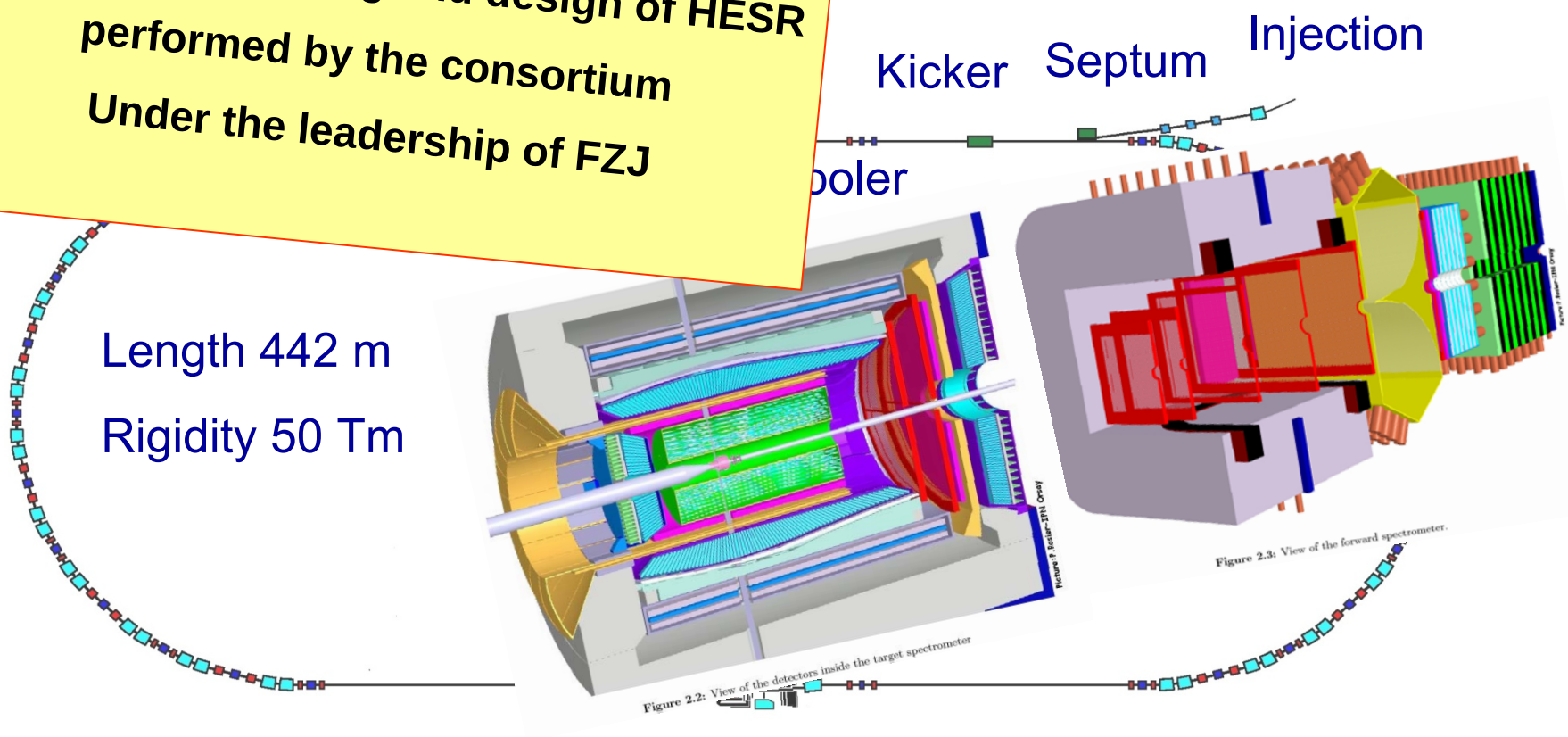
Structure and fundamental properties of anti-matter

HESR and PANDA

Working on planning and design of HESR

performed by the consortium

Under the leadership of FZJ

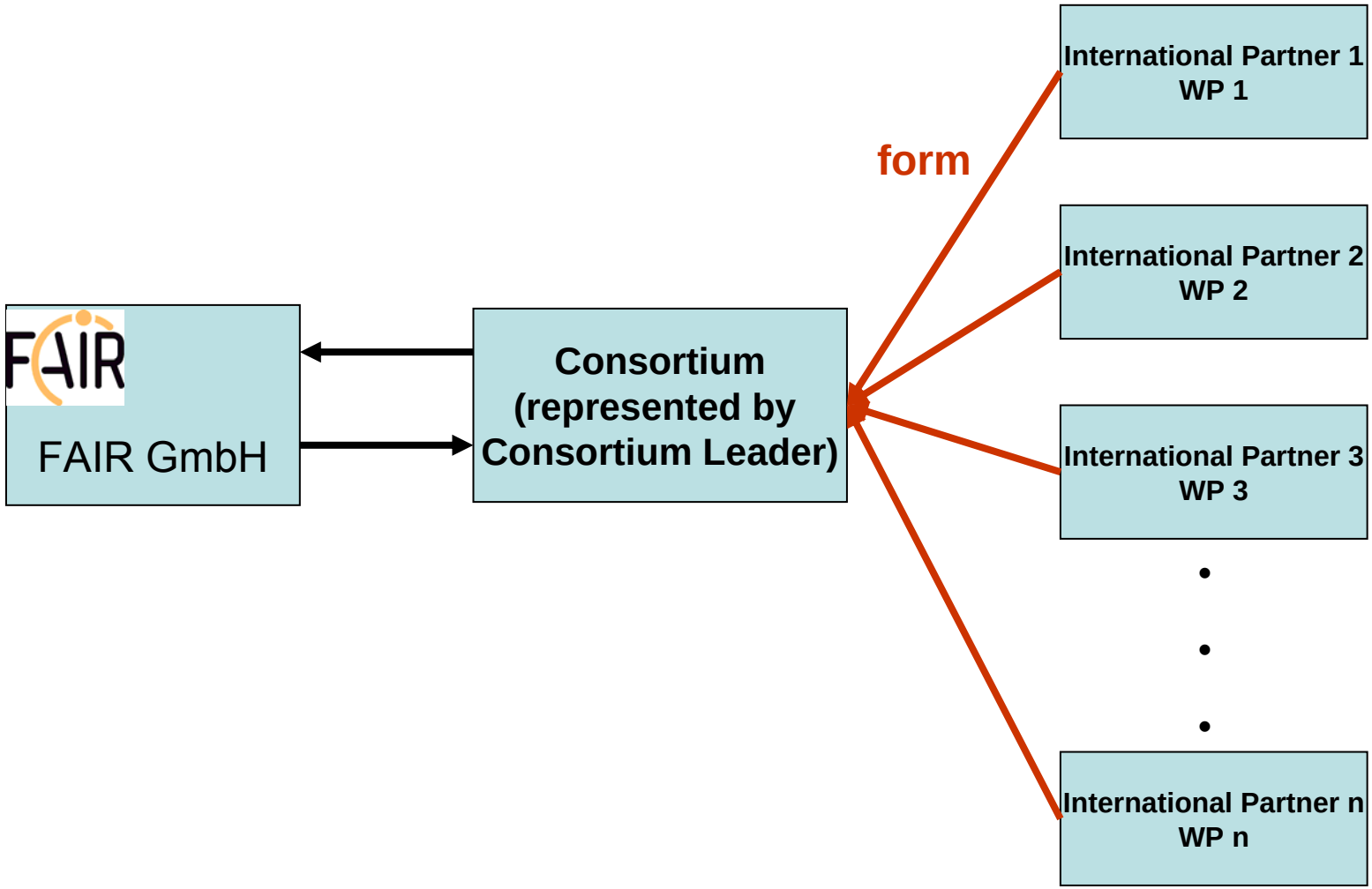


4π detector **PANDA Detector**

FAIR Work Packages

FAIR WPs

		WBS 2.3 **HEBT**	2.4 **Supere FRS**	2.5 **CR**	2.6 **NESR**	2.7 **p-lianc**	2.8 **SIS100**	2.9 **pbar-target**	2.10 **RESR**	2.11 **HESR**	2.12 **SIS300**	2.13 **ER**	2.14 Com. Sys.	3.0 Civ. Constr.	1.0 Experiments	Sum
	CostBook 3.0 (M€)	79,2	72,9	37,8	23,4	13,5	81,9	4,5	20,7	59,4	95,4	11,7	104,4	289,8	108	1003
TS-2	**Magnets**	Bend 12,2 CN	Bend 15 CN	Bend 9 CN	Bend 4 ES	Bend 0,22 IN	Bend 7 RU	Bend 0,7 GSI	Bend 4 GSI	Bend FZJ	Bend 24 IT	Bend 1,1		GSI		
	Cost	Quad 14 GSI	Quad 23 GSI	Quad 2,2 CN	Quad 2,7 ES	Quad 0,7 IN	Quad 8 RU	Quad 0,7 GSI	Quad 2,6 GSI	Quad FZJ	Quad 19 FR	Quad 1,4				
	Partner active interest		Sextupoles 8 GSI	Sextupoles 0,5 GSI	Sextupoles 0,4 ES		Sextupoles 1,1 RU			Sextupoles FZJ	Multipoles 7 GSI	Sextupoles 0,5				
		Other 3 GSI	Other 3,3 GSI	Other 1,5 GSI	Other 0,4 ES		Other 1,3 RU		Other 0,4 GSI	Other FZJ	Other 0,6 GSI	Other 0,25				
TS-3	**Power Converter**	Power Conve 16 GSI	Power Conve 3 GSI	Power Conve 2,4 GSI	ower Converte 2,3 ES	ower Converte 2,3 GSI	ower Converte 5 GSI	ower Converte 1,1 GSI	ower Converte 2,4 GSI	ower Converte FZJ	ower Converte 5,2 GSI	ower Converte 1,5 GSI				
TS-4	**RF-System**			RF 4,4 GSI	RF 3,8 GSI	RF 7 IN	RF 31 GSI		RF 0,1 GSI	RF FZJ	RF 6,8 GSI	RF 1,2				
TS-5	**Inj/Extraction**			Inj/Extr. 3,5 GSI	Inj/Extr. 2 GSI		Inj/Extr. 6 GSI		Inj/Extr. 3 GSI	Inj/Extr. FZJ	Inj/Extr. 7 RU	Inj/Extr. 0,8				
TS-6	**Diagnostics**	Diagnostics 10 GSI	Diagnostics 4,5 GSI	Diagnostics 2 GSI	Diagnostics 1,8 ES	Diagnostics 1,287 IN	Diagnostics 5,5 RU	Diagnostics 0,3 GSI	Diagnostics 1,8 GSI	Diagnostics FZJ	Diagnostics 5,4 RU	Diagnostics 0,75				
TS-7	**Vacuum**	Vacuum 12 GSI	Vacuum 5,4 GSI	Vacuum 3,4 GSI	Vacuum 3,4 ES	Vacuum 0,7 IN	Vacuum 8 RU	Vacuum 0,7 GSI	Vacuum 2,9 GSI	Vacuum FZJ	Vacuum 8 GSI	Vacuum 2				
TS-8	**Part. Sources**					EZR 0,7 FR						Linac 3				
TS-9	**ECOOL**				ECOOL 2,7 GSI					ECOOL SE						
TS-10	**St. Cooling**			St. Cool 6 GSI					St. Cool 3,8 GSI	St. Cool FZJ						
TS-11	**Special inst.**	Special 0,1 GSI	Special 5,5 GSI			Special 0,3 GSI	Special 2 GSI	Special 0,8 GSI								
TS-12	**Local Cryo**	Local Cryo 12 GSI	Local Cryo 6,3 GSI	Local Cryo 3,1 GSI			Local Cryo 6,8 GSI				Local Cryo 12 GSI					
TS-14	**Common System**												Refrigerator 49 GSI Controls/Interfaces 24 GSI Quench Detection 2,1 GSI			


FAIR GmbH
Consortium (represented by Consortium Leader)
form
International Partner 1 WP 1
International Partner 2 WP 2
International Partner 3 WP 3
International Partner n WP n

Cost Estimate Modules 0-3 (Price Basis 2005)

Total accelerator and personnel Modules 0 - 3	**502**
Total civil construction Modules 0 - 3	**400**
Experiment funding	**78**
FAIR GmbH personnel and running costs	**47**
Grand Total Modules 0 - 3	**1027**

all values in M€

Firm Commitments

FAIR Countries	Total declared Contribution (k€)
Austria	5.000
China	12.000
Finland	5.000
France	27.000
Germany	705.000
Great Britain	8.000
Greece	4.000
India	36.000
Italy	42.000
Poland	23.740
Romania	11.870
Russia	178.050
Slovenia	12.000
Slovakia	6.000
Spain	19.000
Sweden	10.000
Total	**1.104.660**
Firm Commitments	**1.038.660**

not firm for the first batch

Kingdom of Saudi-Arabia signed the Declaration to contribute at least 1 %

Finance Summary

Cost of Modularized Start Version = 1027 M€

Firm funding commitments of FAIR Partners = 1039 M€

Modularized Start Version secures a swift start within the current funding commitments

Roadmap

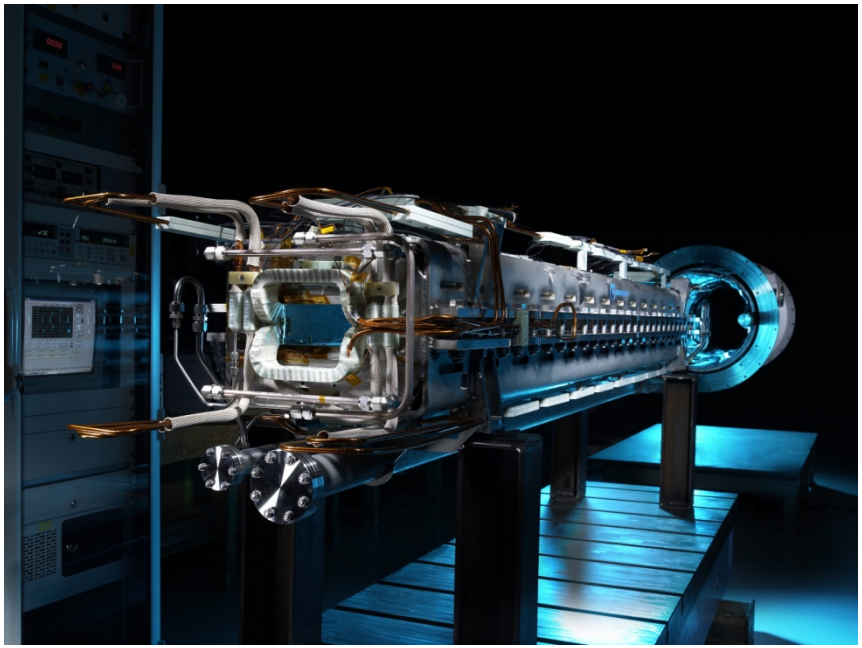
- Start of construction activities 2010/11
- Schadule is driven by **civil construction**
- Aim for earliest commissioning of accelerators and respective experiments

Module	Construction time (months)	Ready for instalation
0	72	2015 / 16
1	28	2015 / 16
2	60	2016
3	60	2016

Evaluation Board 16 October 2009

1. The Modularized Start Version is the right way to proceed.
2. The project is more focussed and is in even better shape.
3. We should now start as soon as possible!

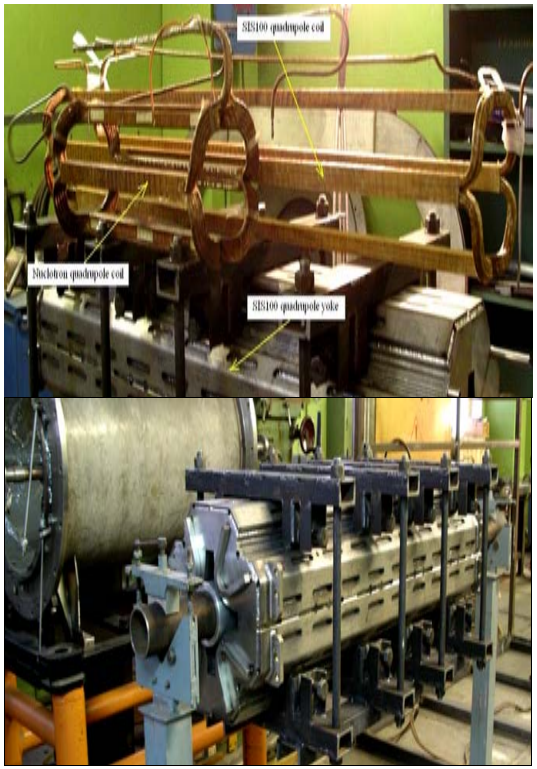
Prototyping examples

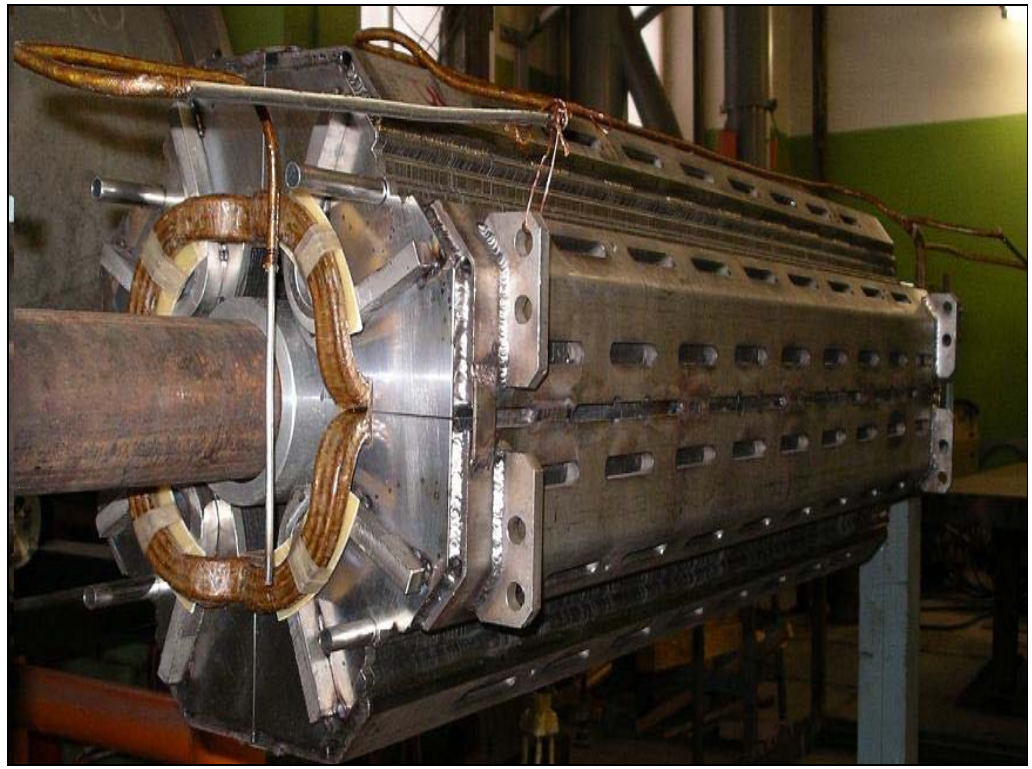


Full size SIS100 dipole (Germany)

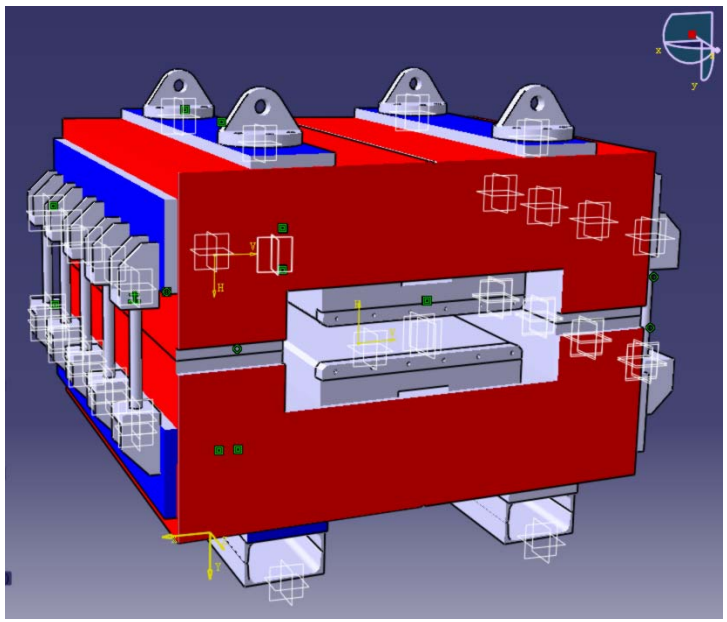
Prototyping examples

First SIS100 Full size quadrupole (Russia)

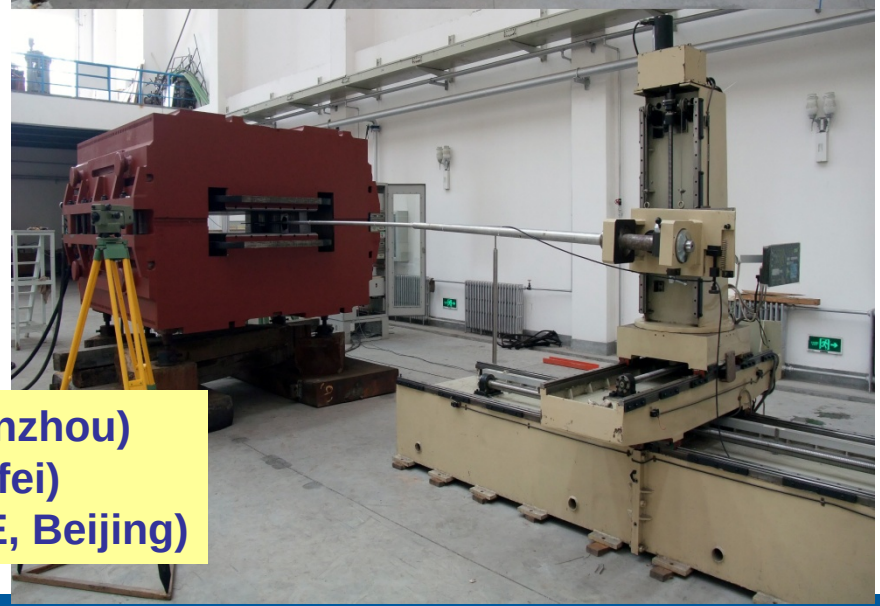




Prototyping examples - China

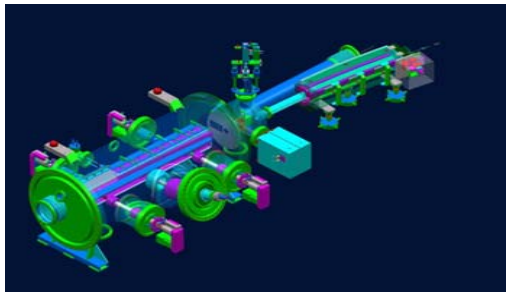


Large Aperture Superferric dipole for Super-FRS

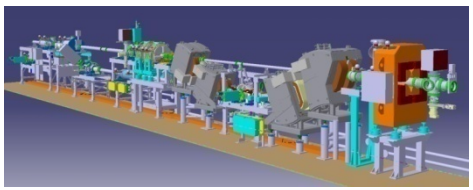


Institute of Modern Physics, CAS (IMP Lanzhou)
Institute of Plasma Physics, CAS (IPP, Hefei)
Institute of Electric Engineering, CAS (IEE, Beijing)

SIS18upgrade Program

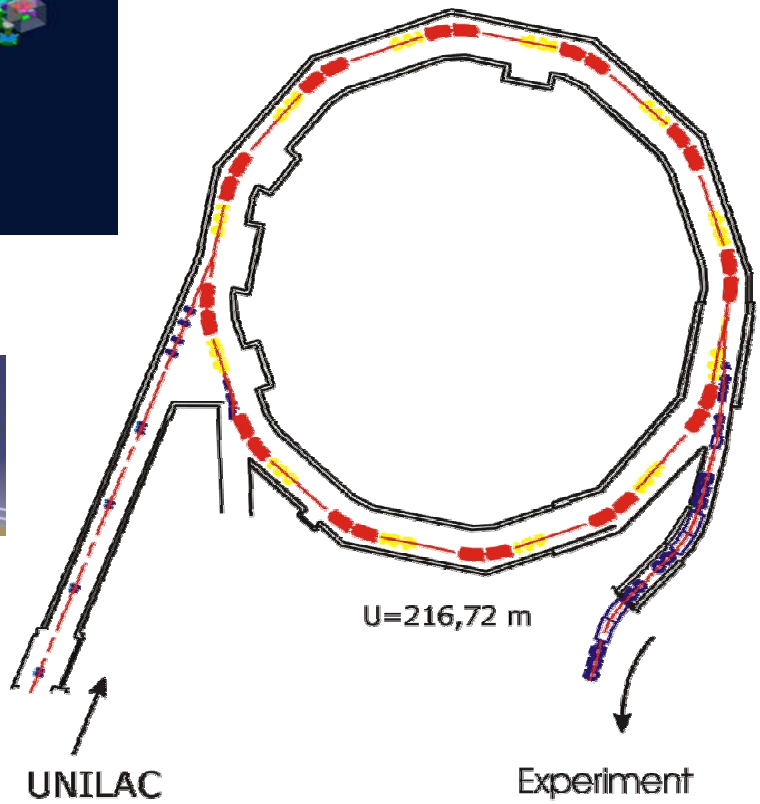


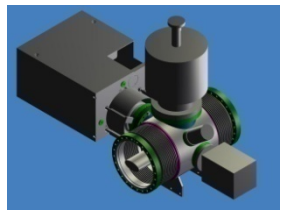
Injection system for low charged state heavy ions



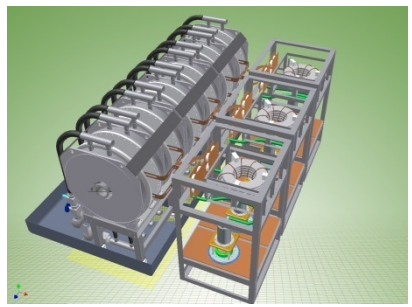
Charge separator for higher intensity and high quality beams

Power grid connection





Scrapers and NEG coating for pressure stabilization



h=2 acceleration cavity for faster ramping

The SIS18upgrade program: Booster operation with low charge state heavy ions

FAIR will open a new era in hadronic, nuclear and atomic research as well as in applied science.

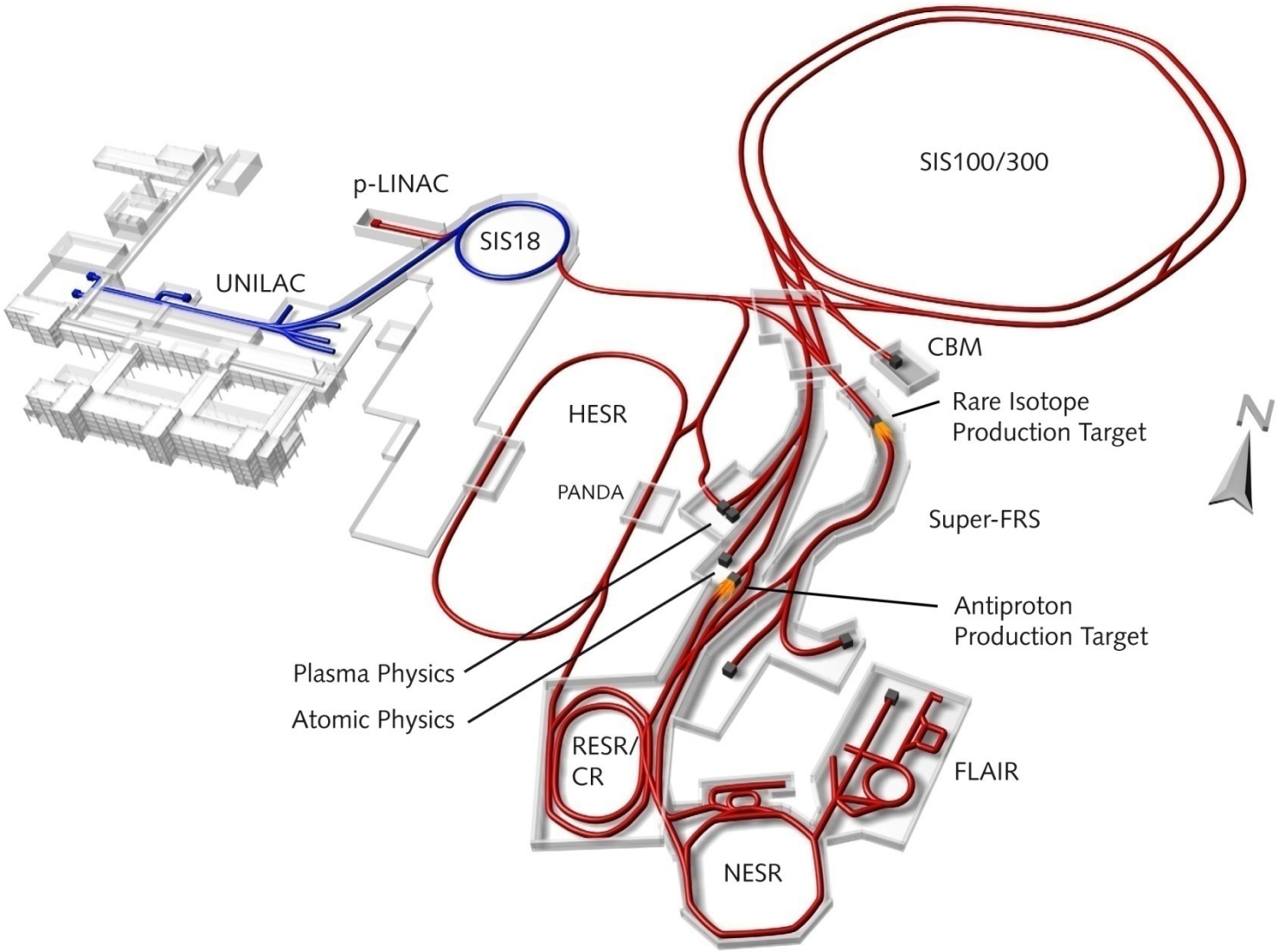
The Green Paper outlines the path to achieve this goal.

The Modularized Start Version provides an outstanding and world-leading research program for all scientific FAIR communities.

Conclusions

- Based on recent cost estimates and firm commitments of FAIR Member States the Modularized Start Version is elaborated
- Modules 0-3 ensure a physics programme that is unique, competitive with great discovery potential
- All FAIR science communities can perform excellent physics from early on
- The facility can be smoothly upgraded towards the full version of FAIR (modules 4,5,6)
- Setup of the international FAIR company proceeds in parallel

FAIR facility BTR 2005



Participation in FAIR project opens opportunities for :

- Support of local research institutions
- Support and education of local young generation of scientists
- Investments in development of local high-tech industries
- Support in development of novel detector materials and technologies
- Access to forefront accelerator technologies
- Development and implementation of modern IT technologies
- Access to unique variety of beams of heavy ions, antiprotons and radioactive isotopes