



Status of the FAIR Project

Klaus Peters

@ Fermilab 19.5.2010



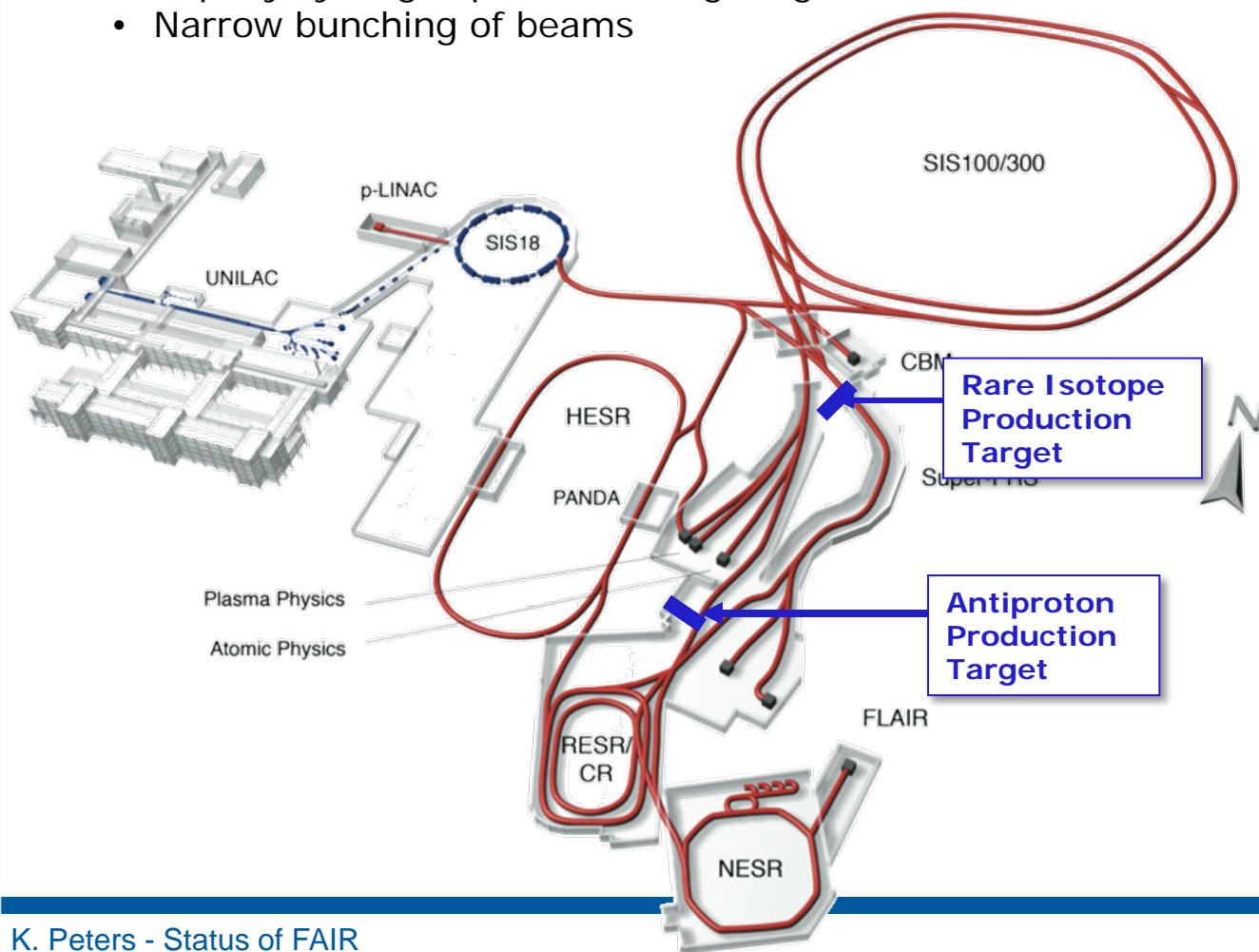
FAIR a bird's eye view



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**

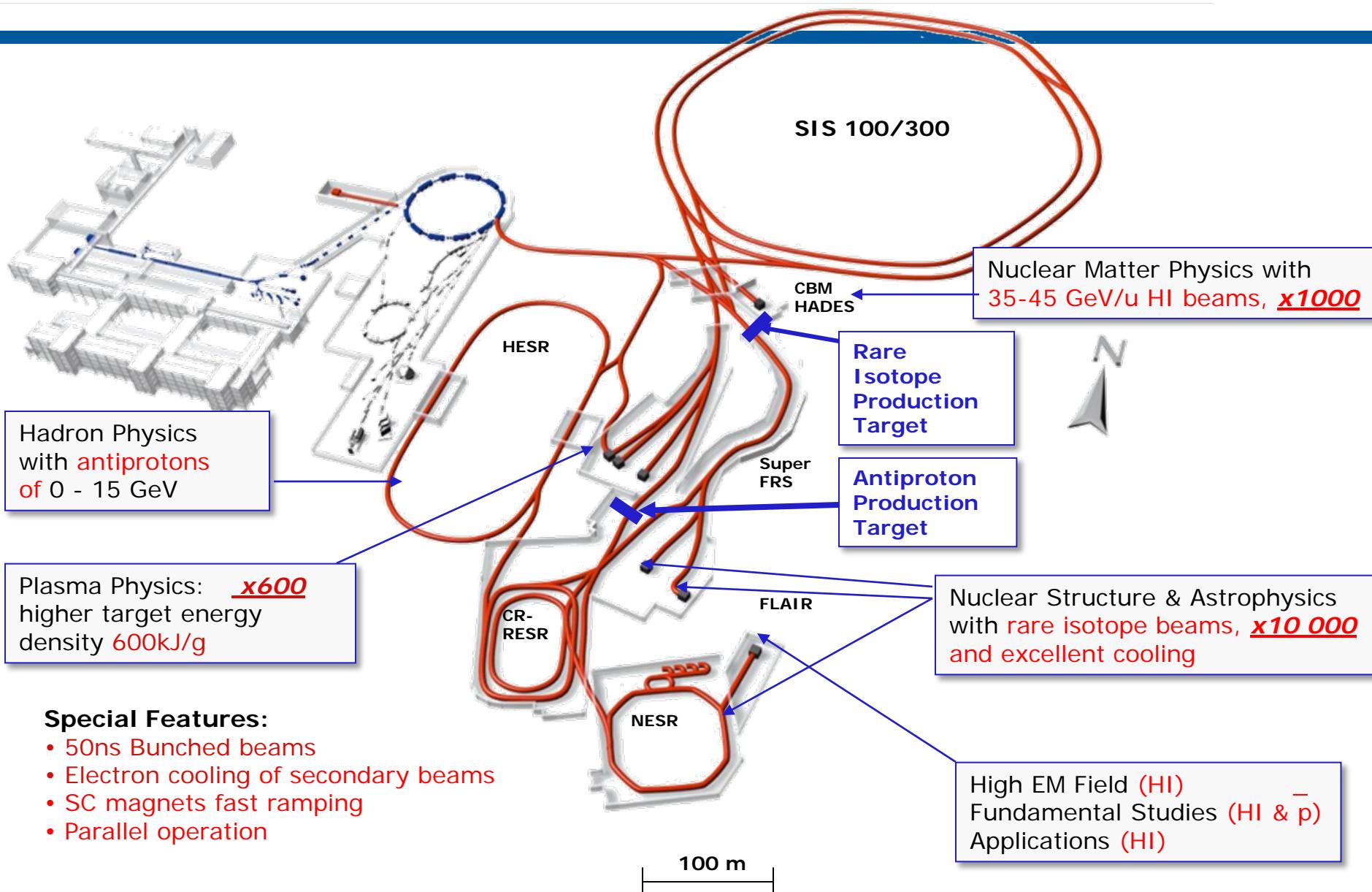
Secondary Beams

- 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



Special Features:

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

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€ !

The image shows a press release header. At the top left is the logo of the Federal Ministry of Education and Research (BMBF), featuring the German eagle and the text "Bundesministerium für Bildung und Forschung". Next to it is the logo of the State of Hesse, featuring the Hessian coat of arms and the text "HESSEN". To the right is a graphic with three stylized human figures in red, yellow, and black, with the text "Freiheit Einheit Demokratie" below it. Below these logos, the text "HAUSANSCHRIFT Hannoversche Straße 28-30, 10115 Berlin" and "POSTANSCHRIFT 11055 Berlin" is listed. In the center, the word "Presse- mitteilung" is written in a large, bold, serif font. To the right of the title, contact information is provided: "TEL 030 / 18 57-50 50", "FAX 030 / 18 57-55 51", "E-MAIL presse@bmbf.bund.de", and "HOMEPAGE www.bmbf.de". At the bottom left of the header, the date "03. September 2009" and the reference number "216/2009" are given. The main text area of the press release begins with "Konjunkturpaket II unterstützt Spitzenforschung in Darmstadt".

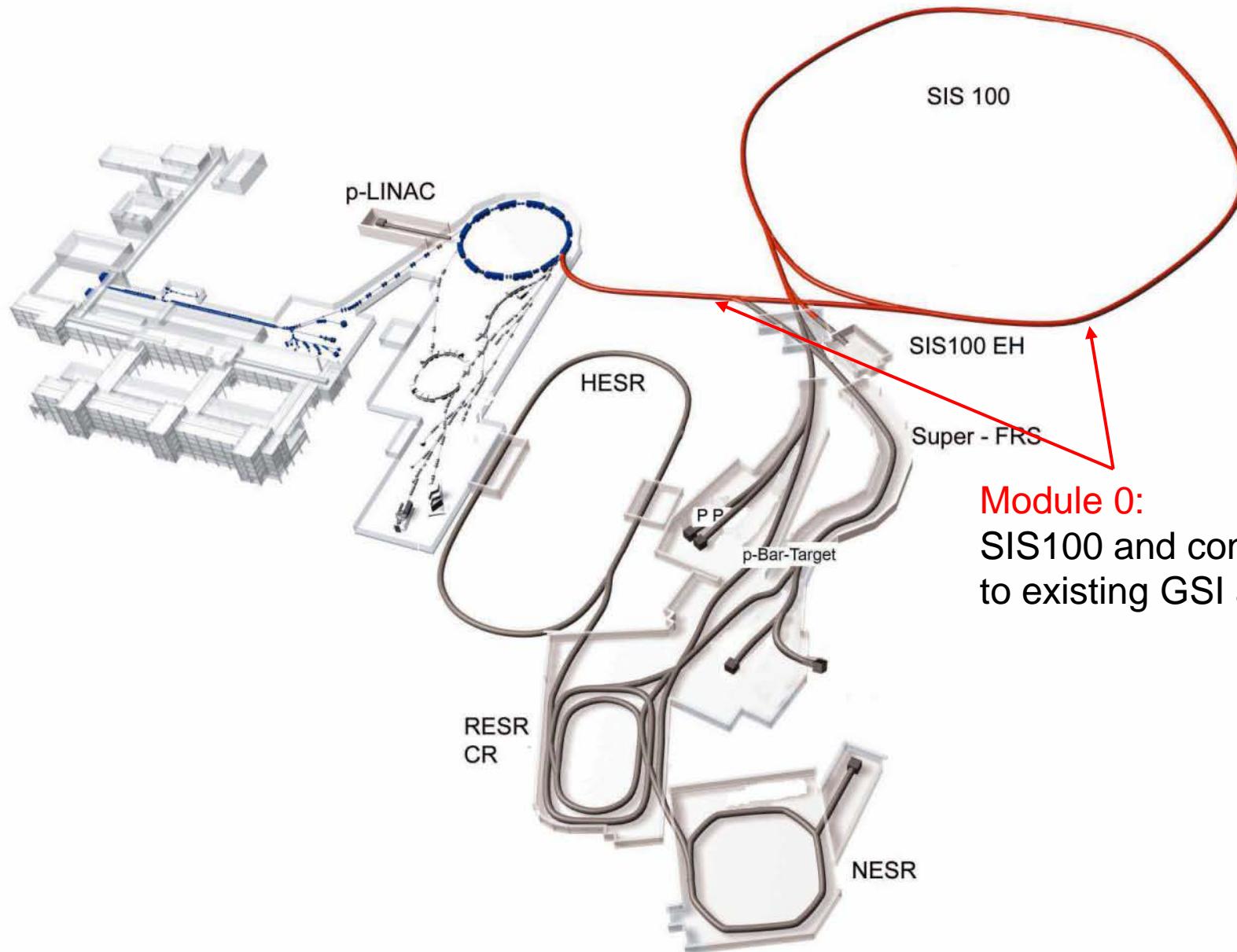
Development of Project Staging

2003	Recommendation by WissenschaftsRat – FAIR Realisation in three stages						
2005	Entire Facility Baseline Technical Report						
2007	Phase A						
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

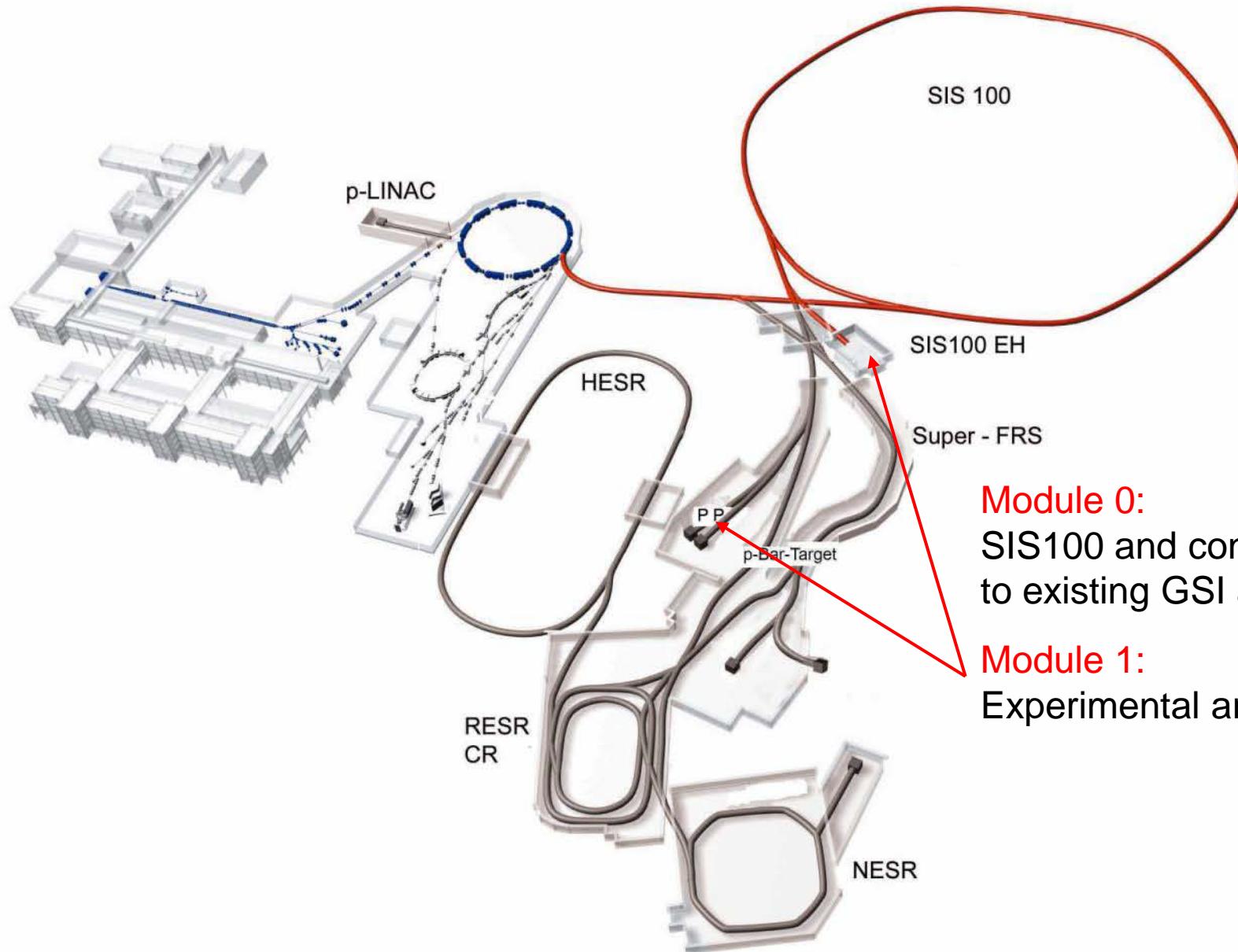
Modularized Start Version

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 accelerators

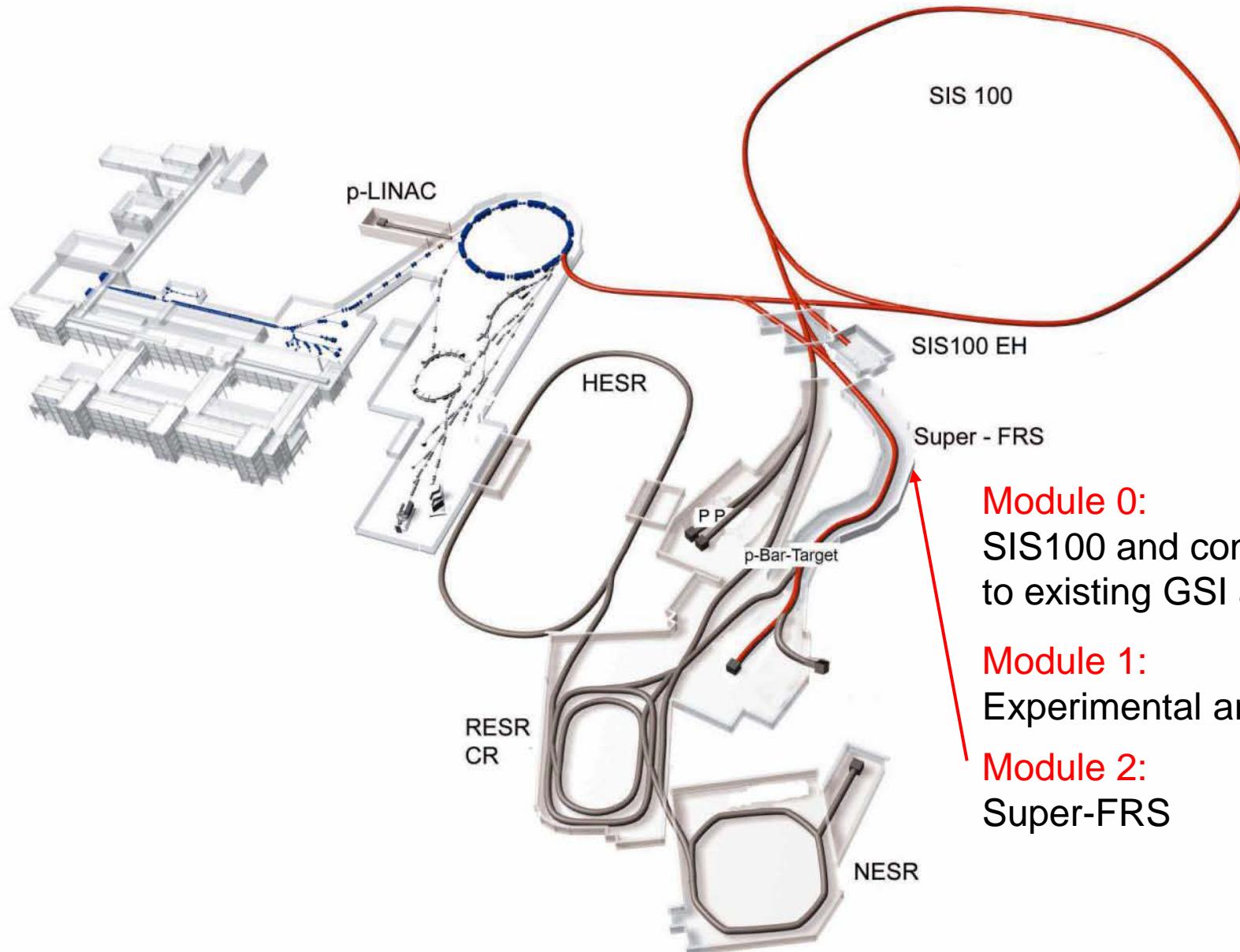


Module 0:

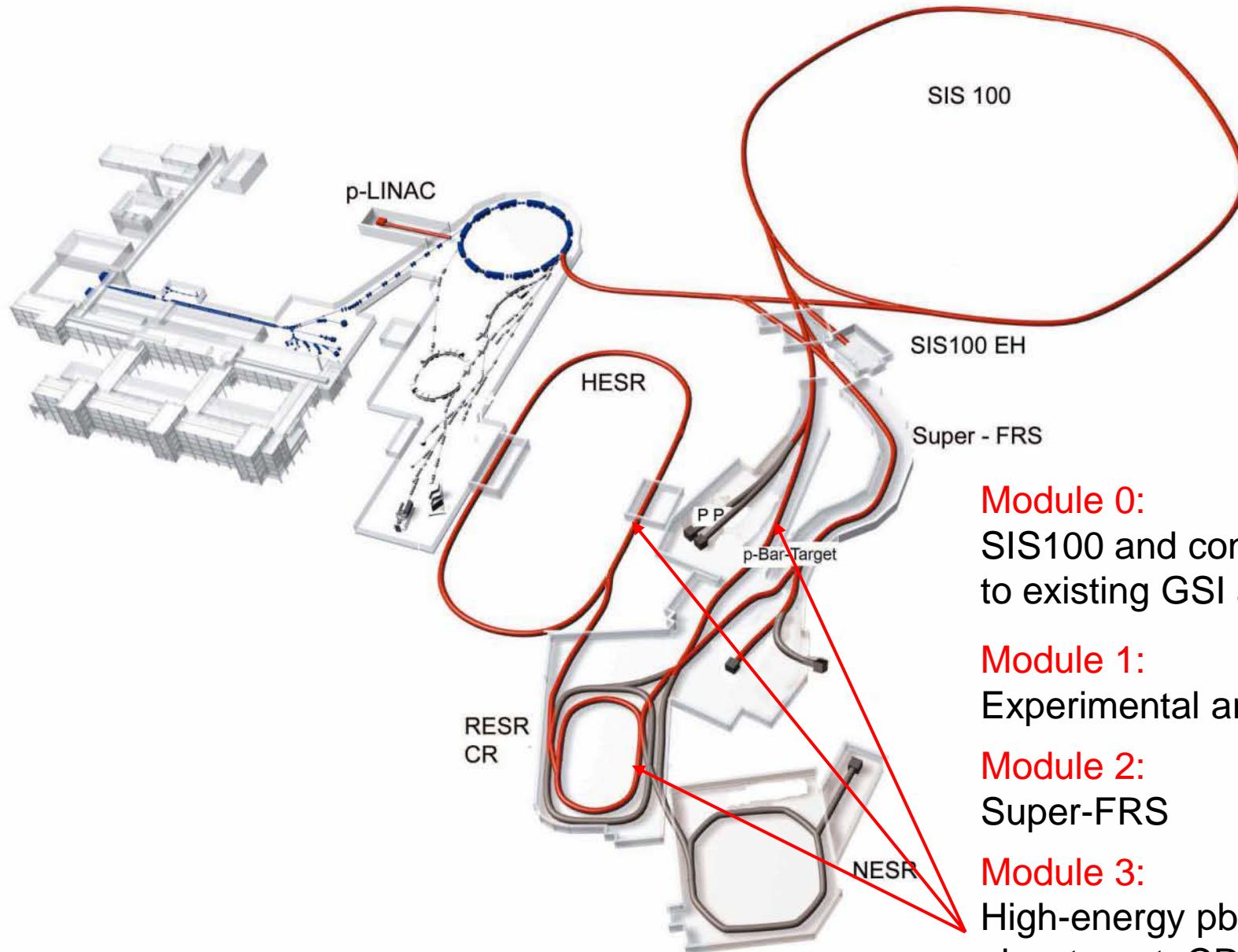
SIS100 and connection
to existing GSI accelerators

Module 1:

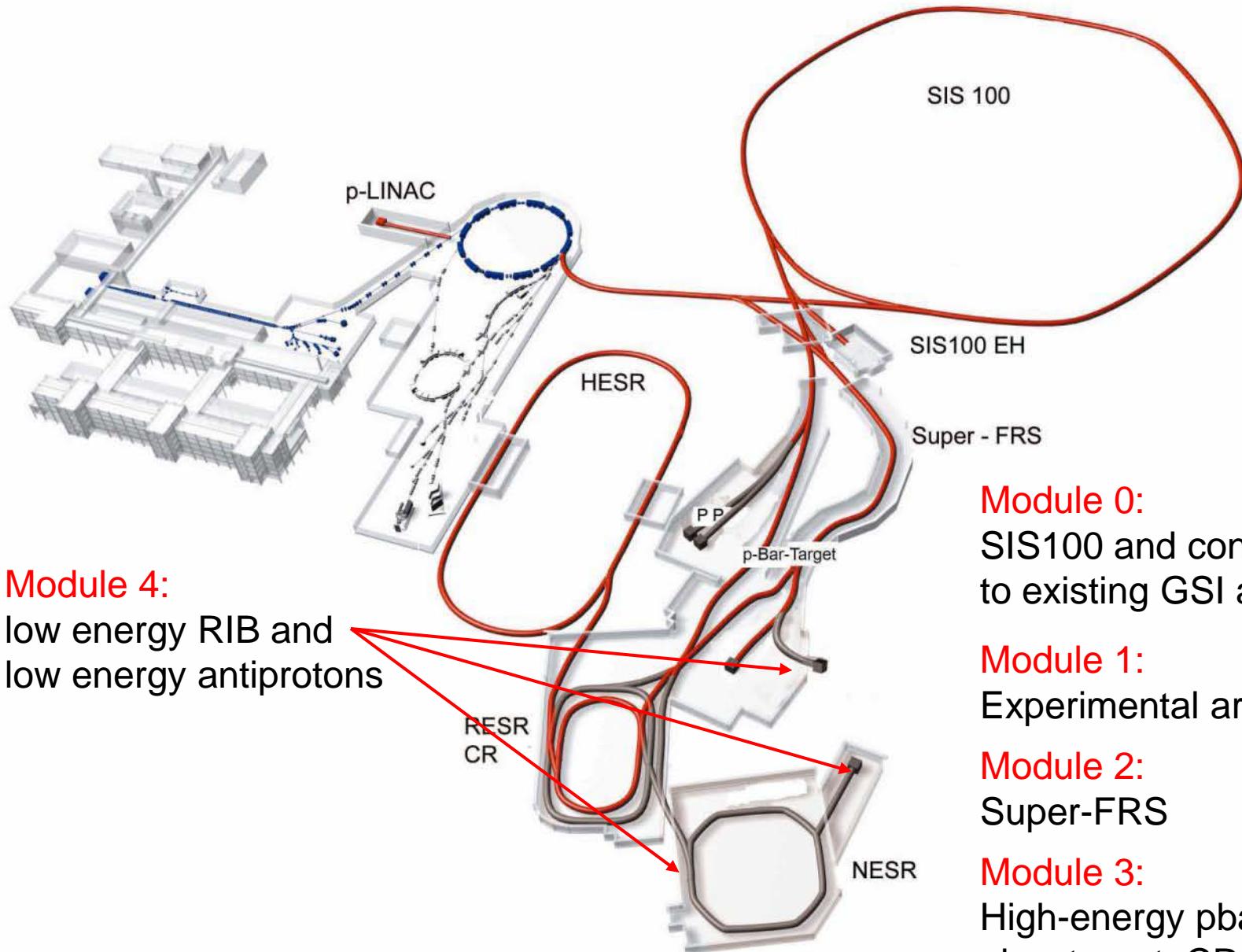
Experimental areas



- Module 0:**
SIS100 and connection to existing GSI accelerators
- Module 1:**
Experimental areas
- Module 2:**
Super-FRS



- Module 0:** SIS100 and connection to existing GSI accelerators
- Module 1:** Experimental areas
- Module 2:** Super-FRS
- Module 3:** High-energy pbar (p-linac, pbar-target, CR, HESR)

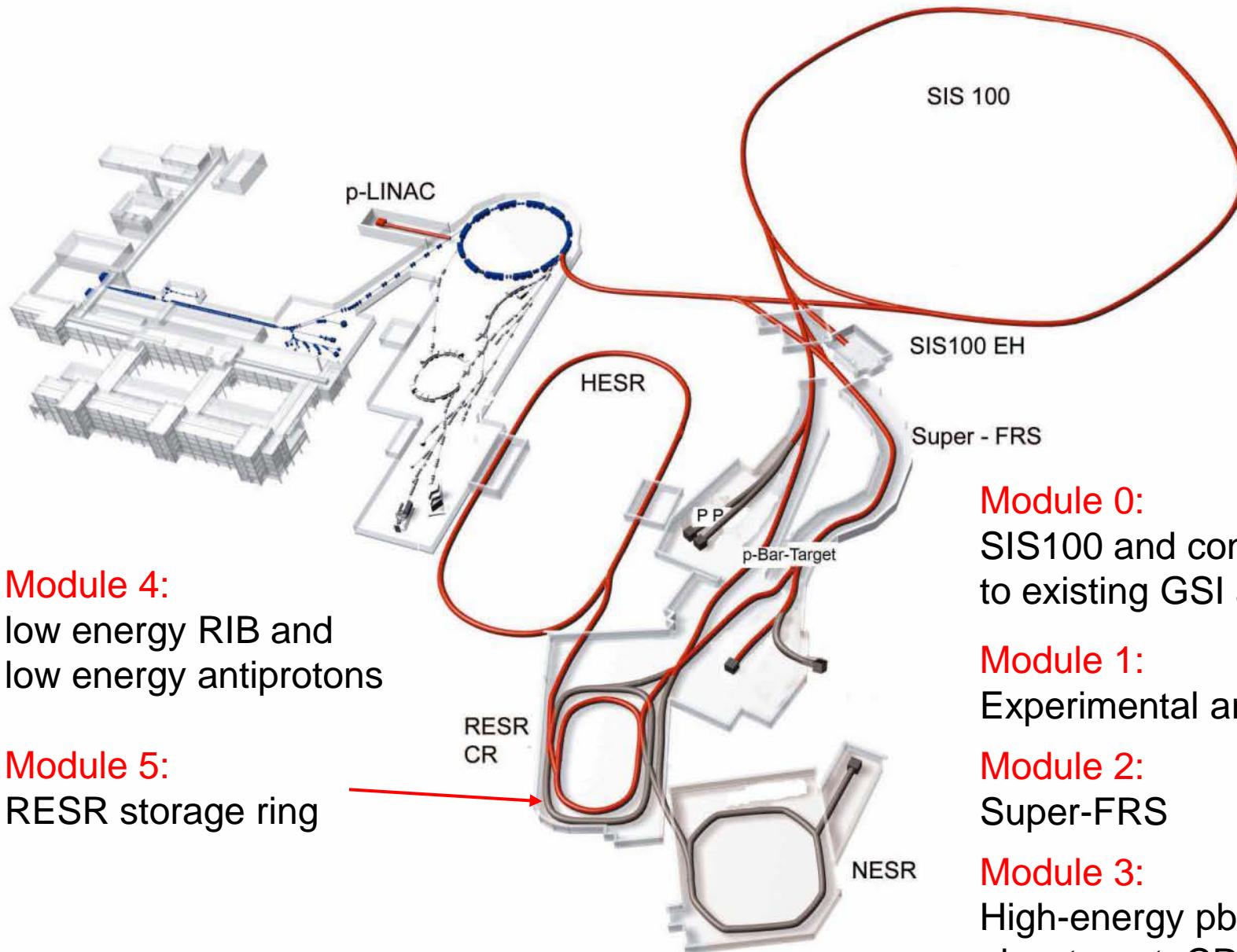


Module 0:
SIS100 and connection
to existing GSI accelerators

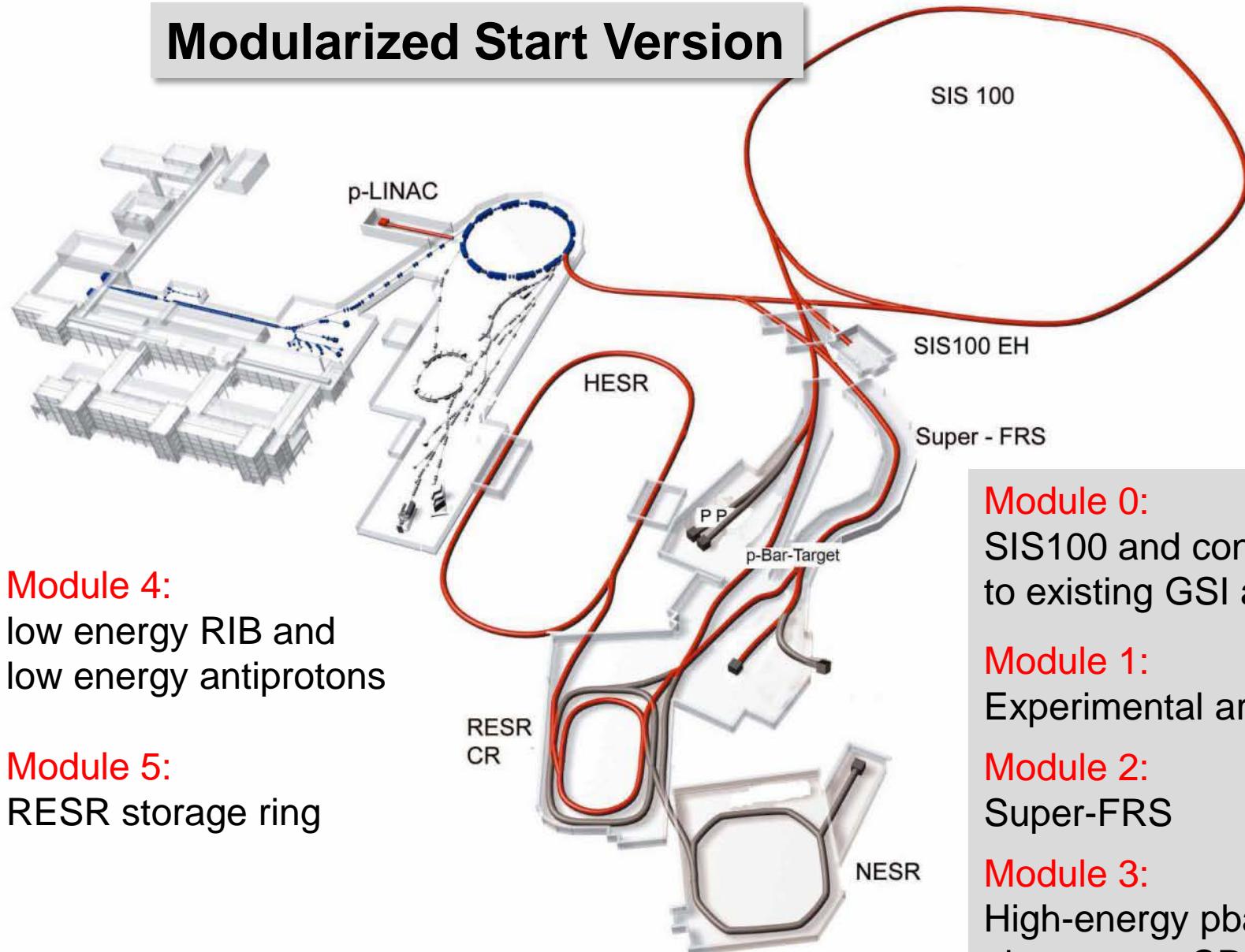
Module 1:
Experimental areas

Module 2:
Super-FRS

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



Modularized Start Version



Module 4:

low energy RIB and
low energy antiprotons

Module 5:

RESR storage ring

Module 0:

SIS100 and connection
to existing GSI accelerators

Module 1:

Experimental areas

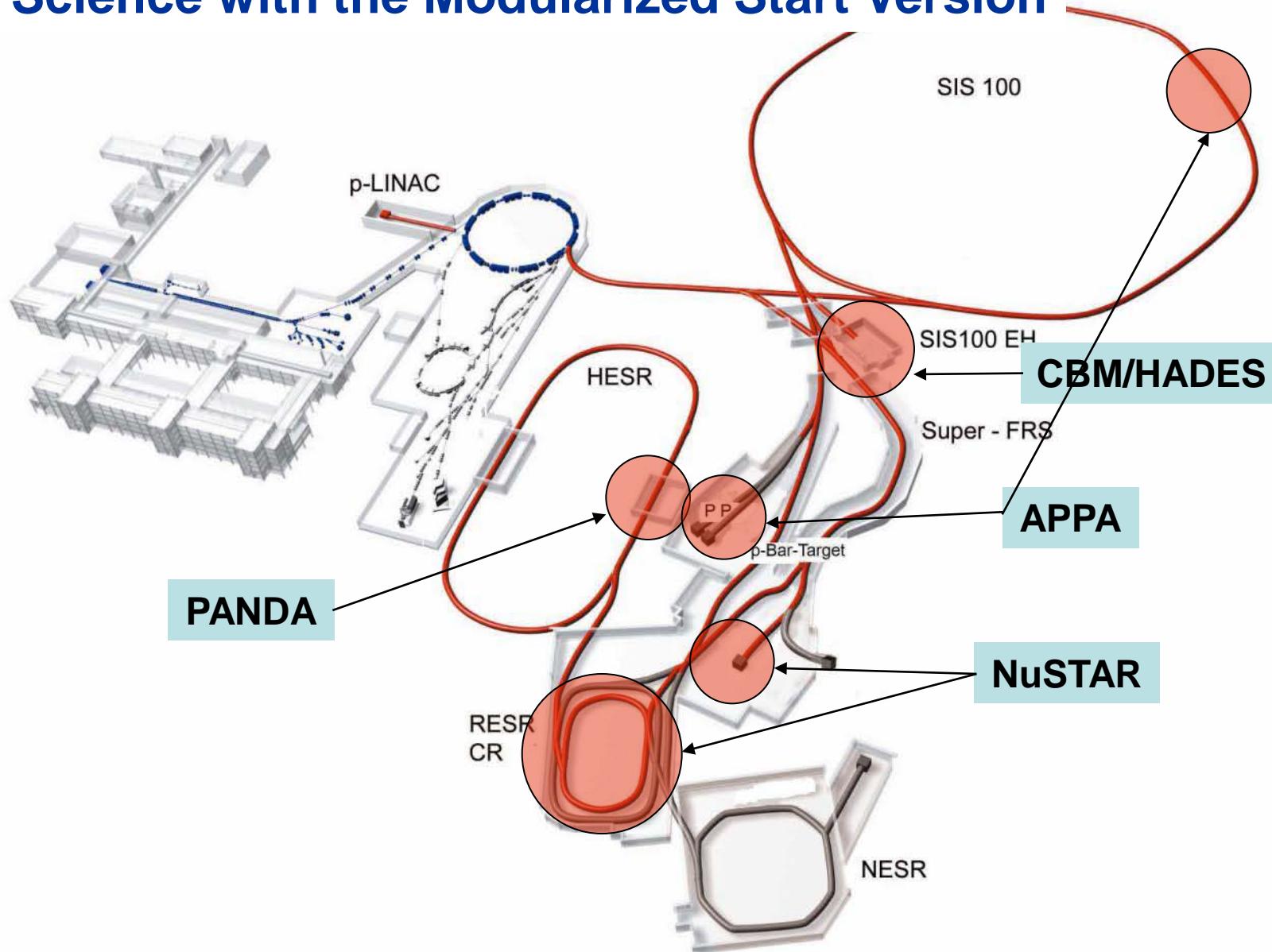
Module 2:

Super-FRS

Module 3:

High-energy pbar (p-linac,
pbar-target, CR,HESR)

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**

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

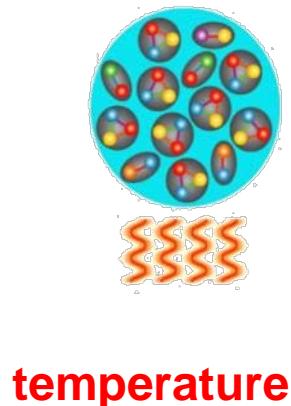


14th CBM Collaboration meeting
5-9 Oct. 2009, Split, Croatia

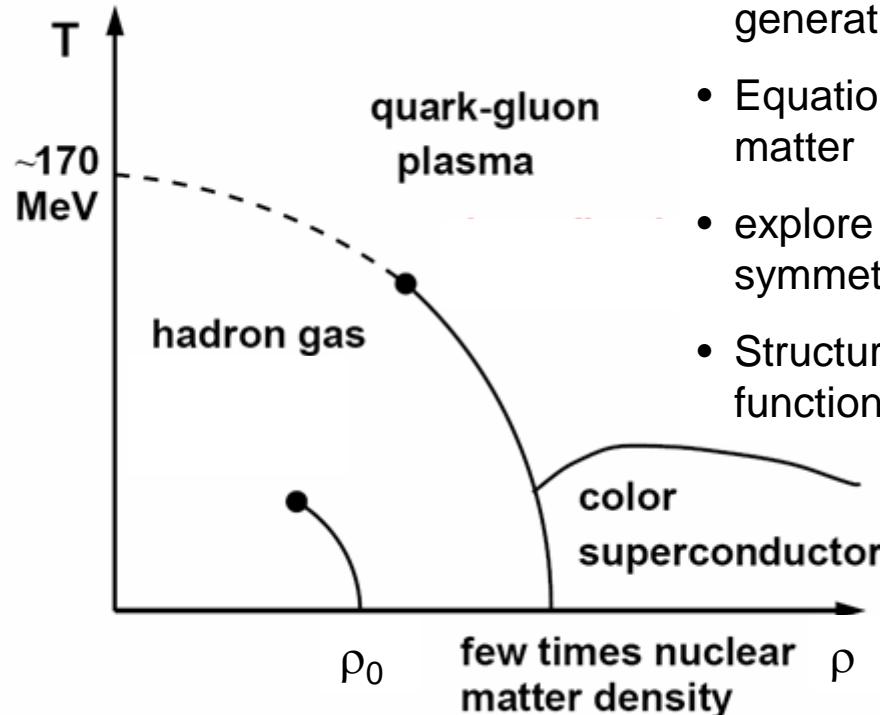
Phasediagram of strongly interacting matter

Fundamental questions of QCD

CBM and HADES at SIS 100 and SIS 300

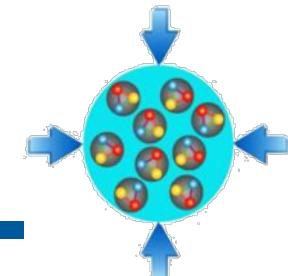


temperature



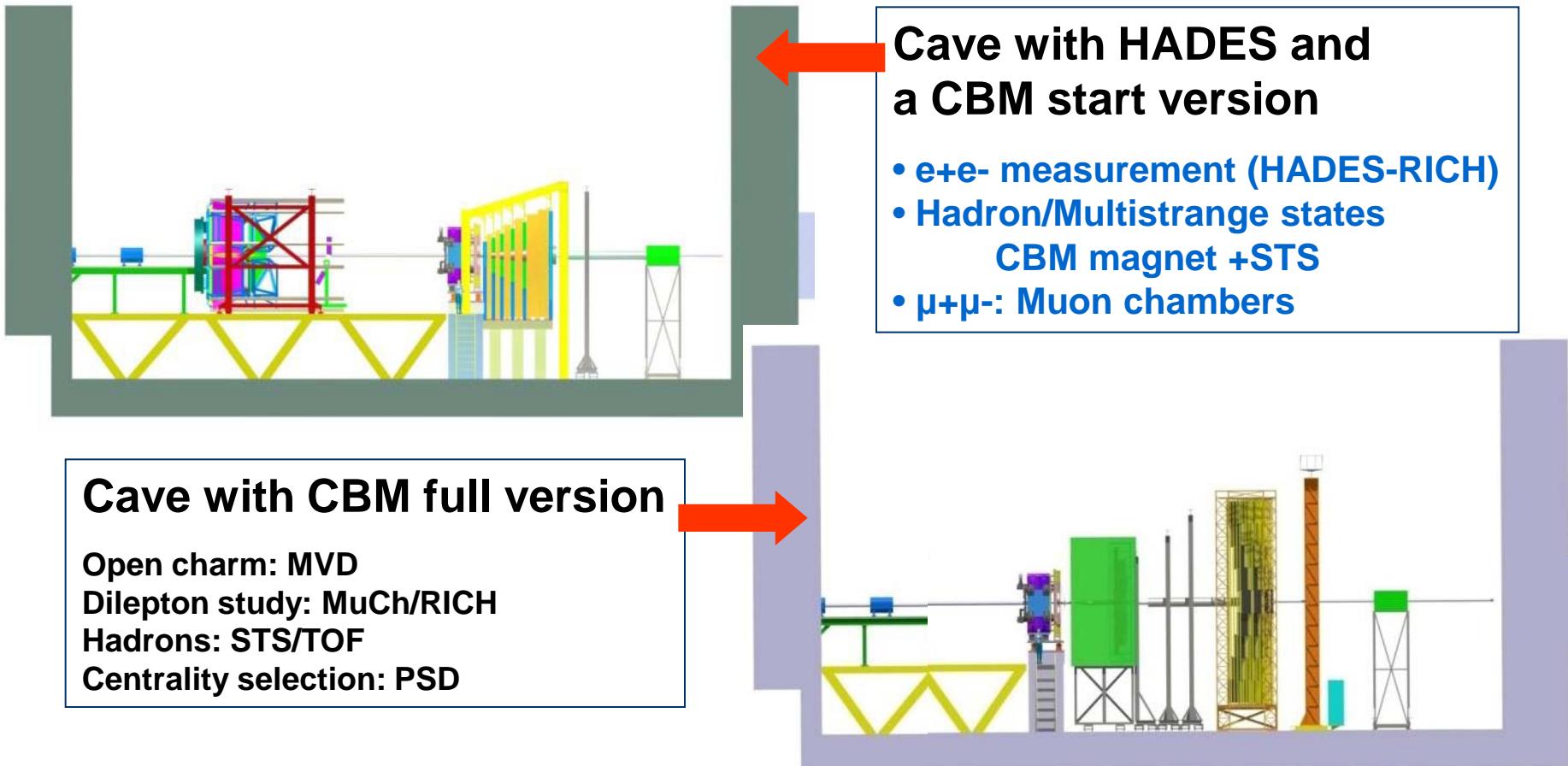
address with heavy-ion collisions

pressure



Experimental equipment (FAIR Modules 0,1)

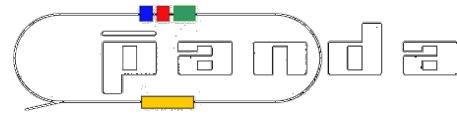
- HADES: existing setup at SIS18
- CBM: New instrument with ultra radiation-hard and high-rate detectors, free-streaming electronics, online event selection



Nuclear STructure, Astrophysics and Reactions

> 800 members from 37 countries and 146 institutions





strong and
international collaboration
> 430 scientists 56 Institutions

<http://www.gsi.de/panda>



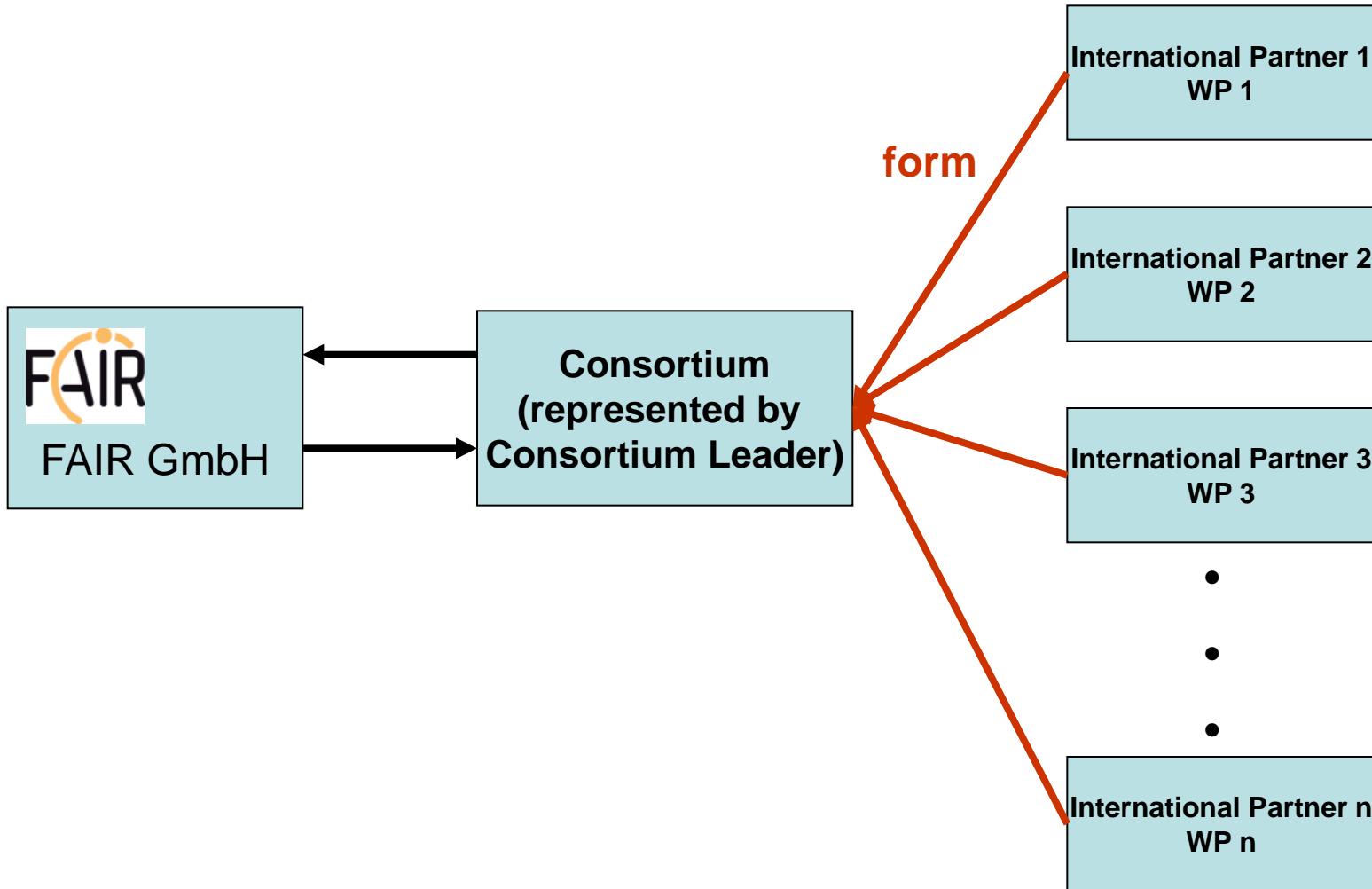
U Basel
IHEP Beijing
U Bochum
U Bonn
U & INFN Brescia
IFIN Budapest
U & INFN Catania
U Cracow
GSI Darmstadt
TU Dresden
JINR Dubna
(LIT,LPP,VBLHE)
U Edinburgh
U Erlangen

NWU Evanston
U & INFN Ferrara
U Frankfurt
LNF-INFN Frascati
U & INFN Genoa
U Glasgow
U Gießen
KVI Groningen
IKP Jülich I + II
U Katowice
IMP Lanzhou
U Mainz
U & INFN Milano
Politecnico di Milano
U Minsk
TU München
U Münster
BINP Novosibirsk
LAL Orsay
U & INFN Pavia
IHEP Protvino
PNPI Gatchina
U of Silesia, Katowice
U Stockholm
KTH Stockholm
U & INFN Torino
Politecnico di Torino
U Oriente, Torino
U & INFN Trieste
U Tübingen
U & TSL Uppsala
U Valencia
SMI Vienna
SINS Warsaw
U Warsaw

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	
TS-2	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
	Magnets Cost Partner active interest	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		
	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					
	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 Conv 16 GSI	Power Conv 3 GSI	Power Conv 2,4 GSI	Power Conv 2,3 ES	Power Conv 2,3 GSI	Power Conv 5 IN	Power Conv 1,1 GSI	Power Conv 2,4 GSI	Power Conv FZJ	Power Conv 5,2 GSI	Power Conv 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 RU	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		Refrigerator 49 GSI		Controls/Interfaces 24 GSI	Quench Detection 2,1 GSI	
TS-14	Common System															



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

not firm for the first batch

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

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
- Schedule is driven by civil construction
- Aim for earliest commissioning of accelerators and respective experiments

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

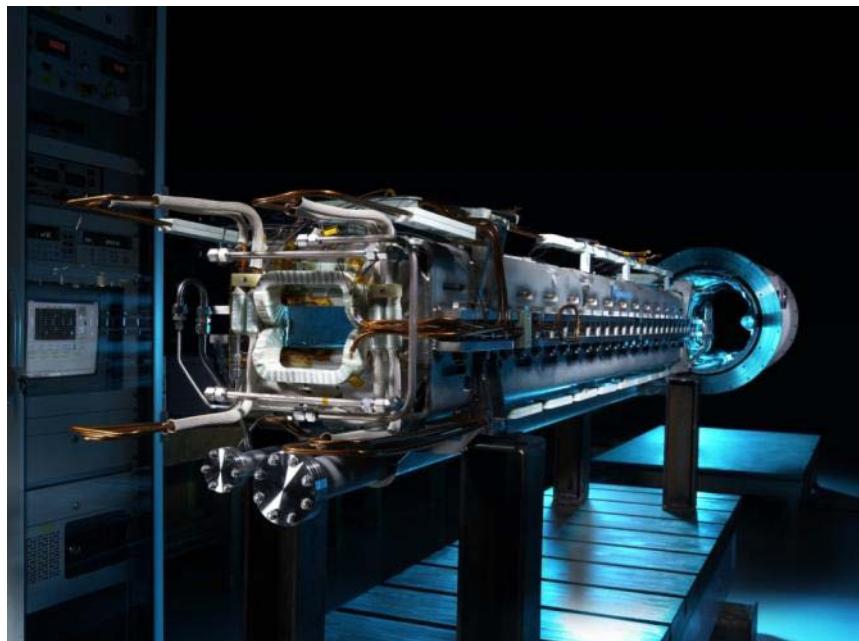
+1

due to the need for a new building permit

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!

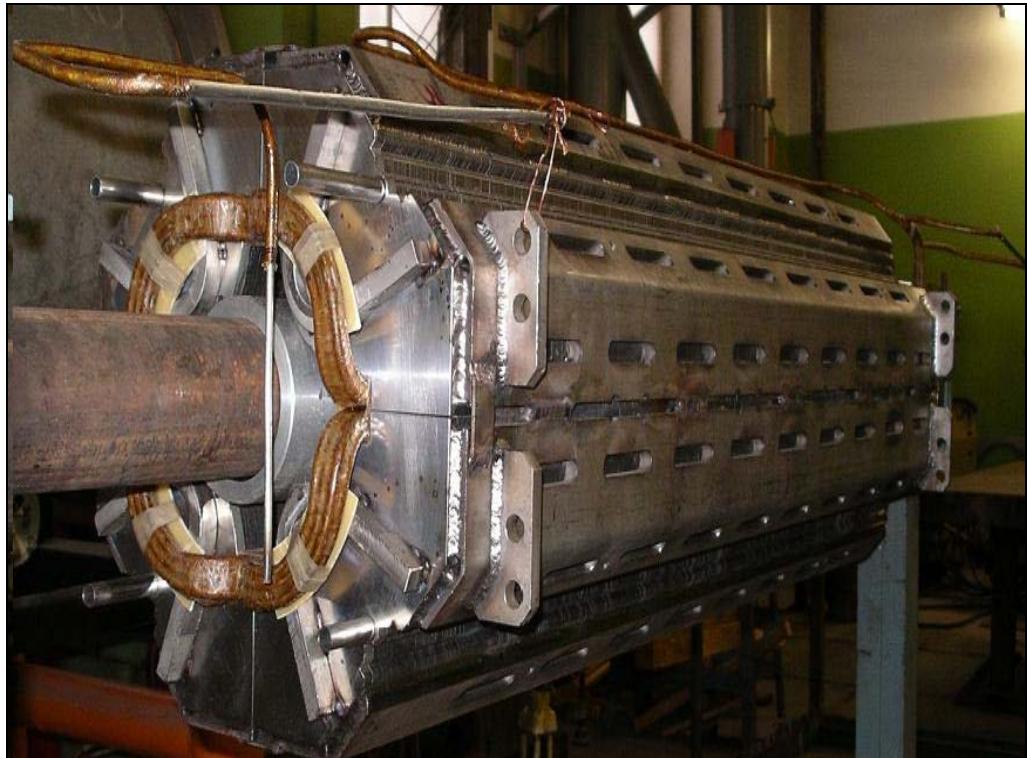
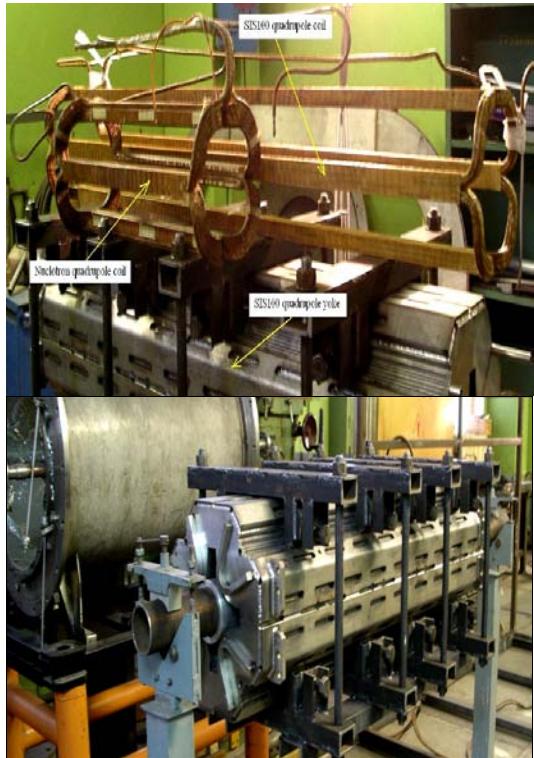
Prototyping examples



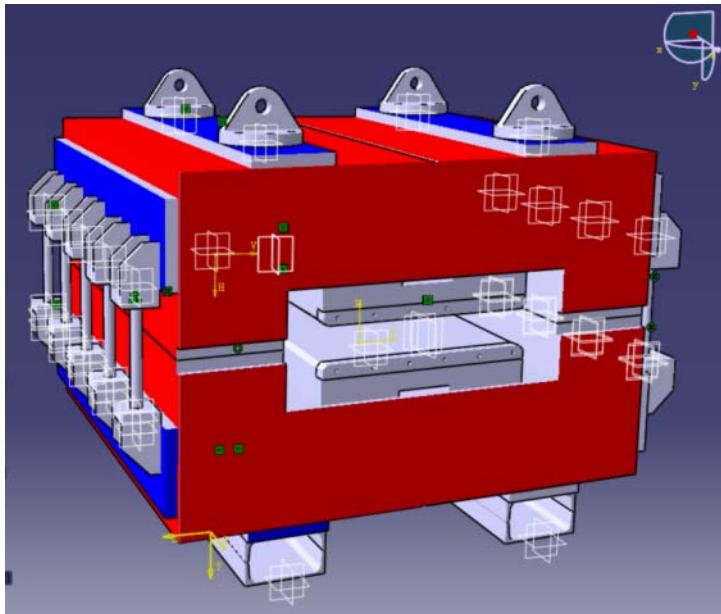
Full size SIS100 dipole (Germany)

Prototyping examples

First SIS100 Full size quadrupole (Russia)



Prototyping examples - China

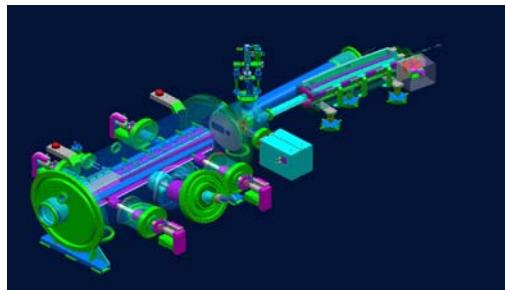


**Large Aperture Superferric
dipole for Super-FRS**

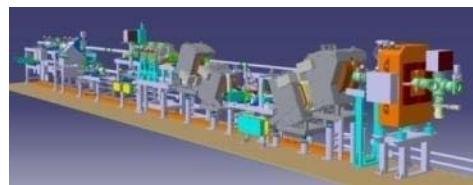


Institute of Modern Physics, CAS (IMP Lanzhou)
Institute of Plasma Physics, CAS (IPP, Hefei)
Institute of Electric Engineering, CAS (IEE, Beijing)

SIS18upgrade Program



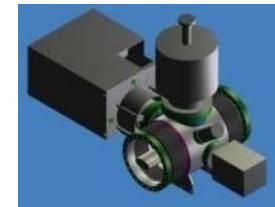
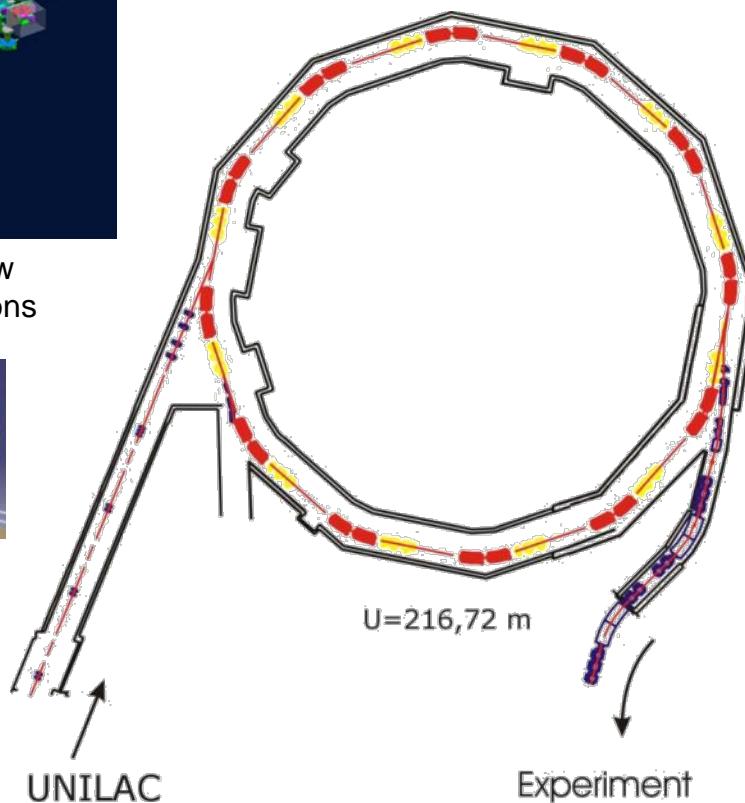
Injection system for low charged state heavy ions



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