Status of the FAIR Accelerator Project

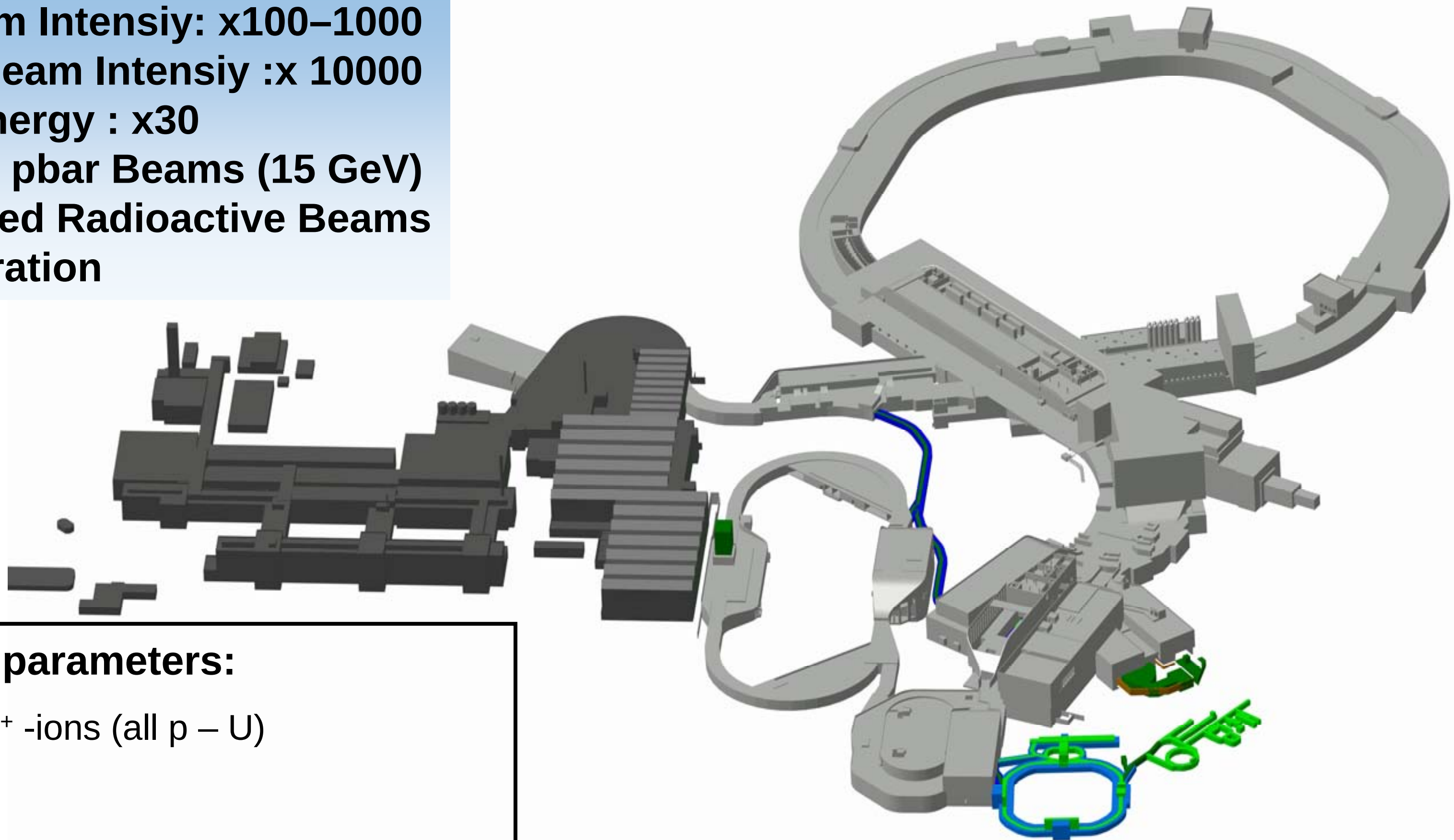
Peter Spiller

RUPAC 2012

26.9.2012

FAIR – Beam Parameters

- **Primary Beam Intensiy: x100–1000**
- **Secondary Beam Intensiy :x 10000**
- **Heavy Ion Energy : x30**
- **New: Cooled pbar Beams (15 GeV)**
- **Intense Cooled Radioactive Beams**
- **Parallel Operation**



SIS100 beam parameters:

Ion species : U^{28+} -ions (all p – U)

N: 5×10^{11} /cycle

Rep. rate: 0.5 Hz

Energy : 400 – 2715 MeV/u

Pulse length : 30 – 90 ns

The FAIR Start Version (Modules 0-3)

Modul 0
SIS100

Modul 1
CBM,
APPA

Modul 2
Super-FRS

Modul 3
Antiproton-
target, CR,
p-Linac,
HESR

Project Funding

- The project funding application (PMA) for the German inkind contributions to the accelerator facilities and the civil construction of the FAIR buildings as been approved and accepted.

- Important international contributions to the subproject accelerators and experiments:

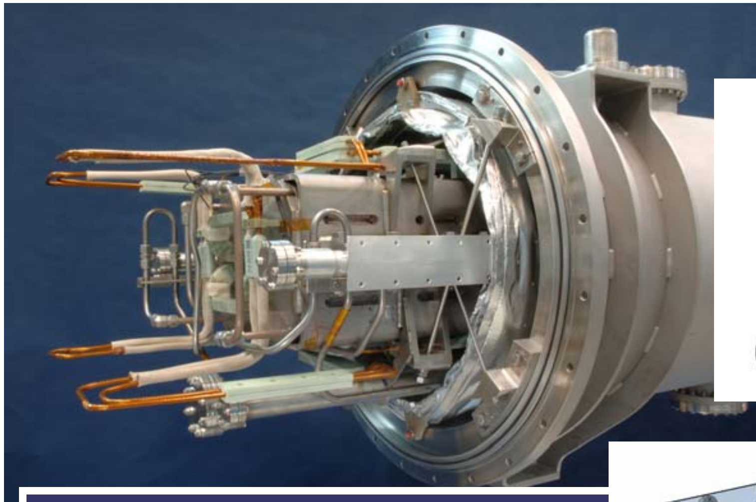
Russia is the biggest international shareholder of FAIR.

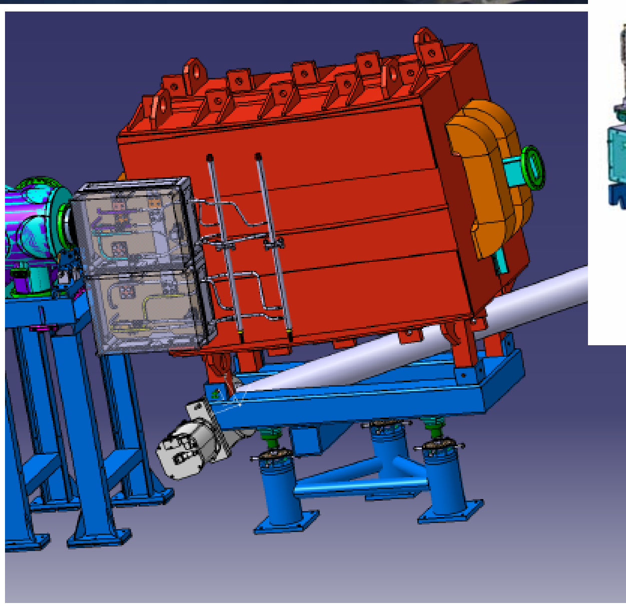
Inkind contracts with international partners in preparation.

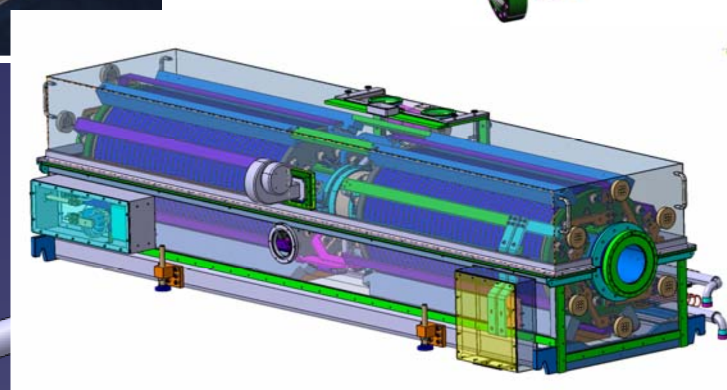
Preparation of FAIR Construction Side

Civil construction and procurement of major accelerator components and series has started

Major Procurements for Accelerator Components Started







Focusing on the Construction of FAIR: Restructuring of GSI

WBS of the Accelerator Subproject

09.10.2011	HEBT 2.3 F. Hagenbuck	Super FRS 2.4 M.Winkler	CR 2.5 M.Steck	p-Linac 2.7 L.Groening	SIS100 2.8 P.Spiller	pbar-Separator 2.9 K.Knie	HESR 2.11 D. Prasuhn	Common Systems 2.14 H. Kollmus
System design	HEBT F. Hagenbuck	Super-FRS M. Winkler	CR M. Steck	p-Linac L. Groening	SIS100 P. Spiller	pbar-separator K. Knie	HESR D. Prasuhn	
Beam Dynamics	HEBT Beam Dynamics	Super-FRS Beam Dynamics	CR Beam Dynamics	p-Linac Beam Dynamics C.Clemente	SIS100 Beam Dynamics O. Boine-Frankenheim	pbar-separator Beam Dynamics	HESR Beam Dynamics	
Magnets	HEBT Magnets 2.3.2 C.Mühle	Super-FRS Magnets 2.4.2 H. Leibrock	CR Magnets 2.5.2 C.Mühle	p-Linac Magnets 2.7.2 C.Mühle	SIS100 Magnets 2.8.2 E. Fischer	pbar - Separator Magnets 2.9.2 C.Mühle	HESR Magnets 2.11.2 U. Bechstedt	Electrical Power 2.14.1 H.Ramakers
Power Converters	HEBT Power Converter 2.3.3 H.Ramakers	Super-FRS Power Converters 2.4.3 H.Ramakers	CR Power Converters 2.5.3 H.Welker	p-LINAC Power Converters 2.7.3 H.Ramakers	SIS100 Power Converters 2.8.3 H.Ramakers	p-bar Separator Power Converters 2.9.3 H.Ramakers	HESR Power Converters 2.11.3 M. Retzlaff	Detector gas supply 2.14.2 M.Schwickert
RF-Systems			CR RF-Systems 2.5.4 U.Laier	p-Linac RF-Systems 2.7.4 G.Schreiber	SIS100 RF-Systems 2.8.4 H.Klingbeil		HESR RF-Systems 2.11.4 R. Stassen	Cryogenics supply 2.14.8 M.Kauschke
Injection/Extraction			CR Inj/Extr 2.5.5 U.Blell		SIS100 Inj/Extr 2.8.5 U.Blell		HESR Inj/Extr 2.11.5 R. Tölle	Survey and Alignment 2.14.9 I.Pschorn
Beam Diagnostics	HEBT Beam Diagnostics 2.3.6 B.Walasek-Höhne	Super-FRS Beam Diagnostics 2.4.6 H. Simon	Beam diagnostics 2.5.6 G.Schepers	Beam diagnostics 2.7.6 P.Forck	Beam diagnostics 2.8.6 P.Kowina	p-bar Seperator Beam diagnostics 2.9.6 A. Reiter	HESR Beam diagnostics 2.11.6 J. Dietrich	Accelerator Control System 2.14.10 R.Bär
Vacuum	HEBT Vacuum 2.3.7 A.Krämer	Super-FRS Vacuum 2.4.7 A.Krämer/Mukha	CR Vacuum 2.5.7 A.Krämer	p-Linac Vacuum 2.7.7 A.Krämer	SIS100 Vacuum 2.8.7 A.Krämer	p-bar Separator Vacuum 2.9.7 A.Krämer	HESR Vacuum 2.11.7 M. Esser	Link Existing Facilities 2.14.11 O.Kester
Particle Sources				P-linac ion source 2.7.8 R.Hollinger				Installations / Assembly 2.14.12 H.Reich-Sprenger
Stochastic Cooling			CR Stochastic Cooling 2.5.10 F.Nolden				HESR Stochastic Cooling 2.11.10 R. Stassen	Magnet Testing 2.14.13 P. Schnizer
Special Installations	HEBT Special Installations 2.3.11 F. Hagenbuck	Super-FRS Special Installations 2.4.11 H. Weick		p-Linac Special Installations 2.7.11 L. Groening	SIS100 Special Installations 2.8.11 H.Kollmus	pbar- Separator Special Installations 2.9.11 K.Knie	HESR - Special Installations 2.11.11 D. Prasuhn	Quench Detection and Protection 2.14.14 E.Floch
Cryogenics		Cryogenics 2.4.12 Y.Xiang			Cryogenics 2.8.12 M. Kauschke			

Time Schedule

- Coordinated process of setting-up a detailed time schedule for each machine and division
- First approach: Machine Project Leader (requirements meet Work Package Leaders)
- Goal: Meeting the milestone „building readiness“ for all components needed for the comissioning with beam.
- Synchronisation between subprojects accel. and civil constr.
- Milestone: Completeness within the single subprojects (machines), completness of substructuring, identification of (time) critical components (long lead items), consideration of procurement strategies, definition of procurement packages
- Milestone: Estimation of required human resources for each subproject (machine) and resource loaded schedule
- Consideration of interconnection and links of the subprojects (optimization, synergies etc.)
- Extraction of funding profiles and funding requirements
- Final goal: Tool for the continous follow-up of all subproject

Frame Schedule

SIS100	All major contracts closed for building and infrastructure	All contracts closed for major component	All major component series Production started	Building and infrastructure ready for assembly (***)	All components ready for installation (incl. testing)	Assembly and alignment finished	Building and infrastructure ready for commissioning	Commissioning without beam finished
Dipole Moduls	-	Q1/2012	Q4/2013	-	Q1/2017	Q3/2017	Q1/2017	-
Quadrupole modules	-	Q2/2013	Q4/2014	-	Q2/2017	Q4/2017	Q1/2017	-
Rf system	-	Q1/2013	Q4/2014	-	Q2/2017	Q4/2017	Q4/2017	-
Magnet testing dipole moduls	Q2/2013	Q1/2013	Q4/2014	Q2/2014	Q1/2017	-	-	-
Magnet testing quad moduls	-	Q1/2013	Q4/2014	Q1/2012	Q2/2017 (5)	-	-	-
Stringtest	Q2/2013	Q2/2013	Q2/2013	Q2/2014	Q4/2014	Q1/2015	-	-

Building Readiness

Facility	BOE
HEBT Connection SIS18 - SIS100 (T1S1, T1S2, T1S3, T1S4)	29.04.2016
HEBT-SIS100 (T8DU)	29.04.2016
SIS100	29.04.2016
HEBT - T1X1, T1C1,T1D1-T1C2,TNC1 - T1X2,TXL1,TXL2,TXL3,TXL4,TPP1,TPP2	01.05.2017
Multifunction Cave (CBM HADES)	01.05.2017
HEBT - T1F1,T1F2,TFF1, TSX1, TSF1, FRF, TFC1	28.10.2016
HEBT - TAP1, TAP2, TCR1, THS1	23.01.2017
p-Bar TARGET	28.10.2016
p-LINAC	01.05.2017
CR	23.01.2017
Super FRS	28.10.2016
HESR	23.01.2017

Updated planning presently in progress !

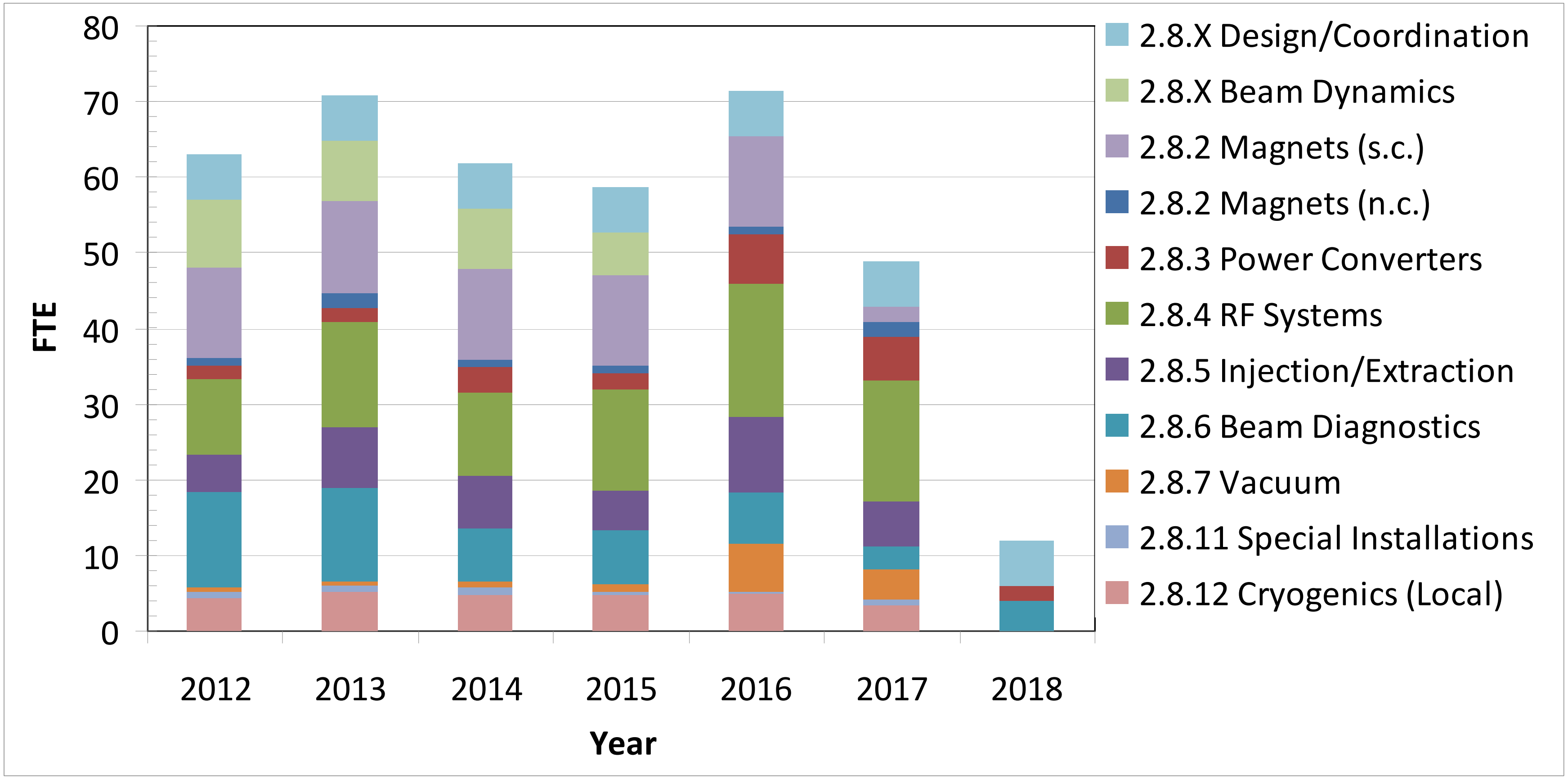
No major staging possible. Installation basically in parallel. Requires an optimized logistics- and installation planning and a strongly parallel commissioning of devices (without beam).

GSI Technical Supervisor for FAIR Accelerator

In-kind contract on the Technical Supervision on accelerator components between FAIR and GSI has been signed, i.e.: 1450 FTE will be provided by GSI to the project for technical follow-up of accelerator components approved by Council. (equ. of 110 M€ for GSI within Ger funding for FAIR)

- Manpower (FTEs will be deduced from the time schedule):
  - Project coordination (recruitment in progress)
  - Additional personnel for technical departments and groups
  - Collaboration with large scale facilities:
    Helmholtz centers (KIT, FZJ), CERN, IMP Lanzhou, DOE labs
  - “Buying” support from industrial partners

SIS100 Resource Schedule



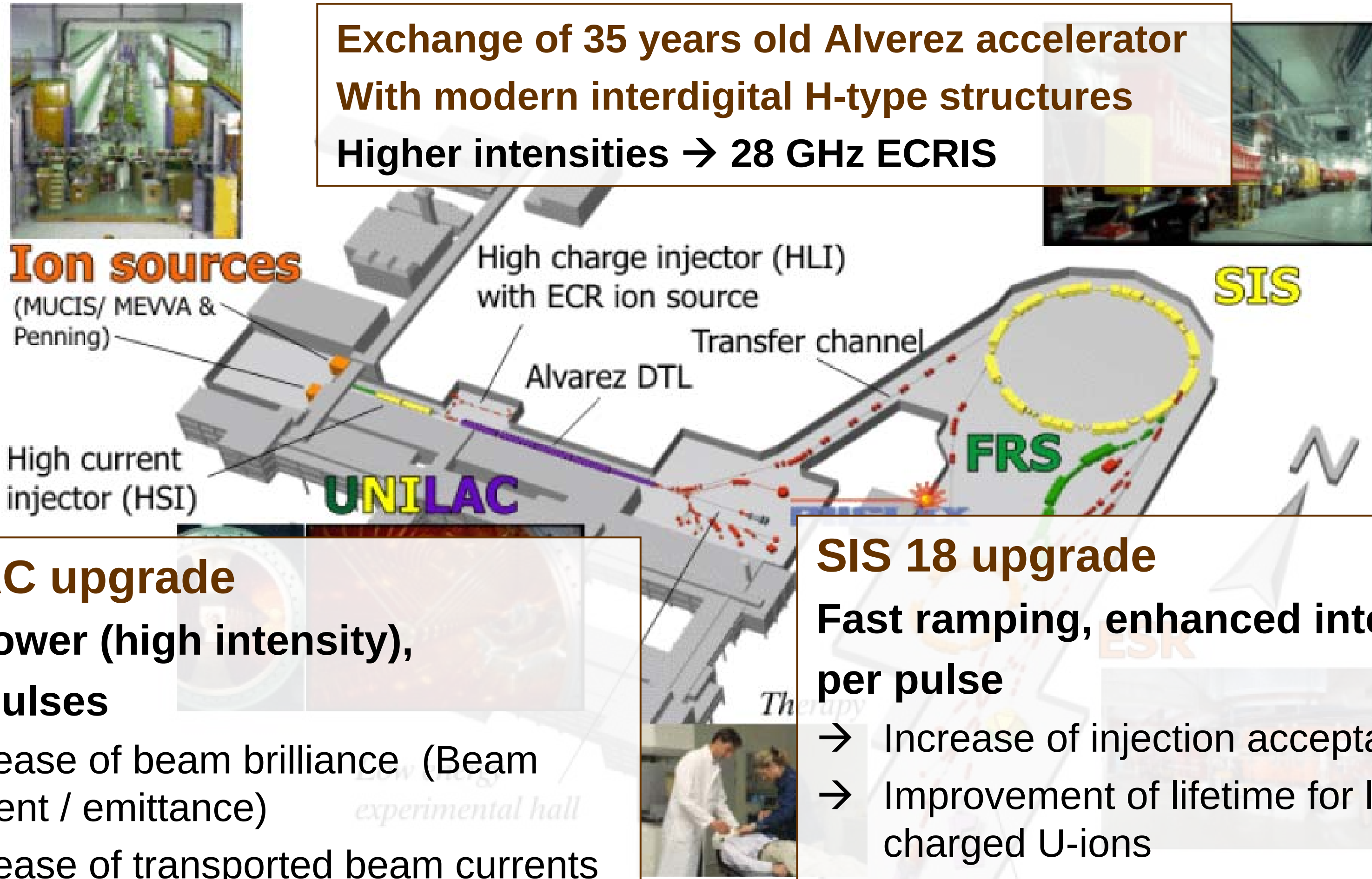
Link Existing (Accelerator) Facility

- Upgrade and preparation of the injector chain

  (high current sources,UNILAC and SIS18)

  Considerations for ALVAREZ replacement.
- Modifications in the transfer channel for linking the proton linac.
- Modifications in the HEBT system for linking the FAIR HEBT system.
- Upgrade of the shielding of SIS18 and other radio protection issues
- Construction of a new main control room

Preparing the Injector Chain – UNILAC upgrade



Exchange of 35 years old Alverez accelerator
With modern interdigital H-type structures
Higher intensities → 28 GHz ECRIS

UNILAC upgrade

High power (high intensity), short pulses

→ Increase of beam brilliance (Beam current / emittance)

→ Increase of transported beam currents

→ Improvements of high current beam diagnostics / operation

SIS 18 upgrade

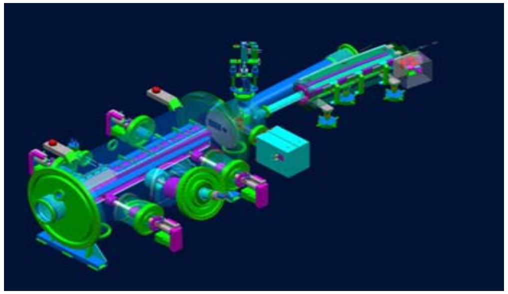
Fast ramping, enhanced intensity per pulse

→ Increase of injection acceptance

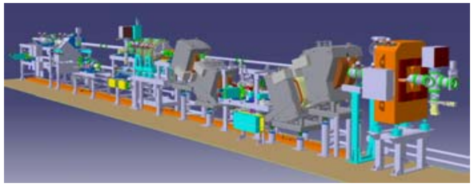
→ Improvement of lifetime for low-charged U-ions

→ Increase of beam-intensity per time due to reduction of SIS18- cycle time

Preparing the Injector Chain - SIS18 Upgrade

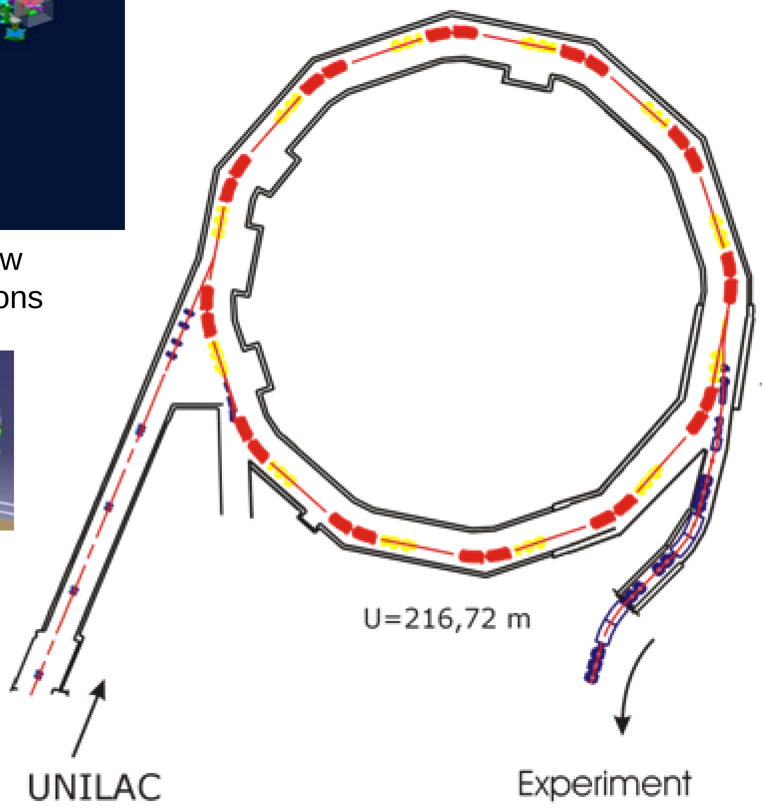


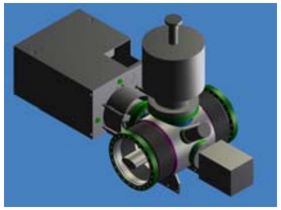
Injection system for low charged state heavy ions



Charge separator for higher intensity and high quality beams

Power grid connection



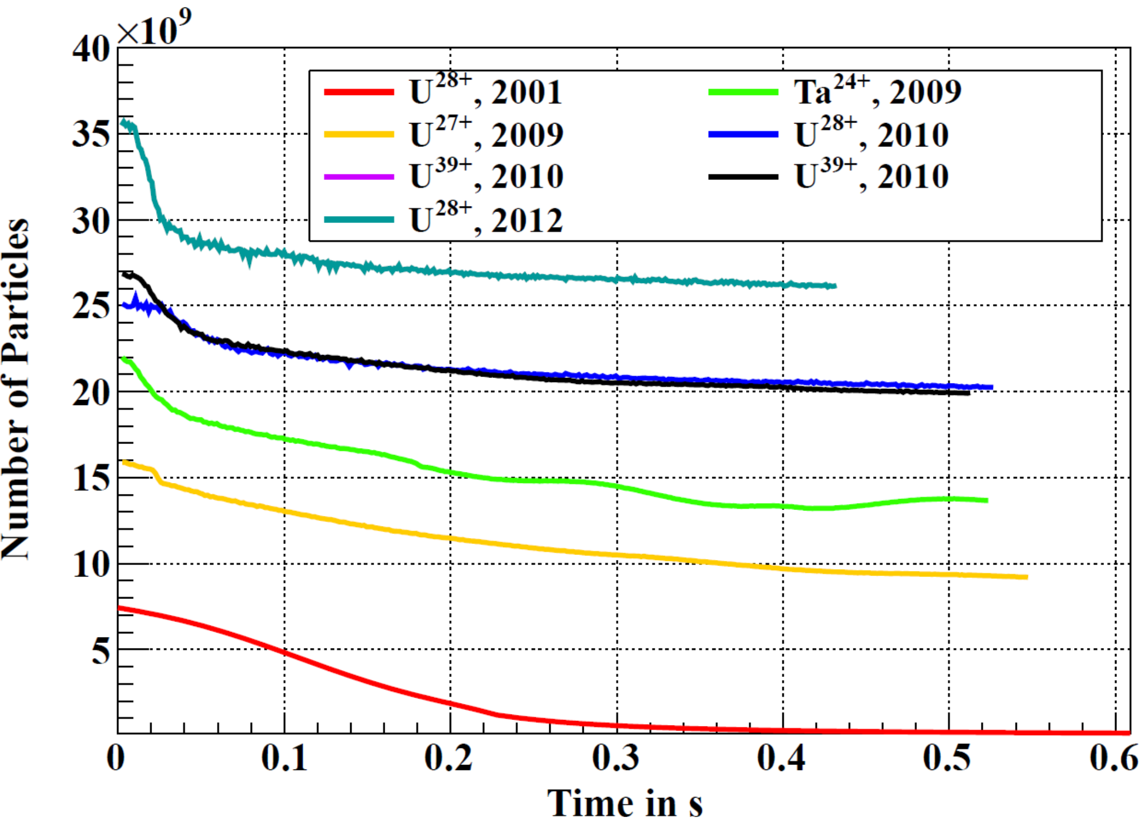


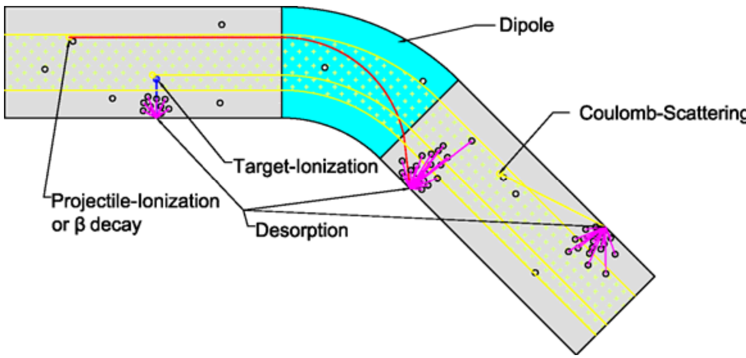
Scrapers and NEG coating for pressure stabilization

h=2 acceleration cavity for faster ramping

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

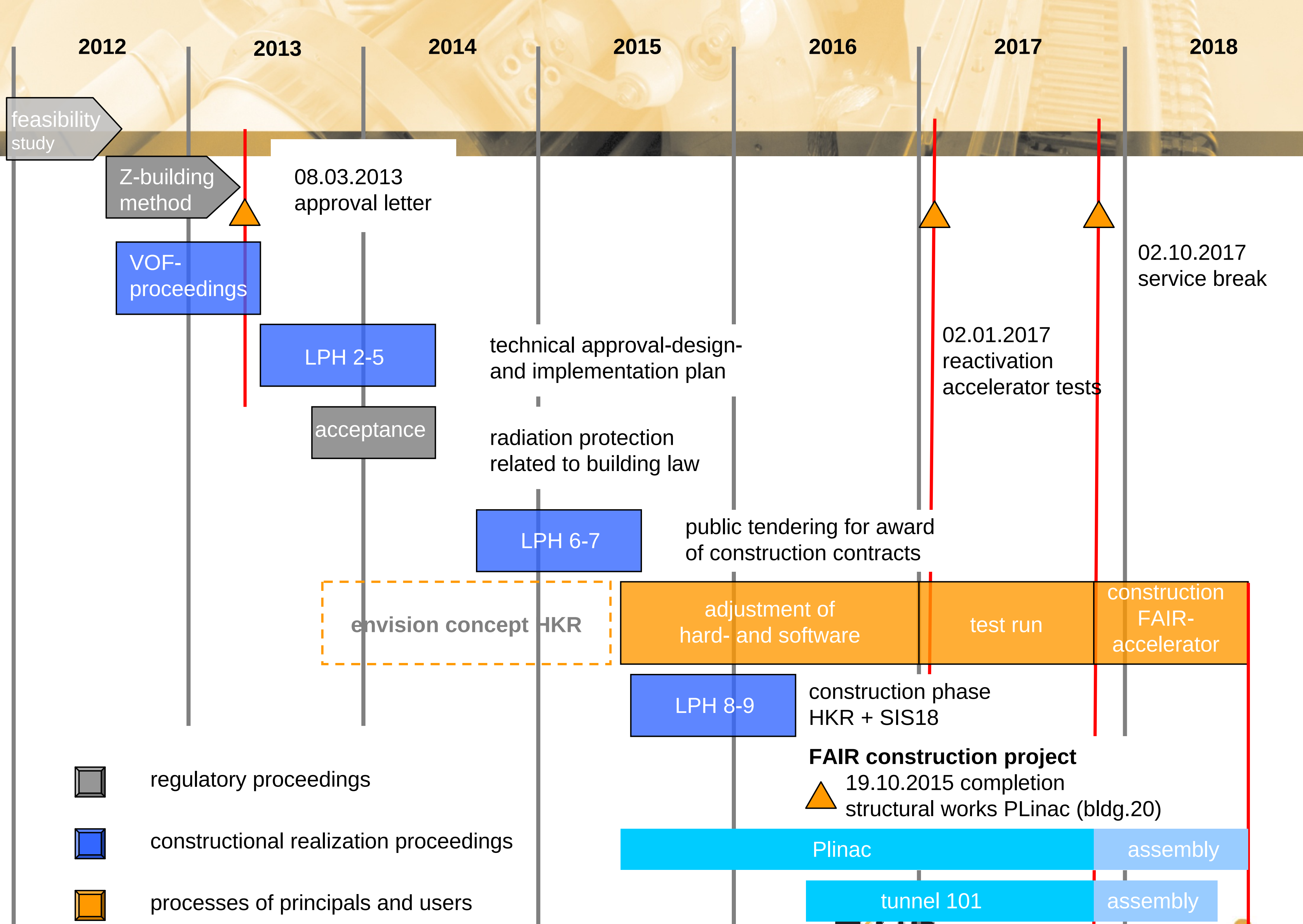
Intensity Record for Intermediate Charge State Heavy Ions





Ionization Beam Loss, Gas Desorption, Dynamic Vacuum

Intensity Record in SIS18 for Heavy Ion Beams


2012
2013
2014
2015
2016
2017
2018
feasibility study
Z-building method
08.03.2013 approval letter
VOF-proceedings
LPH 2-5
technical approval-design- and implementation plan
acceptance
radiation protection related to building law
02.01.2017 reactivation accelerator tests
02.10.2017 service break
LPH 6-7
public tendering for award of construction contracts
envision concept HKR
adjustment of hard- and software
test run
construction FAIR-accelerator
LPH 8-9
construction phase HKR + SIS18
FAIR construction project
19.10.2015 completion structural works PLinac (bldg.20)
Plinac
assembly
tunnel 101
assembly
regulatory proceedings
constructional realization proceedings
processes of principals and users

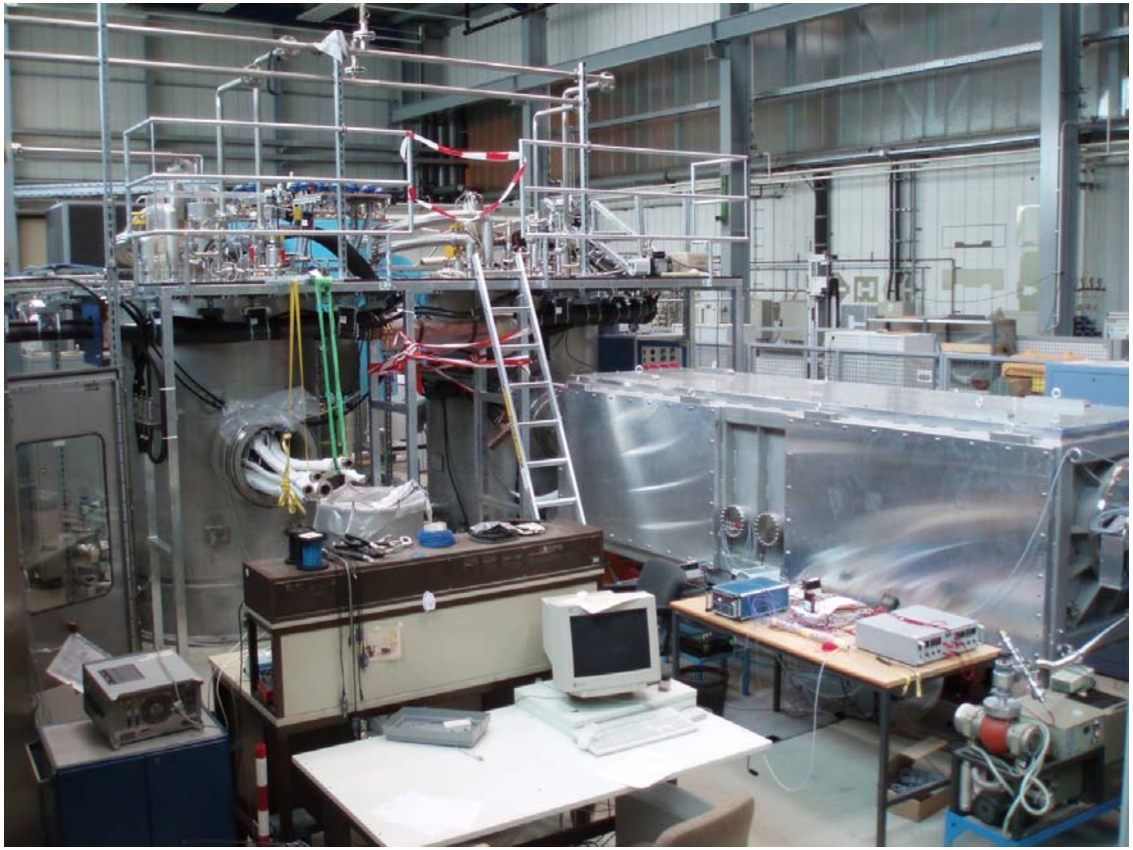
S.C. Magnet Testing

- SIS100 dipole units will be tested at GSI
- SIS100 quadrupole units expected to be tested at JINR
- Super-FRS magnets expected to be tested at CERN

Since the testing is strongly linked to the magnet production – all missing decisions must be taken soon.

For the SIS100 dipole testing and the SIS100 string test, an existing large building plus annex buildings are prepared at GSI.

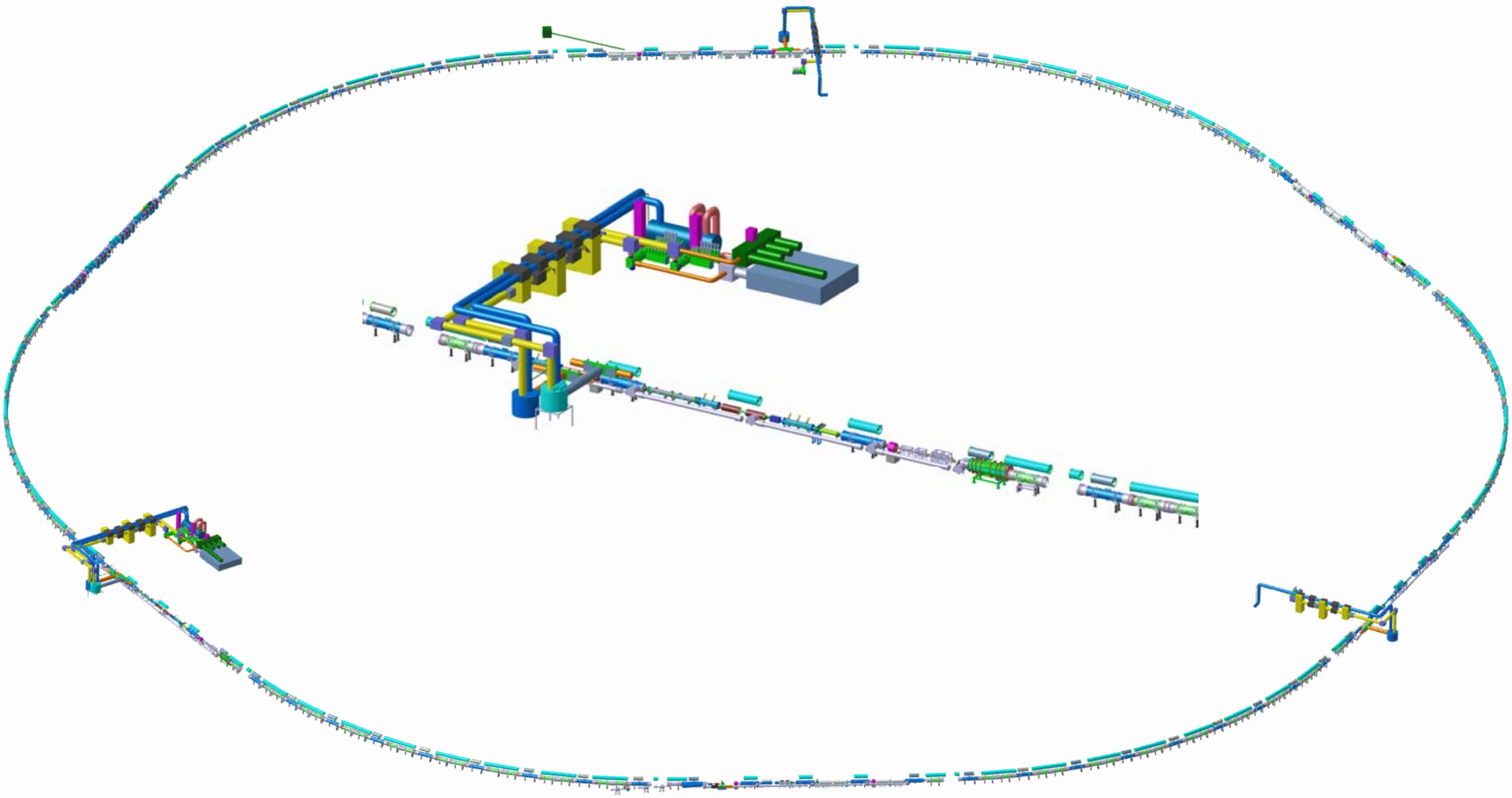
Upgrade GSI Magnet Teststand



20 kA upgrade of the test facility at GSI in preparation

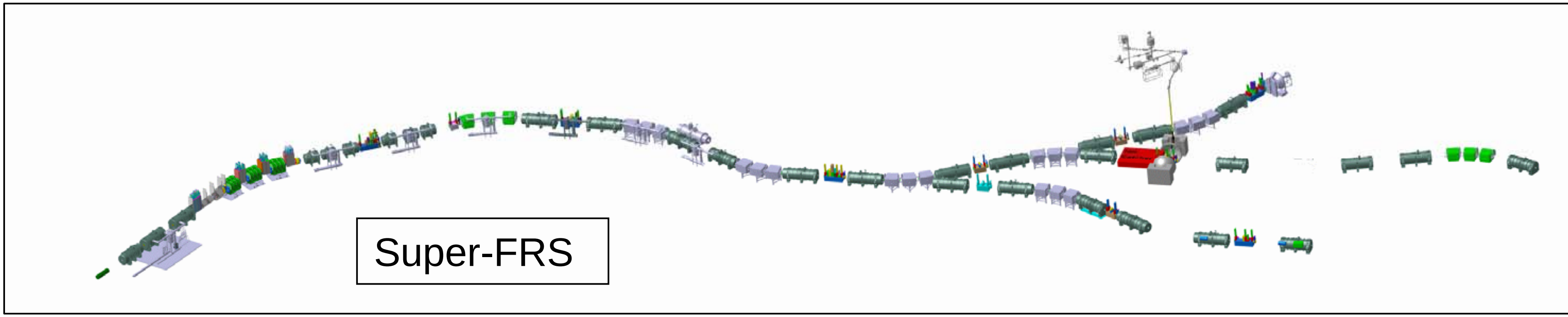
- Power converter upgrade contracted
- New HTS current leads contracted

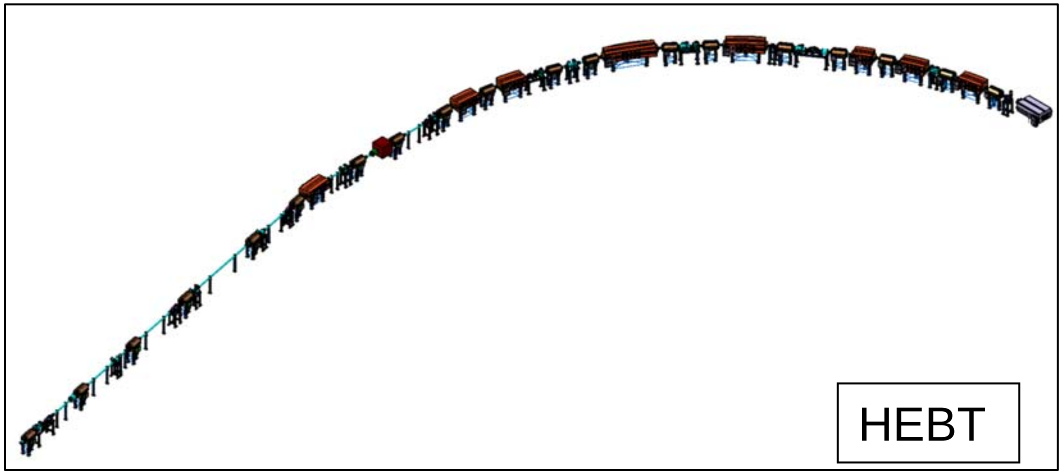
System Design - DMU/Integration

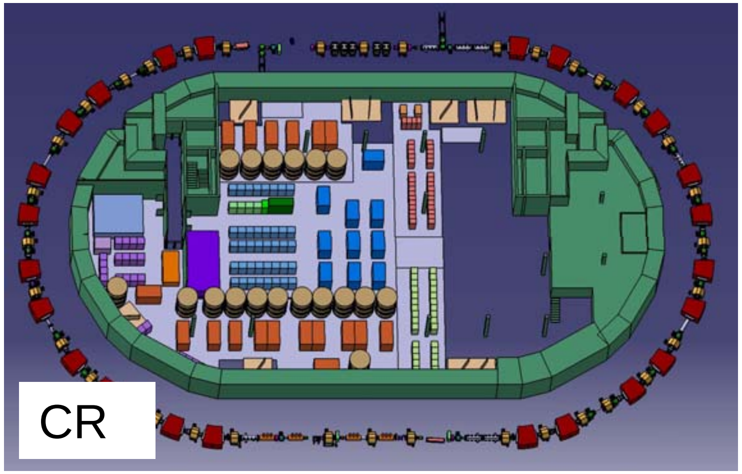


SIS100

System Design - DMU/Integration Status







Interaction with Civil Engineering

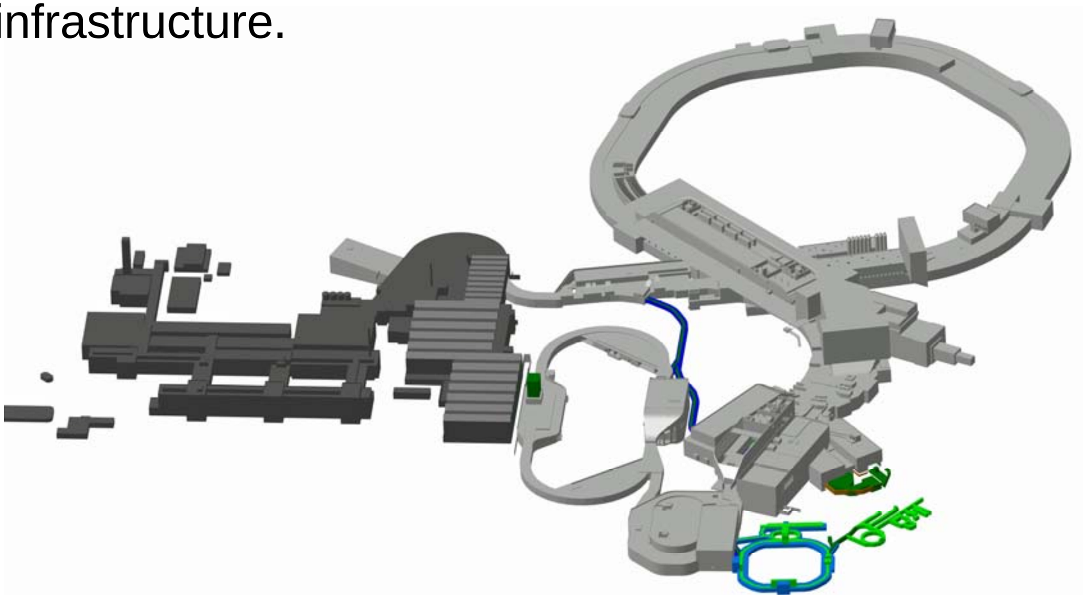
- Collision check with “concrete” has been completed → 4 cases have to be investigated in detail
- Room specific data (temperature tolerance, humidity..)
- Revisions of cable data for cable routing and cable trays
- Component data (in the supply areas)
- Full integration of infrastructure and final collision checks

- Support for establishing the radiation safety documents from the MPLs

Collision Checks

Integration of 3D CATIA envelope models and DMU machine models into civil construction design.

Collision checks with „concrete“ and accelerator infrastructure.



Civil construction design

Envelope model of FAIR

Civil Construction

Next civil construction steps for beginning of 2013:

- Contracting of construction of pillars
- Contracting of construction roads

Summary

- FAIR 0-3 machine system design fixed (with minor exceptions).
- Machine DMU/integration well developed and progressing.
- First major accelerator procurements via tendering and inkind contracts started.
- Completion of detailed specifications of all accelerator components in work.
- Final input and definitions for civil construction planning.
- Several inkind proposals for machine components presented in the IKRB.
- Management structured incl. quality assurance and control is being established.

> Construction of FAIR has started