Status of the FAIR Accelerator Project

Peter Spiller

RUPAC 2012
26.9.2012
FAIR – Beam Parameters

- Primary Beam Intensity: x100–1000
- Secondary Beam Intensity: 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: 5x10^{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
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

FAIR@GSI Organisationseinheiten - 01.07.2012

Project Coordination
- Project Planning
- Configuration Management
- Project Controlling
- Interfaces
- System Configuration

Common Systems
- Cryogenics
- Control System
- Electronics (BES)
- Vacuum
- Detectors
- Magnet Laboratory

Primary Beams
- Primary Beams
- Antiprotons
- Storage Rings

Antiprotons and Storage Rings
- Detectors
- SPARC Detectors
- Panda Detectors
- GBM Detectors
- Photon Detectors
- Luminosity Measurement - BISWAT

Separators
- Ring ESR
- Ring 2
- Ring 3

Linear Accel. and Operation
- LIA Detectors
- LIA Targets
- LIA Electromagnets

Schnittstellen zur FAIR GmbH

Schnittstellen zur Forschung und zur FAIR GmbH

Abteilungs- oder Gruppenleitung identifiziert

GSI Helmholtzzentrum für Schwerionenforschung GmbH
### WBS of the Accelerator Subproject

**09.10.2011**

<table>
<thead>
<tr>
<th>System design</th>
<th>HEBT</th>
<th>Super-FRS</th>
<th>CR</th>
<th>p-Linac</th>
<th>SIS100</th>
<th>pbar-Separator</th>
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<th>Common Systems</th>
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<tbody>
<tr>
<td></td>
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**Beam Dynamics**

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**Power Converters**

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**RF-Systems**

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<th>CR RF-Systems</th>
<th>p-Linac RF-Systems</th>
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<tr>
<td>U.Leiher</td>
<td>G.Schreiber</td>
<td>H.Klingbein</td>
<td>R. Stassen</td>
<td>U.Pachern</td>
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**Injection/Extraction**

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<th>CR Inj/Extr</th>
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**Vacuum**

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<th>HEBT Vacuum</th>
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**Particle Sources**

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<th>CR b-ion source</th>
<th>p-Linac ion source</th>
<th>SIS100 ion source</th>
<th>pbar-Separator ion source</th>
<th>HESR ion source</th>
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</thead>
<tbody>
<tr>
<td>2.78</td>
<td>R. Hollinger</td>
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**Stochastic Cooling**

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<tbody>
<tr>
<td>2.5.10</td>
<td>F. Nolten</td>
<td>2.8.11</td>
<td>H. Kollmus</td>
<td>2.11.10</td>
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**Special Installations**

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<th>HEBT Special Installations</th>
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<tbody>
<tr>
<td>2.4.12</td>
<td>Y. Xiang</td>
<td>2.8.12</td>
<td>M. Kaushke</td>
</tr>
</tbody>
</table>

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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 commissioning with beam.

Synchronisation between subprojects accel. and civil constr.

Milestone: Completeness within the single subprojects (machines), completeness 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 continuous follow-up of all subproject
# Frame Schedule

<table>
<thead>
<tr>
<th>SIS100</th>
<th>All major contracts closed for building and infrastructure</th>
<th>All contracts closed for major component</th>
<th>All major component series Production started</th>
<th>Building and infrastructur e ready for assembly (***</th>
<th>All components ready for installation (incl. testing)</th>
<th>Assembly and alignment finished</th>
<th>Building and infrastructure ready for commissioning</th>
<th>Commissioning without beam finished</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dipole Moduls</td>
<td>-</td>
<td>Q1/2012</td>
<td>Q4/2013</td>
<td>-</td>
<td>Q1/2017</td>
<td>Q3/2017</td>
<td>Q1/2017</td>
<td>-</td>
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<tr>
<td>Quadrupole modules</td>
<td>-</td>
<td>Q2/2013</td>
<td>Q4/2014</td>
<td>-</td>
<td>Q2/2017</td>
<td>Q4/2017</td>
<td>Q1/2017</td>
<td>-</td>
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<tr>
<td>Rf system</td>
<td>-</td>
<td>Q1/2013</td>
<td>Q4/2014</td>
<td>-</td>
<td>Q2/2017</td>
<td>Q4/2017</td>
<td>Q4/2017</td>
<td>-</td>
</tr>
<tr>
<td>Magnet testing dipole moduls</td>
<td>Q2/2013</td>
<td>Q1/2013</td>
<td>Q4/2014</td>
<td>Q2/2014</td>
<td>Q1/2017</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Magnet testing quad moduls</td>
<td>-</td>
<td>Q1/2013</td>
<td>Q4/2014</td>
<td>Q1/2012</td>
<td>Q2/2017 (5)</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</table>
### Building Readiness

<table>
<thead>
<tr>
<th>Facility</th>
<th>BOE</th>
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</thead>
<tbody>
<tr>
<td>HEBT Connection SIS18 - SIS100 (T1S1, T1S2, T1S3, T1S4)</td>
<td>29.04.2016</td>
</tr>
<tr>
<td>HEBT-SIS100 (T8DU)</td>
<td>29.04.2016</td>
</tr>
<tr>
<td>SIS100</td>
<td>29.04.2016</td>
</tr>
<tr>
<td>HEBT - T1X1, T1C1, T1D1-T1C2, TNC1 - T1X2, TXL1, TXL2, TXL3, TXL4, TPP1, TPP2</td>
<td>01.05.2017</td>
</tr>
<tr>
<td>Multifunction Cave (CBM HADES)</td>
<td>01.05.2017</td>
</tr>
<tr>
<td>HEBT - T1F1, T1F2, TFF1, TSX1, TSF1, FRF, TFC1</td>
<td>28.10.2016</td>
</tr>
<tr>
<td>HEBT - TAP1, TAP2, TCR1, THS1</td>
<td>23.01.2017</td>
</tr>
<tr>
<td>p-Bar TARGET</td>
<td>28.10.2016</td>
</tr>
<tr>
<td>p-LINAC</td>
<td>01.05.2017</td>
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<td>23.01.2017</td>
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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

Year: 2012 to 2018

- 2.8.X Design/Coordination
- 2.8.X Beam Dynamics
- 2.8.2 Magnets (s.c.)
- 2.8.2 Magnets (n.c.)
- 2.8.3 Power Converters
- 2.8.4 RF Systems
- 2.8.5 Injection/Extraction
- 2.8.6 Beam Diagnostics
- 2.8.7 Vacuum
- 2.8.11 Special Installations
- 2.8.12 Cryogenics (Local)
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

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

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

h=2 acceleration cavity for faster ramping

Scrappers and NEG coating for pressure stabilization

The SIS18 upgrade program: Booster operation with intermediate charge state heavy ions
Intensity Record for Intermediate Charge State Heavy Ions

Intensity Record in SIS18 for Heavy Ion Beams
Z-building method
VOF-proceedings
LPH 2-5
acceptance
LPH 6-7
LPH 8-9
envision concept HKR

regulatory proceedings
constructional realization proceedings
processes of principals and users

feasibility study
08.03.2013 approval letter
technical approval-design-implementation plan
radiation protection related to building law
public tendering for award of construction contracts
adjustment of hard- and software
test run
construction FAIR-accelerator
construction phase HKR + SIS18
FAIR construction project
19.10.2015 completion structural works Plinac (bldg.20)

Plinac assembly
tunnel 101 assembly
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 Status

Super-FRS

HEBT

CR
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

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