The Control System for the FAIR Facility – Project Status and Design Overview

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FAIR

HELMHOLTZ GEMEINSCHAFT

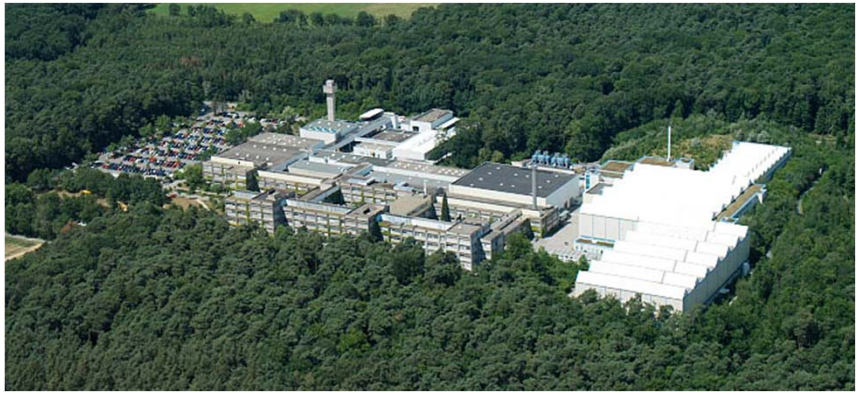
GSI

Outline

- The FAIR facility
- FAIR Project status & Organization
- Major Challenges to the CS
- Architecture and Technology Decisions taken
- Summary

GSI and FAIR

National research center for Heavy Ion beams research in Darmstadt, Germany.

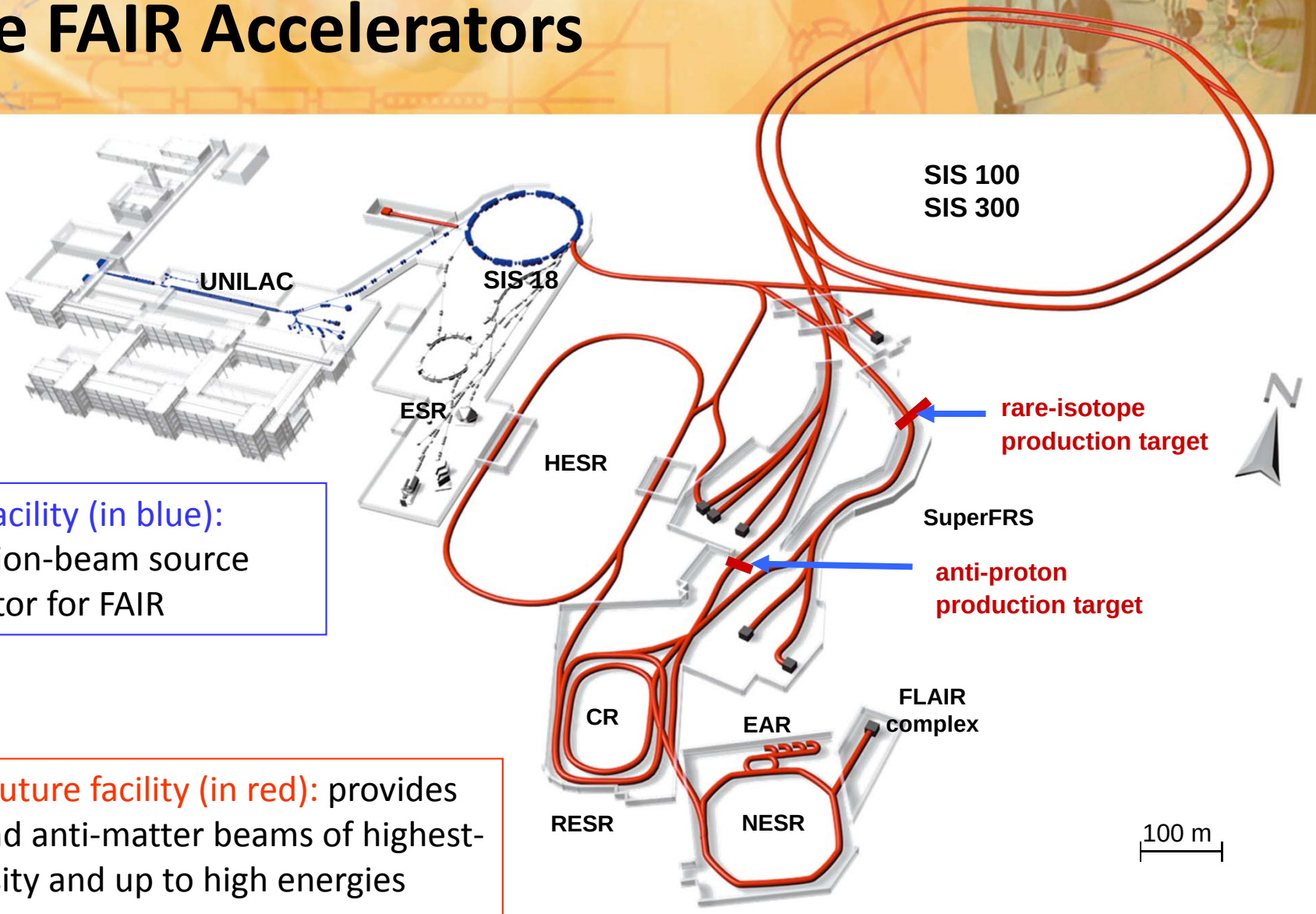


GSI operates a large, in many aspects worldwide unique accelerator facility for heavy ion beams.

2001: Proposal for major extension to GSI accelerator facilities

FAIR = **F**acility for **A**nti-proton and **I**on **R**esearch

The FAIR Accelerators



Existing facility (in blue):
provides ion-beam source and injector for FAIR

New future facility (in red): provides ion and anti-matter beams of highest-intensity and up to high energies

Improvements and Special Features

Improvements

- primary beam intensities: factor 100 – 1000
- secondary beam intensities for radioactive beams: up to factor 10.000
- ion beam energy: factor 15

Special features

- intense cooled beams of radioactive beams
- cooled anti-proton beams up to 15 GeV
- in-beam targets for experiments with high luminosity

New technologies

- rapidly cycling superconducting magnets (SIS100: 4 T/s)
- electron cooling with high ion intensities and beam energies
- fast stochastic cooling systems in storage rings

The International FAIR Project

- Project costs ~1.000 M€ (2005 value)
- FAIR: International facility
- Project owner: FAIR company
  (2 company model)
- Shareholders: Germany 75%, others 25%

- Contributions to FAIR: in-kind or in-cash
  In-kind work-package takers are fully responsible for implementation, delivery and commissioning

- Accelerator Control System:
  - in-kind contribution of GSI as FAIR host-institute
  - in-kind contribution of Slovenia to the Control System

FAIR Milestones and Schedule

- **Nov 2007** (ICALEPCS 2007, Knoxville): positive commitment by German government, FAIR Kick-off event
- **Oct 2009**: Re-evaluation due to massive cost overrun, Scientific Council approves modularization of the project
- **Oct 2010**: FAIR company founded, 9 countries sign intern'l agreement on the construction of FAIR
- **Sep 2011**: Application for CC permit submitted
- **This week**: IKRB recommends to assign CS in-kind contract to GSI and Slovenia

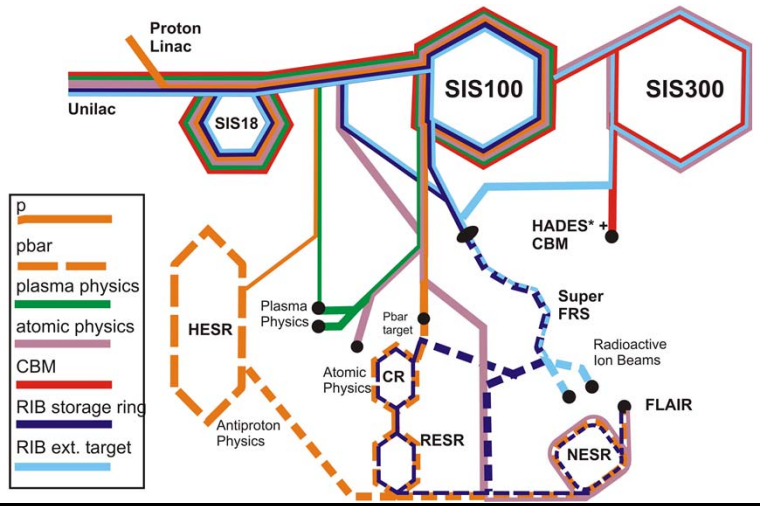
- **This winter**: begin of tree felling works
- **04.2016**: first buildings expected ready for installations

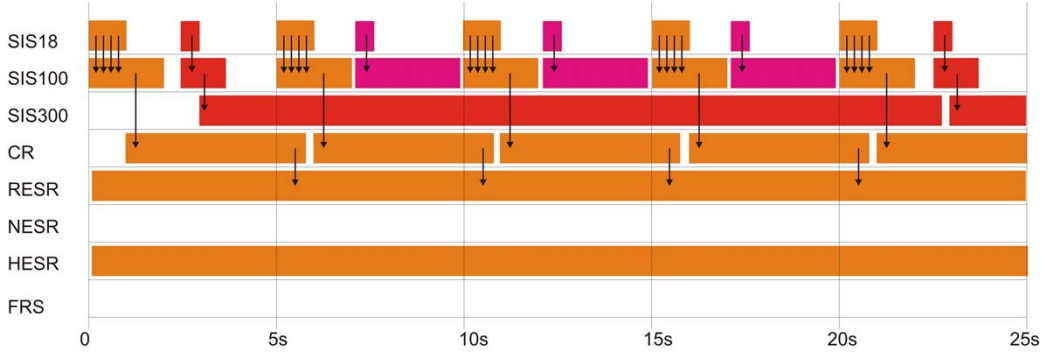
Major Controls Challenges

Parallel Operation

- important consideration of FAIR is a high degree of parallel operation of different research programs
- provide maximum integrated beam time or luminosity
- up to 5 different research programs may be served in parallel

Sophisticated coordination and synchronization of accelerator production chains needed (timing, sequencing)





Operation Mode #5: pbar in HESR, CBM in SIS300 and high energy Atomic Physics.

General Strategy for Controls

- Standardization: define and enforce standards
- Build new system substantially on proven principles & solutions of the existing system
- Modernize existing system to integrate into new system; obsolete technology needs to be replaced
- Develop and use uniform frameworks to simplify development and ease maintenance; provide frameworks to developers
- Implement and test everything on existing machine
- Evaluate existing CS solutions/frameworks; enter collaborations and adapt/extend to FAIR needs
- Concentrate development on missing things
- Have a team to ensure system coherency and integrity all along the development process
- Replace legacy components by FAIR solutions once available

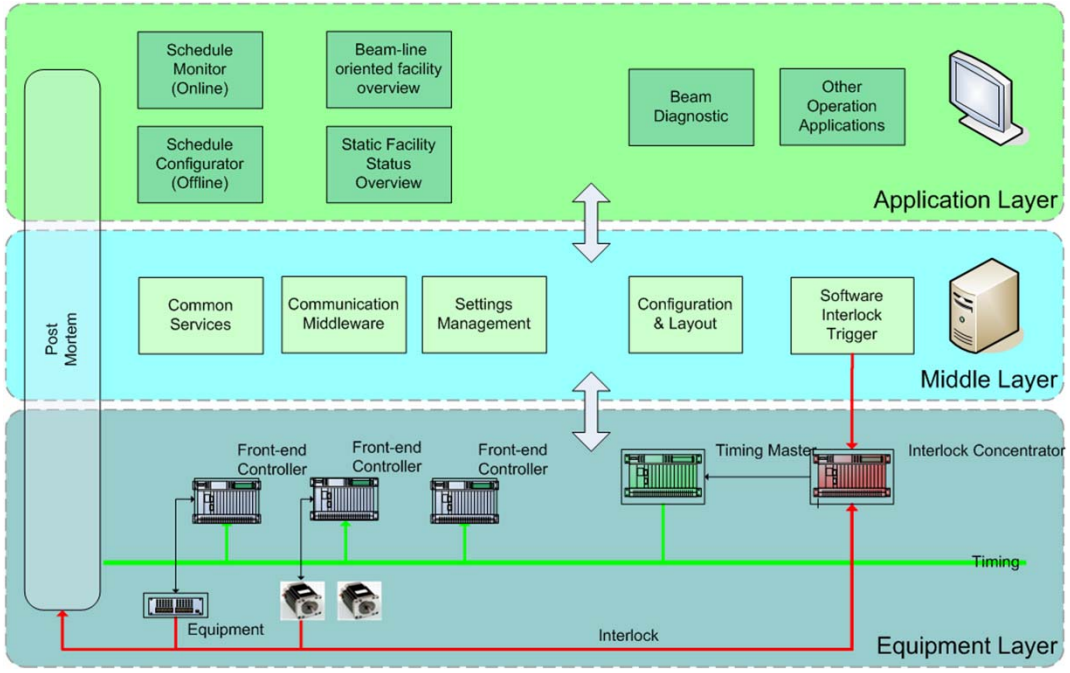
Architecture

- Standard model (or: every system is the same…)
- Decentralized, distributed, OO system, …
- modular design with well defined interfaces

Presentation Tier
Java; LSA

Middle Tier
powerful servers

Resource Tier
C++; FESA



Network

Middleware

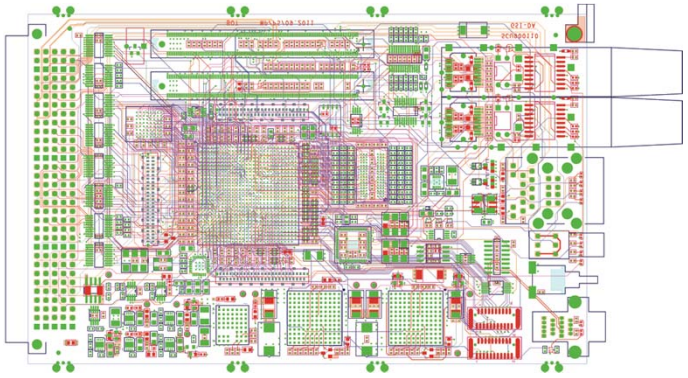
TimingSystem

Equipment Controller

WEPMN018
Stefan Rauch

Development of a custom and cost-effective solution for FE equipment control (**SCU**)

- Multipurpose project standard solution for all power converters, RF system, kickers, etc. (~1500 units for FAIR)
- integrated in equipment (e.g. power converter cabinet)
- form factor / bus system evolution for compatibility/upgrade
- Com Express module: CPU for Linux/FE software
- powerful FPGA (Arria II) for time-critical functions (e.g. WR timing receiver, FG)



Development by the Controls Group:

- development started 2009
- first complete prototype units for end of 2011

Front-End Software

MOPMN008
Tobias Hoffmann

FESA (Front-End System Architecture) framework
core component of the FAIR CS on the FE level

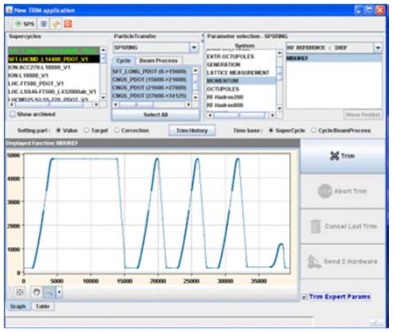
- well developed framework, broad equipment and driver support (CERN)
- FESA provides a standard and coherent software solution
- allows equipment specialists to develop and deploy FESA equipment classes (distributed development)
- easy design and deployment of FESA device classes with FESA shell and code generation tool chain

- technology: OO C++ on Linux OS, CORBA access
- integrates real-time and non-RT actions on one CPU, multiplexing support
- similar to present GSI system
- FESA v3.0 developed CERN/GSI (beta status), major redesign
- Active collaboration with CERN on the development of FESA v3.x

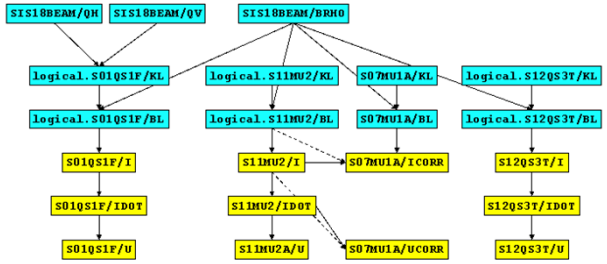
Settings Management

LSA is the core component at operation level

central part for accelerator settings management based on physics parameters



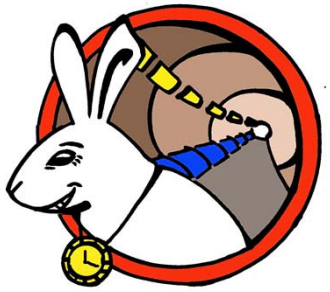
- well developed framework for CERN LHC
- Highly data-driven, DB is the master and contains all relevant information on optics, devices, cycles, …
- consistent settings generation and management on all levels
- all machines are operated on physics level in a consistent way (same model for all accelerators)
- parameters are organized in hierarchies (from physics to hardware)



- present SIS-18 machine modeled in LSA already operated during MD
- Collaboration on further development of LSA with CERN established

Timing System: White Rabbit (1)

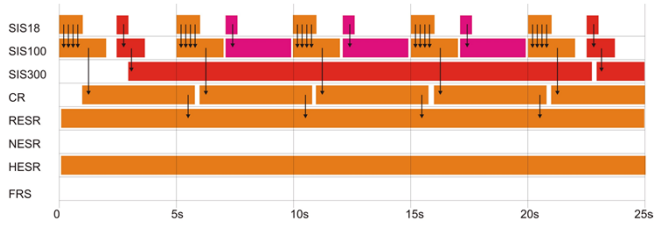
White Rabbit (WR) technology base for the GSI/FAIR Timing System
Collaboration with CERN on others already since 2008



White Rabbit is a time-deterministic low-latency Ethernet-based network which enables transparent, sub-ns accuracy timing distribution (PTP IEEE1588, Synchronous Ethernet)

FAIR requirements:

- Synchronization of ~2000 receivers over ~2 km with ~1 ns precision
- Robust communication (FEC)
- Use for Interlock System?



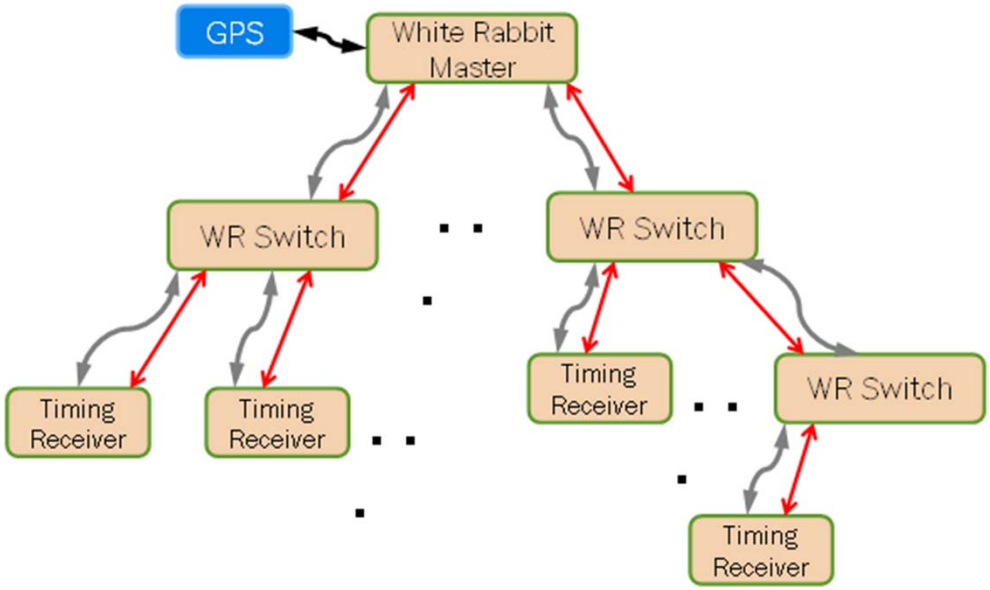
Operation Mode #5: pbar in HESR, CBM in SIS300 and high energy Atomic Physics.

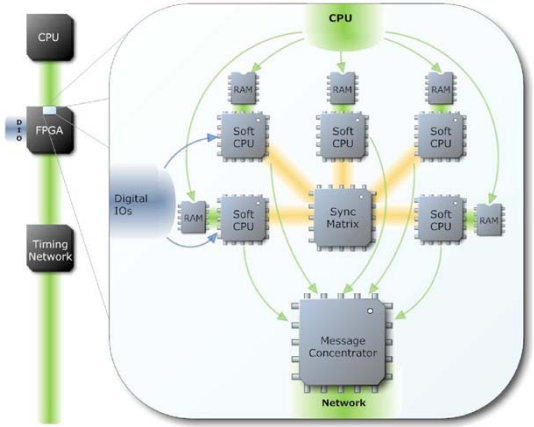
Timing System: White Rabbit (2)

Collaboration on Timing System with CERN Controls group

Timing System

- Timing Master (Timing Master, Data Master, Mngt Master) ontop
- Timing network (Timing switches), several layers
- Timing receiver nodes





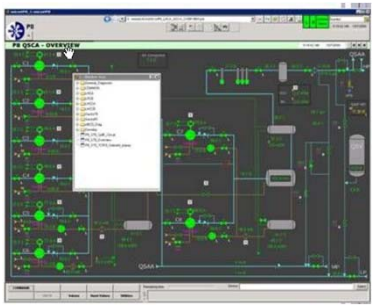
WEPMS011
Mathias Kreider

Industrial Controls

Some technical subsystems are not time-critical and highly industrial related: Cryogenics and Vacuum CS

Selected: CERN **UNICOS** (Unified Industrial Control System)

- framework with methods to design and develop complete industrial control applications
- Based on Siemens PLCs and commercialo SCADA system PVSS (now: WinCC OA)
- Tools to automate the instantiation of devices and generate logic code



- Slow control systems can work autonomously if needed
- Collaboration with CERN cryogenic team easy

Control System Upgrade Activities

Present GSI control system needs to be modernized for integration into new FAIR CS (injector chain)

- **Front-End Layer**
  - obsolete VME controllers replaced **done**
  - FE software & middleware modernized **done**

- **Control Room Application Software**
  - migration from OpenVMS/Alpha to Linux
  - middleware for interoperation with Java applications
  - set of libraries available, migration tested
  - migration until end of 2012 completed

MOPMS014
Ralf Huhmann

Summary

- The FAIR project at GSI has started
- Project is a challenge, on the technical as well as on the managerial and organizational side

- Modernization works on the present control system are advanced and will be completed by end of 2012
- Architecture and Design of the new CS is roughly defined
- Significant technology choices have already been taken
- Design and implementation is ongoing…

  … glad to tell you more at ICALEPCS 2013!

Thank you for your attention !

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