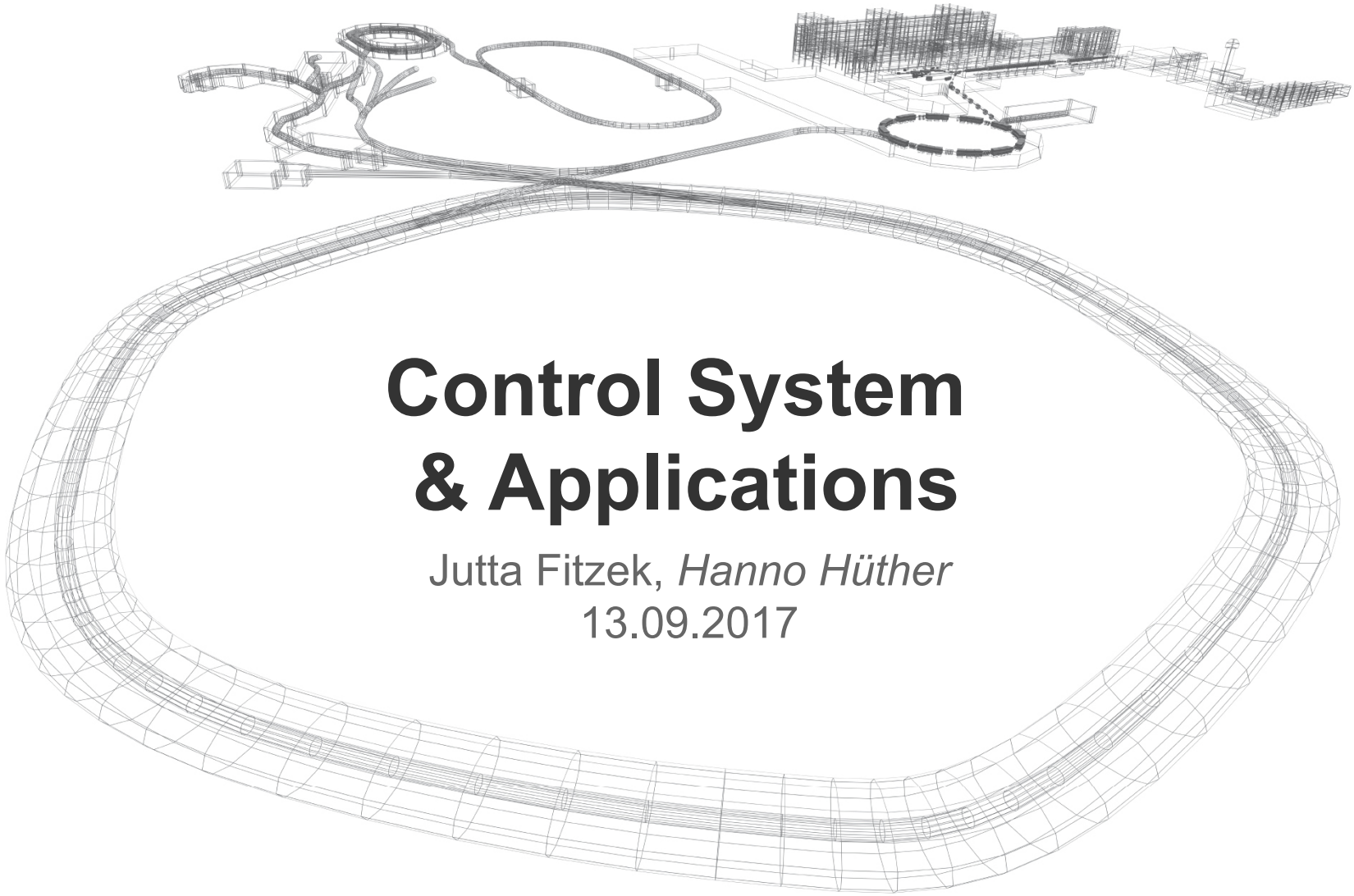

# Control System & Applications

Jutta Fitzek, *Hanno Hüther*

13.09.2017

# Agenda

- Control System Overview
- Patterns & Beam Production Chains
- Applications
- Outlook

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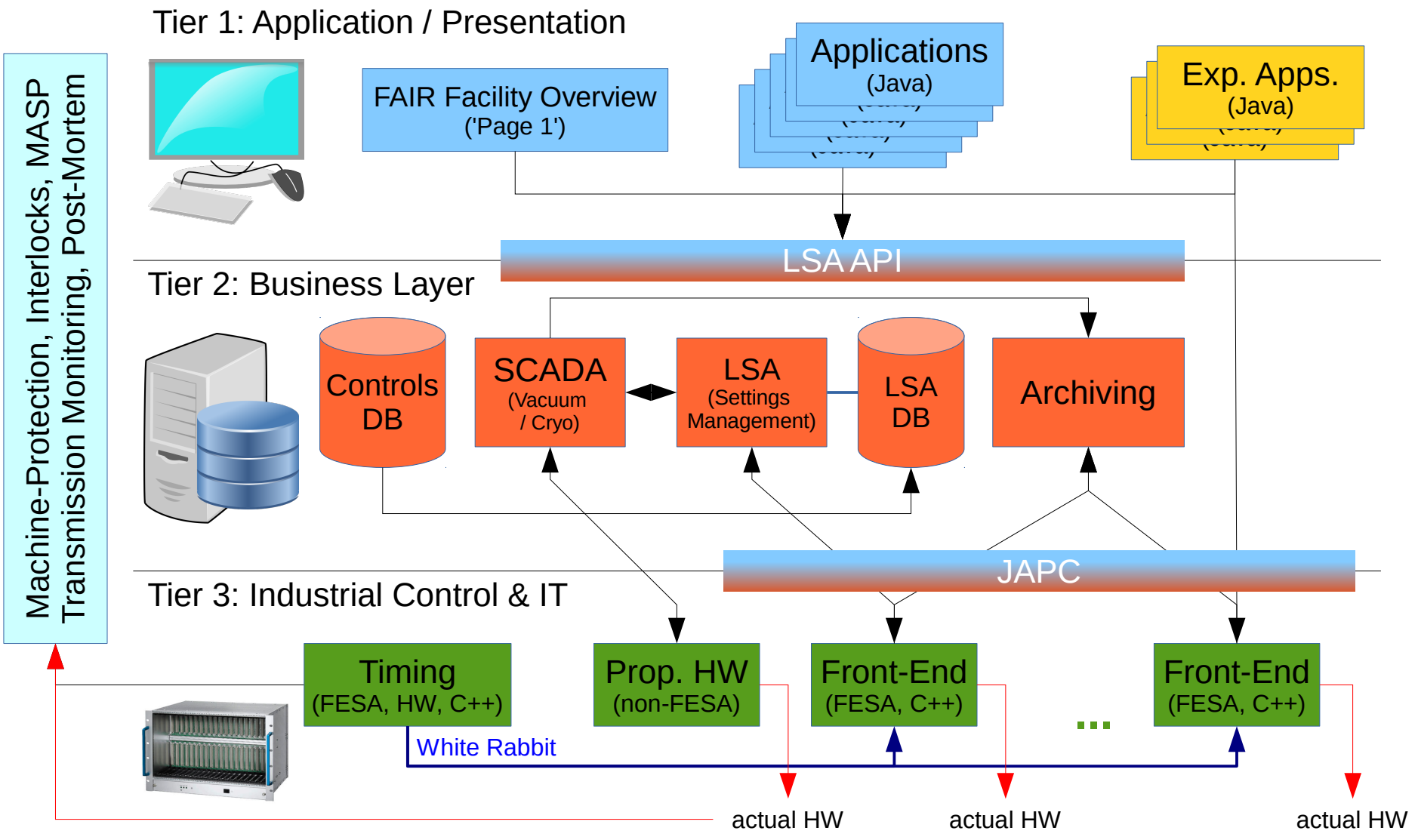
# Control System Overview



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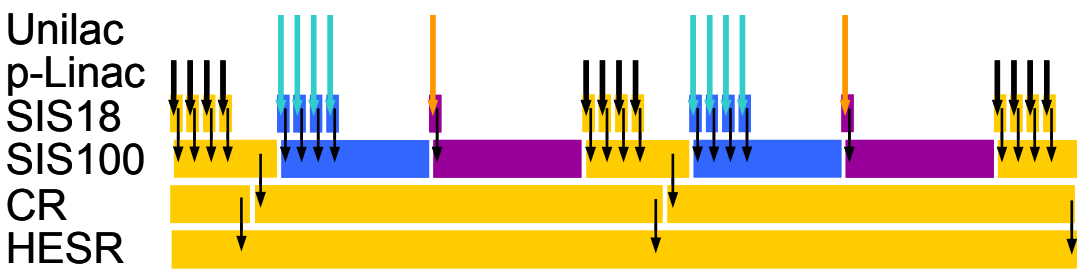
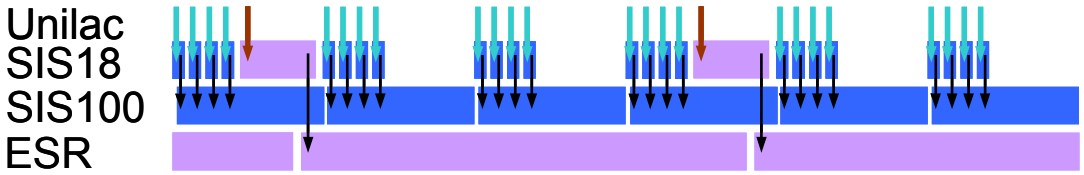
# FAIR Operation Scenarios

Examples for periodic Patterns, each dominated by one main experiment

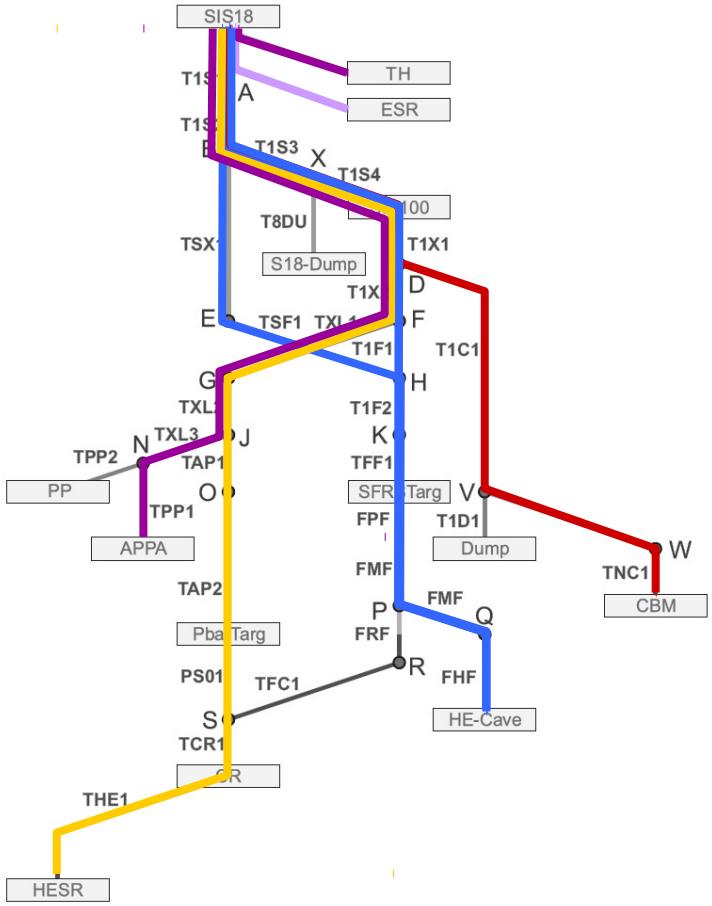



*pbar + RIB ext. target ($U^{28+}$) + AP (HE)*


*CBM + RIB ext. target ($U^{73+}$) + AP (LE)*

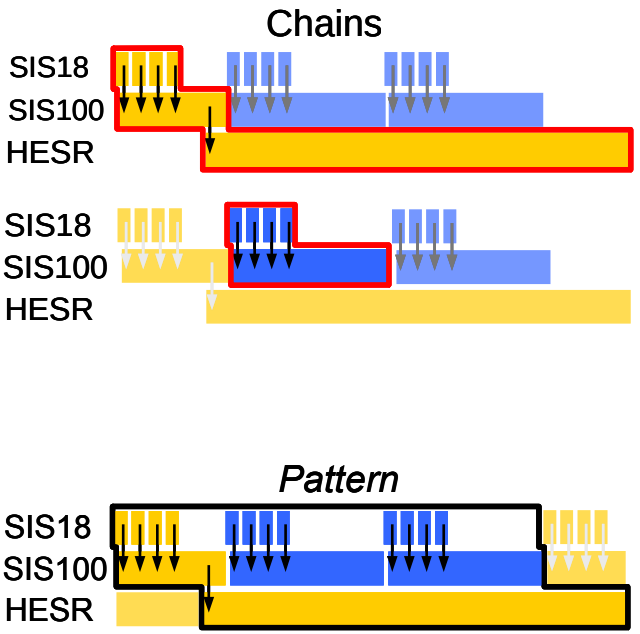



*RIB ext. target ($U^{28+}$) + ESR*



# Beam Production Chains & Patterns

- Beam Production Chain (BPC)
  - Organisational structure to manage parallel operation and beam transfer through FAIR accelerator facility
  - Defines sequence and parameters of beam line from the ion-source up to an experiment
- Pattern
  - Grouping of Beam Production Chains that are executed periodically
- For 2018
  - One BPC per Pattern
  - Multiple Patterns in Round Robin
  - Similar to working with Virtual Accelerators



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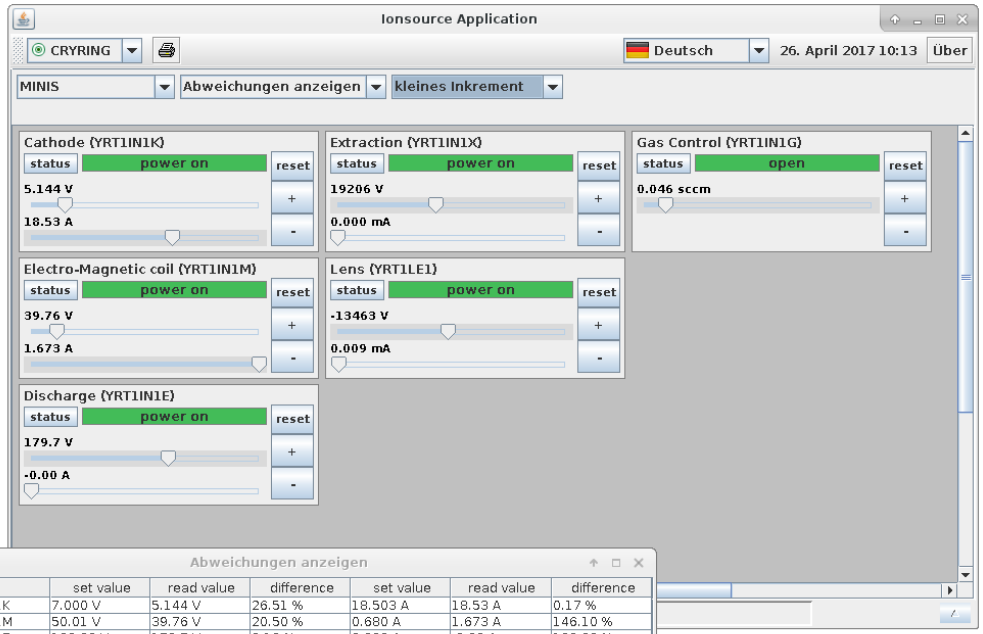
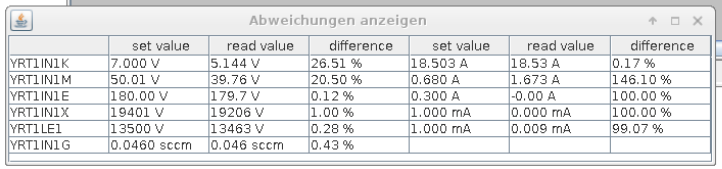
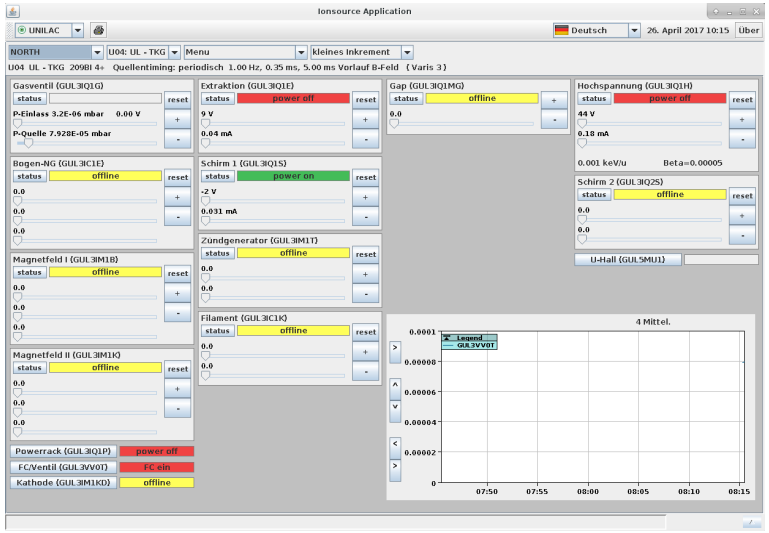
# Ionsource Application

- Generic Ion Source Program for FAIR,
  used at Cryring (operational)
  and Unilac North/South (as prototype)



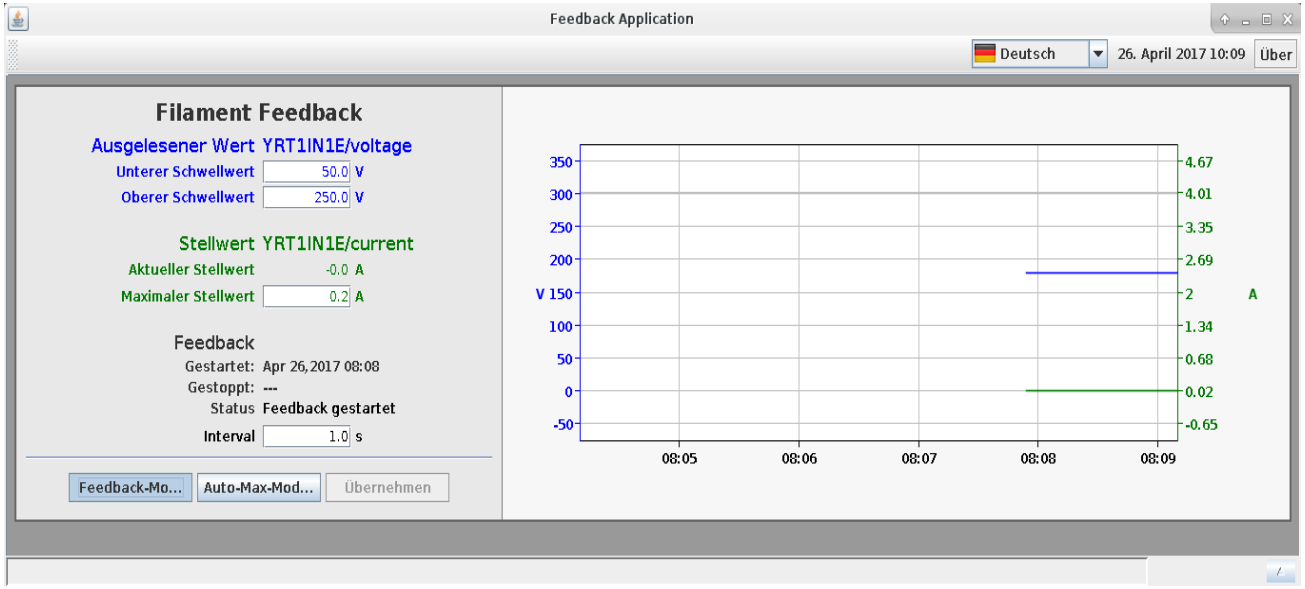




| | set value | read value | difference | set value | read value | difference |
|---|---|---|---|---|---|---|
| YRT1IN1K | 7.000 V | 5.144 V | 26.51 % | 18.503 A | 18.53 A | 0.17 % |
| YRT1IN1M | 50.01 V | 39.76 V | 20.50 % | 0.680 A | 1.673 A | 146.10 % |
| YRT1IN1E | 180.00 V | 179.7 V | 0.12 % | 0.300 A | -0.00 A | 100.00 % |
| YRT1IN1X | 19401 V | 19206 V | 1.00 % | 1.000 mA | 0.000 mA | 100.00 % |
| YRT1LE1 | 13500 V | 13463 V | 0.28 % | 1.000 mA | 0.009 mA | 99.07 % |
| YRT1IN1G | 0.0460 sccm | 0.046 sccm | 0.43 % | | | |



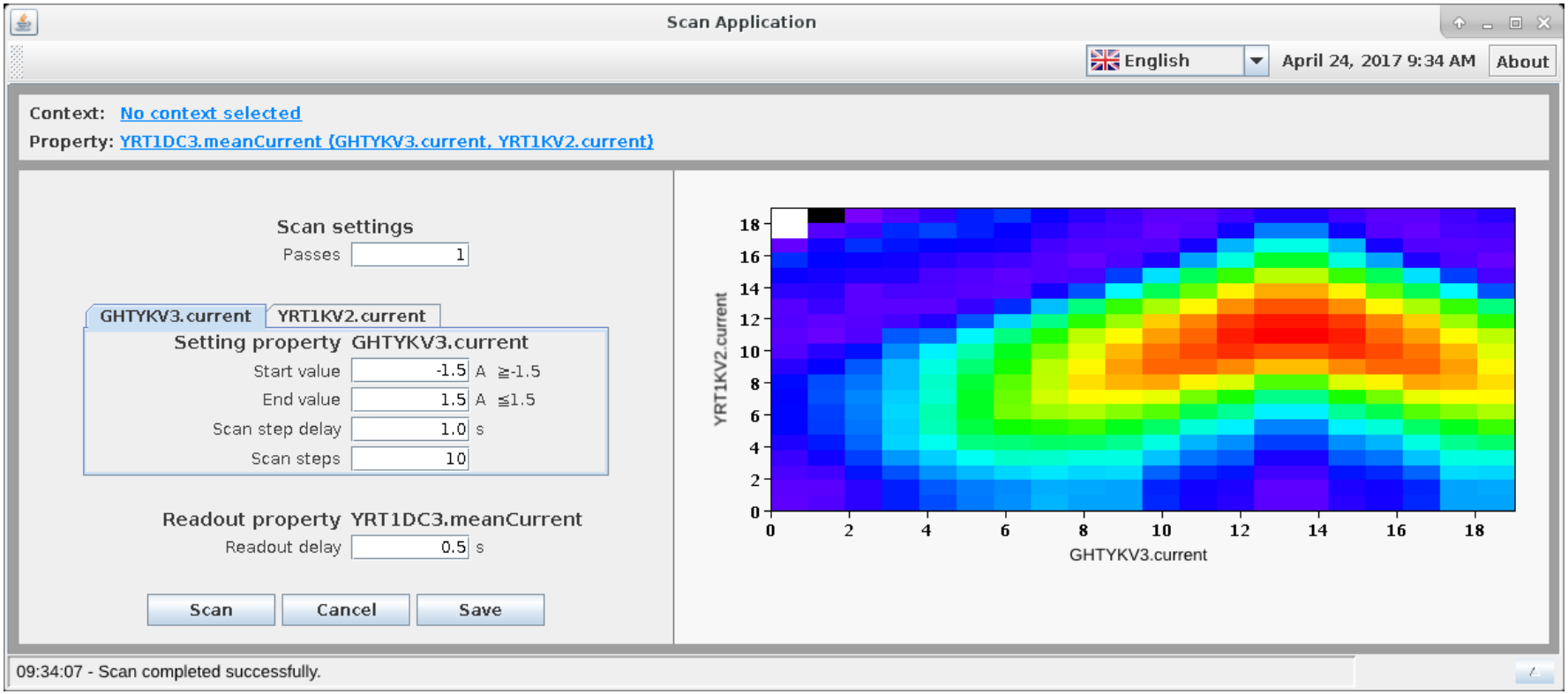
# Feedback Application

- Remake of an existing Cryring Ion Source Feedback Program from Sweden
- Collect ideas for a more generic feedback program for other ion sources



# Scan Application

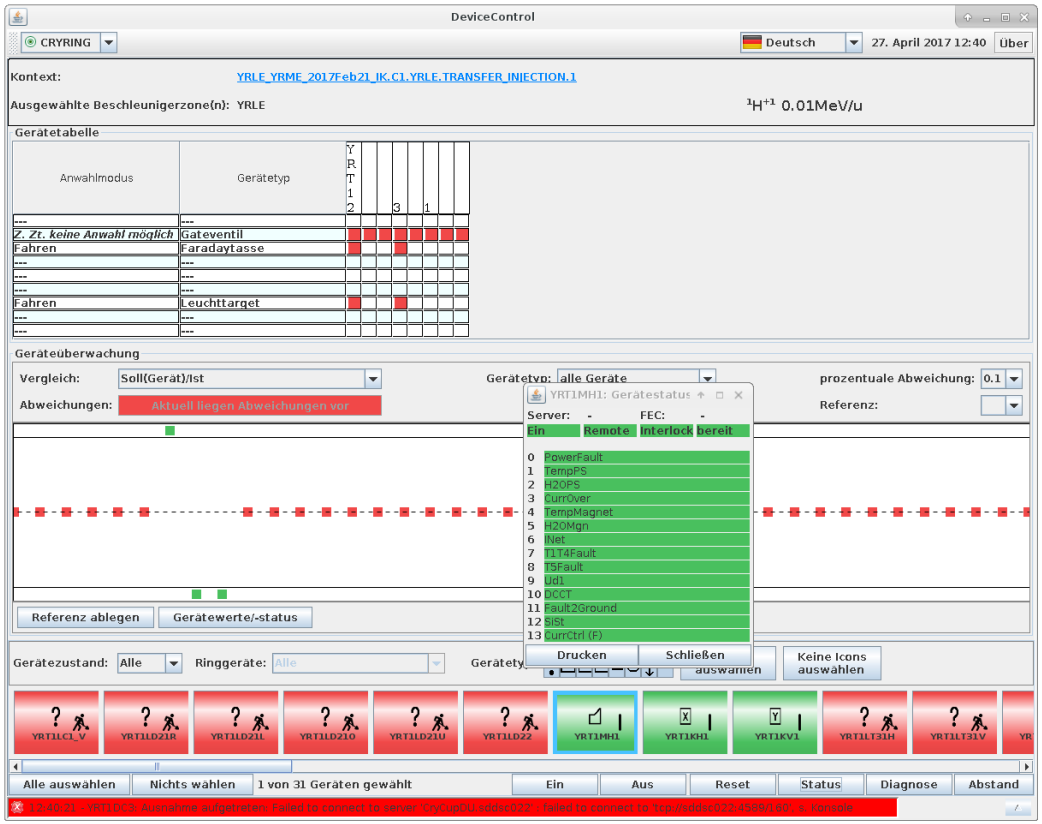
- Prototype of a generic scan application
- 1-/2D parameter scan



# Device Control

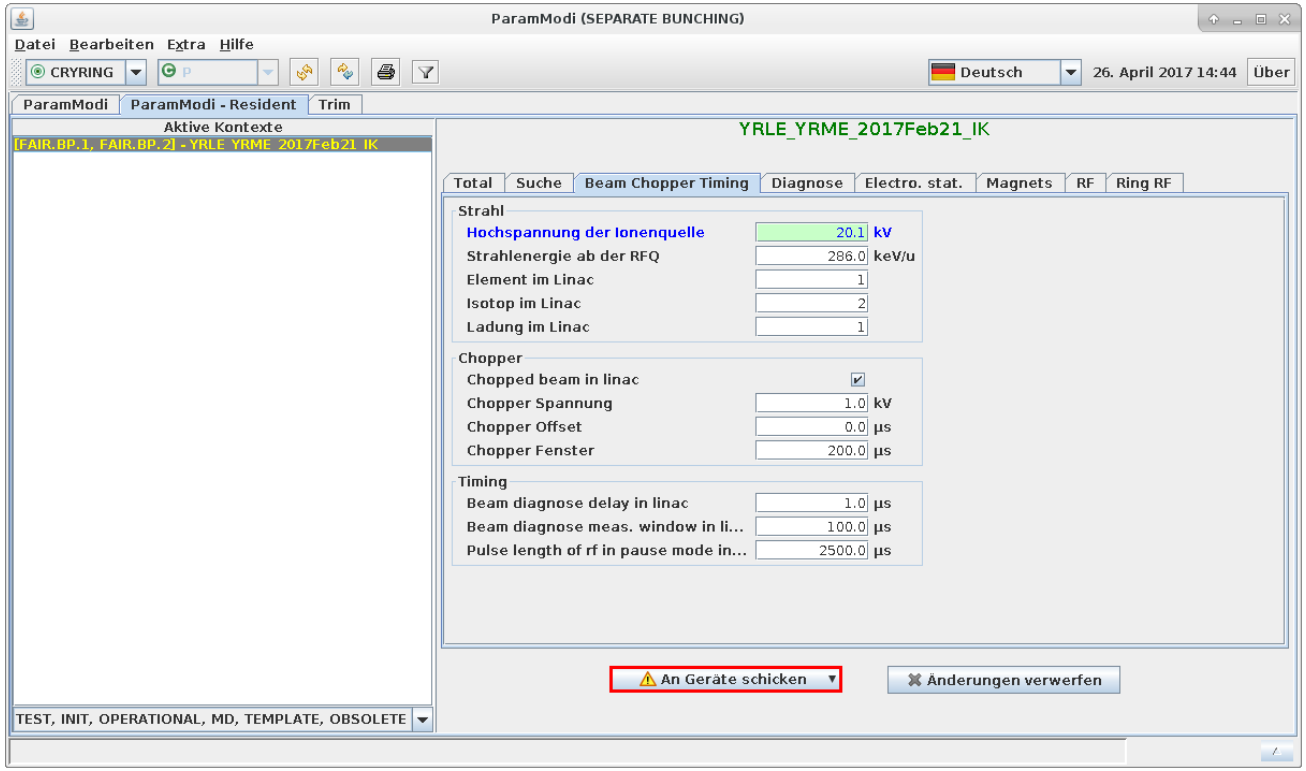
- Control on device level
  - Reading status
  - Comparing set and actual values
  - Switching on / off
  - Driving step motors

  ...



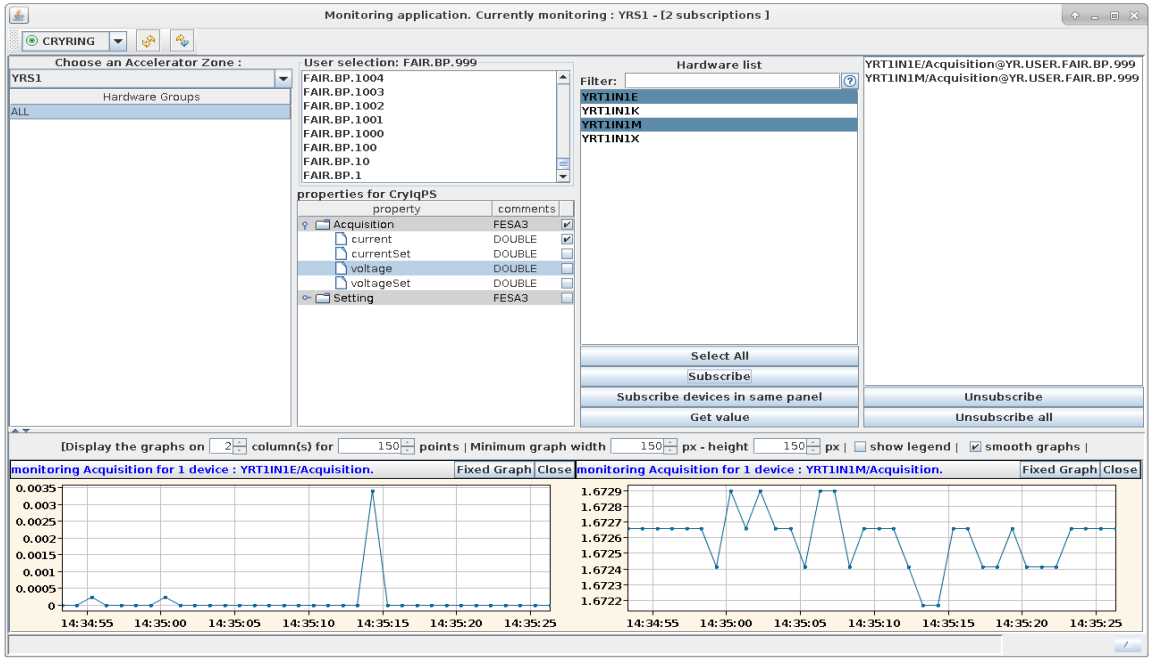
# ParamModi

- Central application for manipulating setting values
- View the settings on all levels of the hierarchy (plus expert trim)



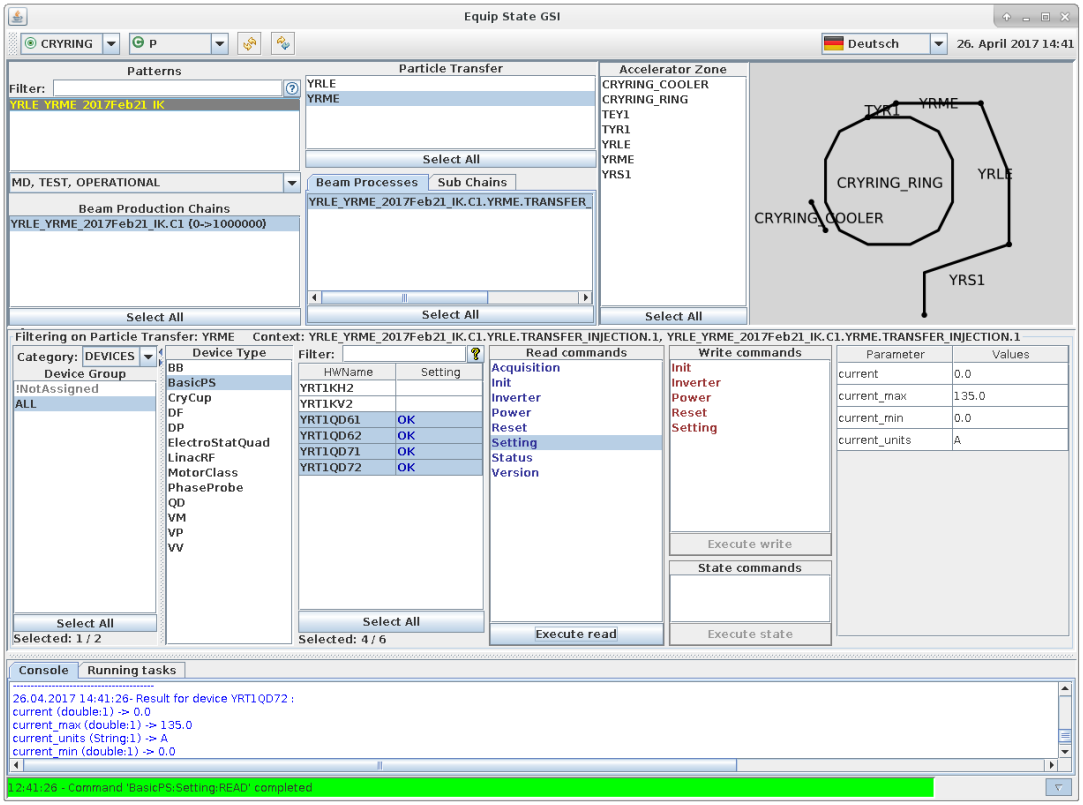
# EquipMonitor

- EquipMonitor: Subscribe to all properties of the devices
- Will be replaced in the future by the Archiving System GUI



# EquipState

- EquipState: Set/Read all properties of the devices (comparable to FESA Explorer, bit less „low-level“)



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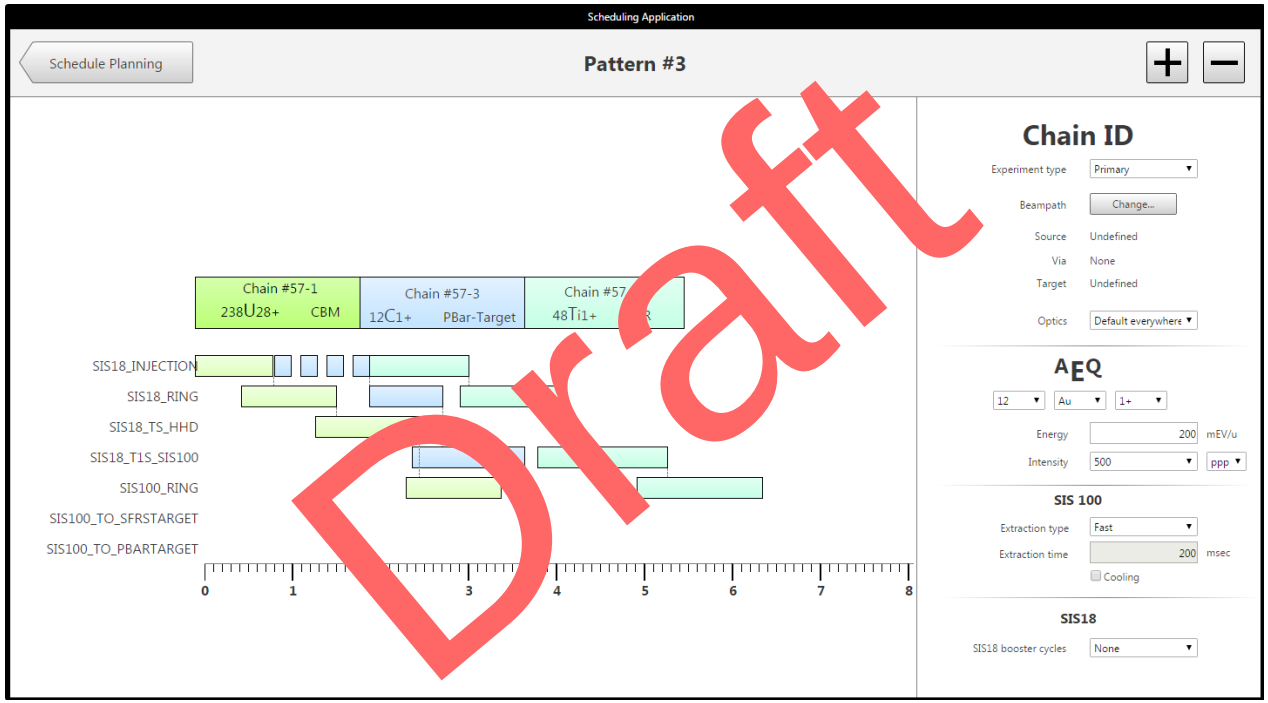
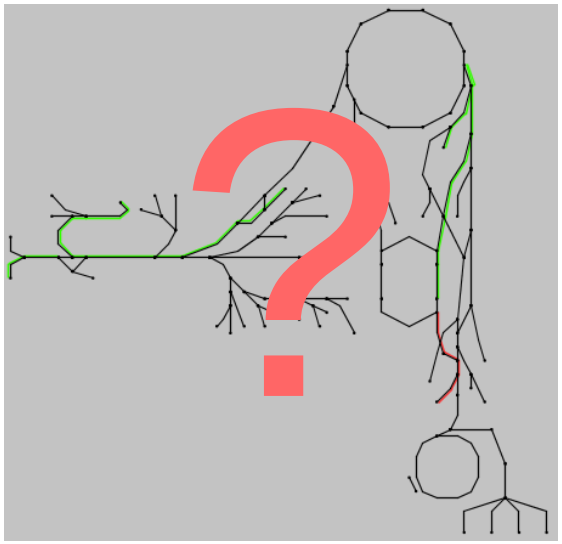
# Outlook: Scheduling Application

- Plan and execute patterns
- Comparable to “Init” application



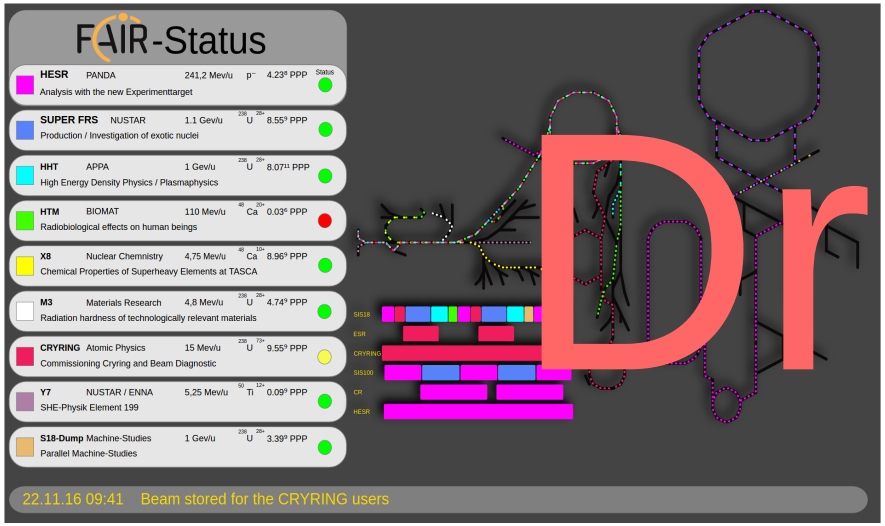
# Outlook: Status Overview

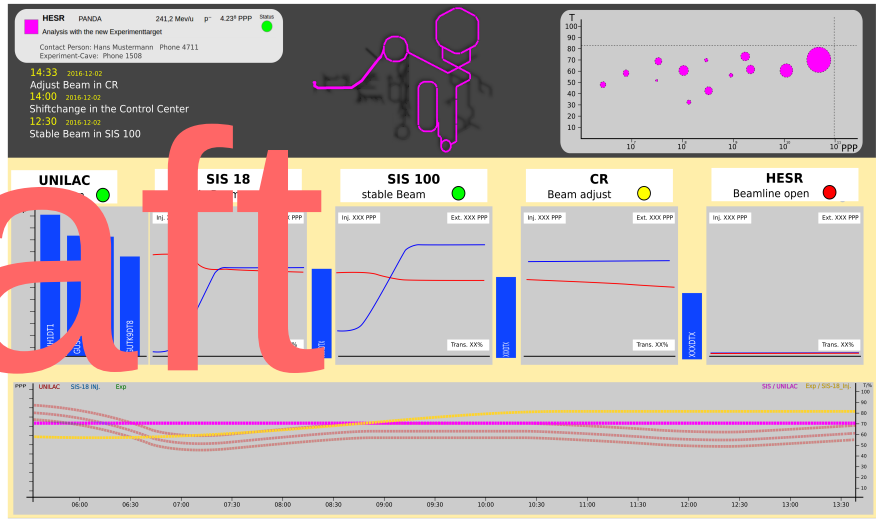
- Based on MASP (Master Accelerator Status Processor)
- Displays the status of the whole machine with clear indication of current problems
  - Current Status of all machines
  - Interlocks, Alarms, ...
  - Accelerator Modes
  - Clear indication of current problems



# Outlook: Facility Overview

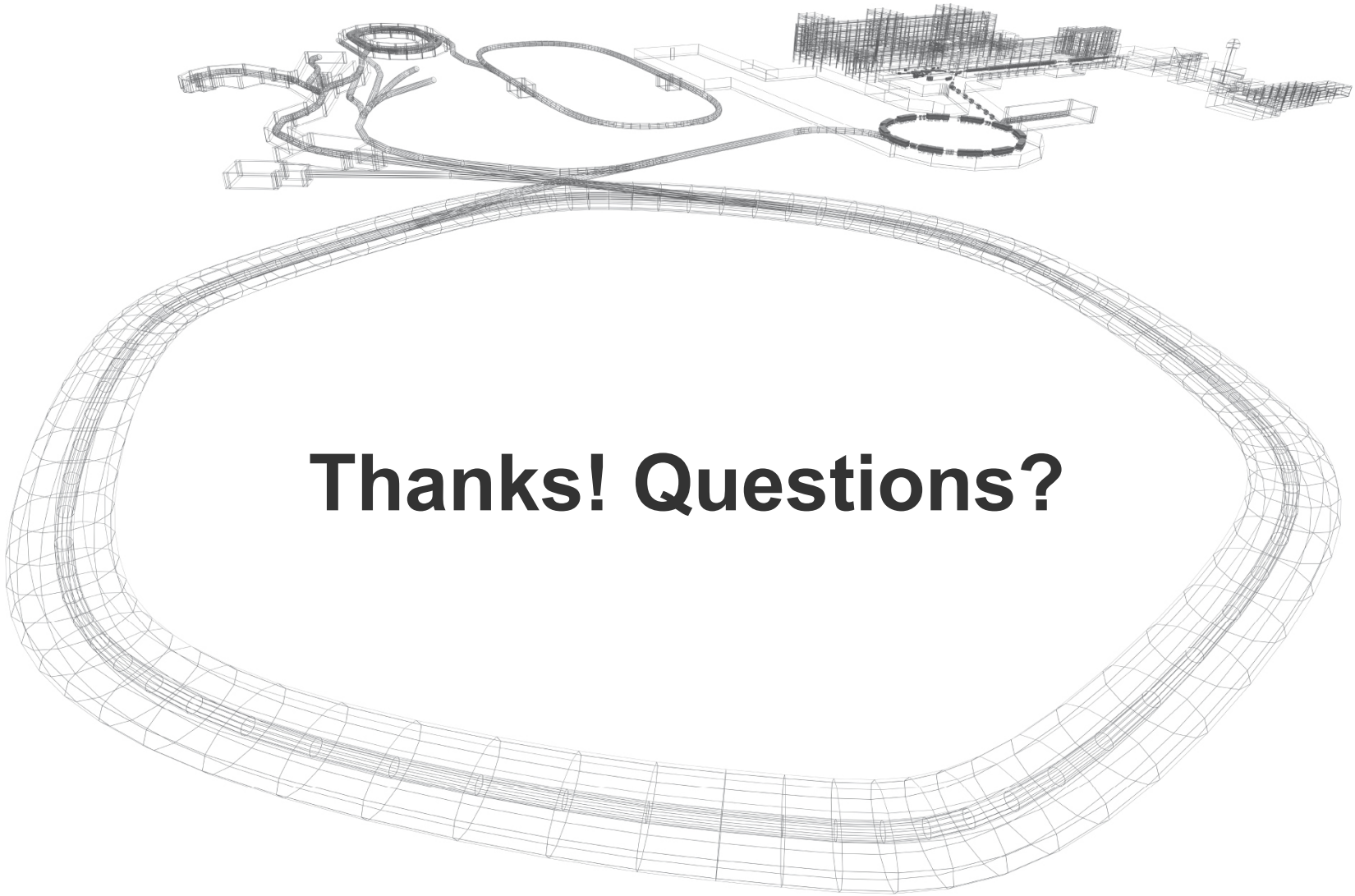
- HKR / FCC Overview Application
  - Which beams are running?
  - What is their status?
  - Transmission, history
  - => fixed / detailed version for the control room,
    short (possibly rotating) version for the canteen



# More upcoming Applications

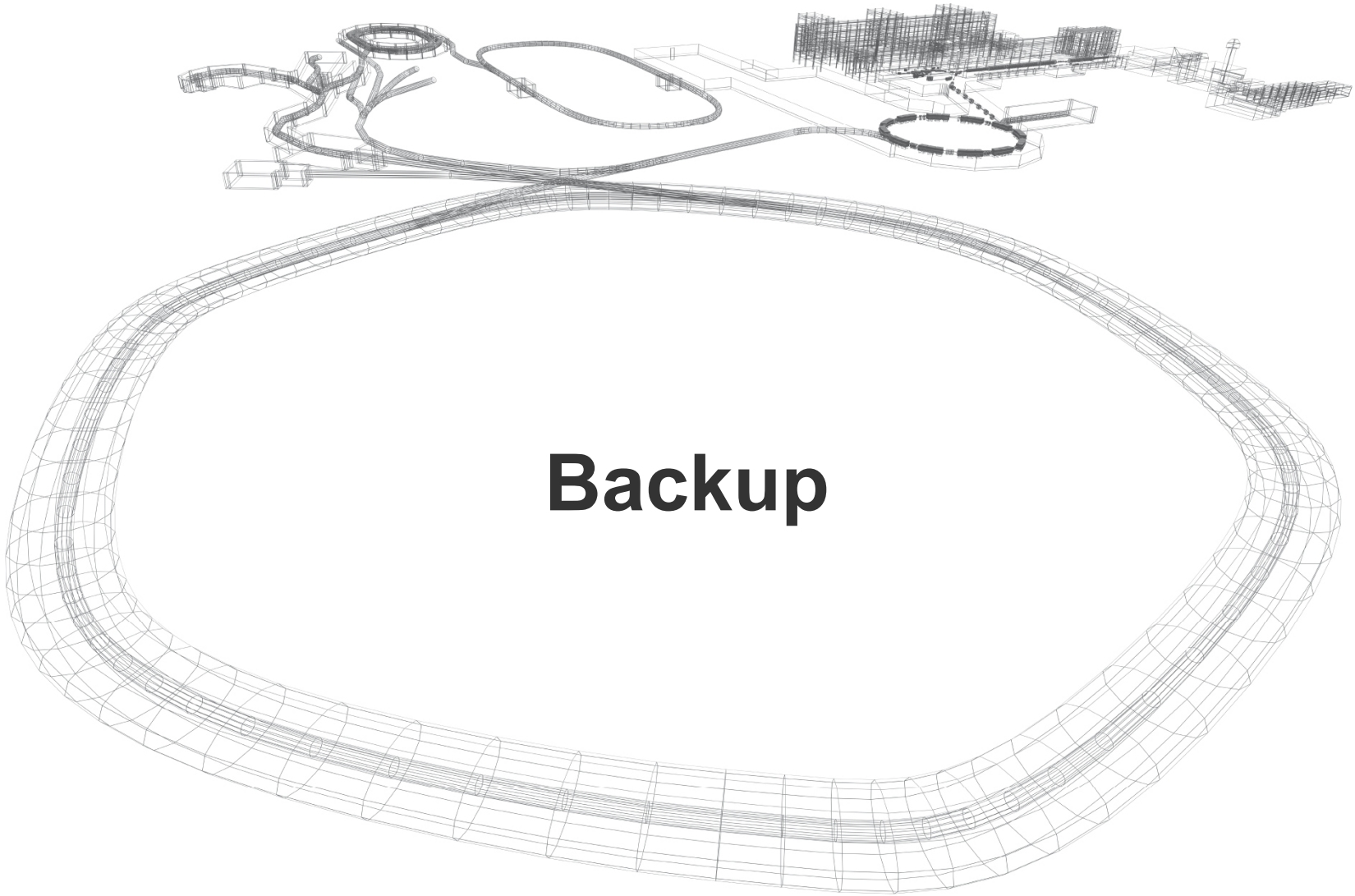
- Beam Transmission Monitoring Application (spec draft)
- Beam-based feedbacks together with machine physicists
  - LSA-based Orbit Feedback (proof-of-concept during beamtime 2016)
  - LSA-based Macro-Spill & Harmonics Control (proof-of-concept 2016)
- Requestor Application



# Thanks! Questions?

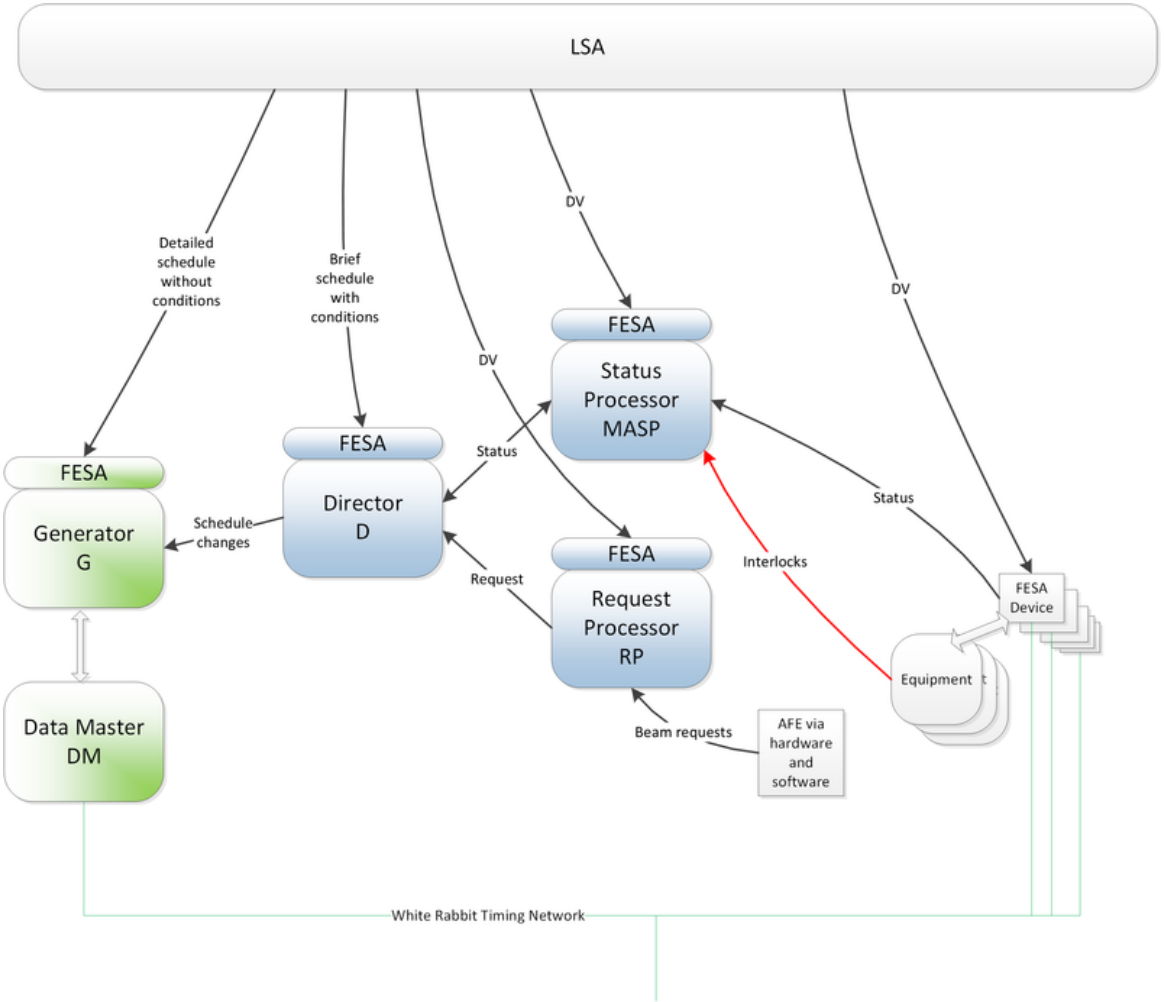
# Thanks!
# More questions later?

Drop by anytime! Also interesting:
Control System Glossary



# Backup

# Beam Scheduling System (BSS)



# Equipment Controller: SCU

**SCU** (Scalable Control Unit): Development of a custom and cost-effective solution for equipment control

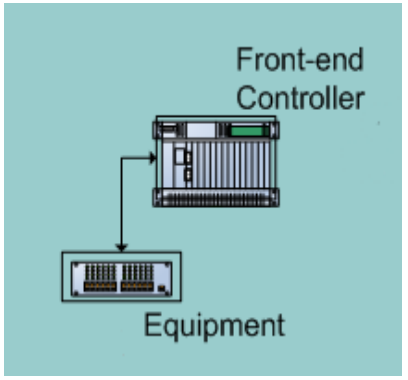
- base board with powerful FPGA for time-critical functions (e.g. timing receiver, function generators)
- COM Express module with Intel Atom CPU
- primary interface: SCU Bus (16-bit wide parallel bus)
- option: high-speed serial connectors (>500 MBit)
- 2 SFP slots on base board (timing), 1 GbE for communication

Used as central Front-end controller for FAIR:

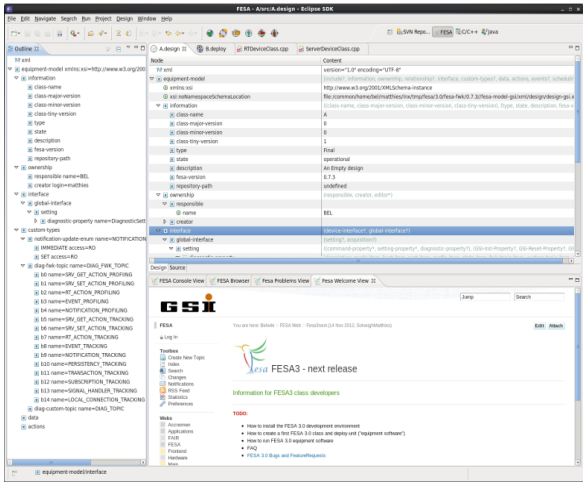
- about 1500 units for power converters, RF, etc
- integrated in equipment (e.g. power converter cabinet)
- form factor / bus system evolution for compatibility / upgrade

# Equipment Control Software: FESA

**FESA** (Front-end Software Architecture) will be the core component of the "FEC Software Framework" for the FAIR accelerator complex




- developed and maintained in collaboration by CERN and GSI
- allows to develop standardized and coherent equipment software for accelerator operation
- development tool is integrated into Eclipse IDE: code generation, building+linking, debugging, documentation, SVN integration, deployment
- XML-description of the device interface
- object-oriented C++-sources are generated
- target system is a Front-end operating with Linux (currently Scientific Linux), e.g. the SCU

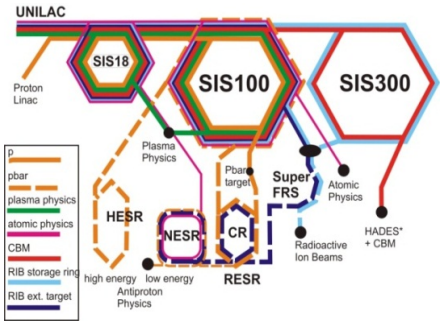


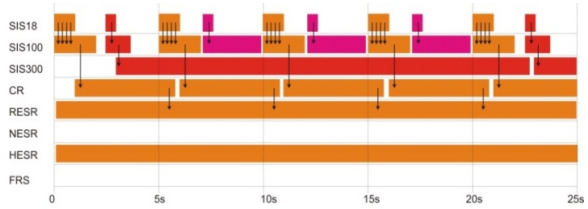
# Timing System

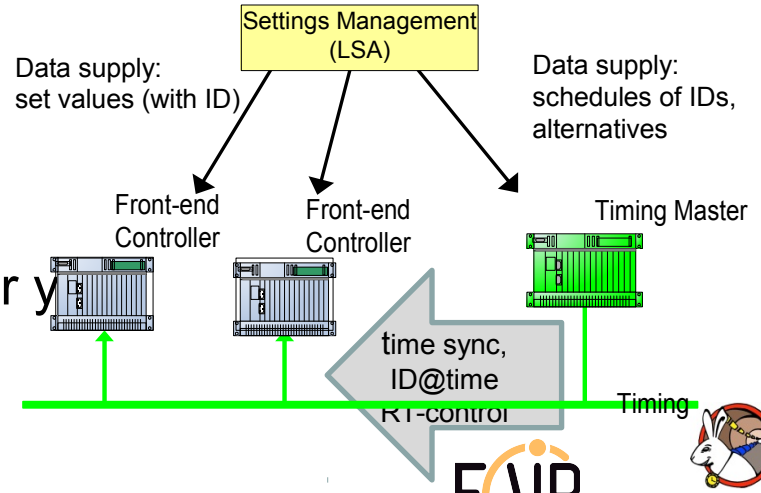
**GMT** (General Machine Timing System)

- parallel execution of beam production chains
- cycles: 20ms to hours
- trigger and synchronize equipment actions
- 1 µs precision in 99% of all cases
- few ns precision for kickers
- (few ps for rf-systems: BuTiS)

- many rings
- >2000 devices connected to timing system
- large distances
- robustness: loose at most one message per y

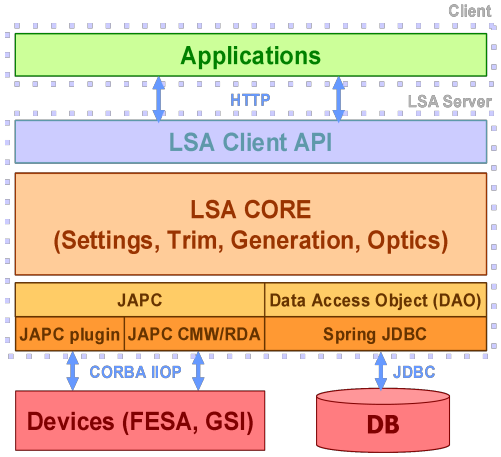


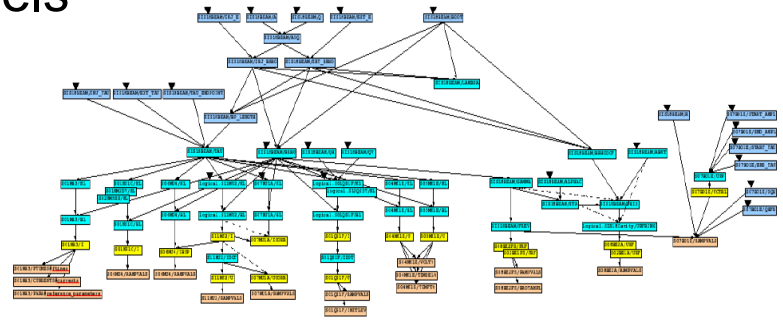
# Settings Management: LSA

**LSA** (LHC Software Architecture) will be the core component for the accelerator settings management



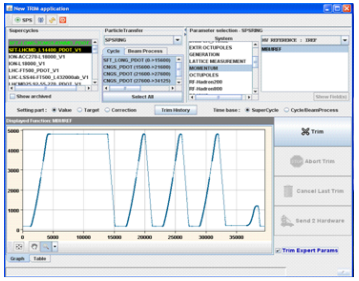

- well developed framework for CERN accelerators, now maintained and enhanced in collaboration
- highly data driven
- DB is the master, contains optics, devices, cycles, etc. for all accelerators

- parameters are organized in hierarchies (from physics to HW)
- consistent settings management on all levels
- devices are accessed using an abstraction layer that hides middleware



# Applications

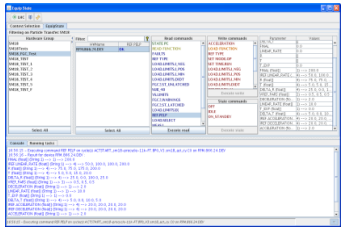
**Applications** provided by CO will cover all standard operation software used in the central and local control rooms of FAIR

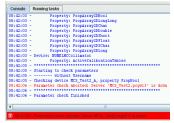


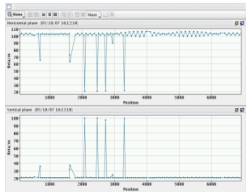
- modular and distributed SW architecture
- all processes are data driven
- separation of concerns, MVC, logic in central or distributed services
- usage of code templates, libraries, widgets, prefilled components
- Java with Swing / JavaFX as GUI technology

Console environment:

- coherent work environment for operators
- central mechanisms for context switching
- supports different views on the facility:
  e.g. focus on beams or accelerators



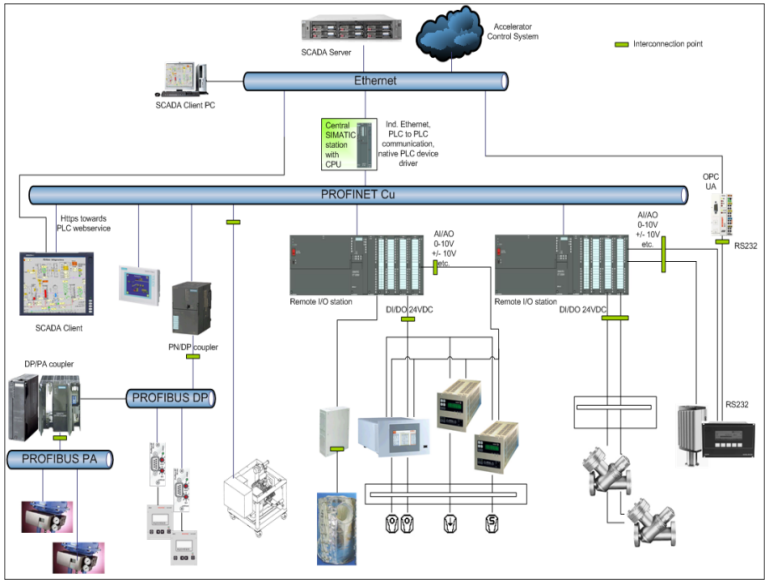




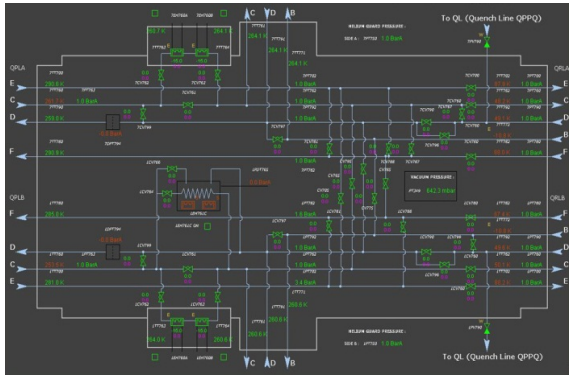
# Industrial Controls

Industrial Controls will be used for slow control subsystems such as:

- Vacuum Control
  - for CRYRING: 12 x 28 bake out heating channels,
    20 vacuum valves, 8 ion sputter pumps,
    10 hot cathode extractor gauges, 10 wide range gauges
- Cryo Control
- Personnel Safety System
- Interlock System




UNICOS framework from CERN is based on PLC (Siemens) and SCADA (WinCC OA) and will be used as basis for development



System consists of three layers:

1. field layer: sensors, actors => PLC Remote I/Os
2. control layer: PLC logic
3. supervision layer: SCADA logic and visualization