Super FRS - Meeting

EoI. No. 13i: Beam Diagnostic Data Acquisition for FAIR

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FAIR – Beam Diagnostics

General aspects of Beam Diagnostic Workpackage

Definition of GSI EoI No. 13i and Interfaces

Controls Issues

FESA – Front-End Software Architecture

Summary

Beam Diagnostics for FAIR

Accelerator Beam Diagnostic System comprises equipment for all machines:

p-LINAC: high current 70 mA, 70 MeV

SIS100: Superconducting, 100 Tm, 1-10 GeV/u
high current operation p to U
design: p:$4*10^{13}$, U^{28+}: $5*10^{11}$

SIS300: 300 Tm, stretcher or acceleration
up to 30 GeV/u

S-FRS: slow extraction, low & high currents

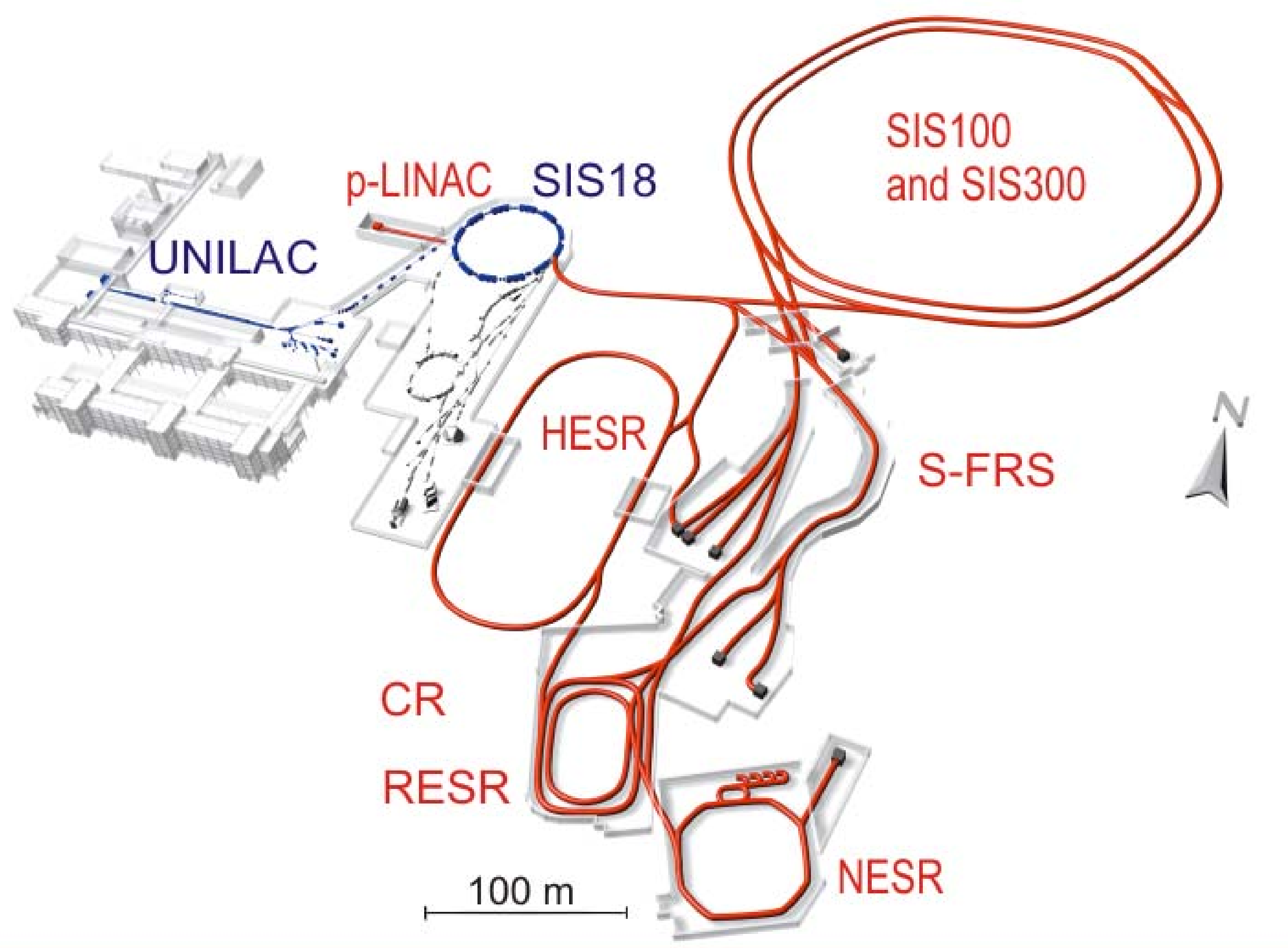
CR: stochastic cooling of RIB and pbar

RESR: accumulation of pbar, deceleration of RIB

NESR: versatile experimental ring for stable ions,
RIB, pbar cooling, gas-target, e-A collider

HESR: storage and acceleration of pbar to 14 GeV/u

HEBT: for fast & slow extraction and low & high currents.



→ Challenging set of requirements for beam diagnostic equipment !

General Layout Concept

General criteria for the layout of beam diagnostic devices for FAIR:

- Application of **industrial standards** to maximum extent:

  Mechanics: flanges, valves, connectors etc.

  Electronics: form factors, bus systems, pinnings, network

- Facility-wide **standardization**
  (wherever possible: common realizations for all machines!)
  → improves maintainability
  → saves time +manpower
  → reduces spares inventory

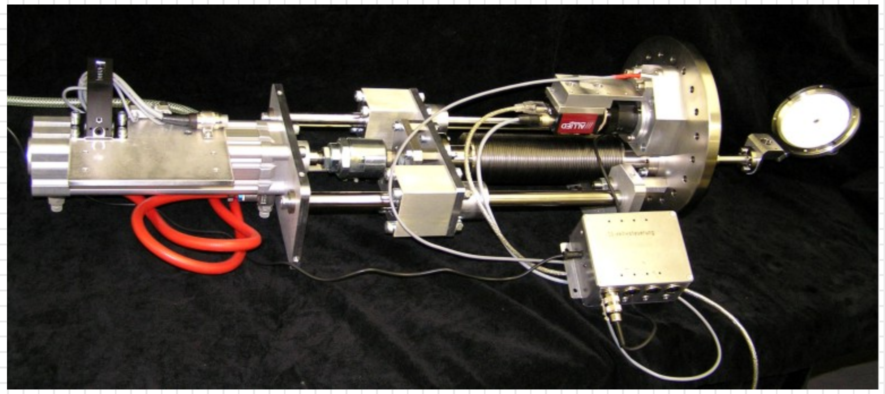
- Where applicable, e.g. for actuators, electronic parts:
  Use of **commercially available products** (COTS), with "second source"

- For software:
  Full access to source code (down to VHDL) is mandatory

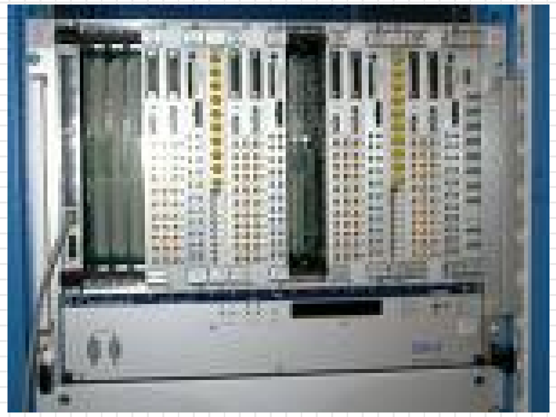
Beam Diagnostics System Definition

Constituents of a Beam Diagnostic System:

as given in the Work Breakdown Structure



- Vacuum chamber
- Detector / sensor
- Mechanics / actuators / feed-throughs
- Analog and front-end electronics
- Cabling („short“ and „long“)
- All Sub-systems (high voltage, pressured air and stepping motor control etc.)
- Data acquisition (VME, cPCI, PXI, DAQ-boards, software....)



What is *not* included?

Technical infrastructure

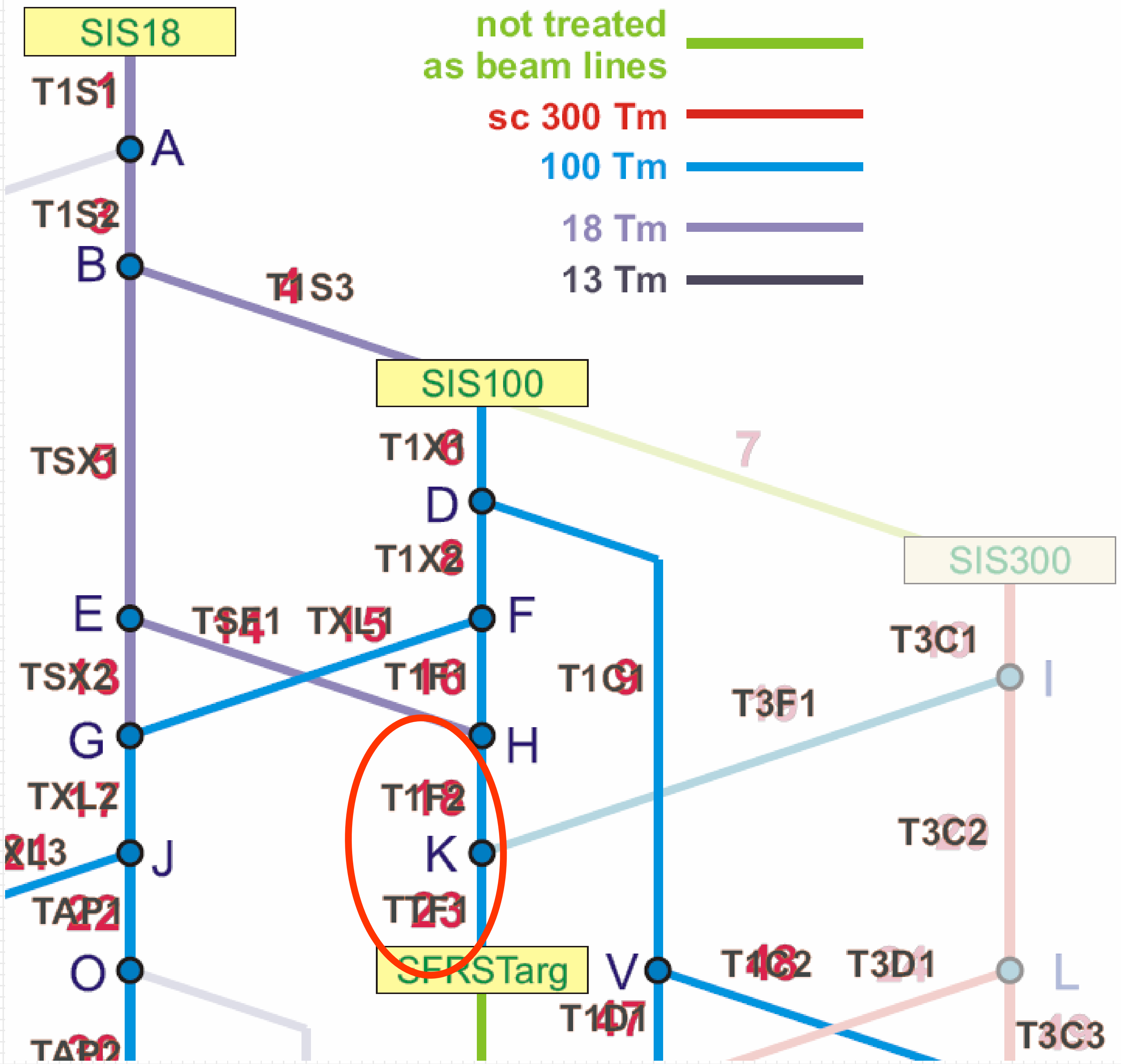
- Vacuum: pumps, pressure measurement
- Controls: ethernet, timing distribution
- Technical: electricity, pressured air distribution, detector gas etc.

S-FRS as Part of HEBT

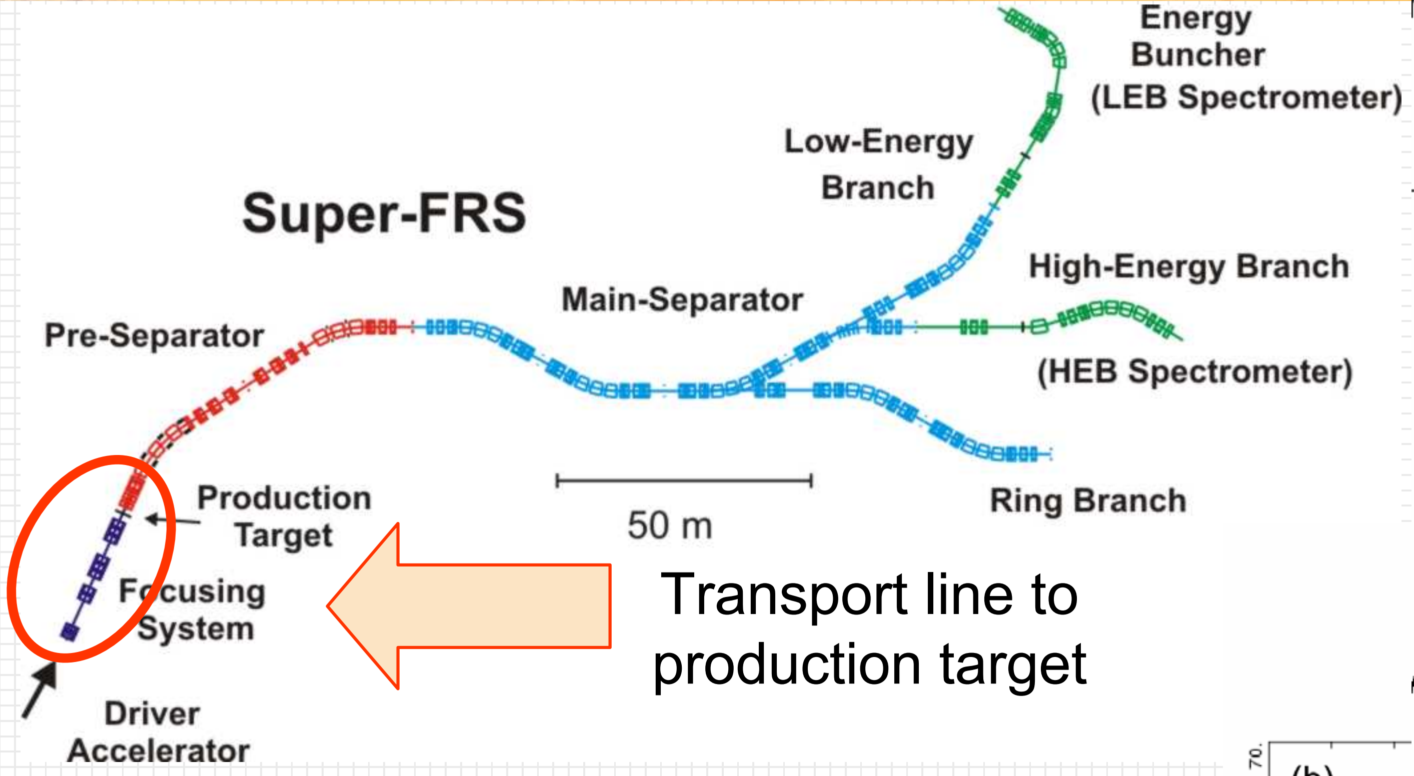
Diagnostic installations in transfer lines to S-FRS

Beamline No.	Nomen-clature	Beam Diagnostic Equipment
18	T1F2	2 Profile grids, 2 Multi-wire proportional chambers 1 Resonant transformer 1 Particle detector combination
23	TTF1	1 Scintillating Screen, 1 Profile grid, 1 Multi-wire prop. chamber 1 Resonant transformer 1 Particle detector combination 1 Beam-induced fluoresc. monitor 1 Cryogenic current comparator 1 Fast current transformer

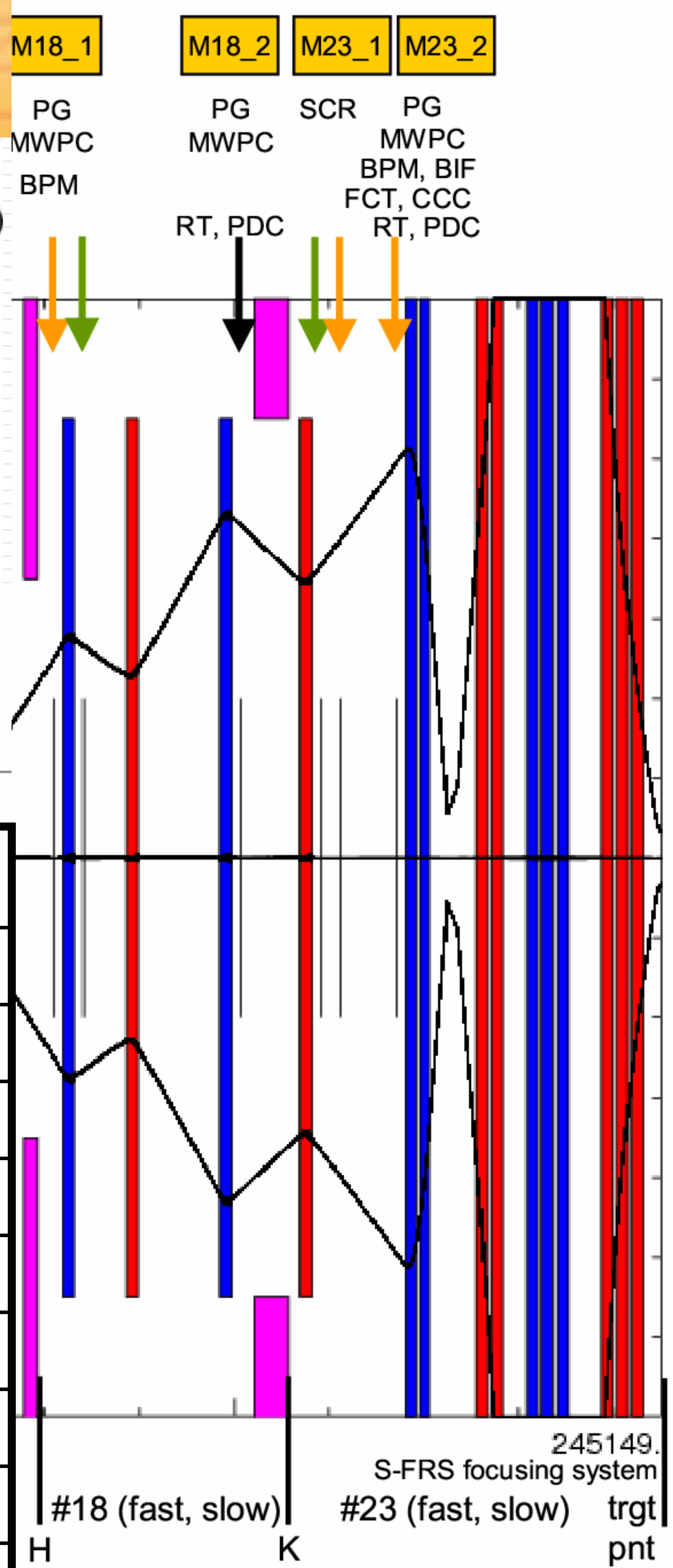
Schematic overview of HEBT beamlines

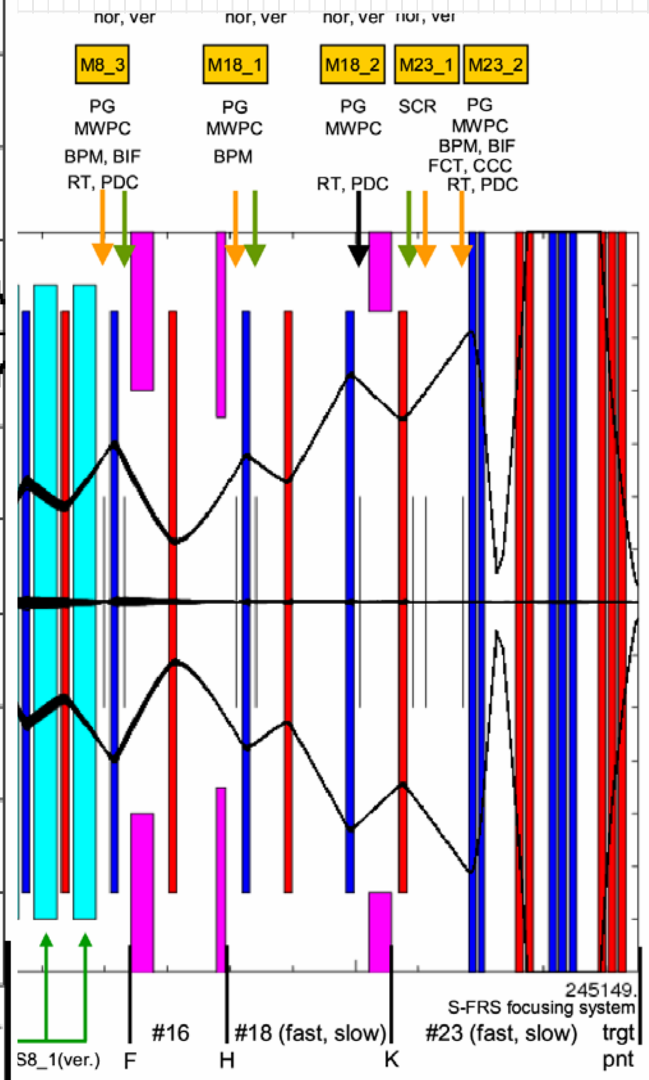


Super-FRS Layout



Transport line to production target



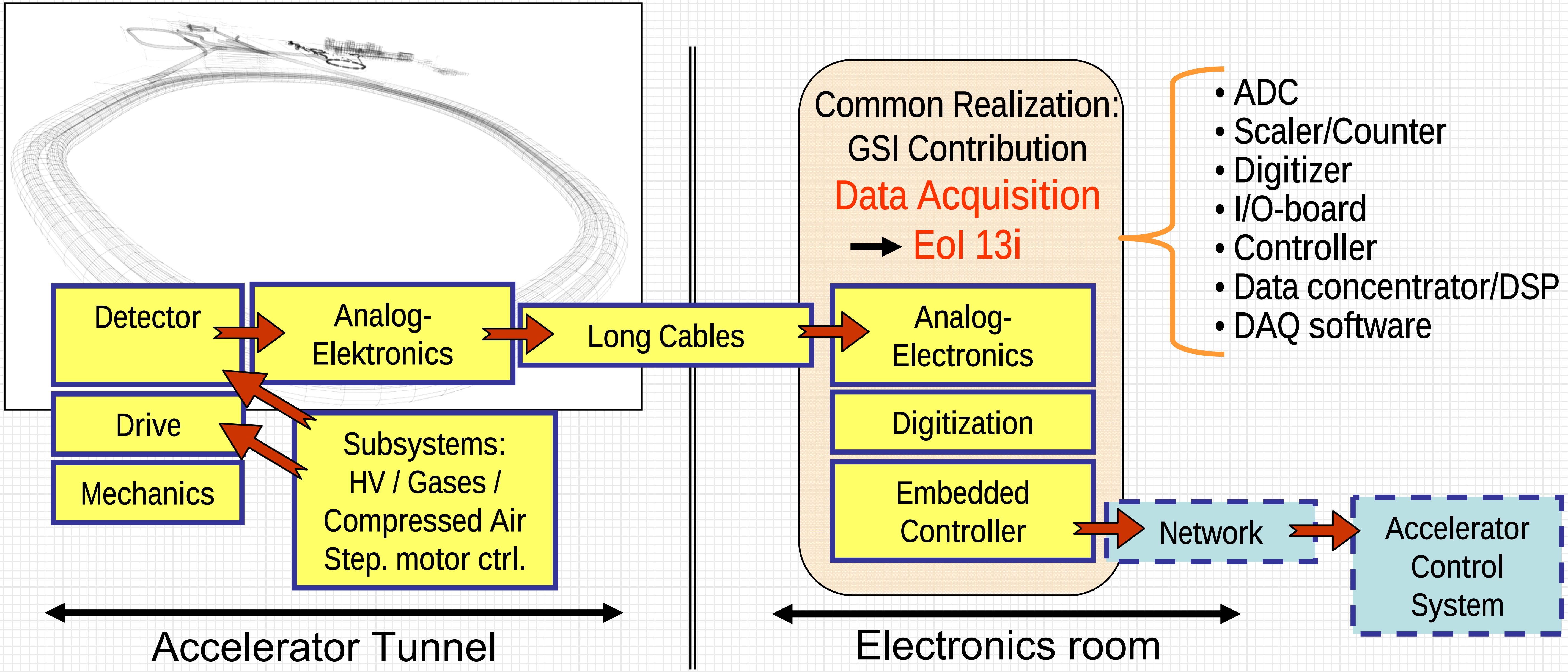


Abbrev.	Diagnostic Device
PG	Profile Grid
MWPC	Multi-Wire Prop. Chamber
SCR	Scintillating Screen
BPM	Beam Position Monitor
RT	Resonant Transformer
FCT	Fast Current Transformer
PDC	Particle Detector Combination
BIF	Beam-Induced Fluorescence Monitor
CCC	Cryogenic Current Comparator

(Courtesy F. Hagenbuck)

Work Package Structure / EoI 13i

Schematic for Beam Diagnostic Device



• **NO common scheme valid FOR ALL** ~30 different beam diagnostic systems

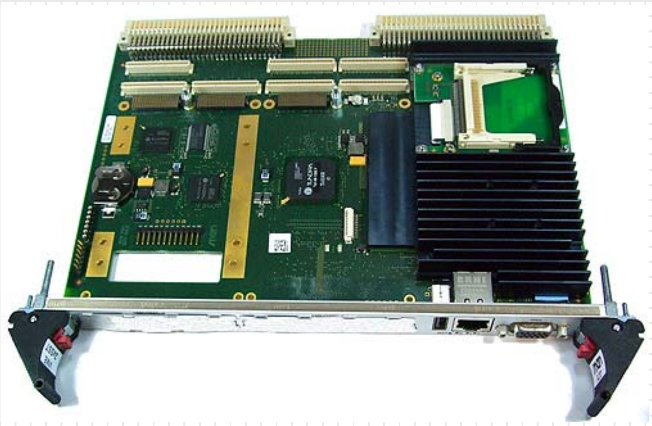
What is included in EoI 13i?

Data Acquisition (DAQ):

Equipment and Software required to control, digitize, pre-process and transmit detector signals to the accelerator control system.

The DAQ consists of:

- Embedded controller / industrial PC
- Data concentrator / DSP board
- ADC, scaler/counter, digitizer, I/O board
- RF equipment (RSA, NWA)
- DAQ software (FESA, C++)



```
void acquisition::execute(RTEvent * pEv){
  MultiplexingContext* pCtxt = pEv->getMultiplexingContext();
        for (unsigned int i=0; i < deviceCollection.size(); i++){
        DemoDevice * pDev = deviceCollection[i];
```

Additionally included:

- 'Slow Controls' (stepping motor, pressured air drive, hv supply, detector gas supply)

NOT included:

- E.g. detectors (mechanics, analog electronics), vacuum parts, drive mechanics, **'long' cables (!)**

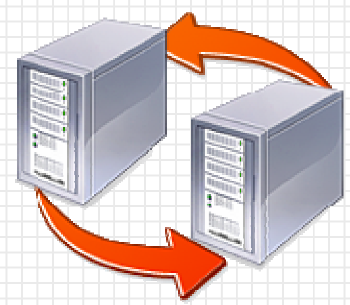
Interfaces & Standards for DAQ

Interfaces (Detector side):

- Output signal level
- Signal time structure
- Bus systems (GigE, IEEE1394...)

Interfaces (Accelerator control system):

- Software standard:
  Front-**E**nd **S**oftware **A**rchitecture, FESA (CERN)
- Data protocols / timing definition
- Fieldbus definition
- Alarms / interlocks specification



Standardized Components

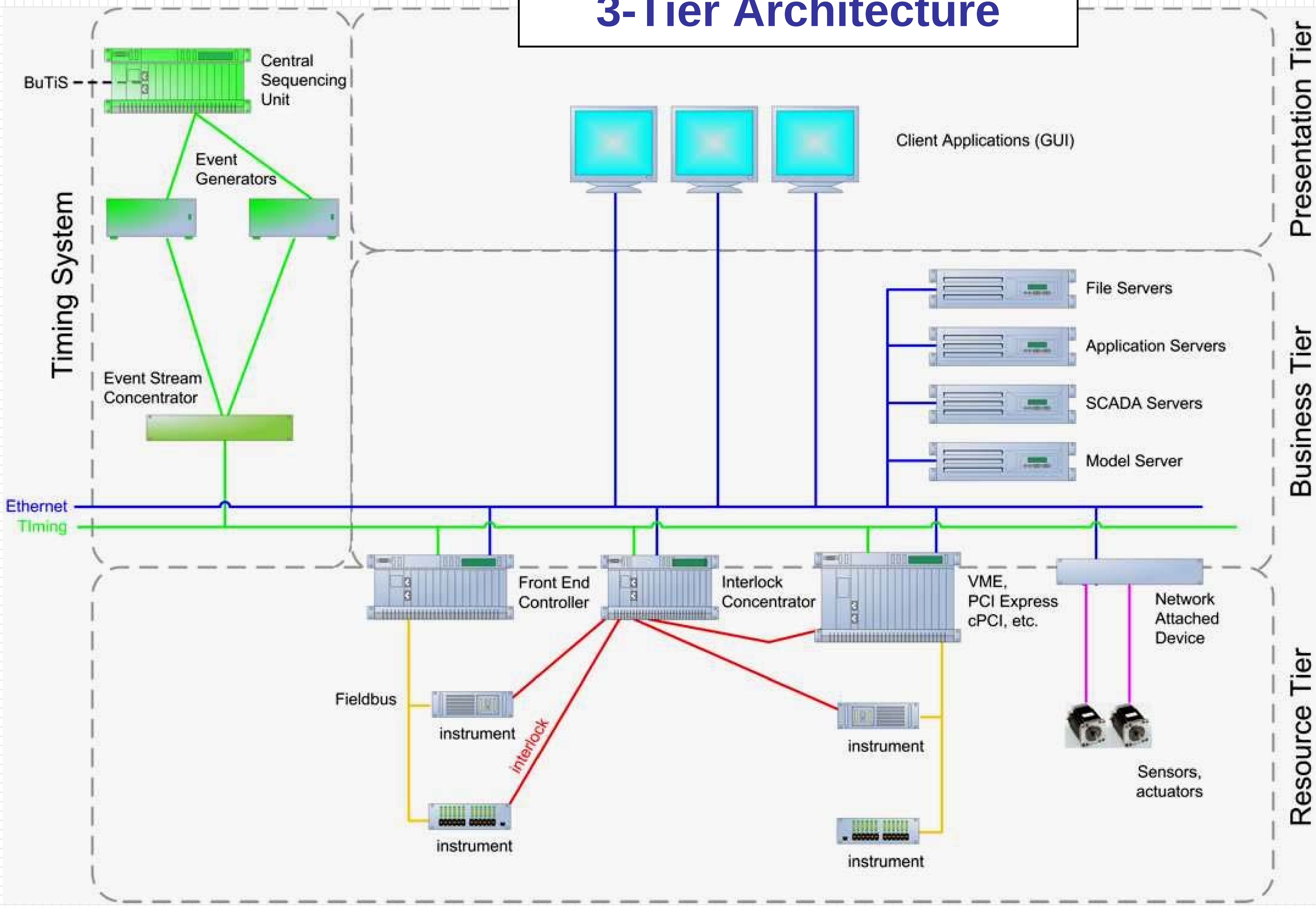
- Embedded controllers / electronic boards
- Network protocols
- Form factors (VME, MicroTCA...)
- Connectors, cables

Accelerator Controls Issues

Goals of the FAIR control system:

- strictly object-oriented
- decentralized distributed
- modular design
- well defined interfaces

3-Tier Architecture



Tasks

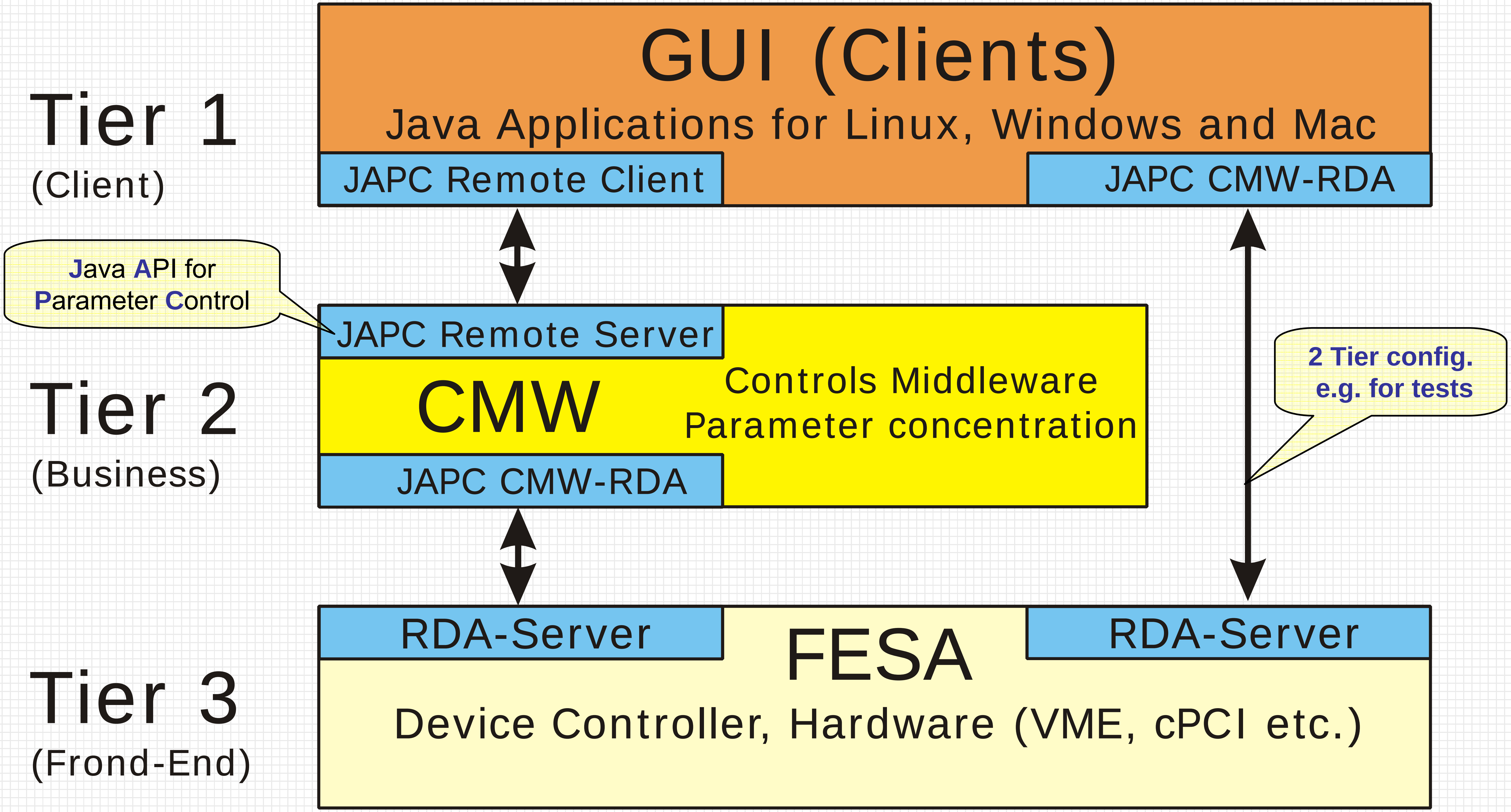
- Applications for operators and end-users
- Web applications
- Scripting tools

- Services to the CS
- Name service, Archive
- All applications reside upon common layer

- Map device-specific protocols (e.g. read/write of process variables) to standardized protocols
- Data acquisition
- Device control

Possible Controls Layout

(CERN Model)

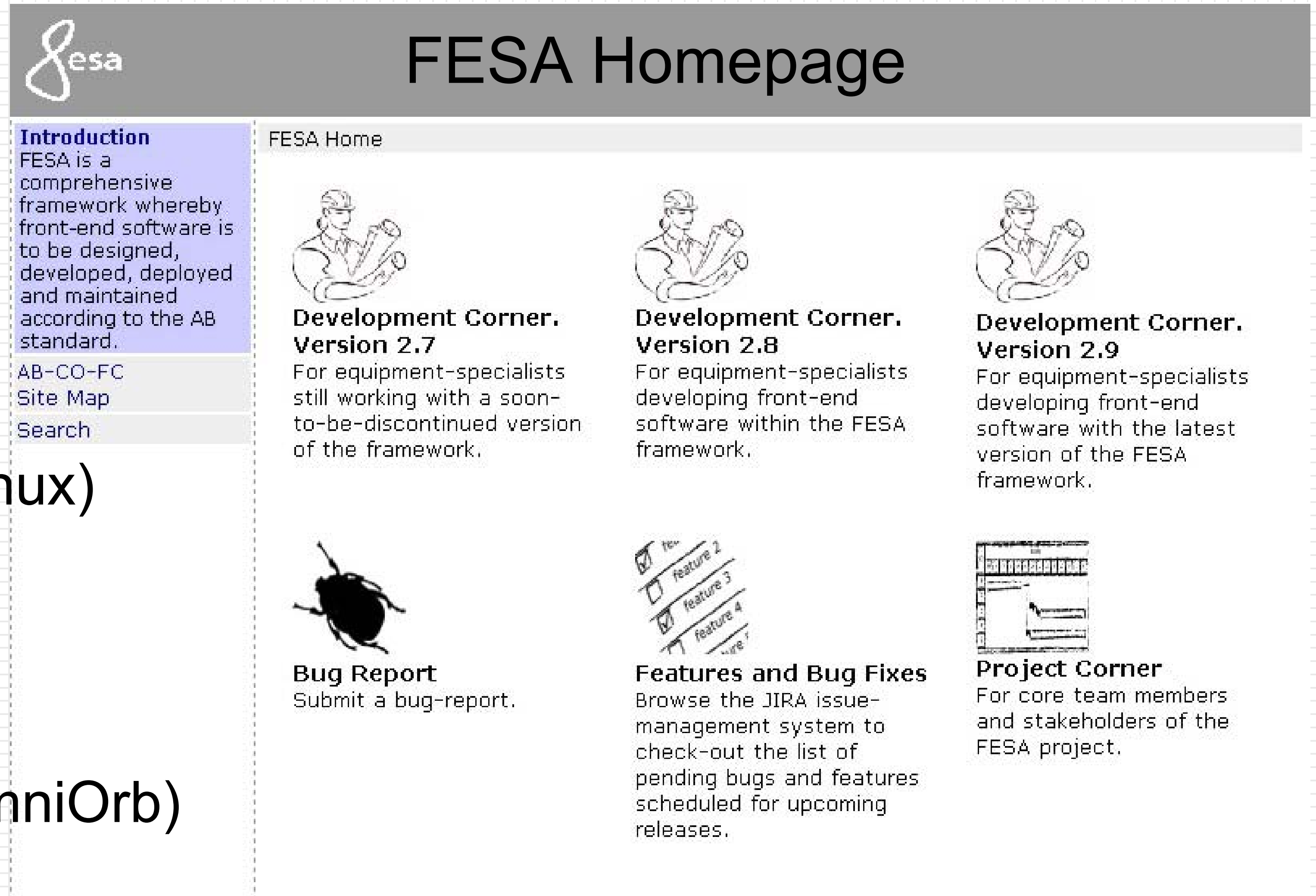


(Courtesy T. Hoffmann, GSI)

FESA - Overview

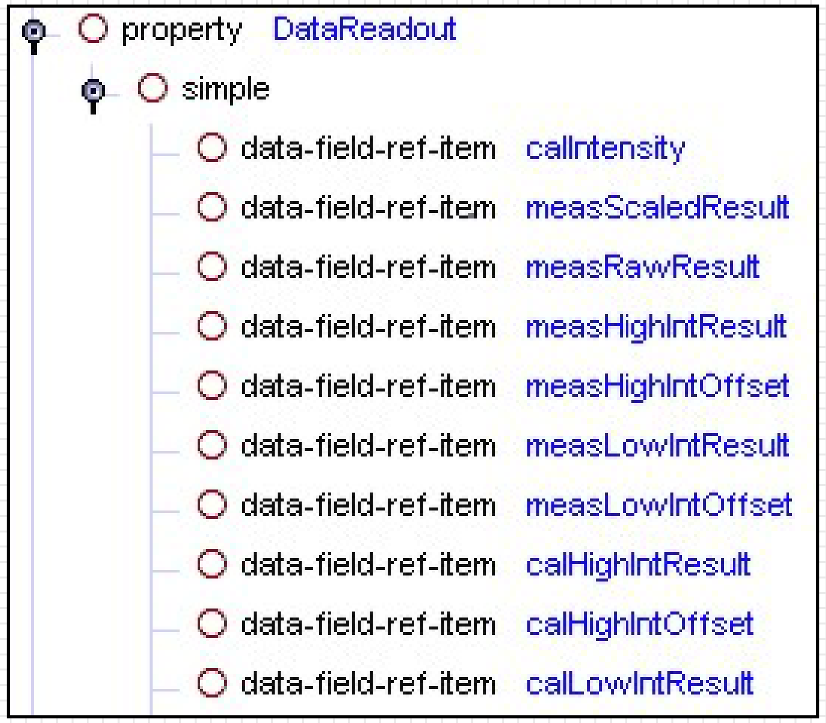
FESA: Front-End Software Architecture, Roots in CERN Beam Diagnostics group

The Front-End Software Architecture, known as FESA, is a ***complete environment for the equipment specialists*** *to* ***design, develop, deploy and test*** *their* ***equipment software****, called a FESA class. The primary reason to develop such an infrastructure is to* ***standardize, speed-up and simplify*** *the task of* ***developing front-end software****. (M. Arruat et al., ICALEPCS07, Knoxville)*



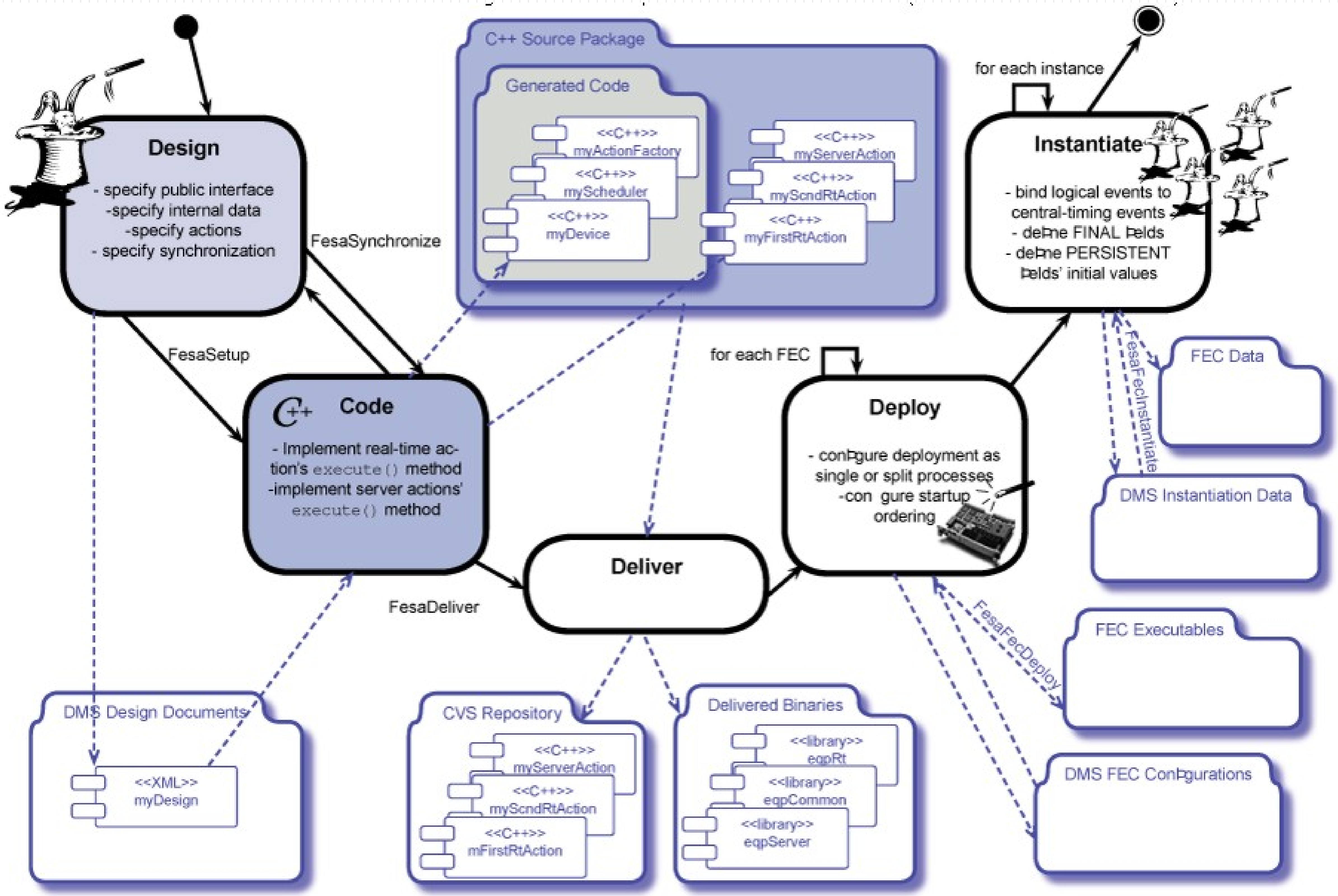
Supports:	VME, cPCI/PXI, VXI, PCI, PLC (Schneider & Siematic)
OS:	Linux/LynxOS
CPU:	Motorola, PowerPC, Intel
Devel:	Java based (Mac, Windows, Linux) and Linux access for source code development
	Creation of a binary for DAQ
	included RDA server (CMW, omniOrb)
	C/C++ for development

FESA Features



• Object-oriented Real-Time Framework	focus on structure and flow control
• Graphical Tools	to produce 3 XML documents (Design, Deployment, Instantiation)
• Code Generation	automatically generate the appropriate source code
• Test environment	auto-generated Java GUI to access every property
• Timing Simulation	testing of equipment software without hw timing
• Run-time Diagnostic	"topic oriented" diagnostics (e.g. "EventTracking")
• Monitoring	to survey the control flow of any equipment sw
• PLC Integration	TCP/IP connect to Programmable Logic Controllers
• Critical Settings Management	setting a property marked critical requires digital signature
•	(Details and references in M. Arruat et al., Proc. ICALEPCS07, Knoxville, USA, 2007, pp. 310.)

Example: Create a FESA Class



Summary

- **Systems and unit numbers** of Super-FRS beam diagnostic devices (pre-target part within responsibility of BD group)
- **Standardization** as a basic concept
- Detailed work package structure for beam diagnostics with **standardized "Data Acquisition"-part** (GSI contribution)
- **Common realizations** of devices for beam diagnostics as "machine overlaping system"
- **3-Tier accelerator control system** is foreseen
- **FESA as standard platform** for beam diagnostic data acquisition

Thank you for your attention.