Update on the control system for FRS and Super-FRS

1. FAIR control system, general notions
2. Super-FRS specific concepts
3. Implementation for FRS
4. Current status

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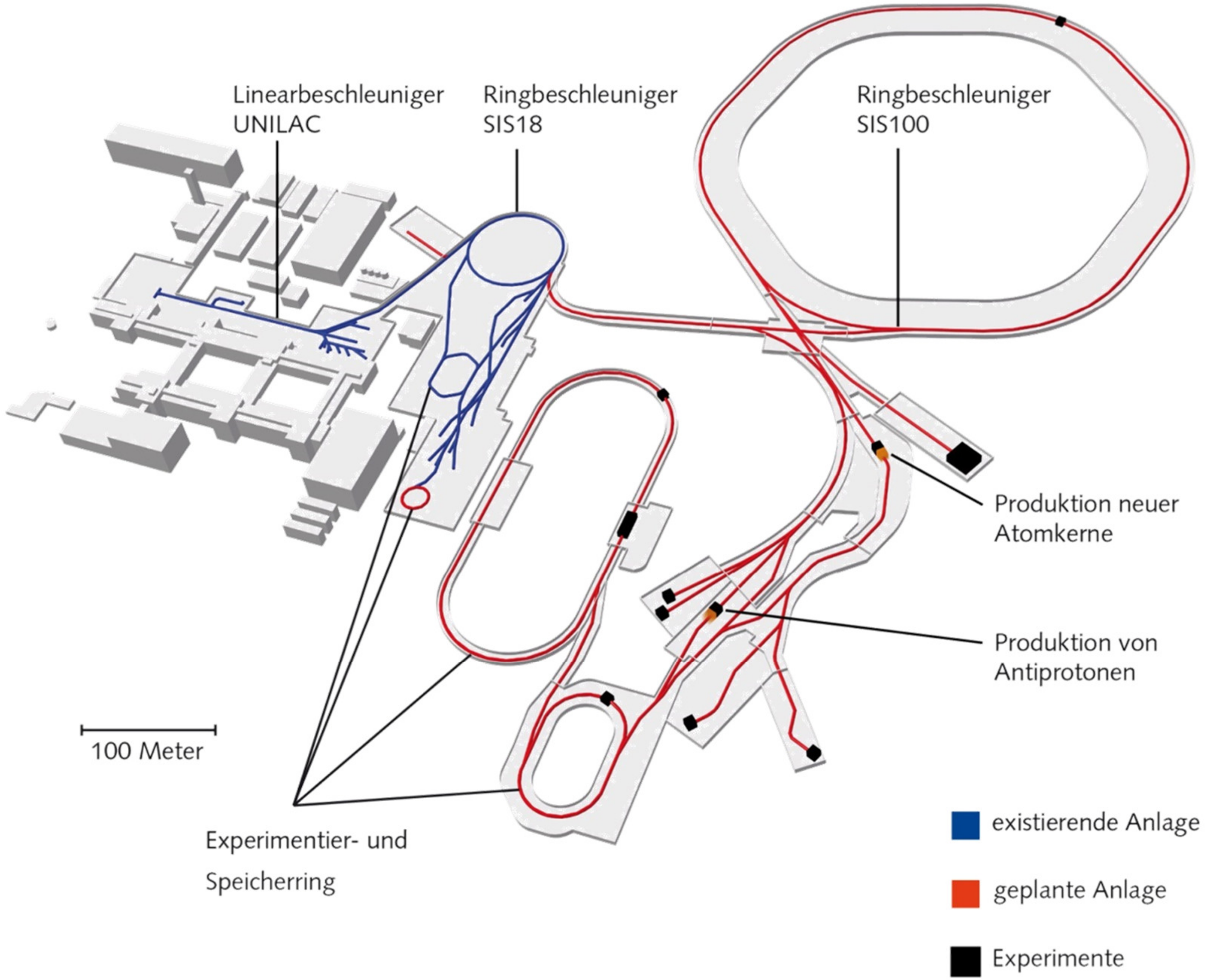
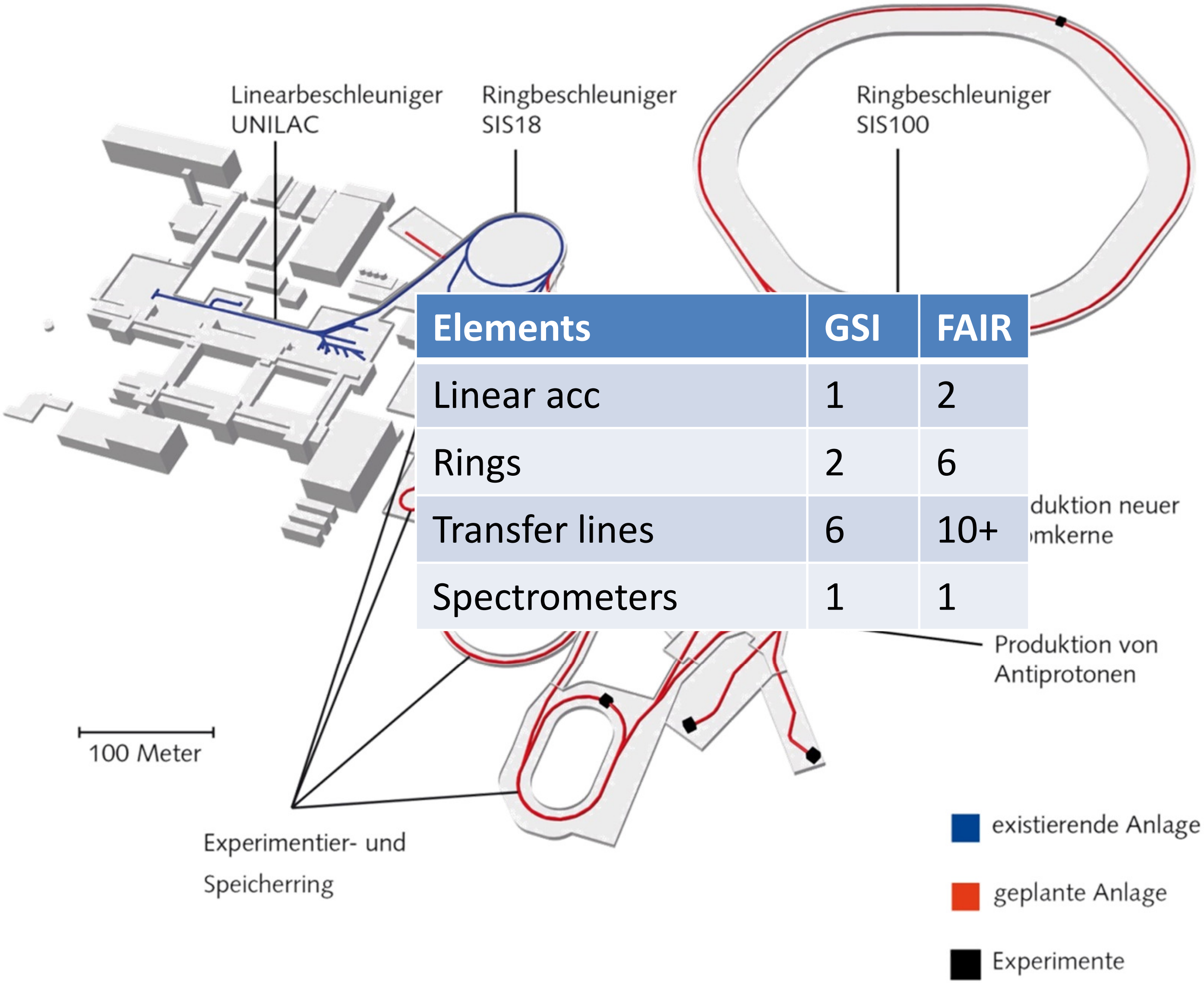
NUSTAR Annual meeting, GSI Darmstadt, 28th February 2019

FAIR control system – guiding principle



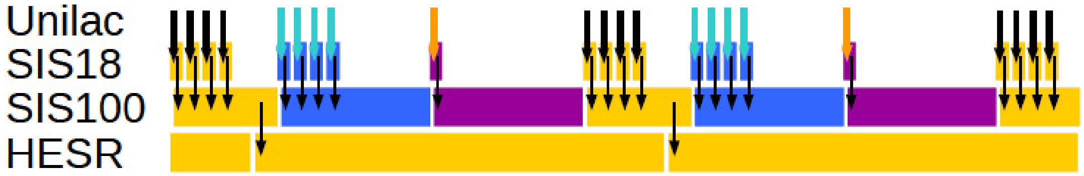
FAIR control system – guiding principle



Elements	GSI	FAIR
Linear acc	1	2
Rings	2	6
Transfer lines	6	10+
Spectrometers	1	1

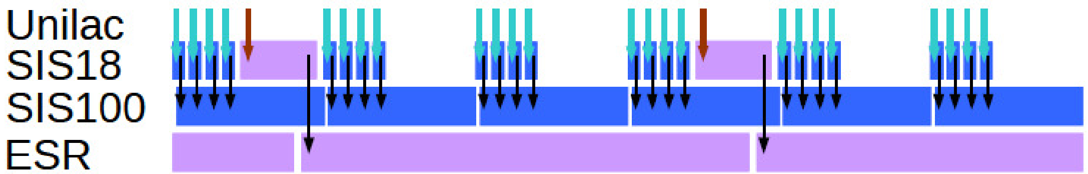
FAIR control system – parallel operations

Periodic beam patterns, dominated by one ***main*** experiment:

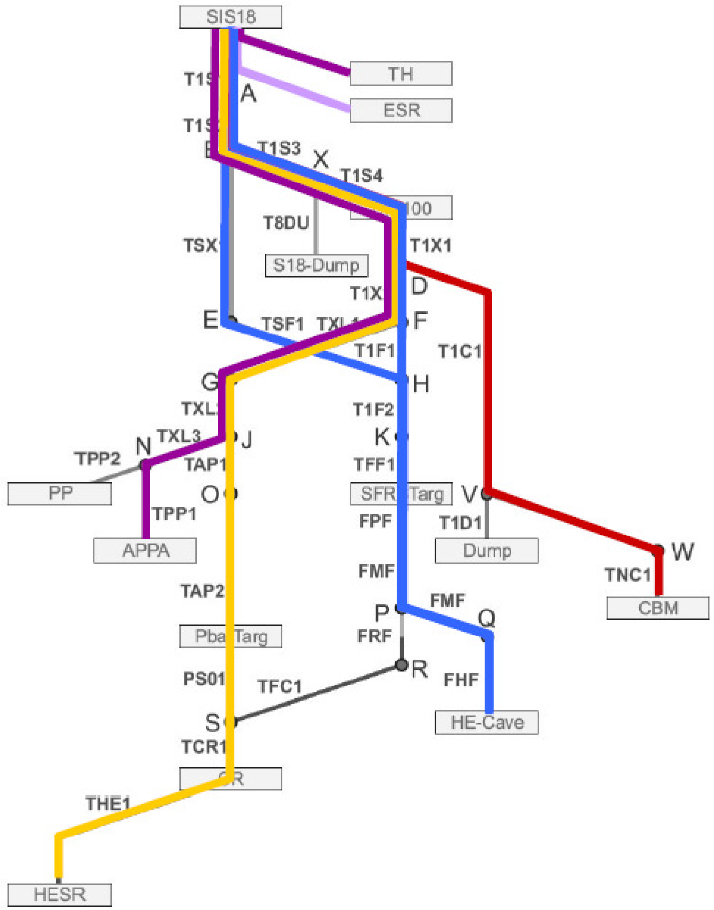


AP + RIB ext. target (U^{28+}) + Biomat

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

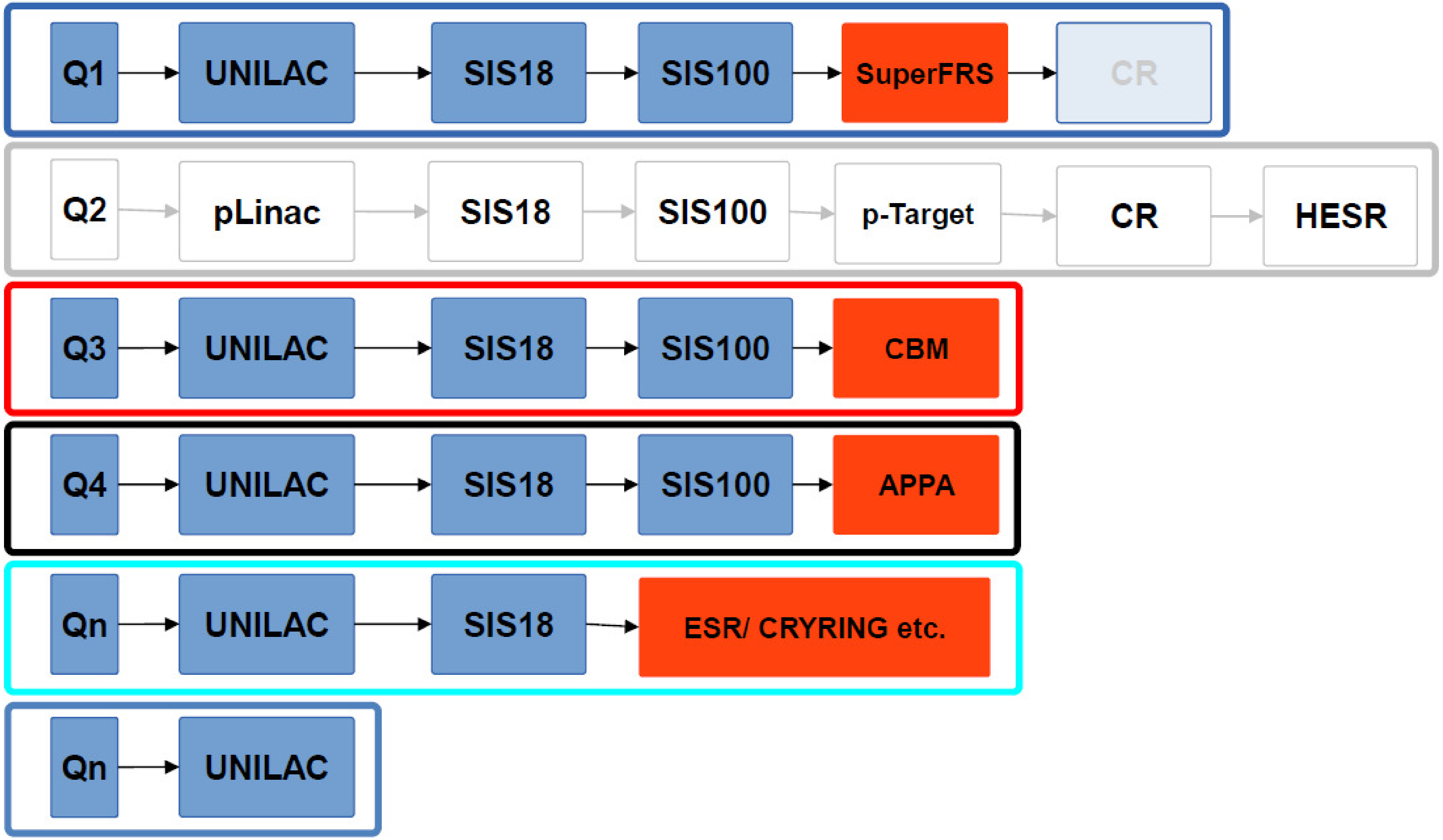


RIB ext. target (U^{28+}) *+ ESR*



courtesy D. Ondreka

FAIR control system – paradigm change from GSI



Question : operators are machine dependent or experiment dependent

GSI: few machines, few experiments in parallel

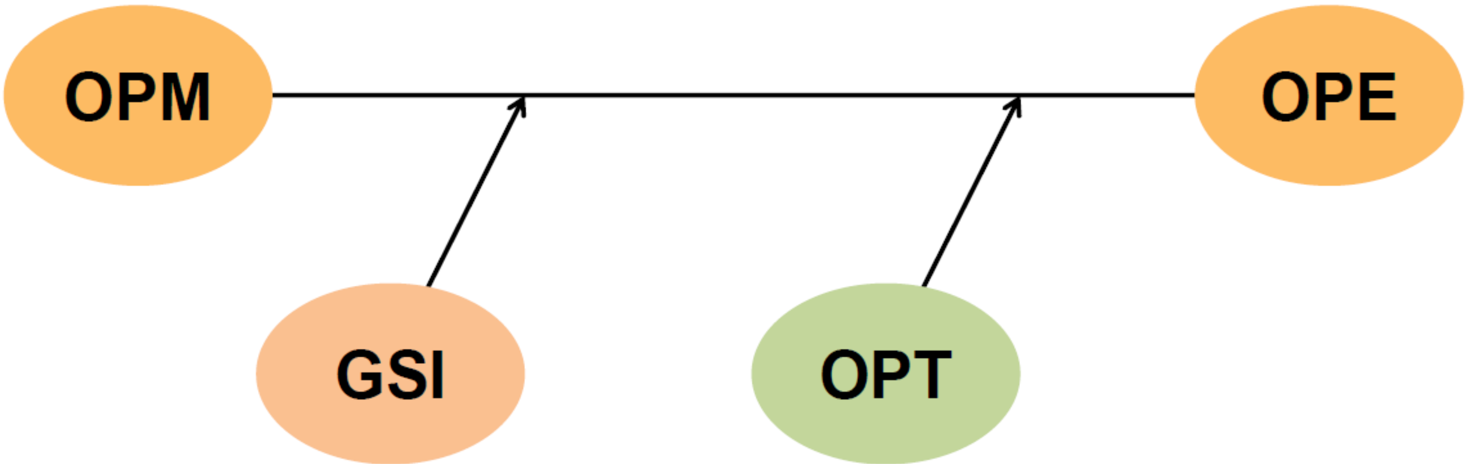
vs

FAIR: many machines, few experiments in parallel

FAIR control system - optimisation

Basic Paradigms

a) 1 operator per machine (OPM)
b) 1 operator per experiment (OPE)
c) optimization (OPT)



FAIR control system – operation consequence

Summary

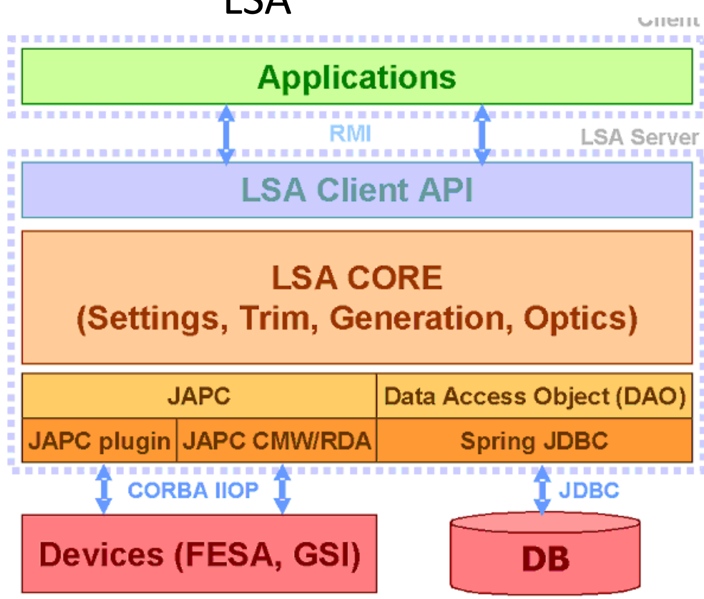
	OPM	OPE	OPT
operators on shift	8	6	4-5
personnel needs	59	44	30-37
Unsolved problems	• Interface problem • Suboptimal use of setup time → • Very much idle time for operators	• Idle operators after setup phase or if less than 6 Experiments are running	
requirements	• larger control room • Shift leader should be an expert of all machines	• larger control room • Experienced and homogeneously trained operators • digital control room • generic operating software • restricted parallel access on machine settings	• larger control room • specialized operator training • stable long term beam time scheduling • digital control room • generic operation software • consistent look and feel • high level automation • restricted parallel access on machine settings

FAIR control system – LSA and FESA core

Generic layout

Presentation tier (Paramodi etc...)

LSA



Application tier (LSA, sequencer etc...)

Resource tier (FESA)

Vaccum

Cryogenics

Magnets

New software based on Java and C++, running on standard Linux architectures (CERN develope.)

➔ **LSA: LHC Software Architecture**

Development partially in CERN, no stress on flexibility, safety/reproductibility are main drive.

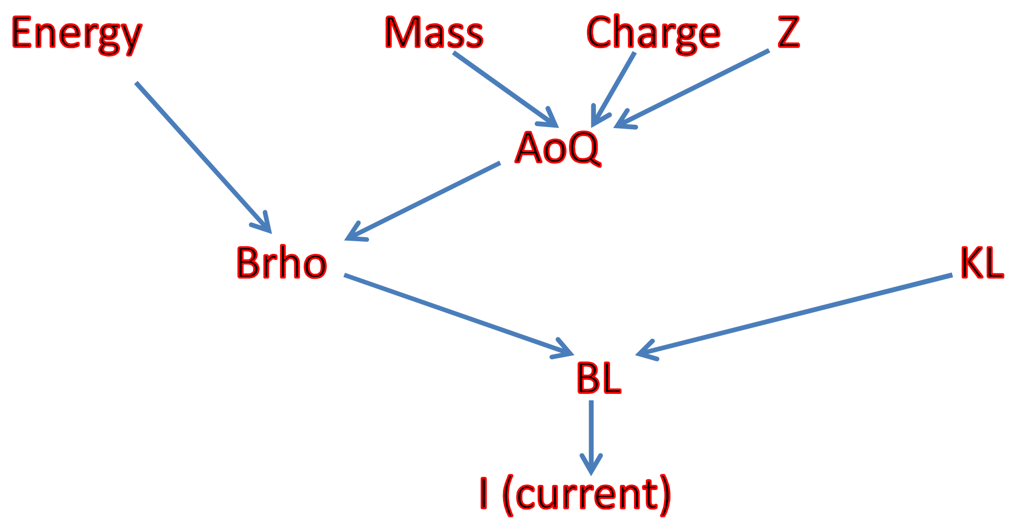
LSA: data base with parameter hierachy

All in data base, simple recover previous settings, easy define back feed loops

From https://www-acc.gsi.de/wiki/Applications/LsaFrequentlyAskedQuestions

Parameter: something for which a value has to be assigned
Parameter hierarchy: link between parameter (Brho, KL to I)

Ex:



Machine model: parameter hierarchy for this machine (incl degraders etc...)

Accelerator Zone: zone with constant beam parameters (so between matter to matter)

Particle Transfer: some of accelerator zones between two branching magnets

FAIR control system – new names

Context: time during which a parameter has a value (think SIS magnets when different patterns/virtual accelerator are present)

Beam process: specific procedure (injection, ramp, extraction...)

Beam production chain (BPC): beam lifespan from source to beam dump, example all processes in an production for SIS+HEST+FRS+ESR

Pattern: a "collection" of BPC

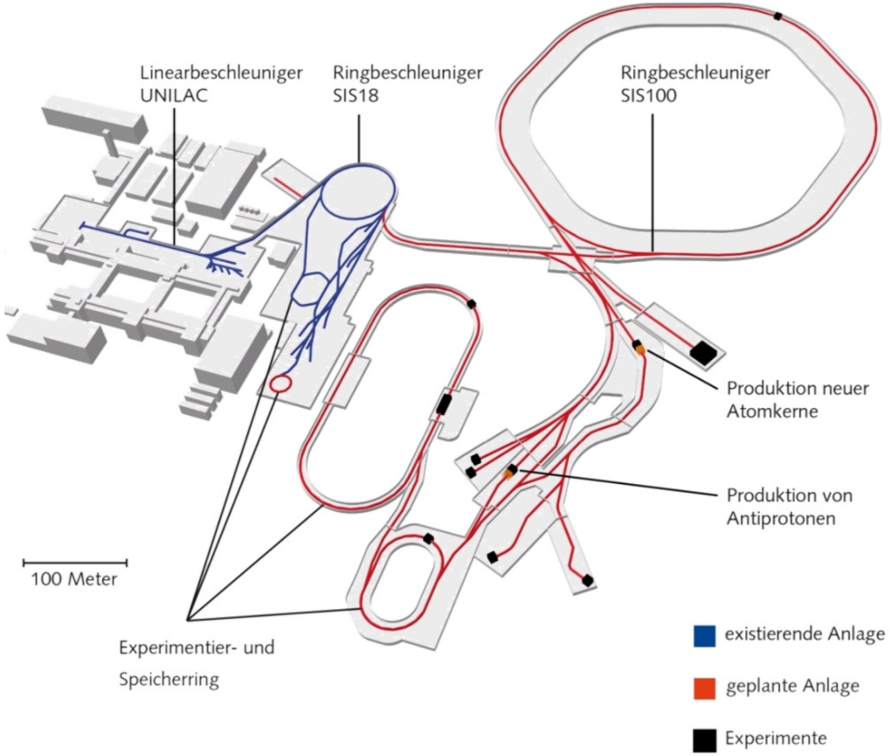
Setting: value of a parameter for a given context

Make rule: how a change on a setting of a parameter affects other the setting of dependent parameters

Trim: change on one or several settings

Knob: scalable parameter with several dependent parameters (alignment for example)

FAIR control system – planned for Super-FRS



Start to work on Super-FRS control system 2012

Super-FRS is an injector for CR
➔ if CR and SIS100 are using LSA, easier if Super-FRS uses LSA

➔ We started working on LSA machine model for Super-FRS in 2013

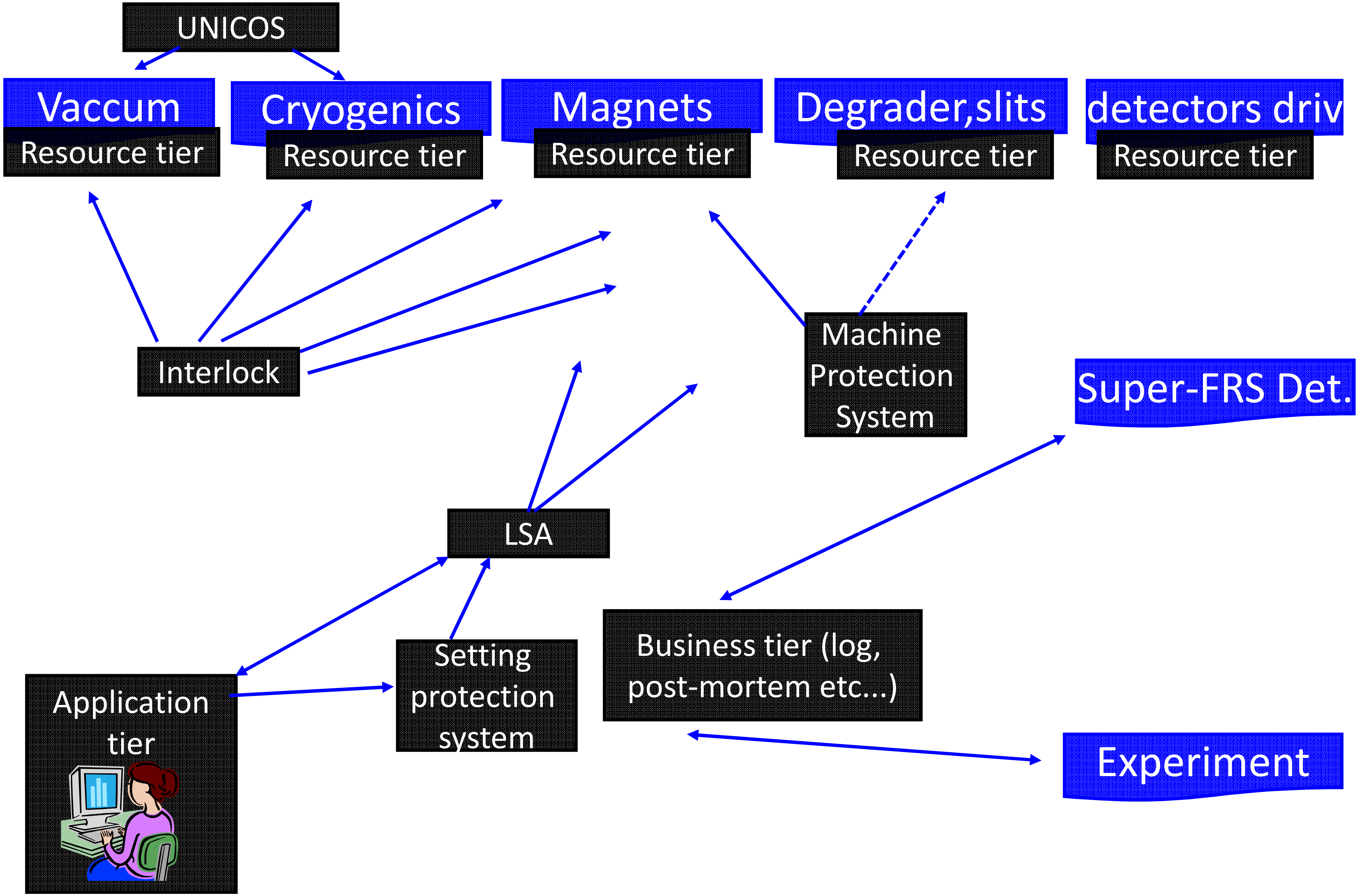
Super-FRS: between an experiment and a machine. Not all in Control System
Part in Control System (machine) – part in NUSTAR DAQ EPICS (slow control)

Example: SEM grid and magnet control in CS, while TPC readout in Nustar DAQ

Device brought by experiment: change Bρ and magnet behind it in LSA ➔ device should be CS

Means: connection from NUSTAR to Control System through Super-FRS

Super-FRS control system design concept



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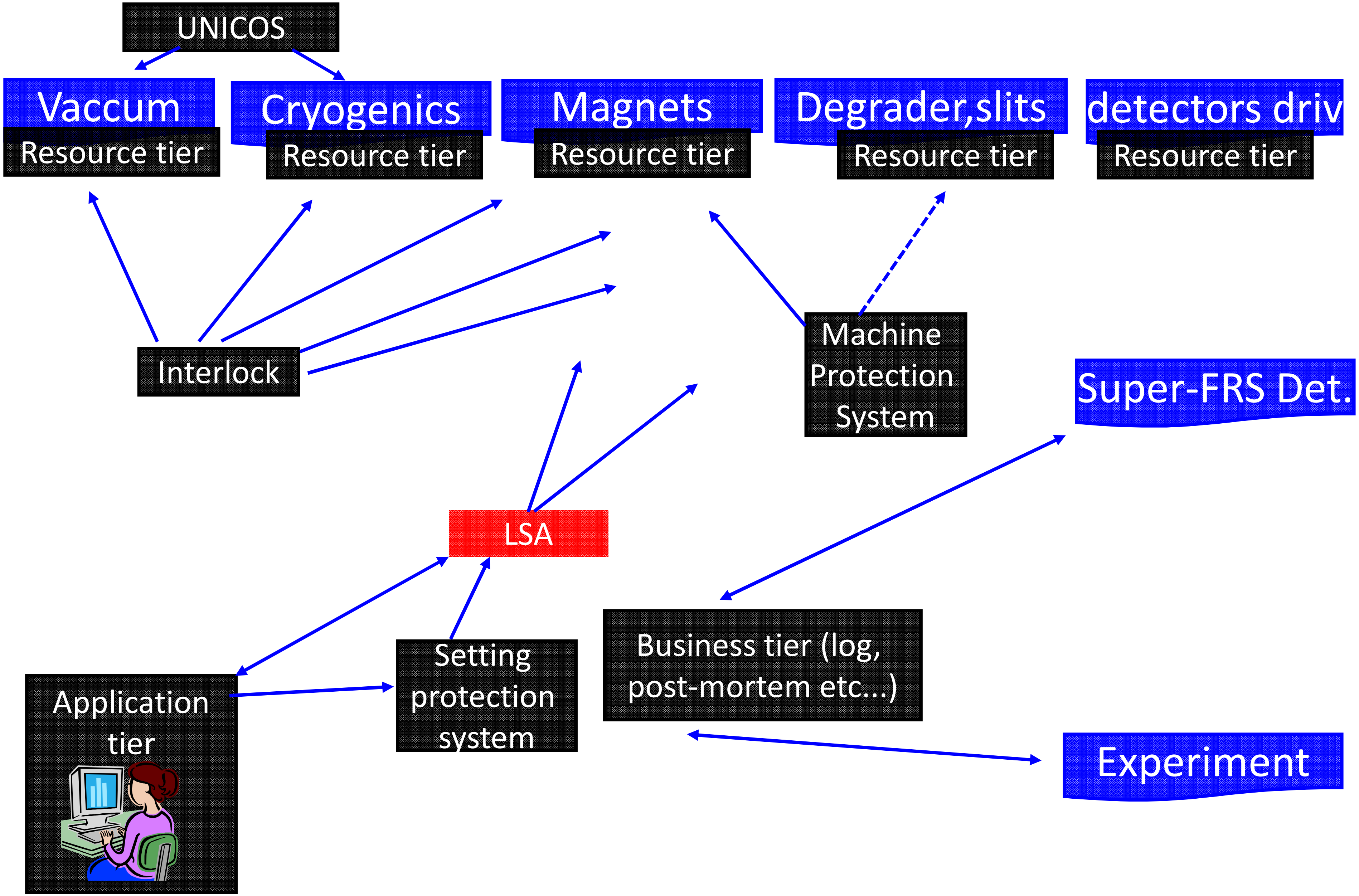
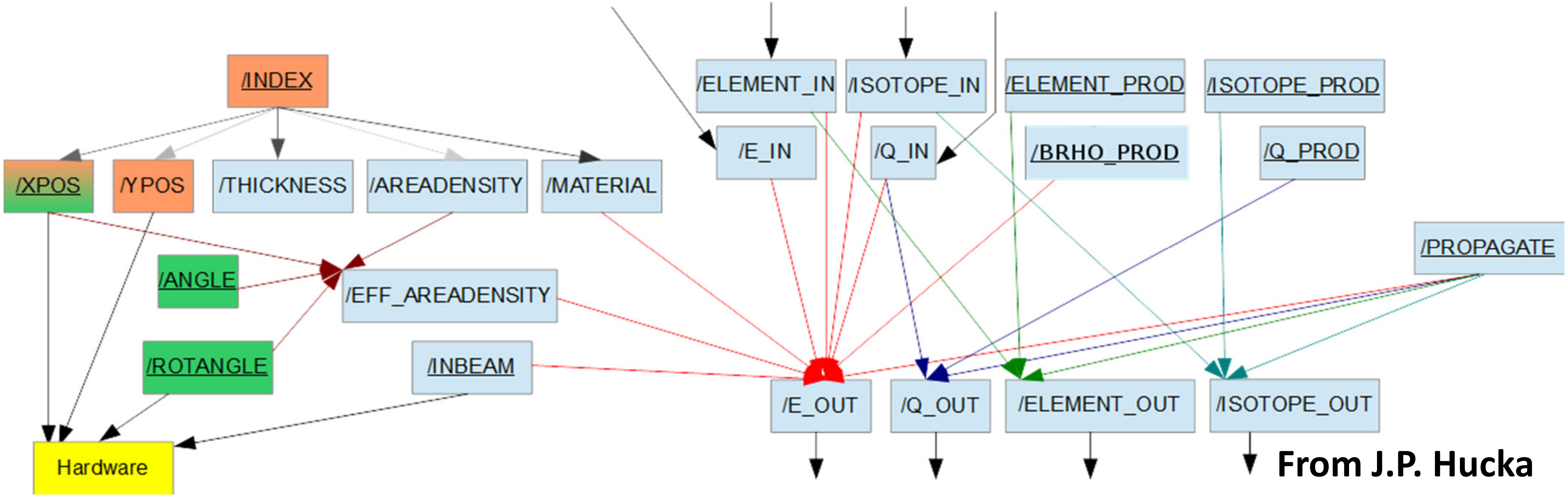


Super-FRS machine model in LSA

Super-FRS is a special FAIR machine: we operate with matter in the beam line
➔ needed to include detectors, targets, degradors and slits in LSA

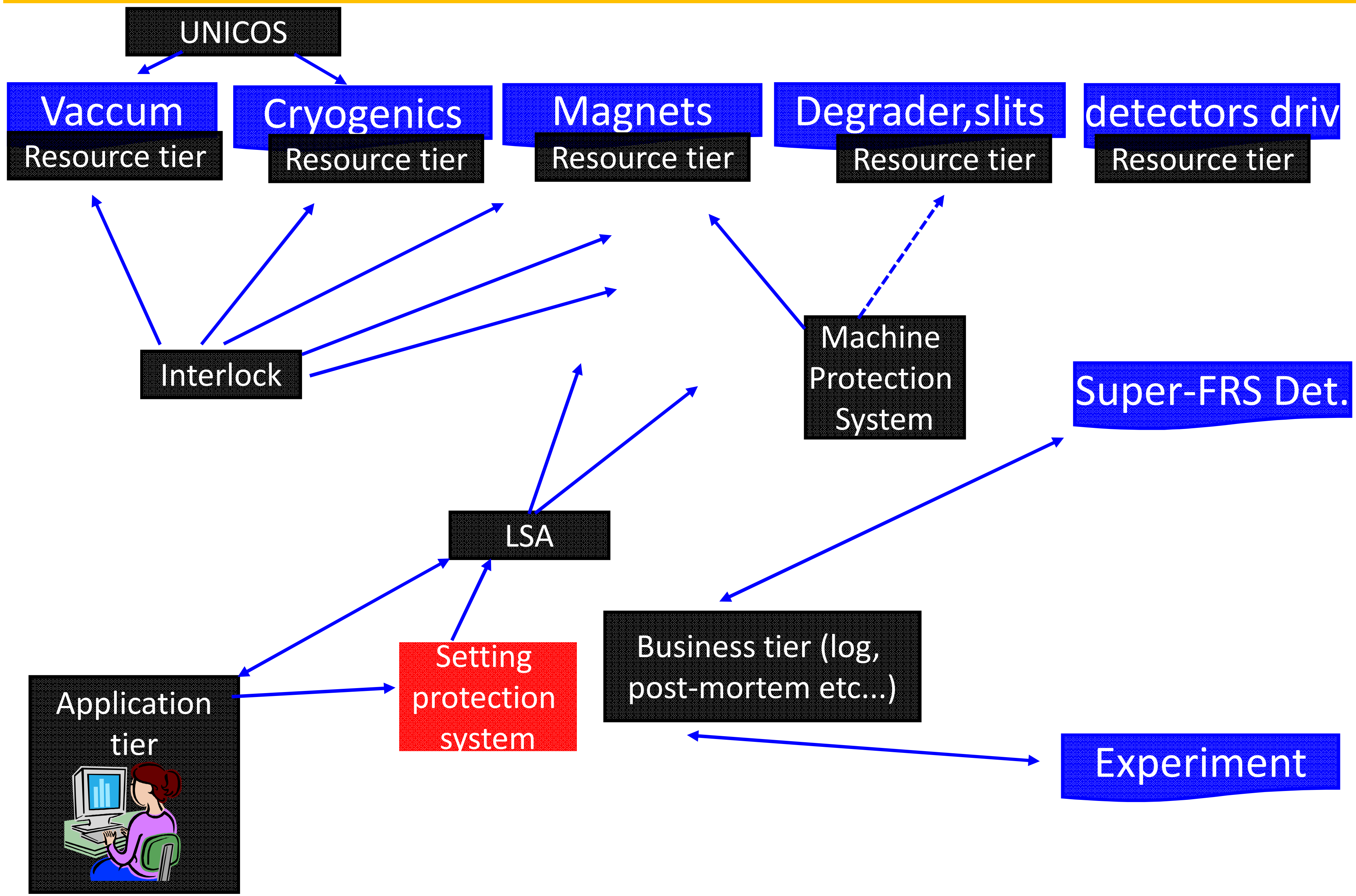


From J.P. Hucka

Needed ATIMA in LSA (Fortran to Java port) ➔ will allow automatic calibration of matter

There will be no nuclear physics modeling done in LSA

Super-FRS control system design concept



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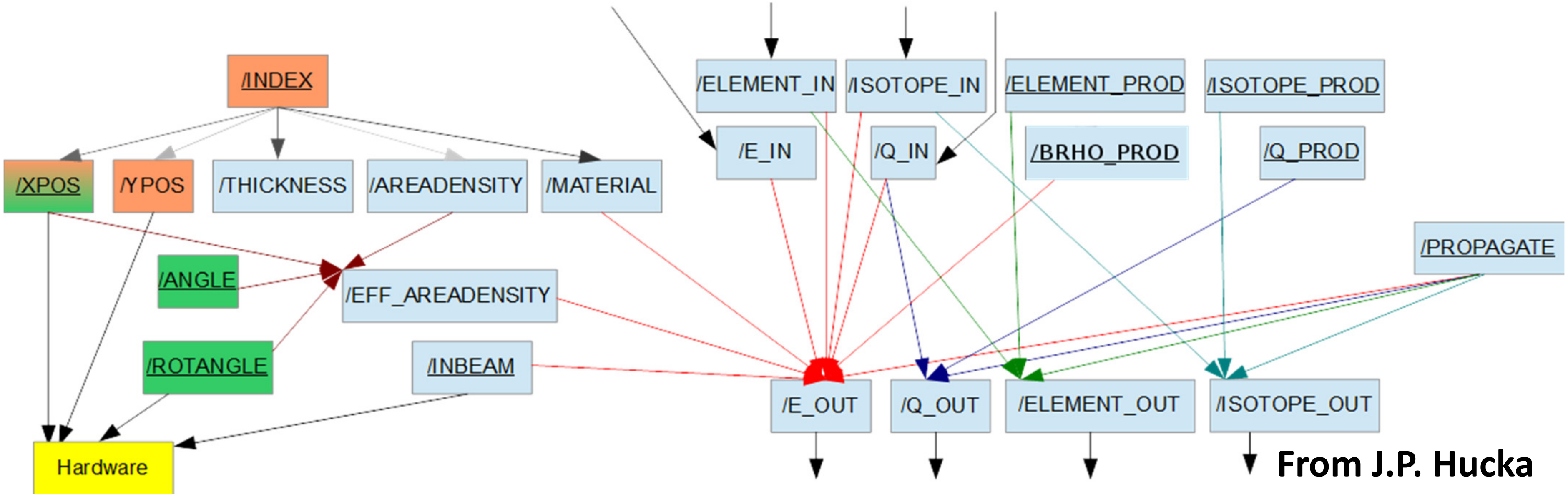

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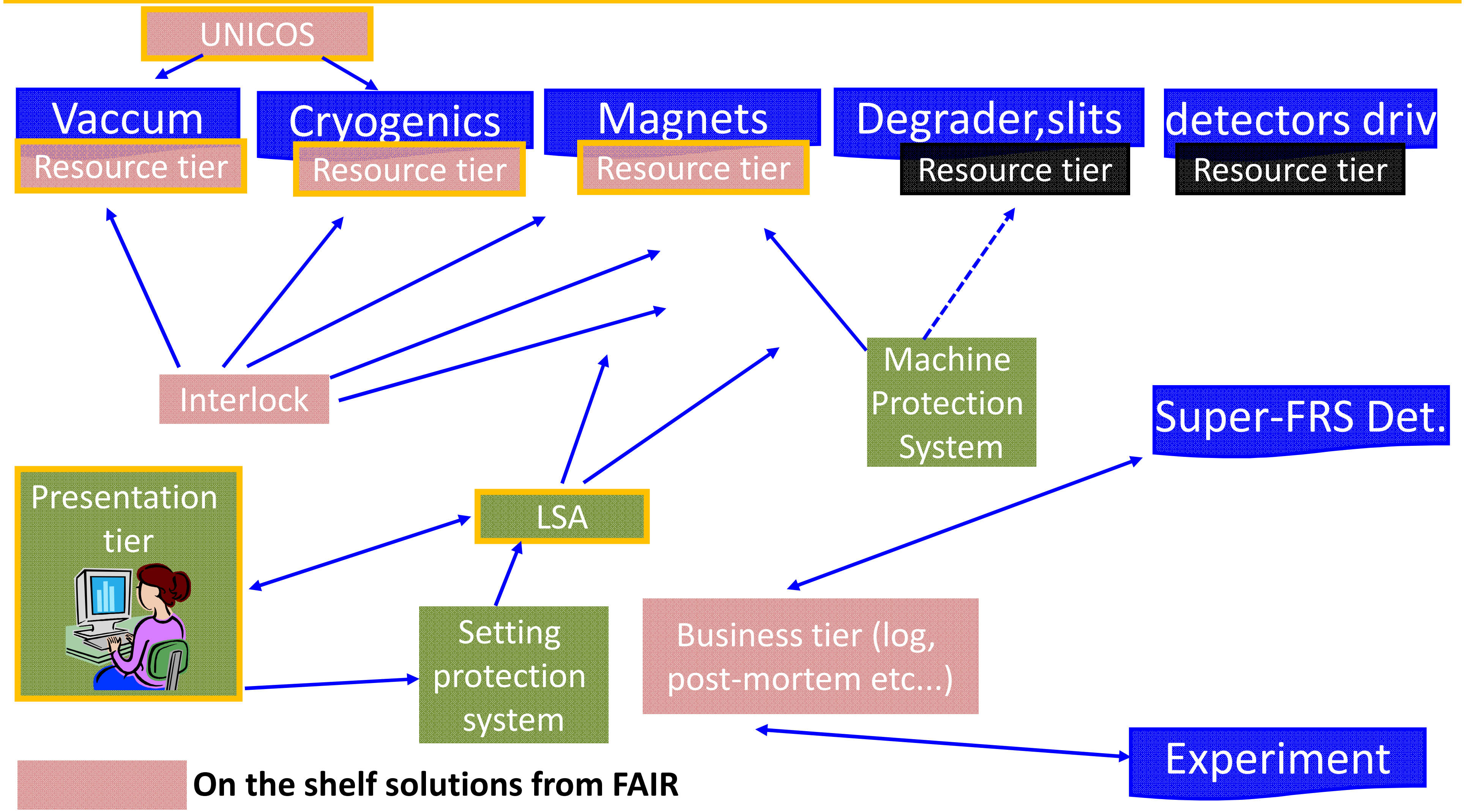
New application: Machine protection/ setting assistance
➔ Setting Protection System (start conceptual development H. Roesch)

The FRS being used for testing/debugging concepts and programs

Super-FRS control system design - advanced

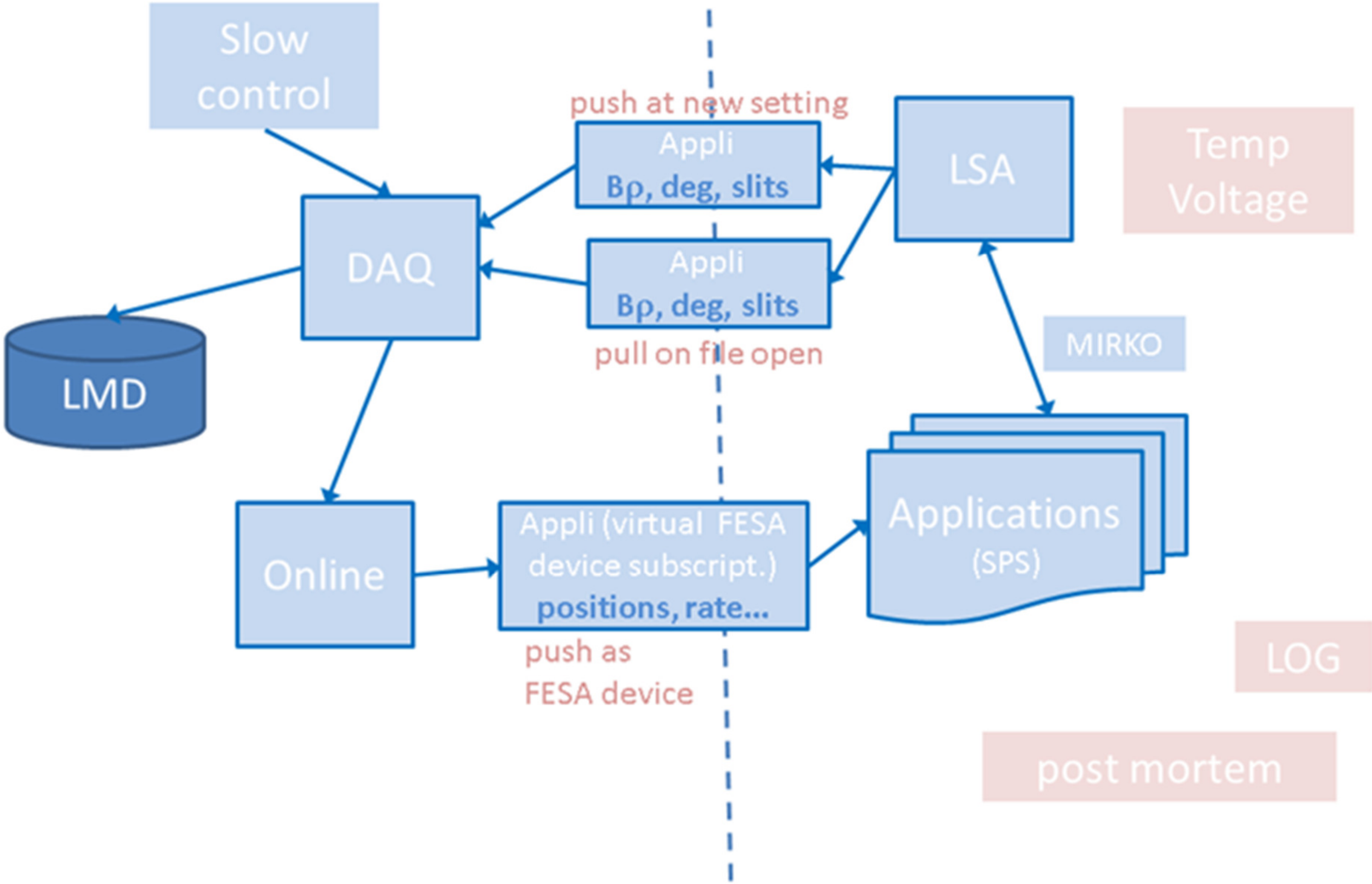


On the shelf solutions from FAIR

Specific development/implementation for Super-FRS

Concept Will be tested at FRS in 2017/18 (or other NUSTAR exp.)

Control system to experiment data acquisition



Information on settings of magnets/drives in data stream from the DAQ
Information from detectors in the control system

Super-FRS control system – operation consequence

Action\operator	AO	NO	SE	PE
HEBT	X			
RING operation (CR, HESR…)	X			
Alignment TFF1	X		X	
First beam through SFRS	X	?	X	
Matter calibration	?	X	X	
Fragment setting		X	X	
Respond need experiment		X	X	X
Implant ions in Cryo cell		X	X	

Table 1 : Normal action performed during and experiment (from top to bottom) presenting the area of responsibilities of the different type of actors[1]

AO: Accelerator Operator, NO: Nustar Operator, SE SFRS Expert, PE: Physicist from Experiment

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Table 1 : Normal action performed during and experiment (from top to bottom) presenting the area of responsibilities of the different type of actors[1]

Operator System	UNICOS	RING	HEBT	FAIR C.S.	EPICS Nustar	DAQ Nustar	ID Nustar	Setting calcul.	Implantation	Special Nustar Equipment	Trap
AO	X	X	X	X							
NO				X	X	X	X	X	X		
PE										X	X

Table 2 : Different system knowledge required for the different actors, the different knowledge and skill to acquire justify the two different operators

AO: Accelerator Operator, NO: Nustar Operator, SE: SFRS Expert, PE: Physicist from Experiment

Reduction of the wave function – 2018 beam time

2016 was an important year → last pulse of the old control system (VMS phased out)

Meant obliged to use the new control system for 2018
→ support from ACO (control system group) limited to general application,
→ Super-FRS group supported and developed needs for FRS operation

Status of project in 2016 for FRS/Super-FRS:
1. **new FRS operators for 2018 (new post-docs)**
2. **new concept for control system and operation (driven by machine model)**
3. **new program developed**

→ high risk of crash, we tried to avoid ("mitigate" in Project Management)

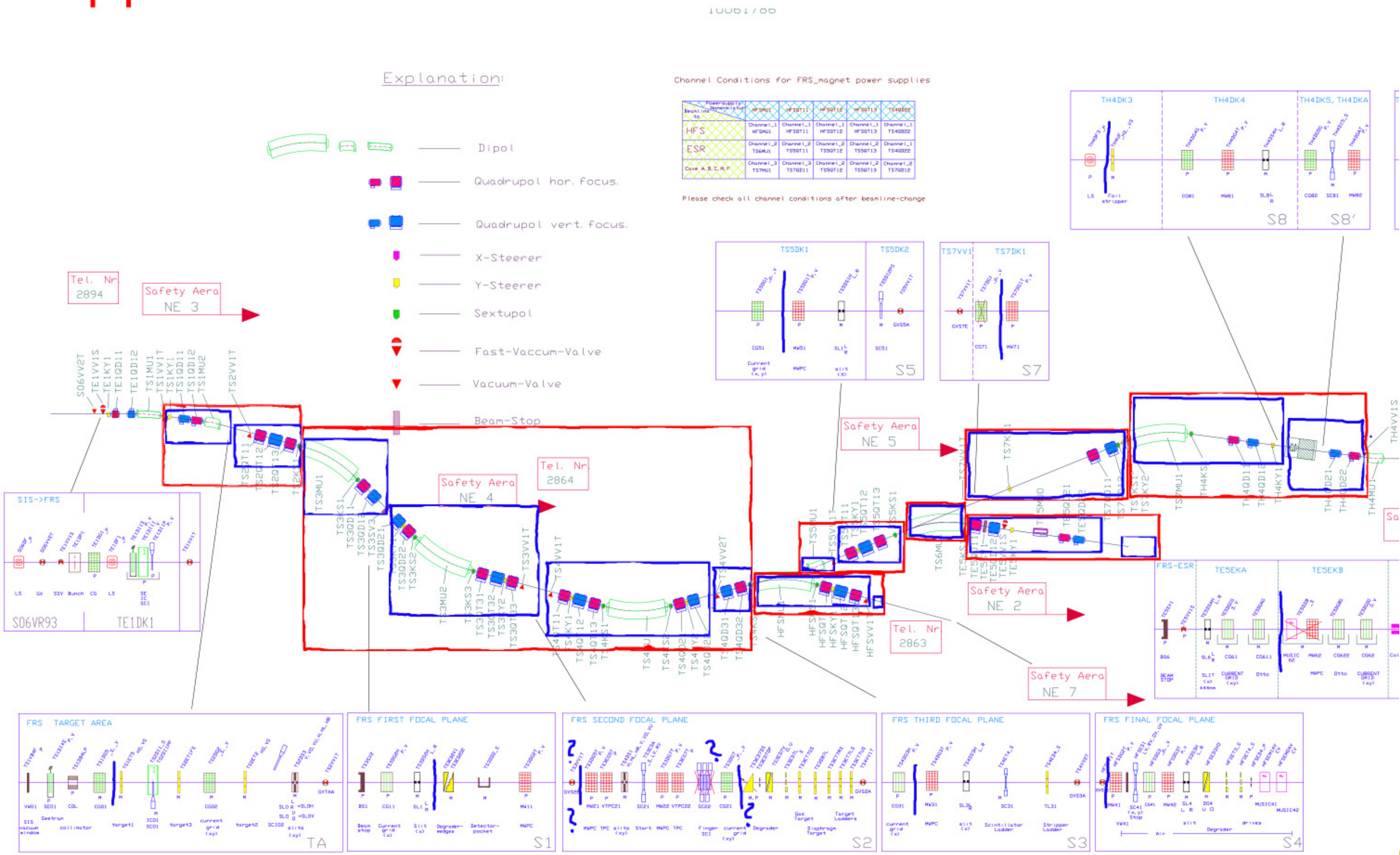
Actions to reduce the risks :
1. **some experienced colleagues will help (Helmut...), trained people in 2016**
2. **possibility to bypass operation with ATIMA, just input Bρ section as before**
3. **Participate in several dry runs**

→ in parallel prepare the specific application to operate the FRS

FRS new mapping

AZ

PT



New application from ACO/LOBI for 2018

Device Control: replacement of SD, but show parameters of individual elements magnets and drives by context and particle transfer (can set drive values with it)

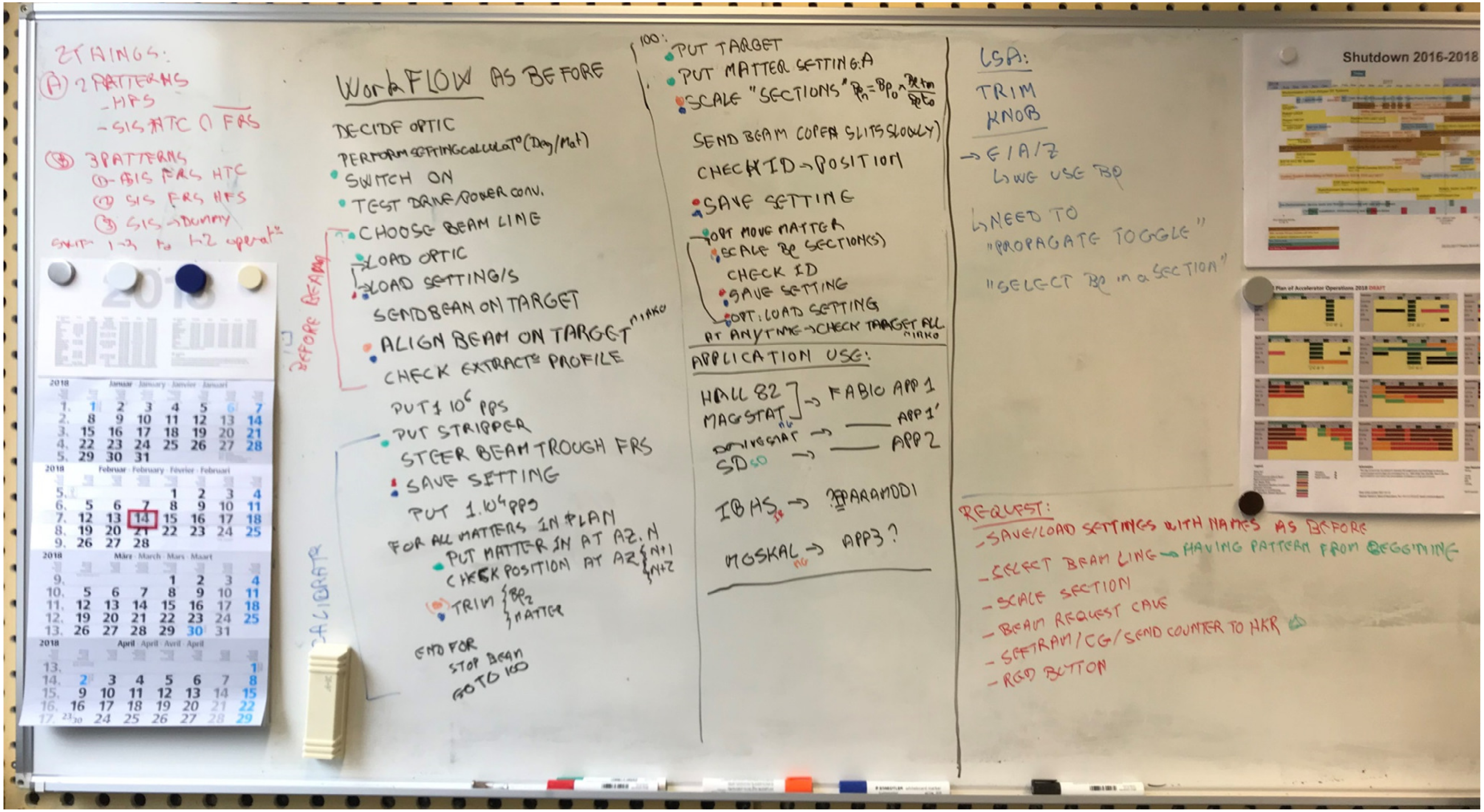
Paramodi: enter parameters to be sent in LSA data base, when sent to LSA if BPC is active then settings will be generated from hardware. Can load and write files of configuration. Optics is define in it (the KL values)

Sequencer: a framework to access variables in the application tier of the control system and bridge user applications to FESA or LSA

Lassie: counter for IC and SEETRAM or pulse we send (last to be tested...)

DGX: Current Grid readout

FRS control system operation planning



FRS control system for 2018 – specific developements

Action	Old control system	New Control System
Set drives	SD	(Device Control)
Set Drives		LSA→ but need special application for to virtually multiplex the drives
Save settings	IBHS	LSA Own scripts
Print magnet status	SD	FMGSTAT
Read hall probes	Hall82/Nodal	FMGSTAT
Read drives	Nodal	FDRIVESTAT
Ramp procedure	MGSKAL	FMGSKAL
SEETRAM, Current Grids	DI	LOBI/ACO specific app.

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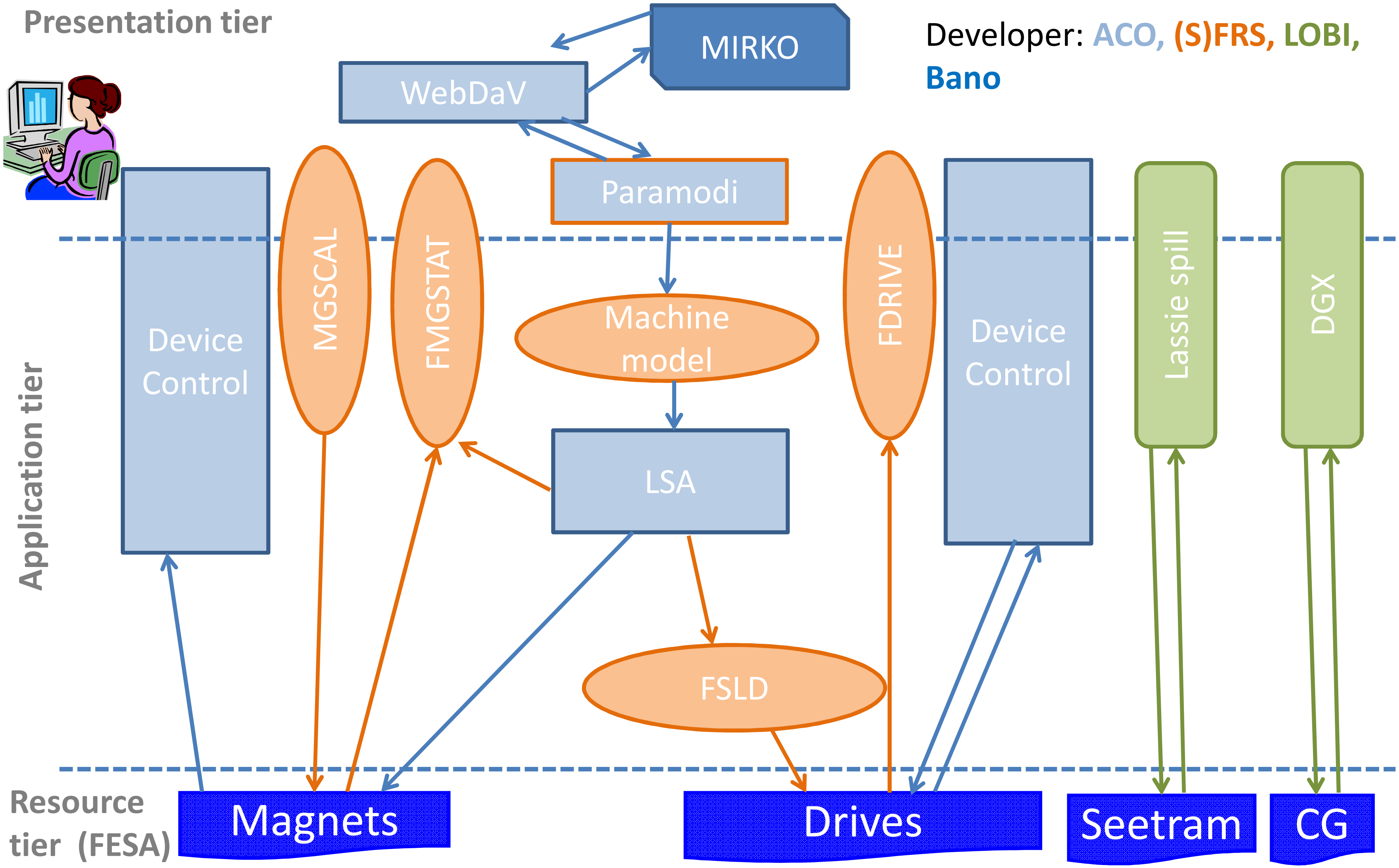
Currently NO protection: means each program controls the FULL Beam Production Chain
→ easy for the operator but <u>NO SAFETY</u> for operation (FRS console access to SIS parameters)

FRS control system – status as of summer 2018

→ **toward hardware: set, towards presentation: read**



FMAGSTAT

MagStat

Pattern SIS18_FAST_HHD_COOLER_20180821 | Chain SIS18_FAST_HHD_COOLER_20180821.C1

Device ID	Status	DC_Mode	I_ist [DC] (A)	I_ist (A)	I_soll (A)	ΔI (A)	BL_ist (T)	BL_soll (T)	KL_soll (T)	Hall Probe (V)
GTE1KY1	1	false	-0.0	-0.0	-0.030945	0.030945	0.000014	0.0	0.0	0.0
GTE1QD11	3	false	-0.0	90.295877	21.152342	69.143535	2.188741	0.515600	0.106997	0.0
GTE1QD12	3	false	-0.0	72.839290	0.000000	72.839289	1.766483	-0.005700	-0.001186	0.0
GTS1MU1	3	false	-0.0	0.210578	287.548339	-287.337761	0.000462	0.630700	0.130900	0.0
GTS1KY1	1	false	-0.0	-0.0	-0.030945	0.030945	0.000014	0.0	0.0	0.0
GTS1QD11	3	false	-0.0	-0.0	67.120306	-67.120306	-0.500000	-2.594000	-0.538341	0.0
GTS1QD12	3	false	-0.0	-0.0	80.835563	-80.835563	-0.500000	3.122100	0.647950	0.0
GTS1MU2	3	false	-0.0	-0.0	131.407930	-131.407930	-0.0	0.630700	0.130900	0.0
GTS2QT11	1	false	-0.0	-0.0	189.167230	-189.167230	-0.0	3.679500	0.764977	0.0
GTS2KY1	1	false	-0.0	-0.0	-0.030945	0.030945	0.000014	0.0	0.0	0.0
GTS2QT12	1	false	-0.0	-0.0	125.396418	-125.396418	-0.0	-2.908600	-0.604706	0.0
GTS2QT13	1	false	-0.0	-0.0	27.213264	-27.213264	-0.0	0.529100	0.110000	0.0
GTS2KS1	1	false	-0.0	-0.0	0.0	-0.0	-0.0	0.0	0.0	0.0
GTS3MU1	1	false	-0.0	-0.0	0.0	-0.0	-0.0	0.0	0.0	0.0

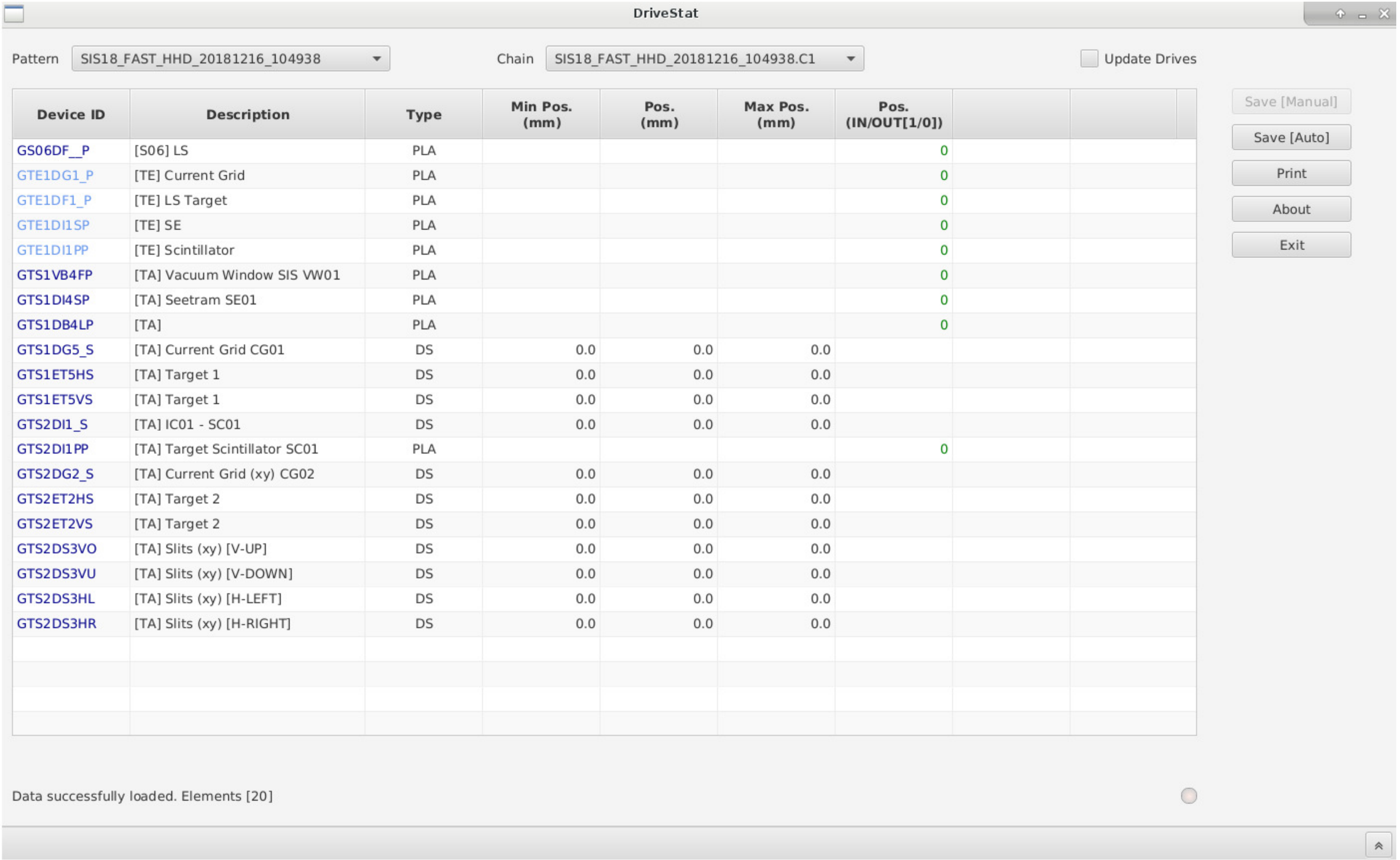
Save [Manual]
Save [Auto]
Print
Graph
About
Exit

Data successfully loaded. Elements [14]

Save in a .txt file, or print the data read in the system

F. Schirru

FDRIVESTAT

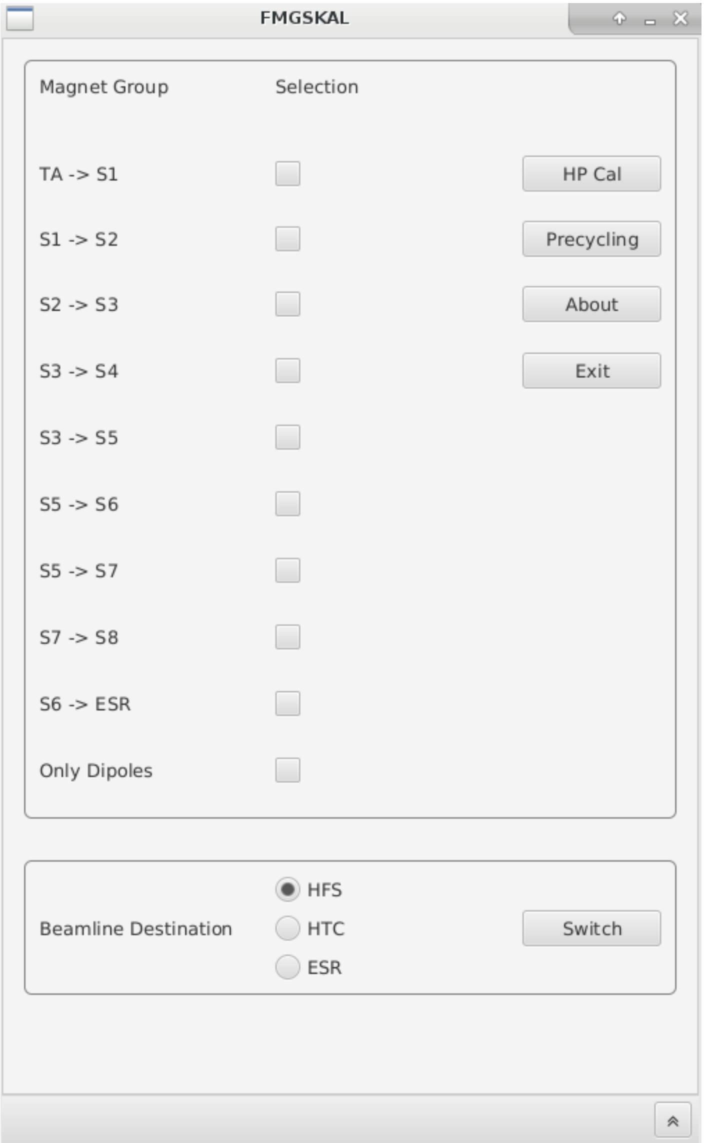


Device ID	Description	Type	Min Pos. (mm)	Pos. (mm)	Max Pos. (mm)	Pos. (IN/OUT[1/0])
GS06DF__P	[S06] LS	PLA				0
GTE1DG1_P	[TE] Current Grid	PLA				0
GTE1DF1_P	[TE] LS Target	PLA				0
GTE1DI1SP	[TE] SE	PLA				0
GTE1DI1PP	[TE] Scintillator	PLA				0
GTS1VB4FP	[TA] Vacuum Window SIS VW01	PLA				0
GTS1DI4SP	[TA] Seetram SE01	PLA				0
GTS1DB4LP	[TA]	PLA				0
GTS1DG5_S	[TA] Current Grid CG01	DS	0.0	0.0	0.0	
GTS1ET5HS	[TA] Target 1	DS	0.0	0.0	0.0	
GTS1ET5VS	[TA] Target 1	DS	0.0	0.0	0.0	
GTS2DI1_S	[TA] IC01 - SC01	DS	0.0	0.0	0.0	
GTS2DI1PP	[TA] Target Scintillator SC01	PLA				0
GTS2DG2_S	[TA] Current Grid (xy) CG02	DS	0.0	0.0	0.0	
GTS2ET2HS	[TA] Target 2	DS	0.0	0.0	0.0	
GTS2ET2VS	[TA] Target 2	DS	0.0	0.0	0.0	
GTS2DS3VO	[TA] Slits (xy) [V-UP]	DS	0.0	0.0	0.0	
GTS2DS3VU	[TA] Slits (xy) [V-DOWN]	DS	0.0	0.0	0.0	
GTS2DS3HL	[TA] Slits (xy) [H-LEFT]	DS	0.0	0.0	0.0	
GTS2DS3HR	[TA] Slits (xy) [H-RIGHT]	DS	0.0	0.0	0.0	

Save in a .txt file, or print the data read in the system

F. Schirru

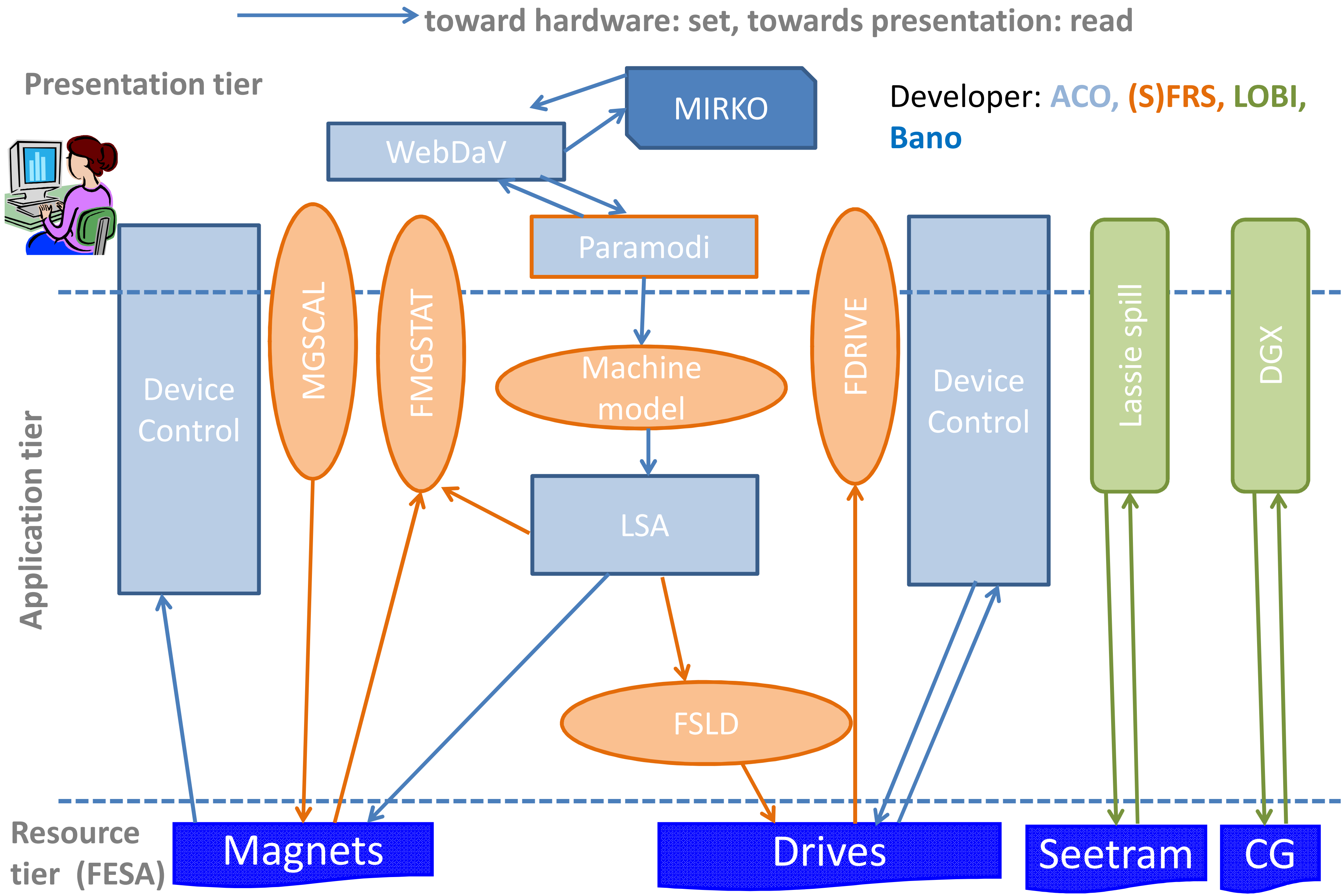
FMGSKAL



- **FMGSKAL is an interface which make uses of the "Sequencer" package.**
- **It is capable of executing the calibration and precycling of the magnets selected via the magnet selection group.**
- **The application needs still to be fully tested.**

F. Schirru, J.P. Hucka

FRS control system – status as of summer 2018



From the 90s.....

.... to the age of smartphones

Thanks