A detailed wireframe model of a particle accelerator, likely the FAIR-DV. The model shows a large, circular ring structure with a complex internal layout of pipes and components. The ring is composed of many segments, and the internal structure is intricate, with various pipes and structures extending from the main ring. The model is rendered in a black and white wireframe style, highlighting the geometric complexity of the facility.

Data Supply: LSA and Applications

GSI Operator Training Course, 12.04.2018

D. Ondreka, FAIR-DV

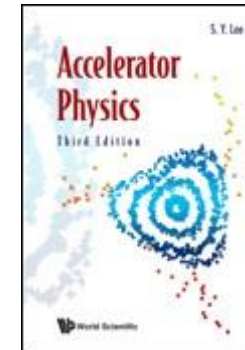
Outline

- Data Supply
- LSA
 - Overview
 - Basic structures
- Machine model
- Applications
 - SchedulingApp
 - ParamModi

Data Supply

- Operation of a complex accelerator requires consistent set values for many devices
 - Intricate relations between physics and device parameters (e.g. tune <-> quad currents, bucket size <-> RF voltage)
 - Set values need to be executed synchronously for the accelerator to work properly
 - Modifications of set values to adjust the accelerator based on observations are necessary

- Scope of Data Supply
 - Calculation of consistent set values for all devices of the accelerator based on a **machine model** providing an abstraction of the accelerator in terms of **physics parameters**
 - Provision of **tuning parameters** for adjusting the accelerator to compensate unavoidable deviations from the ideal machine behaviour
 - Provision of **applications** to initialize and manipulate the set values of the accelerator



Machine Model

Tasks:

- Representation of the accelerator by a set of **physics parameters**, hiding hardware details of individual devices
 - Beam parameters (E, A, Q) instead of dipole currents or frequencies
 - Tunes (Q_h , Q_v) instead of quadrupole currents
 - Angles instead of steerer currents
- **Algorithms** for conversion of physics values to hardware values
 - Integration of accelerator physics knowledge
 - Integration of device properties
 - Checking of hardware limitations
 - Determination of a consistent time evolution
- **Tuning parameters** for deviations from the ideal machine
 - Anticipation of possible deviations
 - Development of correction schemes
 - Interface for beam based corrections

Prerequisites:

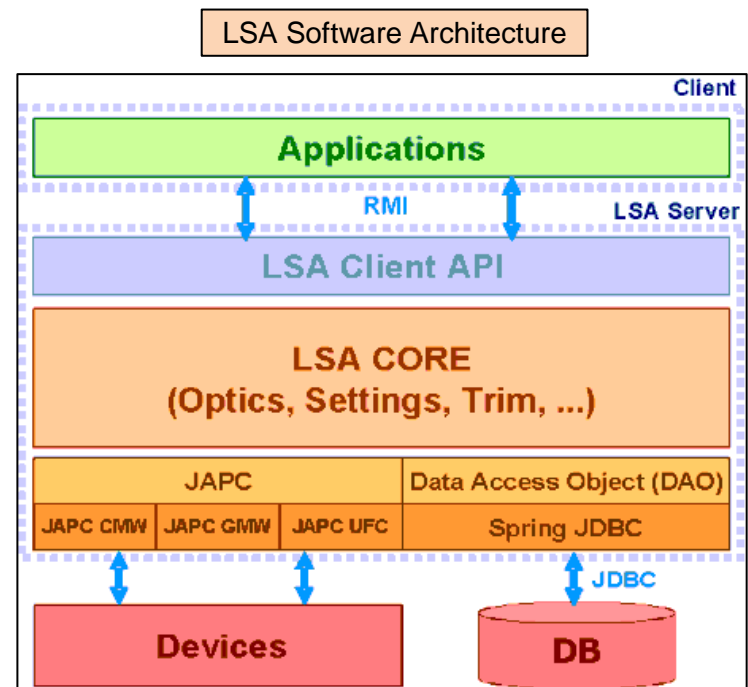
- Device related data
 - Hardware limits (min/max values)
 - Calibration curves
 - Conversion factors
- Machine physics data
 - Accelerator geometry
 - Circumference
 - Distances between devices
 - Ion optical data
 - Optical strength of magnets
 - Twiss parameters
 - Global optics parameters (tune, chromaticity)

How can such a machine model be implemented?

LSA: Overview

- Framework for accelerator modeling
 - Developed by CERN and now maintained and extended by CERN/GSI collaboration
 - Java based 3-tier architecture
 - Generic structures for representing accelerators
 - Management of device and layout data in DB

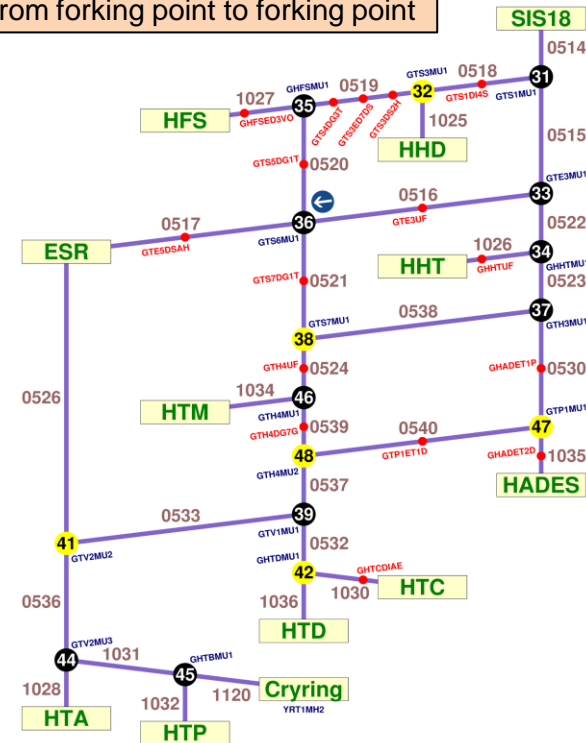
- Advantages of LSA
 - Modern, maintainable architecture
 - Separation of physics and software technique
 - Access to all data via standard Java interfaces
 - Business logic separated from applications
 - All set values in DB including history



LSA: Basic Structures (I)

- Particle Transfer
 - Section of accelerator with identical timing
 - Same as timing group for timing system
- Beam Process
 - Temporal section within a particle transfer with specific purpose (e.g. Injection, Ramp, Extraction, Transfer, ...)
 - Atomic *Context* in LSA
 - Distinction between beam processes with (BEAM_IN) and without beam (BEAM_OUT)
- Parameter
 - Physics or hardware quantity
 - Associated with a device
 - Name typically <DEVICE>/<QUANTITY>
- Setting
 - Value of a parameter in a beam process
 - Sum of *TARGET* und *CORRECTION*
 - Physics parameters don't have values in BEAM_OUT, while hardware parameters do
 - Internally all values in (adapted) SI units

Particle transfers in GSI_HEBT: from forking point to forking point



Setting of energy in SIS18

Parameter	SIS18BEAM/E
Beam Process	P.C1.SIS18_RING.RING_INJECTION.1
TARGET	11400000
CORRECTION	0.0

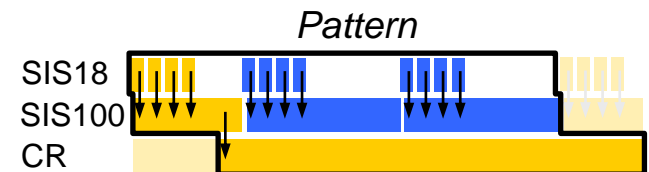
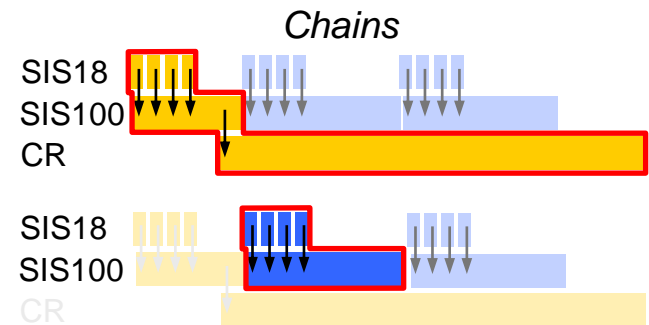
eV/u !

LSA: Basic Structures (II)

- Beam Production Chain
 - Set and temporal relation of all beam processes required for the production of a certain beam
 - Represents acceleration cycle including beam transport over transfer lines
 - Not executable on its own
 - *Context* for aggregation of beam processes

- Pattern
 - Grouping of chains
 - Intended to represent the periodic production of several beams in parallel
 - Executable unit for timing system
 - *Context* for aggregation of chains

- Present limitations
 - Only one chain per pattern
 - Such a pattern is equivalent to the former VirtAcc



LSA: Basic Structures at SIS18 (I)

LSA basic structures as seen on ParamModi Trim view

Parameter selection - SIS18_RING

Parameter Groups

- TOPLEVEL
- BEAM
- BI
- BUMPER
- BYPASS
- CORRH
- CORRV
- DIPOLE
- KICKER
- KO
- OPTICS
- ORBIT
- QUADCORR
- QUADRUPOLE
- RF
- SEPTUM
- SEXTUPOLE
- SYSTEM
- TIMEPARAM

Type Groups

- ALPHAC
- ALPHADR
- BRHO
- BRHODOT
- BUNCHFACOR
- CHROMATICITY
- CHROMATICITY_TH
- DCHROMATICITY
- DELTA
- DPBL
- DPDR
- DPFREV
- DTUNE
- ERHO
- ETA
- FREV
- GAMMA
- GAMMA_T

Parameters

Filter: SIS18BEAM/BRHO

Setting part: Value Target Correction

Trim History

Time base: Pattern BeamProcess Injection

Displayed Function: SIS18BEAM/BRHO

Physics parameter SIS18BEAM/BRHO with no settings in BEAM_OUT (grey)!

LSA: Basic Structures at SIS18 (II)

SIS18 pattern to HFS as seen on pattern display in ParamModi main tab

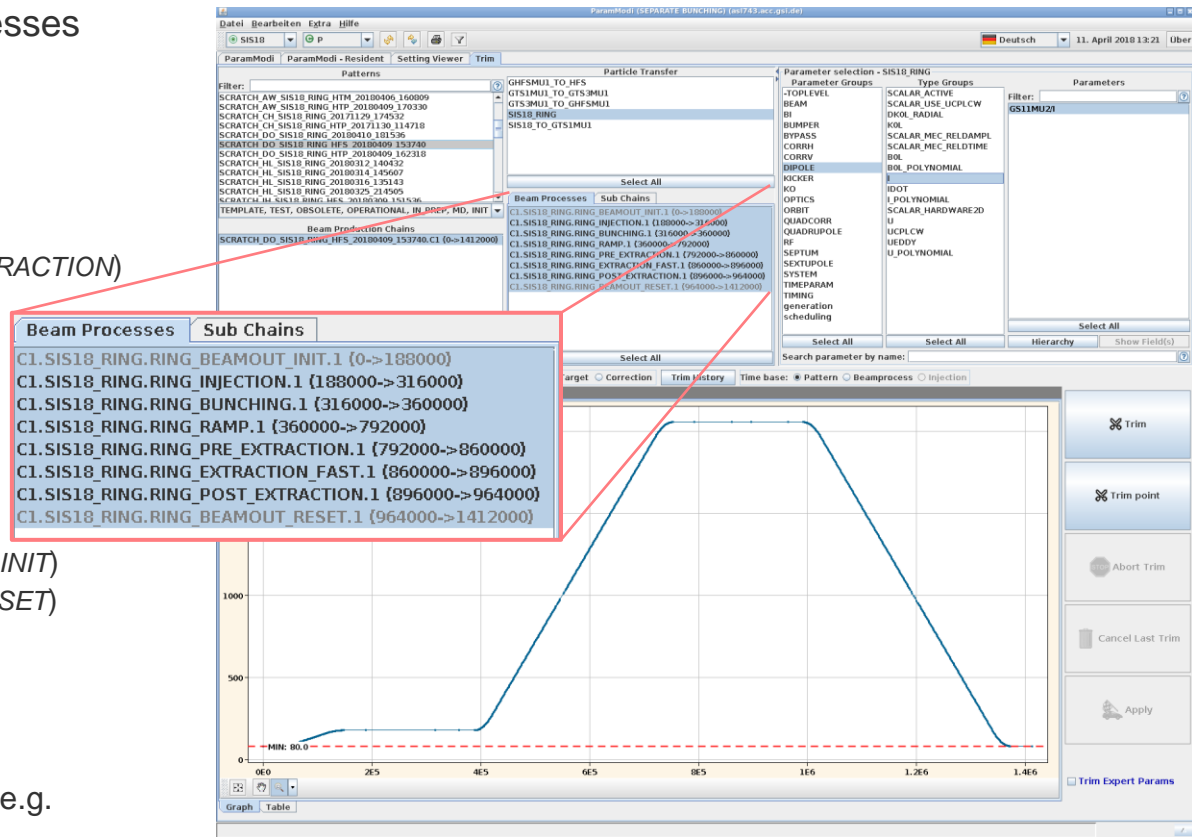
SIS18 patterns in ParamModi context selection panel



LSA: Basic Structures at SIS18 (III)

ParamModi/Trim: SIS18 pattern with fast extraction

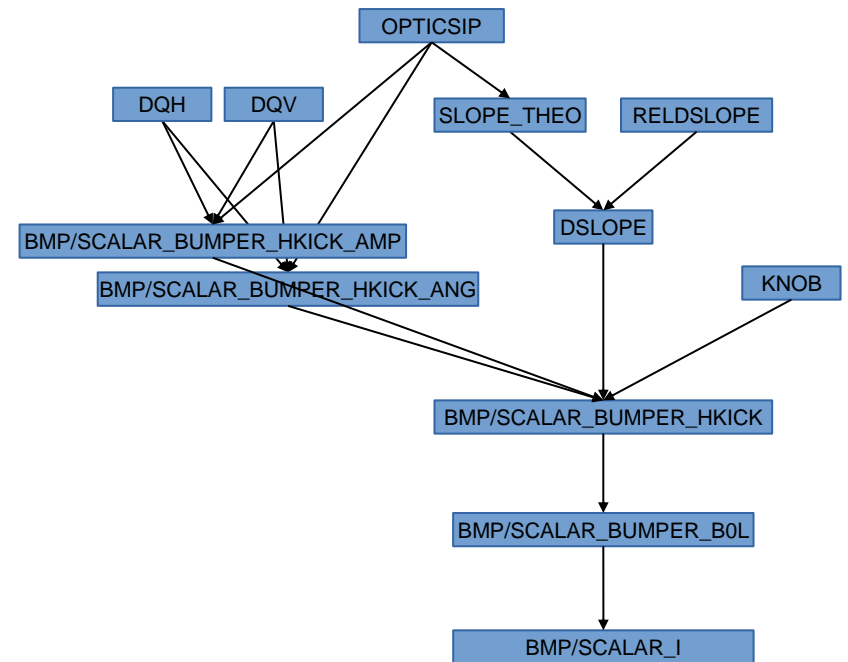
- Division of SIS18 chain into beam processes according to *purpose* of the section
 - Beam processes with beam
 - Injection (*RING_INJECTION*)
 - RF capture (*RING_BUNCHING*)
 - Acceleration (*RING_RAMP*)
 - Preparation of extraction (*RING_PRE_EXTRACTION*)
 - Extraction (several purposes)
 - *RING_EXTRACTION_FAST*
 - *RING_EXTRACTION_SLOW*
 - *RING_EXTRACTION_KO*
 - Finalization of extraction (*RING_POST_EXTRACTION*)
 - Beam processes without beam
 - Preparation of injection (*RING_BEAMOUT_INIT*)
 - Return to initial state (*RING_BEAMOUT_RESET*)
 - Further purposes for special manipulations
- Standard chains for operation
 - Definition by modelers
 - Special sequences require special chains, e.g.
 - two ramps in one cycle
 - RF manipulations like bunch merging
 - Selection in SchedulingApp (see later)



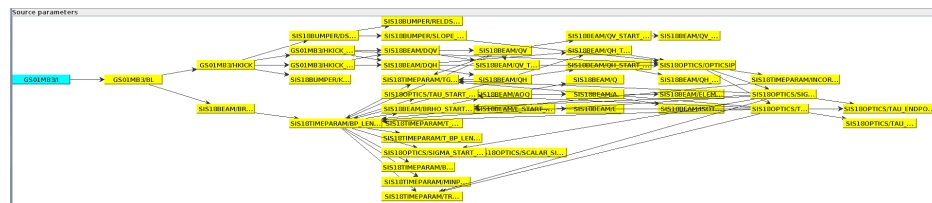
Machine Model: Parameter Hierarchy

- Explicit representation of the relation between parameters for the calculation of values
- Calculation from physics to hardware
 - Control of accelerator via physics parameters
 - Algorithms implemented as Java classes
 - Usage of data from DB (optics, calibrations, etc.)
 - Machine model uses *TARGET* only
 - ParamModi sets *TARGET* values
 - Calculations return *TARGET* values
 - Additive *CORRECTION* possible at each level
 - Supposed to be used for
 - inaccuracies of model
 - erroneous behavior of devices
 - No reverse calculation of explicit corrections
 - CORRECTION* trims only accessible via Trim
- Hierarchy can be displayed in ParamModi
 - Hierarchy button on Trim view
 - But beware: may catch huge number of params!

Example hierarchy: SIS18 injection bump (sketch)

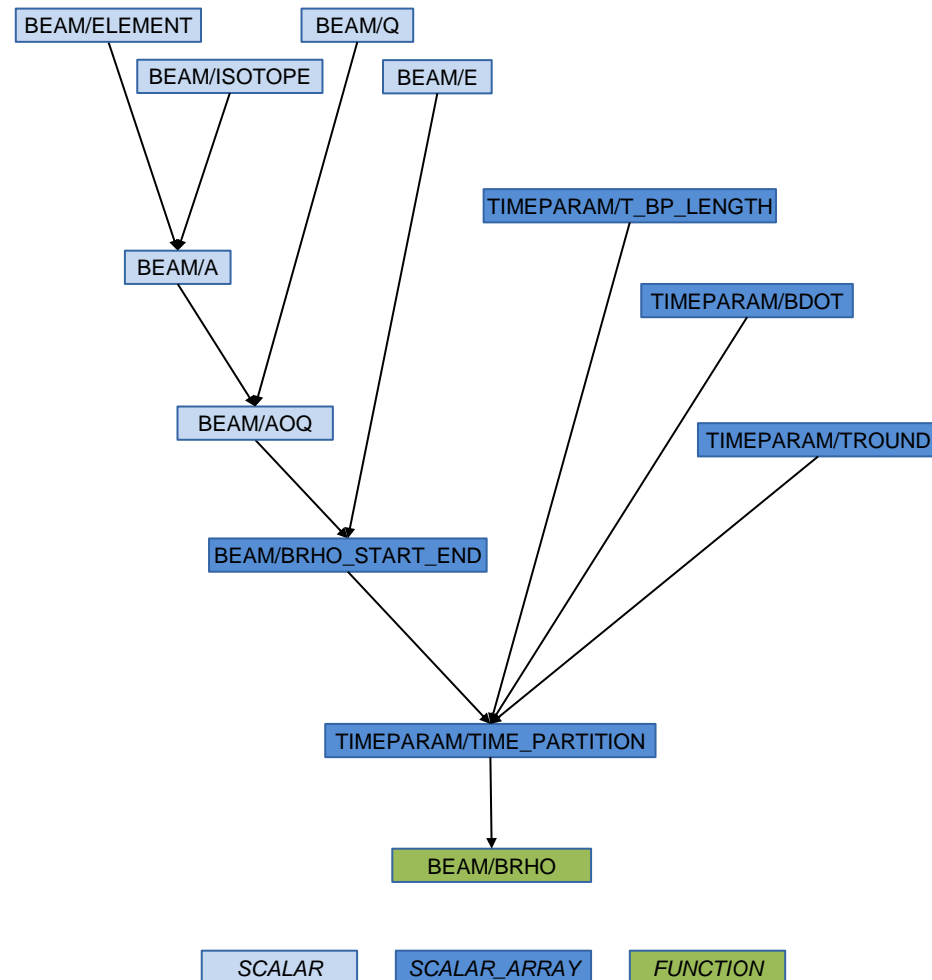


Full hierarchy of GS01MB3 as seen in hierarchy view



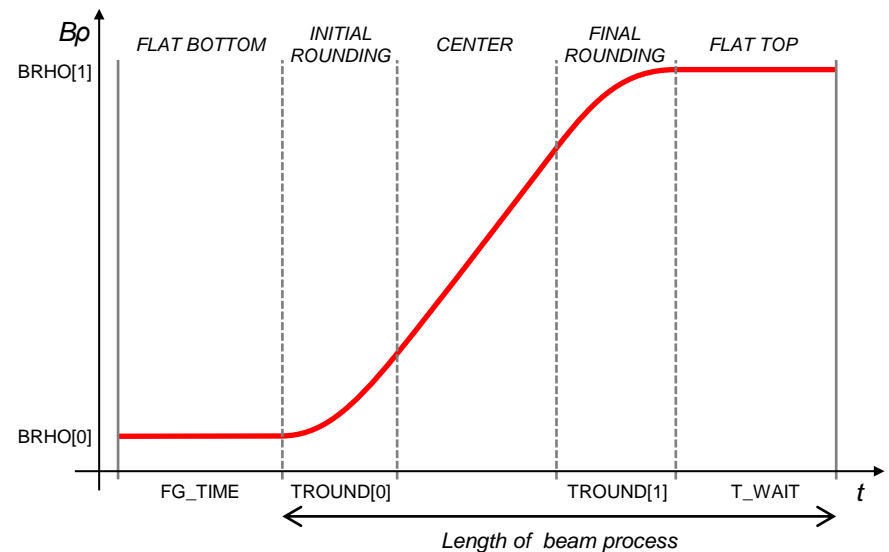
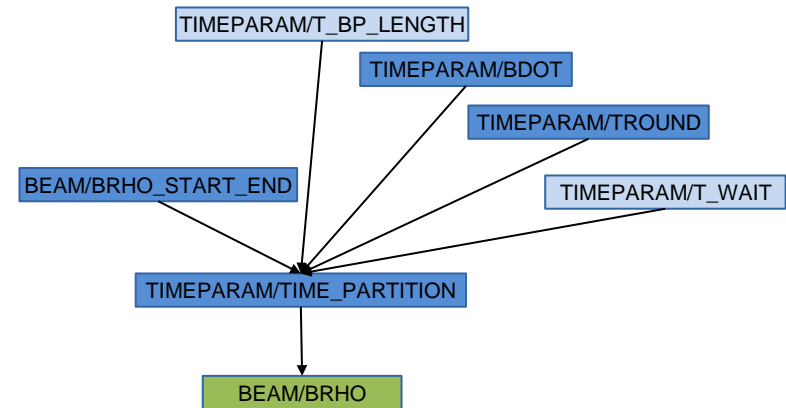
Machine Model: Top-Level Scalars

- Operation of rings requires time dependent set values
- Cycle skeleton needs to be created from scalar inputs
 - Beam parameters
 - Ion type, mass, charge
 - Injection and extraction energy
 - Particle number
 - Machine parameters
 - Tune and chromaticity
 - RF: Harmonic, bucket size
 - Time parameters
 - Bunching time, extraction time
 - Ramping speed
 - Rounding time



Machine Model: Transition to Functions (I)

- Each beam process partitioned into up to five segments
- Dipole field ramps
 - E.g. for acceleration/deceleration
 - Field ramp calculated based on
 - Ramping speed
 - Time parameters
 - Length of ramp is calculated accordingly
- Constant dipole field
 - Other parameters might change
 - Orbit bumps, tune, chroma
 - RF bucket size, RF manipulations



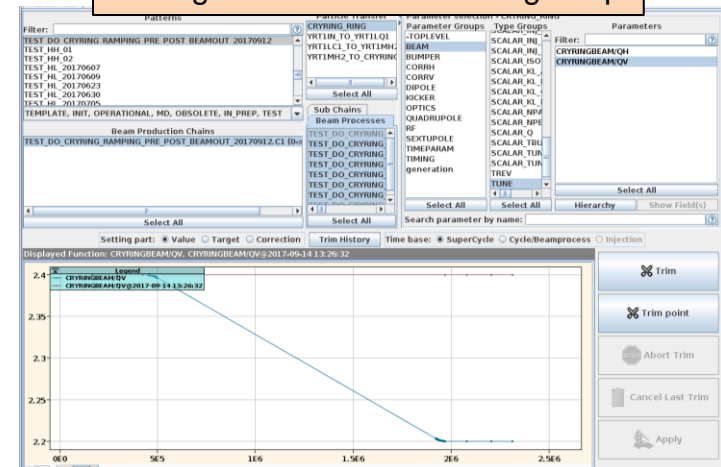
Machine Model: Transition to Functions (II)

- Top-level scalars typically define values in certain beam processes
 - Beam parameters (energy, tune, chroma, ...): injection and end of ramp
 - RF parameters (bucket fill factor, ...): injection, bunching, ramp, storage
 - Time parameters (ramping speed, ...): ramp, init, reset
- Transition to time functions through rules
 - Beam energy
 - Typically change of all time functions through make rules (link rules in beam-out)
 - Time parameters (e.g. ramping speed)
 - Typically change of all time functions through make rules, but only in affected BP
 - Optics and device parameters
 - Changes due to incorporation rules
 - Configuration per BP purpose
 - Changes e.g. during *RING_RAMP*, *RING_PRE_EXTRACTION*
 - Constant during *RING_INJECTION*, *RING_BUNCHING*, *RING_EXTRACTON_**

Change of flat-top energy



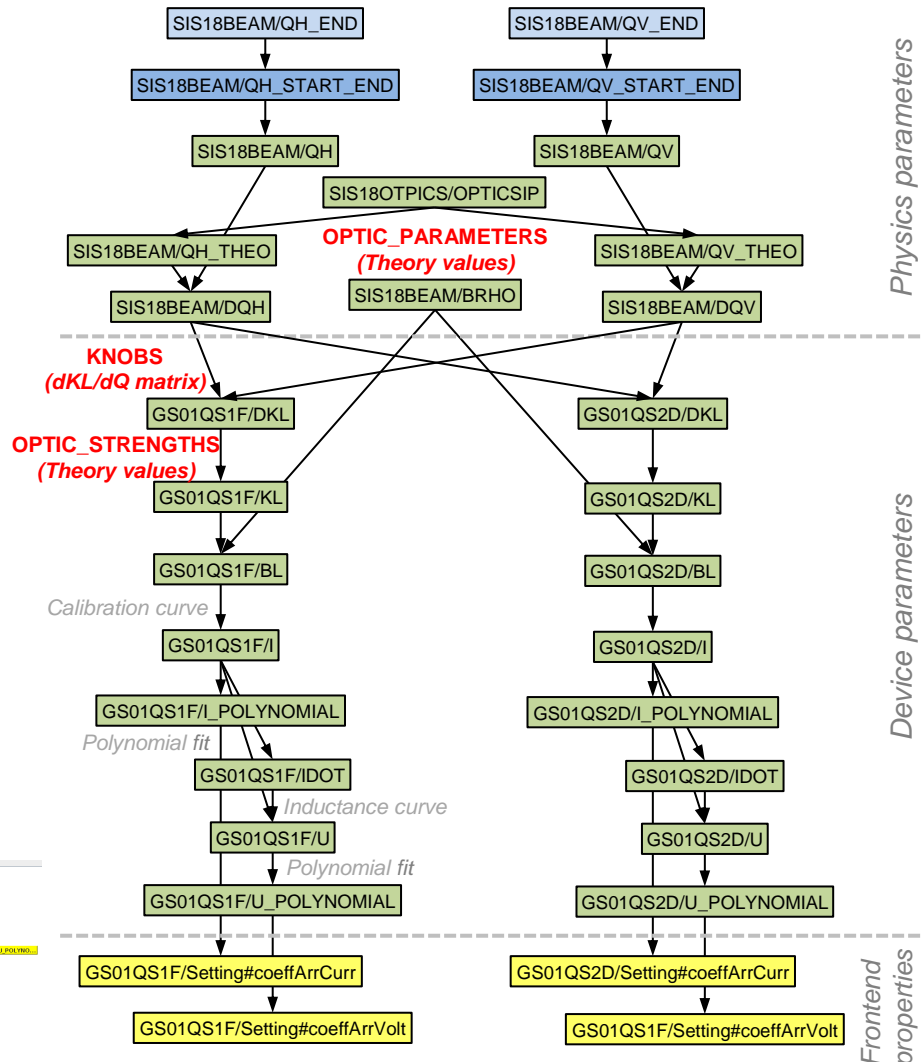
Change of vertical tune during ramp



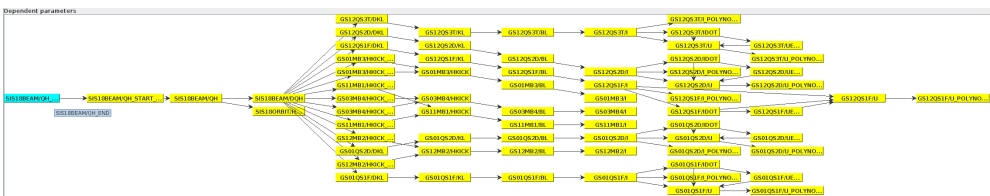
Machine Model: Tune Hierarchy

- Linear tune model
 - Theory strengths KL_0 and tunes $Q_{(h,v)0}$
 - Tune changes through matrix: $\Delta KL = dKL/dQ_h \cdot \Delta Q_h + dKL/dQ_v \cdot \Delta Q_v$
 - All data obtained from off-line simulations
 - One-way hierarchy: tunes \rightarrow strengths
- Optics tables used for tune hierarchy
 - OPTIC_STRENGTHS: theory strengths
 - OPTIC_PARAMETERS: theory tunes
 - KNOBS: tune matrix coefficients
- Calculation in make rules
 - Optics data retrieved from LSA DB
 - Device data retrieved from LSA DB
 - Calibration curves, limits, precision

SIS18: Hierarchy of tunes and quadrupoles (sketch)

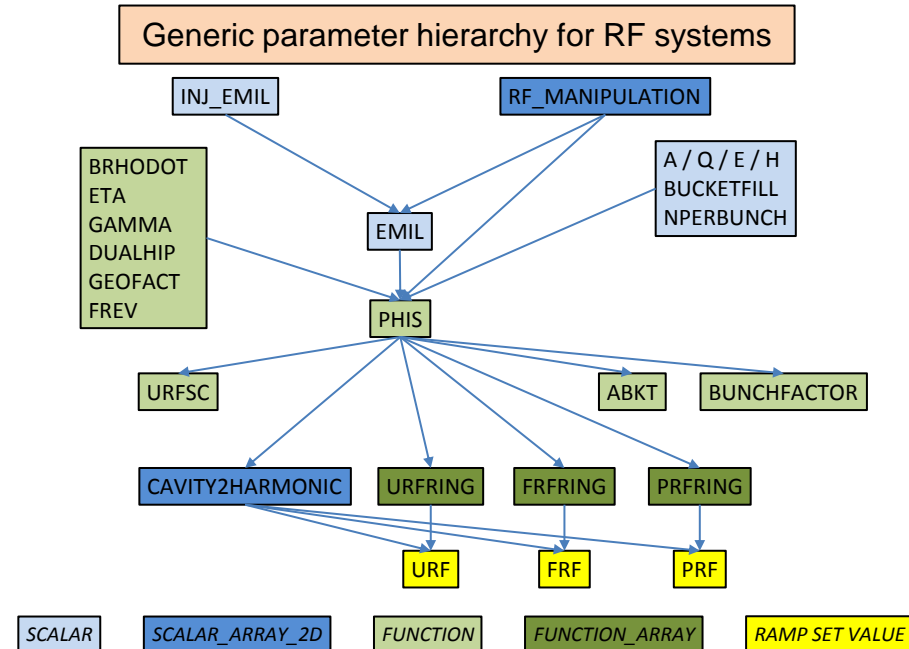


Hierarchy display: Hierarchy below SIS18BEAM/QH_END

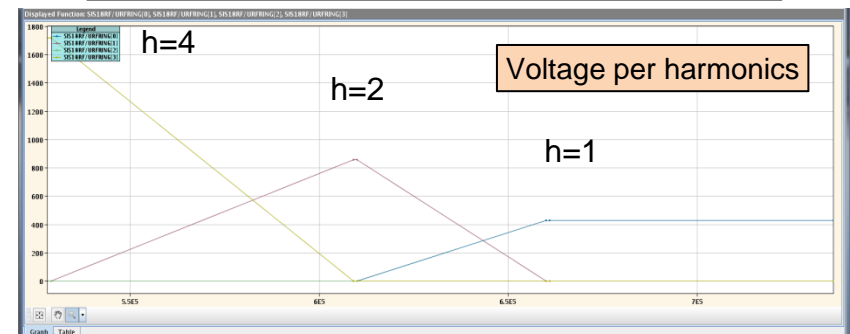


Machine Model: RF Hierarchy

- Calculations for RF among the most complex in the ring hierarchy
 - Multi-harmonic operation
 - RF gymnastics (merging, compression)
- Model driven by physics parameters
 - Input parameters
 - Beam: A, Q, E, emittance, #bunches, #particles
 - RF: h, bucket size, fill pattern, RF manipulations
 - Ramp: dB/dt, gamma, phase slip
 - Algorithms
 - Calculation from first principles
 - Lookup table for 2-h bucket calculations
 - Inclusion of space charge corrections
 - Output parameters
 - Ramp set values for cavities and master
 - Grouping of cavities according to harmonics
 - Additional physics quantities (SC voltage, bunching factor)



Bunch merging in SIS18: RF amplitude ramps



Creation of Patterns: Strategy

- Theory values stored in **Init Beam Processes**

- Contain values for all top-level parameters which need to have a setting
- Beam parameters are excluded, have to be filled in during pattern creation in **SchedulingApp**
- Values in INIT BPs maintained by modelers

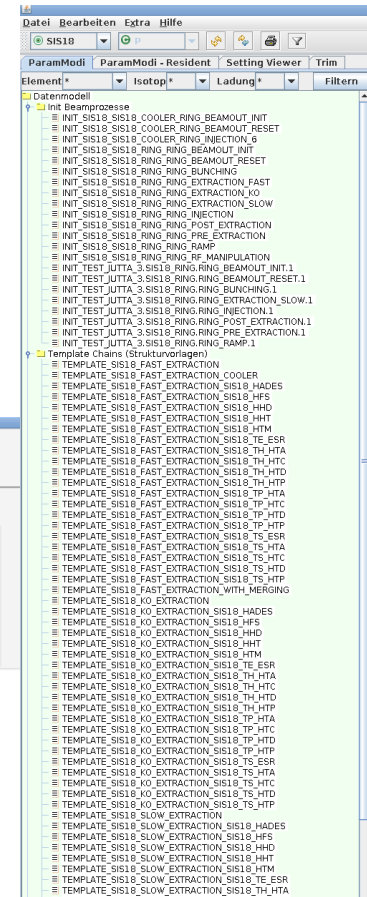
- Beam process structure for chain defined via **Template Chains**

- Contains only beam processes and the definition of their temporal relations
- Predefined by modelers for all operational cases
- Depend on structural selection criteria
 - SIS18 extraction type (fast, slow, KO)
 - Electron cooler usage
 - Bunch merging for single bunch creation
 - Transfer line to target

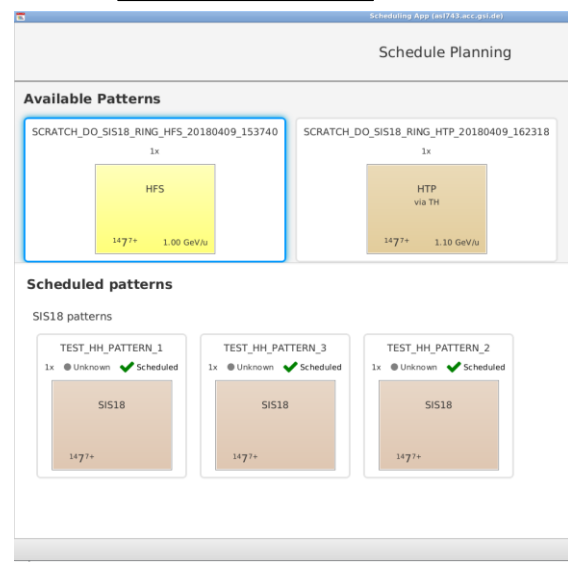
- SchedulingApp**

- General planning tool for patterns
- Used in particular for
 - creation of new patterns
 - scheduling of patterns for execution

Init BPs and Template Chains

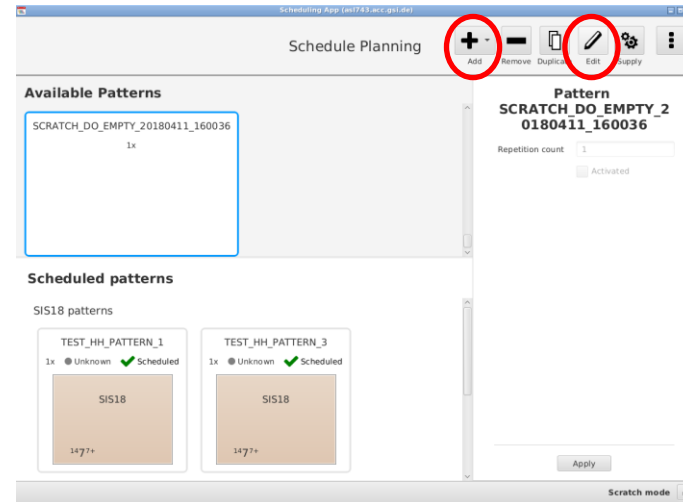


SchedulingApp

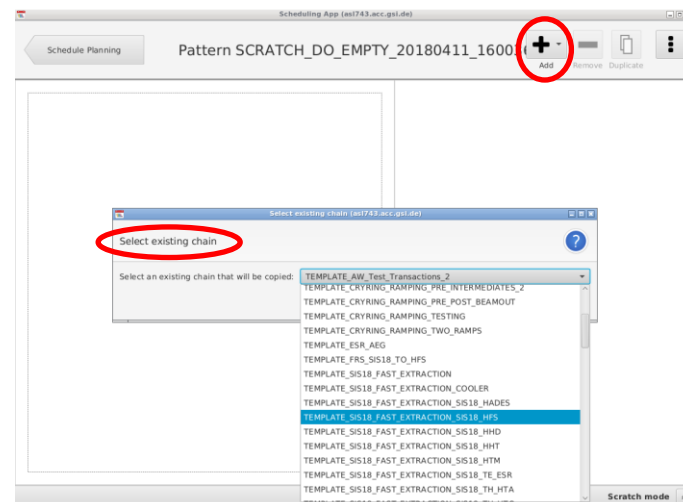


SchedulingApp: Pattern Creation (I)

- Procedure to create new pattern (as of today)
 - Create empty pattern
 - Go to pattern editor
 - Create chain
 - Select appropriate template chain
 - Drop-down menu
 - Based on naming convention
 - Enter missing values
 - Unilac Virtacc
 - Ion type, beam energy
 - Extraction time
 - Optics for transfer line
 - Change predefined values if desired
 - Add chain to pattern
- SchedulingApp is work in progress
 - Expect improved workflow in the future
 - Selection of template chain will be simplified
 - Selection of ion species from drop-down
 - Selection of Unilac Virtacc based on info in IPD
 - Omission of some intermediate steps

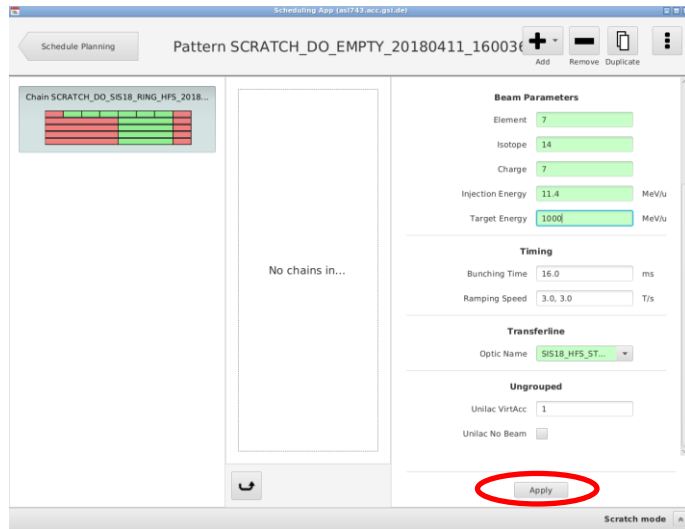


1. Planning view:
Creation of new pattern

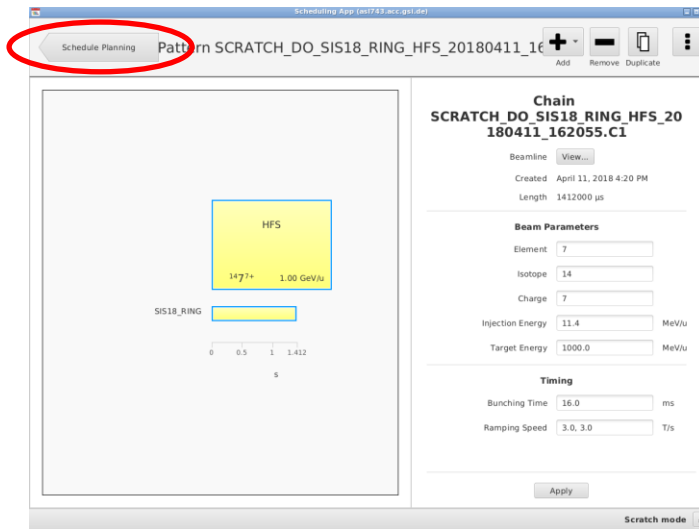


2. Edit view:
Selection of template chain

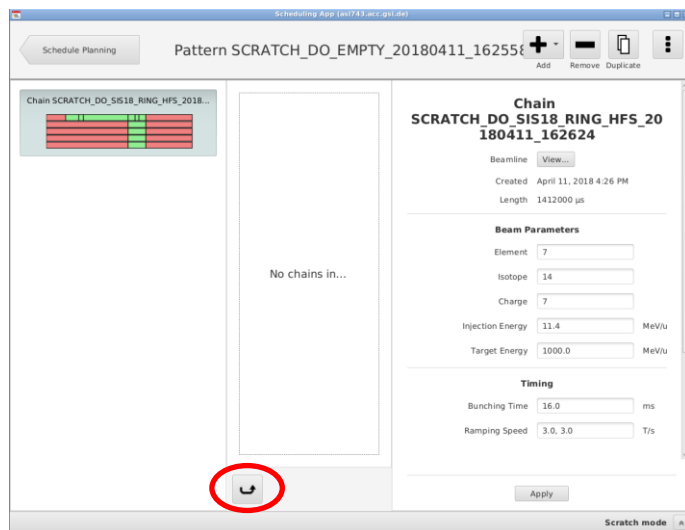
SchedulingApp: Pattern Creation (I)



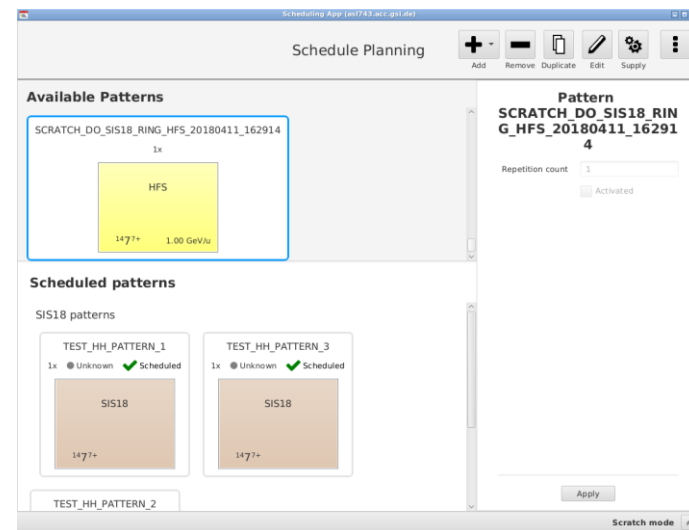
3. Edit view:
Definition of
input value



5. Edit view:
Return to
planning view



4. Edit view:
Chain added
to pattern



6. Planning view:
Pattern ready
for scheduling

CAVEAT:
Settings only in
LSA DB at this
stage, not yet
sent to devices!

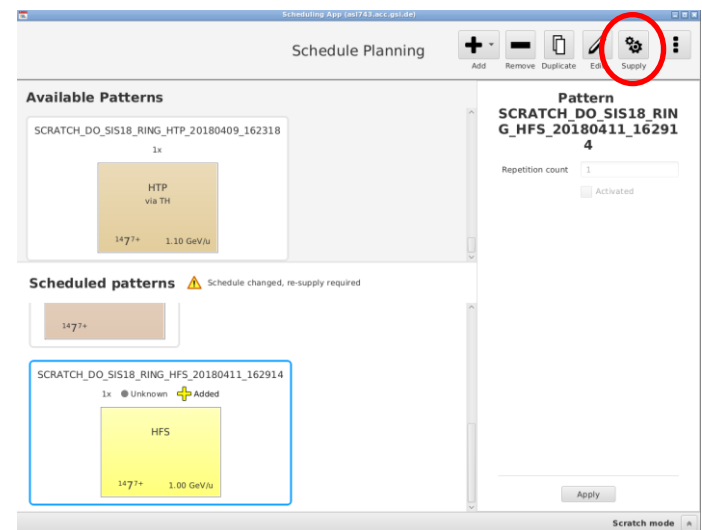
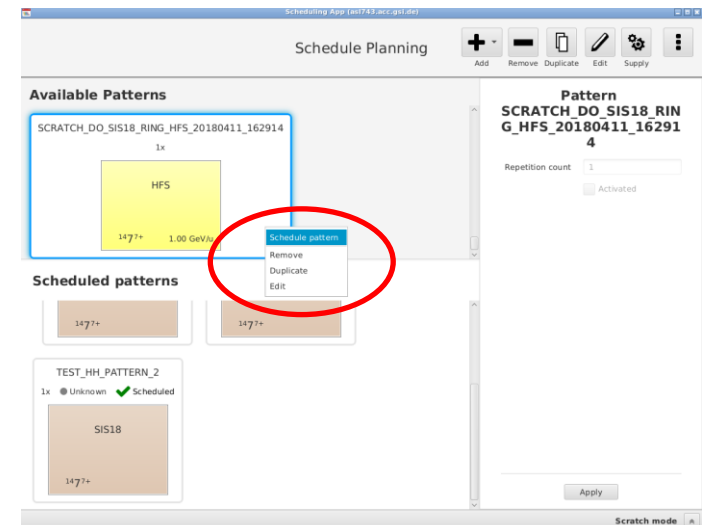
SchedulingApp: Modifying Super-Cycle

- Procedure to add pattern for execution
 - Select pattern
 - Context menu “Schedule Pattern”
 - Button “Supply” to finish

- Similar for removing patterns

- What happens during supply?
 - Timing system stopped
 - All set values sent from DB to devices (only when adding pattern)
 - New timing program sent to timing system
 - Timing system activated again

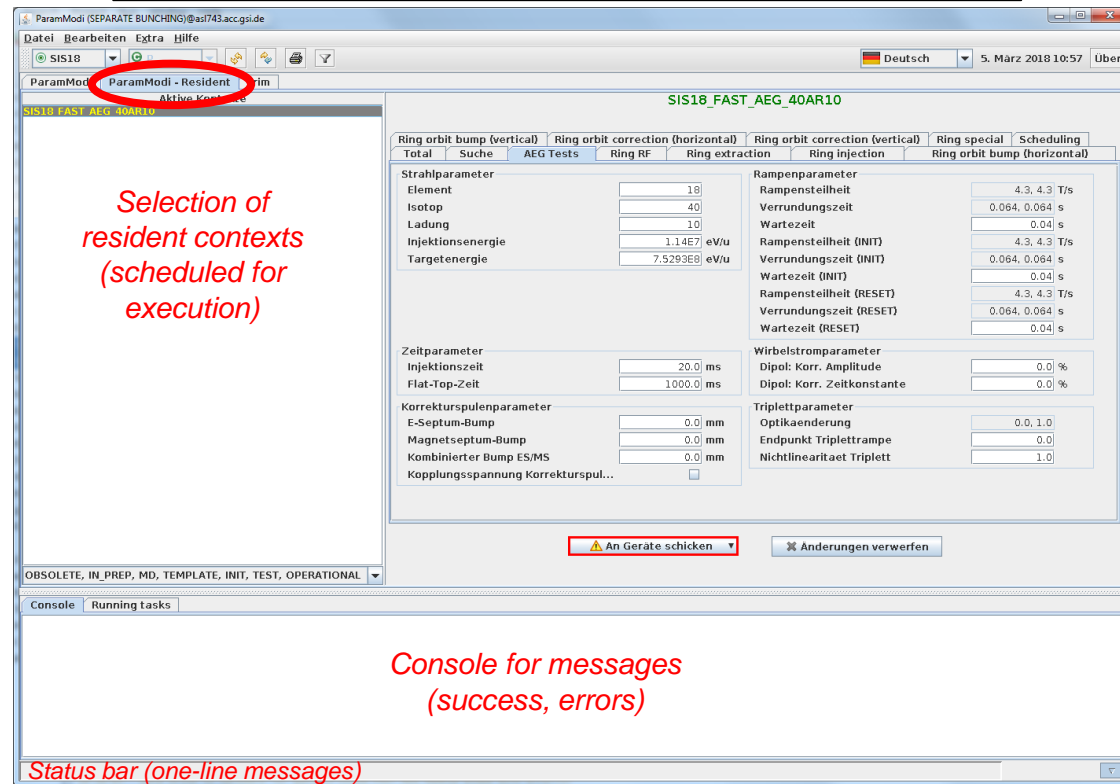
- Limitations of scope of SchedulingApp
 - Only definition of desired status of accelerator execution
 - No real-time information on actual execution
 - Intentional decision
 - Other tools needed for displaying actual status



ParamModi: Operator Interface to Model

- Abstraction layer above parameters of the model
 - Input fields for top-level scalars
 - Combination of parameter and BP
 - Identification via display name
 - E.g. “Injektionsenergie” <-> SIS18BEAM/E in injection BP
- Grouping of input fields
 - Tabs for different functionalities (e.g. injection, extraction, RF)
 - Sub-grouping on tabs possible
 - Configurations defined by modeler
 - Generic standard configurations
- Views for offline and resident patterns
 - Resident view for operation
 - Offline view mainly for modelers
- Configuration is work in progress
 - Tabs for standard operation will be defined until DR8

ParamModi Resident View: Parameters for SIS18 AEG-Tests



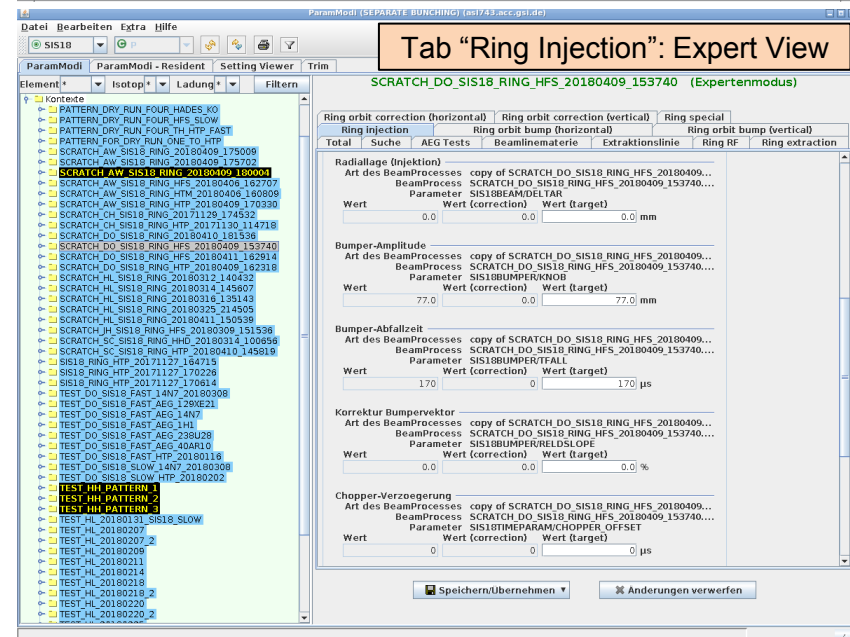
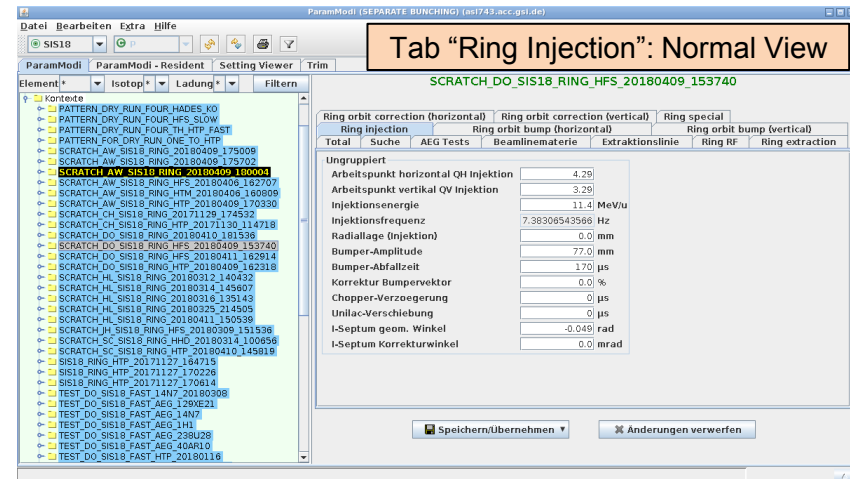
Selection of resident contexts (scheduled for execution)

Console for messages (success, errors)

Status bar (one-line messages)

ParamModi: Input Fields and Parameters

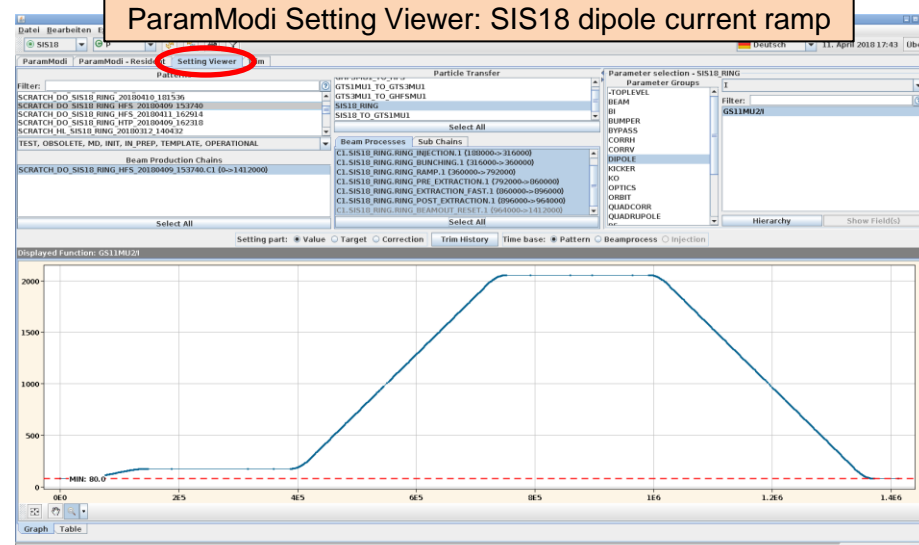
- Disadvantage of abstraction
 - Relation to parameter and BP not obvious
 - Can only be seen on expert view
- Expert view
 - Available via Menu “Extra/Expertenmodus”
 - Displays additional information on input field
 - Display name (same as on normal view)
 - Beam process
 - Parameter
 - TARGET and CORRECTION value (CORRECTION should always be zero, though)
- Searching for input fields/parameters
 - Search button
 - Based on display name and parameter name
- Work in progress
 - Additional functionality for easier access to underlying parameters planned



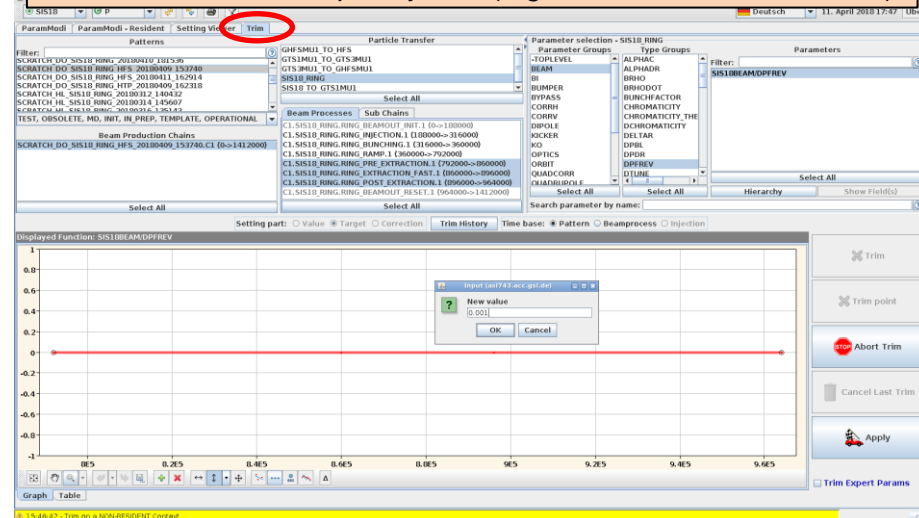
ParamModi: Setting Viewer and Trim

- Direct access to settings per parameter
 - Parameters grouped according to
 - Parameter Groups: Categories of parameters for devices with similar functionality (e.g. dipoles, quadrupoles, RF, etc.)
 - Parameter Type: Specifying the kind of quantity the parameter represents (e.g. strength, current, frequency, etc.)
 - Selection of subsets of beam processes possible
- Setting Viewer
 - Mainly used for inspecting function settings
 - No modifications possible
 - Includes buttons to activate
 - hierarchy view
 - trim history view
- Trim
 - Modifications of parameters (even functions)
 - Expert tool, not intended for standard operation
 - Changes not visible on normal view!
 - Use with care...

ParamModi Setting Viewer: SIS18 dipole current ramp



ParamModi Trim: Frequency shift (e.g. for chroma measurement)



ParamModi: Parameters for SIS18

- Beam parameters
 - Energie
 - Injection, end of ramp
 - Independent of Unilac energy setting
 - Tunes (Q_h , Q_v) and chromaticity (C_h , C_v)
 - Injection, end of ramp, end of pre-extraction
 - Radial displacement (const. energy)
 - Injection, end of ramp
 - Momentum spread at injection (coasting beam)
 - Defines long. emittance, which is used as unit of RF bucket size
- RF parameters
 - Relative bucket size (in units of long. emittance)
 - Specification of boundary values in BPs
 - Ramping not in all BPs possible (e.g. injection)
 - *Note: RF voltage not an input parameter*
 - *Calculated by model from*
 - *long. emittance and rel. bucket size*
 - *ramp rate (during acceleration)*
- Timing parameters
 - Ramp rate
 - Only in BPs with **changing field**
 - Specification of rate dB/dt at start and end of ramp
 - Multi-turn injection
 - Injection pulse length and position
 - Bumper ramp-down time
 - Bunching time
 - Extraction time for slow extraction
- Slow extraction parameters
 - Sextupole amplitude and phase
 - Tune variation or KO parameters
 - Extraction bumps
- Fast extraction parameters
 - Kicker angle and phase
 - Extraction bumps
- Orbit correction
 - Local bumps at injection and flat-top

To be found on appropriate tabs in ParamModi starting from DR8...

ParamModi: SIS18 Tabs (DRAFT)

SCRATCH_DO_SIS18_RING_HFS_20180409_153740

Injection

Ring orbit correction (horizontal)		Ring orbit correction (vertical)		Ring special		
Ring injection		Ring orbit bump (horizontal)		Ring orbit bump (vertical)		
Total	Suche	AEG Tests	Beamlinematerie	Extraktionslinie	Ring RF	Ring extraction
Ungruppiert						
Arbeitspunkt horizontal QH Injektion	<input type="text" value="4.29"/>					
Arbeitspunkt vertikal QV Injektion	<input type="text" value="3.29"/>					
Injektionsenergie	<input type="text" value="11.4"/>	MeV/u				
Injektionsfrequenz	<input type="text" value="7.38306543566"/>	Hz				
Radiallage (Injektion)	<input type="text" value="0.0"/>	mm				
Bumper-Amplitude	<input type="text" value="77.0"/>	mm				
Bumper-Abfallzeit	<input type="text" value="170"/>	µs				
Korrektur Bumpervektor	<input type="text" value="0.0"/>	%				
Chopper-Verzoegerung	<input type="text" value="0"/>	µs				
Unilac-Verschiebung	<input type="text" value="0"/>	µs				
I-Septum geom. Winkel	<input type="text" value="-0.049"/>	rad				
I-Septum Korrekturwinkel	<input type="text" value="0.0"/>	mrad				

SCRATCH_DO_SIS18_RING_HFS_20180409_153740

Horizontal orbit

Ring orbit correction (horizontal)		Ring orbit correction (vertical)		Ring special		
Ring injection		Ring orbit bump (horizontal)		Ring orbit bump (vertical)		
Total	Suche	AEG Tests	Beamlinematerie	Extraktionslinie	Ring RF	Ring extraction
Horizontal orbit bump injection						
Injektionsbump horizontal S01	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S02	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S03	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S04	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S05	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S06	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S07	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S08	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S09	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S10	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S11	<input type="text" value="0.0"/>	mm				
Injektionsbump horizontal S12	<input type="text" value="0.0"/>	mm				
Horizontal orbit bump extraction						
Extraktionsbump horizontal S01	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S02	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S03	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S04	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S05	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S06	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S07	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S08	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S09	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S10	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S11	<input type="text" value="0.0"/>	mm				
Extraktionsbump horizontal S12	<input type="text" value="0.0"/>	mm				

SCRATCH_DO_SIS18_RING_HFS_20180409_153740

Fast extraction

Ring orbit correction (horizontal)		Ring orbit correction (vertical)		Ring special		
Ring injection		Ring orbit bump (horizontal)		Ring orbit bump (vertical)		
Total	Suche	AEG Tests	Beamlinematerie	Extraktionslinie	Ring RF	Ring extraction
Ungruppiert						
Arbeitspunkt horizontal QH Ramp	<input type="text" value="4.29"/>					
Arbeitspunkt horizontal QH Pre-Ext...	<input type="text" value="4.29"/>					
Targetenergie	<input type="text" value="1000.0"/>	MeV/u				
Extraktionsfrequenz	<input type="text" value="19.9786949311"/>	Hz				
Impuls Frequenz Verstimung	<input type="text" value="0.0"/>					
Radiallage (Extraktion)	<input type="text" value="0.0"/>	mm				
Bypass Korrekturwinkel	<input type="text" value="0.0"/>	mrad				
Magnetseptum-Bump	<input type="text" value="0.0"/>	mm				
Kombinierter Bump ES/MS	<input type="text" value="0.0"/>	mm				
Kickwinkel	<input type="text" value="4.85"/>	mrad				
Kick-Start	<input type="text" value="76.5"/>	deg				
Flat-Top-Zeit	<input type="text" value="8.0"/>	ms				

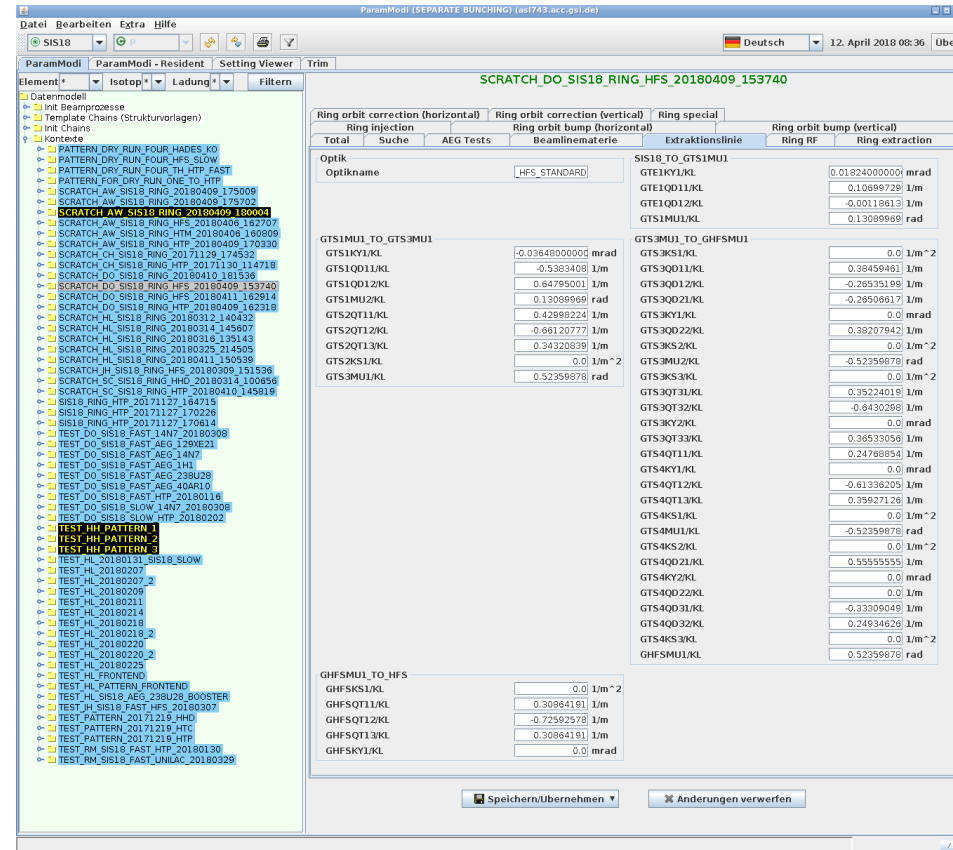
SCRATCH_DO_SIS18_RING_HFS_20180409_153740

Vertical orbit

Ring orbit correction (horizontal)		Ring orbit correction (vertical)		Ring special		
Ring injection		Ring orbit bump (horizontal)		Ring orbit bump (vertical)		
Total	Suche	AEG Tests	Beamlinematerie	Extraktionslinie	Ring RF	Ring extraction
Vertical orbit bump injection						
Injektionsbump vertikal S01	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S02	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S03	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S04	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S05	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S06	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S07	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S08	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S09	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S10	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S11	<input type="text" value="0.0"/>	mm				
Injektionsbump vertikal S12	<input type="text" value="0.0"/>	mm				
Vertical orbit bump extraction						
Extraktionsbump vertikal S01	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S02	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S03	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S04	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S05	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S06	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S07	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S08	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S09	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S10	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S11	<input type="text" value="0.0"/>	mm				
Extraktionsbump vertikal S12	<input type="text" value="0.0"/>	mm				

ParamModi: Transfer Lines

- Separate Tab for transfer line parameters
 - Sorted according to sequence in transfer line
 - Grouped into particle transfers
- Control of magnets via strength parameters
 - Dipoles and steerers: angle
 - Quadrupoles: focusing strength
 - Sextupoles: normalized amplitude
- Initialization from theory optic in LSA DB
 - Optic can be changed
 - Will overwrite all values with theory!
- ParamModi is work in progress
 - Geometric angle of dipoles hidden soon
 - Steering parameter instead
 - No way of creating/setting reference yet
 - Resort to export/import feature
 - More convenient input method planned
 - Arrows with selectable increment (as replacement for "poti board")



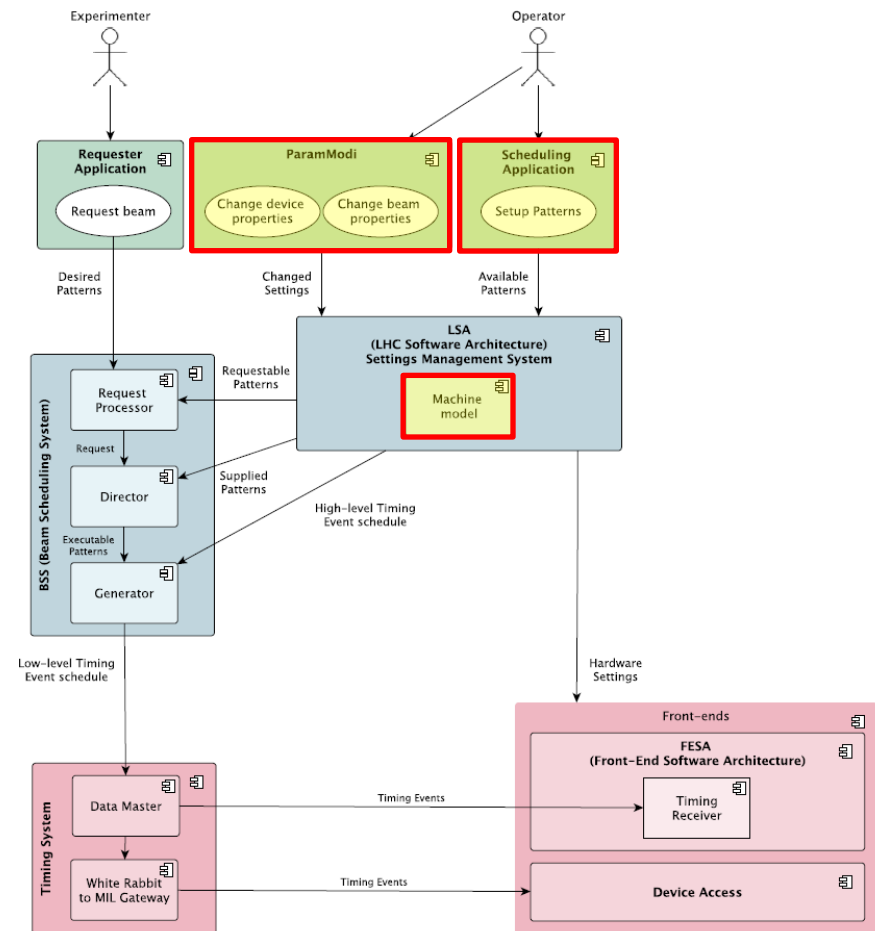
The screenshot shows the ParamModi software interface for the transfer line 'SCRATCH_DO_SIS18_RING_HFS_20180409_153740'. The interface is divided into several sections:

- Left Panel (Tree View):** Lists various components and transfer lines, including 'PATTERN_DRY_RUN_FOUR_HADES_KO', 'SCRATCH_AW_SIS18_RING_20180409_100004', and 'TEST_IH1_PATTERN_1'.
- Top Panel (Navigation):** Includes tabs for 'Ring injection', 'Ring orbit bump (horizontal)', 'Ring orbit correction (horizontal)', 'Ring orbit correction (vertical)', 'Ring special', and 'Ring orbit bump (vertical)'. It also has buttons for 'Suche', 'AEG Tests', 'Beamlinienmaterie', 'Extraktionslinie', 'Ring RF', and 'Ring extraction'.
- Main Panel (Table):** Displays a table of parameters for the selected transfer line. The table has columns for 'Optik', 'Optikname', and numerical values with units.

Optik	Optikname	Value	Unit
GTS1MU1_TO_GTS3MU1		0.0182400000	0.0182400000 mrad
GTS1KY1/KL		0.10699729	0.10699729 1/m
GTE1QD11/KL		-0.00119813	-0.00119813 1/m
GTS1MU1/KL		0.13089969	0.13089969 rad
GTS3MU1_TO_GHFSMU1		0.0	0.0 1/m^2
GTS3KS1/KL		0.38459461	0.38459461 1/m
GTS3QD11/KL		-0.28535199	-0.28535199 1/m
GTS1MU2/KL		0.13089969	0.13089969 rad
GTS3QD12/KL		-0.28506817	-0.28506817 1/m
GTS3KY1/KL		0.0	0.0 mrad
GTS3QD2/KL		0.38207742	0.38207742 1/m
GTS3QD2/KL		0.0	0.0 1/m^2
GTS3KS2/KL		-0.52359878	-0.52359878 rad
GTS3MU2/KL		0.0	0.0 1/m^2
GTS3KS3/KL		0.35224016	0.35224016 1/m
GTS3QD3/KL		-0.6430296	-0.6430296 1/m
GTS3QD3/KL		0.0	0.0 mrad
GTS3QD3/KL		0.38533056	0.38533056 1/m
GTS4QD11/KL		0.24768854	0.24768854 1/m
GTS4KY1/KL		0.0	0.0 mrad
GTS4QD12/KL		-0.61336205	-0.61336205 1/m
GTS4QD12/KL		0.35627126	0.35627126 1/m
GTS4KS1/KL		0.0	0.0 1/m^2
GTS4MU1/KL		-0.52359878	-0.52359878 rad
GTS4KS2/KL		0.0	0.0 1/m^2
GTS4QD21/KL		0.55555555	0.55555555 1/m
GTS4KY2/KL		0.0	0.0 mrad
GTS4QD22/KL		0.0	0.0 1/m
GTS4QD31/KL		-0.33309048	-0.33309048 1/m
GTS4QD32/KL		0.24894626	0.24894626 1/m
GTS4KS3/KL		0.0	0.0 1/m^2
GHSMU1_TO_HFS		0.52359878	0.52359878 rad
GHFSKS1/KL		0.0	0.0 1/m^2
GHFSQD11/KL		0.30864191	0.30864191 1/m
GHFSQD12/KL		-0.72592578	-0.72592578 1/m
GHFSQD13/KL		0.30864191	0.30864191 1/m
GHFSKY1/KL		0.0	0.0 mrad

Data Supply: The Overall Picture

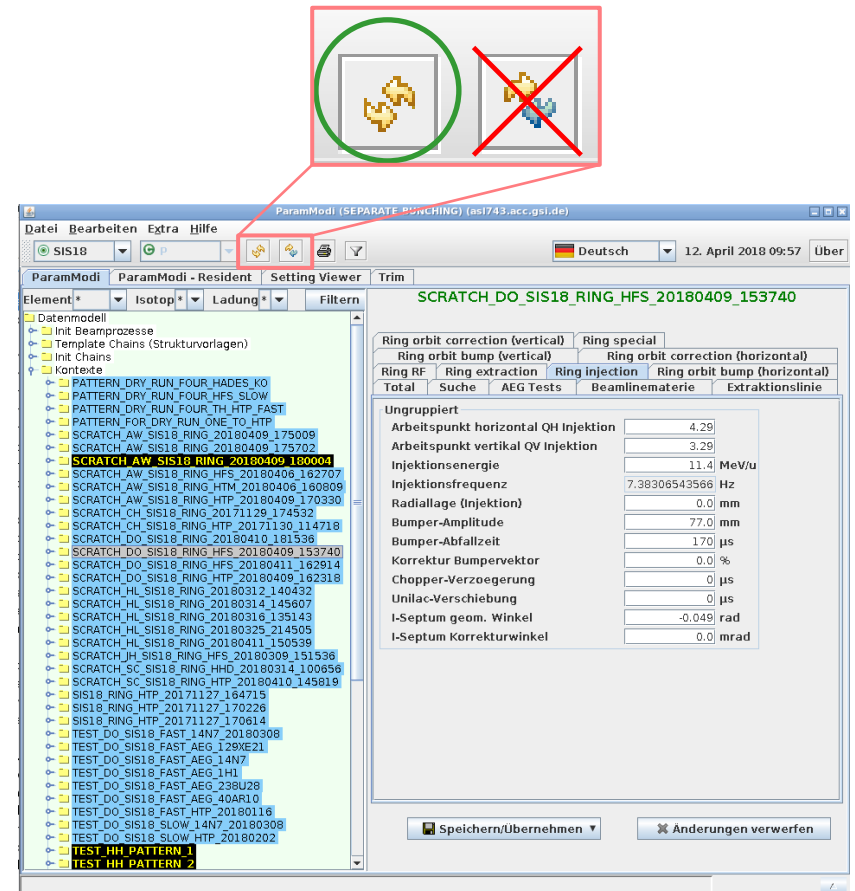
- Data supply embedded in control system
- LSA plays central role
 - Machine model part of LSA server
 - All calculations done on server
 - All data stored in LSA DB
 - LSA server provides data
 - to applications
 - to devices (including timing system)
 - No machine model logic in applications!
- Applications are operator's interface to model
 - SchedulingApp
 - Creation of initial patterns
 - Definition of patterns for execution
 - ParamModi
 - Modification of settings
 - Display of settings
 - Others applications in the future
 - Parameter scan application
 - Beam based feedback



H. Huether, Controls Architecture, presented in this course

Data Supply: Traps

- Separation of application and server
 - PRO: Several applications can modify same data
 - CON: Several applications can modify same data
- No messaging to inform about changes yet
 - Manual refreshing in ParamModi necessary if
 - new pattern has been created (otherwise new pattern not visible)
 - patterns have been added or removed (otherwise resident view is not correct)
 - settings have been changed by another instance of ParamModi (or other program)
 - Messaging to be implemented soon
- Errors during calculation
 - Reported as TrimException
 - Not yet easily interpretable by operators
 - On-call duty for data supply available



Summary

- Data supply: scope and task defined
- Machine model: task defined
- LSA framework
 - Overview over architecture
 - Basic structures and examples
- Machine model
 - Parameter hierarchy with examples
 - Creation and modification of functions
- SchedulingApp
 - Creation of new patterns
 - Adding and removing patterns for execution
- ParamModi
 - Different views: Offline, Resident, SettingViewer, Trim
 - Parameters for control of SIS18 and transfer lines
- Overall picture