YASP for Ions LEIR - PS

Synchrotrons and beam lines are designed in magnetic fields/gradients/multipoles and even p/q independent strengths.  
→ machine models are starting point

Transfer maps/ response matrices and hence control and correction algorithms for important parameters can be constructed on top of these machine models

Option 1: individual tools - that have model/correction algorithm AND model-to-hardware knowledge

Option 2: centralized storage and communication of model-to-hardware translation. Tools only dealing with models and algorithms.  
→ LSA with tools like YASP, AutoSpill, \( \beta^* \) measurement
LSA always existed in LEIR
But the lines were never prepared.
The Preparation...

- LSA in the LEIR transfer lines 2016
  - Transfer functions and lengths (B to I or B’ to I) for all magnets
  - Elements in DB: magnet to power converter
  - JMAD model, optics preparation: 1 combined line
  - Creation of accelerator zones and particle transfers
    - Particle transfers: LEIRInjection, LEIREjection, LEIRRING
      - Optics is associated with a particle transfer
    - Accelerator zones
      - Different accelerator zones become one particle transfer
The Philosophy...

- LEIR transfer lines...controls night mare
  - The issue of the PPMness and non-PPMness
  - ...and functions and discrete references: ETL.BHN10
  - YASP: either – or
    - YASP can only work with 1 beam process (discrete or function)

→ All (also non-ppm) settings are stored PPM with cycle
  - Cycle resident: trim on non-PPM circuit obviously modified for all cycles
  - Brho is not taken from ring (a la PS), but discrete parameter in particle transfer
    - BRHOd
    - Needs to be generated first (do not propagate to all dependents)
  - New parameters (non_PPM): Kd → I_DISCRETE_NON_VIRT
  - New parameters (PPM): Kd → SettingPPM
The Philosophy...

- The hierarchy...
The implementation...

- K

  - $K = \text{angle for dipoles and } k_l \text{ for quadrupoles (currently)}$
  
  - New make rules to take $BRHO_d$ into account
    - LeirK2CurrMakeRule.java in lsa-ext-leir package
  
  - Special make rule and linkrule for function ETL.BHN10
    - K2CurrMakeRule.java in lsa-ext-leir package
    - Linkrule: EtlLinkRule.java

**Advantage:** BHN10 link during beam out is always the same
Other tools

- Equipstate organized in cycles, particle transfers and accelerator zones
- All power converters can be fully controlled and monitored in equipstate
Was it worth it?....YASP in the lines

The goal: deterministic steering (back to a reference). Better reproducibility.

- **Injection line**
  - Working currently with SEMs (only three)
  - Will be really affective with BPMs

- **Extraction line**
  - BPMs available
  - The cool stuff Extraction line + PS ring:
    - Line and injection oscillation correction in one go.
    - Can use YASP in all its beauty
Example – LEIR to PS steering

- LEIR ejection line + PS ring (first turn minus closed orbit).

Reference change at PS injection point.
H: * -1, also for septum and KFA

Also choose LEIR user

EE, ETL, ETP

[PS first turn – closed orbit] * (-1)
Example – LEIR to PS steering

- MICADO correction with 2 correctors: correction in two clicks
Example – LEIR to PS steering

- Tricky part: injection off center in the PS
- Reference established. Correction easy in difference.
- Optics issue? Mainly problem for vertical plane

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Vertical plane not clear. ETL.BVN10 phase not correct. ETP OK.
Example – kick response

- Kick response with PS – no doubt on BPM readings.

Response of ETP.BHN10
  -- measurement
  -- theory
Issue in the vertical plane

- ETL.BVN10??

![Graph showing horizontal and vertical positions with statistical values](image-url)
- Virtual correction

- Beginning of the ejection line not easy to correct with line elements only.

  → use orbit in LEIR

- "Virtual correction" at extraction septum in H and V

  → use calculated values on extraction region orbit bumps x’, y’
Virtual correction in YASP

- Steering -> Expert Steering
  - Choose Single kick, choose plane
Virtual correction in YASP
Virtual correction in YASP

- Then in LEIR change orbit at extraction through knobs
Virtual correction in YASP

- Then in LEIR change orbit at extraction through knobs
THE END