Specifications for Python Middle Layer

Use cases:

Optimal lifetime
Optimal injection efficiency
Optimal beam transfer
Commissioning sequence
Automated commissioning
Thin graphical interfaces
Digital twin (online - hardware switch)
Online model (optics model available for real-machine based experiments)
Optics setting/loading

Slow Orbit correction
Fast orbit correction feedback
Closed orbit bumps

Optics correction
TbT optics corrections
Non-linear optics correction

Tune correction
Chromaticity correction
Dispersion measurement

RF tuning

Beam based alignment
Fast beam based alignment

trajectory steering
trajectory beam based alignment
trajectory tune correction
trajectory based optics correction

Injected beam tuning
Injection element tuning

Artificial intelligence optimizations ()

Machine learning optimizations

Anomaly detection

Open FAIR DATA

GPU computations

History data base, data archiving

Calibrations

Easy configuration installation

ChatGPT generated text below as example of detail specification of each use case.

Use Case Scenario: Correct Orbit Measurement in a Synchrotron Light Source Facility

1. Use Case Name:

Correct Orbit Measurement

2. Description:

The purpose of this use case is to ensure accurate measurement and correction of the electron beam orbit in the BESSY II synchrotron light source to maintain optimal beam quality and stability for various experiments.

3. Actors:

- **Beamline Operator:**Responsible for monitoring and adjusting the beam orbit.
- **Beam Physicist:** Provides expertise on beam dynamics and assists in complex adjustments.

- **Control System:** The automated system that collects orbit data and applies corrections.
- **Diagnostic Tools:**Instruments such as Beam Position Monitors (BPMs) and feedback systems.

4. Preconditions:

- The synchrotron is operational and the electron beam is circulating in the storage ring.
- Diagnostic tools and control systems are calibrated and functional.
- Operators and physicists are trained in using the control and diagnostic systems.

5. Postconditions:

- The electron beam orbit is correctly measured and adjusted.
- Beam stability is within acceptable limits.
- Experimental data quality is optimal.

6. Normal Flow:

1. **Initiate Orbit Measurement:**
    - The Beamline Operator accesses the control system interface.
    - The operator initiates the orbit measurement process using the control system software.
2. **Collect Data from Beam Position Monitors (BPMs):**
    - The control system collects real-time data from BPMs distributed around the storage ring.
    - BPMs provide precise measurements of the beam's position at multiple points.
3. **Analyze Orbit Data:**
    - The control system processes the BPM data to determine the current beam orbit.
    - The Beam Physicist reviews the orbit data for any significant deviations or anomalies.
4. **Apply Orbit Corrections:**

- If deviations are detected, the control system calculates the necessary corrections.
   - Corrective signals are sent to steering magnets to adjust the beam's path.
   - The Beamline Operator monitors the corrections in real-time, ensuring they are applied smoothly.
5. **Verify Orbit Stability:**
   - After applying corrections, the control system continuously monitors the orbit.
   - The Beamline Operator ensures the orbit remains stable and within specified tolerances.
6. **Continuous Monitoring and Feedback:**
   - The diagnostic tools continuously provide feedback to the control system.
   - The control system automatically adjusts to maintain optimal beam orbit.
   - The Beamline Operator and Beam Physicist conduct periodic reviews to fine-tune the system.

7. Alternative Flows:

- **System Malfunction:**
   - If the control system or BPMs malfunction, the Beamline Operator switches to manual operation mode.
   - The Beam Physicist uses alternative diagnostic tools to assess the orbit and suggest manual adjustments.
   - Maintenance teams are alerted to repair or recalibrate the faulty equipment.
- **Unexpected Beam Instability:**
   - In case of unexpected instability, an alarm is triggered.
   - The Beamline Operator pauses the experiment and initiates a detailed diagnostic routine.
   - The Beam Physicist investigates potential causes such as equipment issues, environmental factors, or beam dynamics.
   - Once the issue is resolved, orbit measurement and correction processes are restarted.

8. Exceptions:

- **Severe Beam Loss:**
  - If severe beam loss occurs, the system may need to perform a full restart.
  - The Beamline Operator coordinates with the Accelerator Operations team to safely restore the beam.
- **Environmental Interference:**
  - Environmental factors like temperature fluctuations might affect measurements.
  - The system compensates for minor fluctuations, but significant changes require manual intervention and environmental control adjustments.

Use case for middle layer, what we expect Middle layer to do:

- Easy way to access family of equipment
- Save and restore services
- Store and access measurement data with metadata (can be done by something else (ex: TILED)
- Interface / common ground to other tools
- Keep general, modular approach, to be able to account for future additions
- Allow abstract model for magnet calibrations (to include cross talks, hysteresis, etc…)
- Successive layer of abstraction (device, measurement, procedures,(the middle layer could be multiple middle layers actually, device classes at middle layer level)
- History database, data archiving
- Interaction/interface with digital twin
- Interaction/interface with online model (GPU computations)
- simultaneous use on tl, sr, linac, etc..
- Sustainability of software
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Evaluate Sirius code, (and solaris code)
Propose a version of pyML for next workshop
Next workshop: Sirius, or HZB or Soleil

Everyone could send a list of features, to make sure for every lab there are all the features

We could miss out some features, we will add later. We will change as we progress
Ex: PETRAIV document for specification

Consortium:
Make MoU, for directors to sign and for lab to be involved and see themselves and their objectives in the project.

Proposal:
Include Participation Fee to pay external development?
Chip in contribution and hire personnel from external company (Radiasoft, CosyLab) ?

List of people to look for funds: JE (radiasoft), PS (HZB), SL (ESRF),
COST (SL to file in application)
MSCA DN

Exploratory projects working groups:
Sirius code SL TO MG WSK PS VG (Soleil)
Bluesky (RR, Eddy (KIT), PS, YH, Julian Gethmann (KIT))
pyTAC (YH)
TILED (YH, SL)

Proposal for next workshop:

1) TO MG WSK PS VG SL
2) JLP+SW to work on option 2

Communication channel:
EMAIL list (brainstorming document + workshop participants)
MatterMOST?

Name of the code:
Middle Layer? Not good, machine learning. Choose a name.