Present and Future Operation Tools and Algorithms at ALS

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ALS Accelerator Physics Group

20.06.24

ALS Will Stick with EPICS

- EPICS 7:
  - Flat naming -> adding structures to PV names
- Phoebus Tools:
  - Control Room Displays
  - Alarm handler

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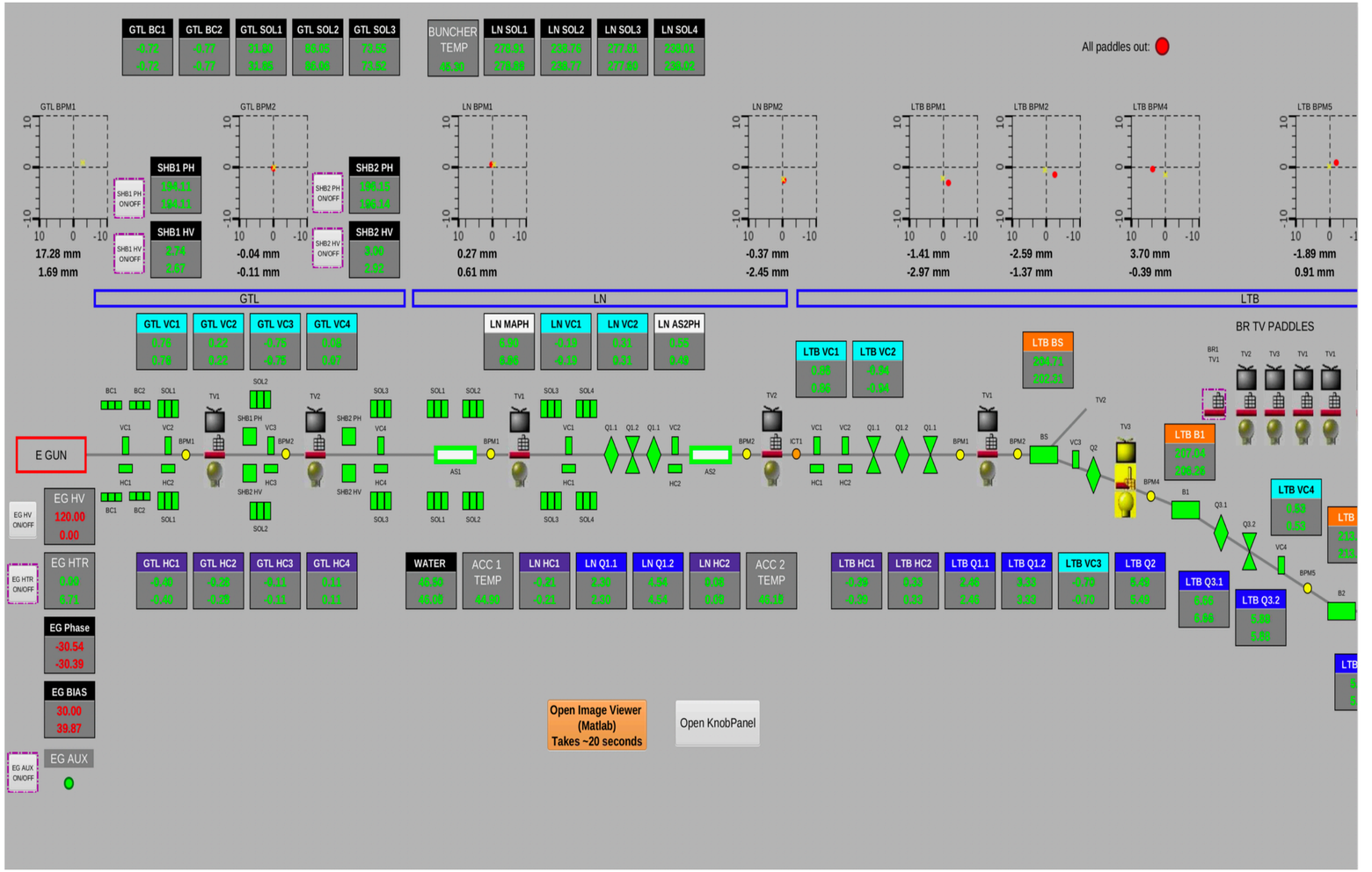
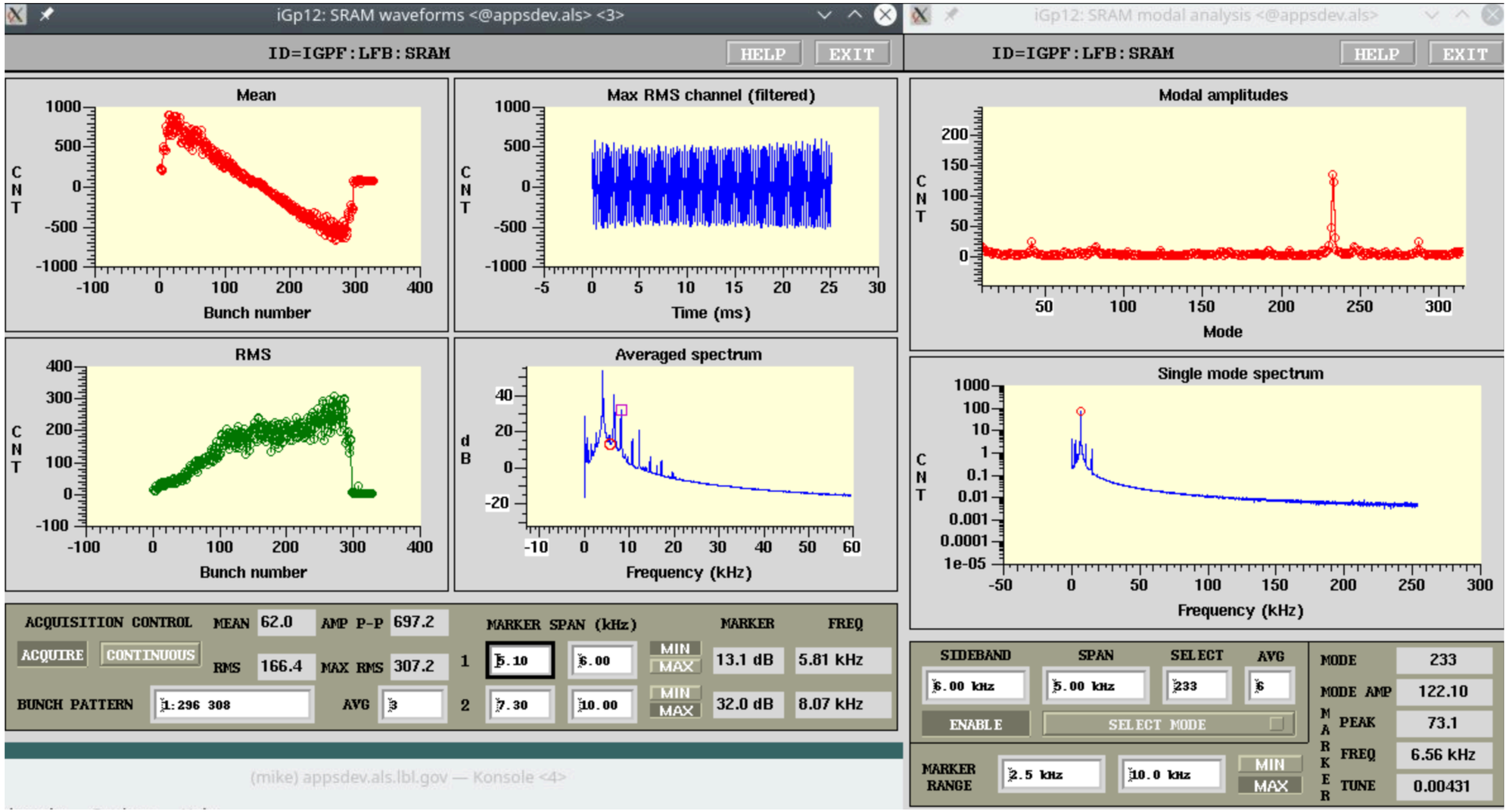


ALS Will Stick with EPICS

- EPICS 7:
  - Flat naming -> adding structures to PV names
- Phoebus Tools:
  - Control Room Displays
  - Alarm handler
- Archiver Appliance:
  - Python / Matlab
  - Grafana (new)

https://grafana.com/

LFB & TFB: Dimtel



ALS is Very Matlab Focused

Naming Convention

Family = Group descriptor (text string)
Field = Subgroup descriptor (text string)
DeviceList = [Sector Element-in-Sector]

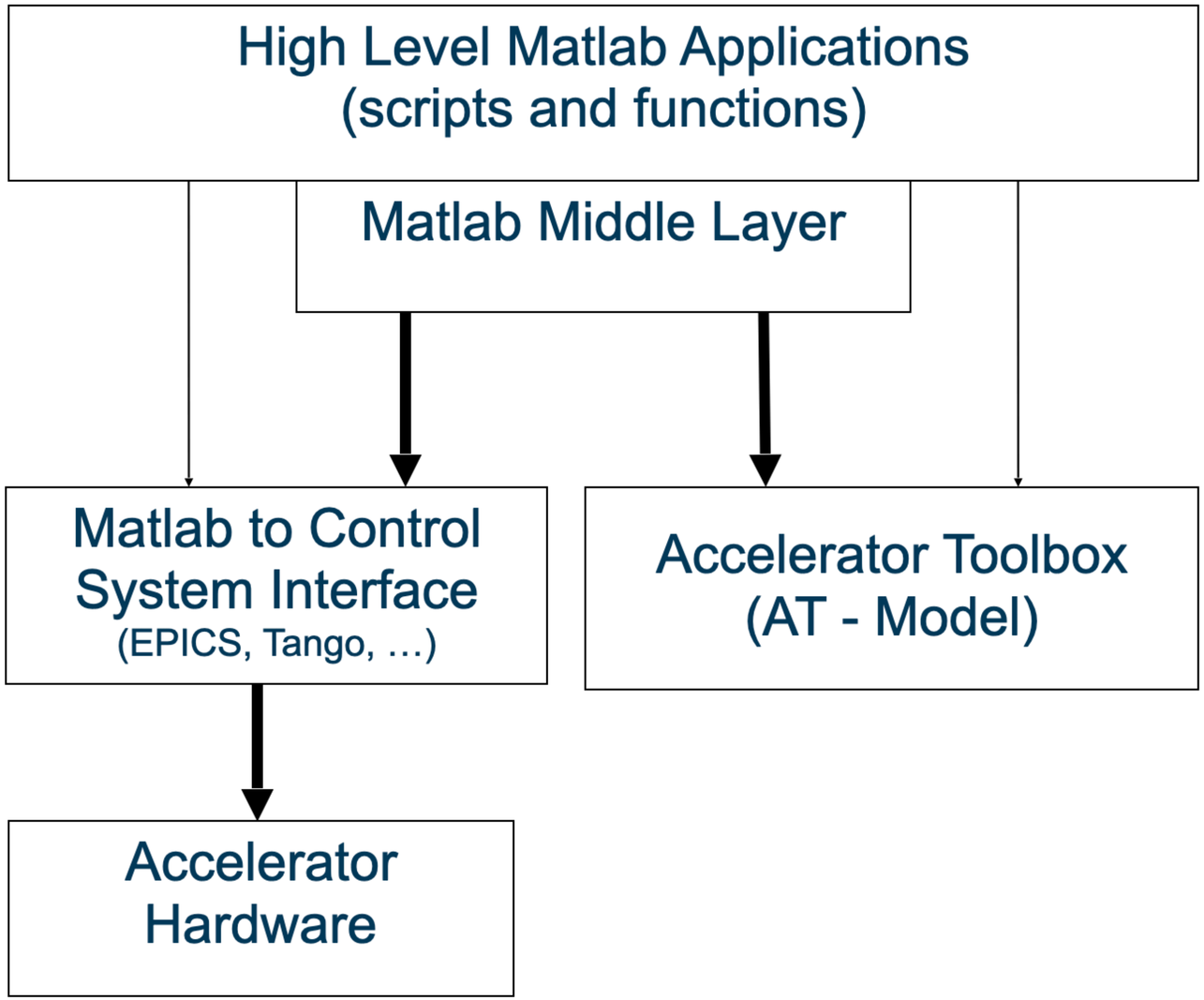
Basic Functions

getpv(Family, Field, DeviceList);
setpv(Family, Field, Value, DeviceList);
steppv(Family, Field, Value, DeviceList);

These functions can branch between the model and online.

Examples:

```
x = getpv('BPMx', 'Monitor', [3 4;5 2]);
h = getpv('HCM', 'Setpoint', [2 1;12 4]);
setpv('QF', 'Setpoint', 81);
```



Name Server: EPICS Channel Finder

At the ALS, the channel finder service tags channels using the same “Accelerator, Family, Field, Device” scheme as in the MML.

Controls Main × | Ops Launcher × | ALS Launcher × | Linac × | MOD1 × | MOD2 × | miniDCCT × | EPBI × | Channel Table × | Channel Table ×

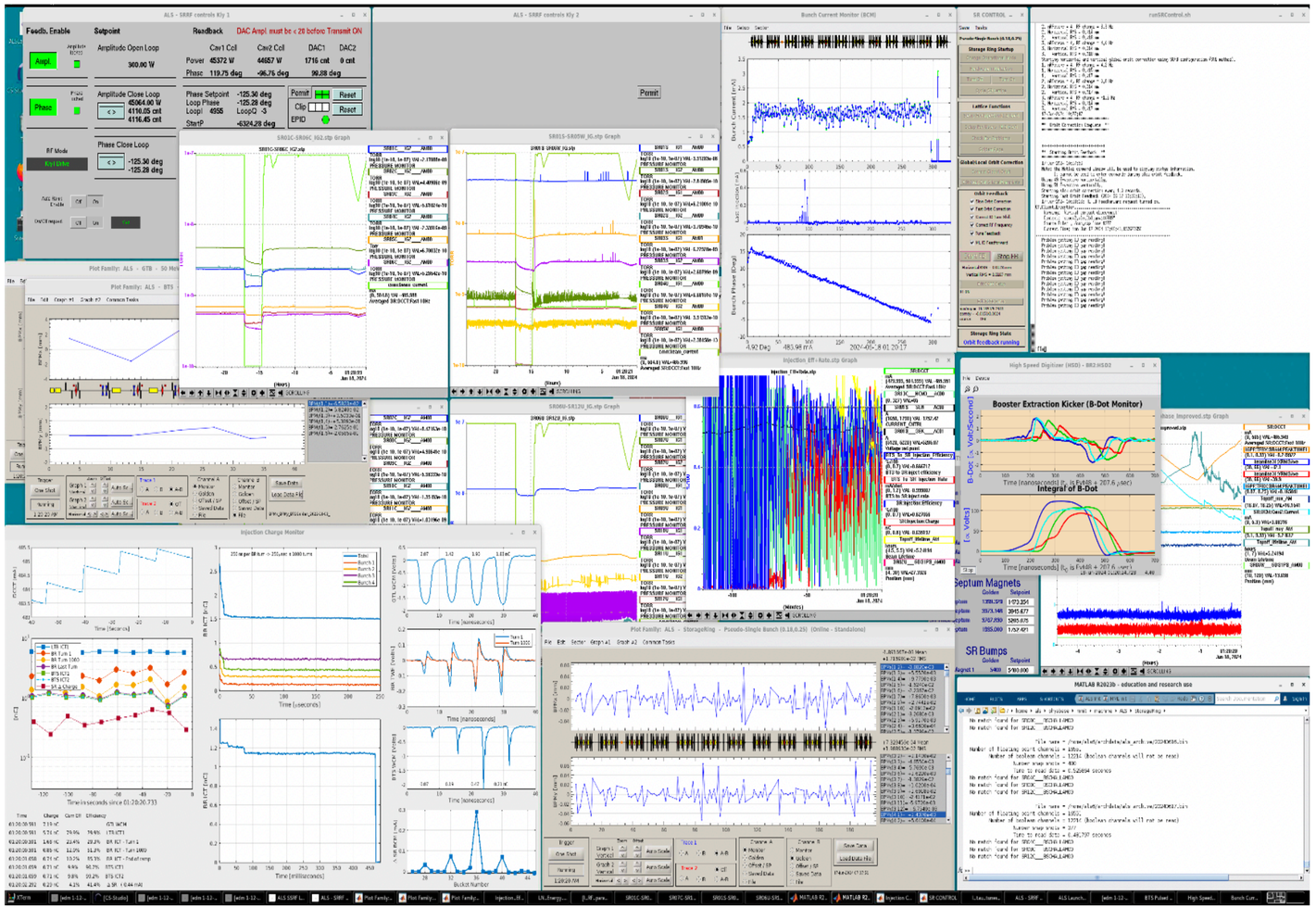
Query: * Acc=SR Family=QF Field=Setpoint Sector=* Device=*

name	Acc	Family	Field	Sector	Device	Position	Golden	archive	recordType	iocName
SR01C___QF1____AC02	SR	QF	Setpoint	1	1	3.378696	96.908063344168553	Fast	ao	ffbsec01
SR01C___QF2____AC03	SR	QF	Setpoint	1	2	12.677306	96.548511743507575	Fast	ao	ffbsec01
SR02C___QF1____AC02	SR	QF	Setpoint	2	1	19.778696	95.675469420609659	Fast	ao	ffbsec02
SR02C___QF2____AC03	SR	QF	Setpoint	2	2	29.077306	96.25629257026965	Fast	ao	ffbsec02
SR03C___QF1____AC02	SR	QF	Setpoint	3	1	36.178696	96.254993755862387	Fast	ao	ffbsec03
SR03C___QF2____AC03	SR	QF	Setpoint	3	2	45.477306	94.968993154771908	Fast	ao	ffbsec03
SR04C___QF1____AC02	SR	QF	Setpoint	4	1	52.578696	97.362668560344588	Fast	ao	ffbsec04
SR04C___QF2____AC03	SR	QF	Setpoint	4	2	61.879111	96.997481310809263	Fast	ao	ffbsec04
SR05C___QF1____AC02	SR	QF	Setpoint	5	1	68.980501	95.703886987555819	Fast	ao	ffbsec05
SR05C___QF2____AC03	SR	QF	Setpoint	5	2	78.279111	95.288593169344963	Fast	ao	ffbsec05
SR06C___QF1____AC02	SR	QF	Setpoint	6	1	85.380501	96.447573180643431	Fast	ao	ffbsec06
SR06C___QF2____AC03	SR	QF	Setpoint	6	2	94.679111	96.5060204101957	Fast	ao	ffbsec06
SR07C___QF1____AC02	SR	QF	Setpoint	7	1	101.780501	95.744347344953354	Fast	ao	ffbsec07
SR07C___QF2____AC03	SR	QF	Setpoint	7	2	111.079111	96.566816850643619	Fast	ao	ffbsec07
SR08C___QF1____AC02	SR	QF	Setpoint	8	1	118.180501	96.1579998863688	Fast	ao	ffbsec08
SR08C___QF2____AC03	SR	QF	Setpoint	8	2	127.480916	97.18719441846909	Fast	ao	ffbsec08
SR09C___QF1____AC02	SR	QF	Setpoint	9	1	134.582305	95.3480583970734	Fast	ao	ffbsec09
SR09C___QF2____AC03	SR	QF	Setpoint	9	2	143.880916	96.182497070246868	Fast	ao	ffbsec09
SR10C___QF1____AC02	SR	QF	Setpoint	10	1	150.982306	96.266783582685619	Fast	ao	ffbsec10
SR10C___QF2____AC03	SR	QF	Setpoint	10	2	160.280916	95.861797805405516	Fast	ao	ffbsec10
SR11C___QF2____AC03	SR	QF	Setpoint	11	2	176.680916	95.543268540128	Fast	ao	ffbsec11
SR11C:QF1:Setpoint	SR	QF	Setpoint	11	1	167.382306	95.775254811217167	Fast	ao	genesys
SR12C___QF1____AC02	SR	QF	Setpoint	12	1	183.782306	96.484200063890142	Fast	ao	ffbsec12
SR12C___QF2____AC03	SR	QF	Setpoint	12	2	193.082721	106.21448885069287	Fast	ao	ffbsec12

Current High Level Applications in Matlab

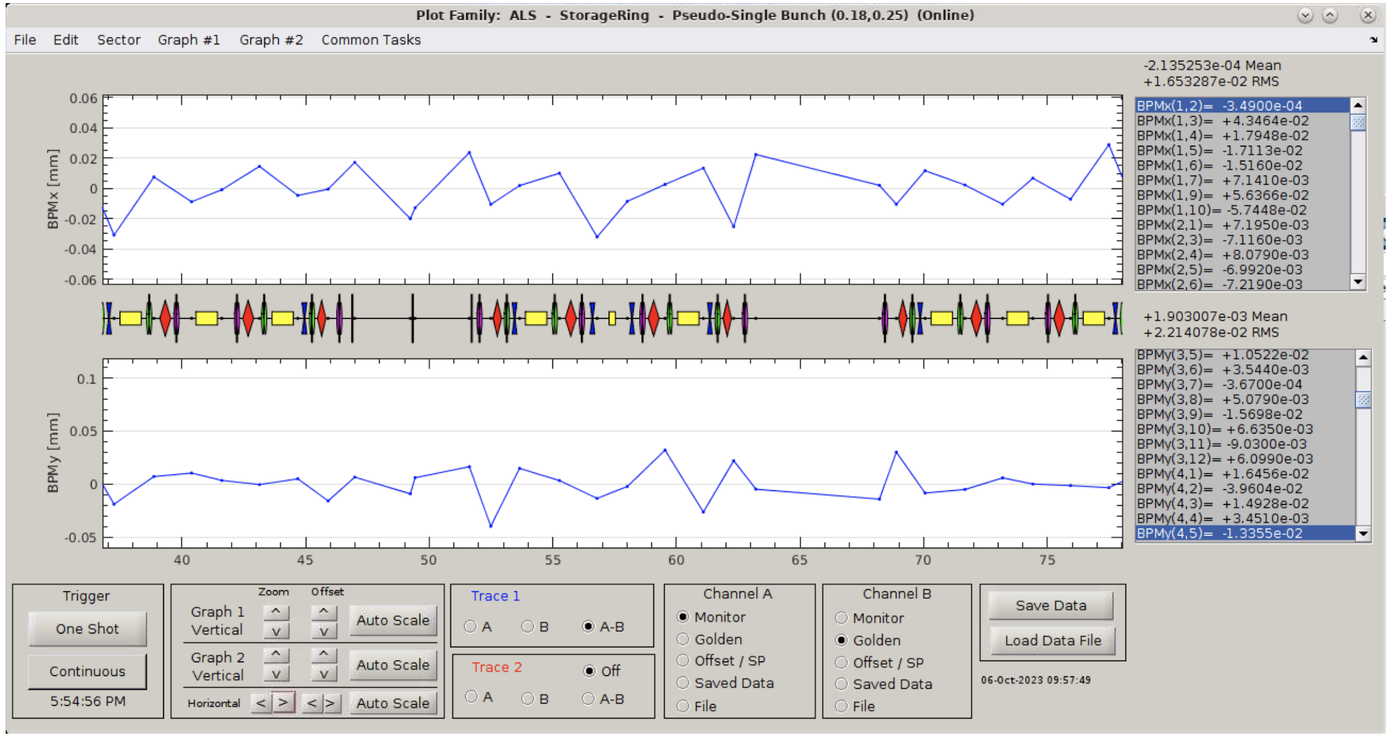
High Level Applications in Matlab

- **Display** (plotfamily, mmlviewer)



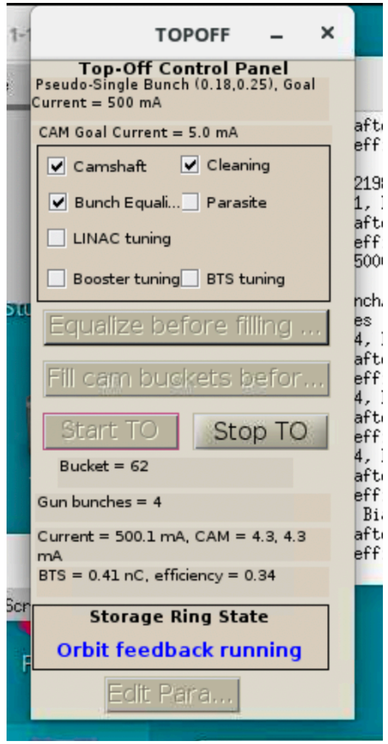
High Level Applications in Matlab

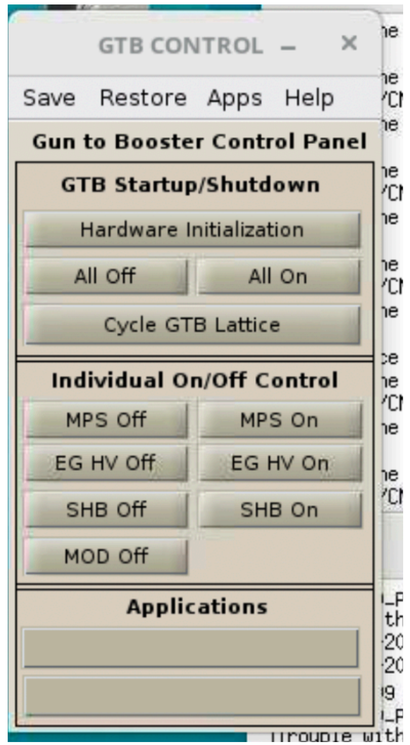
- **Display (plotfamily, mmlviewer)**

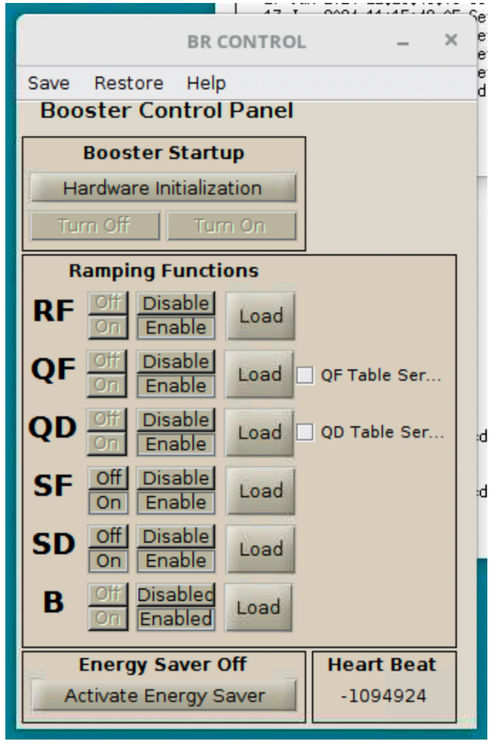


High Level Applications in Matlab

- Display (plotfamily, mmlviewer)
- **Main Control Panels**

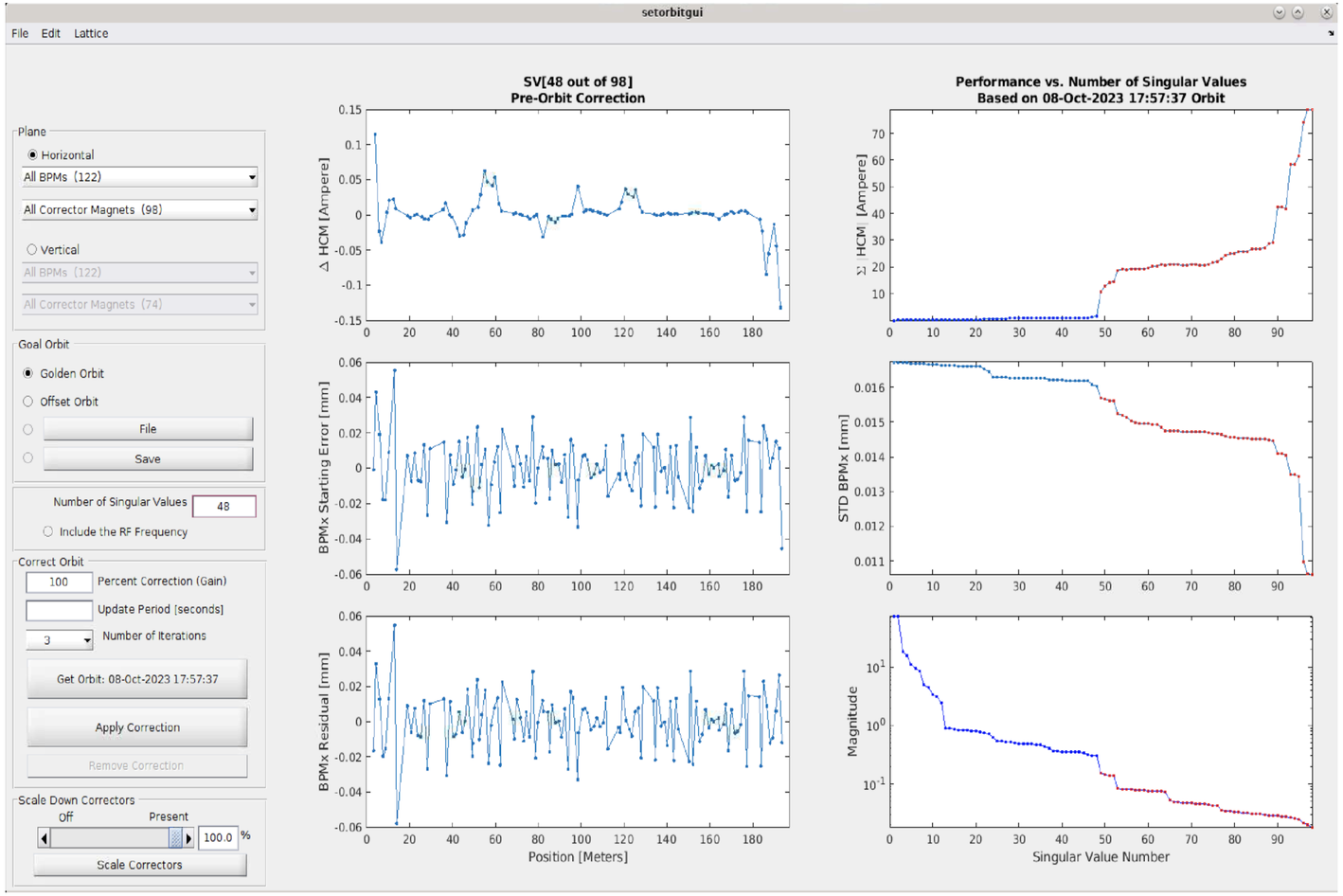






High Level Applications in Matlab

- Display (plotfamily, mmlviewer)
- Main Control Panels
- **Orbit correction and slow orbit feedback**



High Level Applications in Matlab

- Display (plotfamily, mmlviewer)
- Main Control Panels
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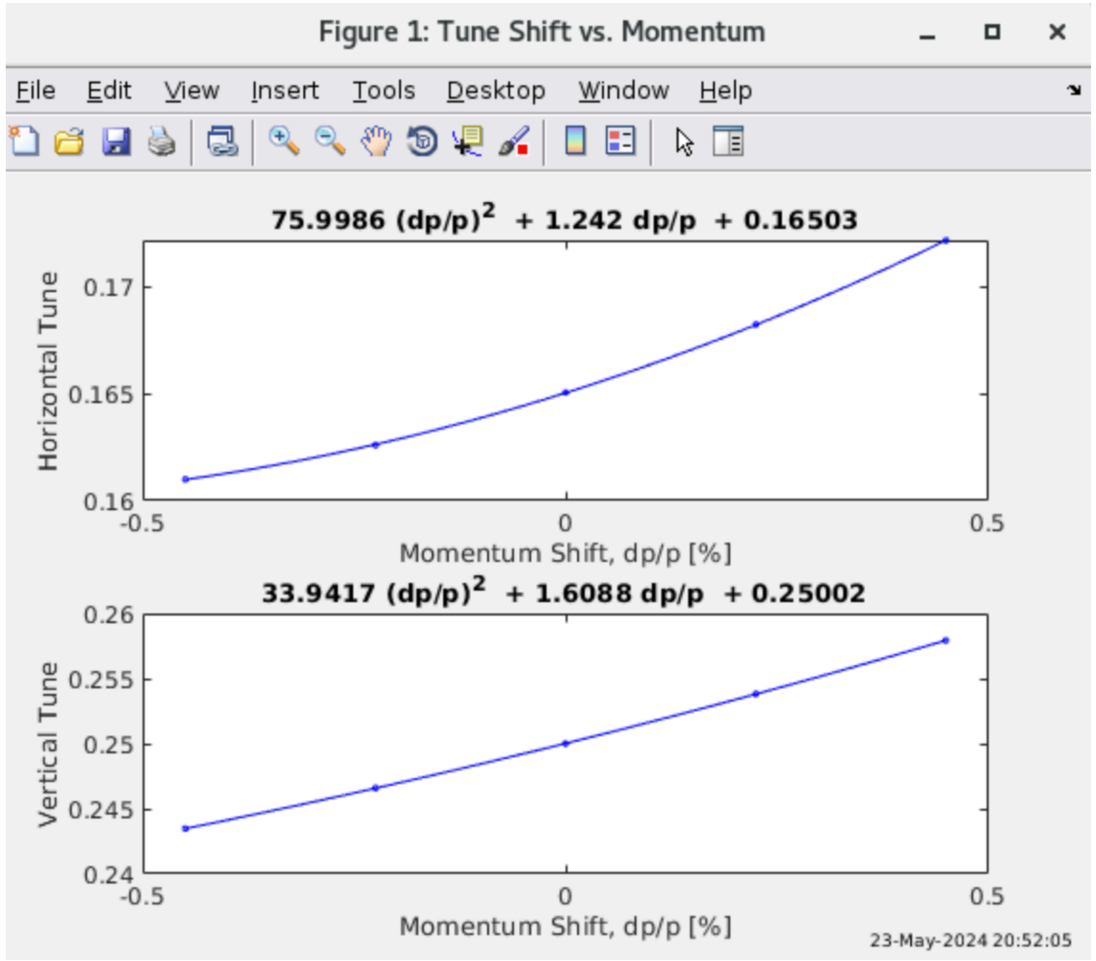
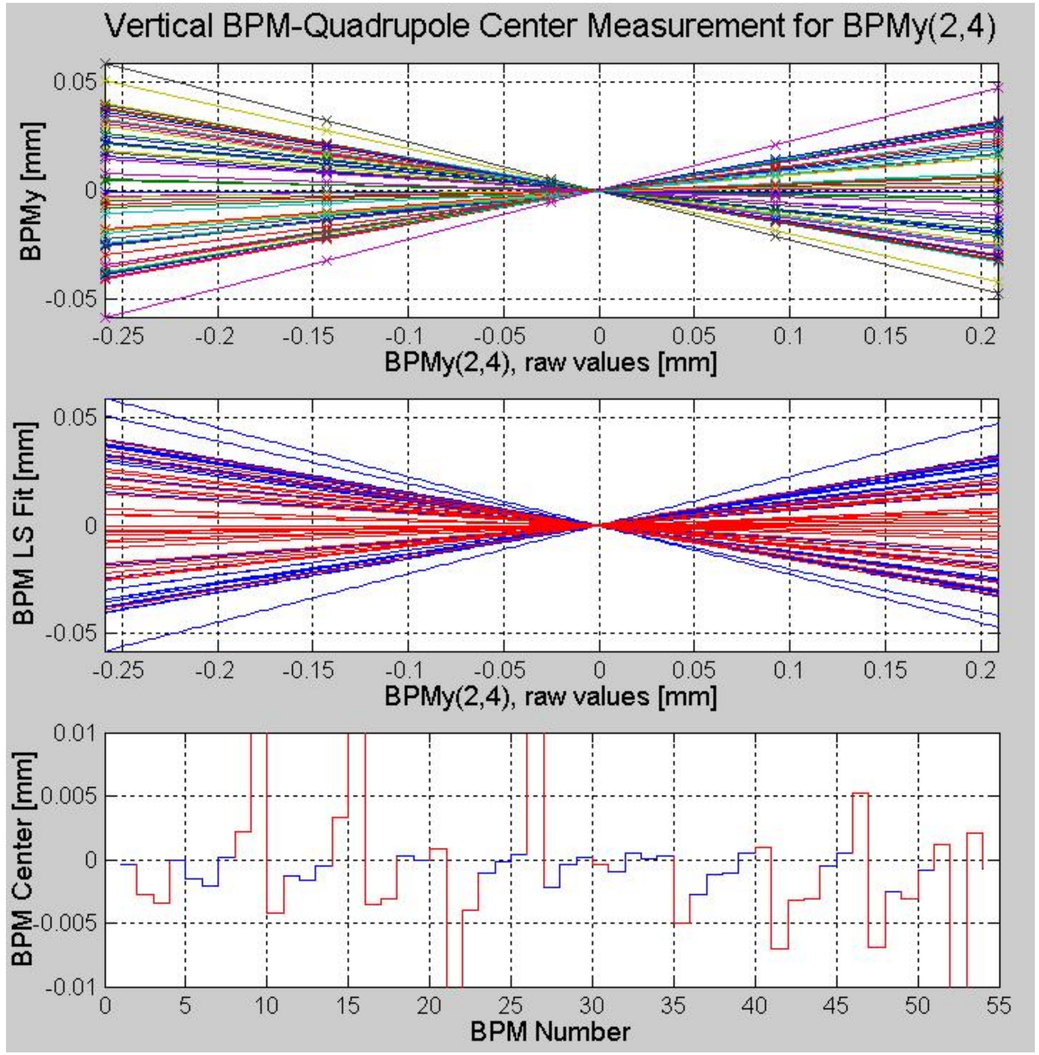
- **Chromaticity Correction**



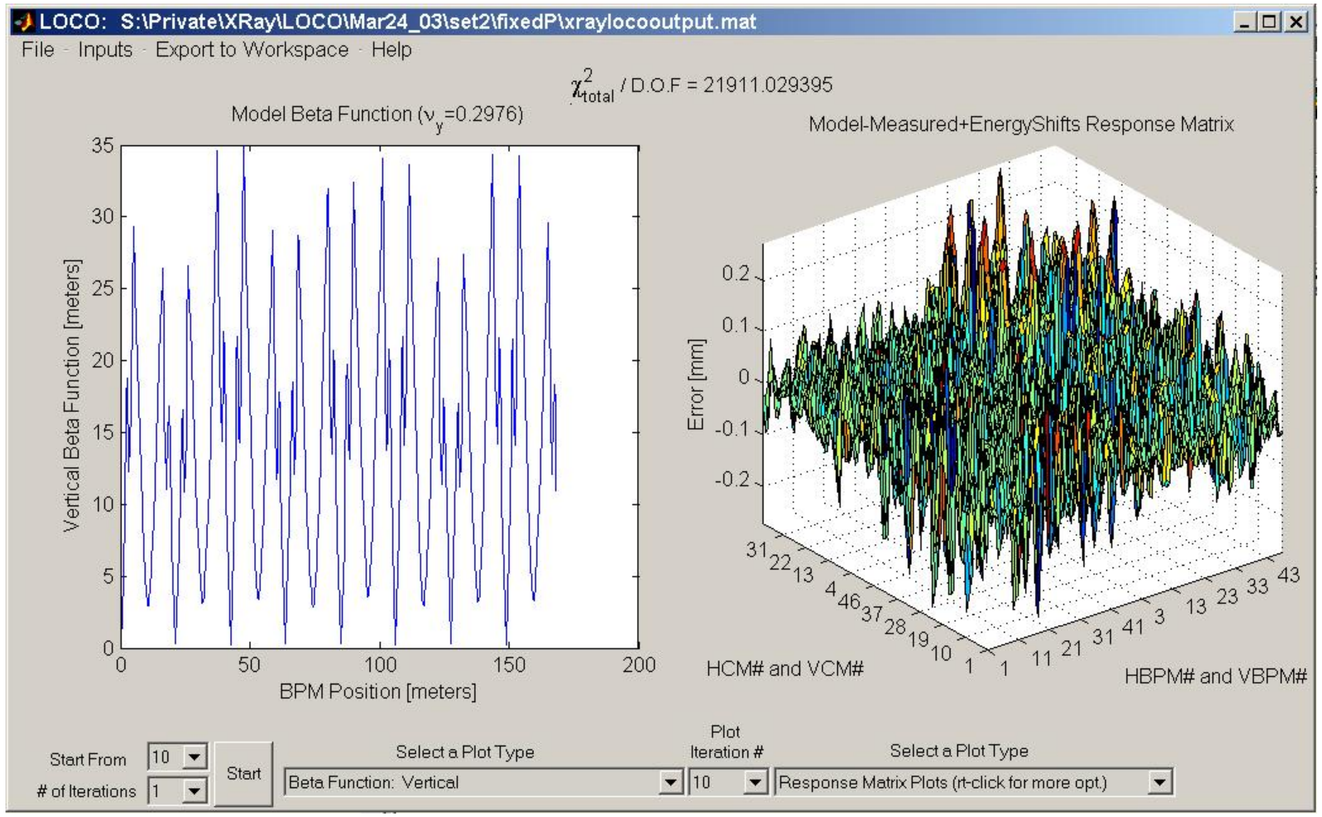
High Level Applications in Matlab

- Display (plotfamily, mmlviewer)
- Main Control Panels
- Orbit correction and slow orbit feedback
- Chromaticity Correction
- **Beam Based Alignment**



High Level Applications in Matlab

- Display (plotfamily, mmlviewer)
- Main Control Panels
- Orbit correction and slow orbit feedback
- Chromaticity Correction
- Beam Based Alignment
- **LOCO (Response matrix analysis, machine calibration)**



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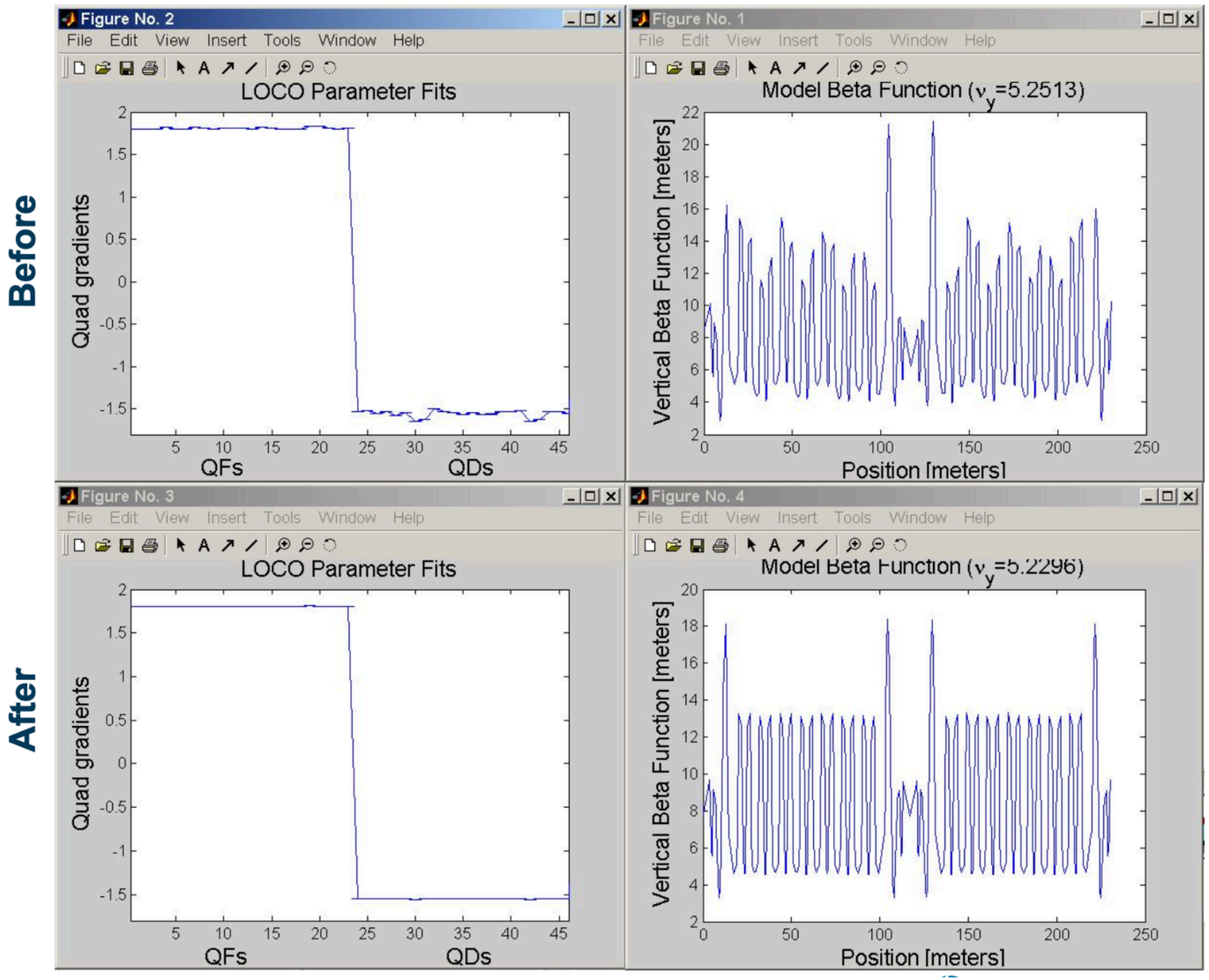
- **Insertion device focusing compensation**



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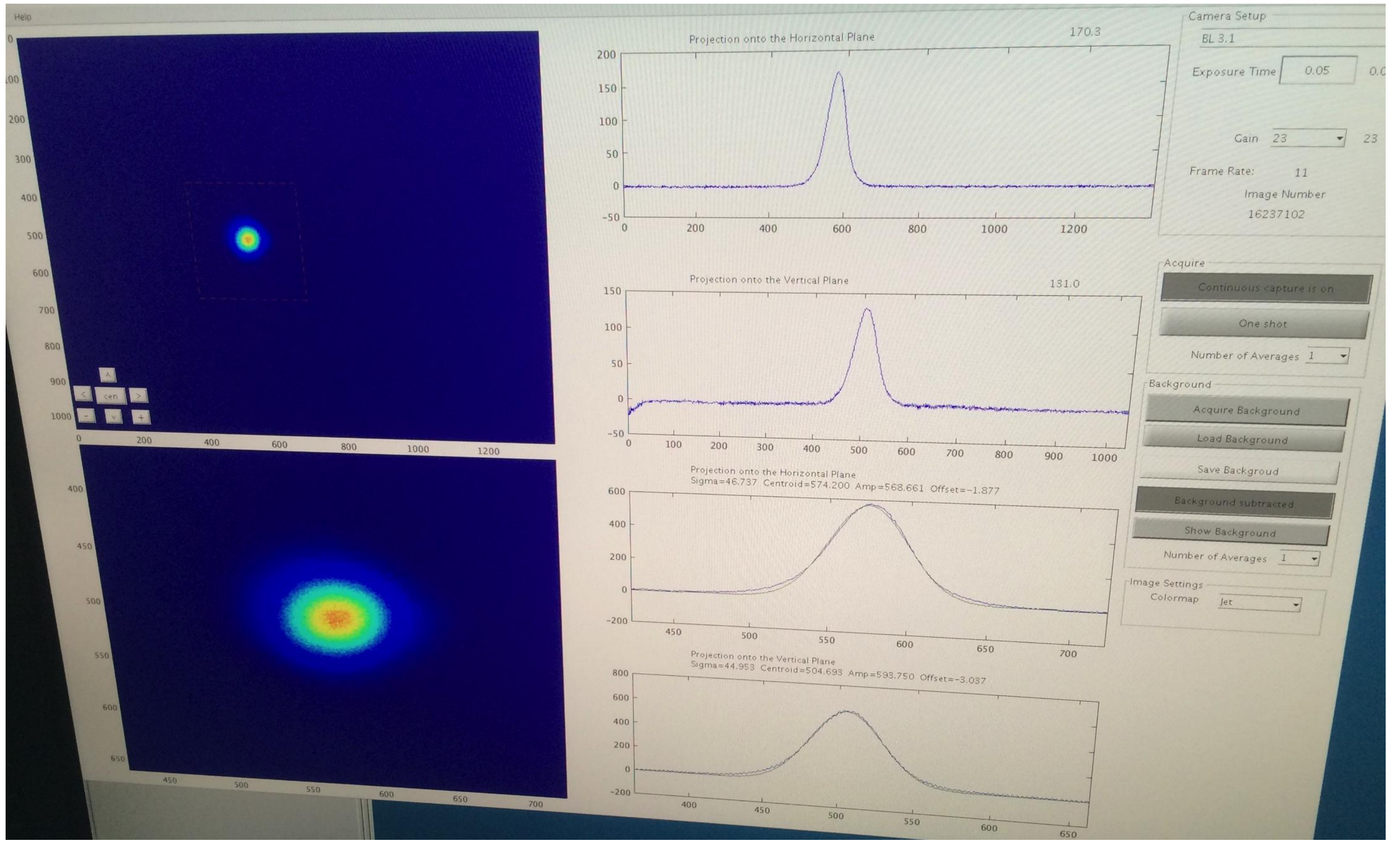
- **CCD cameras analysis**

Cameras / image displays have all been using Matlab (now slowly moved to Phoebus) for analysis



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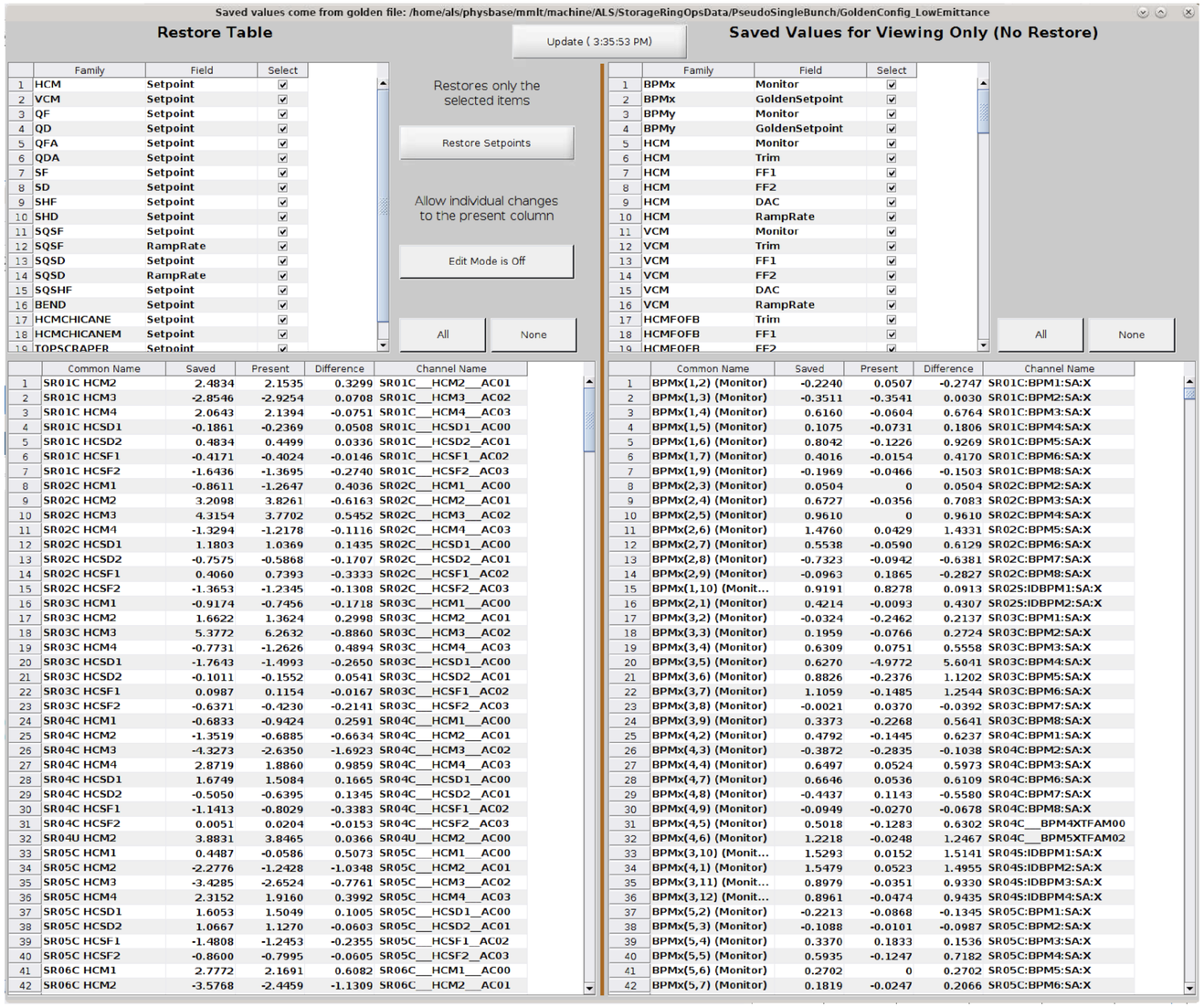
- CCD cameras
- **Save/ restore / configuration control**



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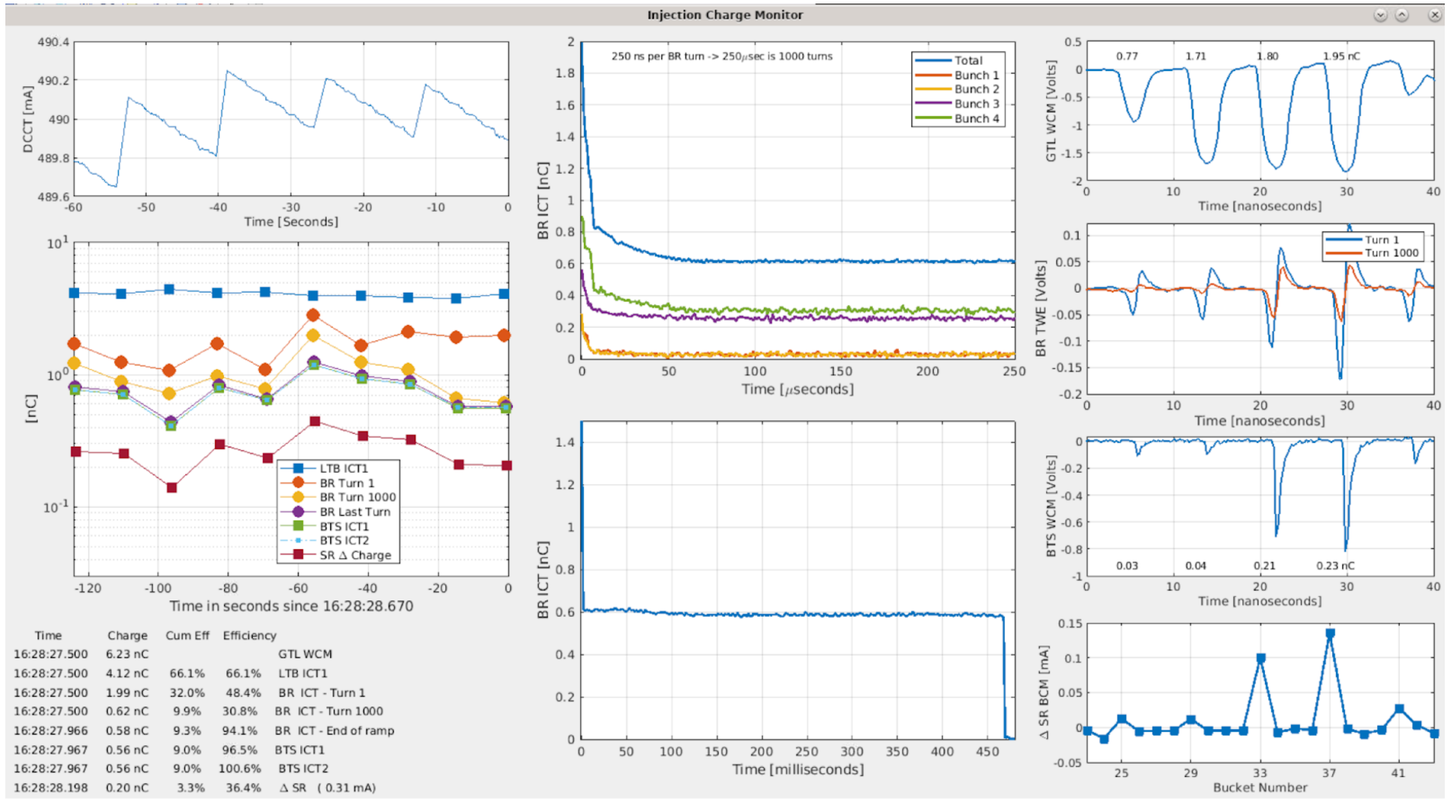
- **Injection Monitoring**



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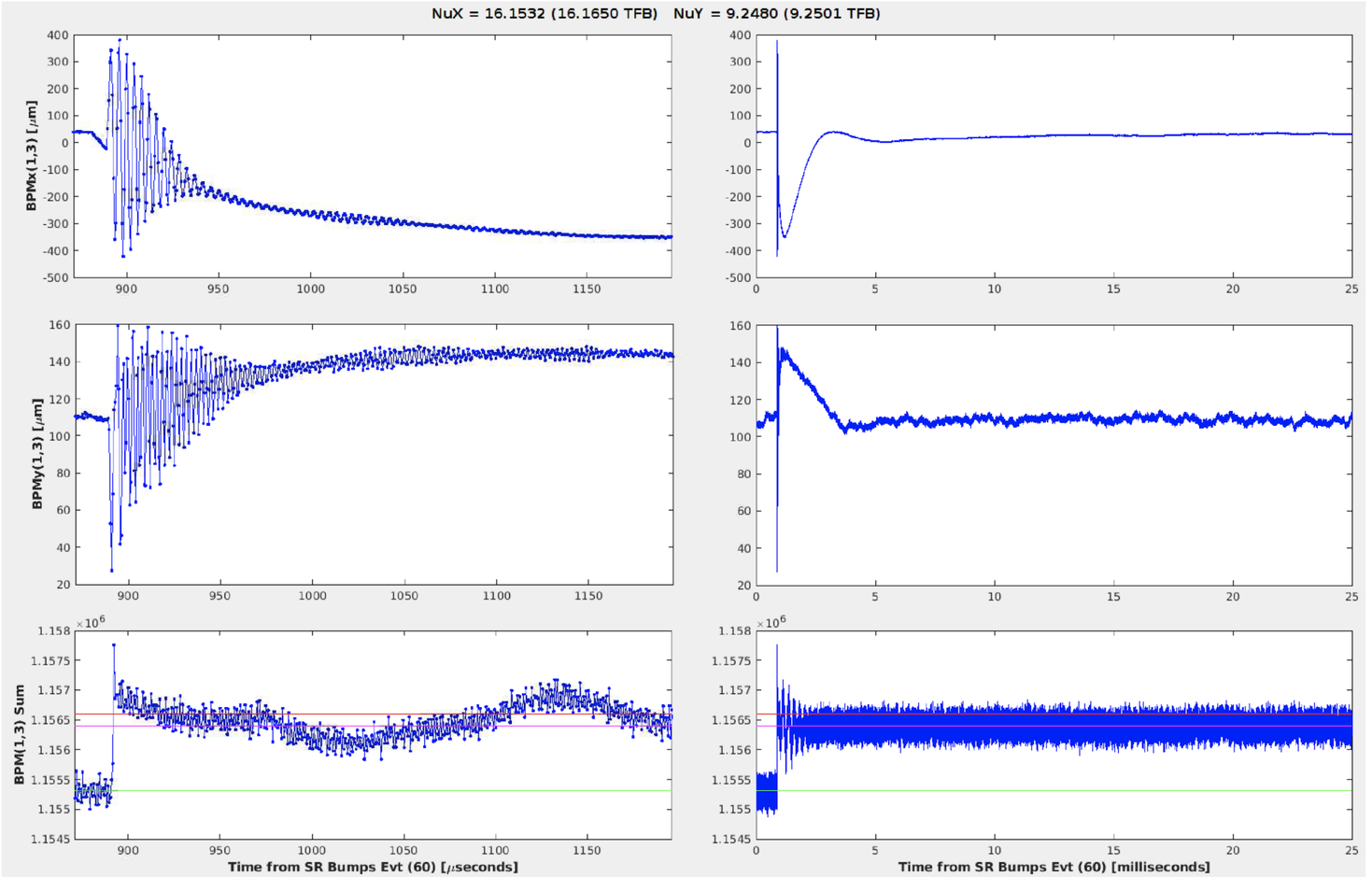

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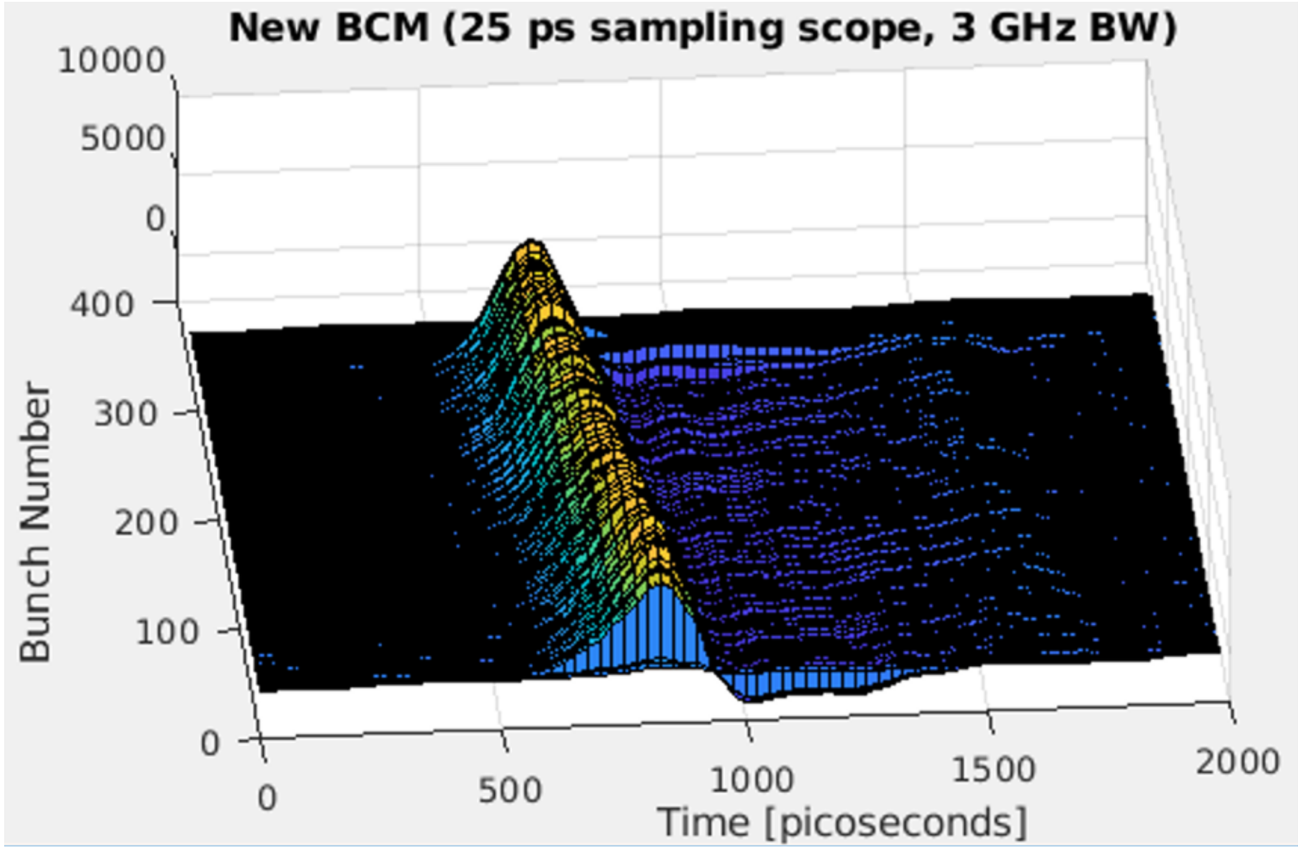
- Injection Monitoring
- **Bunch Current and Phase**



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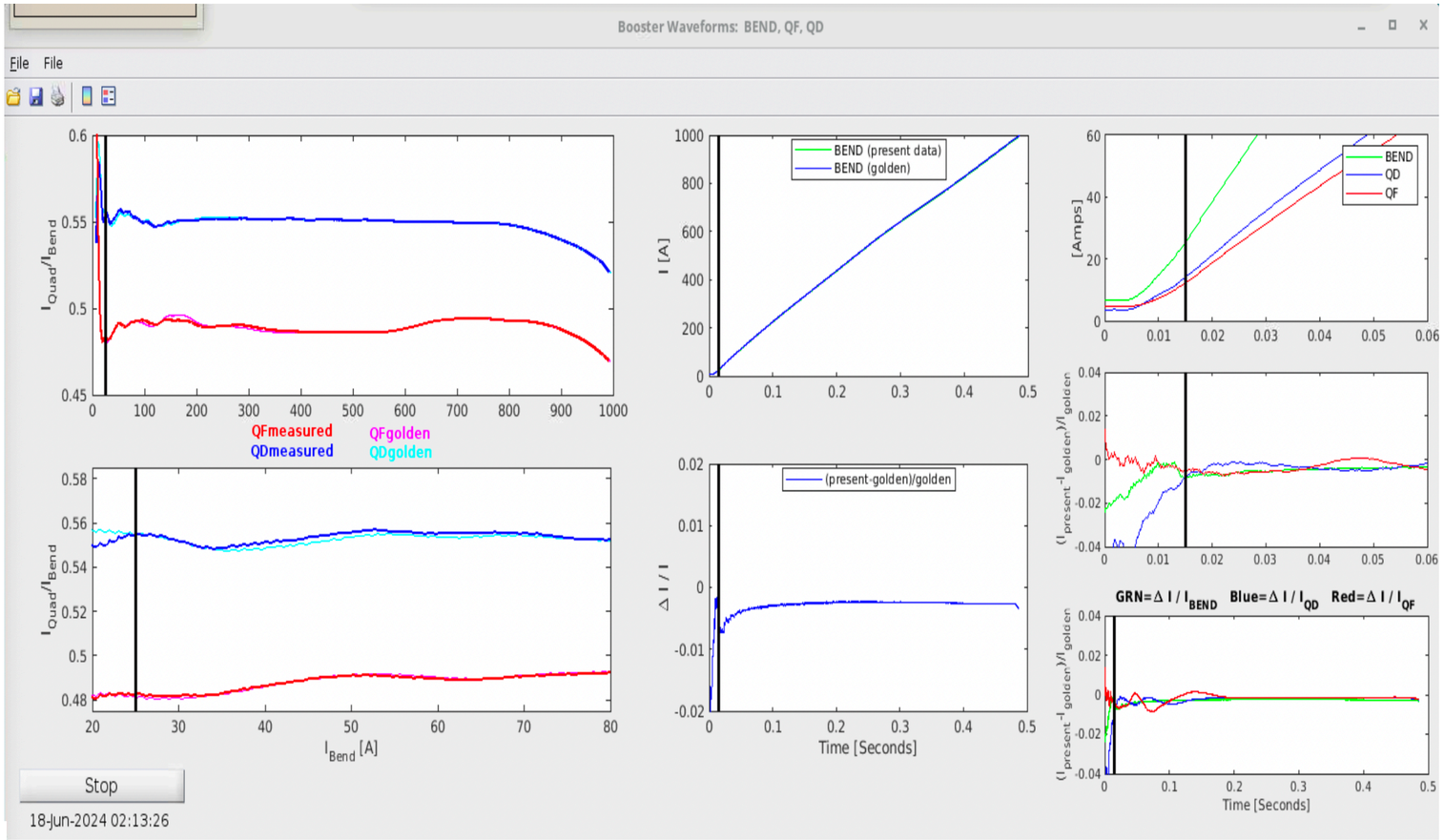
- Bunch Current and Phase
- **Energy Ramping**



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- **Hysteresis / Standardization of Magnets**

High Level Applications in Matlab

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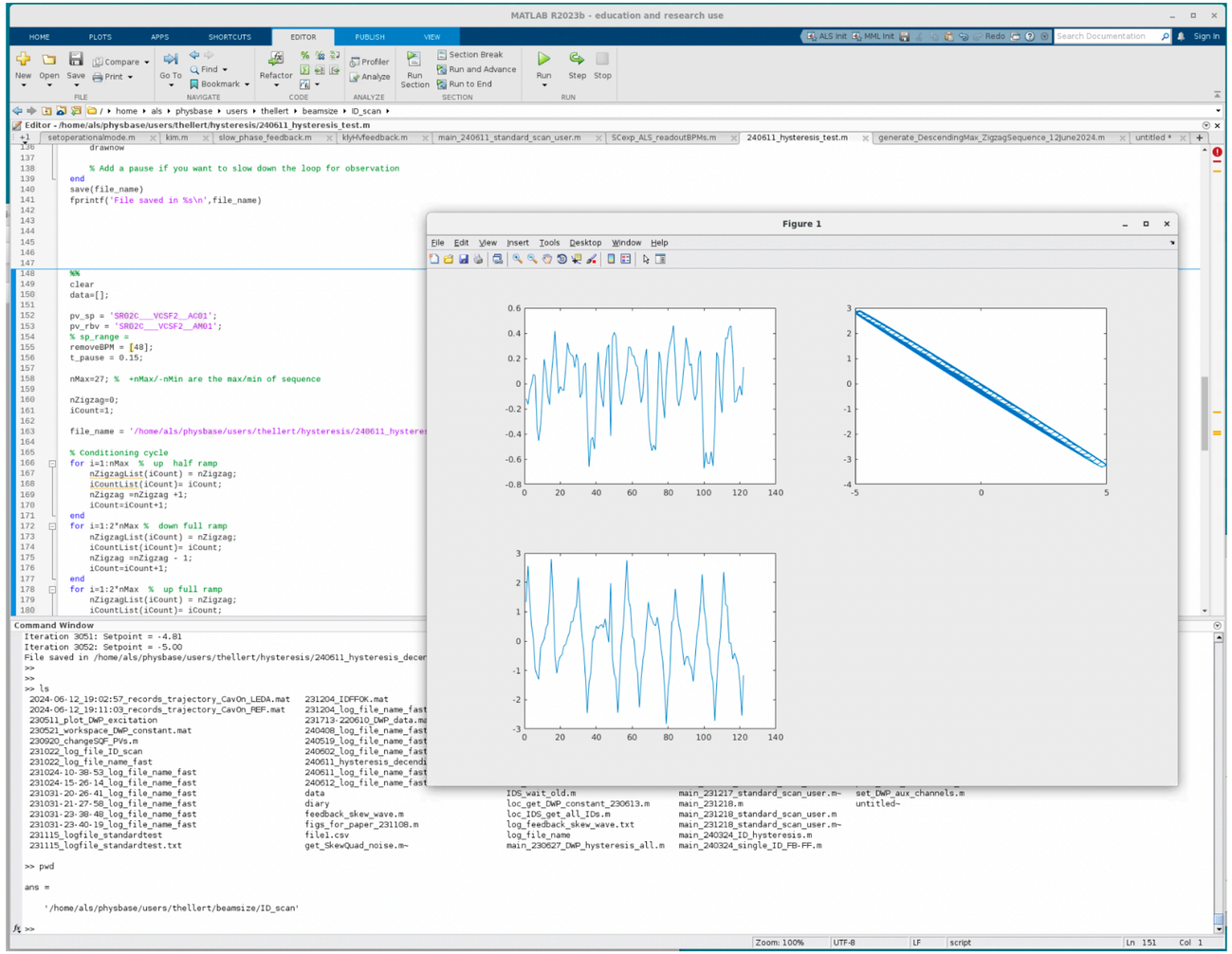
- **Primary Scripting Language for Physics Shifts**



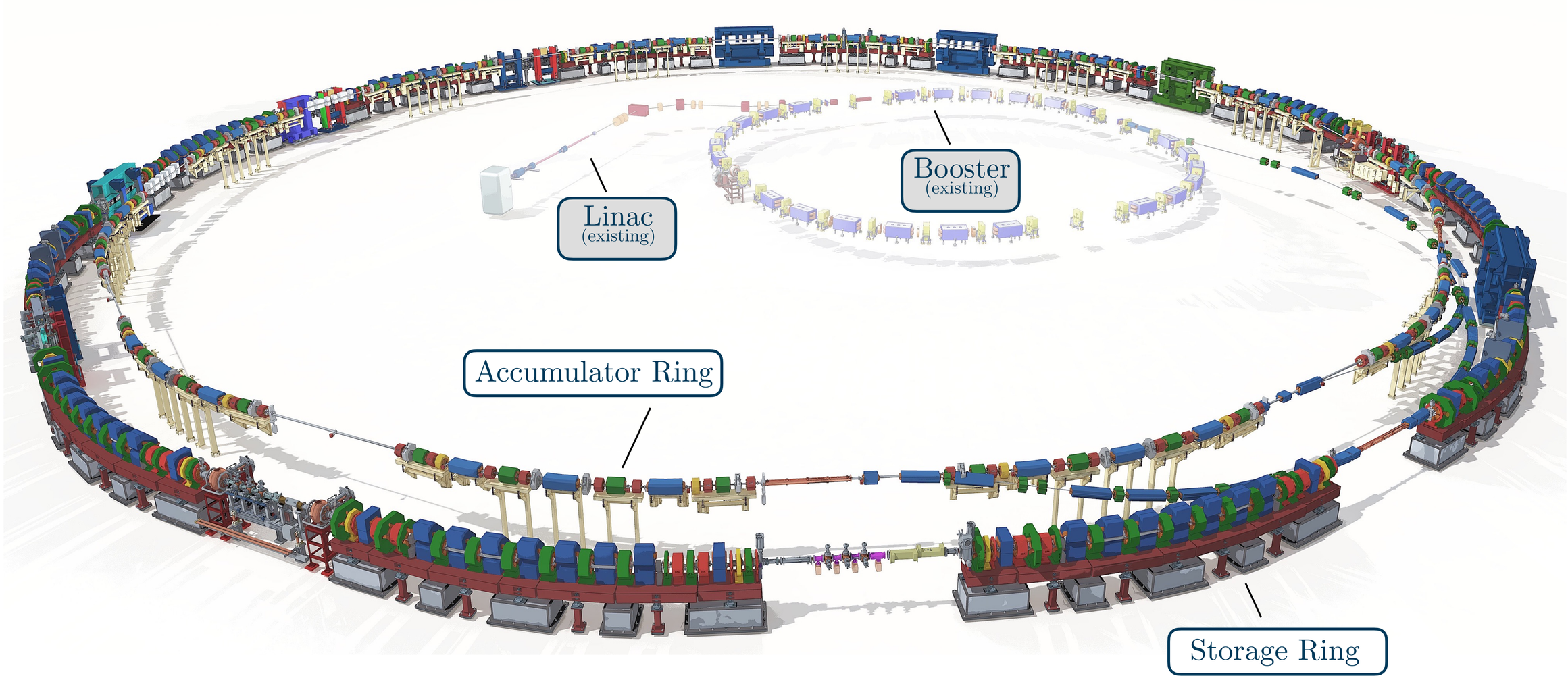
Future Applications

Machine Learning Projects are Implemented in Python

Python ↔ EPICS ↔ PHOEBUS

- Machine learning applications will become more important in the future
  - Implemented in python
  - Currently without any middle layer

Overview of the ALS-U Accelerator Facility



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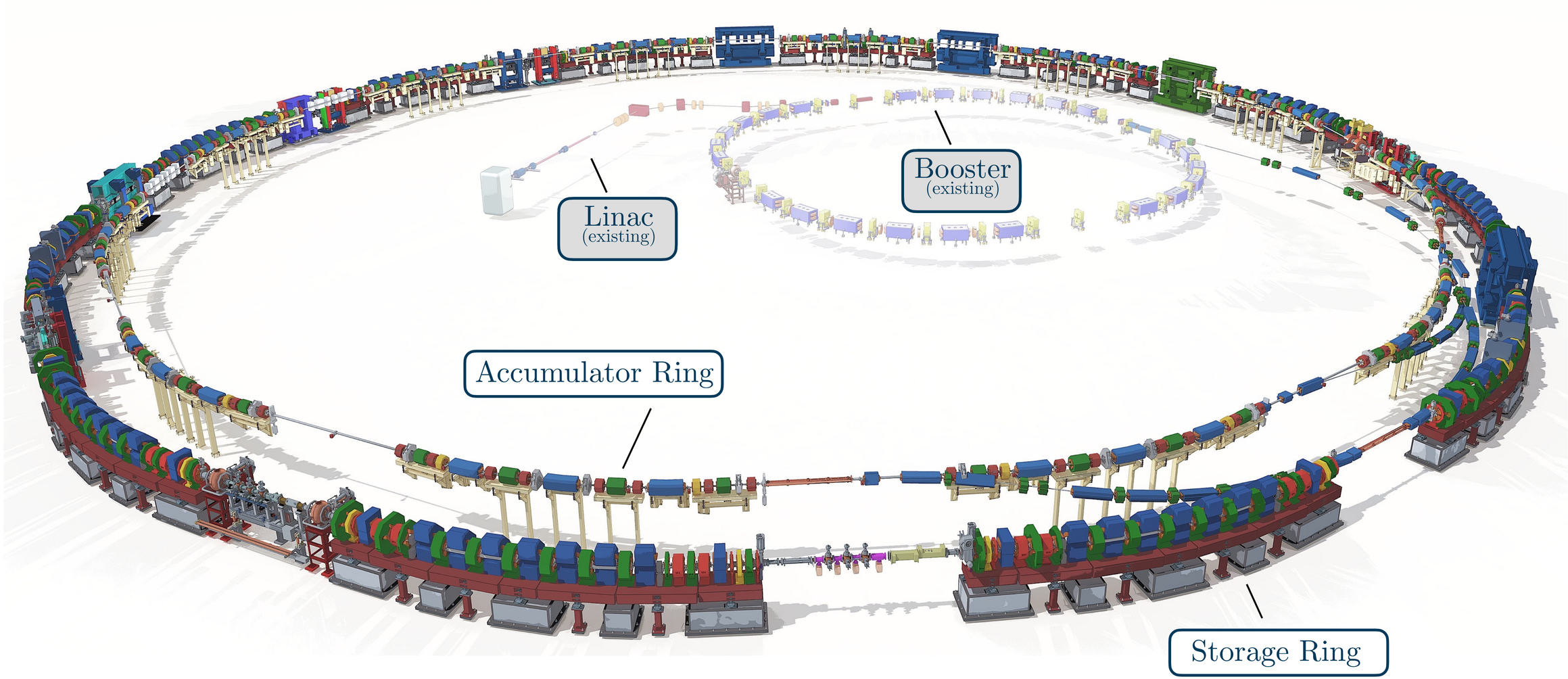
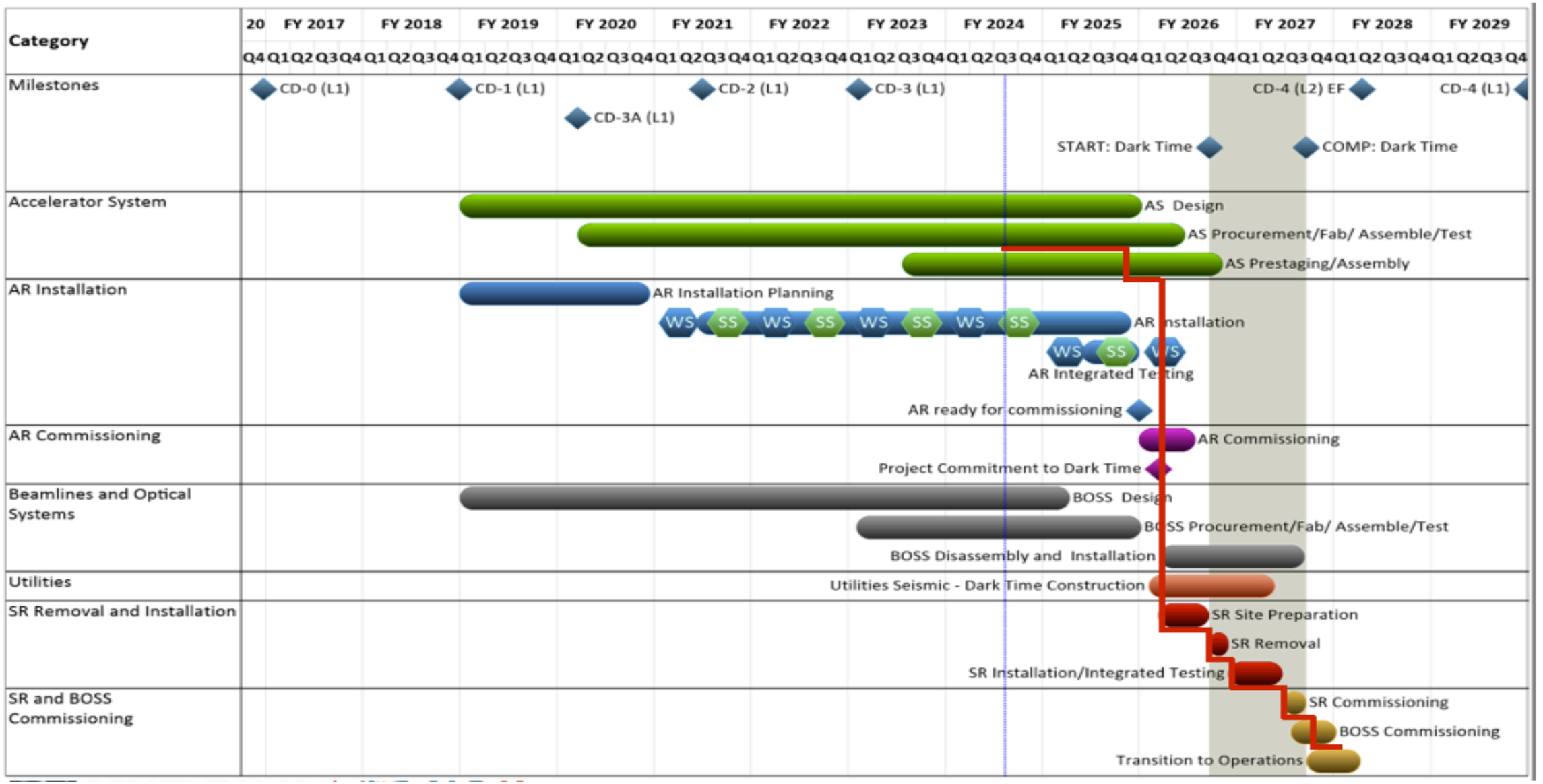


ALS-U Schedule



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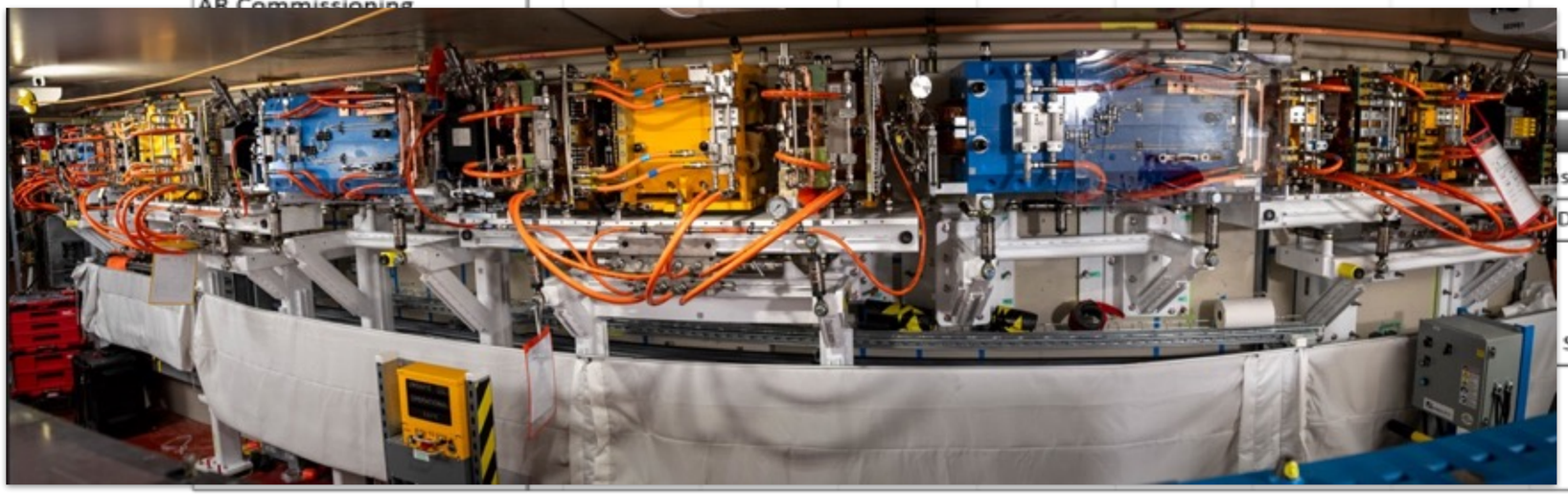
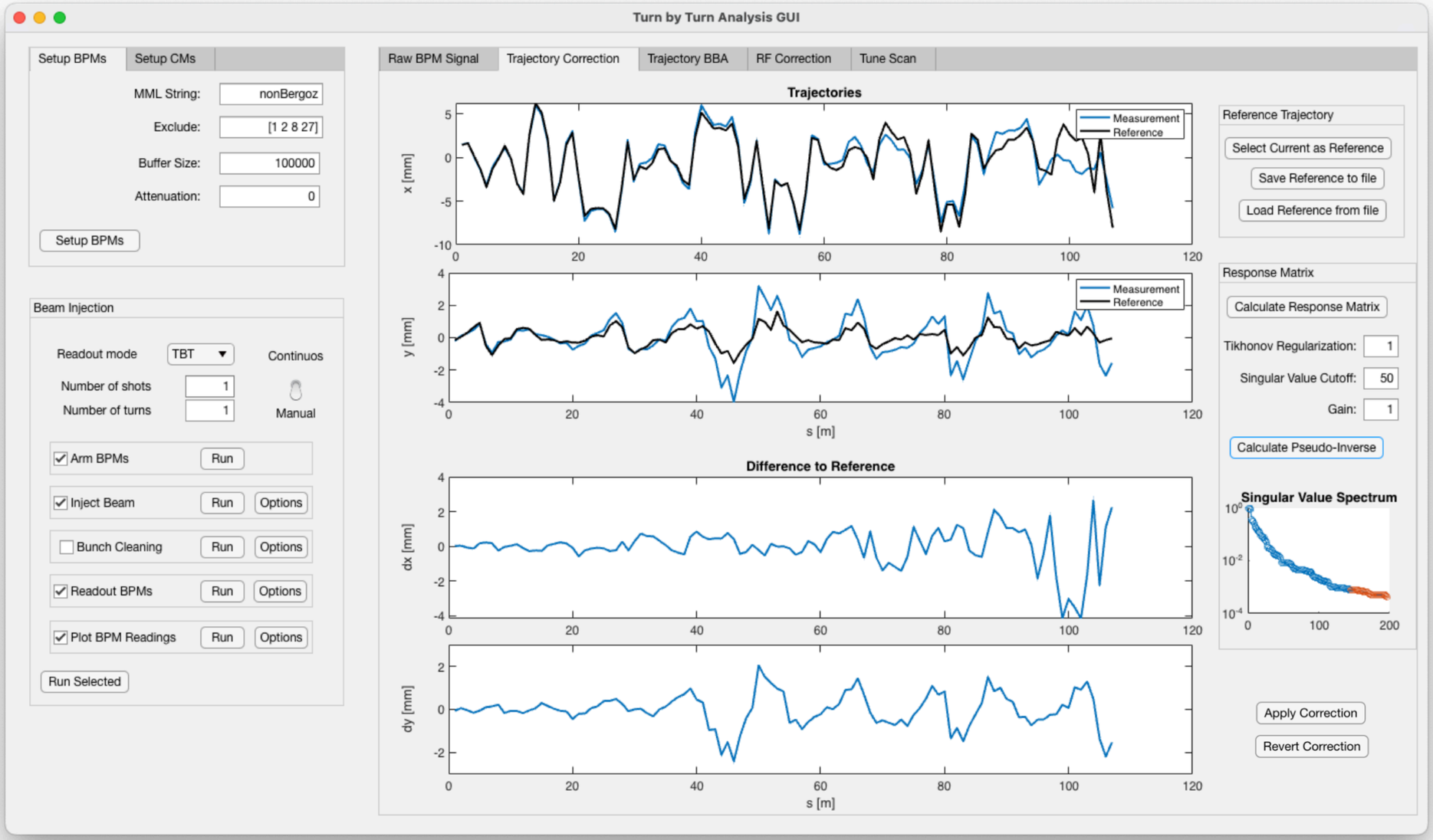
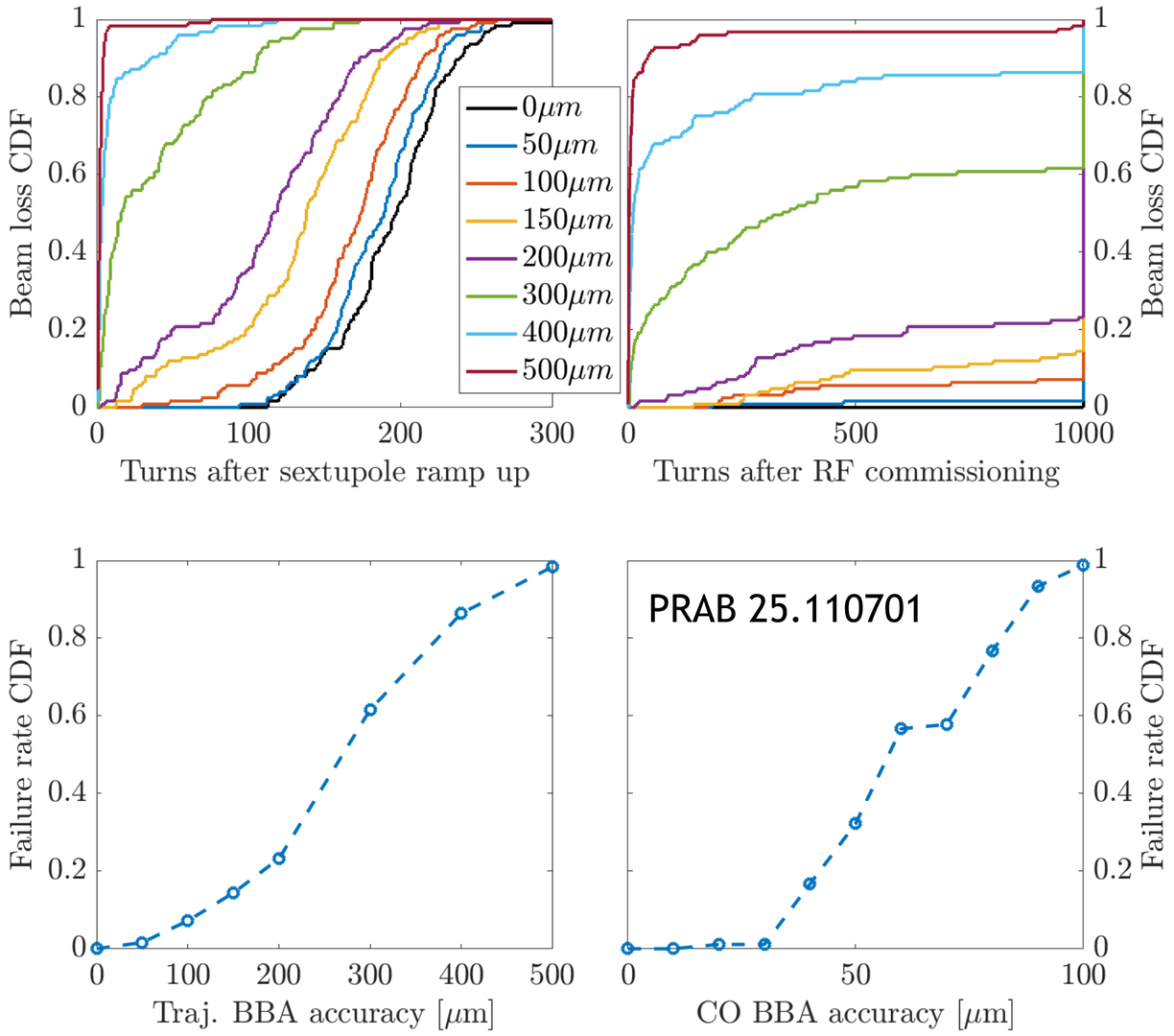


Turn-by-Turn Trajectory Correction / Beam Threading



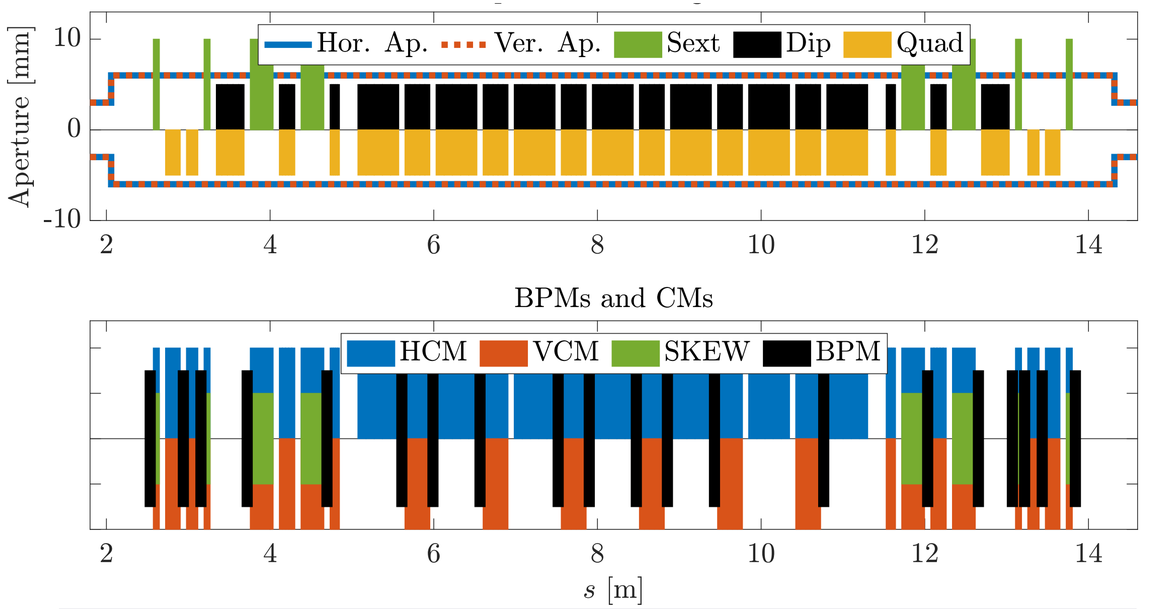
Turn-by-Turn Beam Based Alignment

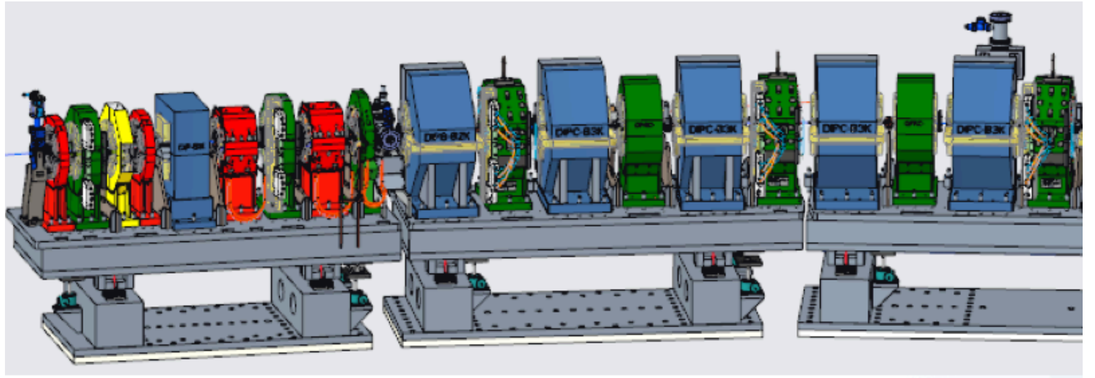
- Turn-by-Turn BBA Required for ALS-U
  - Commissioning simulations for ALS-U Storage Ring show that without ~100um rms BPM offsets reliable beam capture can not be expected
  - Initial BPM offsets to be expected at ~500um rms
  - Turn by turn BBA routine mandatory for successful beam capture at ALS-U SR



Beam Dynamics Challenges

- Tight space constraints
  - Most correctors are embedded in combined function magnets
  - Dipole field compensation critical for BBA
- Little Margin for Errors
  - Commissioning simulations show that the lifetime goal of 30min is met with little margin (including IDs)
  - Hysteresis might become critical to compensate





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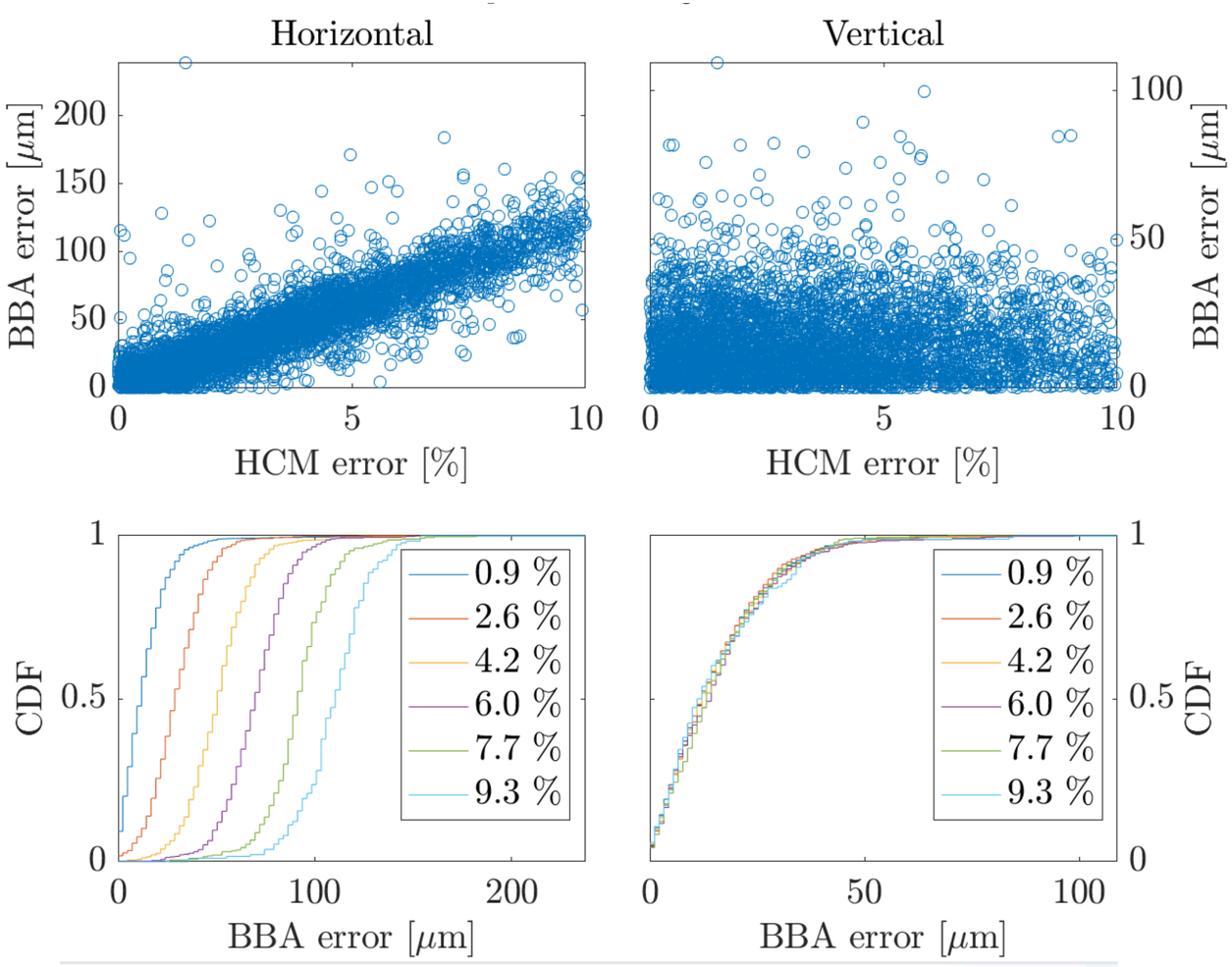

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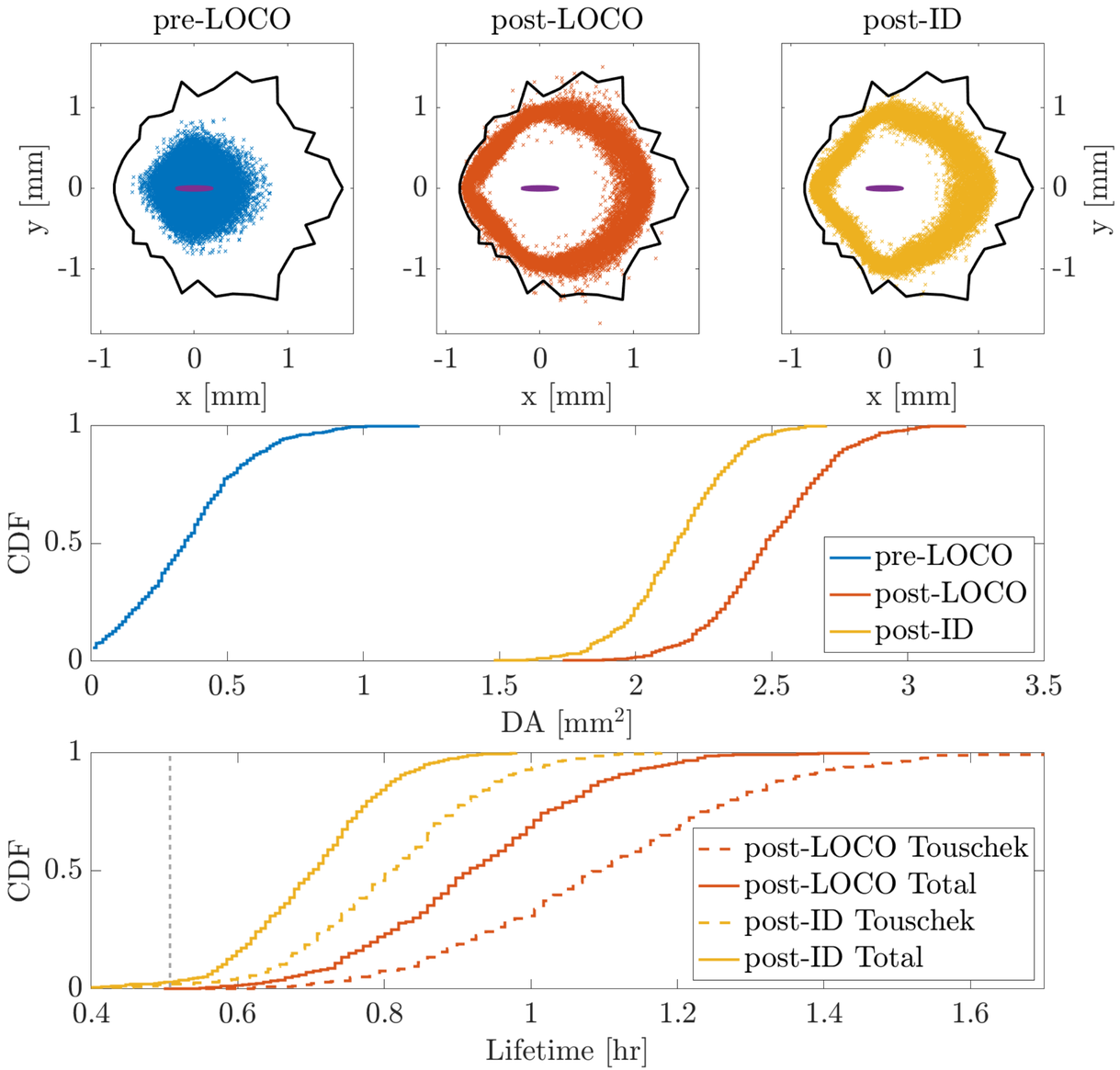
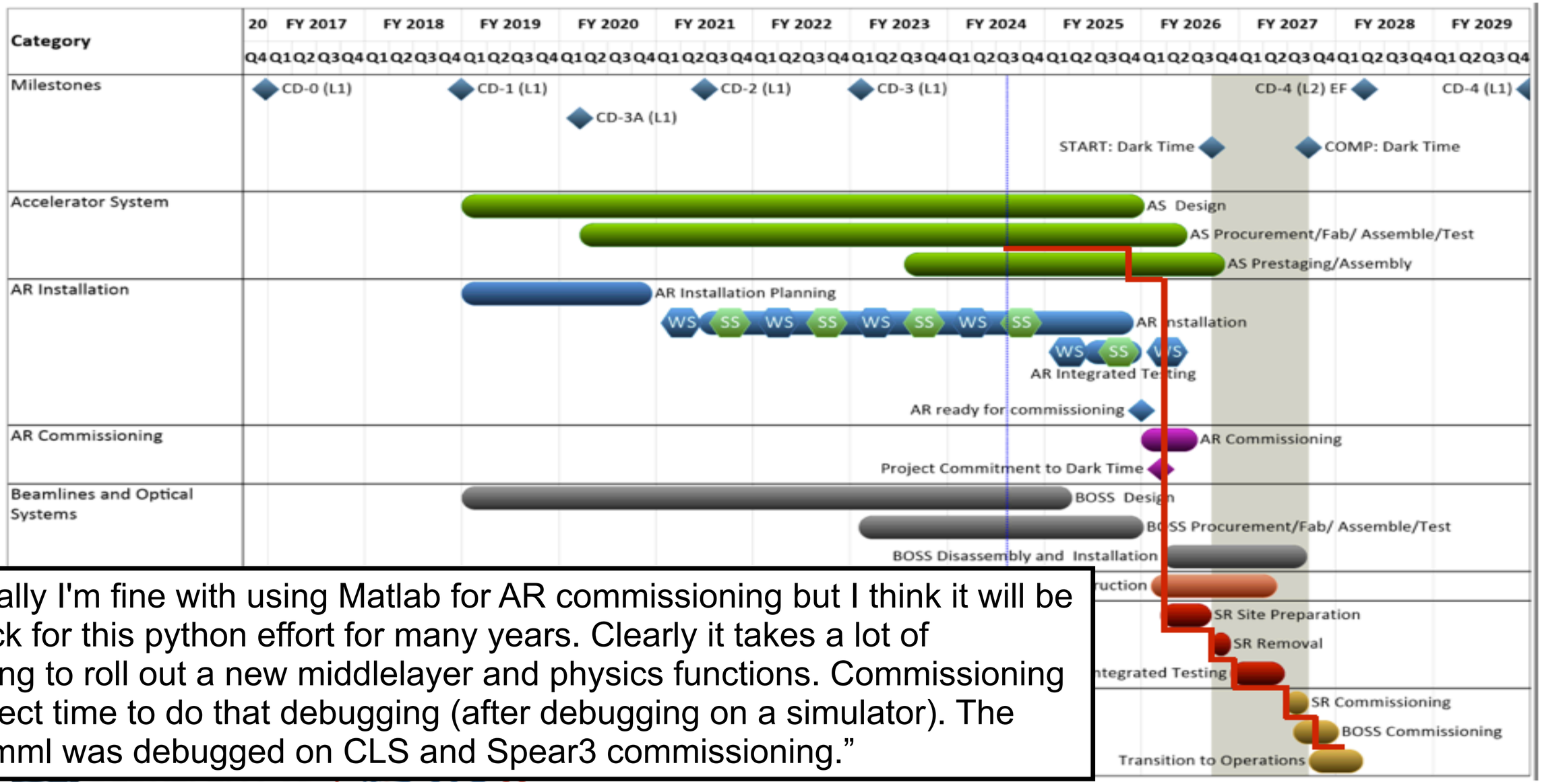


Outlook



"Personally I'm fine with using Matlab for AR commissioning but I think it will be a setback for this python effort for many years. Clearly it takes a lot of debugging to roll out a new middlelayer and physics functions. Commissioning is a perfect time to do that debugging (after debugging on a simulator). The matlab mml was debugged on CLS and Spear3 commissioning."