Status and future of SOLEIL Fast Orbit Feedback

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Presentation outline

- Integration to the Control System and commissioning
- New identification features
- Future of the Sniffer Archiver

Integration to the Control System and commissioning

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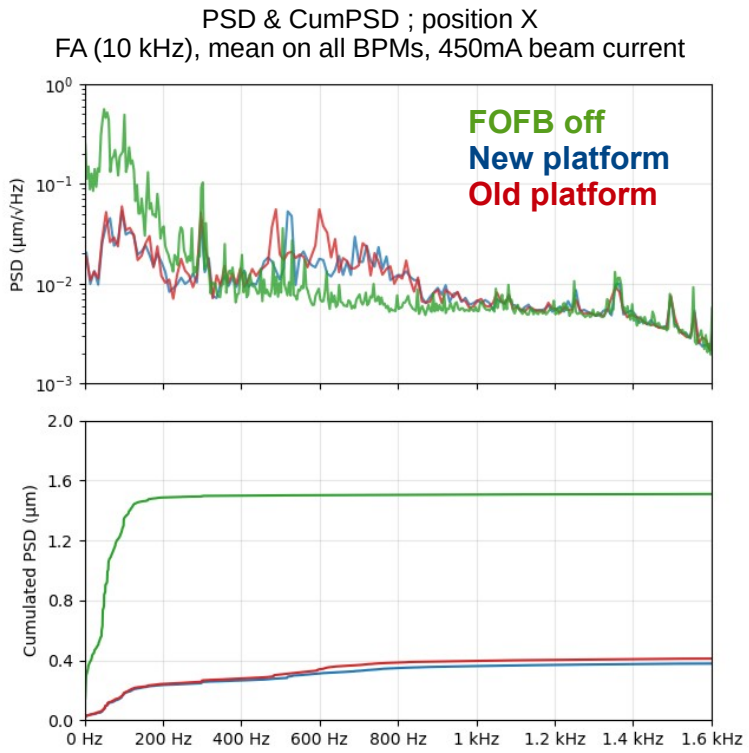
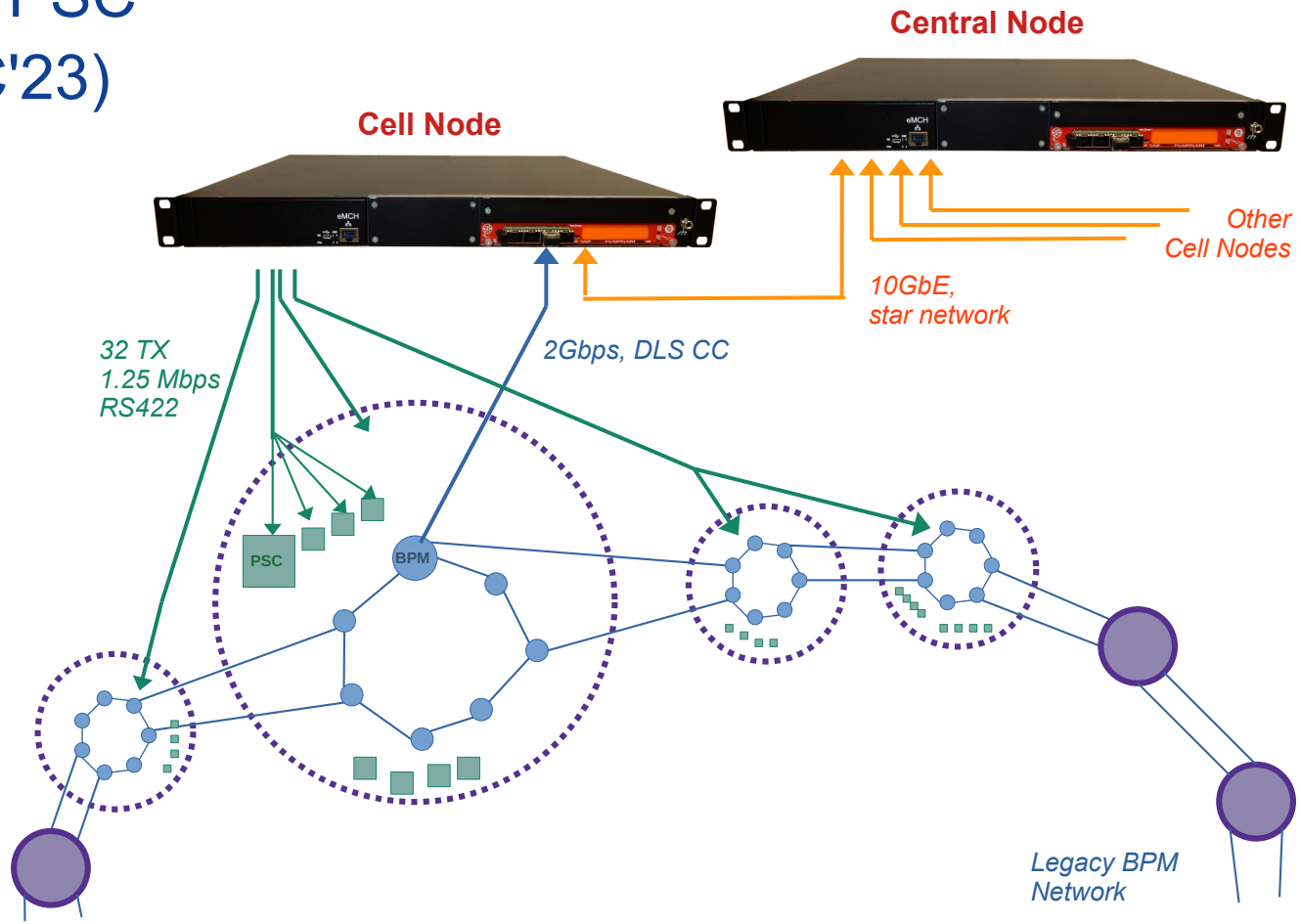
System Overview

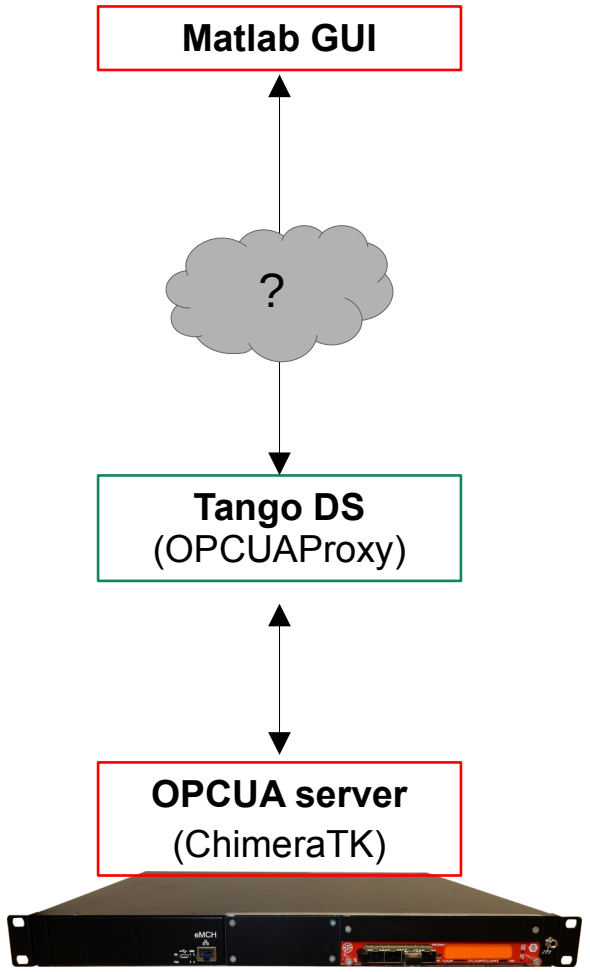
- BPM data collected and forwarded to Central Node
- Correction data distributed back to PSC
- Tested and reported last year (IBIC'23)





Integration to the Control System

- Original Tango device : Fofb-Manager
  - Big, complete software with multitask
  - Shaped for Libera Electron (write registers with "magic values")
  - Has an inside state machine
  - Hard to modify
- What's required at the Control System Level
  - Get the system state
  - Manual actions: start, stop, configure
  - Automatic action: stop
  - Driving from original Matlab GUI must be kept
- Linking FofbNodes to Tango
  - Generic ChimeraTK application, running on the SoC
    Polls FPGA registers but notify clients only if value change
  - Client is a generic Tango device, running on the Control System server



Tango devices for Control & Monitor

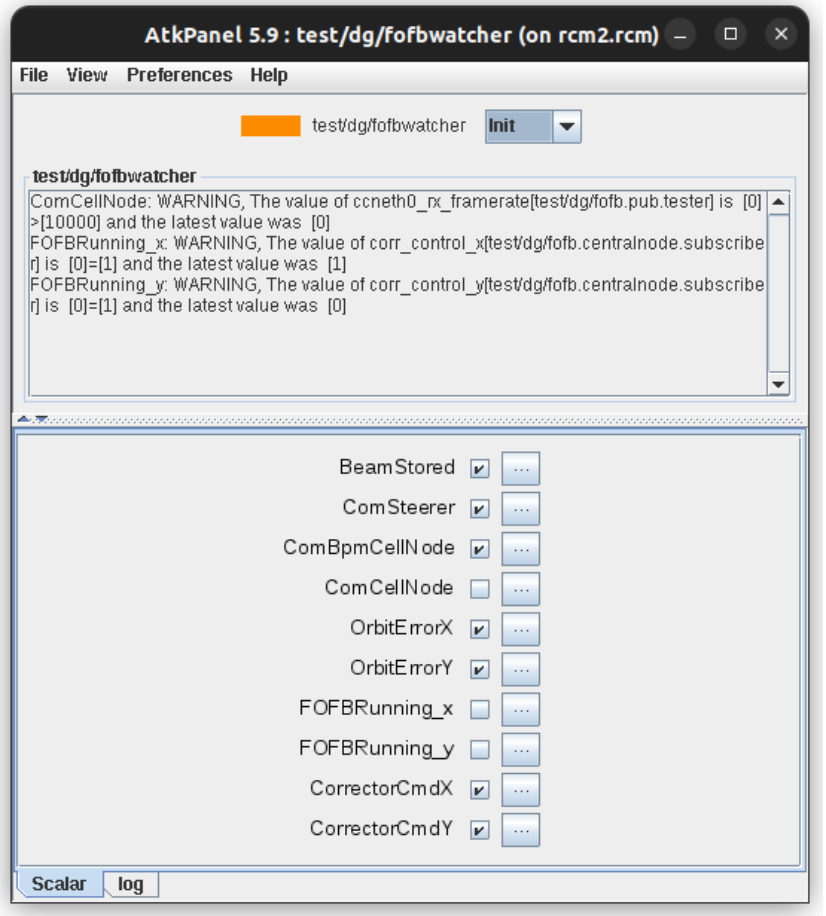
- FofbWatcher
  - Composes the system state (booleans) from attributes of ~200 devices.
  - Not a state machine !
  - Boolean state flag are configured via properties
  - Log and send event on boolean change
  - One stop place to get a picture of the system state

FOFBWatcher, properties higlights

Device properties [test/dg/fofbwatcher]

Property name	Value
DefaultTaskPeriod	100
Device_CellNodes	test/dg/fofb.cellnode-C01.subscriber test/dg/fofb.cellnode-C06.subscriber test/dg/fofb.cellnode-C09.subscriber test/dg/fofb.cellnode-C14.subscriber test/dg/fofb.pub.tester
Device_CentralNode	test/dg/fofb.centralnode.subscriber
Device_DCCTLifeTime	ans/dg/dcct-ctrl
Device_Hsteerers	FREE_PROPERTY:FOFB/HSteererList
Device_Vsteerers	FREE_PROPERTY:FOFB/VsteererList
InhibitedDevice_Hsteerers	
Inhibit_bpmX	63 0 123 124 125 126 127
Inhibit_bpmY	63 0 123 124 125 126 127
Inhibit_CorrX	
Inhibit_CorrY	
Period_CorrectorCmdX	500
Period_CorrectorCmdY	500
Period_OrbitErrorX	500
Period_OrbitErrorY	500
SeparatorProperties	;
Tests_List_Prop	BeamStored;ThresholdDouble;DCCTLifeTime;;current;Threshold_BeamCurrent;> ComSteerer;ThresholdDouble;Hsteerers;state;Threshold_SteererState;= ComSteerer;ThresholdDouble;Vsteerers;state;Threshold_SteererState;= ComSteerer;ThresholdDouble;Hsteerers;nbframesec;Threshold_FofbRate;> ComSteerer;ThresholdDouble;Vsteerers;nbframesec;Threshold_FofbRate;> ComBpmCellNode;ThresholdDouble;CellNodes;;combpm_protocol_status;Threshold_ComBpmStatus;= ComCellNode;ThresholdDouble;CellNodes;;ccneth0_rx_framerate;Threshold_FofbRate;> OrbitErrorX;ThresholdDouble;CentralNode;orbit_error_x;Threshold_OrbitErrorX;a<;INHIBITED_INDEXES_PROP=Inhibit_bpmX;MAX_FAILURE=5 OrbitErrorY;ThresholdDouble;CentralNode;orbit_error_y;Threshold_OrbitErrorY;a<;INHIBITED_INDEXES_PROP=Inhibit_bpmY;MAX_FAILURE=5

FOFBWatcher, attributes and status



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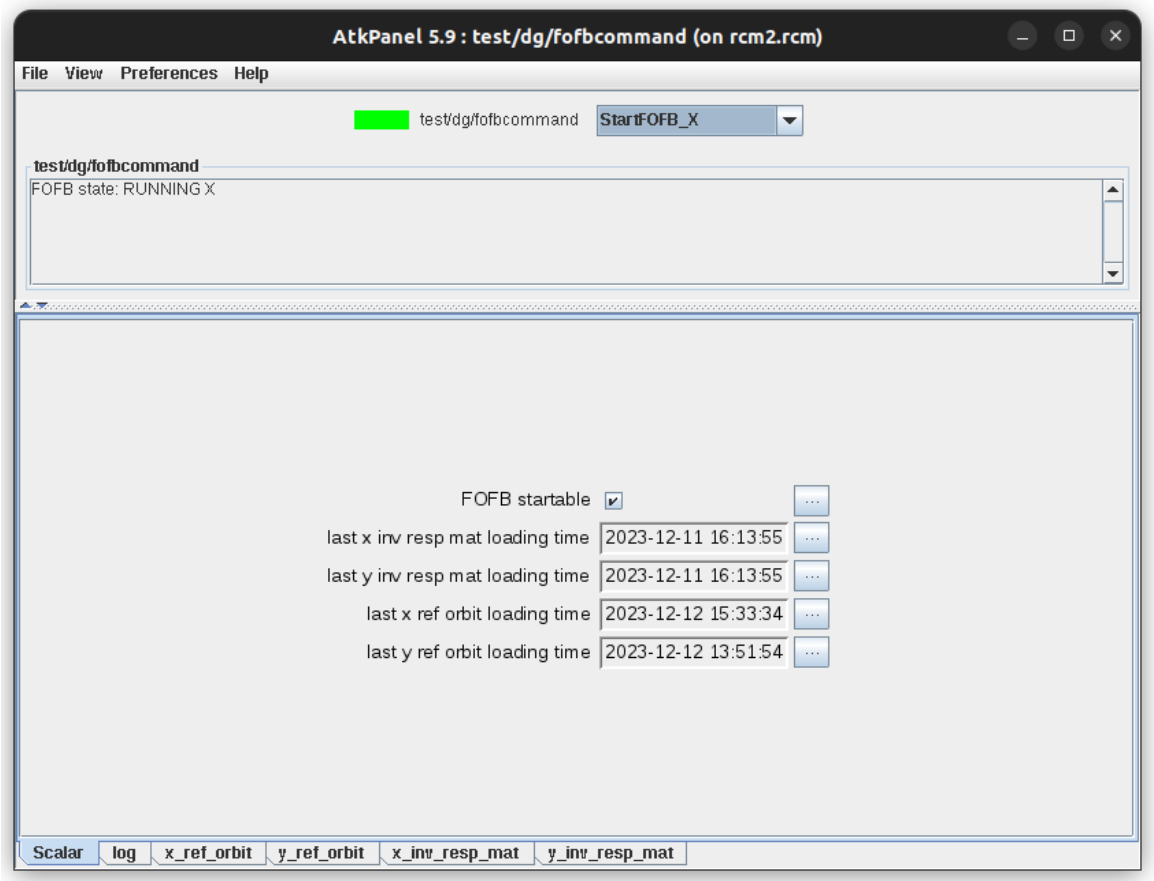
Tango devices for Control & Monitor

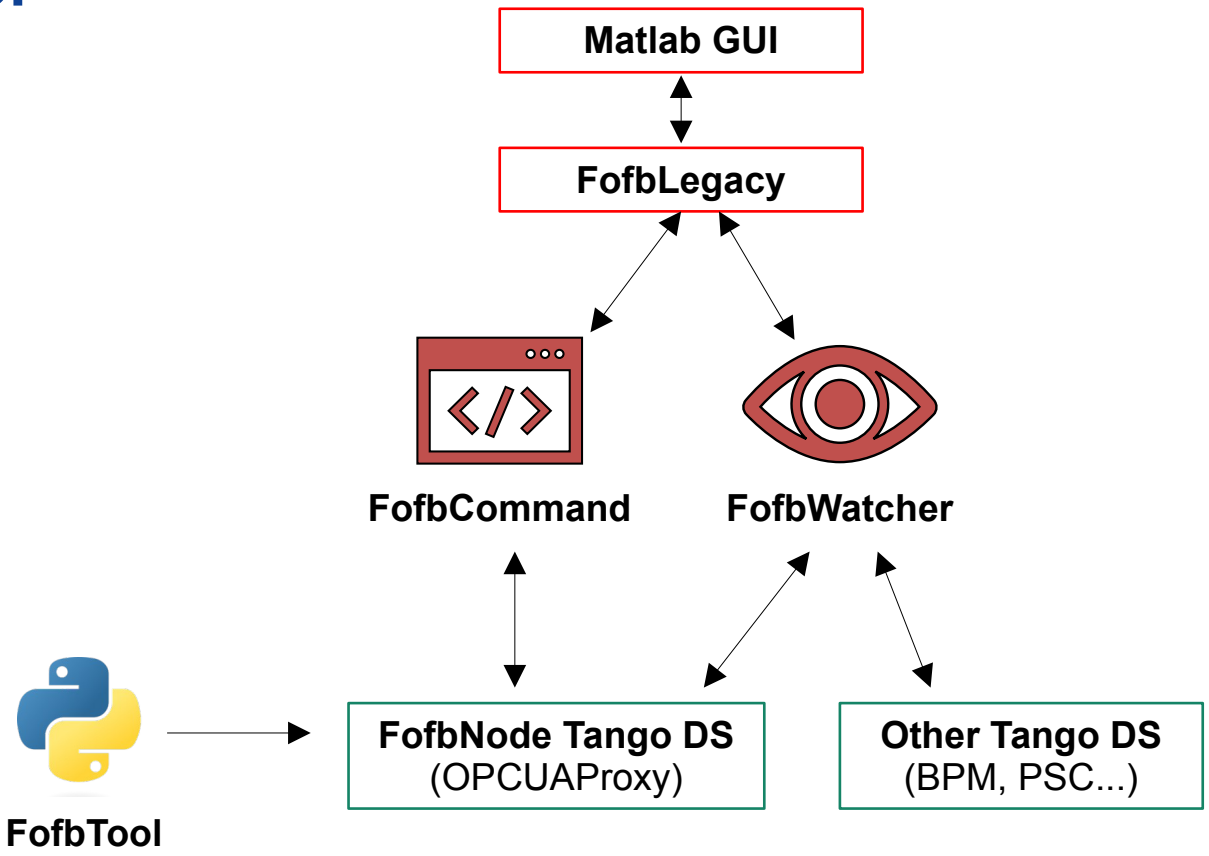
- FofbWatcher
- FofbCommand
  - Runs pre-defined operations
  - Hold and transmit the Inverted Response Matrix, orbit reference
  - Act automatically or on user demand
  - Receives events from the FofbWatcher
  - Can condition actions with boolean states of FofbWatcher

FOFBCommand, attributes and status



Tango devices for Control & Monitor

- FofbWatcher
- FofbCommand
- FofbLegacy
  - Attribute/command translator to adapt Matlab GUI
- FofbTool
  - Python module
  - Expert tool for configuration
  - inter FofbNode communication bring up



Commissioning

- Final test on a dedicated machine shift 29/01
- Followed by a production test week
  - Quick fallback to Libera based system (tango proxy, relay switches) → Not used !
- On-Duty call exercises for the team
- Few incidents since
  - FofbWatcher a little more sensitive to Tango Read hangs on Steerer devices
    → Auto stop, solved by a simple "start"
- Very transparent for the operation team
  - Same Matlab GUI
- Pending test on log handler system
  - Based on ElasticSearch

New identification features

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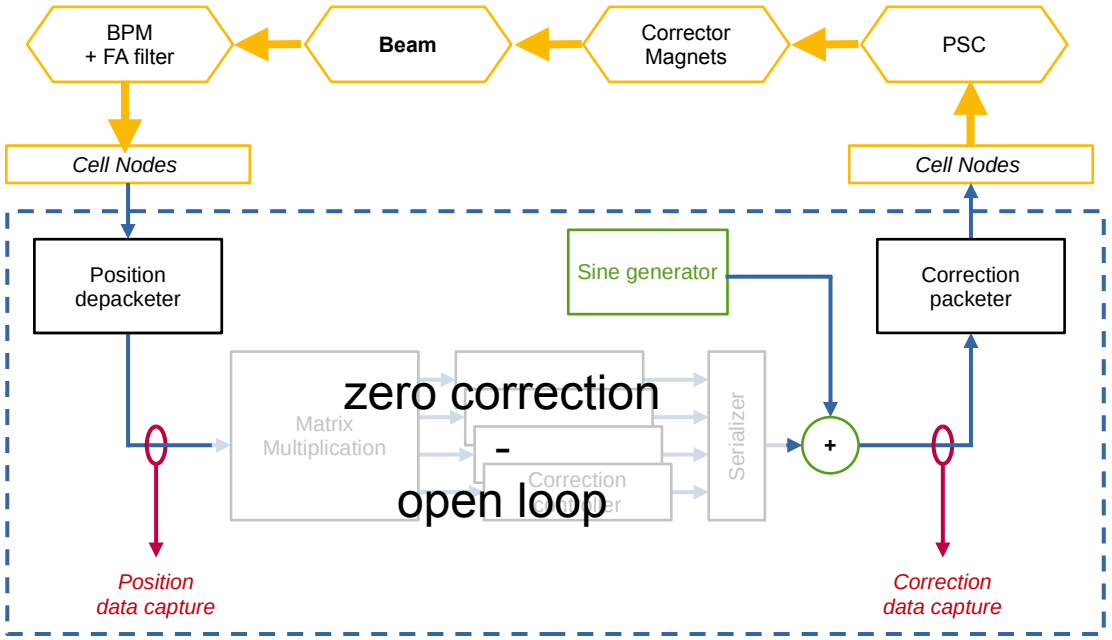
PSC to Beam identification

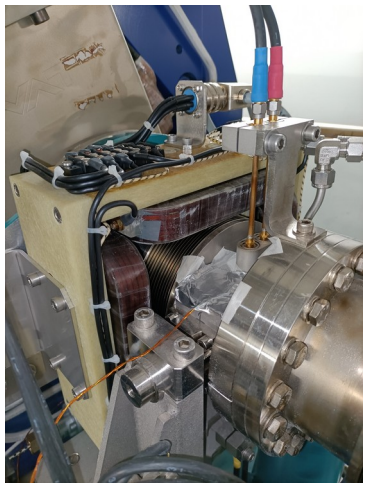
Open loop transfer function measure

- Input: Sine waveform drives the PSC, 40Hz – 1600Hz
- Output: Position data from the 60 most sensitive BPM, normalized by ORM
- 3 groups of correctors: Nominal (blues) ; Injection (reds) ; Close-by Invar stands (greens)



Open loop schematic for transfer function measures

Corrector magnets groups



Nominal
over bellow

Injection
over stainless steel
vaccum chamber

Close-by Invar stands

PSC to Beam identification

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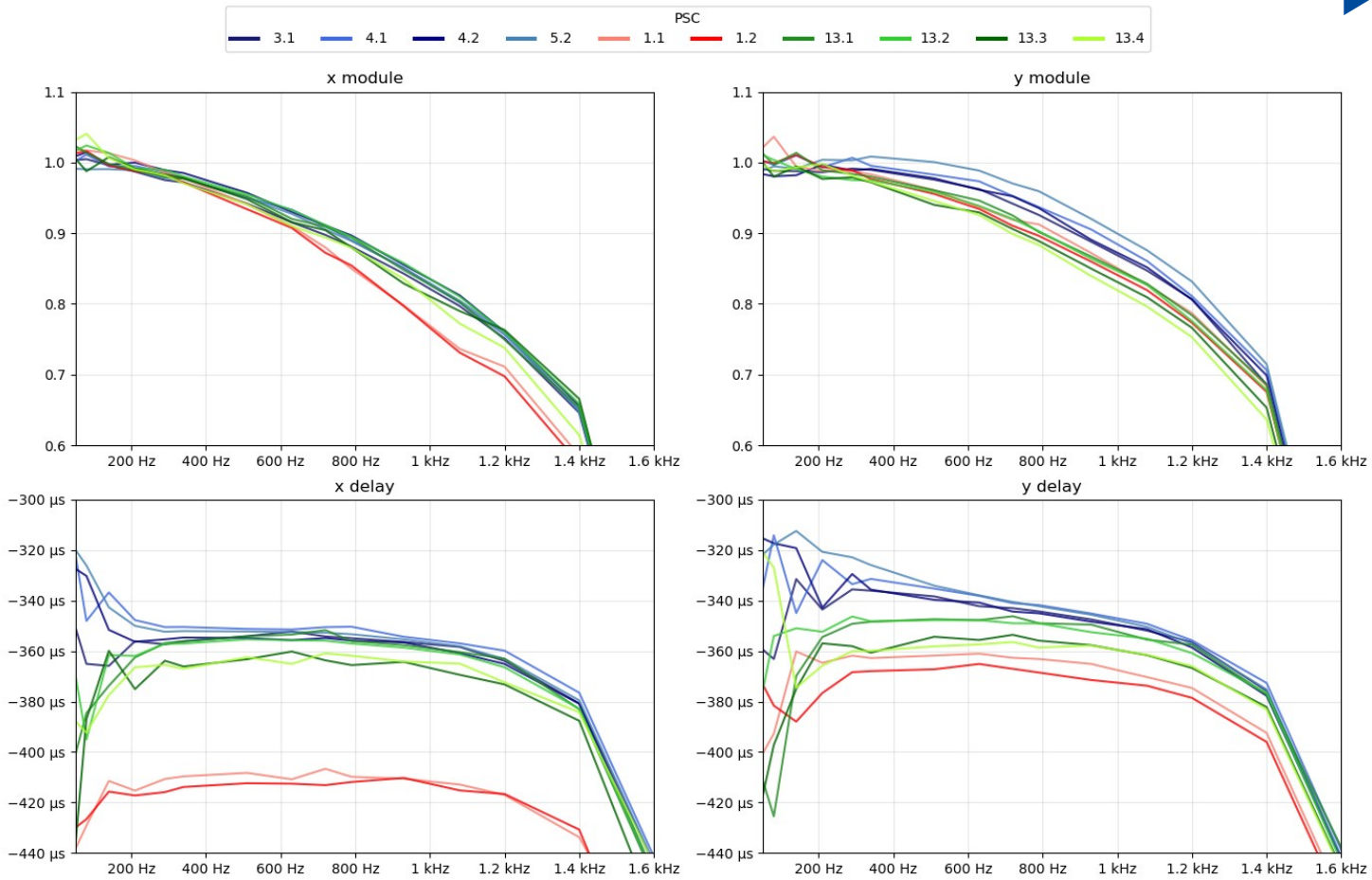


Observations

- Injection section PSC show additional X/Y delay 55/25 µs ; lesser gain above 600/300 Hz
- Some close-by Invar PSC show additional X/Y delay of about 10 µs.
- Y delay of nominal PSC show a phase shift, whereas other are flatter.
- Delay result disturbed under 150Hz. Probably because of noisy band.
- Strong diversity of module shape: This is challenging for fast ORM measure.

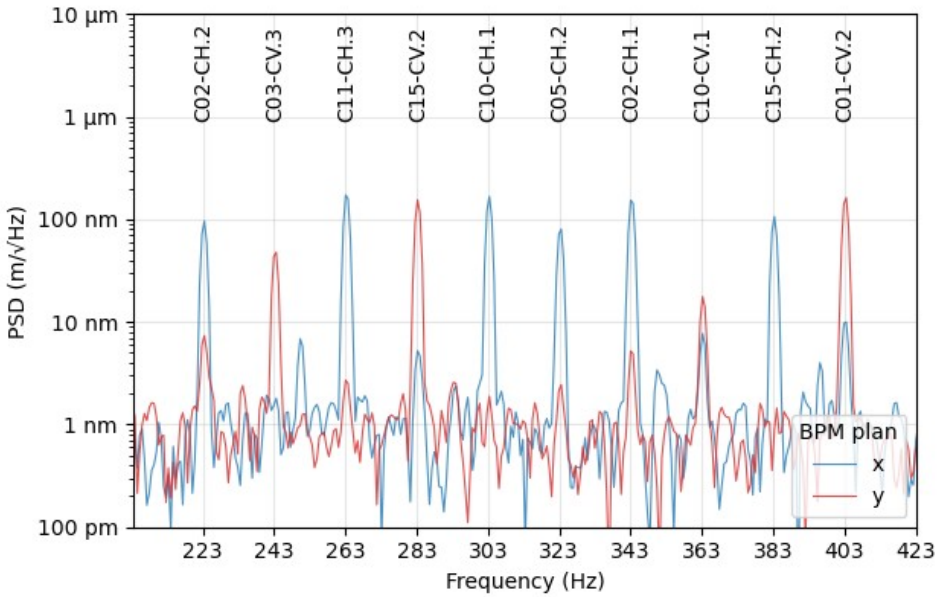
Fast Orbit Response Matrix Identification

Fast ORM measure

- "Slow" measure: 1 PSC at a time, (time multiplexing). 18 minutes.
- "Fast" measure: (add Frequency mutliplexing) 10 PSC at a time, each on at a narrow frequency in band 200-400 Hz
  2 minutes.

Tackle module diversity in 200-400 Hz band

- Make 2 measures, each PSC will be measured at a different frequency.
- Interpolate results at a unique frequency point.



Driving ten PSCs with different frequencies, observing mean PSC over all BPMs.
Sampling 10 kHz, duration 1.5 s, blackman window.

Fast Orbit Response Matrix Identification

- Assessing reproducibility of Slow/Fast measure
  - 4 observations for each method
  - For each coefficient, compute peak to peak of observations.
  - Work per quadrants, units in µm/A
  - Unexplained differences X/Y for slow method
- Change methodology: consider ORM as an operator ?

BPM / PSC	X	Y
X	S: 1.8 F: 0.5	S: 0.3 F: 1
Y	S: 1.3 F: 0.6	S: 0.3 F: 0.7

Worst peak to peak coefficient observation, for Slow/Fast method (µm/A)

BPM / PSC	X	Y
X	64	4
Y	4	27

Max coefficient magnitude for each quadrant (µm/A)

Future of the Sniffer Archiver

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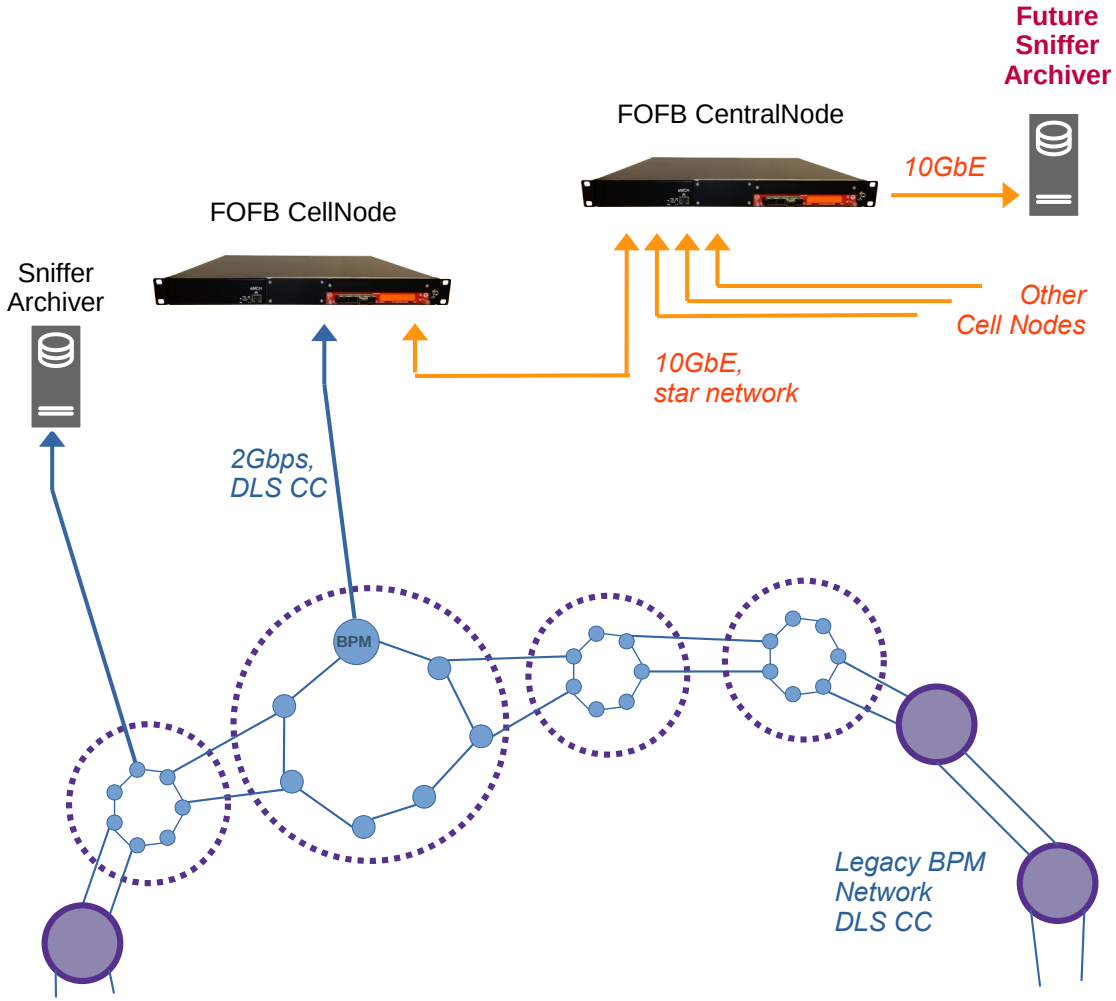
Future of the sniffer archiver

- Current Sniffer Archiver decommissioned soon
  - As soon as the legacy ring network is emptied of BPM (2025)
- Future Sniffer Archiver
  - Ingest position, correction and sum data from the CentralNode
  - Ease event search: localize time system triggers
  - Machine evolution
    10→100 kHz data rate ; +65% BPMs ; +20% PSC
  - Leads to data throughput & volume tenfolding
    16 to 280 MBytes/s ; Daily volume from 1.4 to 24 TB



Future of the sniffer archiver

- Discussion started with DLS, ALBA, MAX IV, ESRF
- Two options for SOLEIL
- Option 1: Update the Sniffer
  - Use 10GbE interface, UDP socket
  - BPMid → id (BPM, sum, corr, timing)
  - Increase storage
- Option 2: Generalized solution
  - UDP socket server
  - Pushing data to file / Timeseries DataBase

→ Common next step:
CentralNode outputs UDP frames

Thank you !

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