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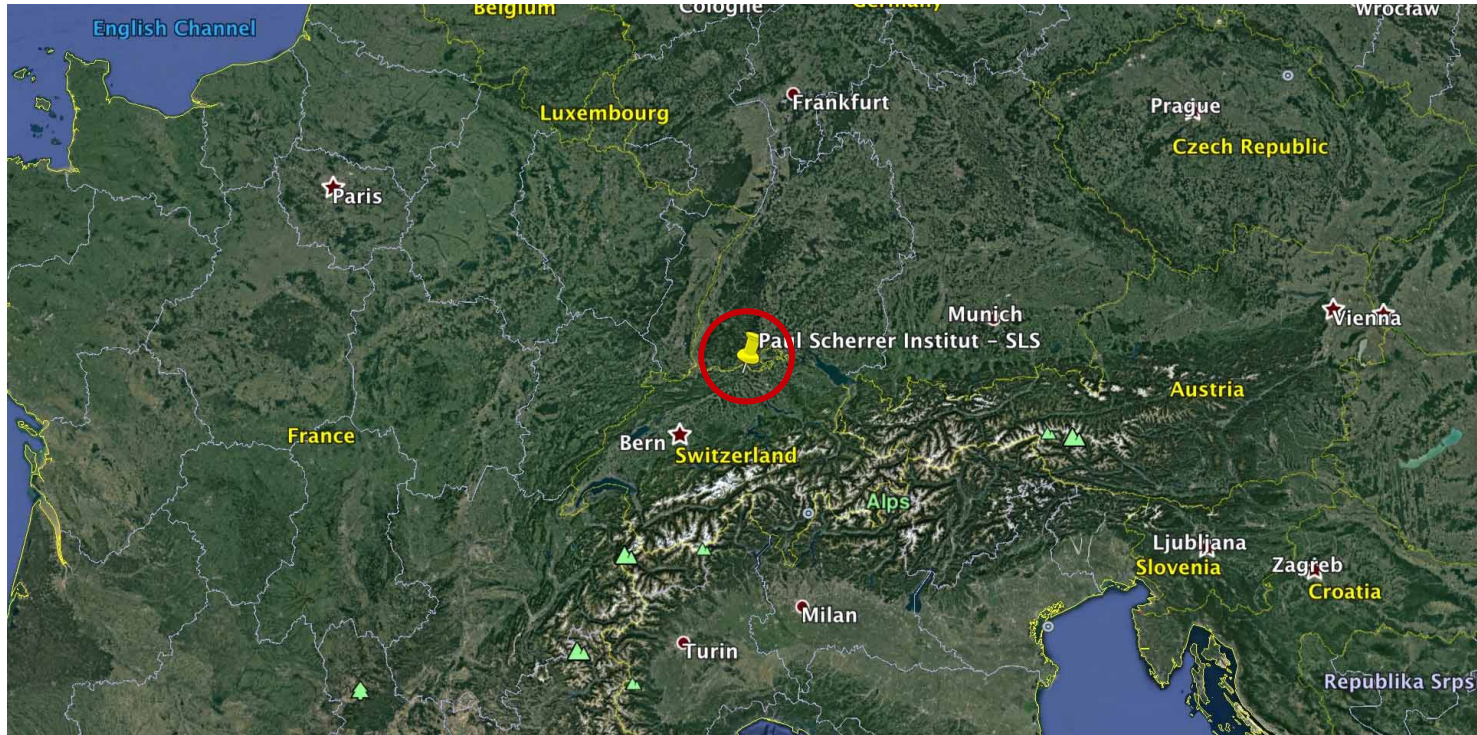


Klaus Wakonig :: Software Scientist :: Paul Scherrer Institute

A Beamline and Experiment Control System for SLS 2.0

October 9, 2023

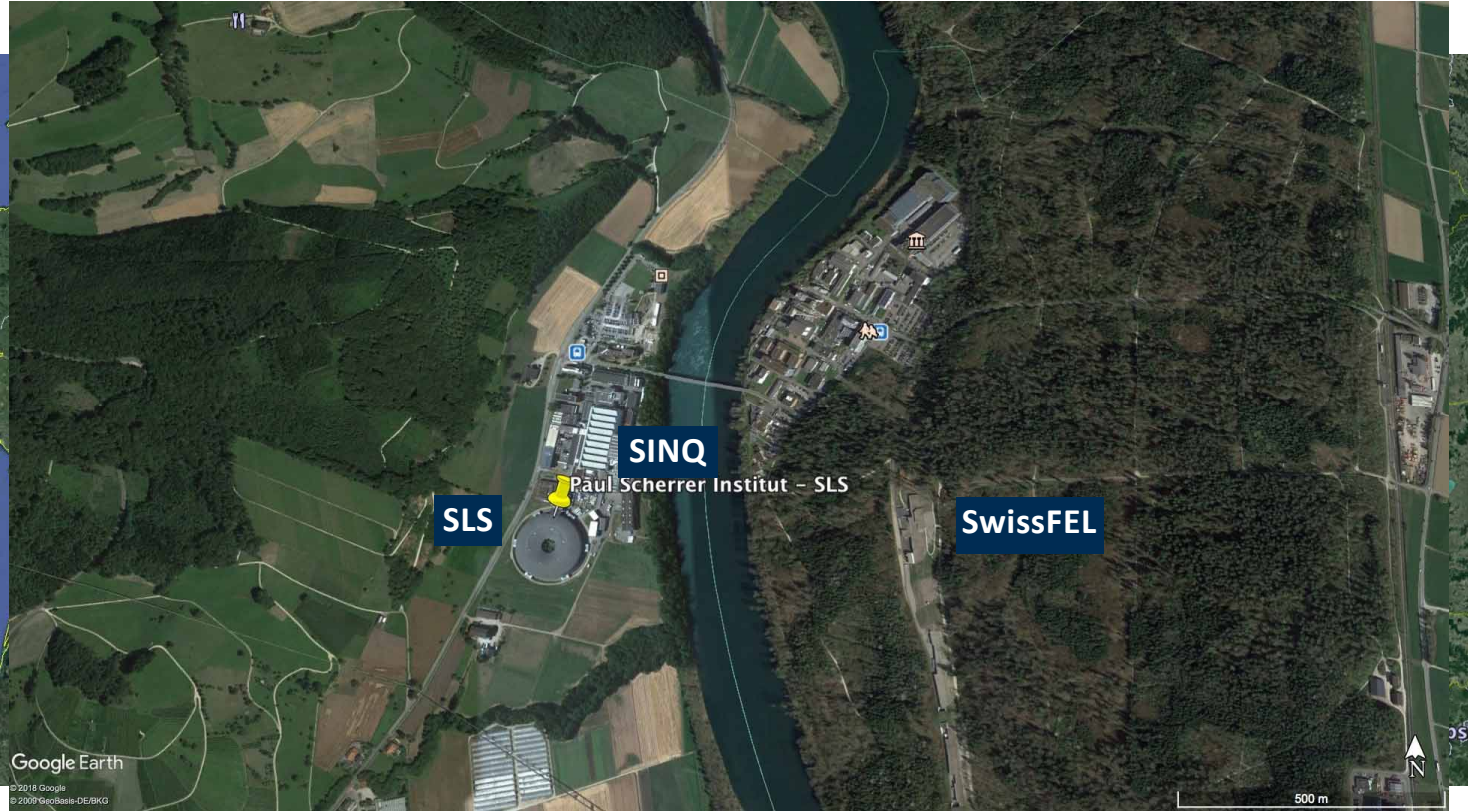
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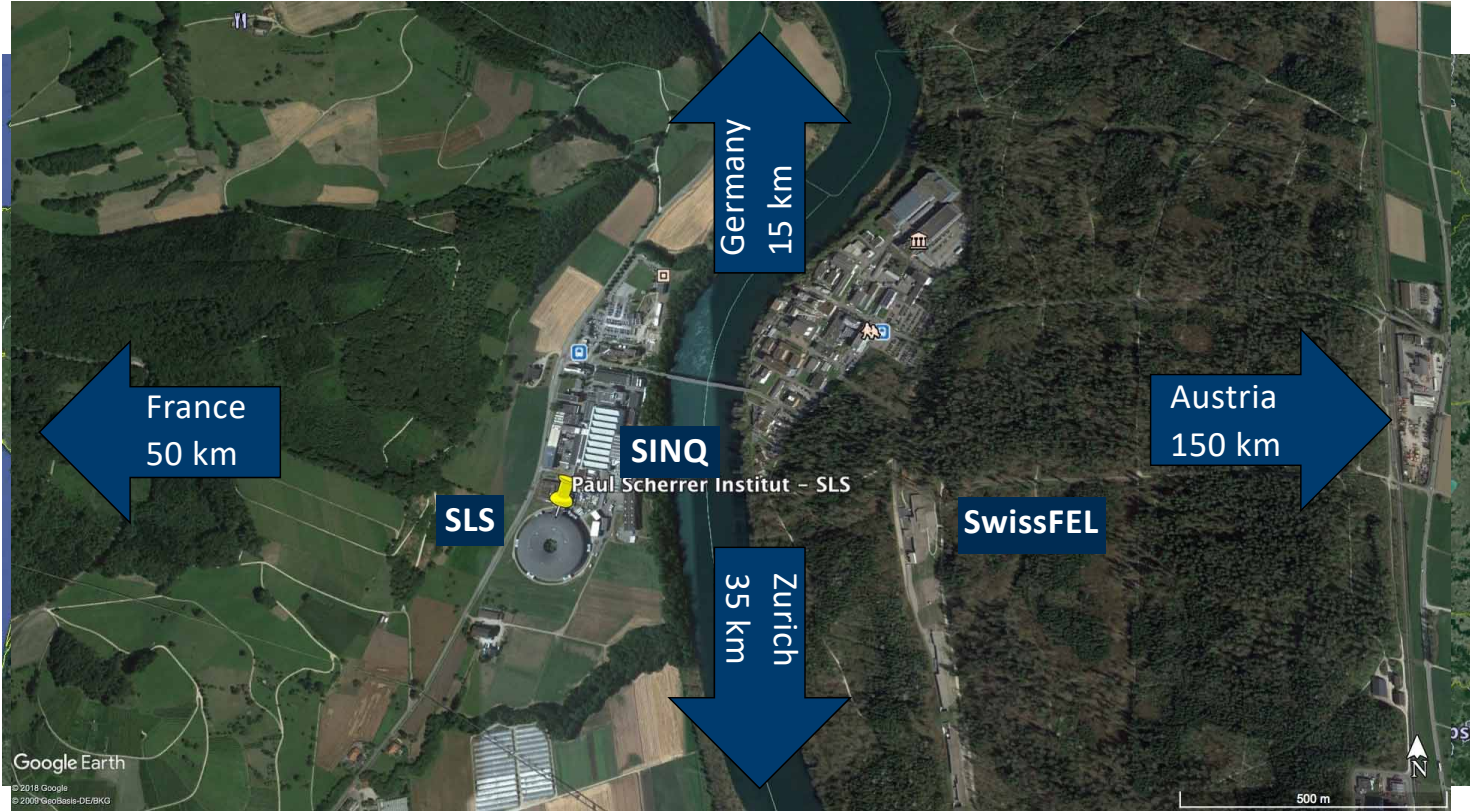
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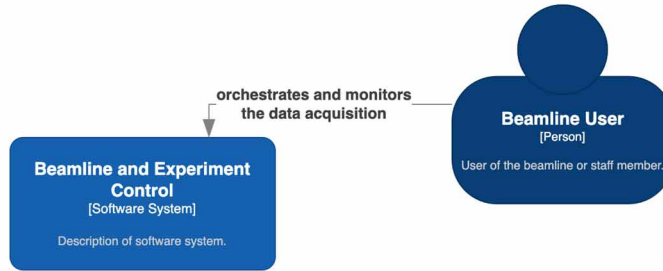


What's a BEC?

Beamline (and) Experiment Control

“... the layer above the control system tasked with the orchestration of the data acquisition.”

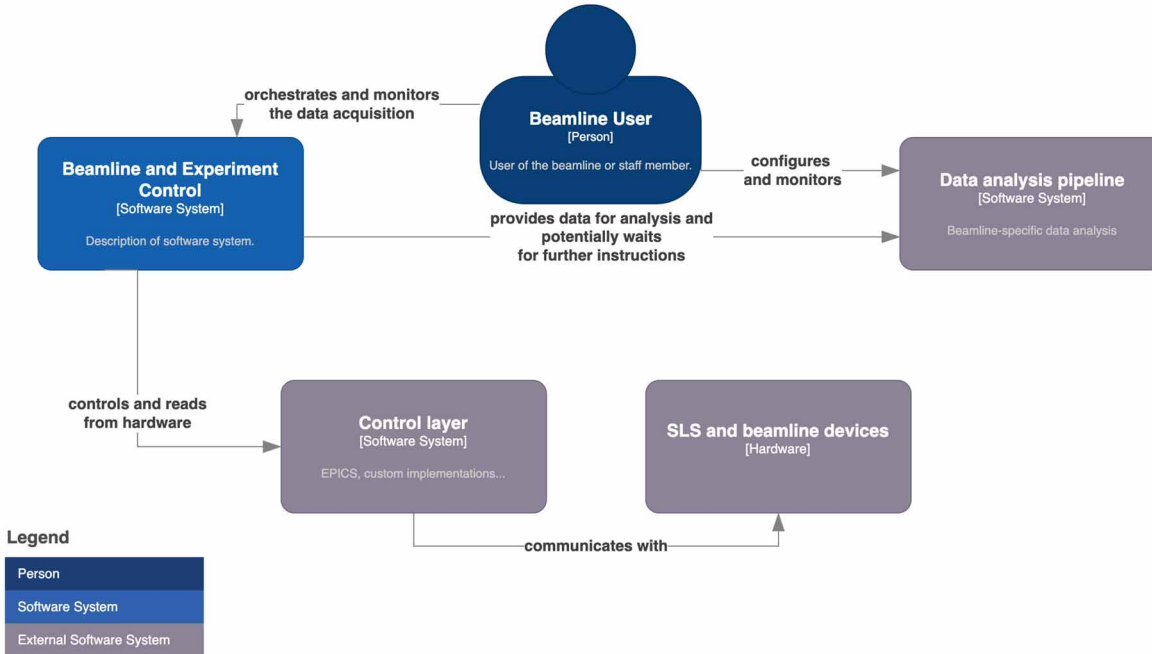
Beamline and Experiment Control



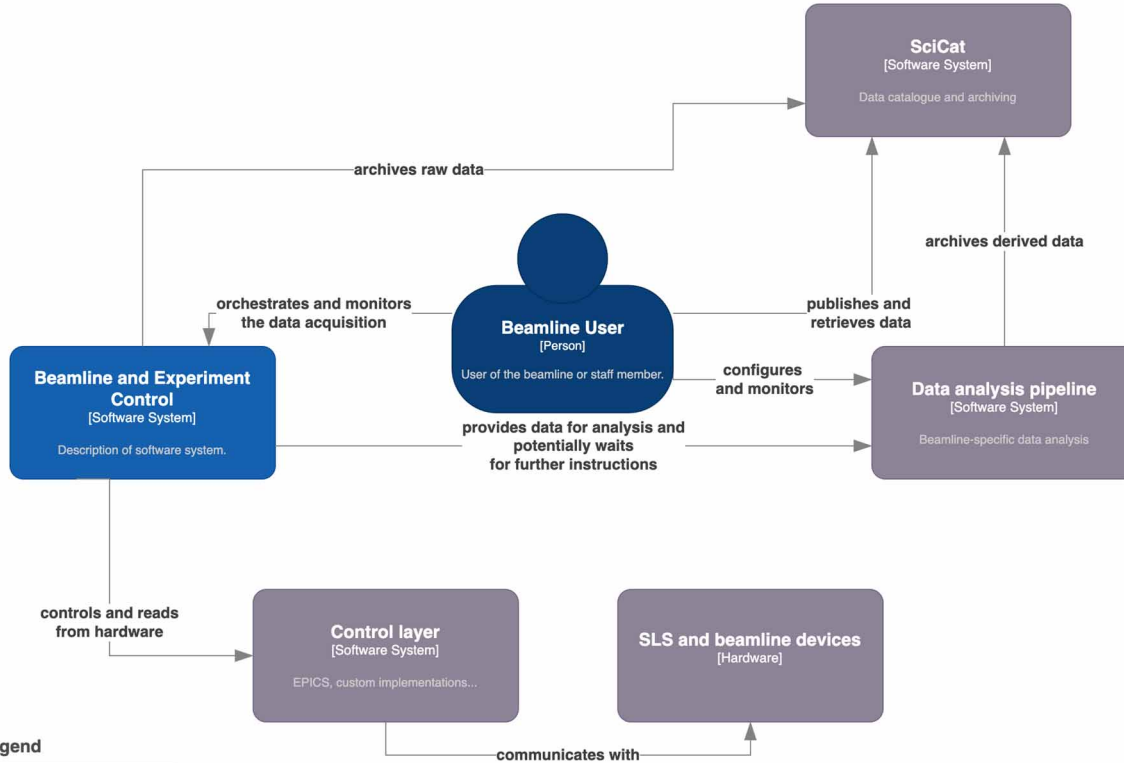
Legend

Person
Software System
External Software System

Beamline and Experiment Control



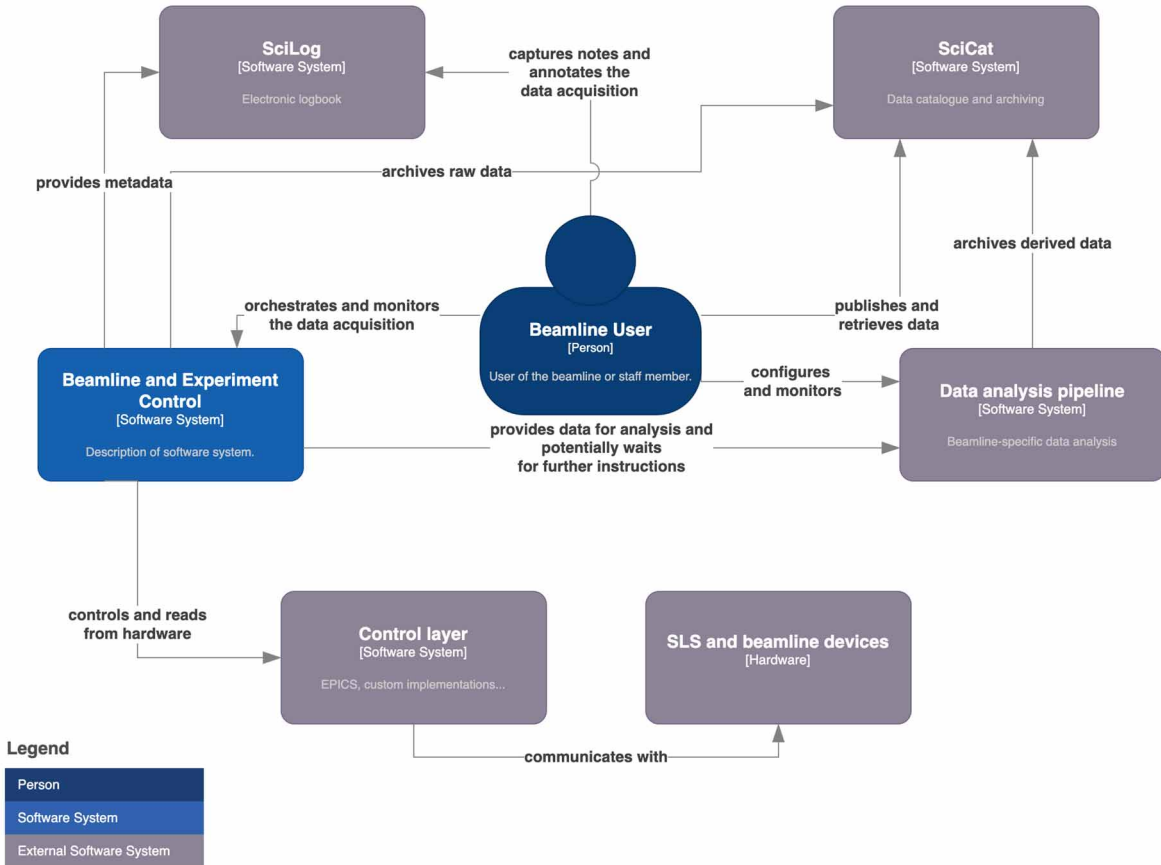
Beamline and Experiment Control



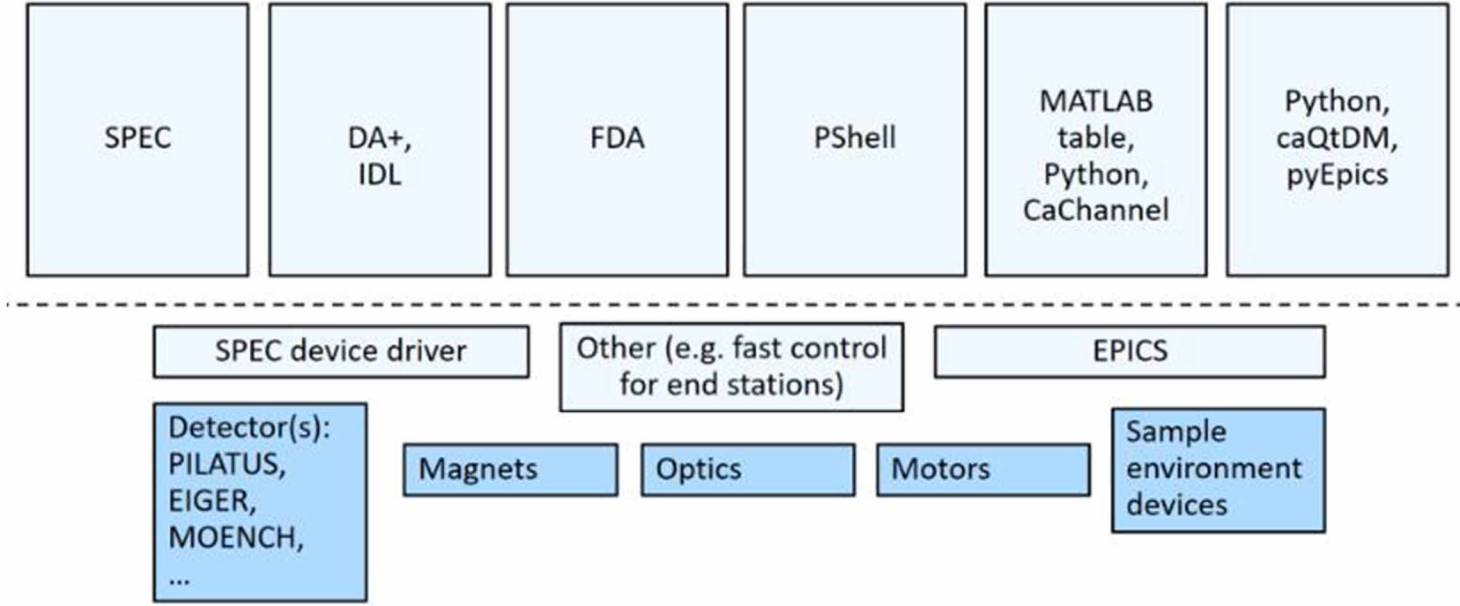
Legend

Person
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Beamline and Experiment Control



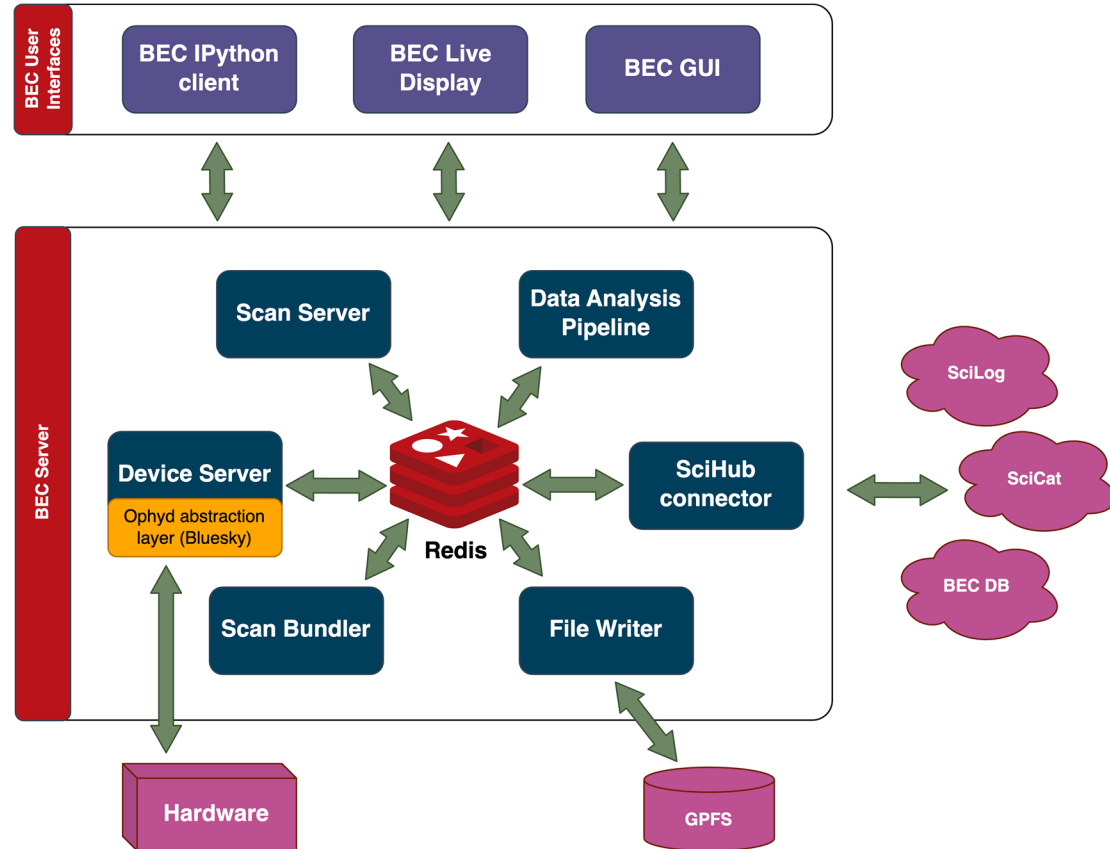
Current state at SLS



Source: CaSIT CDR



BEC Architecture



BEC development with LamNI

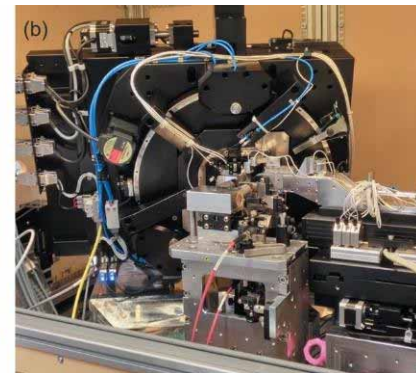
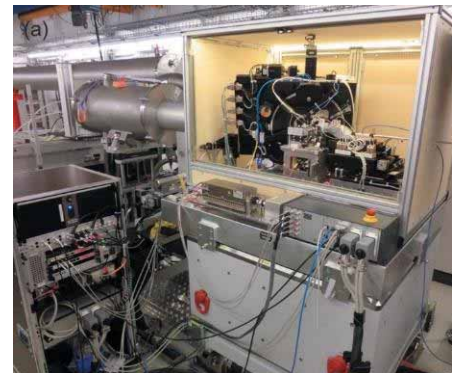
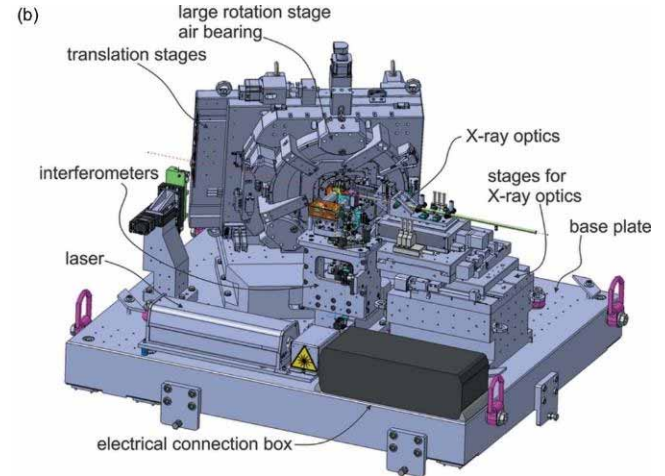
- LamNI hardware independent of beamline operation
- BEC prototyping in OMNY hutch
- Development without interference with user operation

Non-EPICS devices, direct interfacing to HW

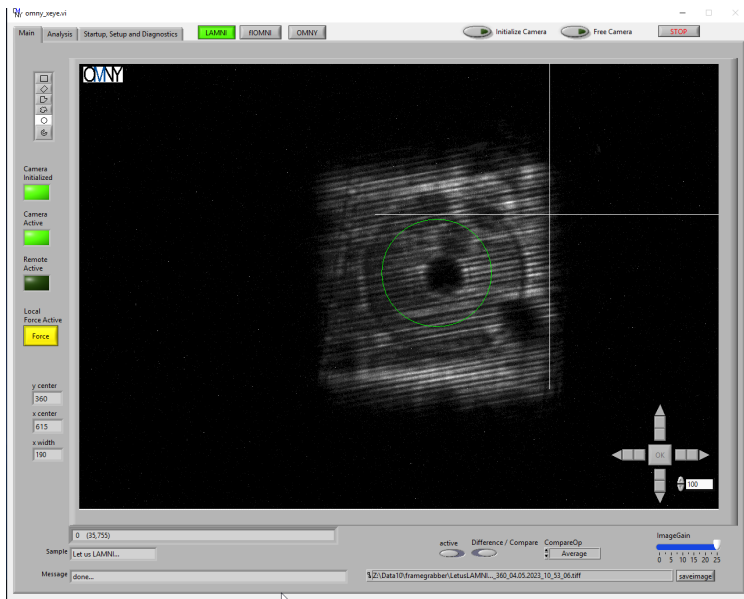
- Galil motor controller
- Smaract motor controller
- RT linux based scanning system (interferometers, piezo stages, etc.)

Offline development and testing during summer 2022

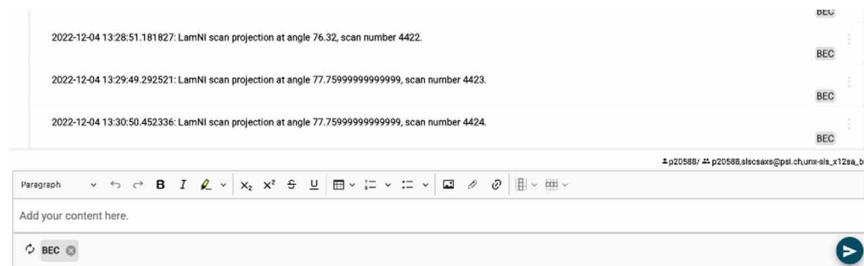
Slide courtesy: Mirko Holler, Photon Science Division (PSD)



- File writer writes NeXus-compatible files, defined through plugins
 - currently NXsas
- BEC-internal dataset ID for automated data archiving using SciCat.
- Connected to alignment GUI

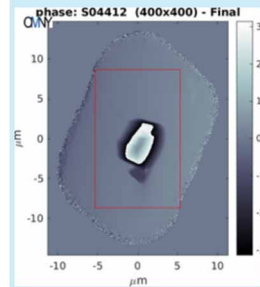


- Connected to cSAXS's automated data processing and archiving pipeline
 - cSAXS code (Matlab) subscribes to BEC events (from Redis)
- Connected to SciLog



- Connected to legacy web log.

2022-12-04 13:17:49.232039: LamNI scan projection at angle 69.12, scan number 4411.
 2022-12-04 13:18:50.342654: LamNI scan projection at angle 69.12, scan number 4412.
 2022-12-04 13:19:48.487331: LamNI scan projection at angle 69.12, scan number 4413.
 2022-12-04 13:20:50.599317: LamNI scan projection at angle 70.56, scan number 4414.
 2022-12-04 13:21:49.709172: LamNI scan projection at angle 72.0, scan number 4415.



```

:::          :::          :::  :::  ::::  :::  ::::::::::::::
:+:          :+:  :+:      +:::+  +:::+  +:::+  :+:  :+:
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#####  ###      ###  ###          ###  ###  ####  #####

```

Sample Name: Y350c_L1
 Measurement ID: 1160
 Dataset ID: 20054
 Sample Info: Sample Info
 e-account: e20632
 Number of projections: 752
 First scan number: 20055
 Last scan number approx.: 20817
 Current photon energy: 6.2027
 Exposure time: 0.10
 Fermat spiral step size: 0.50
 Piezo range (FOV sample plane): 79.00/79.00
 Restriction to circular FOV: 27.00
 Stitching: 0.00/0.00
 Number of individual sub-tomograms: 8
 Angular step within sub-tomogram: 3.83

Y350c_L1 LamNI dataset_id_20054 tomo_parameters BEC

Beam checks

Starting subtomo: 1. First scan number: 20055.

BEC tomo_id_1160 Y350c_L1 BEC_subtomo

Beamline checks failed at 2023-05-02 22:12:54.842205: Check beam failed: Light not available.

beam_check BEC

Operation resumed at 2023-05-02 22:38:43.103098.

beam_check BEC

Starting subtomo: 2. First scan number: 20151.

BEC tomo_id_1160 Y350c_L1 BEC_subtomo

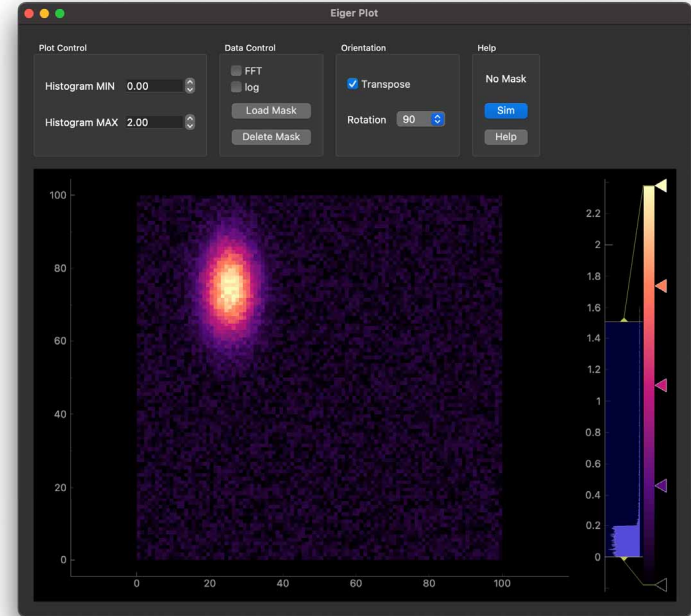
Starting subtomo: 3. First scan number: 20245.

BEC tomo_id_1160 Y350c_L1 BEC_subtomo

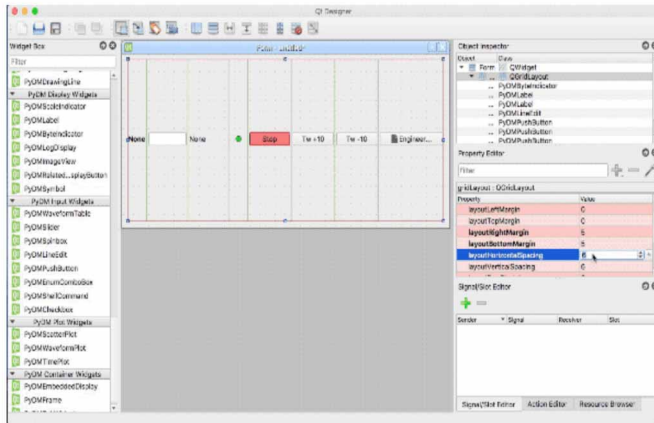
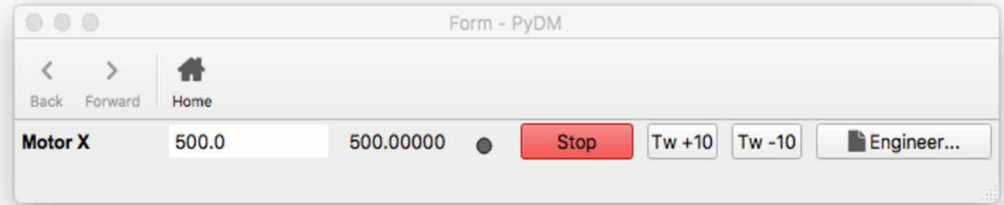
Starting subtomo: 4. First scan number: 20339.

BEC tomo_id_1160 Y350c_L1 BEC_subtomo

- PyDM (based on QtDesigner, PyQt5 and pyqtgraph) datasource plugins for BEC
- Additional BEC-specific plugins with fast feedback loops from PSD scientists.
 - Long-term goal: Collection of modular plugins for beamline scientist to build the desired interface themselves



PyDM datasource plugins for moving devices using BEC (EPICS and non-EPICS)

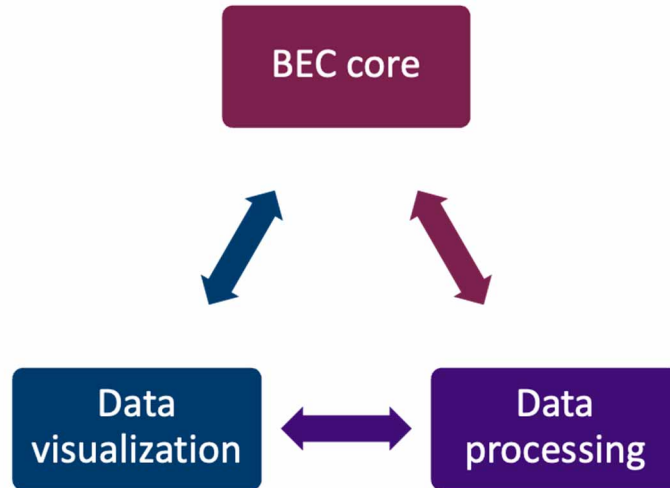


Drag and drop widgets to compose new user interfaces

Visualization using BEC-specific widgets

Extending the functionality of PyDM with BEC-specific QtDesigner plugins

BEC's event-based architecture facilitates fast development cycles.



<https://gitlab.psi.ch/bec/bec-widgets>

User interfaces using BEC widgets

Motor Controller

Motor Selection: Motor X (samy), Motor Y (samy)

Motor Relative: Step [X] = Step [Y], Decimals, Step [X], Step [Y]

Motor Absolute: Save position with Go, X, Y, Save, Set, Go, Stop Movement

Scan parameter (points to 'Coordinates' tab)

Move	Show	Tap	X	Y	sample name	step_x [m]	
1	Go	✓	samy_samy	0.035	-9.026	sample 1	25
2	Go	✓	Cur 1	8.035	-9.026	sample 2	25
3	Go	✓	Cur 2	16.042	-1.027	sample 3	25
4	Go	✓	Cur 3	16.043	6.974	sample 4	25
5	Go	✓	Cur 4	8.042	10.978	sample 5	25
6	Go	✓	Cur 5	20.000	-14.996	sample 6	25
7	Go	✓	Cur 6	-9.996	20.001	sample 7	25
8	Go	✓	Cur 7	-40.008	59.998	sample 8	25
9	Go	✓	Cur 8	20.006	49.999	sample 9	25
10	Go	✓	Cur 9	28.001	37.995	sample 10	25

Tweak motors (points to plot)

Tweak history (points to plot)

Import / export (points to buttons)

Line Plot

Generate 1D and 2D data without stream
1st angle of estimated segment (deg): 0.00

Moved: $x = 0.0139, y = 0.0351$
Clicked coordinates (X, Y)

Import / export (points to buttons)

Moved: $(49.0, 64.0)$
Clicked coordinates (X, Y)

Eiger Plot

Fit Control: Histogram MIN, Histogram MAX

Data Control: FFT, log, Load Mask, Delete Mask

Orientation: Transpose, Rotation: 90

Help: No Mask, Help

MultiWindow

Change the layout (points to 'Load Config' button)

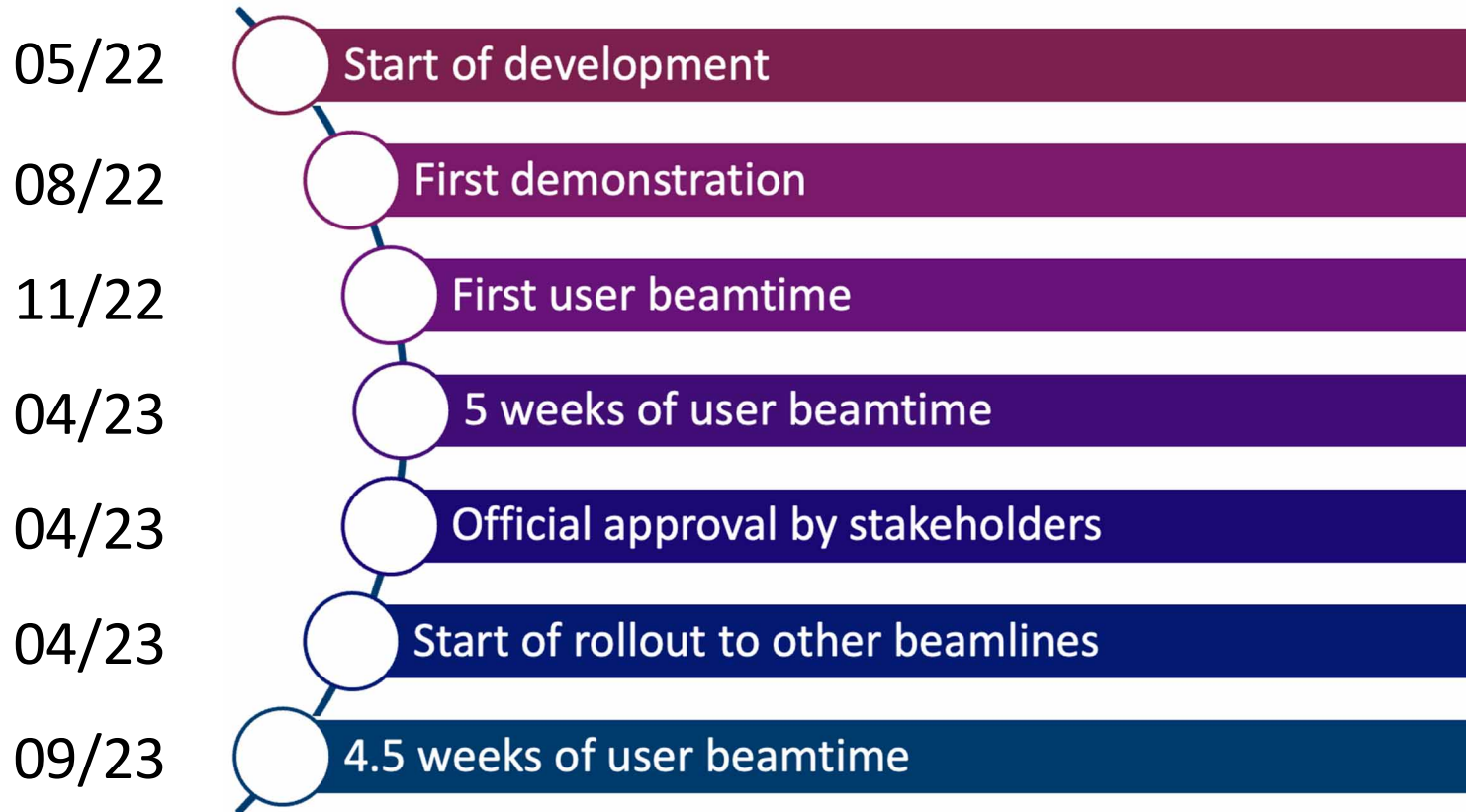
Number of Columns: 2

Cursor

Moved	Clicked	Color	
gauss_1pm (gauss_1pm) - Gauss 1 plot	(4.66, 0.0)	(1.201, 0.876)	Red
gauss_1pm (gauss_1pm) - Multiple Gauss	(-4.657, 0.012)	(0.525, 3.127)	Pink
gauss_1dct (gauss_1dct) - Multiple Gauss	(-4.657, 0.0)	(0.525, 8.933)	Purple
gauss_1dct (gauss_1dct) - Multiple Gauss	(-4.657, 0.0)	(0.525, 8.713)	Orange
samy (samy) - Linear Signal	(3.27, 3.27)	(0.871, 0.871)	Yellow
samy (samy) - Linear Signal	(3.27, 3.281)	(0.871, 0.866)	Blue

Store clicked coordinates (points to table)

Milestones / Summary



SLS 2.0 upgrade program (18 months)

- Transition most phase 0 / phase 1 beamlines to BEC
- Further explore the data processing pipelines
- BEC DB (under development)
 - Hosted on external cloud service provider (similar to SciLog and SciCat)
- Web interfaces for monitoring (and control)
 - Daiquiri
 - ...

- **Christian Appel**
- **Ivan Usov**
- **Jan Wyzula**

- **Science IT**
- **Photon Science
Division**
- **Controls**

*Everyone who
contributed and
facilitated the swift
prototype development!*

