

Hard X-Ray Pair Distribution Function (PDF) Beamline And End- Station Control System

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Lead Controls Engineer

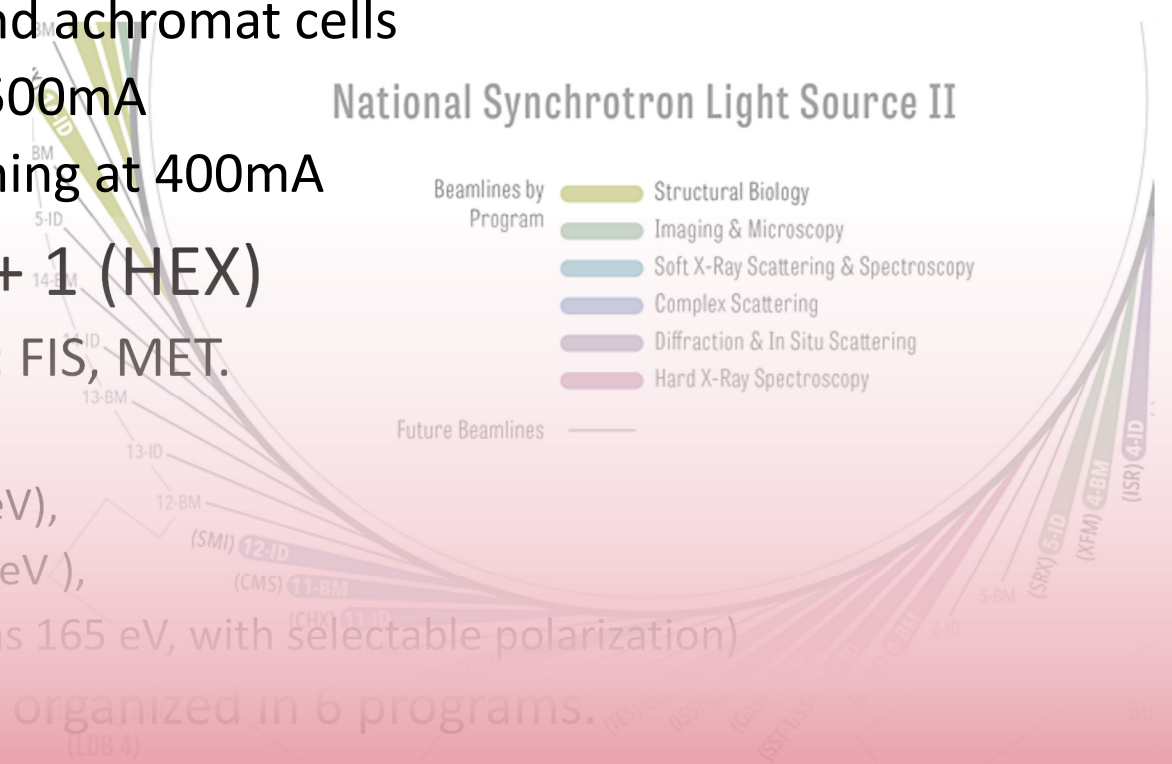
October 10, 2019

Outline

- A few words about NSLS-II and PDF beamline.
- Beamline network.
- Control system architecture.
- End-station Bridge.
- Movie.
- Conclusion.
- Acknowledgments.

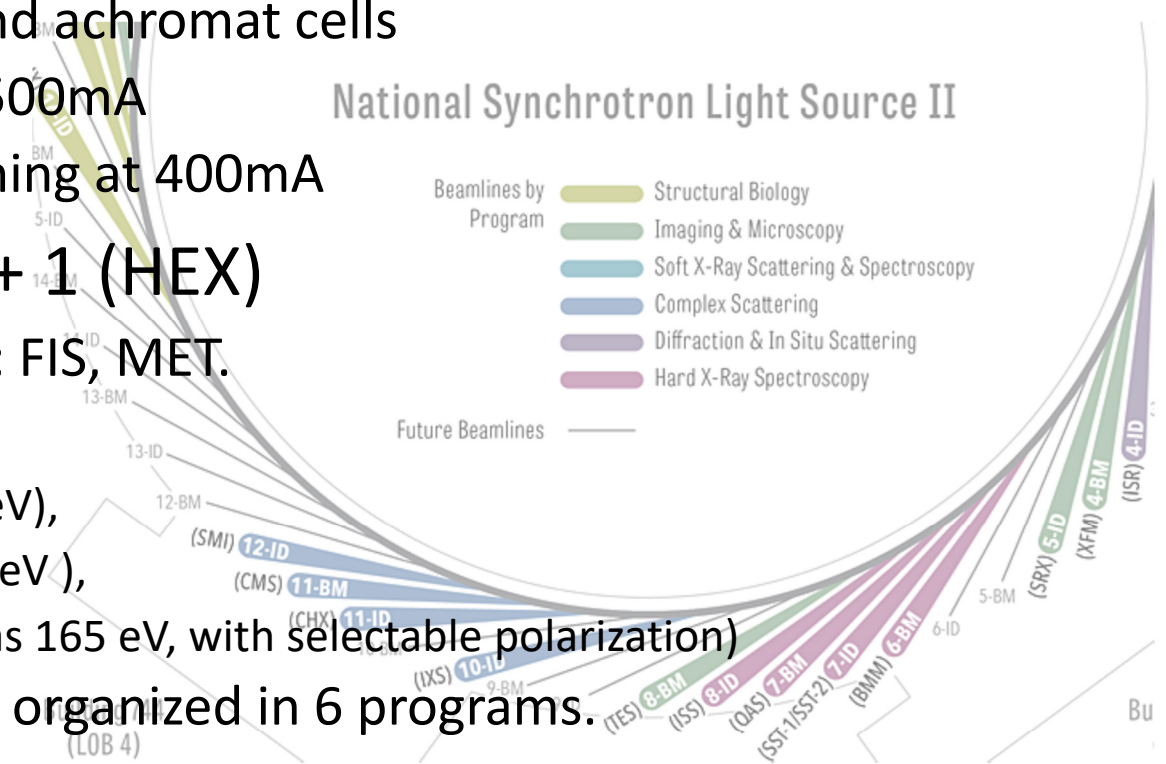
NSLS-II in a snapshot

- 3.0 GeV synchrotron
 - Circumference 792m
 - 30 double-bend achromat cells
 - Designed for 500mA
 - Currently running at 400mA
- 29 beamlines + 1 (HEX)
 - Infrared IR-22: FIS, MET.
 - X-Rays:
 - hard(5-75 keV),
 - tender (1-5keV),
 - soft(as low as 165 eV, with selectable polarization)
 - Beamlines are organized in 6 programs.



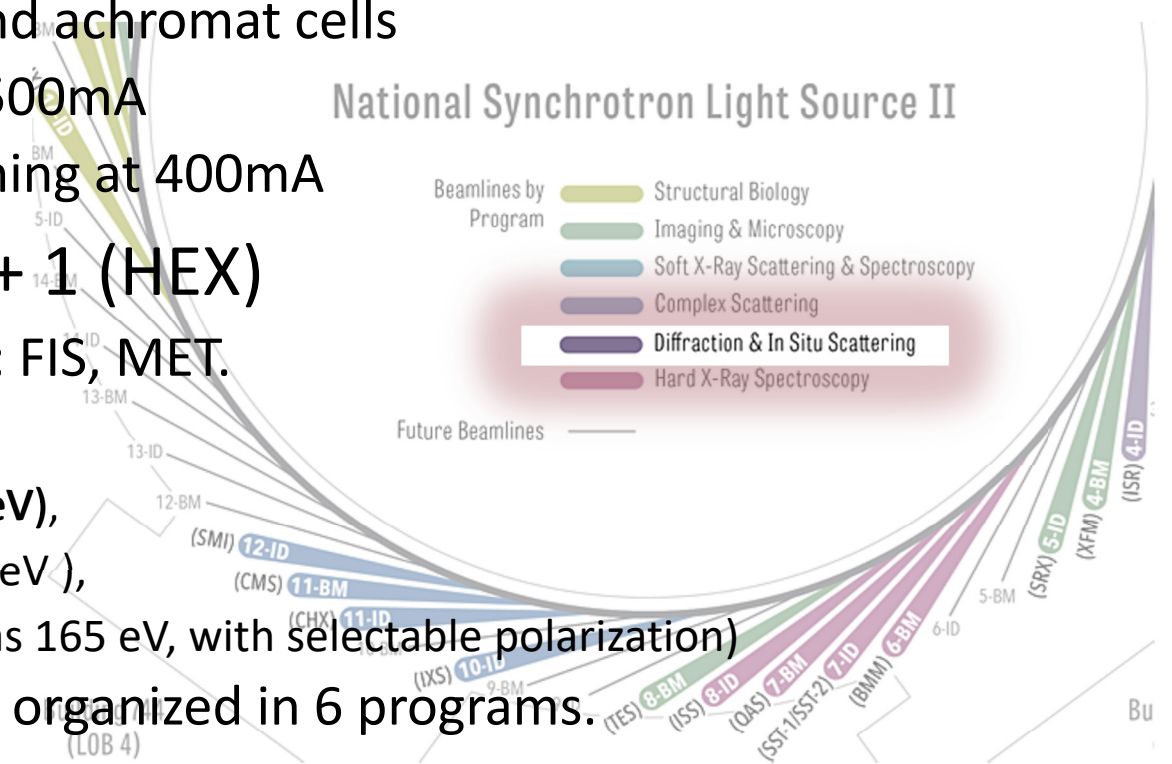
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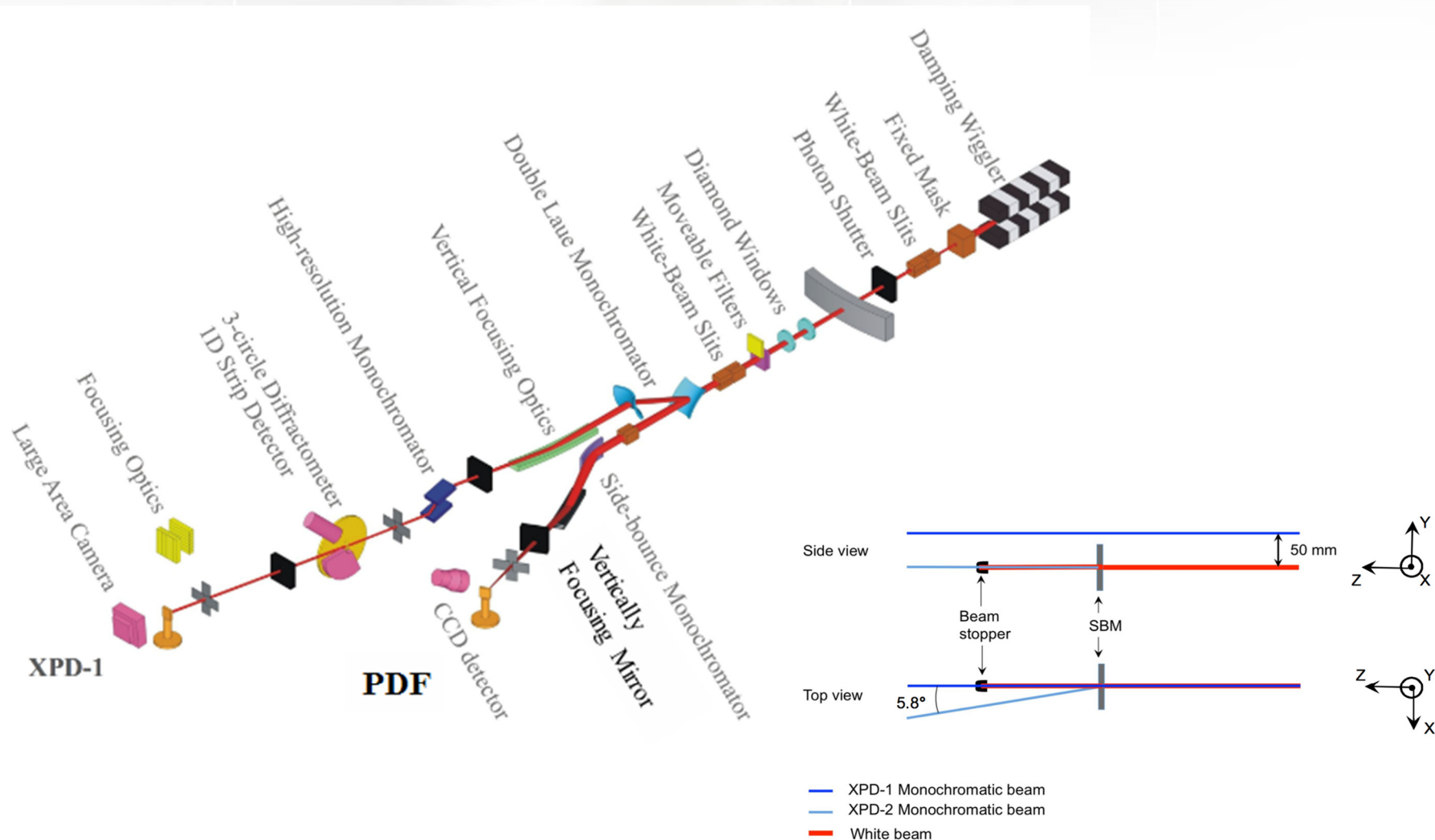


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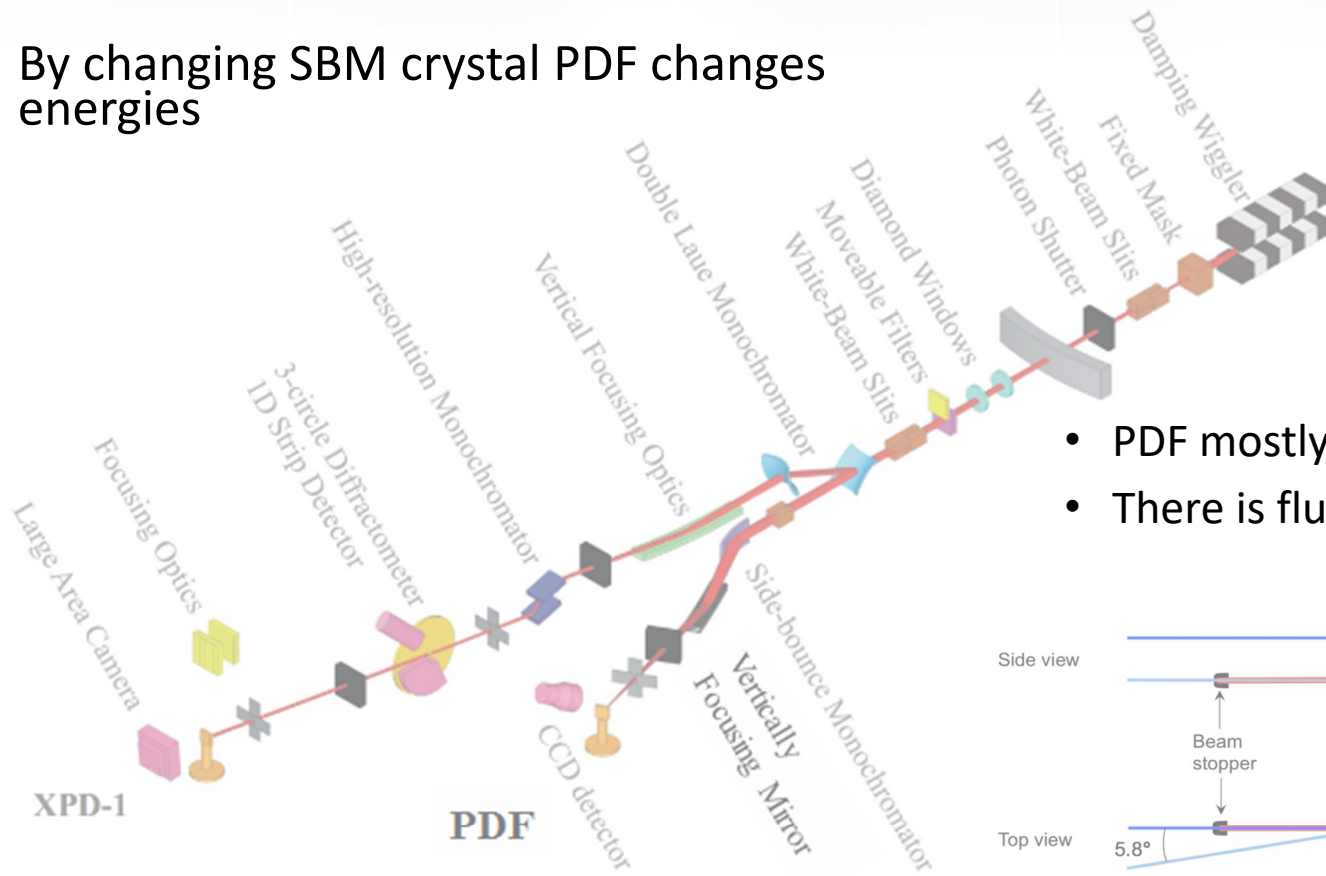


PDF layout

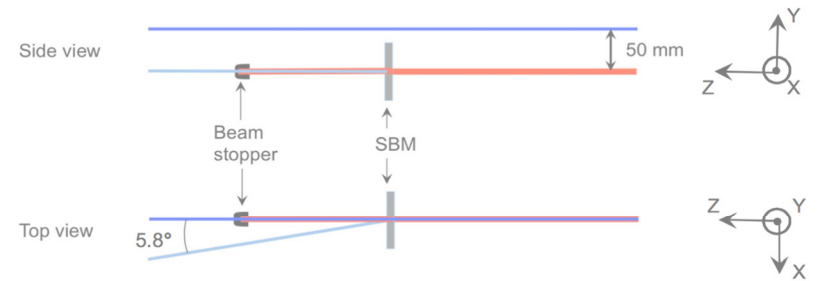


PDF layout

- By changing SBM crystal PDF changes energies



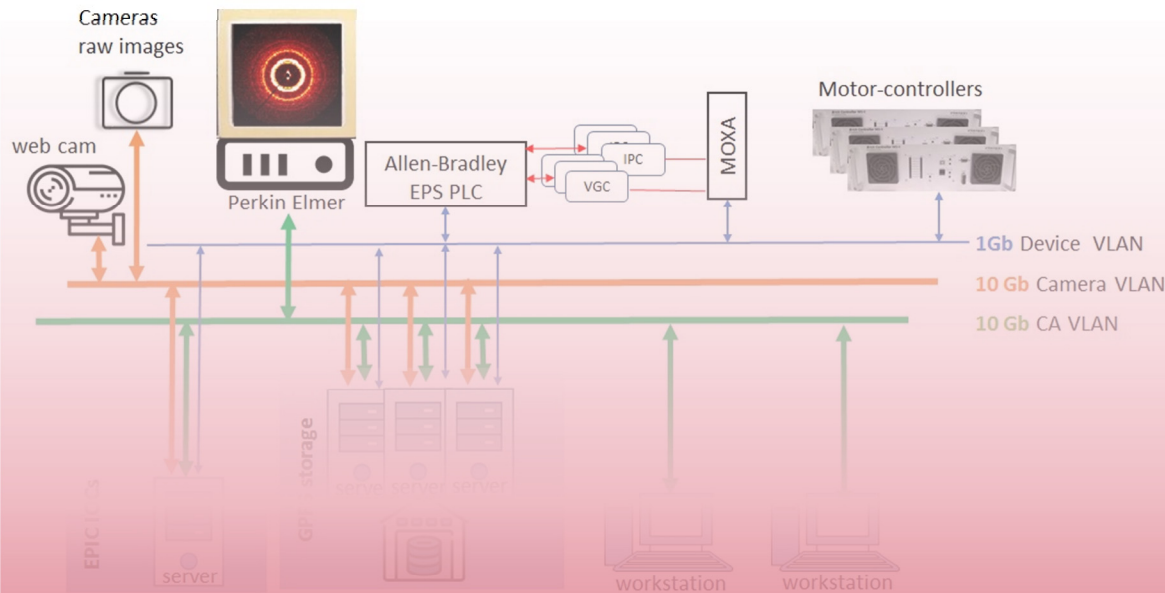
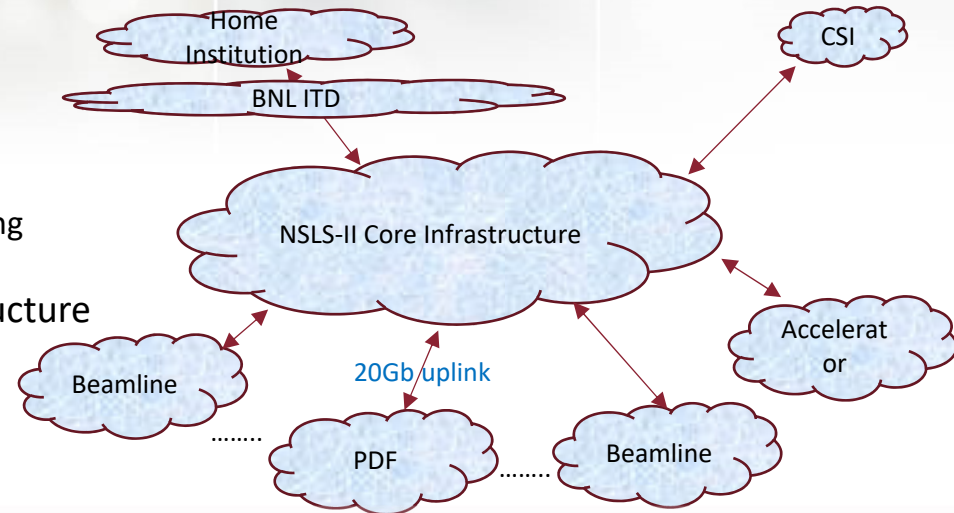
- PDF mostly operates at 75keV
- There is flux at **117keV** at 400mA



— XPD-1 Monochromatic beam
— XPD-2 Monochromatic beam
— White beam

PDF Controls Infrastructure

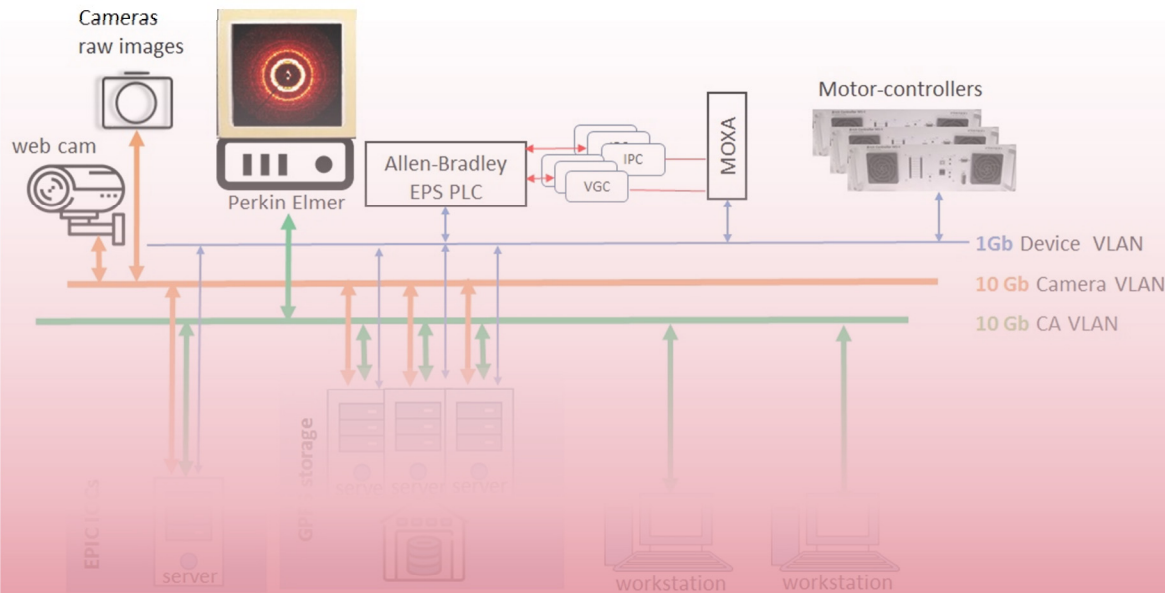
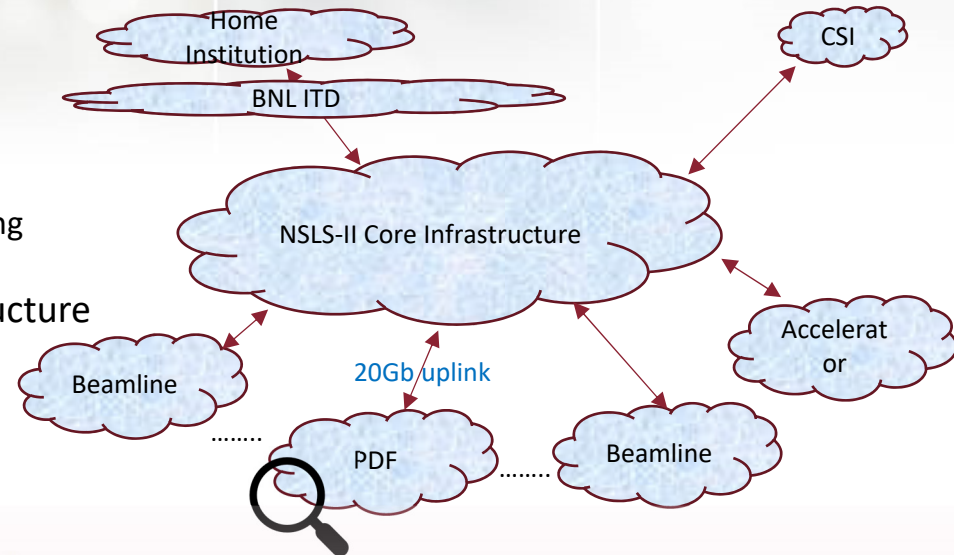
- Each beamline is a separate subnet
 - Allows easy maintenance without affecting others.
 - Controls system is alive when others are undergoing maintenance
- PDF is connected via 20Gb uplink to Core Infrastructure



- 3 VLANs: Device, Raw images, CA
- Subnet's traffic is isolated from each other
- Device VLAN is dedicated to low bandwidth devices: motor controllers, EPS status, temperature, vacuum information, etc.
- Device subnet never starves for resources
- Each subnet can be independently troubleshot for problems
- 80 TB of local high-performance storage for exclusive use at PDF

PDF Controls Infrastructure

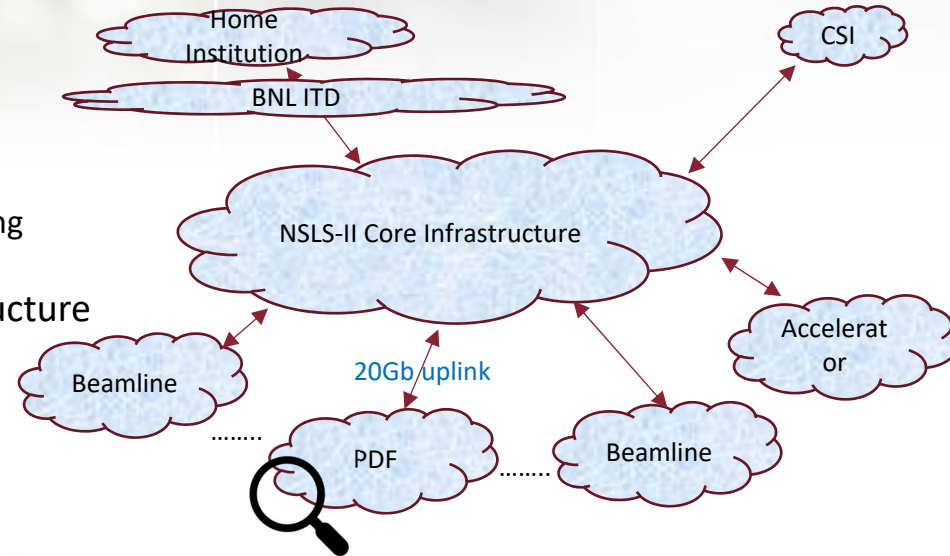
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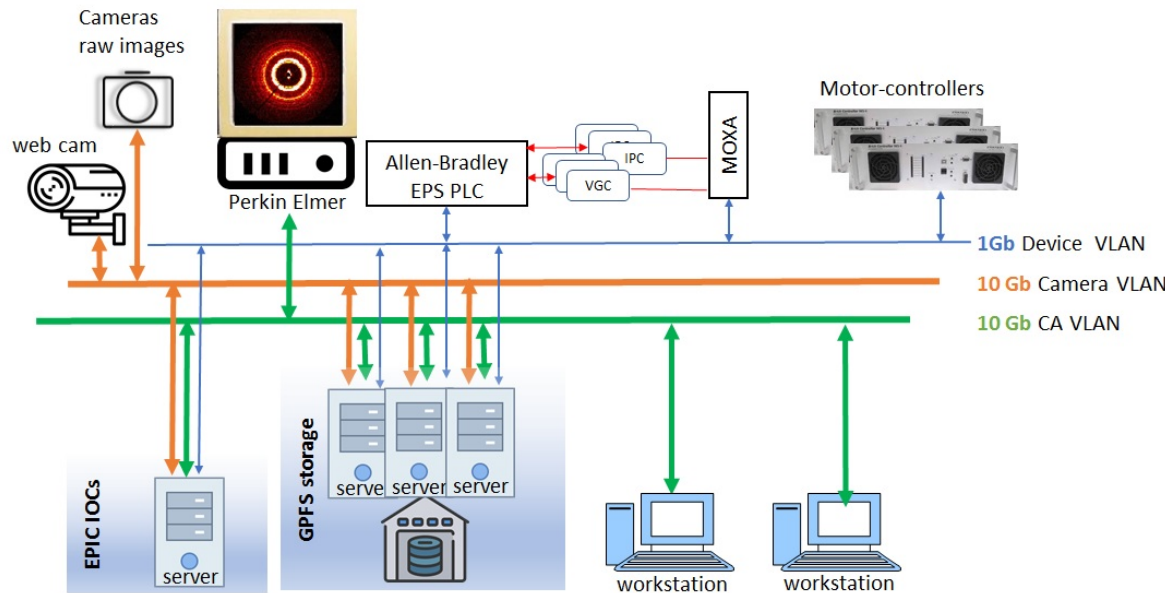
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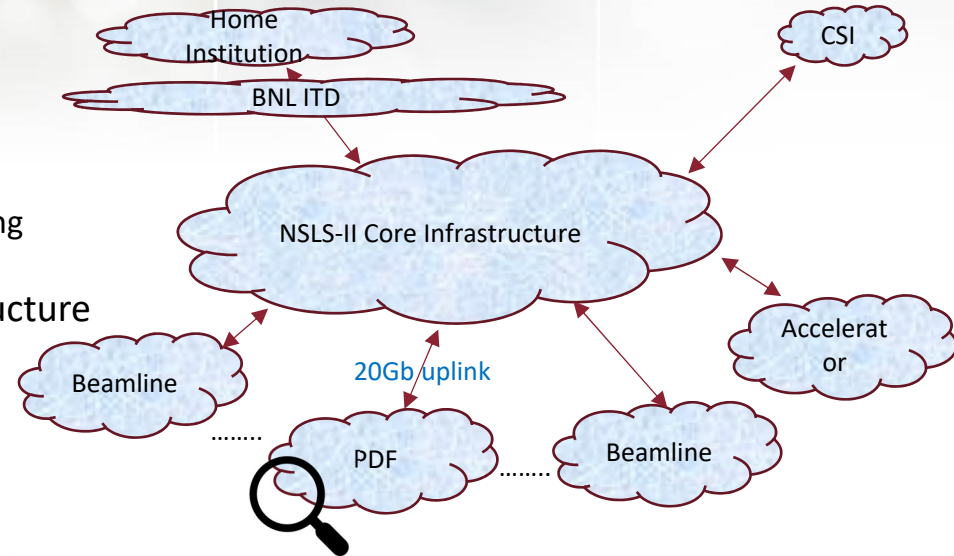


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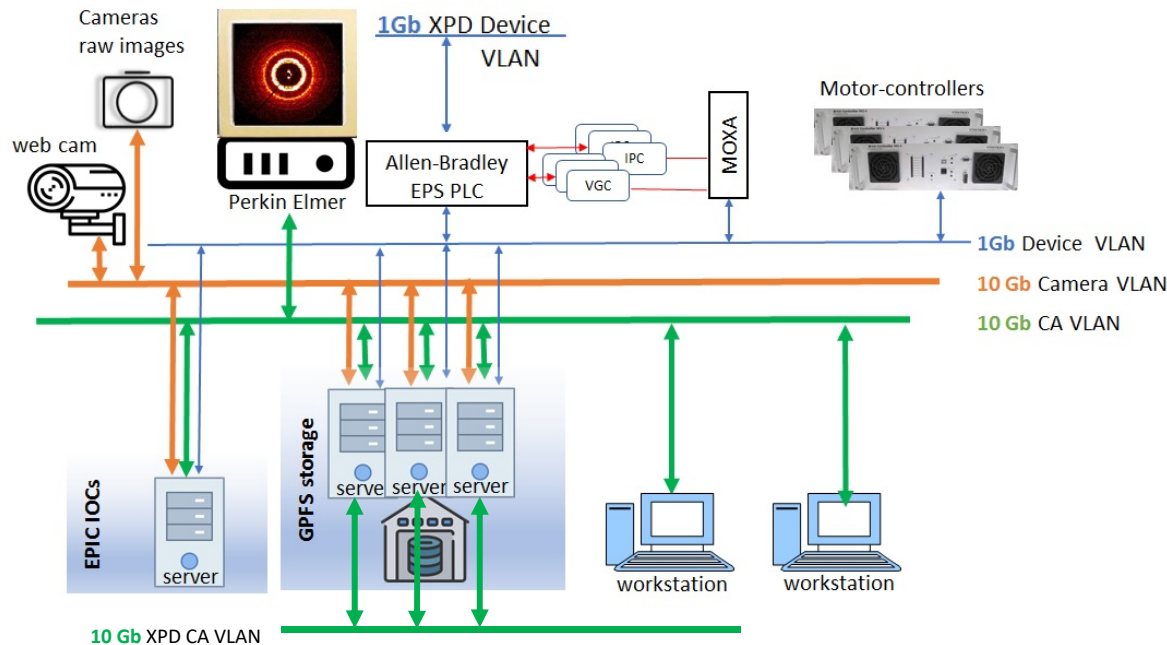


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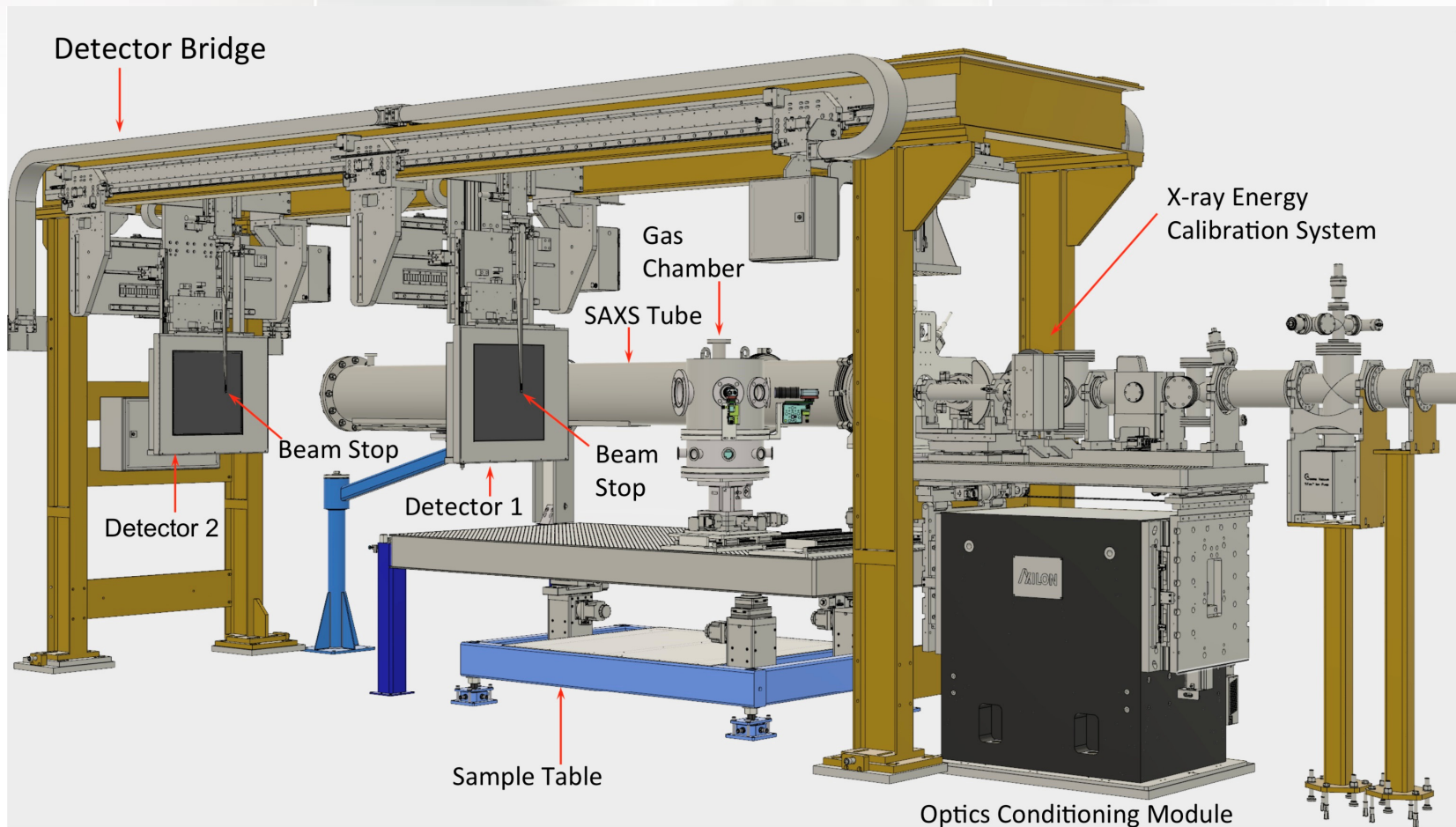
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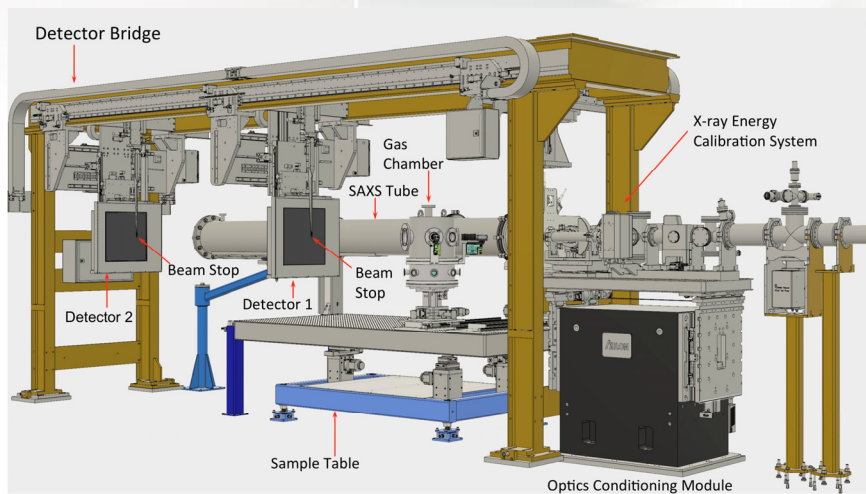
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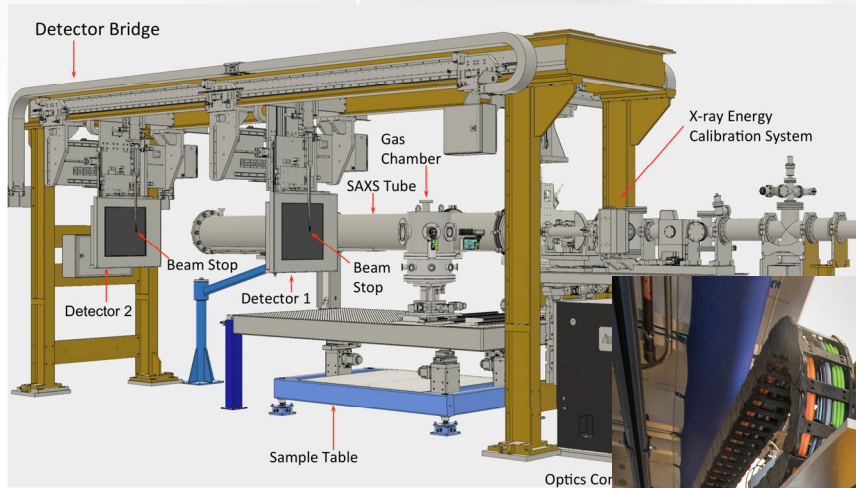
PDF End Station



PDF End Station



Bridge control features



- Each stage moves independently along 3m travel @ 300mm/s along Z.
 - by 2 BLDC servo motors in a gantry configuration
 - controlled by a single channel of Delta Tau GBLV motor controller



- Absolute encoder 50nm resolution provides feedback to all 3 stage.
- There are proximity switches installed on each stage, which get activated within 40 cm from each other or the end of the bridge.
 - If the switches are activated, the stages move @30mm/s
- When the hutch is unsecured:
 - Safety breaks and motor breaks are applied
- There is a bypass key under access control.

Hardware, Software and Standards

Standard HW

- Allen Bradley PLC
- Delta Tau GBLV
- SmarAct MCS2
- Prosilica cameras for diagnostic
- Axis webcams for in-hutch visuals
- Perkin Elmer detectors
- Lakeshore 625 for 5T magnet
- Lakeshore 335 cryostat
- FMB C400
-

Standard SW

- Debian LINUX
- EPICS via Debian packages
- Archiver Appliance
- Control System Studio (CSS)
 - Logbook
 - Data browser
 - BEAST
- Bluesky for data collection
- SW Configuration: Git, Hg

Custom, One of a kind

- Bridge three (3) stages Z translation
- Custom PLCs, motion programs with slew feature
- Reconfigurable speeds.

Conclusions

- PDF beamline is available for user operations
 - we made the right design decisions.
- PDF offers high degree of automation thanks to
 - maintenance free design approach
 - early user feedback during commissioning
- PDF control system follows NSLS-II standards
 - which greatly simplifies maintenance
 - by limiting diversity of the equipment and solutions.
- Delta Tau GBLV motor controller offered enough features to put in place reliable solution which
 - combines high speeds and protects equipment
 - Hides complexity from the user.

Acknowledgments :



Milinda Abeykoon, Lead Beamline Scientist
& First Users

NSLS-II Sysadmin team:

- Rob Petkus
- Leon Flaks
- Mizuki Karasawa (now at CAD)
- Matt Cowan
- Tom Smith

NSLS-II Controls:

- Garret Bischoff (EPS)
- Susheng Xin (PPS)
- Zhijian Yin
- John Sinsheimer
- Ji Li
- Barret Clay
- Harman Bassan (EPS, now at SLAC)
- Ruslan Kadyrov (EPS, now at SLAC)
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Vendors