Synchrotron calibration needs of the National Ignition Campaign

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NSLS II User workshop
July 17-18, 2007

UCRL-PRES-232958

This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48

The current situation

- Beamlines U3C and X8A are operated by a PRT consisting of NWLs and NSTec
- LLNL performs x-ray calibrations from 0.2 – 6.5 keV at these beamlines
- We have negotiated and exercise access (3 weeks/year) to higher energy (6.5 - 25 keV) beamlines X15A and X12

PRT Member Representatives

Jeffrey Keister	SFA, Inc.
Bin Dong	SFA, Inc.
Gordon Chandler	SNL
Ken Moy	NSTec
Jim Distel	LANL
Tom Tierney	LANL
Franz Weber (PRT chair)	LLNL

Institutional Members

- Sandia National Laboratory
- NSTec, LLC
- Los Alamos National Laboratory
- Lawrence Livermore National Laboratory

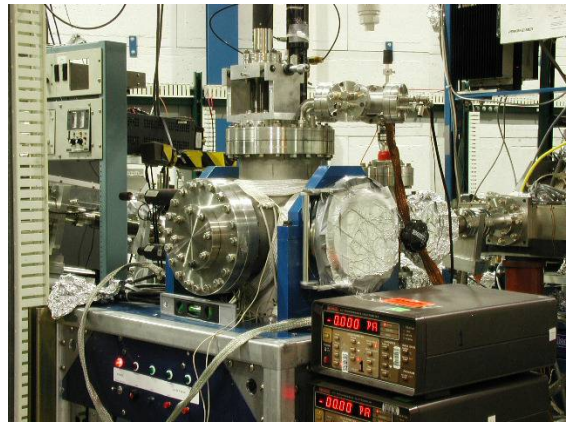
Collaborators

- AWE, UK
- CEA, France

Calibration Work at U3C and X8A Supports Several Programs

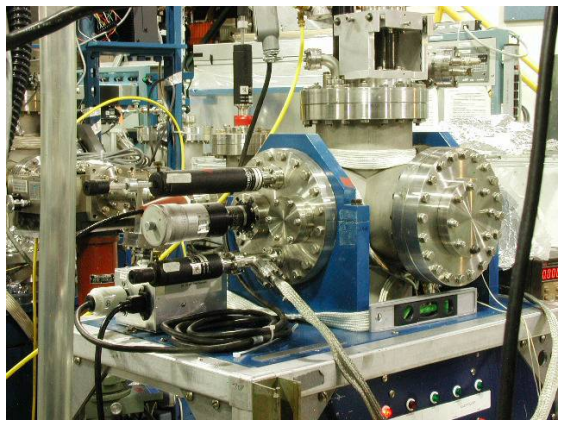
<u>Supported Programs</u>

- Laser driven experiments on Omega and on NIF (LLNL)
- Nudet satellite systems (LANL)
- Pulse power experiments on the Z accelerator (SNL)
- Petawatt laser experiments at Vulcan (RAL)
- Laser driven experiments on Helen (AWE)

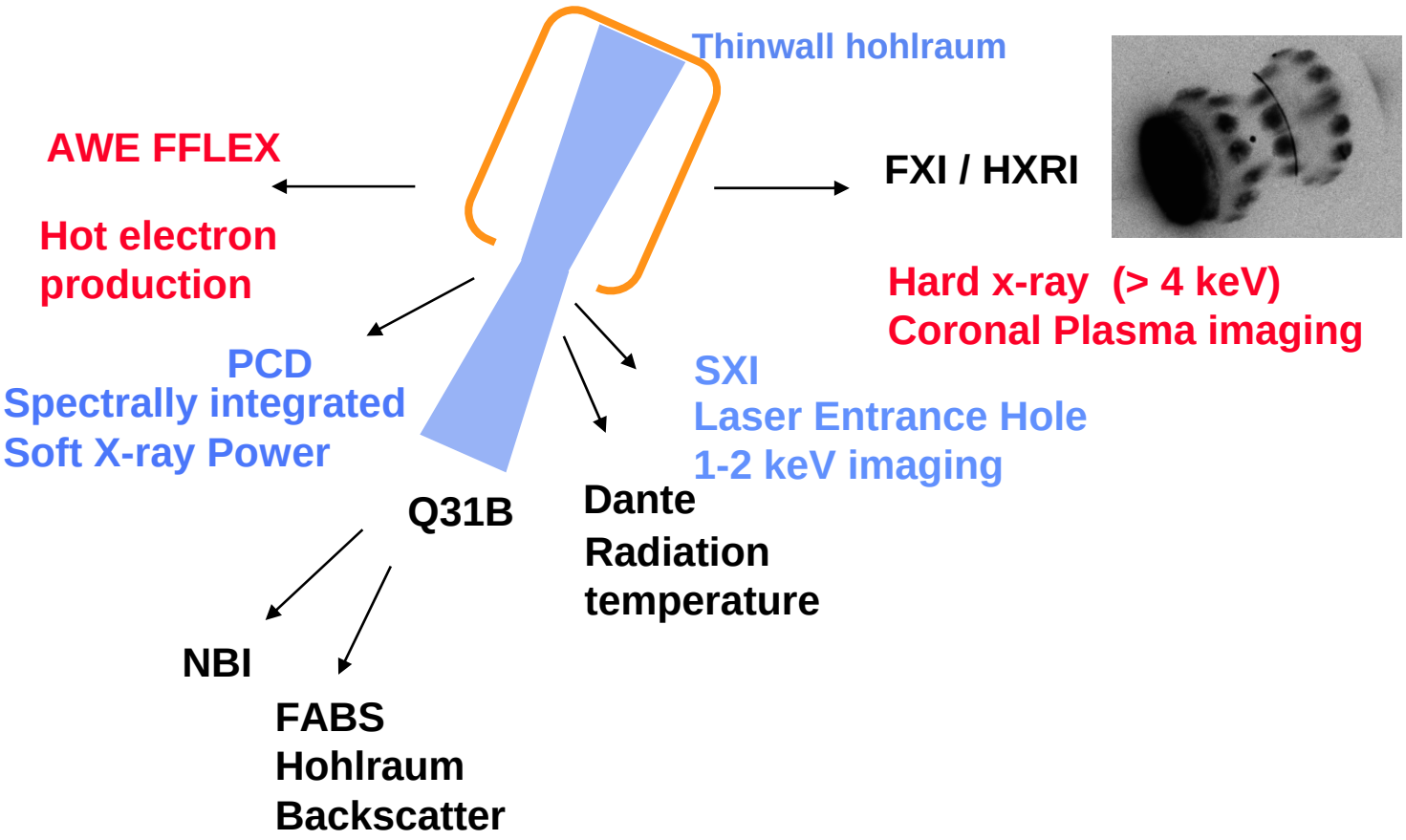


<u>LLNL specific requirements</u>

- Instrumentation development and calibration
- Detector development and calibration
- X-ray component characterization and calibration
- Special studies (e. g., response of time resolved X-ray and XUV diagnostics)



At NIF multiple plasma diagnostics are employed to study hohlraum physics



LLNL routinely requires characterization of a large variety of X-ray components and devices

- **Metallic Vacuum X-ray diodes (XRDs)**
- **Grazing incidence X-ray mirrors**
- **Thin film filters**

90% of the current LLNL workload at U3C and X8A

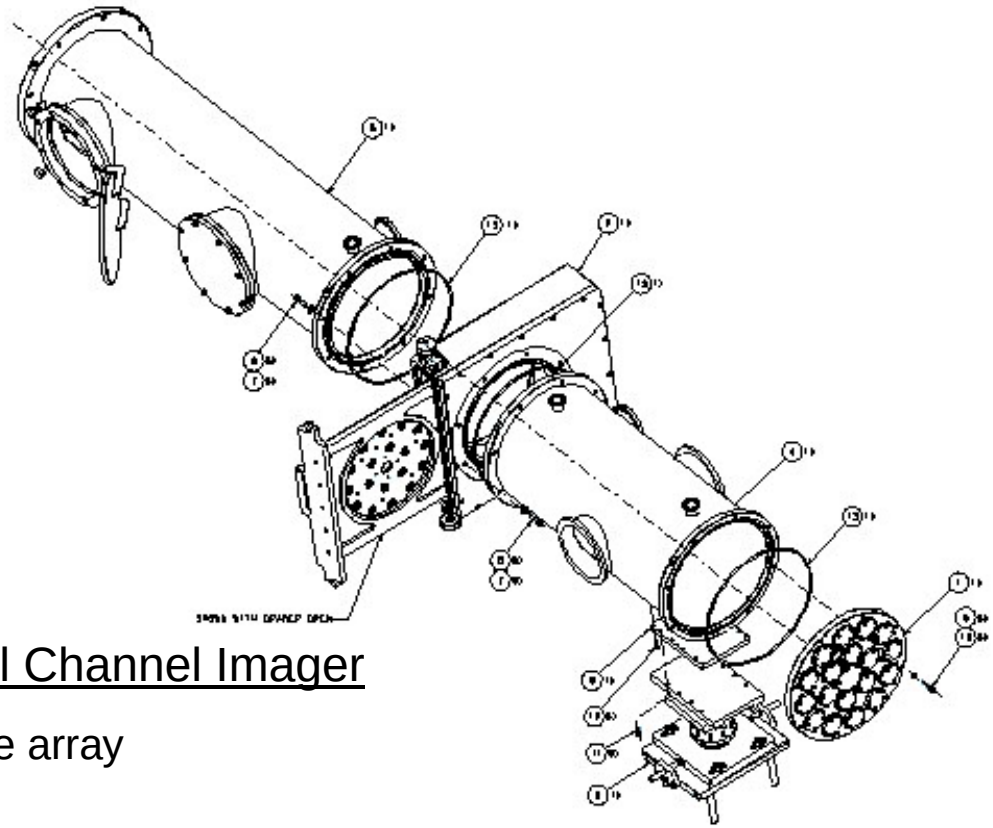
- PN junction diodes
- Charge coupled devices (CCDs)
- CMOS based radiation detectors and readout systems
- Photo conductive diodes (PCDs)
- Pixellated diamond detectors (PDDs)
- Transmission gratings
- Figured surface and plane X-ray mirrors
- Multilayer mirrors (LSMs)
- Micro channel plates (MCPs)

Desired beamline properties

- High intensity (optimize flux)
- Minimize stray light and higher order harmonics
- Broad energy range
- Differential pumping

The vast majority of the LLNL calibration effort at NSLS is devoted to component calibration for the LLE and NIF Dante X-ray spectrometers

The Dante spectrometer has multiple spectrally segregated channels and a central imaging system



Central Channel Imager

- Pinhole array
- PCD
- MCP
- CCD readout

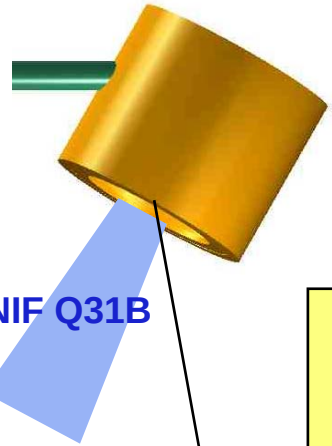
Spectral Channels

- Collimator
- Filter/Grid
- Mirror (E_{ch} < 1 keV)
- XRD
- Power supply
- Power cables
- Signal cables
- SCD 5000

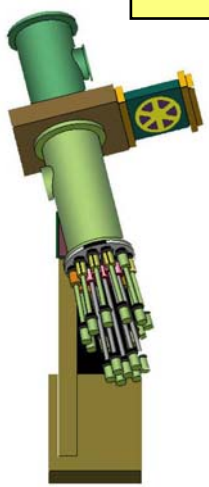
Dante is multi-channel, X-ray spectrometer that is utilized to measure the radiation temperature, T_r, in the hohlraum

4-16 kJ, 1- 9 ns,
10^{15}-10^{16} W/cm^2
with beam smoothing

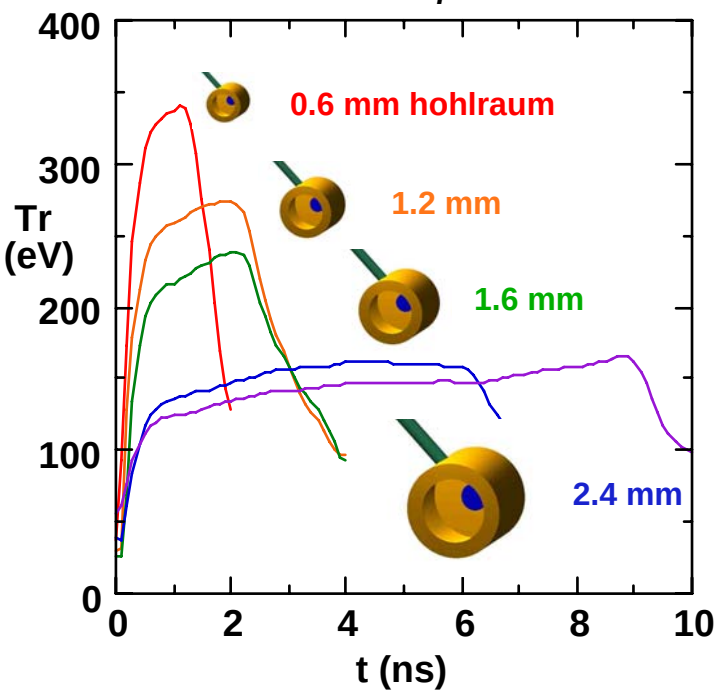
Thinwall Au Hohlraum



Hohlraum T_r (Dante)
18 channel soft x-ray detector (0.1- 10 keV)



Hohlraum T_r vs time



Dante component calibration requirements: FY ’07- FY ‘11

- NIF will reactivate Dante 1 spectrometer in FY ’07 for FY ’08 experiments
- NIF will activate Dante 2 spectrometer in FY ’08 for FY ’09 experiments

Component	Diagnostic	Calibration Type	Calibration Energy	Calibration Frequency	FY '07	FY '08	FY '09	FY '10	FY '11
Mirrors	Omega Dante	Reflectance	0-1 keV	Semi-annually	6	6	6	6	6
	NIF Dante	Reflectance	0-1 keV	Semi-annually	6	14	14	14	14
				Totals	**24**	**40**	**40**	**40**	**40**
Filters	Omega Dante	Transmission	0-1 keV	Semi-annually	35	35	35	35	35
		Transmission	2-6.5 keV	Semi-annually	35	35	35	35	35
	NIF Dante	Transmission	0-1 keV	Semi-annually	25	50	50	50	50
		Transmission	2-6.5 keV	Semi-annually	25	50	50	50	50
				Totals	**240**	**340**	**340**	**340**	**340**
XRDs	Omega Dante	Responsivity	0-1 keV	Semi-annually	18	18	18	18	18
		Responsivity	2-6.5 keV	Semi-annually	18	18	18	18	18
	NIF Dante	Responsivity	0-1 keV	Semi-annually	21	42	42	42	42
		Responsivity	2-6.5 keV	Semi-annually	21	42	42	42	42
				Totals	**156**	**240**	**240**	**240**	**240**

Anticipate increased requirement for (non-Dante) calibrations at E > 25 keV

Calibration workload increases significantly through FY ’07 and FY ‘08

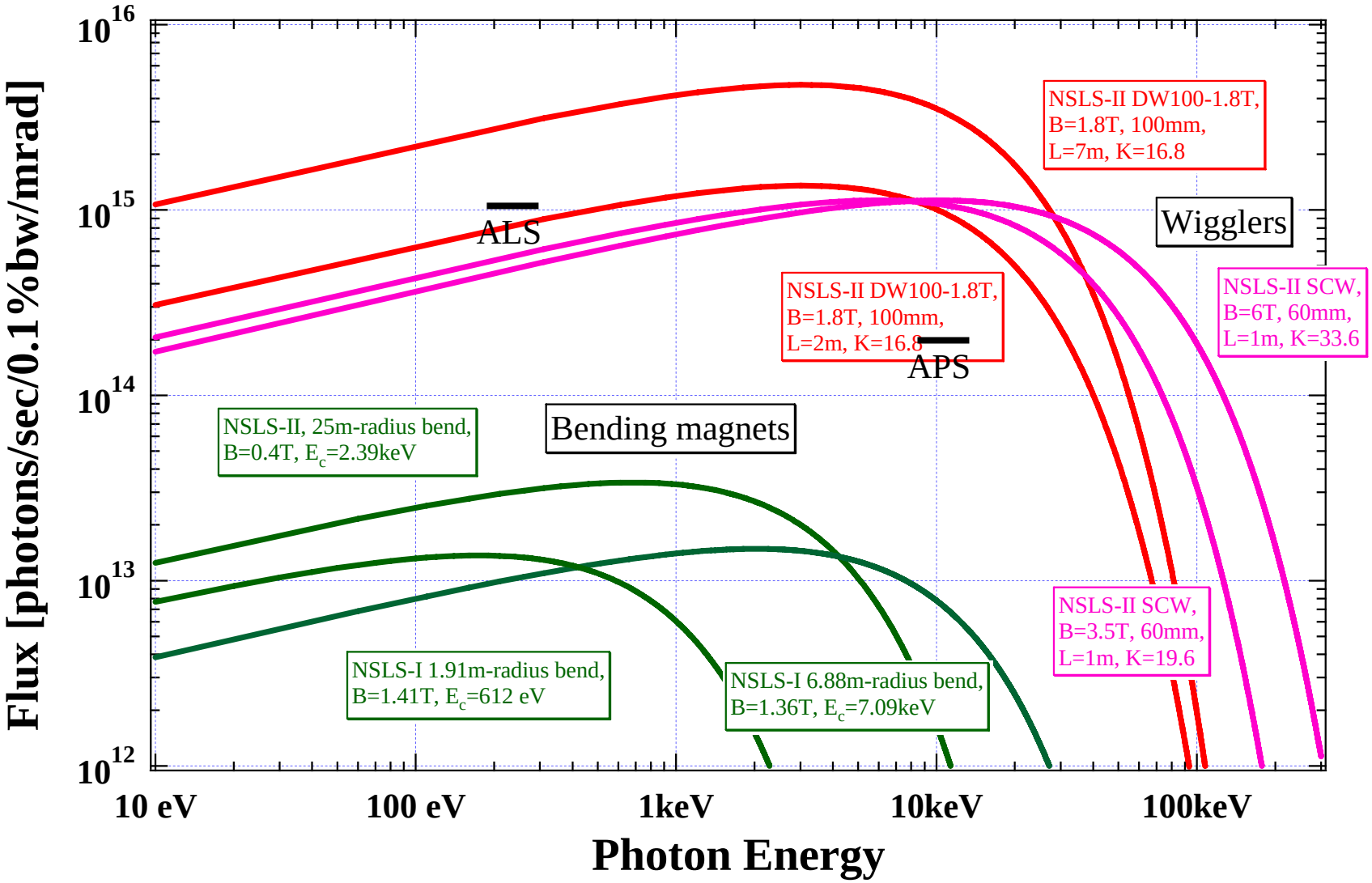
Timing of the transition occurs during peak PRT demand for U3C and X8A

- Omega and NIF Dante requires ~ 720 “component” calibrations per year (2 components a day) for FY ’08 and beyond …
  - 40 mirrors
  - 240 XRDs
  - 340 filters

- According to the presently adopted schedule, NSLS 1 terminates operations in 2012
  - ~ 1 year of concurrent NSLS I + II operations facilitating transitional activities in 2011

- Implications for U3C and X8A
  - We presently have a heavy subscription from PRT with a manageable GU work load
  - Transition will occur during period of highest beamline utilization (support all experimental facilities at SNL, LANL, and LLNL, in addition to Omega)

Options and opportunities at NSLS



Conclusions

- “Disappearance” of NSLS I is problematic for LLNL
  - Coincides with period of highest utilization of the existing PRT beamlines
- Current belief is that x-ray calibrations require synchrotron radiation, beamlines and end-stations with “appropriate” characteristics
- Path forward re: NSLS II will depend on available resources
  - There is a need; however, cost effective scenarios appear to represent a loss compared with current capabilities
- May need to consider alternate approaches (venues)
  - Combination of ALS, SSRL and ALS beamlines