



*... for a brighter future*

# **12-ID Upgrade to Two Independent Beamlines**

**Dec 17, 2008**

**APS Monthly Operations Meeting**

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***X-ray Science Division***

***Oliver Schmidt and Soon-Hong Lee***

***Mechanical Engineering and Design***

***APS Engineering Support Division***



U.S. Department  
of Energy



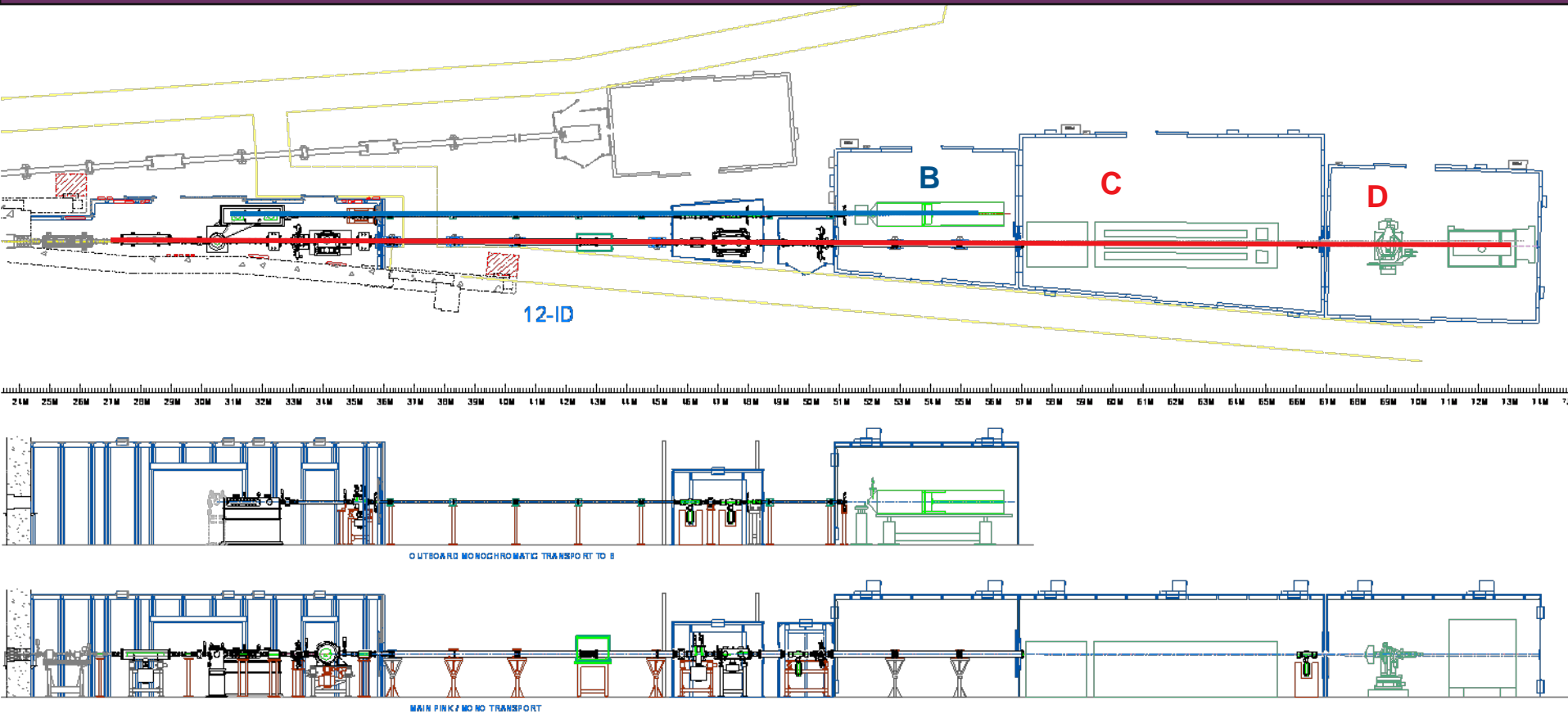
# 12 -ID Upgrade to Two Beamlines with Canted Undulators

- APS Strategic Plan calls for 12-ID to become a dedicated Small angle X-ray scattering (SAXS) facility.
- The 12-ID SAXS facility (FY 1996 DOE Scientific Facilities Initiative) is 50% of the GUP beamtime with x2 oversubscription.
- SAXS publications - 165 and users - >300
- The increasing demand for SAXS beam time has been driven by:
  - Research into the structure and dynamics of nanoscale materials
  - Increased interest in soft matter
  - Time-dependent structural investigations
- Plan was endorsed by the SAC review of Sector 12 in March, 2005

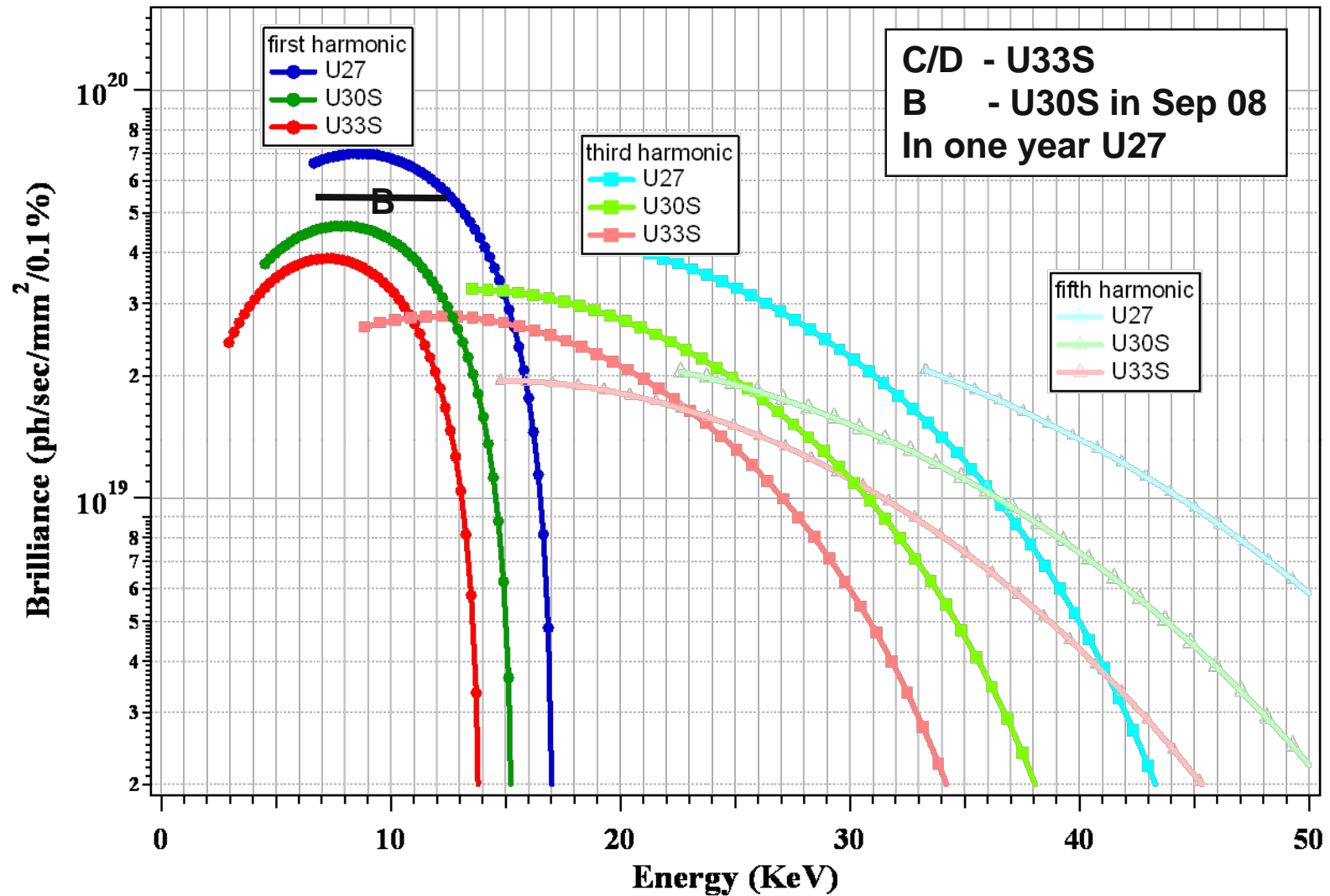
# 12 - ID Upgrade to Two Beamlines with Canted Undulators

- Versatile Anomalous and time resolved SAXS/WAXS/GISAXS/USAXS beamline [12-ID-C]
  - Technically complicated experiments which takes full advantage of insertion device capabilities
  - Pink beam – high flux for fast experiments
  - Wide Q range 0.001 – 5.0
  - Wide energy range 4.5 – 36 Kev
  - Combined experiments – XANES, MS, DSC
- Surface Scattering [12-ID-D]
  - MOCVD
  - Diffractometer (from 12-ID-B)
  - Wide energy range 4.5 – 36 Kev
  - 60 cm mirror in 12-ID-C
- Dedicated (6.9 - 13 Kev) SAXS/WAXS/GISAXS beamline [12-ID-B]
  - Easily adjustable Q range (0.006 – 2.0)
  - Rapid access
  - Regular access (set aside time)

# Layout of 12-ID Upgrade



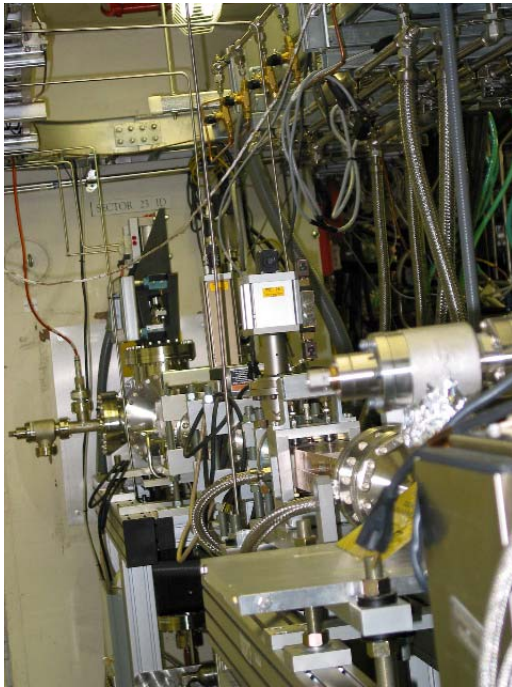
# Selection of an Undulator for 12-ID-B



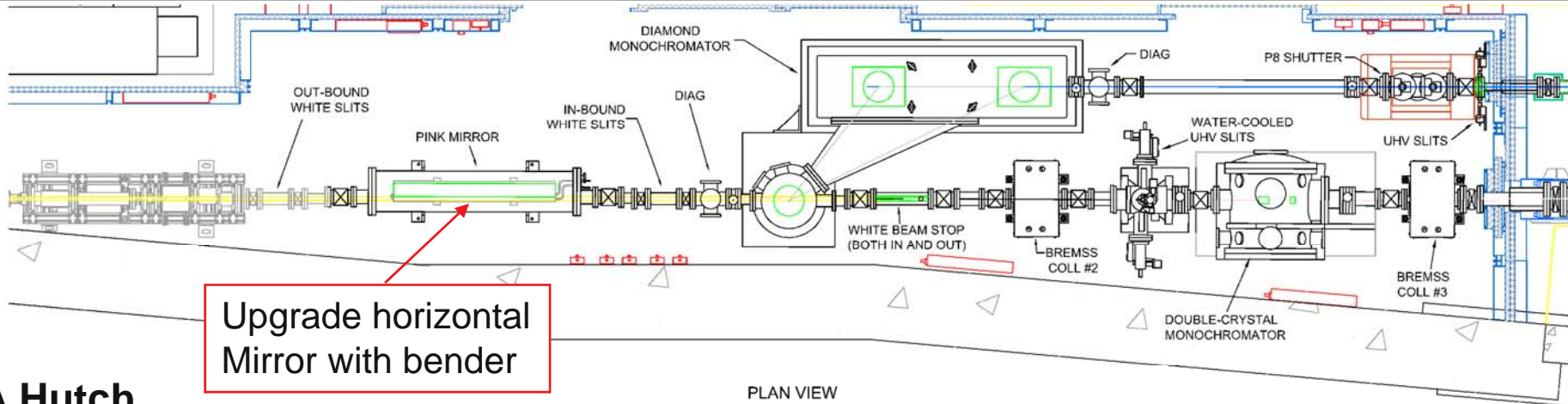
# Sep 2008 Shutdown

Canted front end was installed by AES in 12-ID  
but will not be canted until installation of the side bounce monochromator

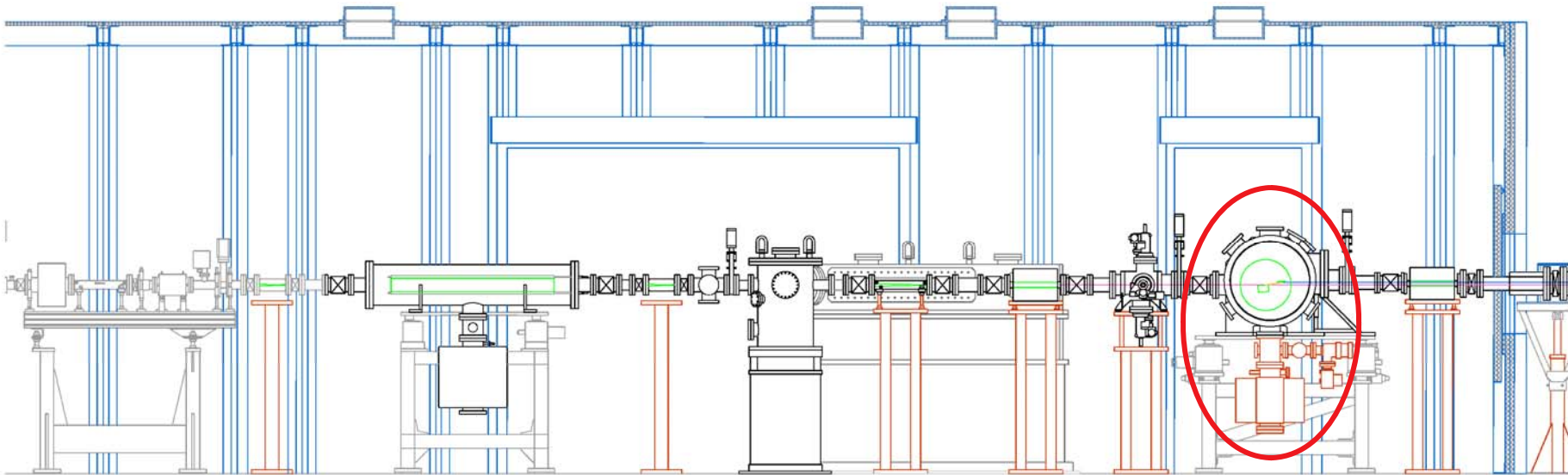
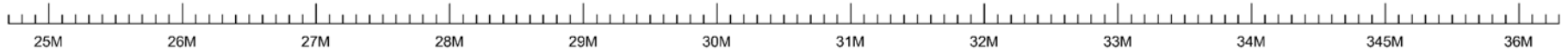
3.0 undulator was installed inline with the existing undulator



# Layout of 12-ID Upgrade C/D Line



A Hutch

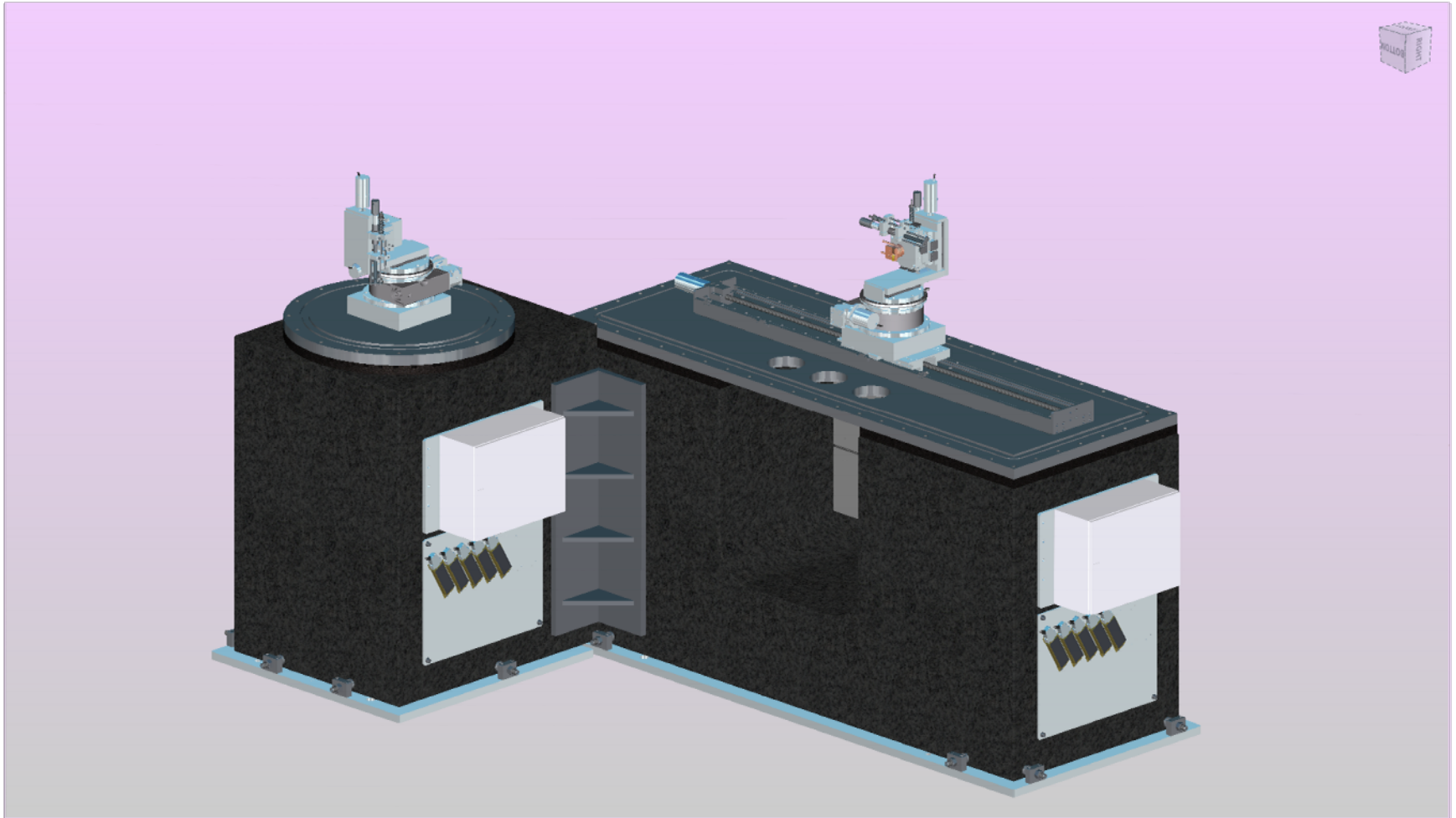


# 12-ID-C/D Monochromator Upgrade

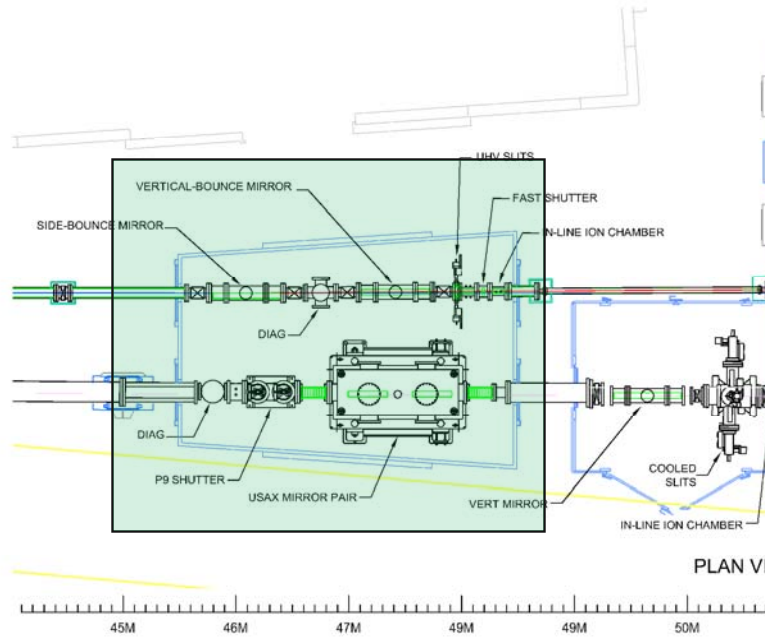
	Before the upgrade	After the upgrade
Diffraction type	Si(111)	Si(111)
Second Crystal Offset	35 mm Constant offset	<b>20 mm Constant offset</b>
Energy range	4.2KeV-28 KeV	<b>4.5KeV-36 KeV</b>
Coolant	Liquid Nitrogen	Liquid Nitrogen or (water)
1 <sup>st</sup> Xtal Cooling type	Direct cooling	<b>Indirect cooling</b>
Diffractometer	Huber	Huber
Heidenheim encoder	No	<b>Yes</b>
Motor type	Stepper motor	Stepper motor
Vacuum	2 Ion getter pumps 10 <sup>-8</sup> Torr	2 Ion getter pumps 10 <sup>-8</sup> Torr



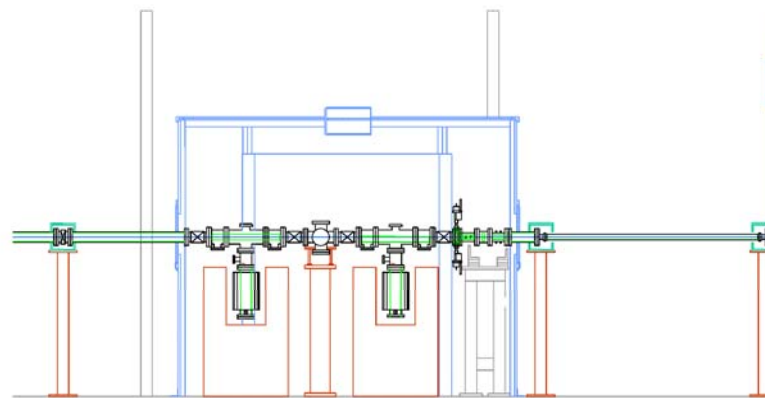
# 12-ID-B Beamline with a large offset Monochromator



# Layout of 12-ID Upgrade – New Mini-hutch



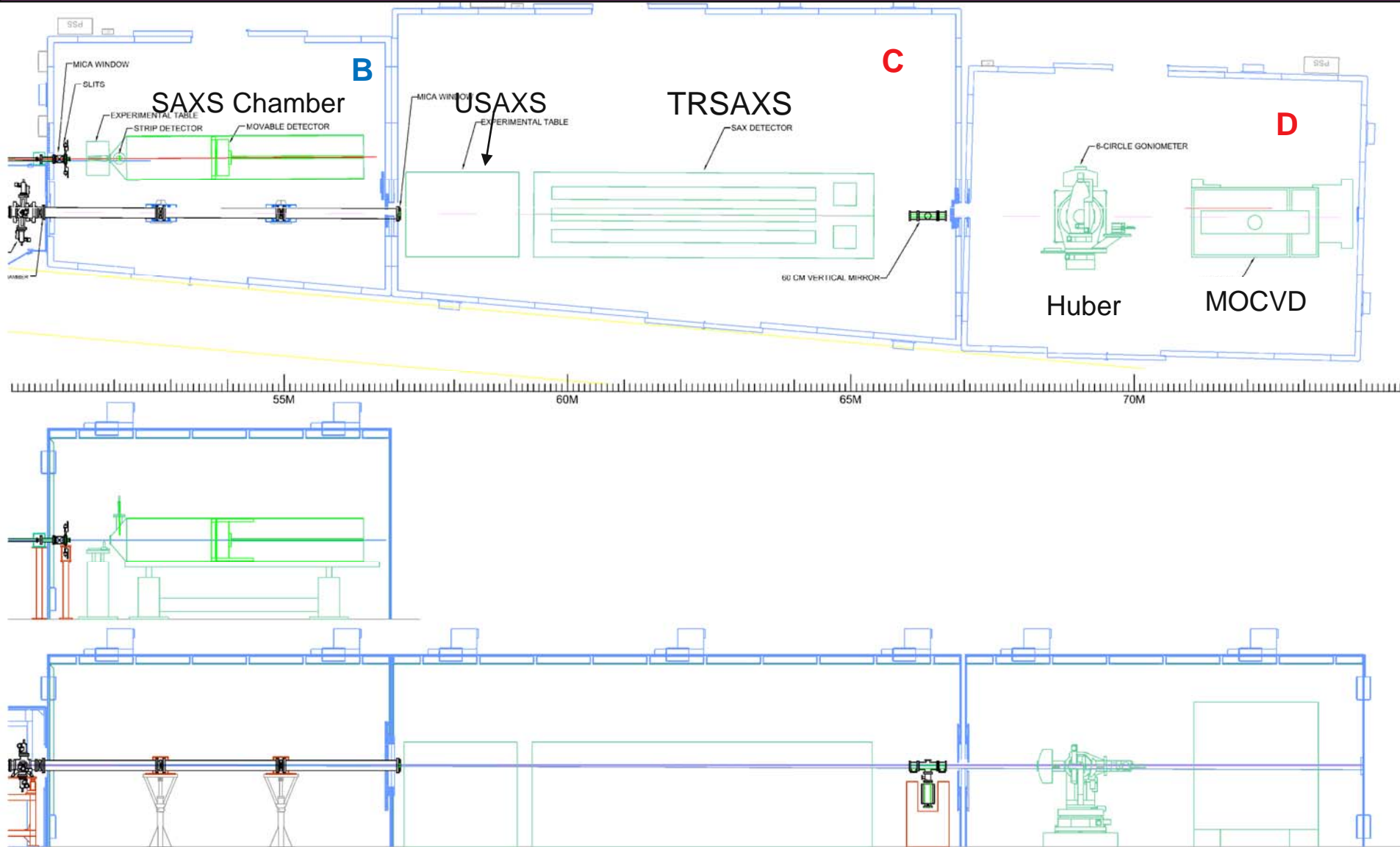
PLAN VIEW



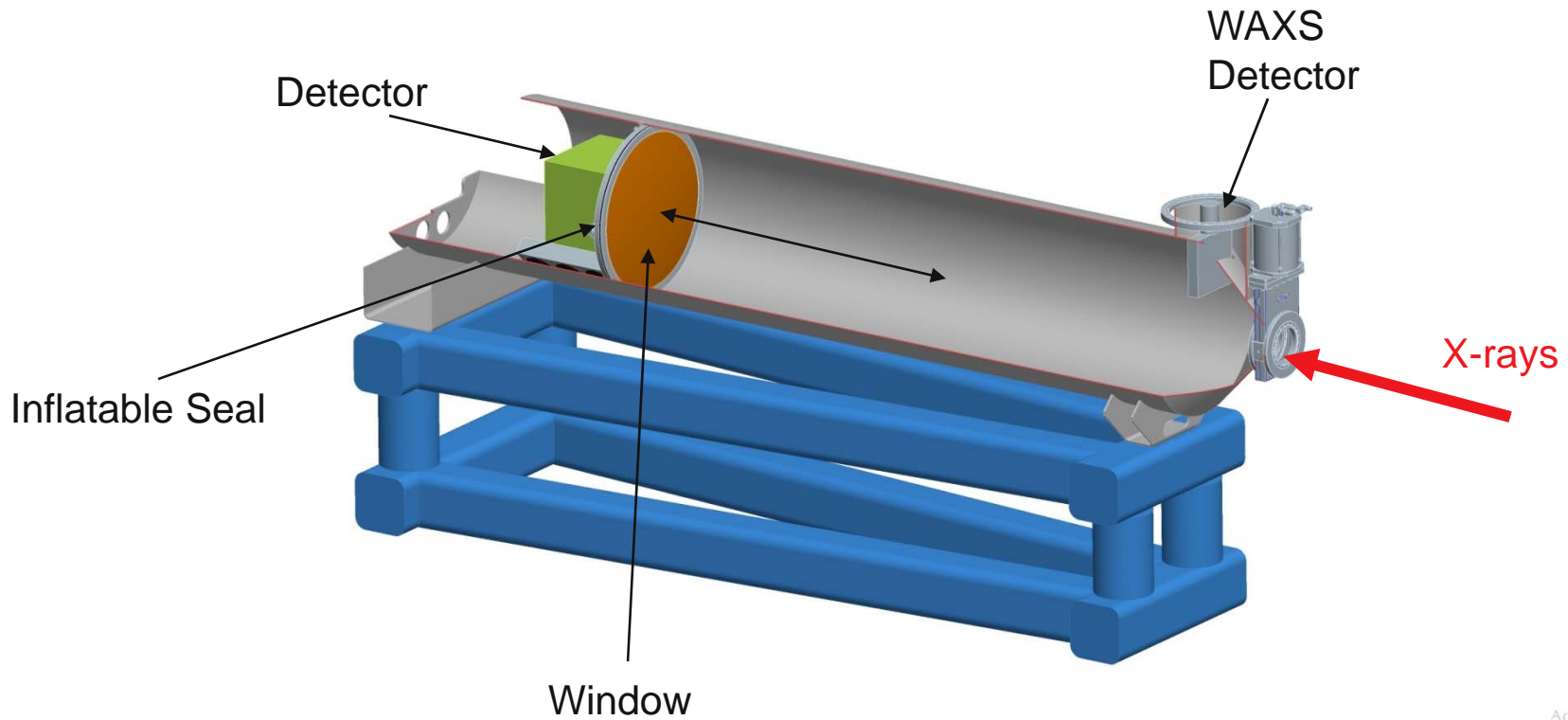
ELEVATION VIEW: MONO BEAM INTO "B" HUTCH



# Layout of 12-ID Upgrade Hutches



# 12-ID-B SAXS Chamber



Active Part:SAX-DETC

X.X+0.1  
X.XX+0.01  
X.XXX+0.001  
ANG,+0.5

# PILATUS 2M Detector for 12-ID-B

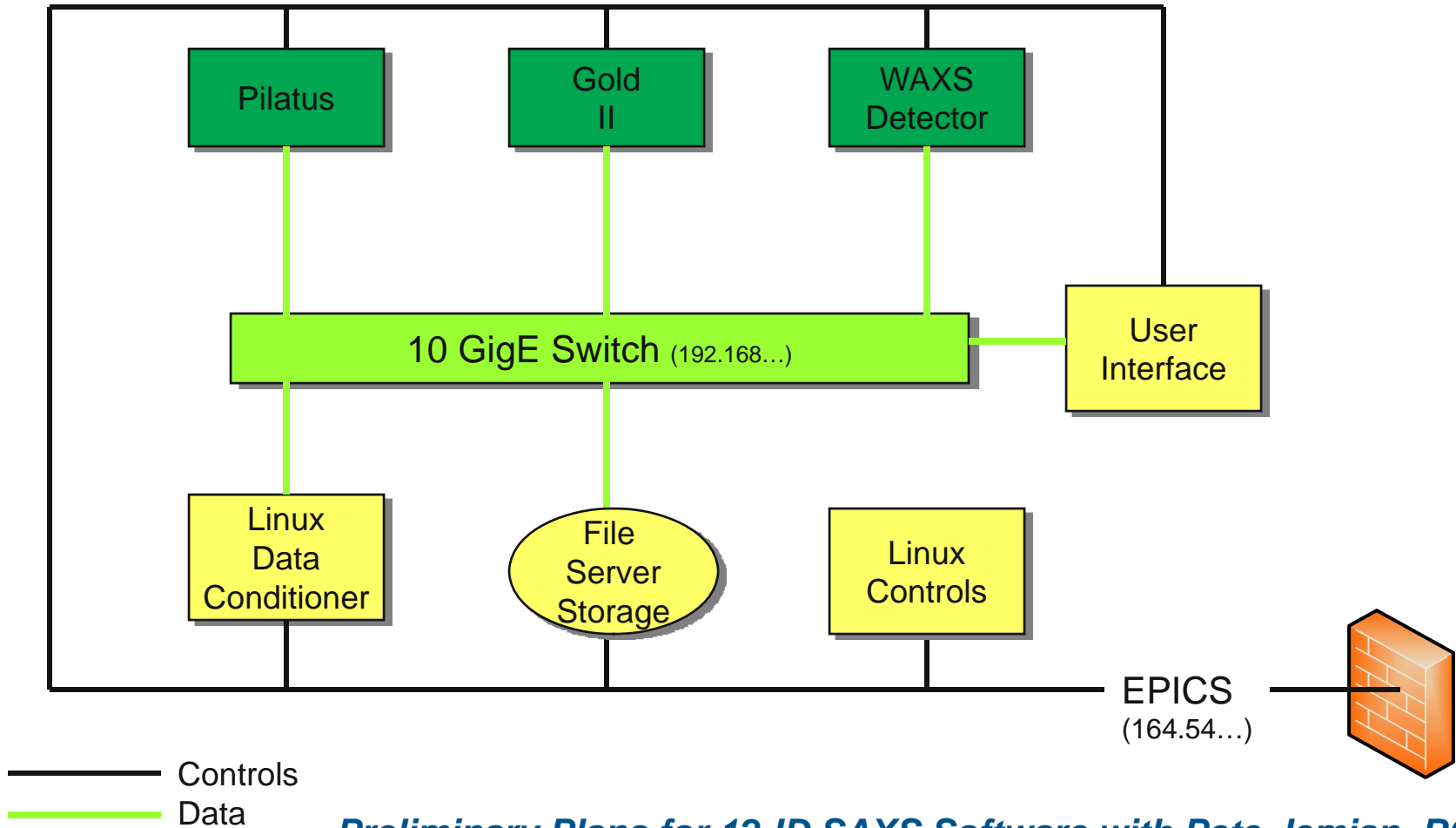
The PILATUS 2M detector is perfectly suited for modern small-angle X-ray scattering, which require fast detectors with very high dynamic ranges. With its large active area of 254 x 289 mm<sup>2</sup>, it's 20 bit (1 Million) dynamic range per pixel per image, its high frame rate of 30 Hz for a full readout of the detector

## Technical data

Pixel size	172 x 172 $\mu\text{m}^2$
Format	1475 x 1679 = 2,476,525 pixels
Active area <sup>2</sup>	254 x 289 mm <sup>2</sup>
Counting rate	$>2 \times 10^6/\text{pixel}/\text{s}$
Energy range	3–30 keV
Readout time	2.7 ms
Framing rate	30 Hz
Power consumption	200 W, air-cooled
Dimensions	388 x 410 x 408 mm
Weight	50 kg

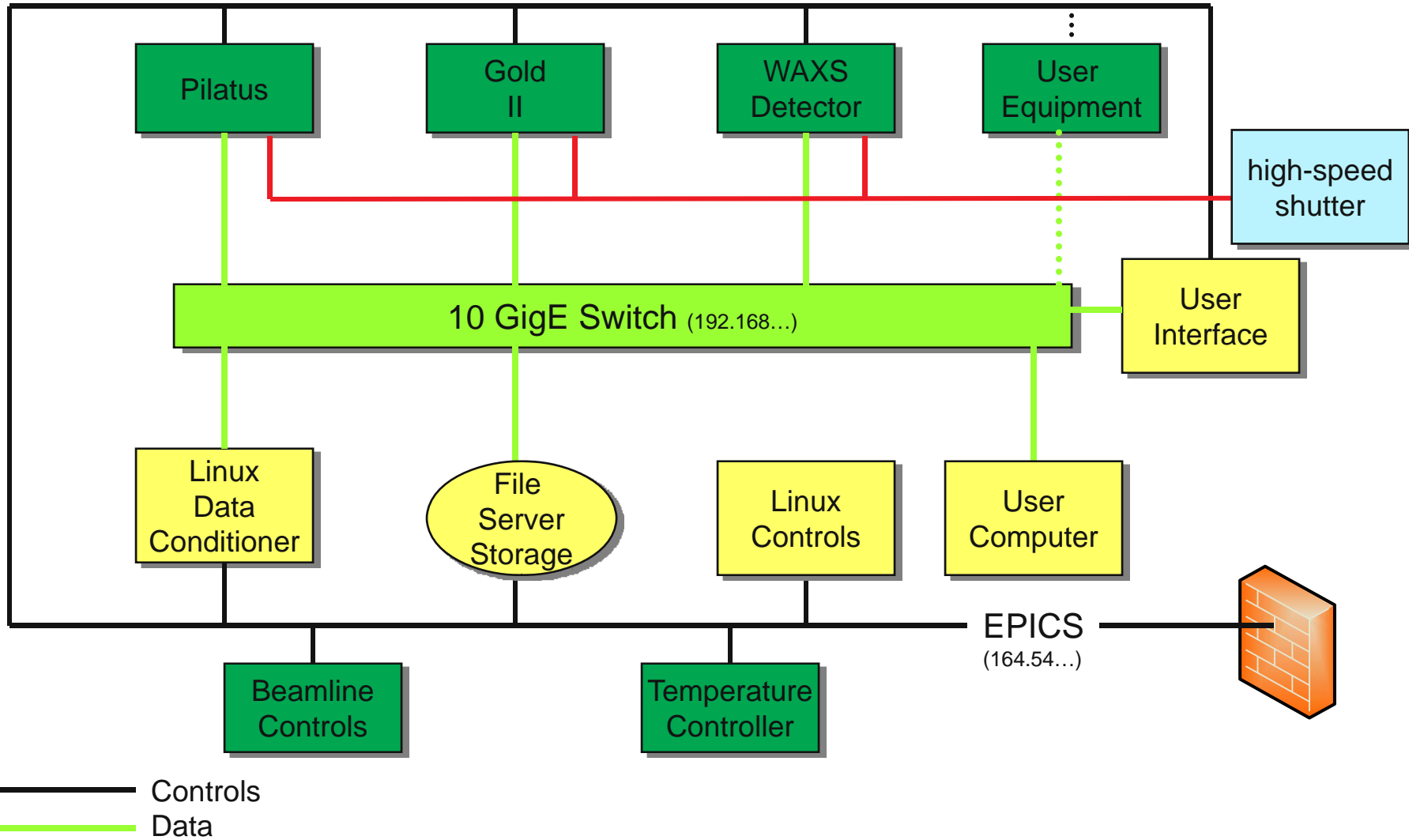


# 12-ID SAXS Beam line Data Acquisition, Control, and Computation Network



***Preliminary Plans for 12-ID SAXS Software with Pete Jemian, BCDA***

# Connect users to the network



Activity Name	Duration (Work Weeks)	Start Date	Finish Date	Resources Assigned	% Complete	2008		2009				2010
						Third Q	Fourth Q	First Q	Second Q	Third Q	Fourth Q	First Q
<b>Front End</b>	<b>108.0</b>	<b>1/1/08</b>	<b>1/25/10</b>		<b>63%</b>							
Front End, dual in-line mode (U33, U30)	41.4	1/1/08	10/15/08		99%							
Front End design	8.6	1/1/08	2/28/08		100%							
Front End procurement	21.8	3/3/08	7/31/08		100%							
Front End installation	6.0	8/1/08	9/11/08	Greg Wiemerslage	95%							
Undulator U30 Procurement	30.4	1/1/08	7/30/08	Liz Moog, Randy Winans	100%							
Undulator U30 install	6.0	7/31/08	9/10/08	Greg Wiemerslage	100%							
controls for simultaneous use	5.4	9/9/08	10/15/08	Randy Winans, John Grimmer	100%							
changes for dual in-line operation	1.6	9/22/08	10/1/08	PSS, Markovitch, Soenke Seifert	50%							
<b>Canted Undulator Configuration</b>	<b>75.8</b>	<b>8/13/08</b>	<b>1/25/10</b>		<b>30%</b>							
Administrative...	27.6	11/3/08	5/13/09		0%							
Front End for canted operation (U33, U30)...	75.8	8/13/08	1/25/10		45%							
<b>12ID-C/D Line</b>	<b>72.6</b>	<b>9/9/08</b>	<b>1/28/10</b>		<b>3%</b>							
<b>Beamline</b>	<b>72.6</b>	<b>9/9/08</b>	<b>1/28/10</b>		<b>3%</b>							
New exit table assembly...	64.0	10/6/08	12/25/09		0%							
Inboard white beam stop...	67.0	10/6/08	1/15/10		0%							
New white beam slits...	62.0	10/7/08	12/14/09		0%							
Upgrade pink mirror...	30.0	2/3/09	8/31/09		0%							
pink mirror diagnostics - phosphor screen...	32.8	5/1/09	12/16/09		0%							
outboard white beam stop...	4.0	12/2/09	12/29/09		0%							
water-cooled slits (pink beam)...	65.8	10/7/08	1/8/10		0%							
Monochromator upgrade...	68.8	9/9/08	1/1/10		2%							
monochromator diagnostics - phosphor screen...	37.4	5/1/09	1/18/10		0%							
2nd Bremsstrahlung...	51.8	1/13/09	1/8/10		0%							
Changes to transport pipes...	61.4	11/4/08	1/6/10		0%							
diagnostic before shutter...	29.8	6/16/09	1/8/10		0%							
P9 mono/pink shutter...	66.8	10/7/08	1/15/10		0%							
USAXS mirror...	66.0	10/6/08	1/8/10		5%							
Transport between mini-hutches...	48.0	1/13/09	12/14/09		0%							
60 cm vertical mirror...	70.8	9/9/08	1/15/10		20%							
cooled slits (mono/pink)...	68.8	10/1/08	1/25/10		0%							
in-line ion chamber (w/Be windows, quad PD)...	67.0	9/29/08	1/8/10		0%							
transport pipes inside 12ID-B...	65.0	10/6/08	1/1/10		0%							
replace sliding stop with guilloine (12ID-B TO -C)...	49.8	1/20/09	1/1/10		0%							
60 cm vertical mirror for 12ID_D...	66.6	10/1/08	1/8/10		19%							
replace/refurbish ion pumps	42.0	10/1/08	7/21/09	Soenke Seifert, Charles Kurtz, Randy Winans	0%							
beamline control...	69.4	10/1/08	1/28/10		0%							
<b>Experimental Hutches</b>	<b>56.8</b>	<b>9/9/08</b>	<b>10/9/09</b>		<b>4%</b>							
12ID-C...	56.8	9/9/08	10/9/09		2%							
12ID-D...	45.0	9/9/08	7/20/09		6%							
PSS	31.8	6/1/09	1/7/10	Soenke Seifert, PSS, Markovitch	0%							
<b>12ID-B LINE</b>	<b>76.8</b>	<b>9/9/08</b>	<b>2/26/10</b>		<b>2%</b>							
<b>Beamline</b>	<b>76.8</b>	<b>9/9/08</b>	<b>2/26/10</b>		<b>3%</b>							
Side-bounce diamond monochromator...	72.0	10/13/08	2/26/10		0%							
diagnostics - Phobdiode...	33.2	5/18/09	1/4/10		0%							
Horizontal 80 cm Pd mirror...	65.6	10/1/08	1/1/10		0%							
mirror diagnostic- phosphor screen/camera...	37.6	5/1/09	1/19/10		0%							
P8 mono shutter...	32.0	6/1/09	1/8/10		0%							
uhv mono slits...	62.2	11/3/08	1/11/10		0%							
transport 12ID-A to mini-hutch...	66.6	10/1/08	1/8/10		0%							
vertical 60 cm. mirror...	68.8	9/9/08	1/1/10		19%							
diagnostic - phosphor screen/camera...	37.6	5/1/09	1/19/10		0%							
horizontal 60 cm mirror...	68.8	9/9/08	1/1/10		19%							
in-line ion chamber (Be windows, quad PD)...	62.4	11/3/08	1/12/10		0%							
HV slits...	62.2	11/3/08	1/11/10		0%							
Transport from mini-hutch to 12ID-B...	62.0	11/3/08	1/8/10		0%							
HV slits...	62.2	11/3/08	1/11/10		0%							
Mica window...	27.8	7/1/09	1/11/10		0%							
Clean up slits installation...	66.4	11/3/08	2/9/10		0%							
Experimental setup	72.8	10/1/08	2/22/10		0%							
SAXS sample table...	72.8	10/1/08	2/22/10		0%							
PSS	34.0	6/1/09	1/22/10	PSS, Soenke Seifert, Markovitch	0%							

Current version of 12ID Upgrade in Fasttrack Schedule, showing top 3 levels



# *Project Management*

## 12-ID Advisory Committee

Andrew Allan (NIST), Chair  
Jeff Eastman (ANL/MSD)  
Anneli Munkholm (Philips Lumileds)  
Barbara Wyslouzil (Ohio State)  
David Tiede (ANL/CSE)

## Weekly Technical Meetings

Byeongdu Lee, Soenke Seifert, Randy Winans, Chuck Kurtz, Jan Ilavsky,  
Mohan Ramanathan, Yeldez Amer, Mark Beno, Gabrielle Long,  
Thomas Gog (side mono), Pete Jemian, Oliver Schmidt and Soon-Hong Lee

## Monthly Meetings with Users

# Updated Time-line for 12-ID Upgrade

2005 - Vacuum chamber and one shorten Undulator A installed  
and some canted front end parts ordered

2007 - Funding for mini-hutch and remaining canted front end parts  
PDR approved for mini-hutch

2008 – Order large offset mono

Sep Construction of mini-hutch  
Installation of canted front end  
Installation of second undulator (U30s in-line)

2009 –Feb FDR

2009 - May or Sep, Move goniometer from B to D

2009 – Summer assemble new C/D mono

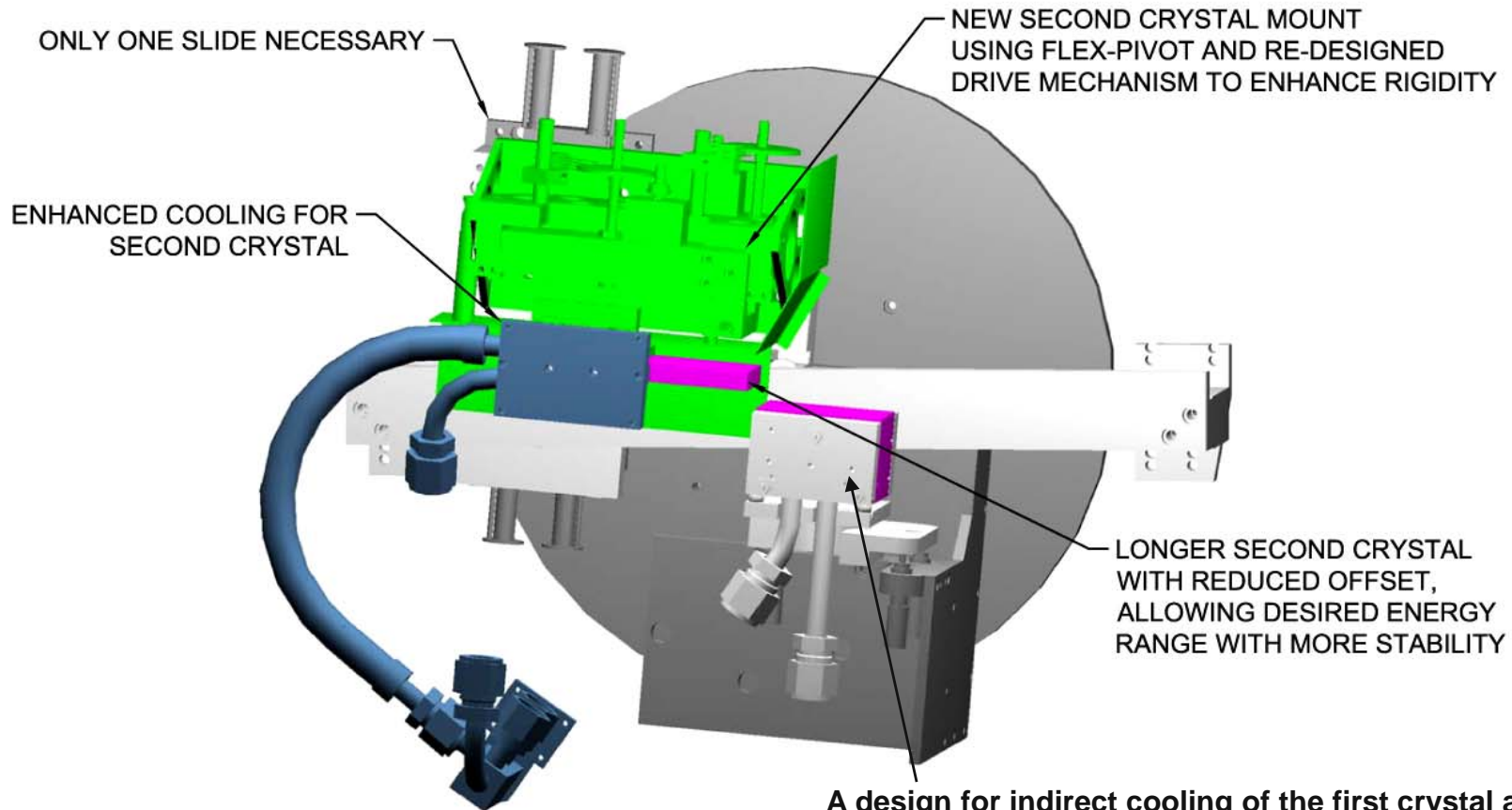
2009 – Dec Shutdown Installations

Install 4 mirrors  
Cant the two undulators  
Large offset mono  
SAXS chamber in 12-ID-B

## *Ancillary Equipment*

- Flow cells, stop flow capability
- Environmental control (heating, cooling) for in situ experiments
- Sample changers for high throughput experiments
- Gas flow control system for multiple and reactive gases
- Other complementary techniques such as mass spectrometry

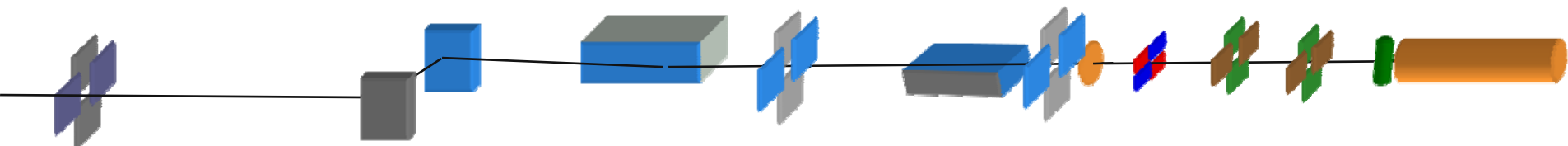
# 12-ID-C/D Monochromator Upgrade



A design for indirect cooling of the first crystal already implemented in 20-ID is planned along with modifications to the 1st crystal Compton shielding

# Proposed 12-ID Beamlines

B Branch



C/D Branch

