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## **Sector 12-ID-B/C and 12-BM SAXS Instruments**

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## ***Technical specs of 12-IDB, 12-IDC and 12-BMB SAXS Beamlines***

- Versatile SAXS/ASAXS/WAXS/GISAXS/AGISAXS beam line at 12-ID-C
  - Technically complicated experiments taking full advantage of insertion device
  - Pink beam – high flux for fast experiments
  - Wide Q range (0.001 – 2.5. Å)
  - Wide energy range 5.5 – 36 KeV
  - Surface Scattering [12-ID-D] (MOCVD, Diffractometer)
- Dedicated SAXS/WAXS/GISAXS beamline 12-ID-B
  - Easily adjustable Q range (0.004 – 2.0 Å)
  - high throughput
  - 7.4 - 14 KeV
- Crystallography/EXAFS/SAXS/WAXS 12-BM-B
  - Fast changeover to the different experiments
  - Broad variety of experiments, allowing simultaneous measurements
  - Wide range 4 - 25 KeV
  - Q range (0.01 – 1.5 Å )

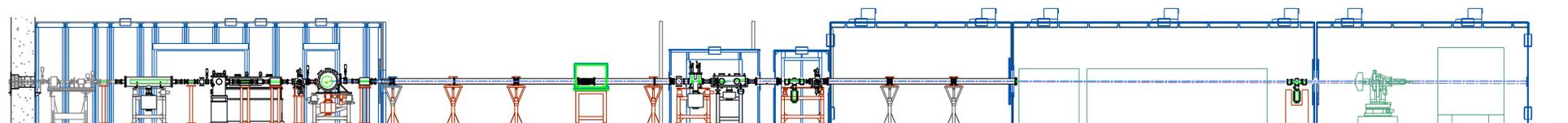
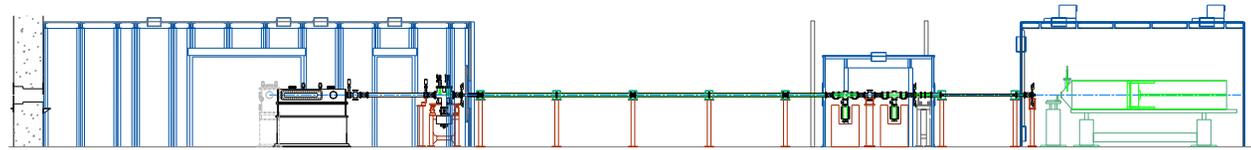
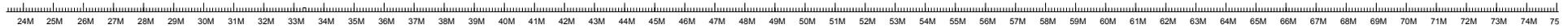
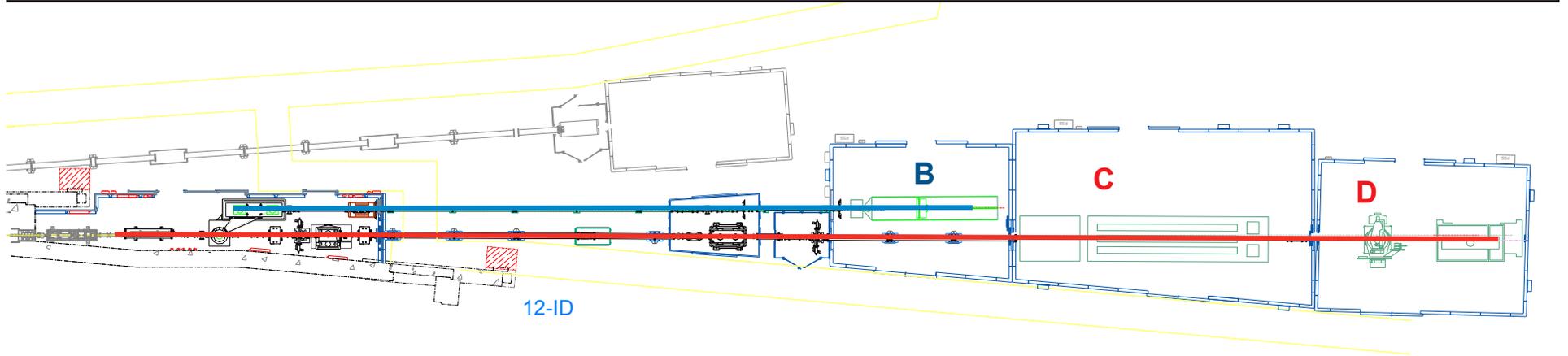
### ■ **Detectors**

APS/XOR Platinum mosaic CCD

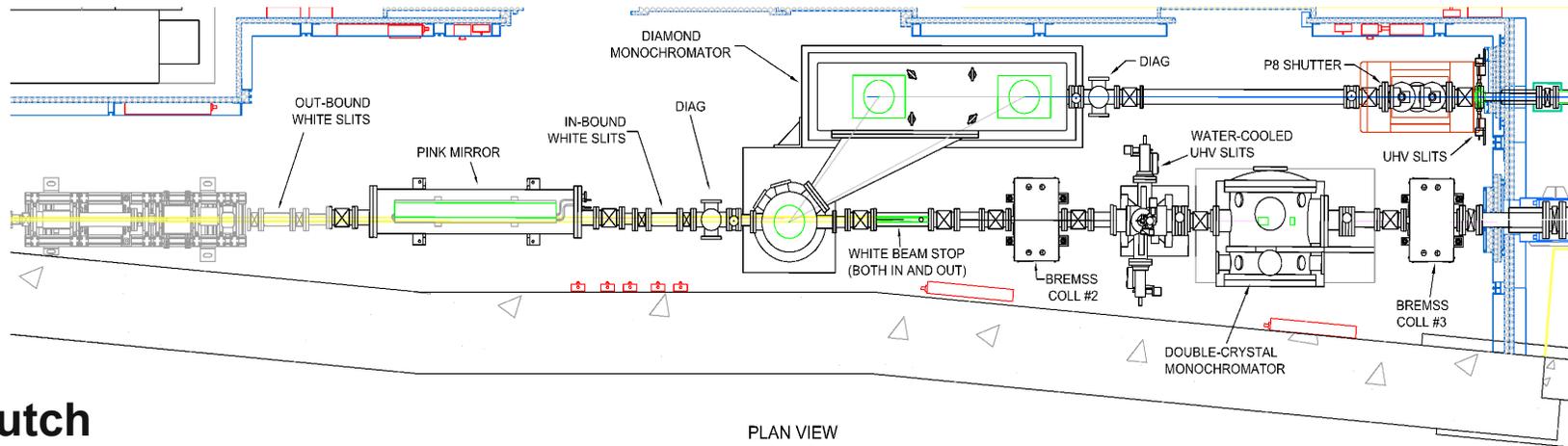
Pilatus 2M and wide angle (300K)

MARCCD

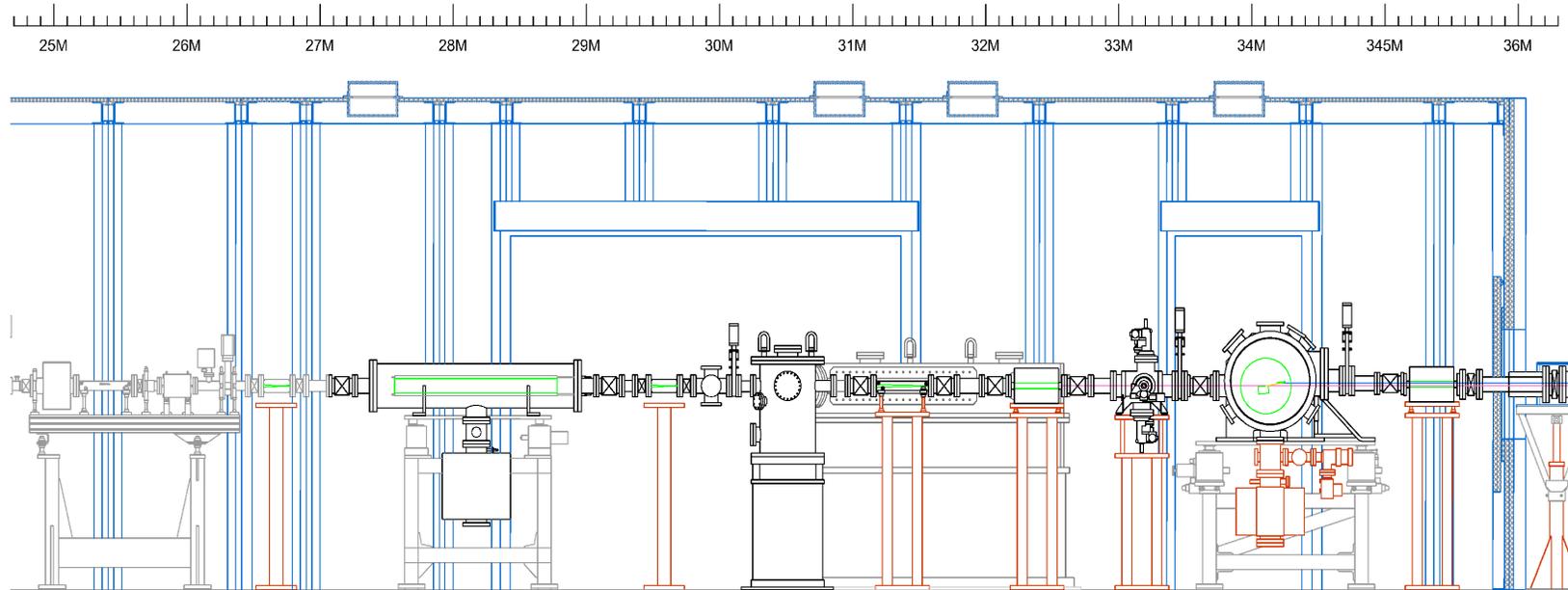
# Layout of 12-ID Upgrade



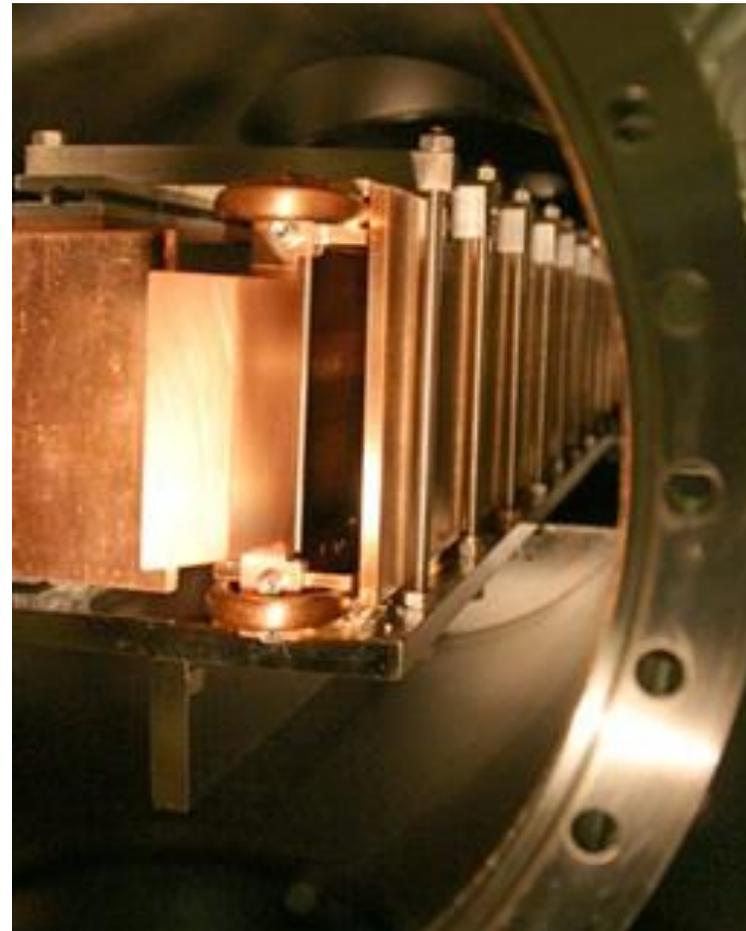
# Layout of 12-ID Upgrade C/D Line



## A Hutch



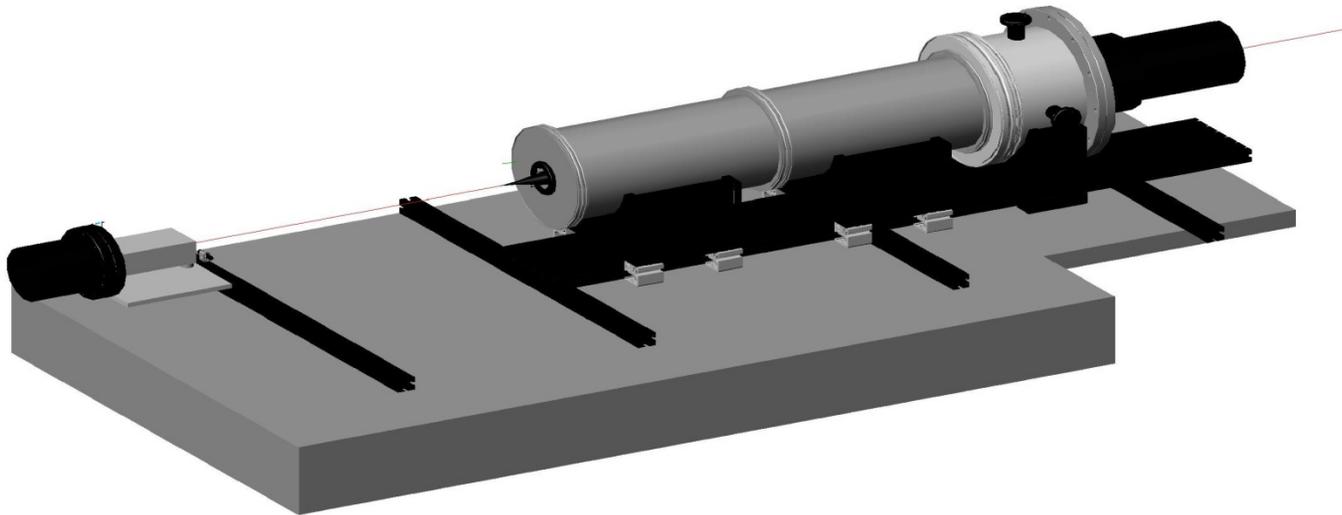
*Side bounce monochromator Inside of white beam mirror*



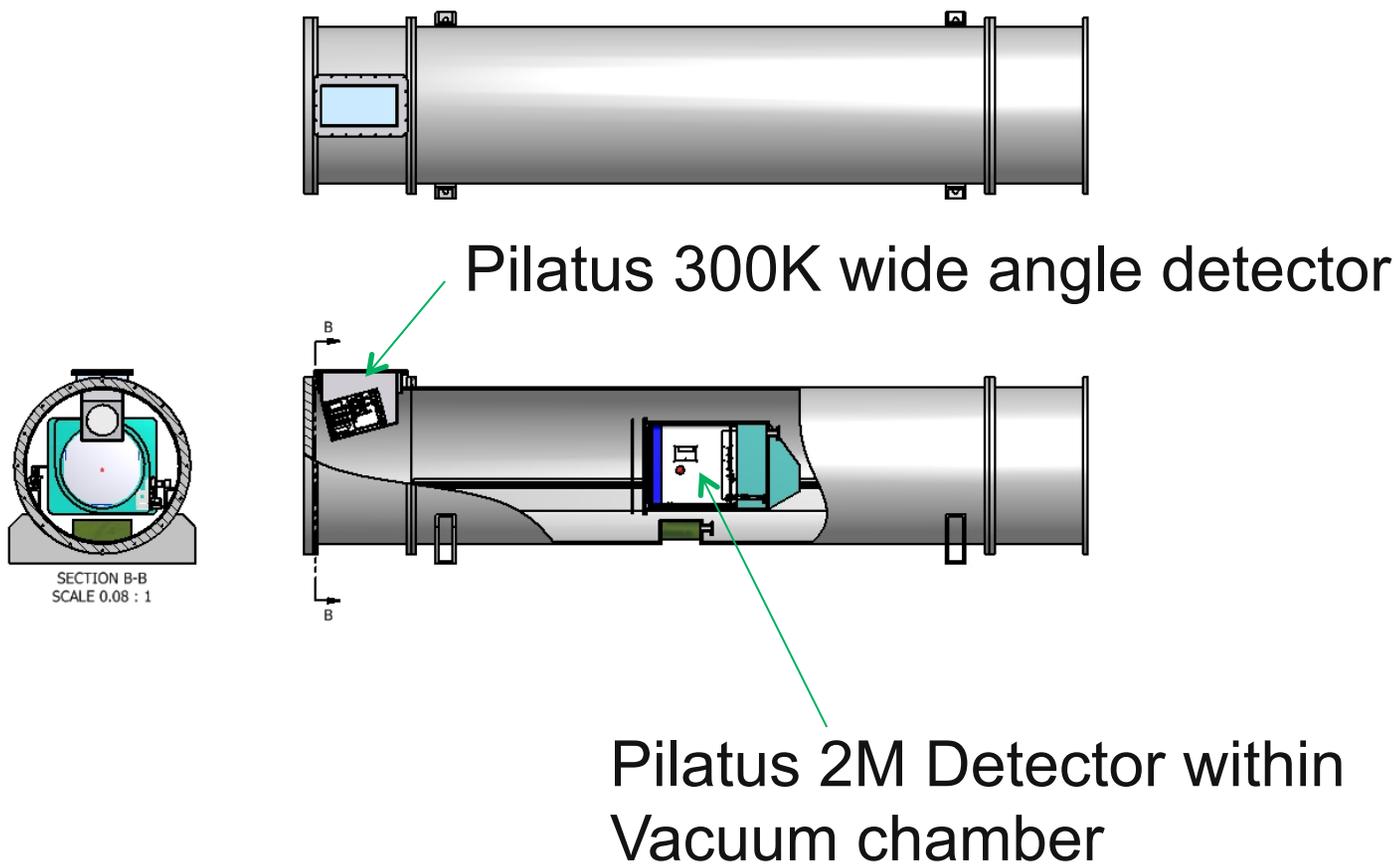
## ***Optimized Beamline for Time Resolved, Anomalous and Grazing Incidence SAXS***

- High beam stability with and without feedback system
- monochromator for spectroscopy specifications
  - Improved ASAXS
  - Provide simultaneous ASAXS/XANES
- high flux – focus with long horizontal and vertical mirror
  - Critical for many time resolved experiments including pink beam experiments
  - Important for dilute samples
- Low background – reduced parasitic scattering with slits
  - Important for dilute samples – solutions, nanoparticles on surfaces
- Detectors
  - 4 quadrant Mosaic CCD (Platinum)
  - MARCCD
  - Pilatus 2M & 300K (100K via detector pool)

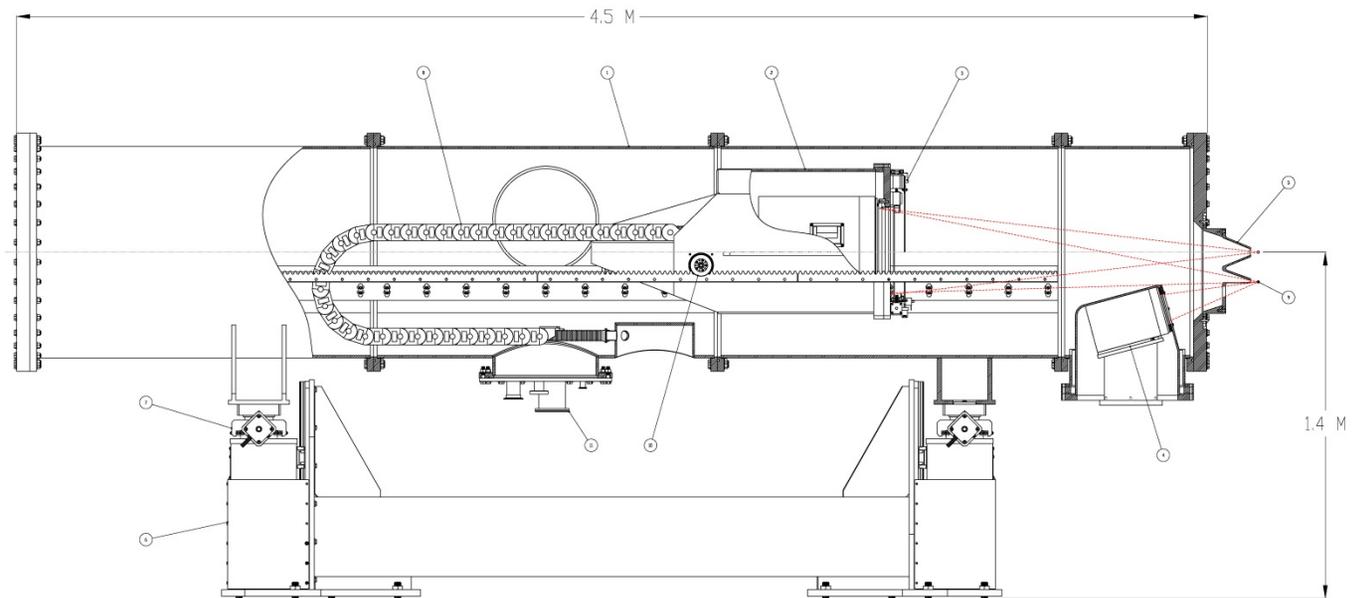
# 12-BM-B SAXS setup



- **12-ID-B SAXS Chamber**
- **Auto control of Q range**



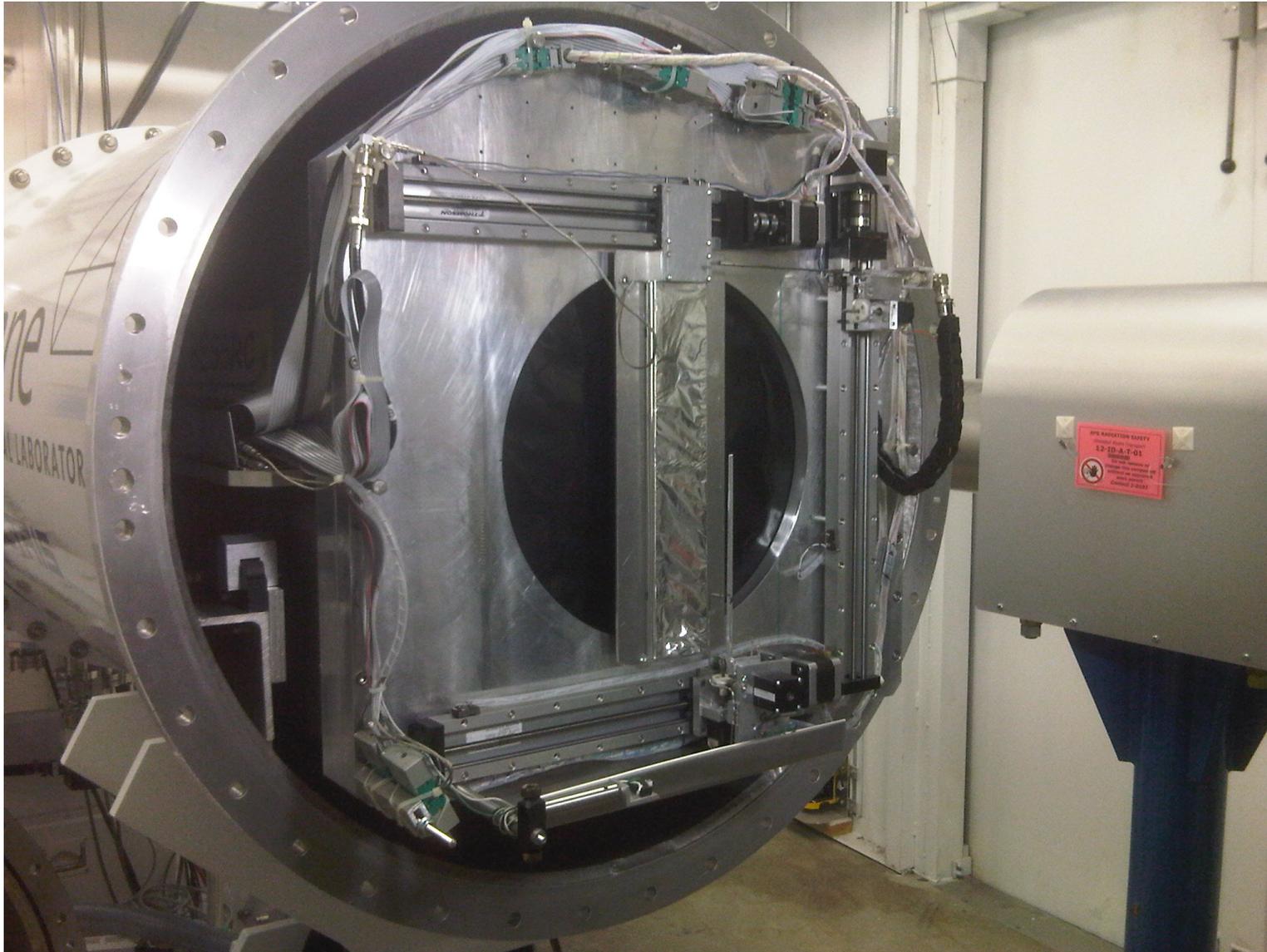
# 12-ID-B SAXS/WAXS chamber



## Custom design



## *Front plate of detector with beam stop mount*



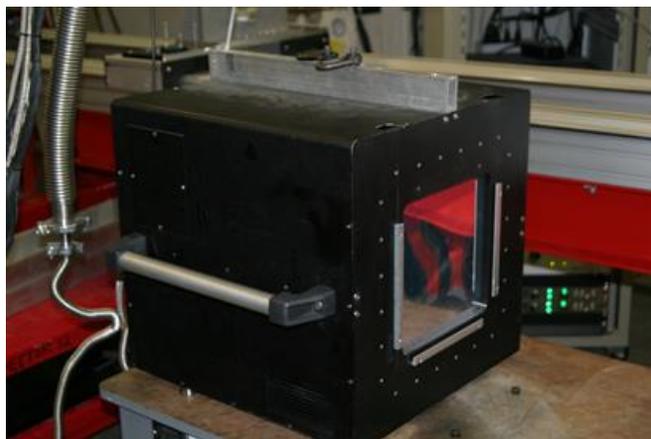
## 12-ID-C SAXS table



## MarCCD



## Platinum



## Pilatus2M



<i>Parameter</i>		<i>Mar</i>	<i>Platinum</i>	<i>Pilatus 2M</i>
Quantum Efficiency	12KeV	0.05	0.25	0.8
Minimum Visible X-rays		5	2	1
Maximum frame rate		0.4 Hz	1.5 Hz	30 Hz
Format		1024 * 1024	1024 * 1024	1475 * 1679
Active Area		165 mm circle	180 * 180 mm	254 * 289 mm
Dynamic range.		16 bit	16 bit	20 bit

# 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



## *GUI Interface*

## *Data Acquisition*

## *Data Reduction*

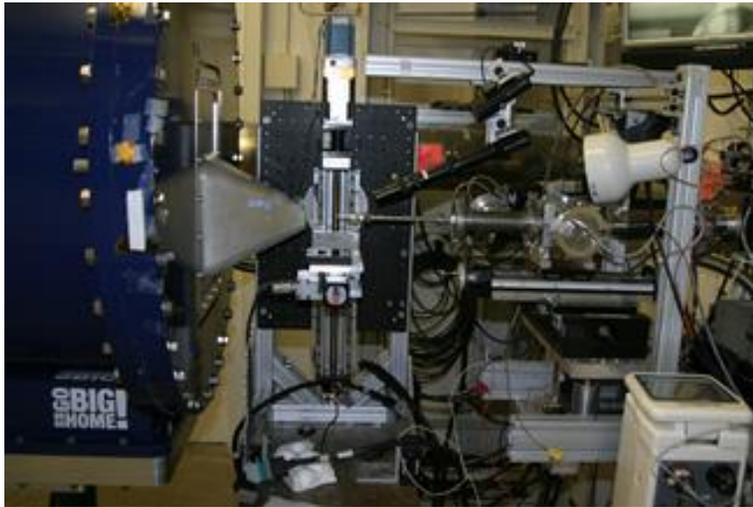
- Various detectors at 12-ID are being interfaced to users via a single GUI residing on a computer which is capable of running user scripts, controlling instruments and triggering the detectors through EPICS.
  - The 2D images obtained by the detector will immediately be displayed.
  - Preliminary data analysis can be done with simple analysis tools to enable the quick decision for further measurements.
- 
- Data acquisition and reduction procedures are constantly being developed based on the experience obtained with users over the years.
  - The system is versatile to allow users to develop more elaborate schemes for their experiments.
- 
- Automatic data correction, normalization, and azimuthal averaging process will run continuously without the necessity of user intervention - shortly after each image has been acquired it will automatically have been processed ready to be examined by the user with software installed on the data analysis computer.

## *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

# Sample environment

12ID-B



12BM-B



12ID-C

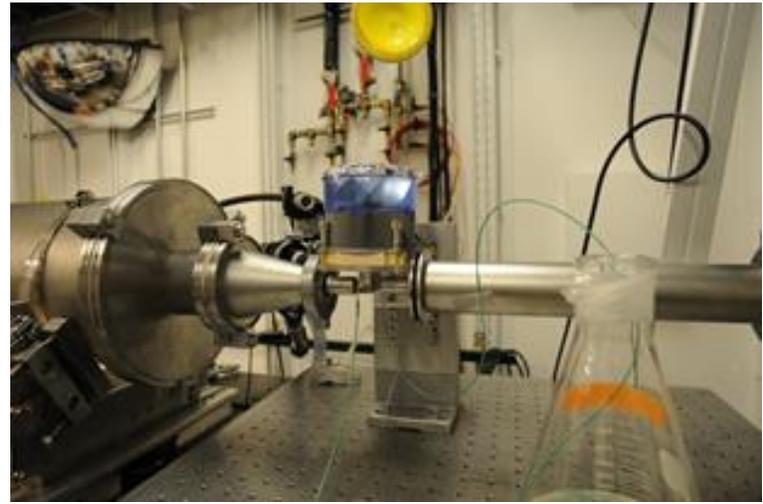


## Examples: sample environment

TGA



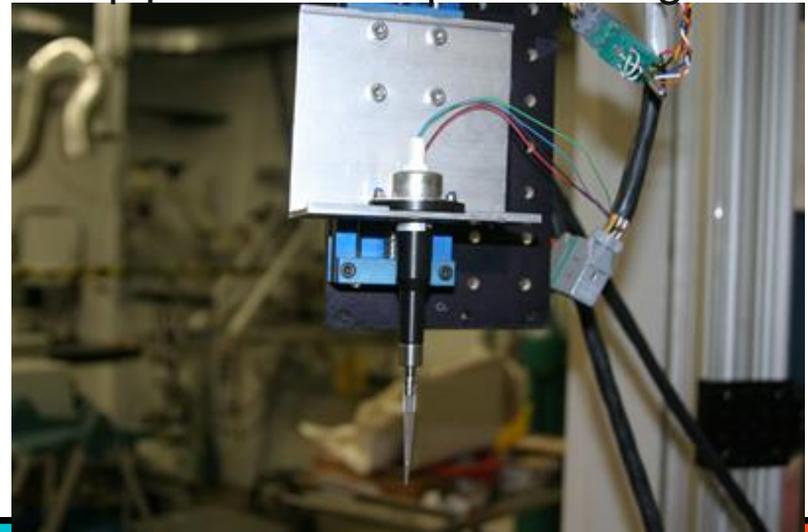
Flow cell



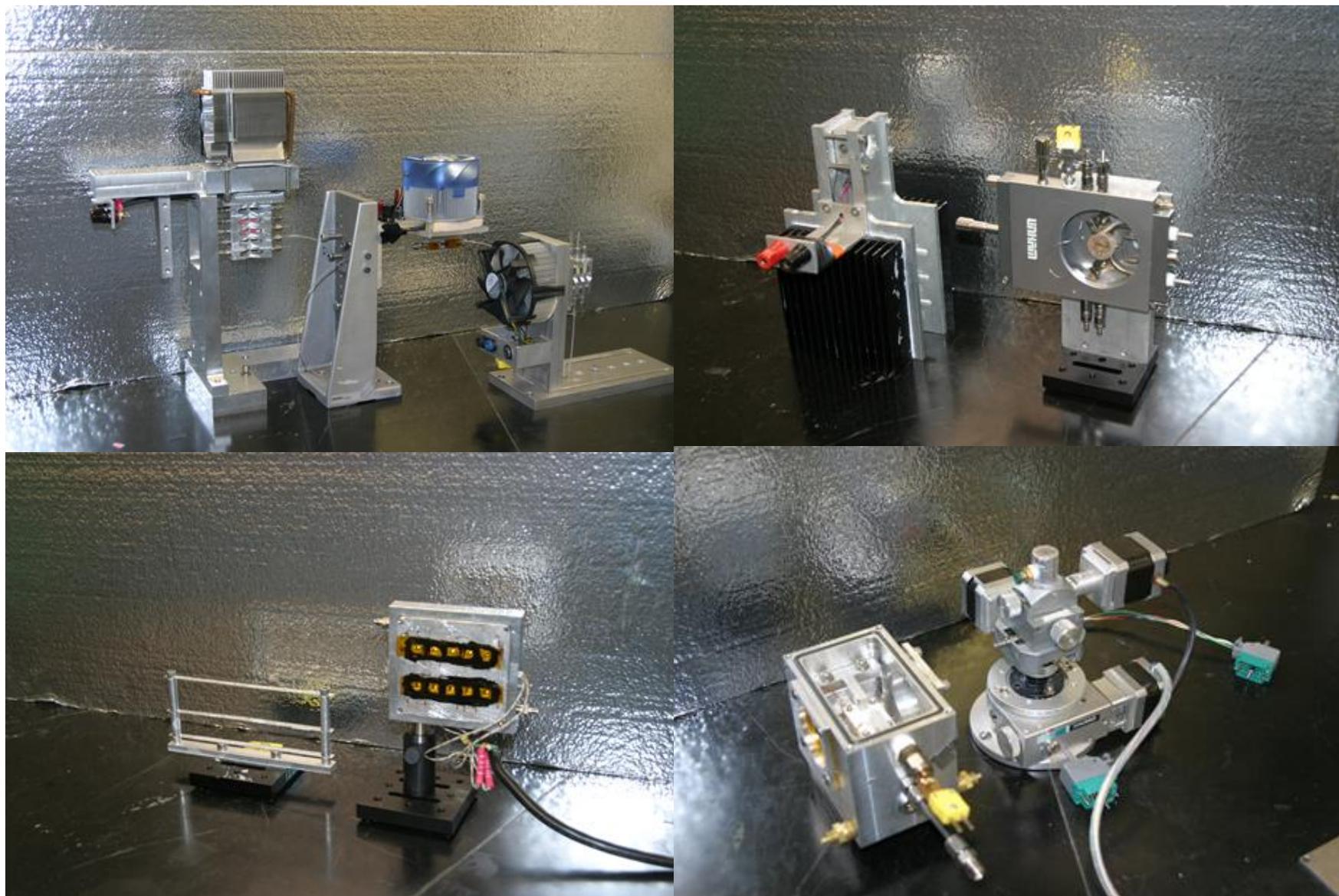
Stop flow



auto pipeter for sample handling

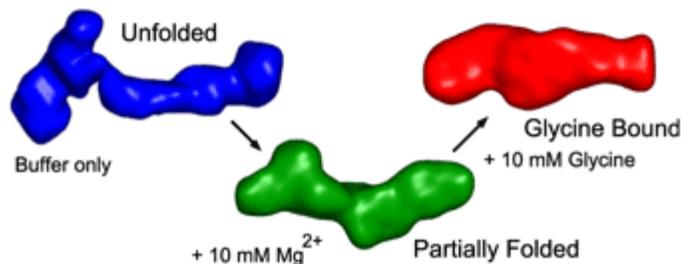


# sample holders



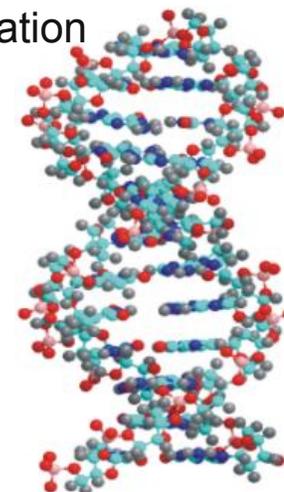
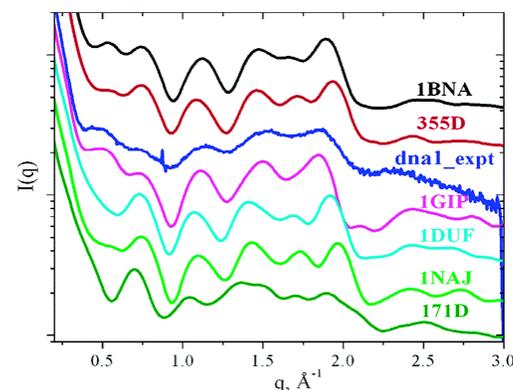
# SAXS at 12-ID

## Watching a Glycine Riboswitch “Switch”



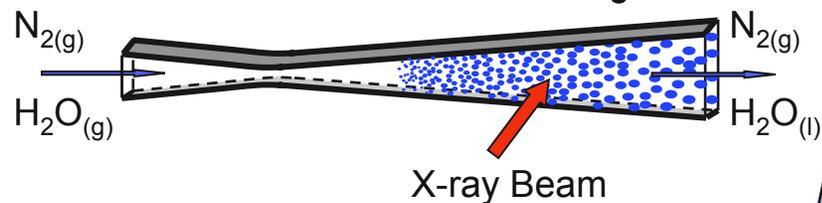
J. Lipfert, R. Das, V. B. Chu, M. Kudaravalli, N. Boyd, D. Herschlag, and S. Doniach, [J. Mol. Biol. 365,1393 \(2007\)](#).

## DNA Scattering and Simulation

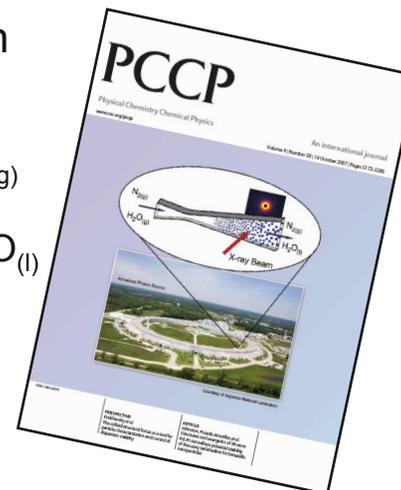


Zuo, X.; Cui, G.; Merz, K. M., Jr.; Zhang, L.; Lewis, F. D.; Tiede, D. M.. [PNAS \(2006\), 103\(10\), 3534-3539](#)

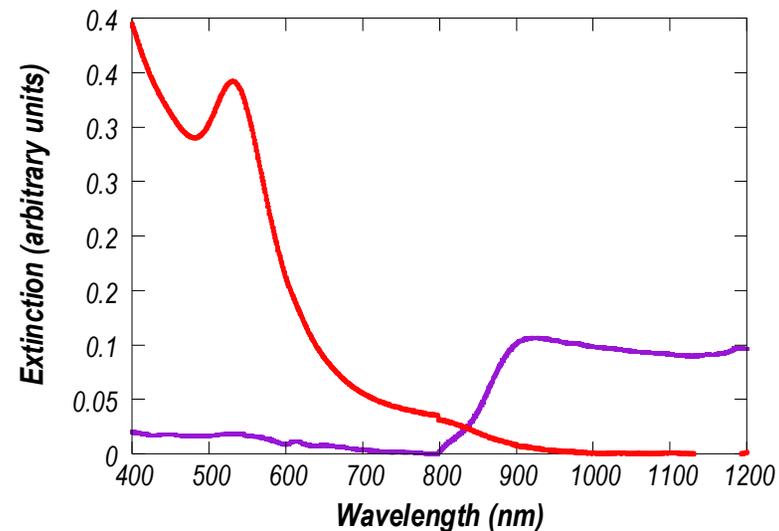
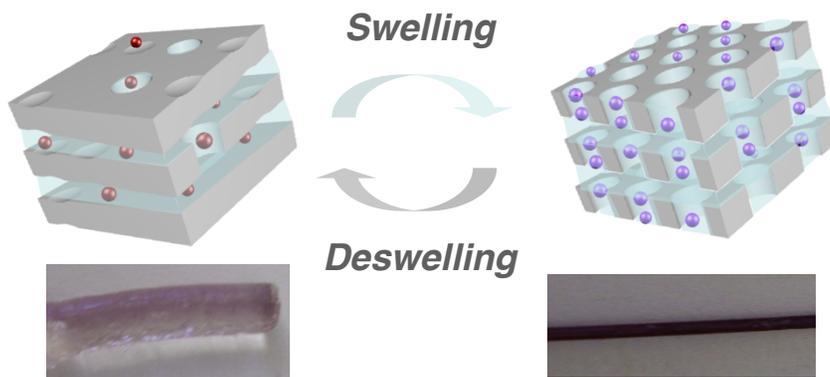
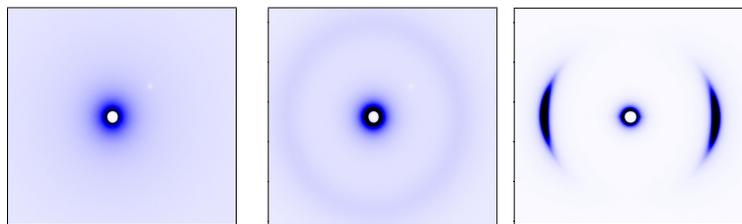
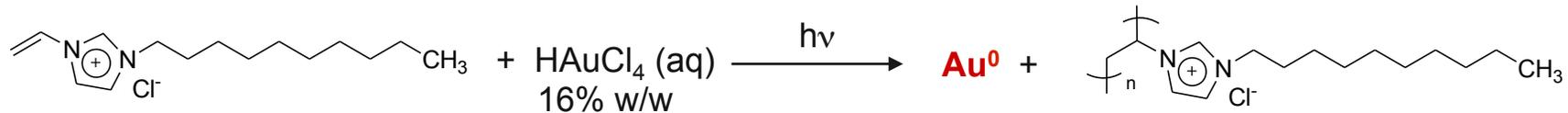
## Probing Water Nanodroplet Evolution



B.E. Wyslouzil, G. Wilemski, R. Strey, S. Seifert, R. E. Winans, [Phys. Chem. Chem. Phys. 9 \(39\), 5353-5358 \(2007\)](#).



## SAXS is used to monitor structure of gold nanoparticle – polymer composites



matrix assisted plasmonic tuning

- concomitant Au nanoparticle and polymer synthesis yielding a robust composite
- Polymerized ILs undergo reversible swelling in solvents – tunable nanostructure

## Sector 12 experimental SAXS stations

	12-BMB	12-IDB	12-IDC
SAXS time	20 -30 %	100%	40%
methods	Fixed energy or Anomalous SAXS/ WAXS/GISAXS	Fixed energy SAXS/ WAXS/GISAXS	Fixed energy or Anomalous SAXS/ WAXS/GISAXS
Beamline handling	Change over time between SAXS and GISAXS (8 hours)	Fast change over from SAXS/WAXS and GISAXS (30 minutes)	Long time between SAXS or WAXS and GISAXS (8 hours)
Q-range	Q-resolution change within 2 hour by beam line personal 0.01 – 0.6 A <sup>-1</sup>	Q-resolution change within minutes by changing SAXS camera length automatically 0.003 – 2 A <sup>-1</sup>	Q-resolution change within 1 hour by beam line personal 0.001 – 2.5 A <sup>-1</sup>
Lab equipment Sample environment	Protein, RNA, Catalysis, gel, alloys, ceramics etc.	Protein, RNA, Catalysis, gel, alloys, ceramics etc.	Protein, RNA, Catalysis, gel, alloys, ceramics etc.
Sample handling, in-situ, ex-situ	Catalytic reactions, t,T,P,M,E dependency, flame reaction	Stop flow, Catalytic reactions, t,T,P,M,E dependency, flame reaction	Stop flow, Catalytic reactions, t,T,P,M,E dependency, flame reaction

## Summary

- Sector 12 is a flexible beam line which can accommodate a lot of different type of experiments.
- Beam line support with broad range of scientific interests
- Provides capabilities for challenging experiments, i.e. pink beam TRSAXS, TRASAXS, GISAXS, AGISAXS
- Provide rapid access
- Provide scientific support
- Adaptability for new experiments on the C station
- Build SAXS communities in non-traditional areas such as catalysis
- Enhance accessibility for new users