Australian Synchrotron
Turning bright ideas into brilliant outcomes

Mechanical Engineering at the Australian Synchrotron

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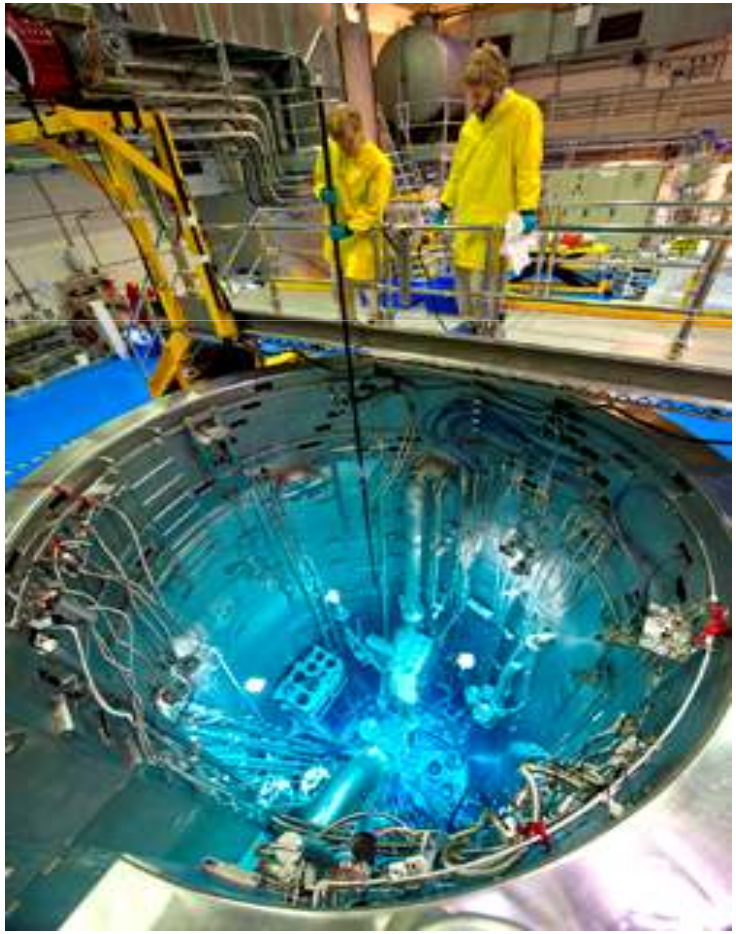
Supported by
Australian Government
State Government Victoria

AUSTRALIAN SYNCHROTRON

Overview

- Located in Melbourne's research and innovation precinct
- Officially opened in 2007
- 3 GeV storage ring, 216m
- 9 operational beamlines
- 3000 research visitors per year
- Currently expanding facility
- Expansion plans for beamlines

Associated Facility
ANSTO – Australian Nuclear Science and Technology Organisation



Opal reactor

- >1000 employees
- 20 MW research reactor
- 13 neutron beam instruments
- 10 MV Tandem accelerator
- 2 MV Tandetron accelerator
- Expansion plans for 2 new accelerators

Tandem ion accelerator

AUSTRALIAN SYNCHROTRON

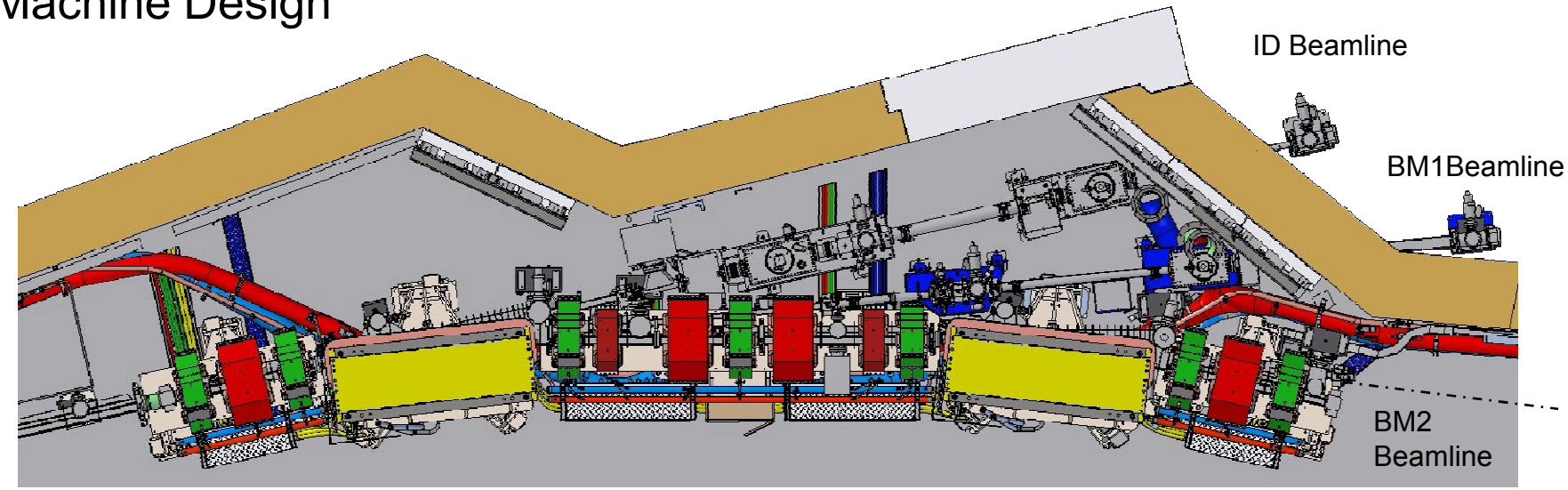
Machine Parameters

Linac	
Energy	100 MeV
Length	10 m
RF Frequency	3 GHz
Booster	
Energy	3 GeV
Circumference	130 m
RF Frequency	500 MHz

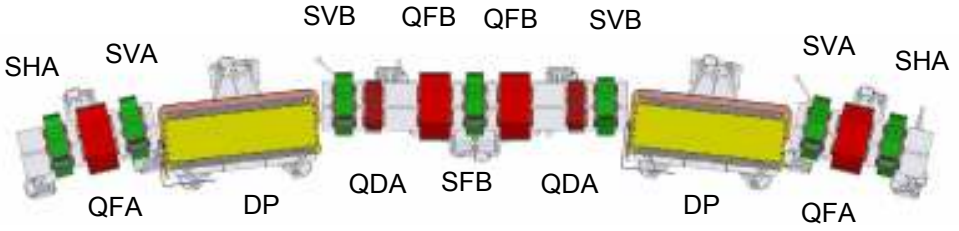
Storage Ring	
Energy	3 GeV
Current	200 mA
RF Frequency	500 MHz
Circumference	216 m
Sectors	14
Beamlines	9
Installed IDs	6

- Broke the world record for vertical beam emittance – 1.2 picometre radians
- First demonstration of emittance of a magnitude required for damping rings of colliders currently under development
- Developed new techniques in measurement of extremely low emittance resulting ongoing collaborations with CLIC and ILC
- Soon to be installed Superconducting Wiggler to produce the worlds largest synchrotron beam at an endstation

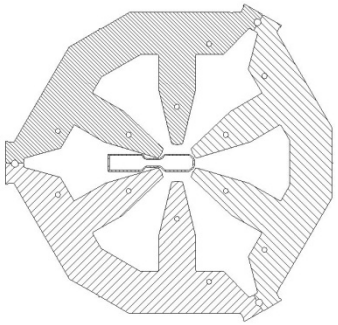
Machine Design



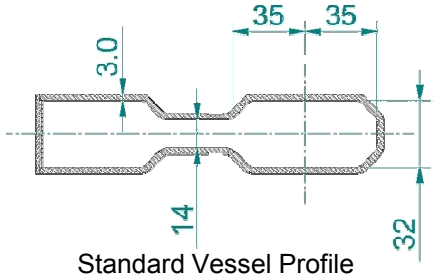
Energy	3.0 GeV	
Circumference	216 m	
Periodicity	14	
Number of straights	12	
Length of straights	5.397 m	
Current	200 mA	
Bend magnet field	1.300 T	
Critical energy	7.78 keV	
Betatron Tune – H	13.30	
Betatron Tune – V	5.20	
Dispersion (η)	0.0 m	0.24 m
Emittance	15.81 nm rad	6.98 nm rad
Beam size in straights (H,V)	389, 21 μm	340, 13 μm
Beam size in dipoles (H,V)	98,72 μm	77,48 μm



Machine Design - Vacuum



Typical Vessel v Magnet Section
(Localised machining for sextupoles)



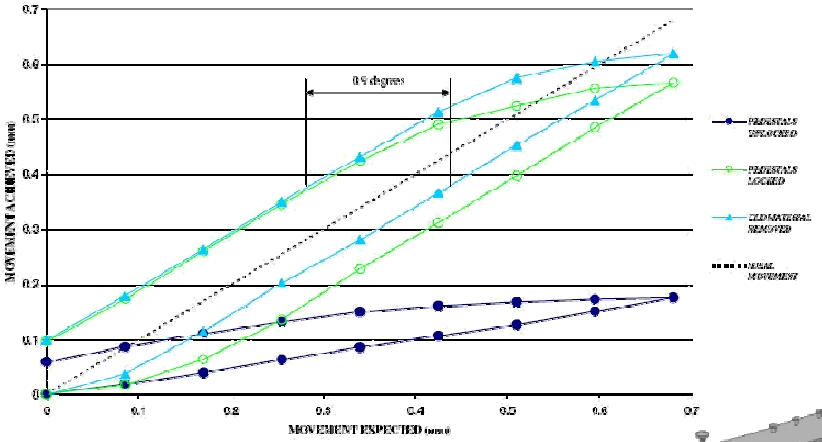
Standard Vessel Profile

Absorber Layout

- 3 mm Stainless Steel 316 LN
- Photon Absorption – Lumped
- Anti Chamber in all vessels but one
- Pumping – Ion pumps, NEG's
- Flanging – Vatseal and CF (would not recommend Vatseal in straight sections)

Machine Design – Girders and Pedestals

Hysteresis in Dipole Girder Movement (x)

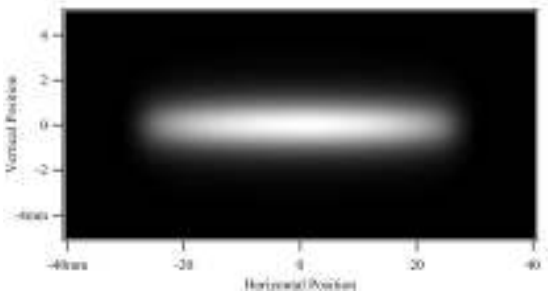


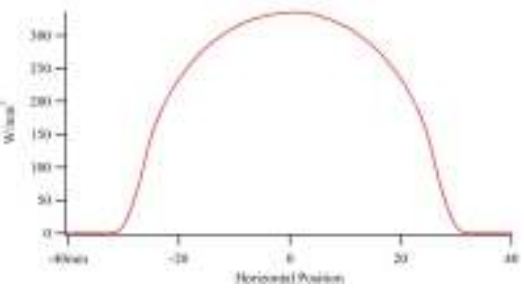
Data produced by J McKinlay

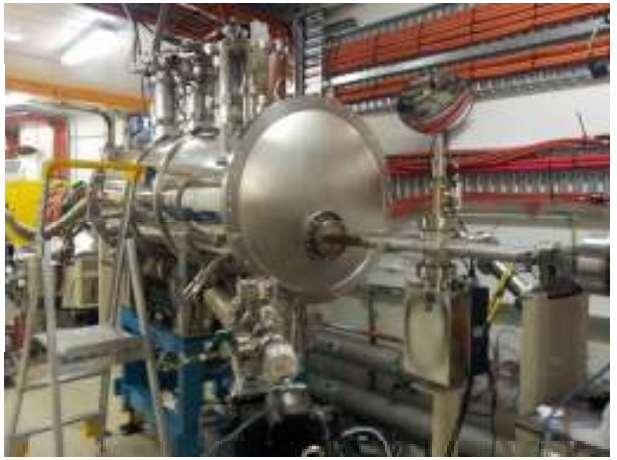
Wedges used to prevent shearing of CLD plates during adjustment

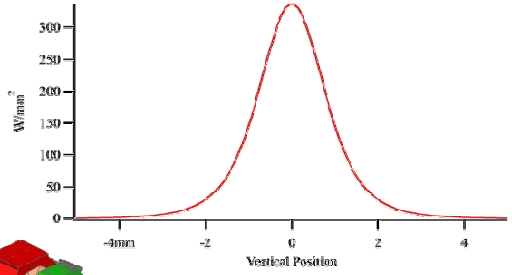
Adjuster configuration for each girder

Superconducting Wiggler









Photon Shutter
- Glidcop
- Inclined 1.5 deg
- 8.15 m from source

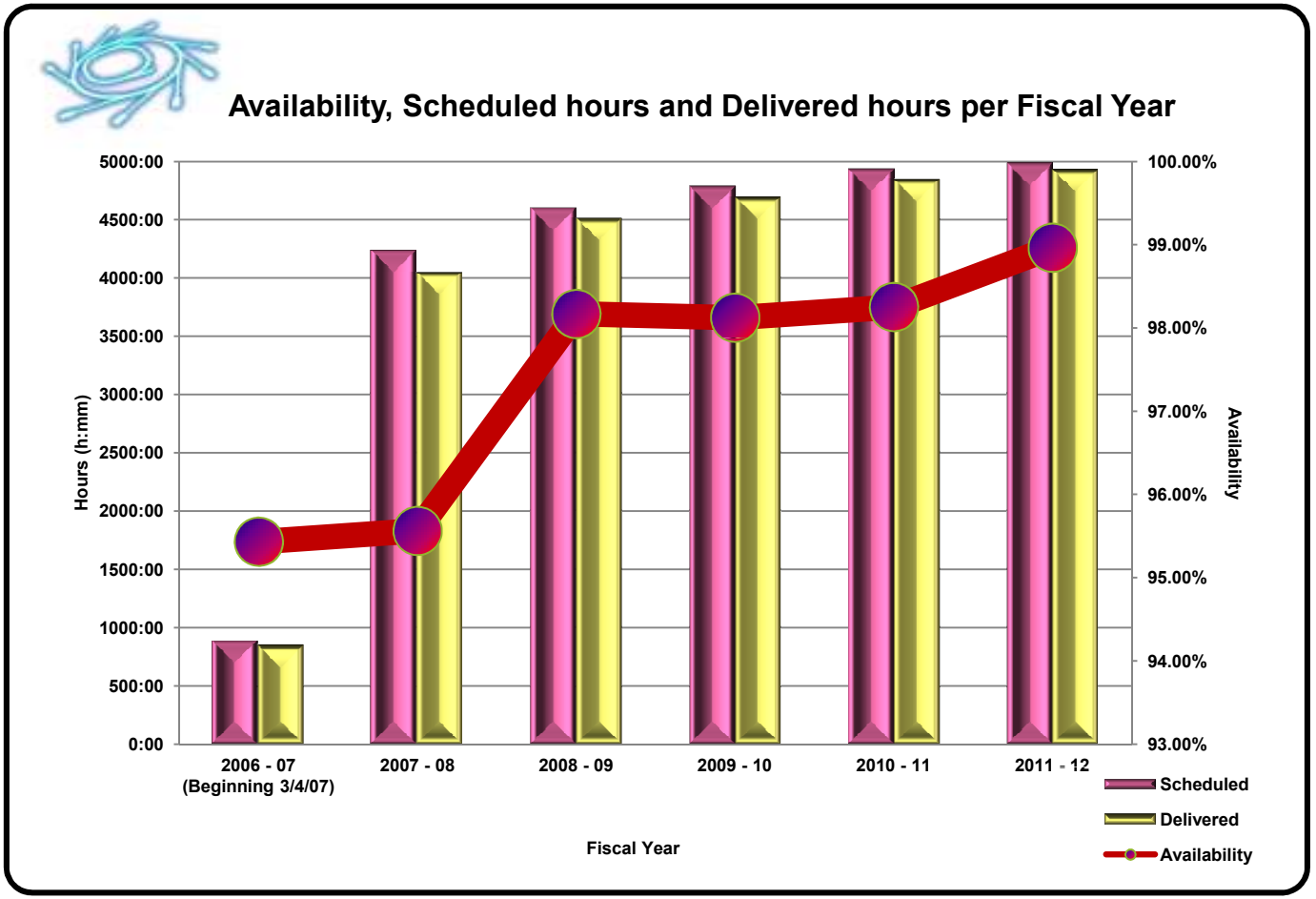
SCW Parameters	
Field	4.2 T
Period	52 mm
# Poles - Full Field	59
# Poles - 1/4 Field	2
# Poles - 3/4 Field	2
Apreture	10 x 80
Photon Power	31.3 kW

Machine Reliability

Rolling 16 week performance

Reliability	
Avaliability	99.13%
MTBF	112:50 hrs
MDT	0:58 hrs
Faults	14
Total DT	13.45 hrs

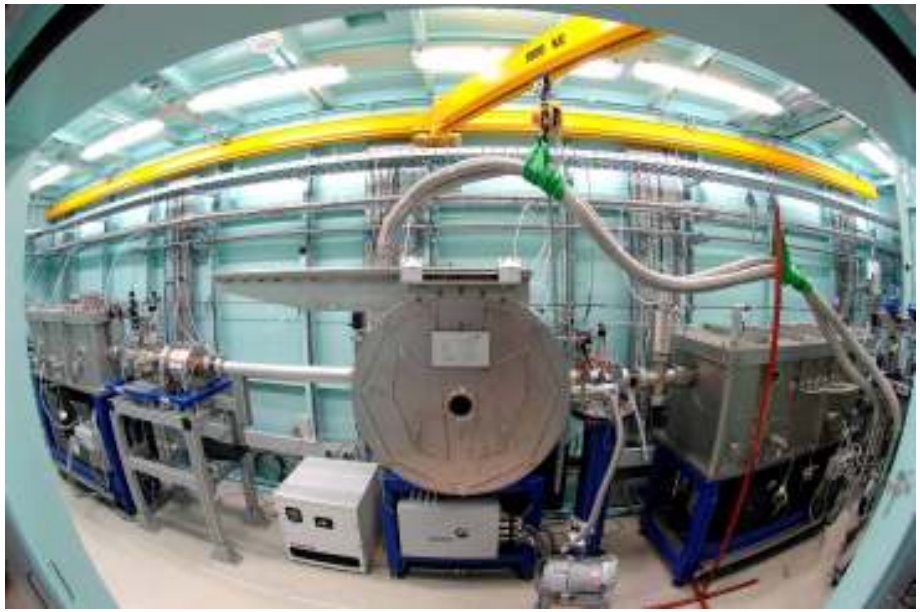
- Fault Breakdown
  - 5x Beamline
  - 4x Human Error
  - 2x RF
  - 2x Power Supplies
  - 1x Mains Power

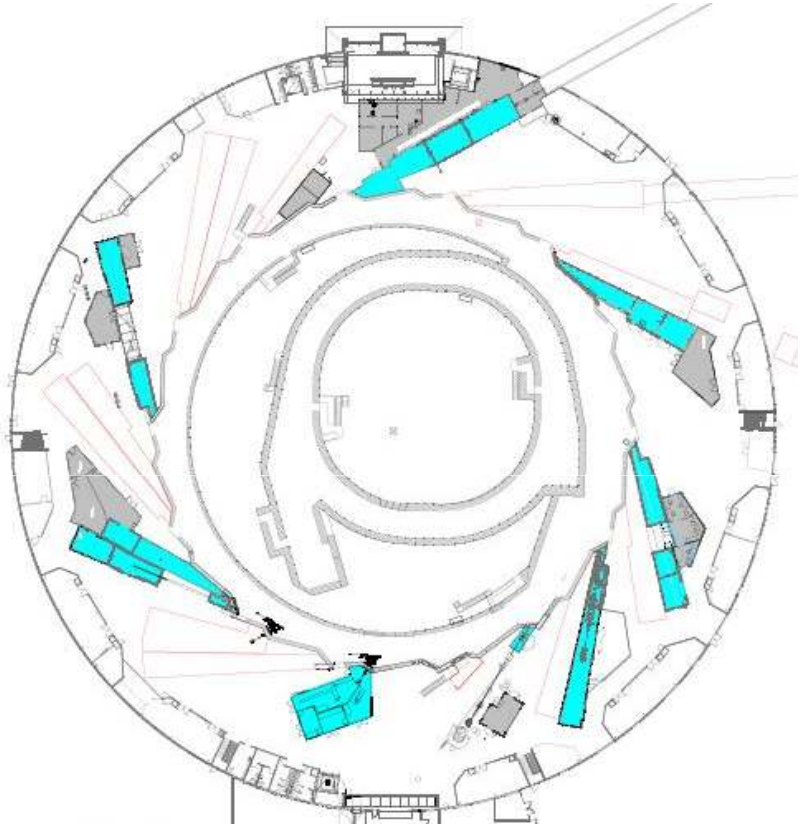


Beamlines

Nine beamlines currently operational

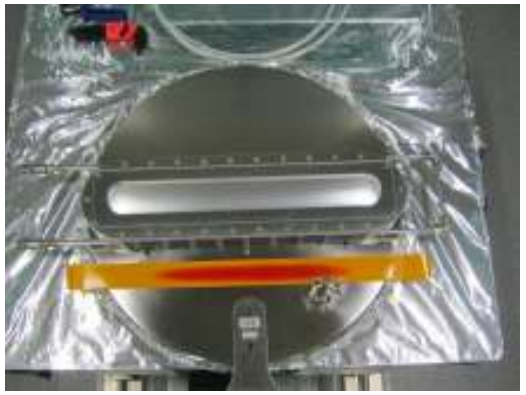
- MX1 - Macromolecular Crystallography
- MX2 - Micro Crystallography
- IR - Infrared Spectroscopy
- XFM - X-ray Fluorescence Microscopy
- IMBL - Imaging and Medical
- PD - Powder Diffraction
- SAXS/WAXS – Small Angle and Wide Angle X-ray Scattering
- SXR - Soft X-ray Spectroscopy
- XAS - X-ray Absorption Spectroscopy





IMBL Beamline

- First light in Satellite Building 18 Sep 2012
- Largest synchrotron beam at an endstation in the world
- Development of 500 x 80 cooled Be Window
- Design and construction of a vacuum vessel 105 m in length ranging in diameter from 250 – 600 mm with a volume of 21 m^3

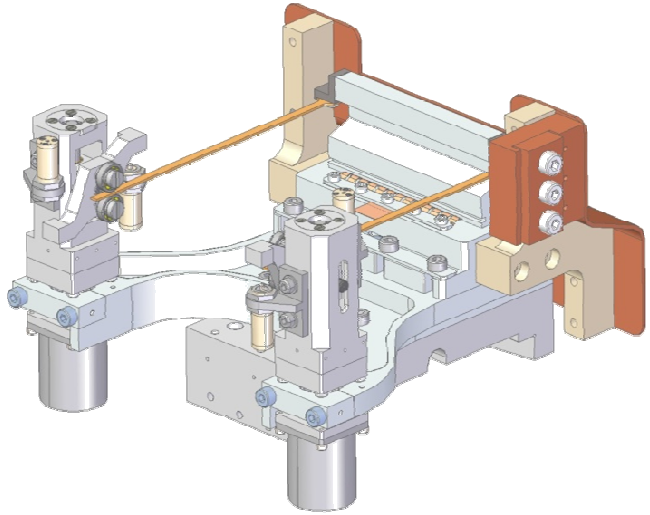


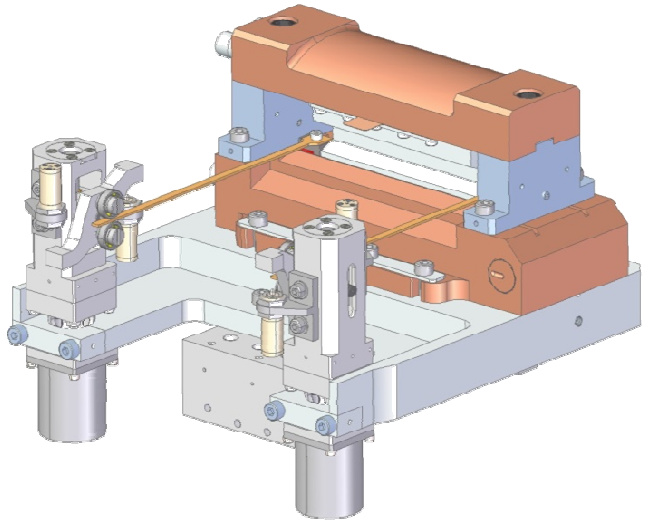
MRT Shutter Design

- Exposures down to 5ms +/- 10% (2 sigma).
- Typically not used for exposure times <100ms.
- Performance (in air) for exposures > 100ms, exposure time +/- 0.21ms (2 sigma) for exposures < 100ms, exposure time +/-0.41ms (2 sigma).
- Has completed several thousand exposures without problem.
- Electronics currently being redesigned to provide more flexible generic solution which can be used with other shutter designs under development.

Laue Crystal Bender – IMBL Monochromator

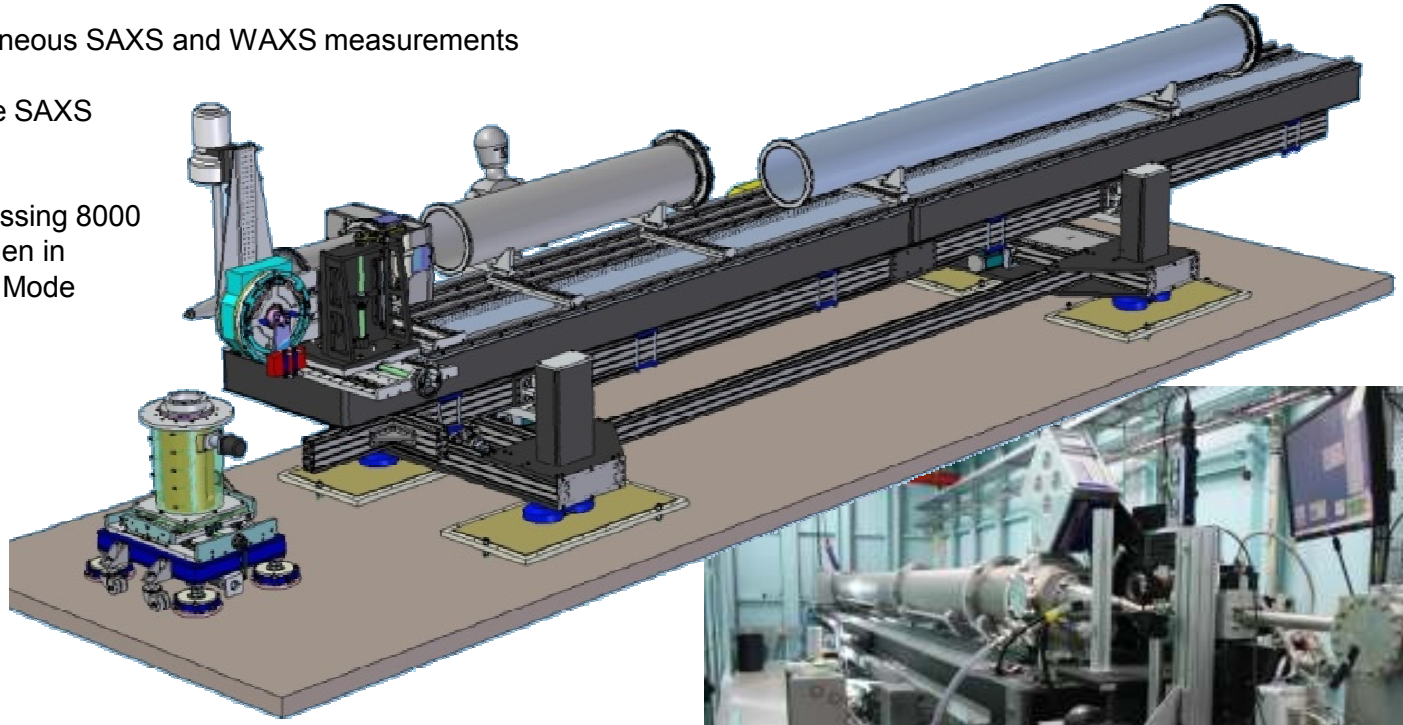
- Based on ESRF design by Pekka, Renier et al.
- Mounting, cooling and bender arms designed in-house
- Actuators and remainder of mono designed by IDT
- Crystals supplied by ESRF
- Crystal bending resolution = 0.016 arc seconds
- Installed and operational since May 2012
- No experimental data available yet for image quality or stability





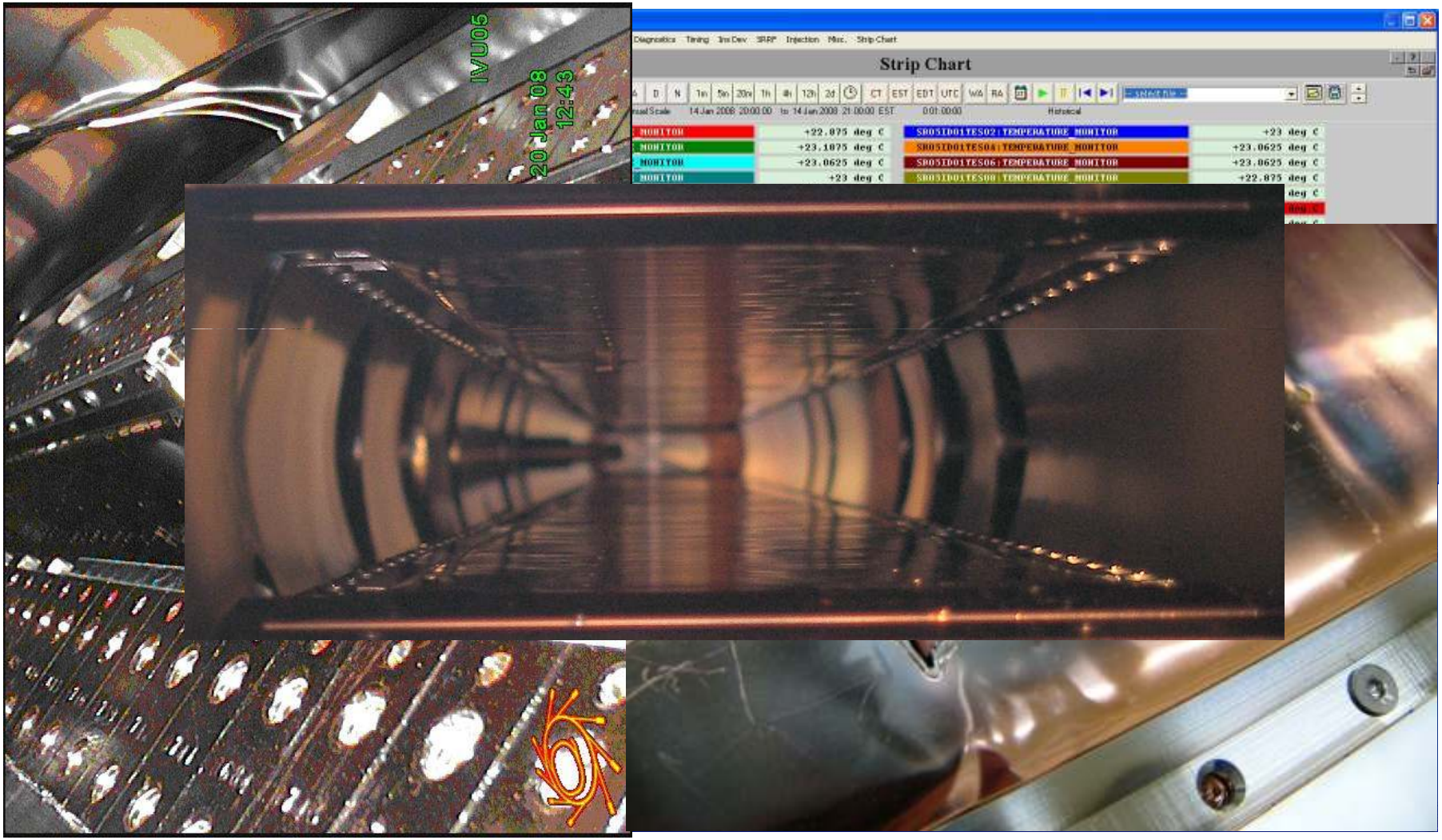
SAXS/WAXS Endstation

- Development of Small Angle and Wide Angle End Station for Scattering X-ray scattering techniques
- Ability for simultaneous SAXS and WAXS measurements
- User configurable SAXS camera length
- Capable of processing 8000 samples / day when in High Throughput Mode
- 500 protein samples / day



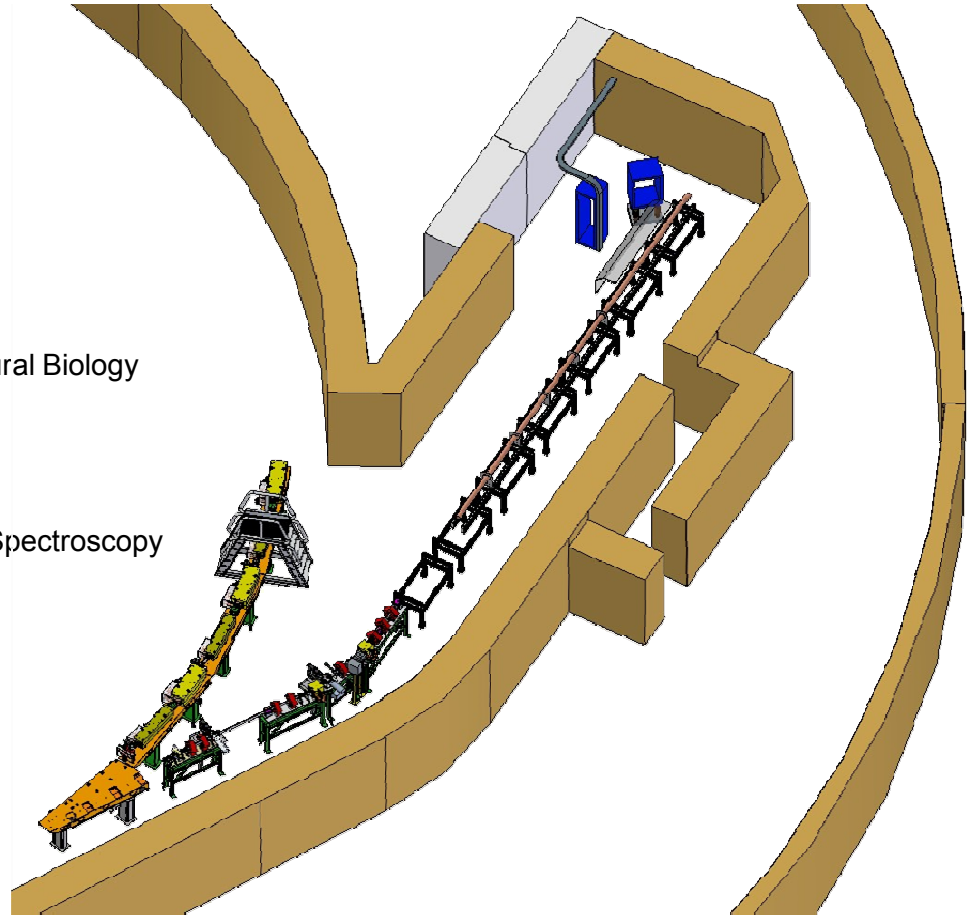
Cavity HOM Damper Failure

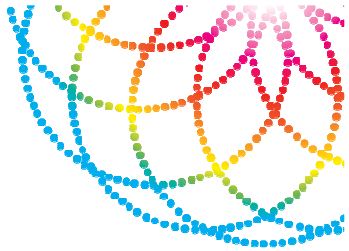
IVU Failure


IVU05
20 Jan 08
12:43
Strip Chart
MONITOR
+22.875 deg C
SR05ID01TES02:TEMPERATURE_MONITOR
+23 deg C
MONITOR
+23.1875 deg C
SR05ID01TES04:TEMPERATURE_MONITOR
+23.0625 deg C
MONITOR
+23.0625 deg C
SR05ID01TES06:TEMPERATURE_MONITOR
+23.0625 deg C
MONITOR
+23 deg C
SR05ID01TES00:TEMPERATURE_MONITOR
+22.875 deg C

The Future

- Accelerator Development Program
  - Electron Gun Test Stand
  - THz Radiation Source IR/VUV FEL
  - Diagnostic and Development Beamline
- Science Case II
  - 9 new beamlines
    - HCN – High Coherence Nanoprobe
    - ADS – Advanced Diffraction Scattering
    - MEX – Medium Energy XAS
    - BioSAXS – Small Angle Scattering – Structural Biology
    - AIR – Advanced Infrared Spectroscopy
    - MMC – Micro Materials Characterization
    - MCT - Micro Computed Tomography
    - CMB – Correlative Micro Spectroscopy
    - HMX – High Performance Macromolecular Spectroscopy





Thank You

Brad Mountford
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Jonathan McKinlay

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Hima Cherukuvada
Anatoly Kaganov