A TRIP TO DESY AND DIAMOND: BEAMLINE ENGINEERING LESSONS LEARNED

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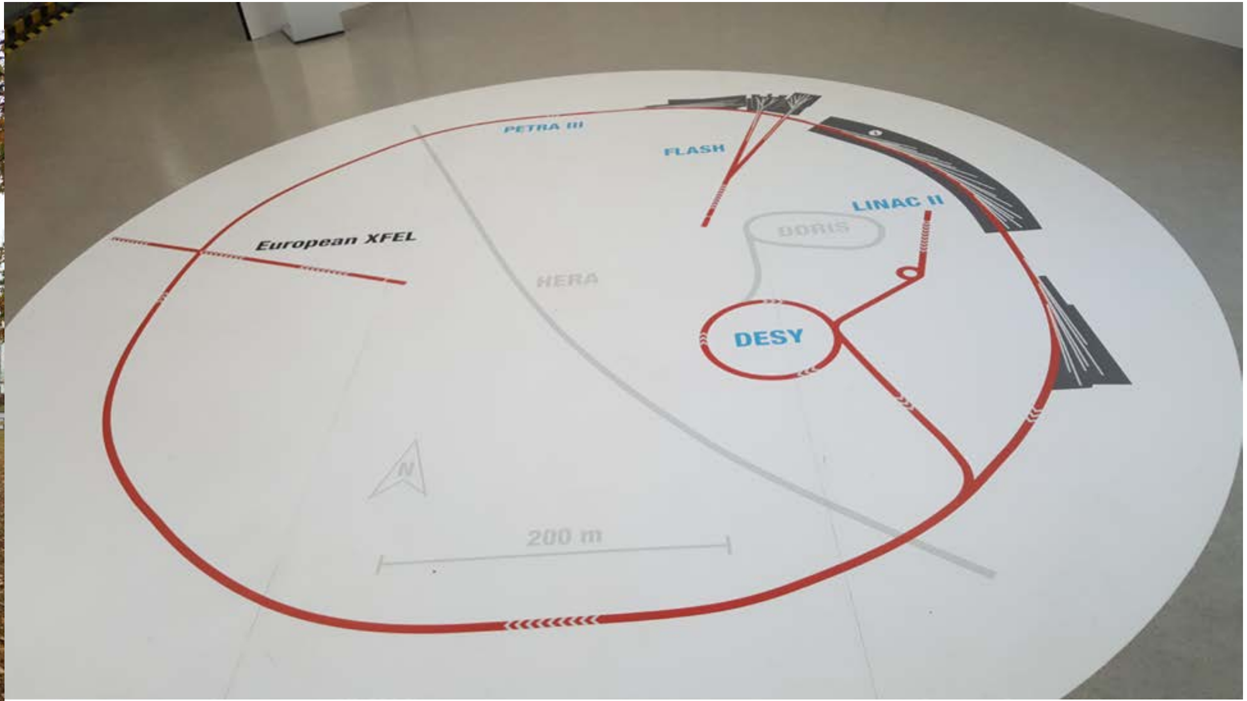
PETRA III AND FLASH II ONSITE



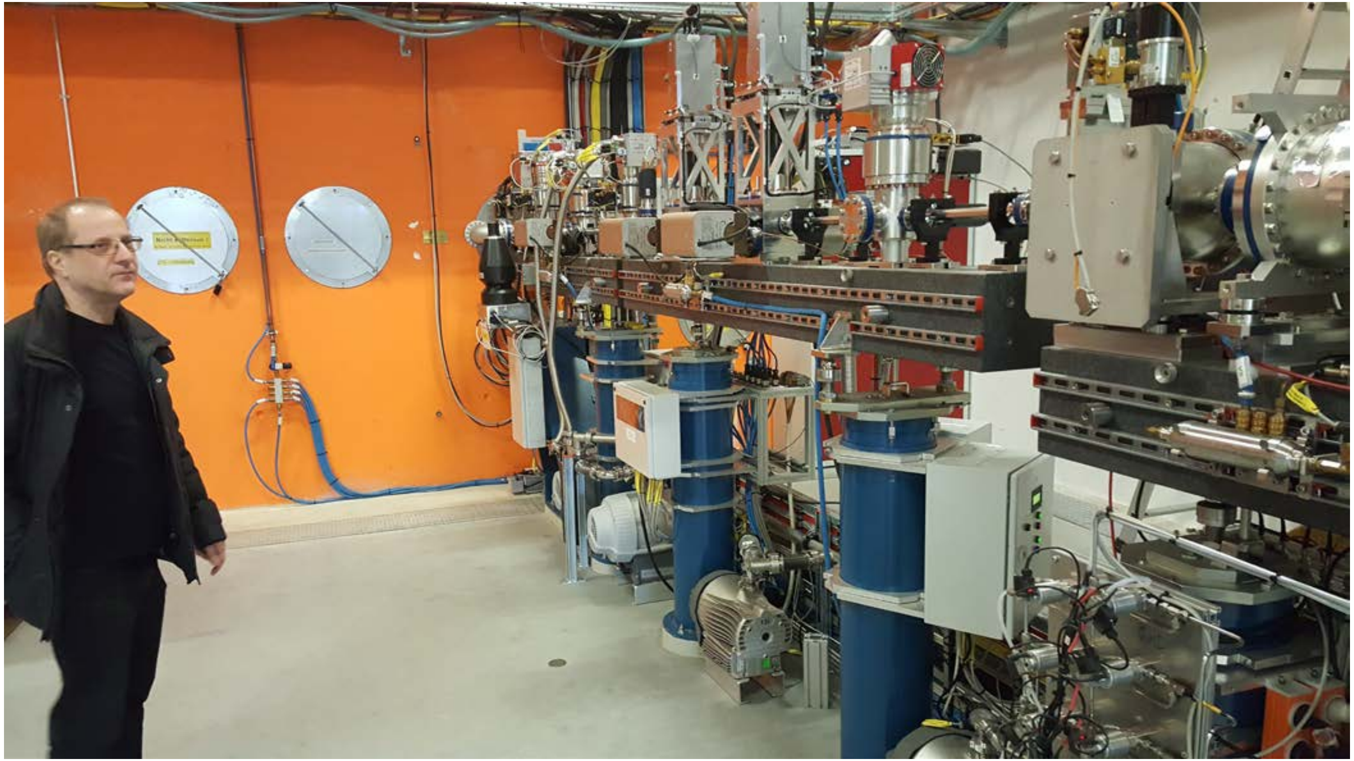
BEAMLINE FL 24 – FLASH II

Tour By:
Horst Schulte-Schrepping

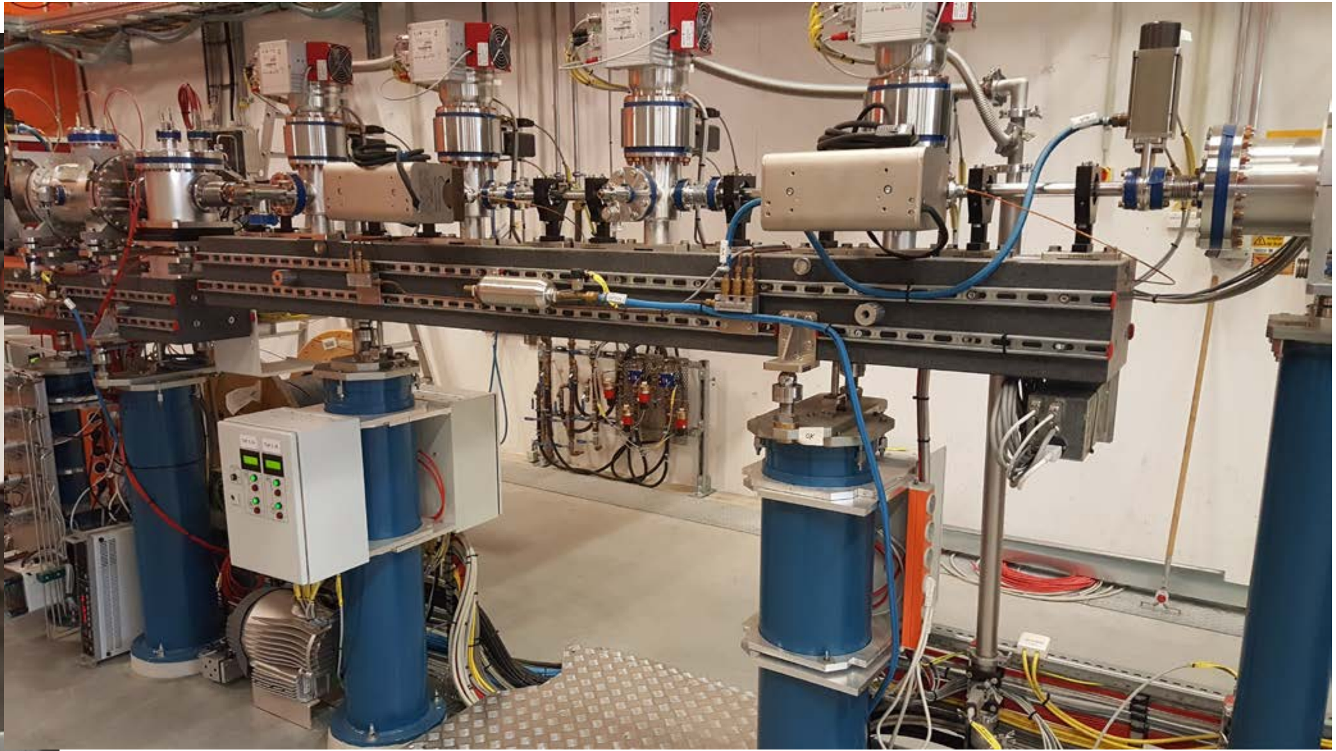
Head Beamline Technology

FL24 Beamline:

Photon beam Energy:
13.7 – 343 eV

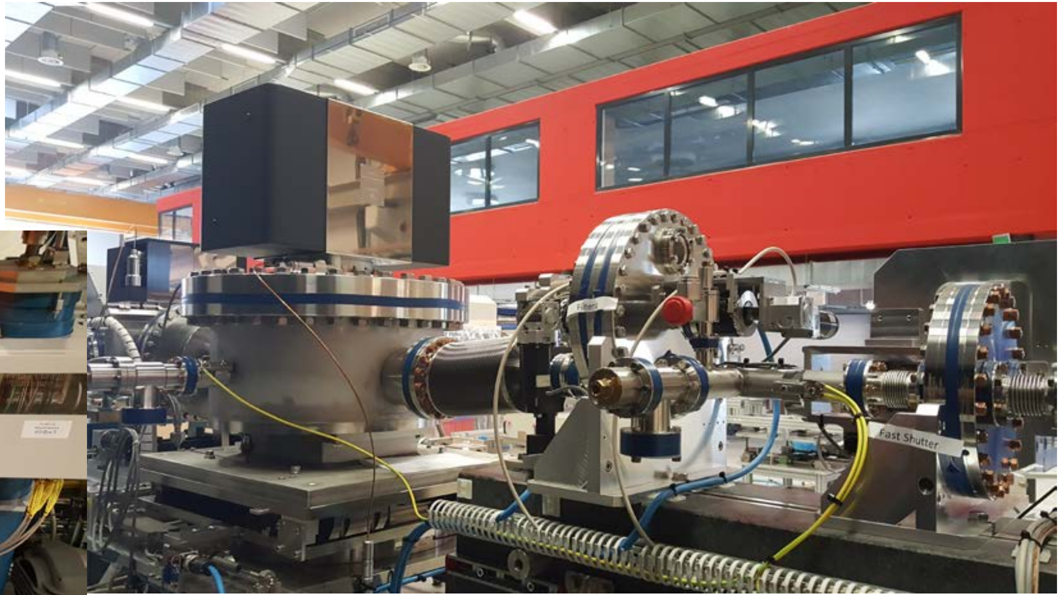


FLASH II MOUNTING MECHANICS

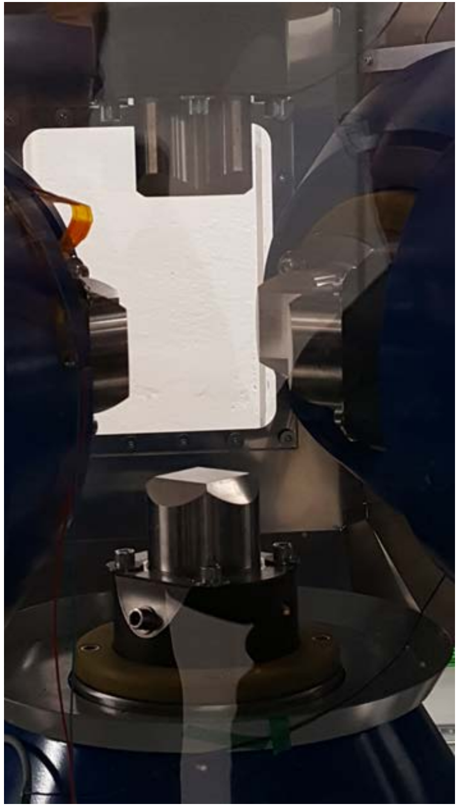


FLASH II – GRANITE MOUNTING

FLASH II – VACUUM PUMPS

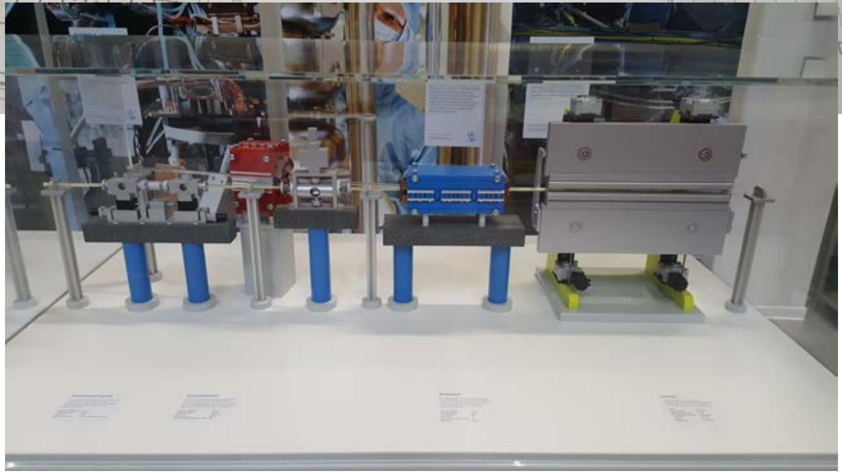


PETRA III NORTH HALL ENDSTATION



PETRA III AND P21 BEAMLINE

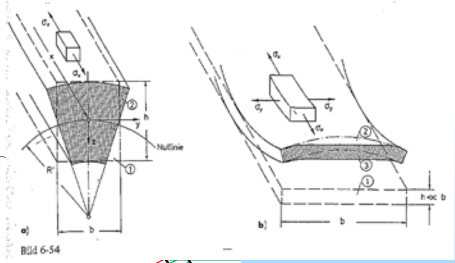
- Energy range 40-150 keV
- Swedish funded beamline studying materials science
- Designed for the combination of WAXS and SAXS

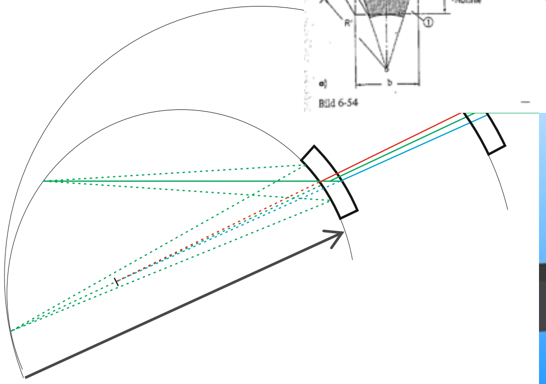


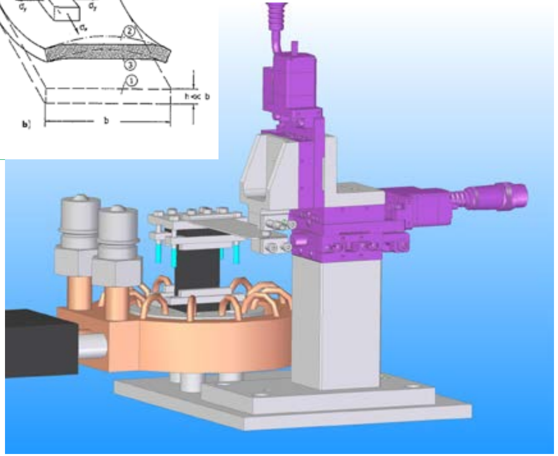
P21 BEAMLINE

Studied Bending of Mono Crystal

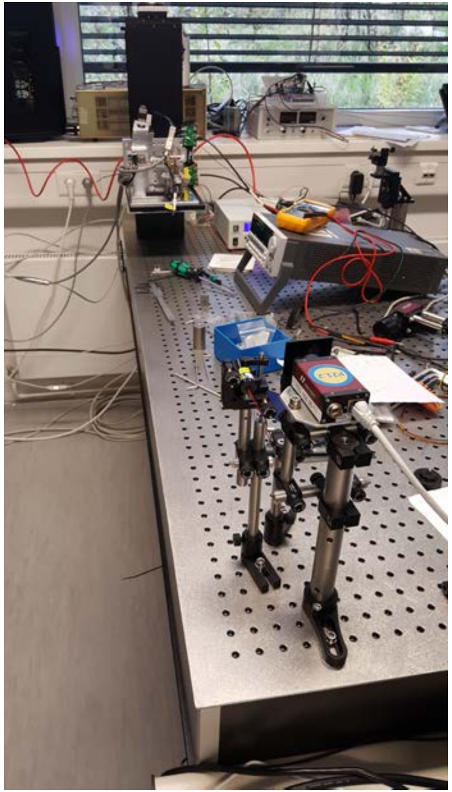
- Anisotropy of Si makes for unique properties when bent (anticlastic bending)
- Take advantage of anticlastic bending due to beam divergence

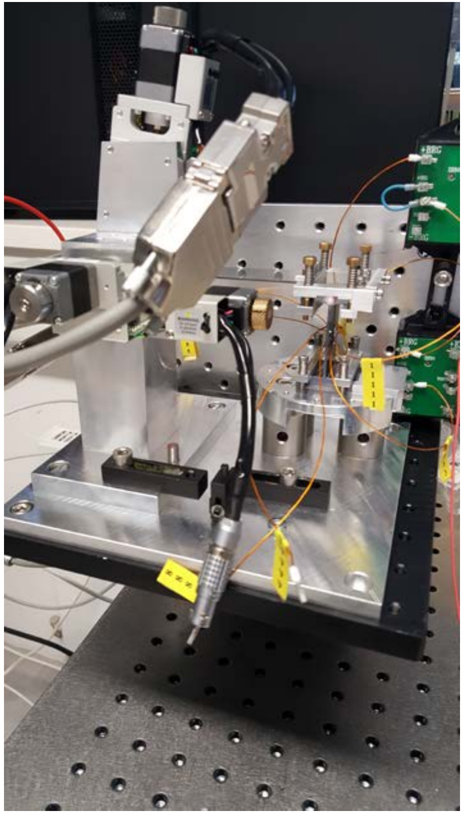


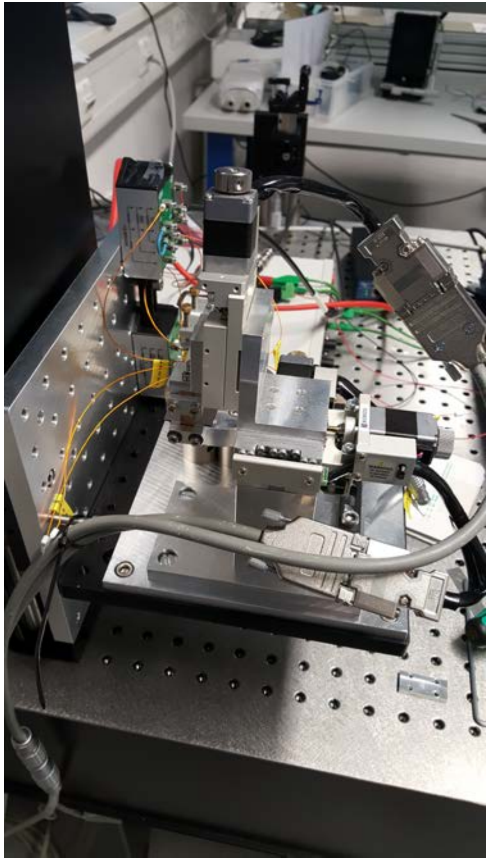




P21 – MONO CRYSTAL BENDING







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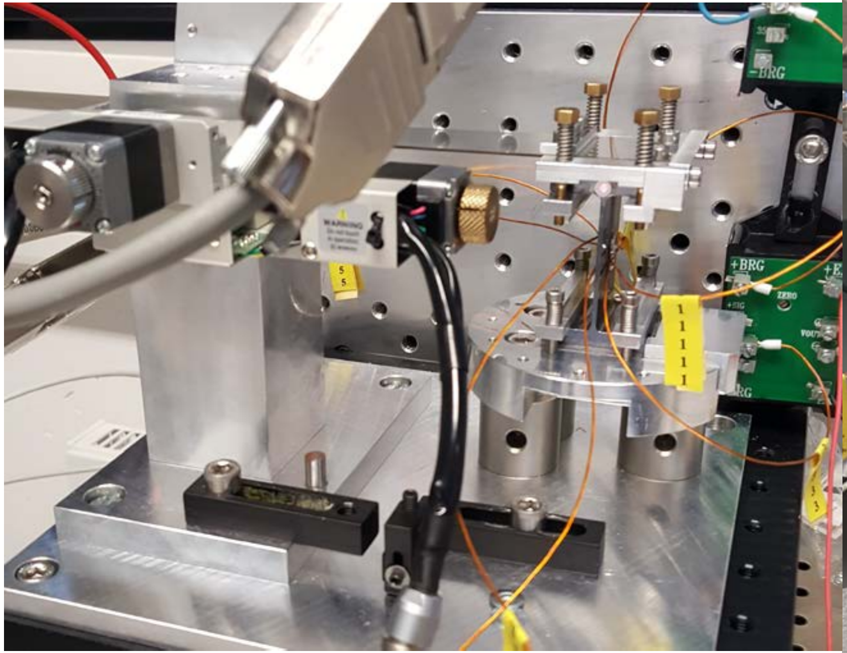

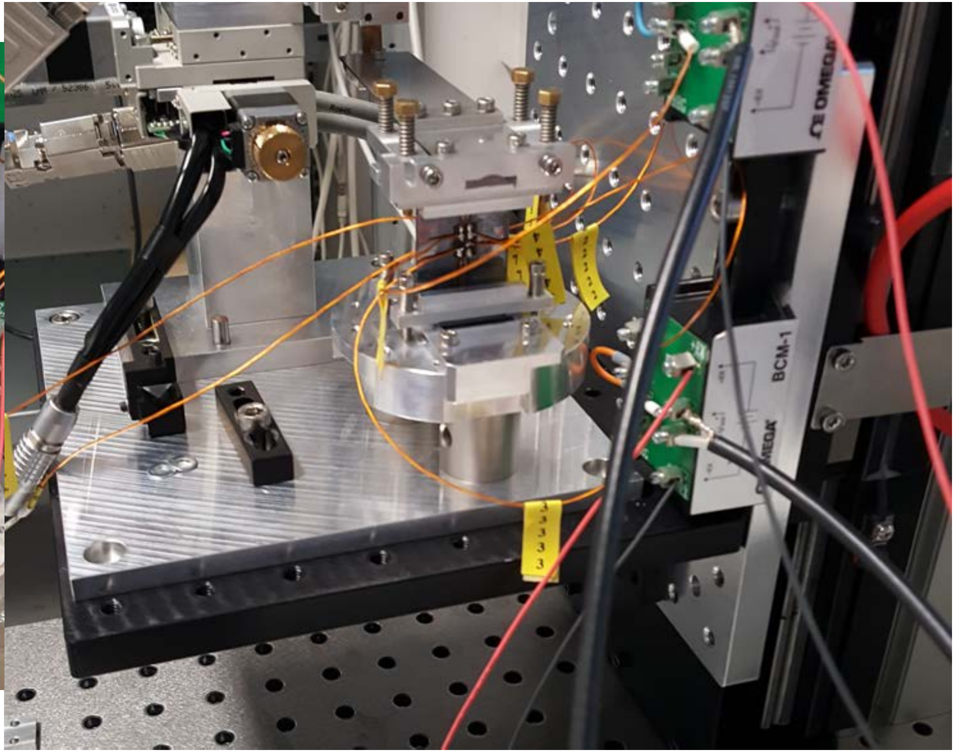

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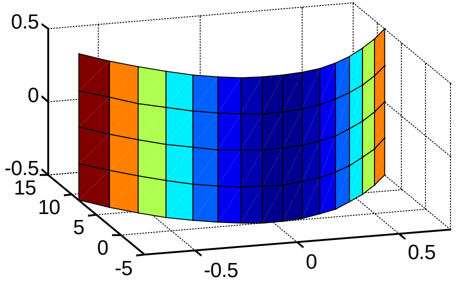
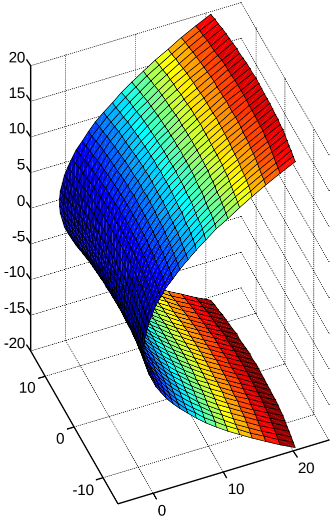
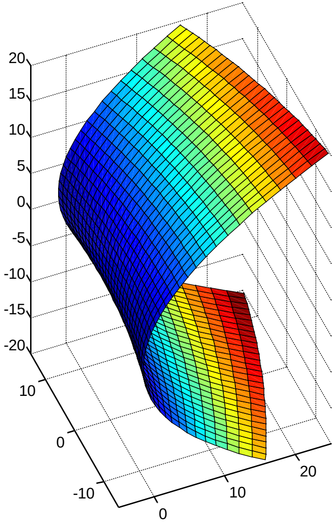
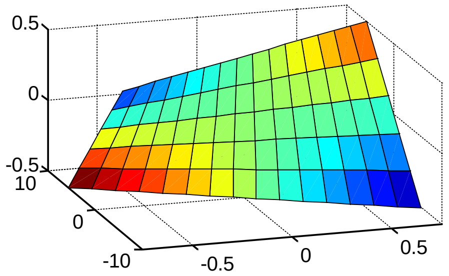








$$\begin{bmatrix} t/2R_{mer} \\ t/2R_{sag} \\ \varepsilon_z \\ 0 \\ \Delta\theta/2 \\ 0 \end{bmatrix} = \begin{bmatrix} 5.3 & -1.0 & -1.0 & 0 & 0 & 0 \\ -1.0 & 5.9 & -1.5 & 0 & -1.7 & 0 \\ -1.0 & -1.5 & 5.9 & 0 & 1.7 & 0 \\ 0 & 0 & 0 & 15 & 0 & -3.3 \\ 0 & -1.7 & 1.7 & 0 & 17 & 0 \\ 0 & 0 & 0 & -3.3 & 0 & 17 \end{bmatrix} \begin{bmatrix} \sigma_{mer} \\ \sigma_{sag} \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} t/2R_{mer} \\ t/2R_{sag} \\ \varepsilon_z \\ 0 \\ 0 \\ \varepsilon_{xy} \end{bmatrix} = \begin{bmatrix} 5.3 & -1.0 & -1.0 & 0 & 0 & 0 \\ -1.0 & 5.9 & -1.5 & 0 & 0 & -1.7 \\ -1.0 & -1.5 & 5.9 & 0 & 0 & 1.7 \\ 0 & 0 & 0 & 15 & 3.3 & 0 \\ 0 & 0 & 0 & 3.3 & 17 & 0 \\ 0 & -1.7 & 1.7 & 0 & 0 & 17 \end{bmatrix} \begin{bmatrix} \sigma_{mer} \\ \sigma_{sag} \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

DIAMOND LIGHT SOURCE

EARLY CAREER ENGINEERING CLASS

DIAMOND LIGHT SOURCE

EARLY CAREER ENGINEERING CLASS

- Diamond Light Source invites engineers from Light Sources around the world to attend a training school that address many of the technical issues that arise when designing, building and testing systems for Light Source facilities. The school is specifically aimed at engineers new to a career in Light Sources.

- Over the course of five days, attendees will cover topics such as how to define systems requirements, system design and integration, CE marking, the applications of 3D printing; as well as more specific technical issues such as vibration, heat transfer and thermal stability.

AGENDA

Early Career Engineering School Programme
12th – 16th November 2018

	Monday - 12th Nov	Tuesday- 13th Nov	Wednesday- 14th Nov	Thursday- 15th Nov	Friday - 16th Nov
09:00		An overview of synchrotron components, the electron from birth to death	Liquid cooling	Diagnostics and detectors (sizes, types, data rates)	Survey and alignment
10:00	Welcome and introduction Sessions	Mechanical design aspects of the storage ring and front ends	Cryo coolers	An overview of vacuum	Application of additive manufacture
11:00		Insertion devices for synchrotron light sources	Materials for synchrotron components	Fast feedback systems	CE Marking
12:00		Introduction to X-ray optics	Optical measurements	Thermal management – extracting power	Conclusion & feedback
13:00	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
14:00	Overview of experimental techniques	Tours & supplier exhibition	Optics modelling	Thermal and vibration stability – Analysis	
15:00	Determining system requirements		Precision mechanics (flexures, air bearings, special materials)	Thermal and vibration stability – Validation	
16:00	System integration and stakeholder identification		Cryogenics	Motion- selection of actuators and control.	
Evening	**Reception dinner and drinks**	**Dinner and free time**	**Dinner and free time**	**Workshop dinner**	

TOUR OF DIAMOND LIGHT SOURCE

TOUR OF DIAMOND LIGHT SOURCE

STORAGE RING ION PUMPS

TOUR OF DIAMOND LIGHT SOURCE

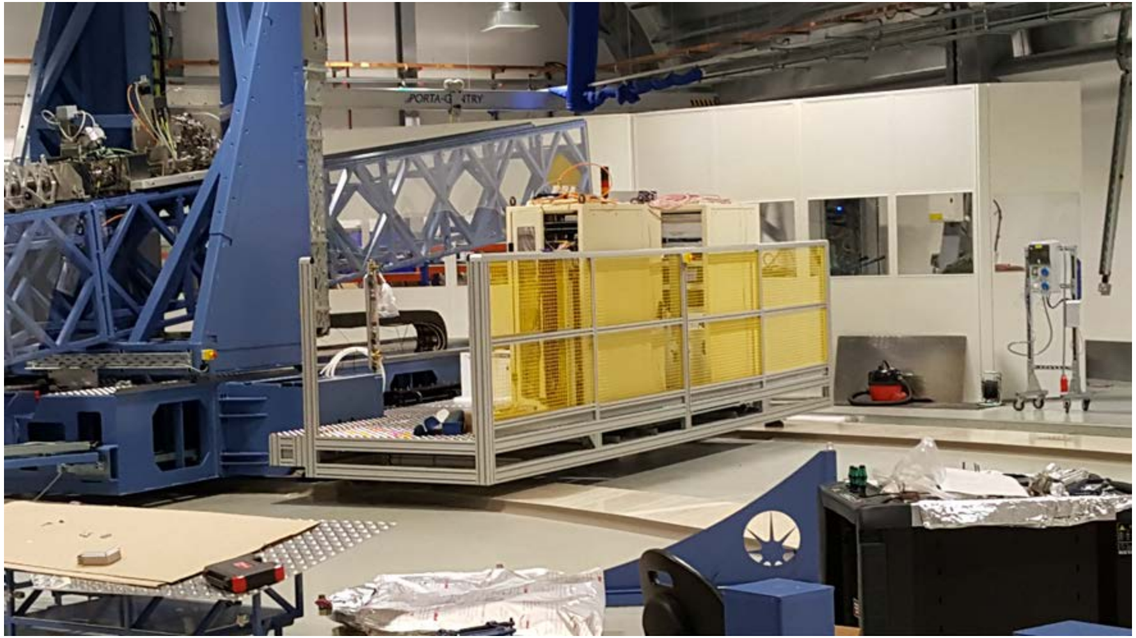
RIXS BEAMLINE

TOUR OF DIAMOND LIGHT SOURCE

RIXS BEAMLINE

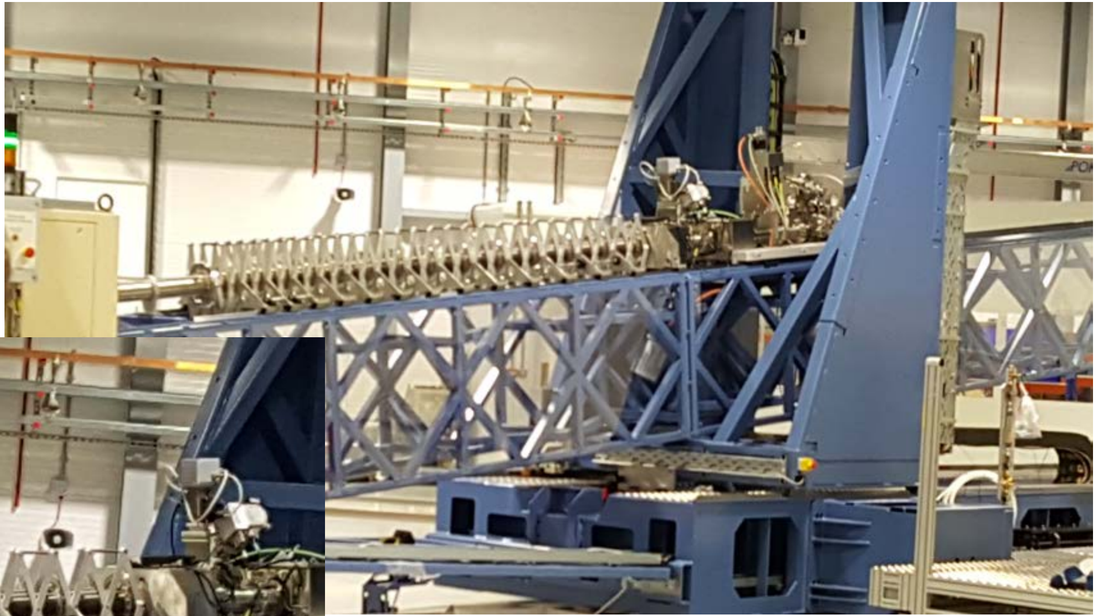
TOUR OF DIAMOND LIGHT SOURCE

RIXS BEAMLINE



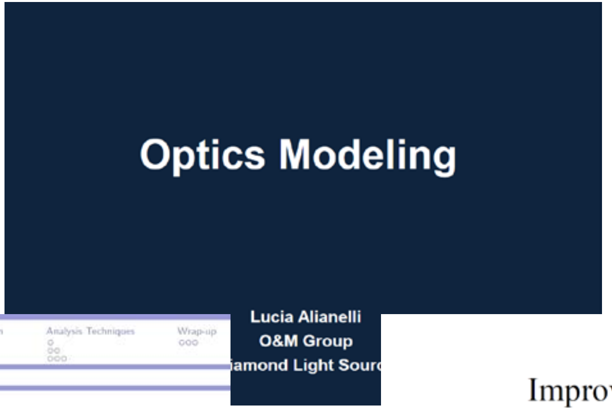
TOUR
RIXS BEAMLINE

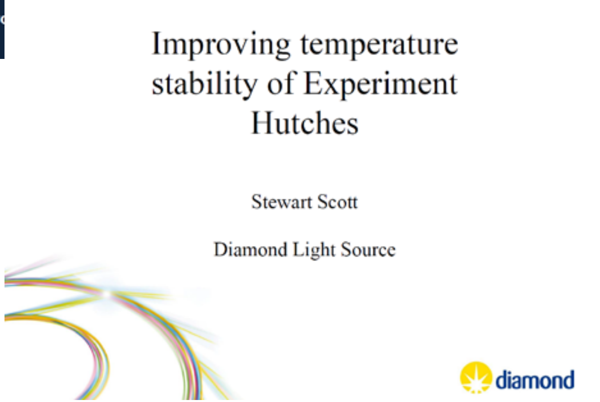
TOUR
RIXS BEAMLINE



BEAMLINE ENGINEERING TALKS

AVAILABLE ON BOX!





MEDSI TALK GIVEN AGAIN AT DIAMOND

Shining a Light on Synchrotron Light
Author: Sylvain Ravy (Laboratory for Solid State Physics LPS, Orsay)

"…we will present in a didactic way the essential properties of synchrotron light, and the basic physical phenomena underlying the interaction between synchrotron light and matter: scattering and absorption. The main classes of techniques that beamlines offer to the users community, namely diffusion-diffraction, spectroscopy and imaging, will then be presented. A special emphasis will be given to the huge increase of brilliance, and thus of coherence, that the new generation of synchrotrons have pledged to provide."

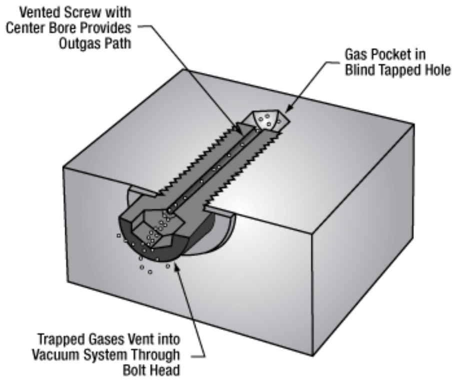
- Best explanation of diffraction-limited storage rings and classes of techniques
- Highly recommend reading the presentation:

BEAMLINE ENGINEERING RELATED TALKS

VACUUM VESSEL DESIGN – BEST PRACTICES

- Use Full Penetration welds whenever possible to reduce trapped volumes, provide corrosion resistence, and are stronger.
- All welding should be completed on the vacuum side to eliminate trapped volumes
- O-Ring grooves should be designed to provide 20% compression or greater

- If a trapped volume is unavoidable, a weep hole is preferred to a vented screw in most instances, with both used in tandem being even better.



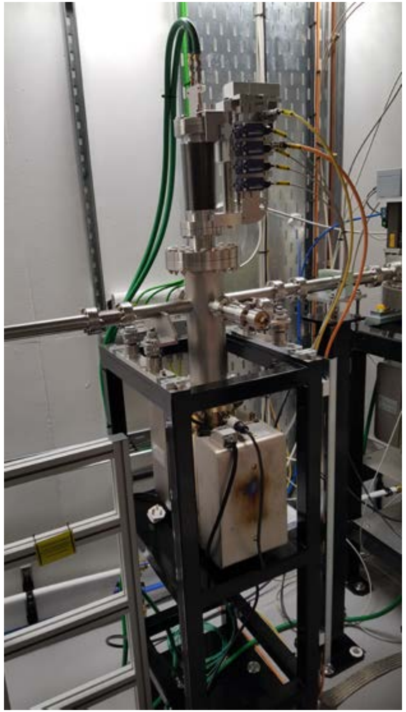
BEAMLINE ENGINEERING RELATED TALKS

ION PUMP PLACEMENT LOCATION – BEST PRACTICES

- Ion Pumps should be placed under optical vessels, crosses, splits, etc. whenever possible.

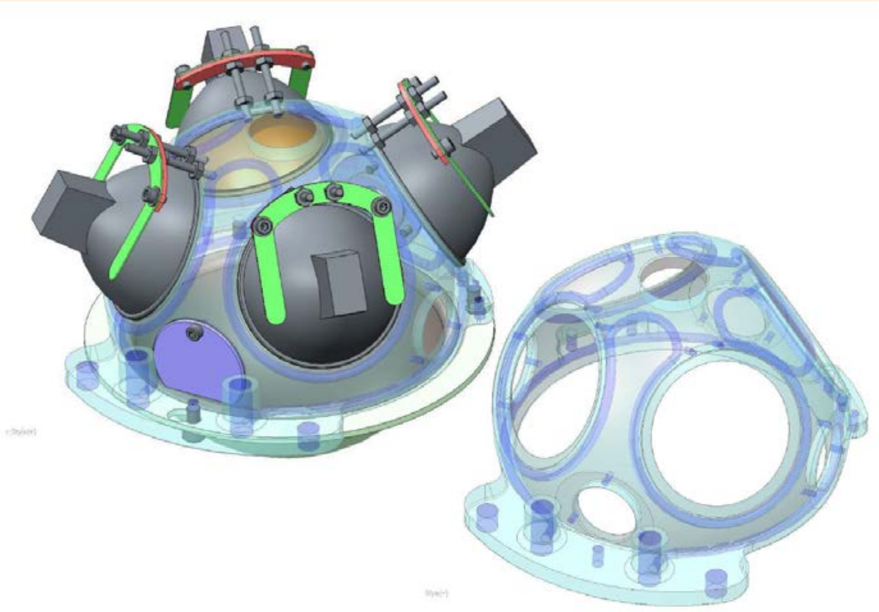
- When placing Ion pumps under optics its important to have a baffle plate to eliminate line of sight due to titanium sputtering.

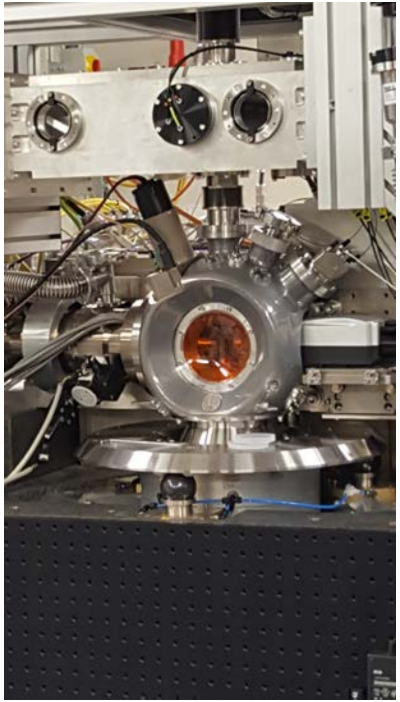
- In-line pumps, while provide better pumping, should only be placed in beamlines far away from optics



BEAMLINE ENGINEERING RELATED TALKS

ADDITIVE MANUFACTURING FOR SYNCHROTRON APPLICATIONS





BEAMLINE ENGINEERING RELATED TALKS

ADDITIVE MANUFACTURING FOR SYNCHROTRON APPLICATIONS

- Generate part geometry based on requirements
  - Light weighting
  - Improved thermal performance
  - Improved fluid flow

Source: ARUP

Heatsink with complex internal geometry – Source Plunkett

Source: Additive Manufacturing Magazine

BEAMLINE ENGINEERING RELATED TALKS

CRYOGENIC WIRING DESIGN – BEST PRACTICES

1. Select wires with durable insulation
2. Separate wires with sensitive signals from noise-ridden signals
3. All instruments must be grounded to one point only / grounded through one path.
4. d.c thermometer leads tightly twisted together in corresponding pairs (voltage leads together, current leads together) to minimise noise pickup. (important if you have strong magnetic fields)
5. Have connections / breaks in wires for individual parts for easy assembly / disassembly (Lemo connectors)
6. Secure any free floating wires
7. Ensure that there is greater than 20M Ω electrical isolation between wires and wires to chasis.
8. Use lead free solder and avoid active rosin flux or non-corrosive flux

BEAMLINE ENGINEERING RELATED TALKS

CRYOGENICS WIRING DESIGN – BEST PRACTICES

Fun facts!

1. What is the general practice for securing free-floating cryogenic wires?

Dental floss

Mono filament fishing wire

2. What is the general practice for protecting wires with weak insulation or providing insulation between wires and metal surface?

Cigarette paper on the wires or surface or both and paste with GE varnish (IMI 7031)

BEAMLINE ENGINEERING RELATED TALKS

PRECISION MECHANICS

Fourth generation synchrotrons have increasingly difficult stability and repeatability requirements. (See Tim Graber's Nanopositioning working group)

What does this mean for us as Engineers?

- A common definition of repeatability and stability for optical systems is that they should be no more than 10% of the 'light' beam or object of interest. i.e. the coincidence of the incident beam and the object of interest should be known, and should not change as a function of time, by more than 10% of the smallest dimension.
- Apply this to a beam size of, say, 300nm and we have a constraint (an error budget) of no more than 30nm. In fact, this constraint generally has to be shared between two components; the position of the beam and the position of the object.
- 30nm is the equivalent of 60-300atoms lined end to end.
- 30nm is the expansion of a 25mm long piece of Invar when its temperature changes by 1°C (or a piece of stainless steel 2.5mm long!).

BEAMLINE ENGINEERING RELATED TALKS

PRECISION MECHANICS

				Improvement factor for air
Bearing	Crossed rollers	Air		
Eccentricity	+/-3	+/-0.1	µm	30
Wobble	+/-25	+/-1.25	µrad	20
Flatness	+/-1	+/-0.05	µm	20
Bidirectional repeatability	+/-1.4	+/-0.7	µrad	2
Minimum incremental motion	1.4	0.35	µrad	4
Torque	0.5	0.7	Nm	1.4
Load capacity (axial)	200	200	N	1
Permissible lateral load	100	40	N	0.4

THE REST OF BEAMLINE ENGINEERING TALKS

- All presentations at the following link:

  https://anl.box.com/s/yi1dgw6aj4ih8xqocjjimtq20gn6ag2m

- Will send out an email with link attached

THANKS! QUESTIONS?