JRA NEUTRON OPTICS

New spectrometer designs implementing advanced optical components

JRA presentation

General Assembly

Villigen, CH

2009, March 31

PARTICIPANTS

- BNC Budapest Neutron Center
- DTU Danmarks Tekniske Universitet
- EPFL Ecole Polytechnique Fédérale de Lausanne
- HZB Helmholtz Zentrum Berlin
- ILL Institut Laue Langevin
- INFM Istituto Nazionale per la Fisica della Materia
- JCNS Jülich Center for Neutron Scattering
- LLB Laboratoire Léon Brillouin
- NPI Nuclear Physics Institute
- PSI Paul Scherrer Institute
- TUM Technischen Universität München
- UCPH University Copenhagen

Objectives

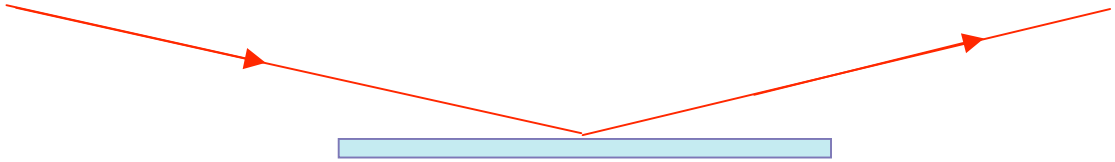
- Implement advanced optical components
- Develop new spectrometer designs

Working plan

- WP1: High flux reflectometry and energy analysis (F. Ott)
  - Task 1: Reflective Optics Energy Analyzer (F.Ott)
  - Task 2: Refraction-encoded reflectometry (K. Andersen)
  - Task 3: Wavelength-encoding by Bragg diffraction (K. Andersen)
- WP2: Advanced Focusing Techniques (K. Andersen)
  - Task 1: Multichannel focusing guide (K. Andersen)
  - Task 2: Adaptive Optics for extreme Environments (P. Böni)
  - Task 3: High resolution imaging using reflective optics (N. Kardjilov)
  - Task 4: Focussing SANS (S. Désert and H. Frielinghaus)
- WP3: Monte-Carlo simulations of complex optics (K. Lefmann)
  - Task 1: Modelling of interacting optical elements.
  - Task 2 : Optical simulation work bench

WP1: High flux specular reflectometry

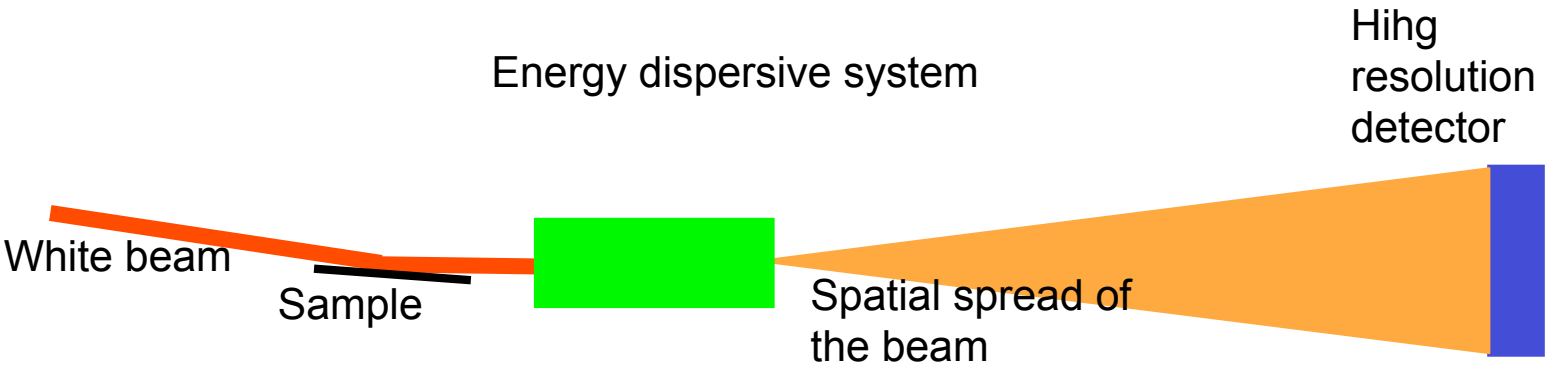
- *Objective:* gain in flux (1-2 orders of magnitude)
- *How:* use all the real space

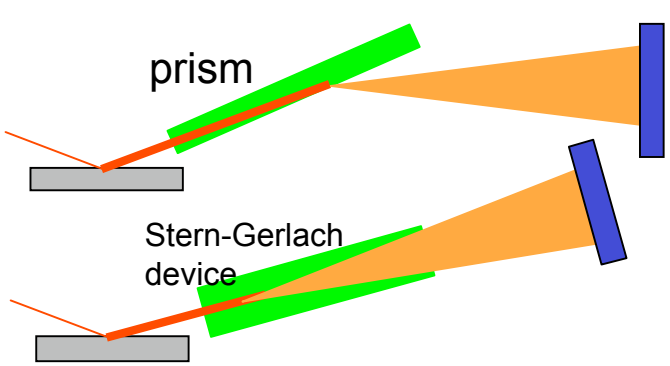


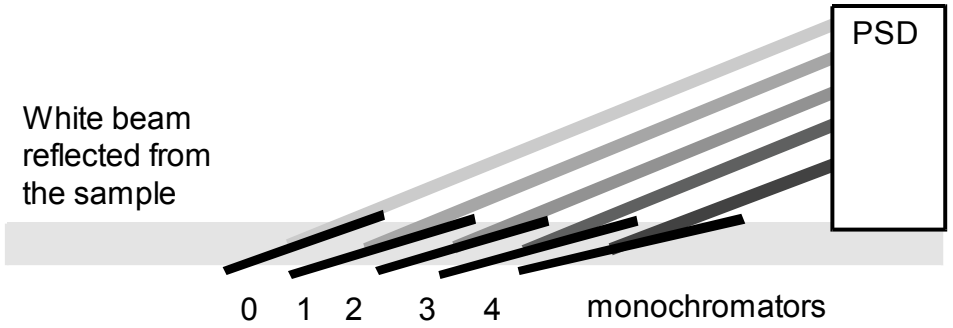
- *Possibilities:*
  - *spin – space encoding (SERGIS)*
  - *time – space encoding (TILTOF)*
  - *energy – space encoding (EASYREF, GRADTOF, REFOCUS)*

Energy – space encoding

- Energy analysis after the sample

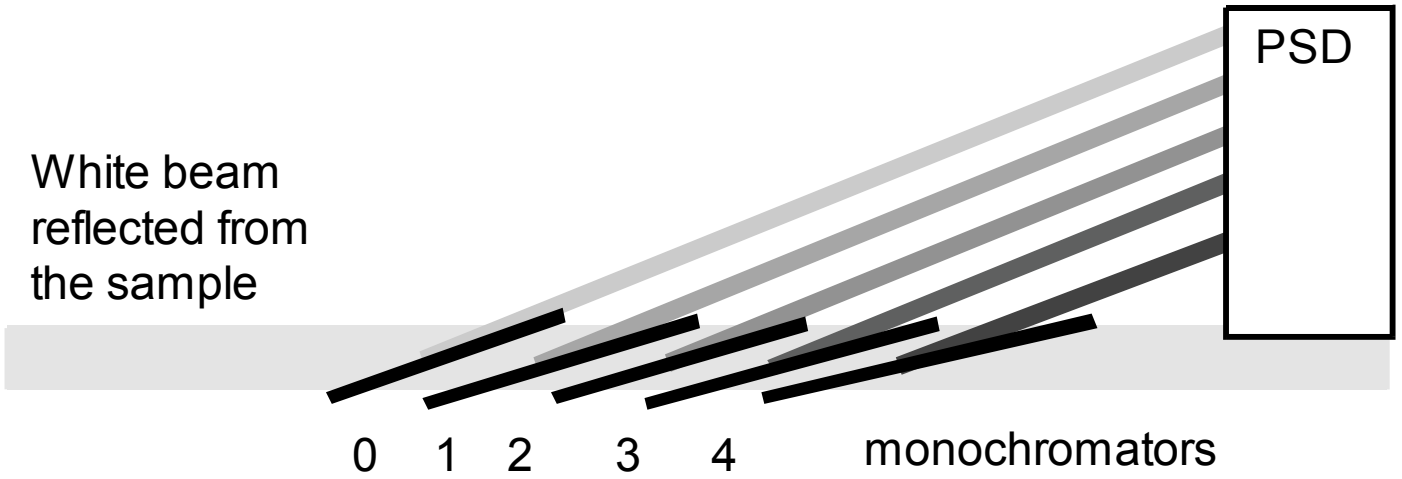






Task 1: EASYREF

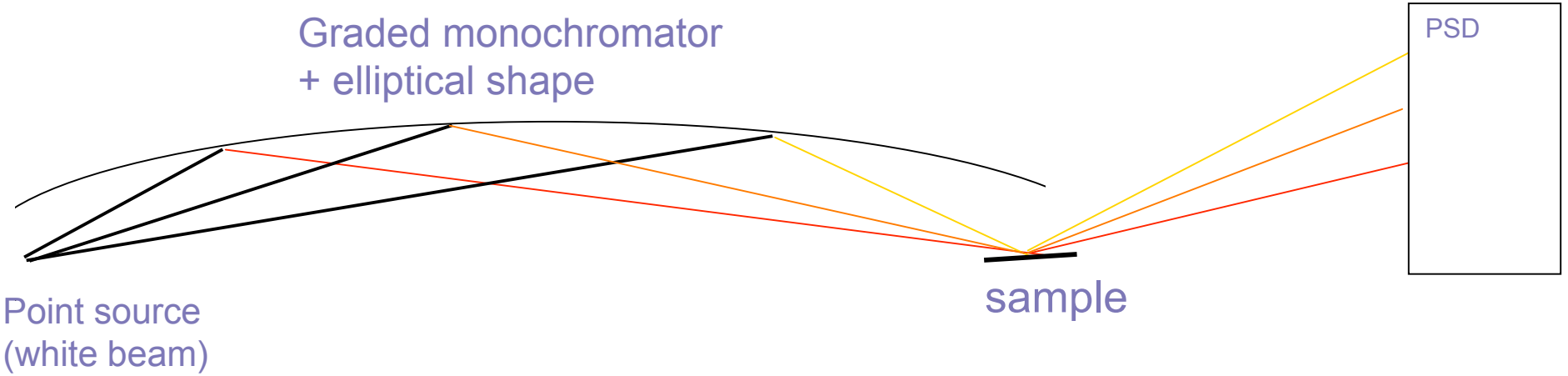
- F. Ott, NIM A **584** (2008) 401-405. EASYREF: Energy analysis system for reflectometers.



- Key technologies
  - High m, without harmonics ML monochromators (m>3) (PSI)
  - Complex assembly of mirrors (HMI)
  - Objective 1: limited bandwidth system (5 - 25A°) (year 1)

Task 1: REFOCUS

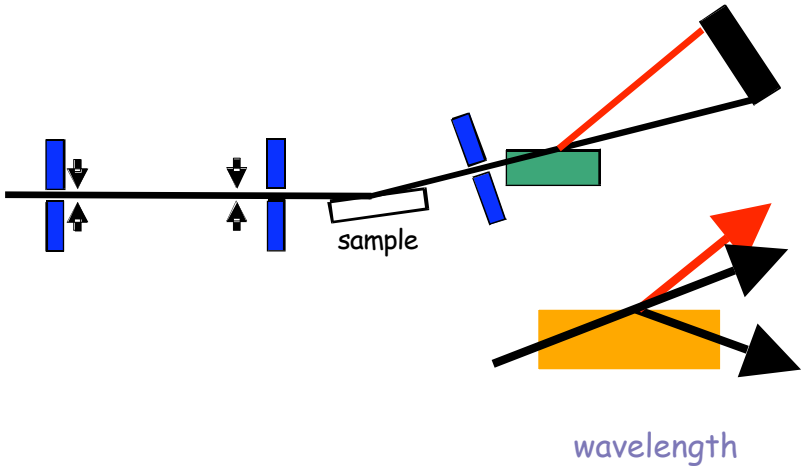
- Energy encoding before the sample

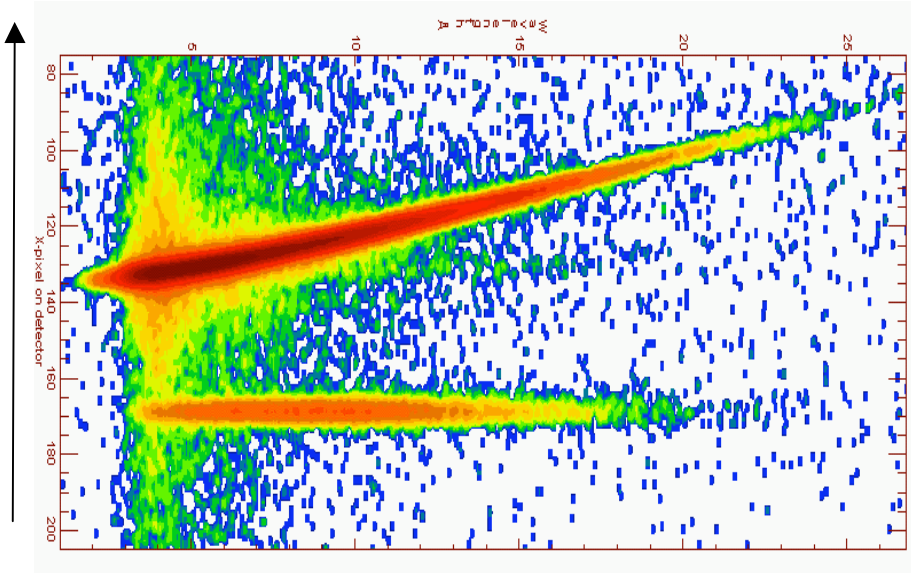


- F. Ott and A. Menelle, NIM A **586** (2008) 23–30.
- Key technologies
  - High m, without harmonics ML monochromators (m>3) (PSI)
  - Graded mirrors (PSI)
  - Elliptical curved mirror (TUM)
  - Objective 1: 2m long proof of principle setup with limited bandwidth system (5 - 25A°)

Task 2: Refraction encoding (R. Cubitt , ILL)

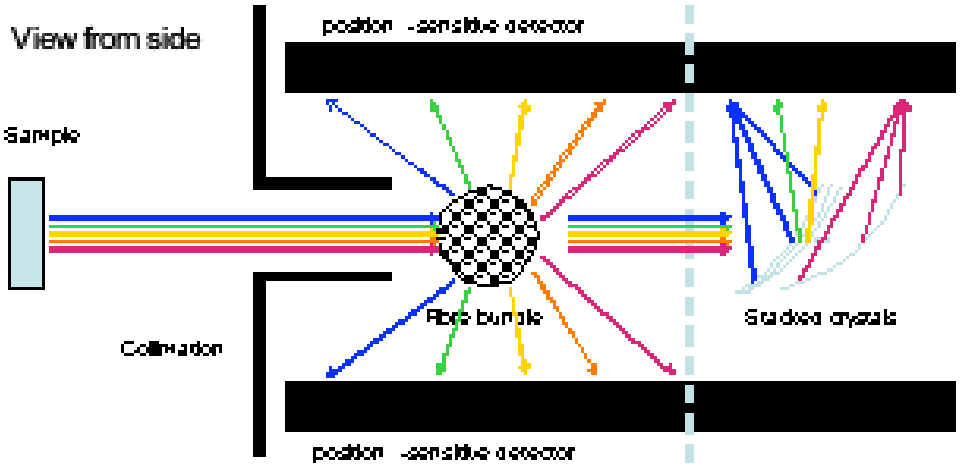
- R. Cubitt, NIM A **558**, 547 (2006).

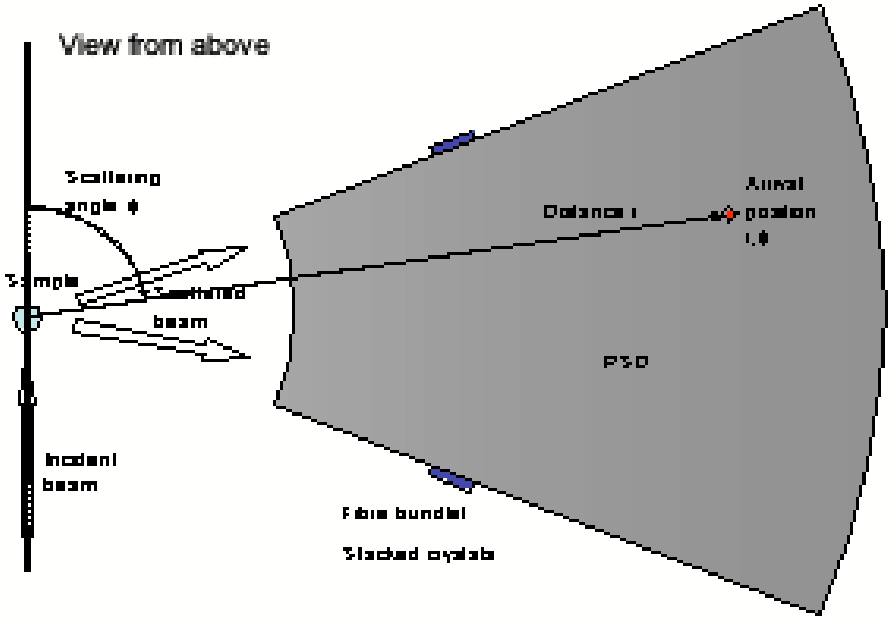




- Key technologies
  - High resolution detector (0.5mm)
  - Flat prism (ILL)
  - Multiple prism array (HMI)

Task 3 : Wavelength-encoding by Bragg diffraction

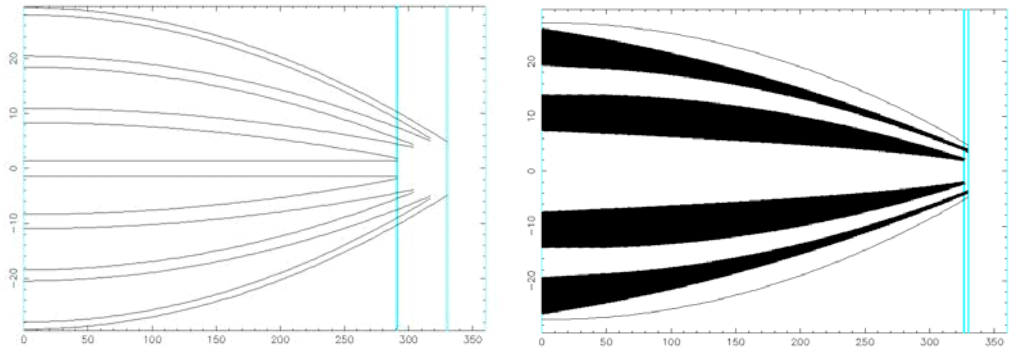


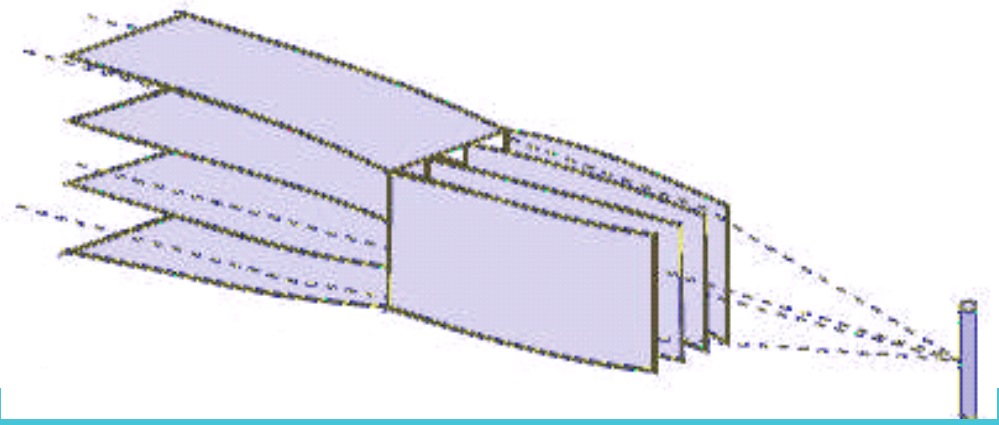


- Stacked-crystal energy analysers — Low risk
- Bundled-fibre energy analysis — Medium risk

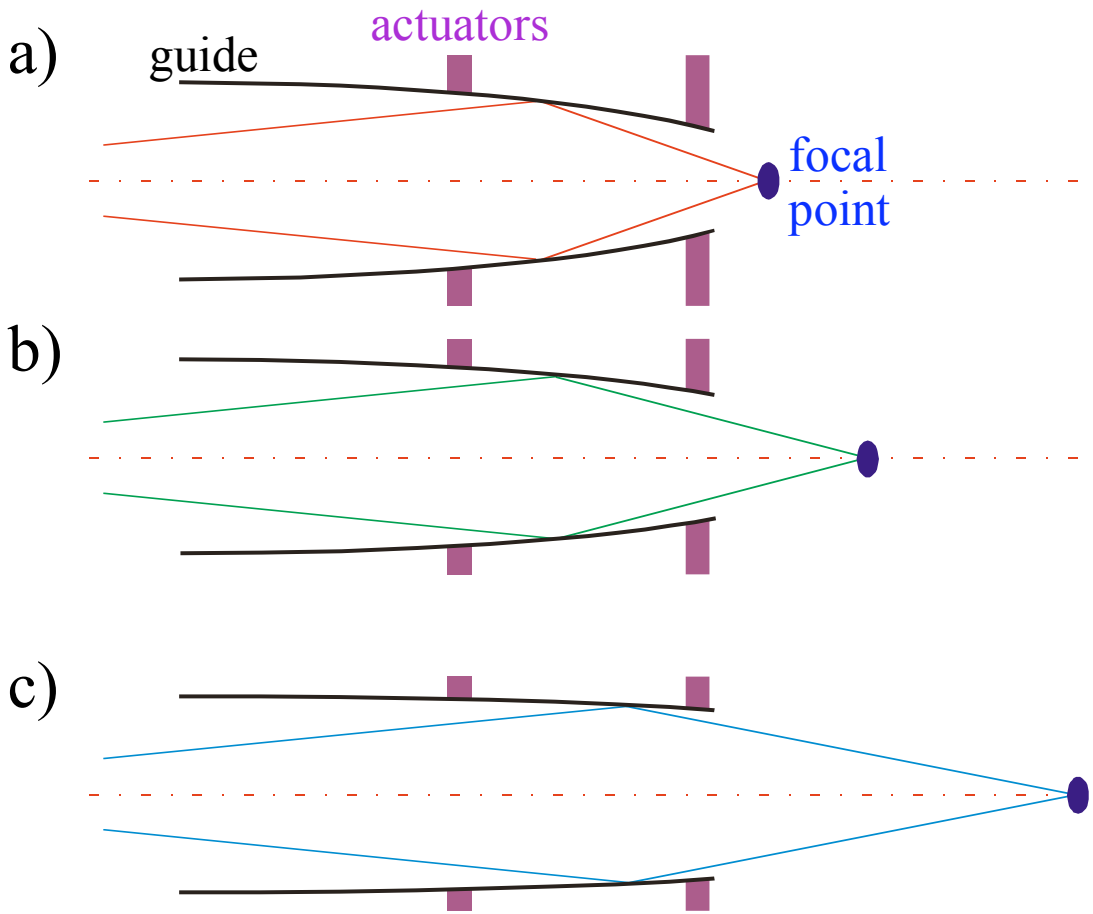
WP2: Advanced Focusing Techniques (K. Andersen)

- Task 1: ***Multichannel focusing guide (K. Andersen)***
- ***ILL – PSI – TUM - INFM***



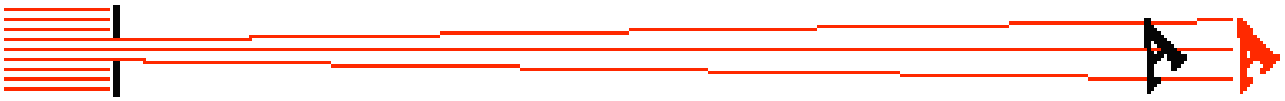


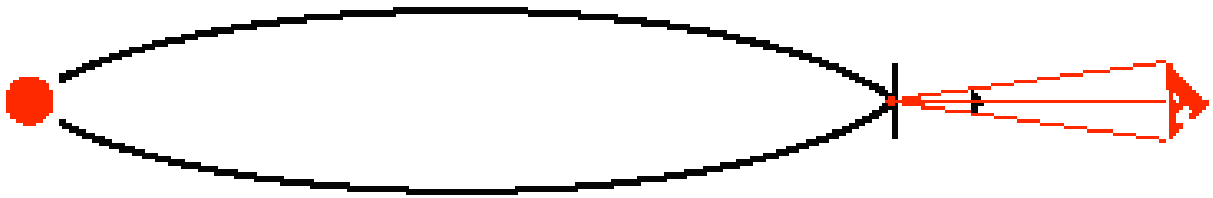
Task 2: Adaptive Optics for extreme Environments (P. Böni)



Task 3: High resolution imaging using reflective optics (N. Kardjilov)

- HZB, TUM, PSI

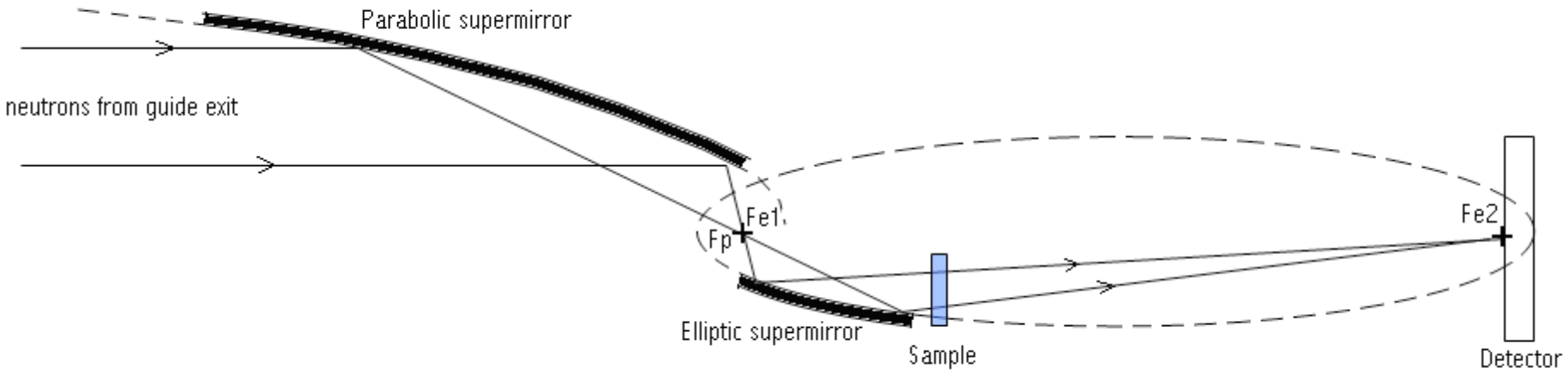




cone beam geometry

Task 4: Focussing SANS
(S. Désert and H. Frielinghaus)

- *Focussing SANS using reflective optics (S. Désert)*
- LLB – BNC –TUM



Task 4: Focussing SANS (S. Désert and H. Frielinghaus)

- Focussing SANS and VSANS using refractive optics (H. Frielinghaus)

- Use of parabolic MgF2 lenses
  - Diffuse scattering from the lenses
  - Chromaticity of the lenses system
  - Gravity effects

WP3: Monte-Carlo simulations of complex optics (K. Lefmann)

- *UCPH – DTU - ILL*
- *Task 1: Modelling of interacting optical elements.*
  - *Answer the specific needs for new complex optical components*
  - *McStas 2.0*
- *Task 2 : Optical simulation work bench*
  - *Train post-doc and scientists willing to use MC programs*

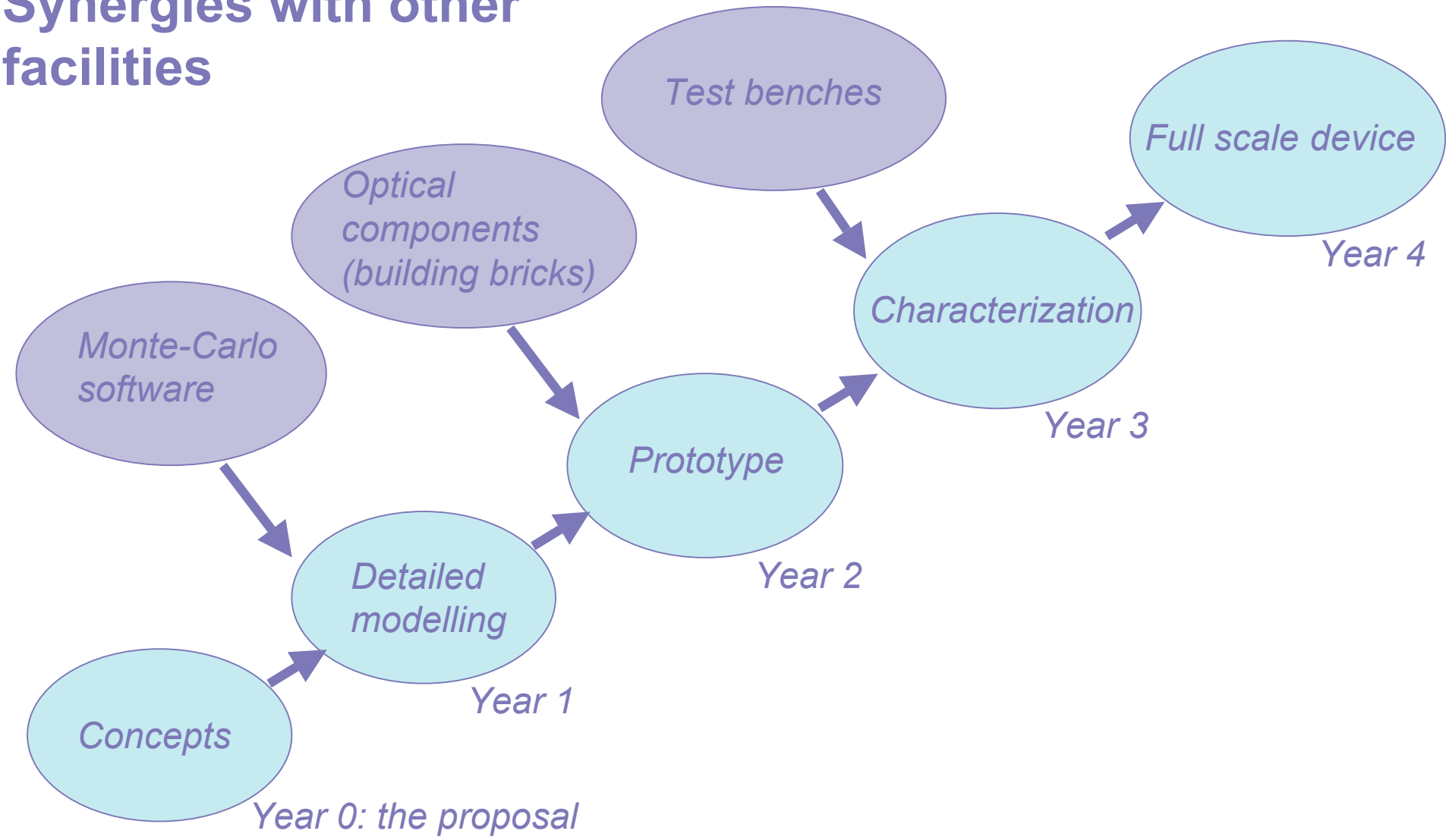
Required key technologies

- High m, without harmonics ML monochromators (m>3) (PSI)
- Graded coatings (PSI)
- Elliptical mirrors (TUM)
- Complex assembly of mirrors (HZB – TUM)
- Stacked-crystal energy analysers (ILL – EPFL – NPI)
- Bundled-fibre energy analysis
- Ultra flat very large wafers

- Present status: detailed design of the concepts is available
- To be done: demonstration prototypes

- Key issue: low diffuse scattering from the optics

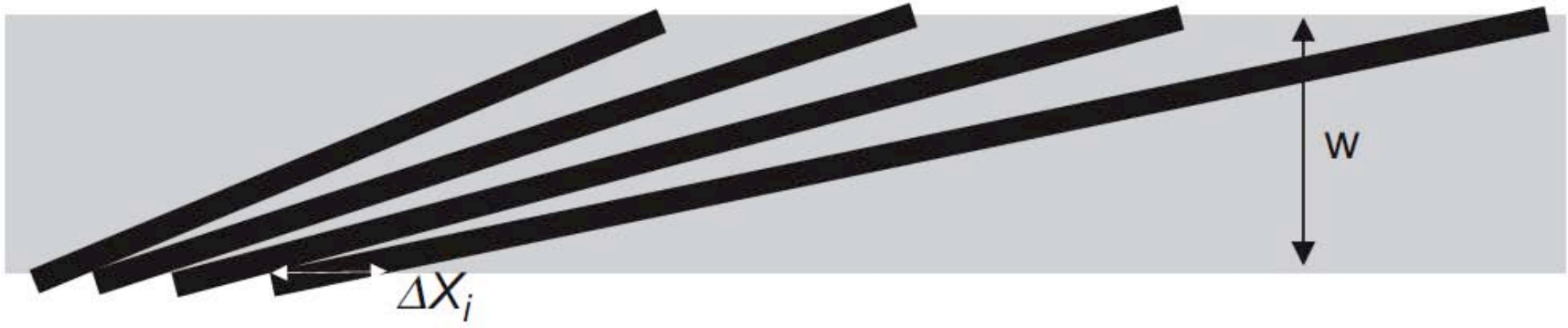
Synergies with other facilities

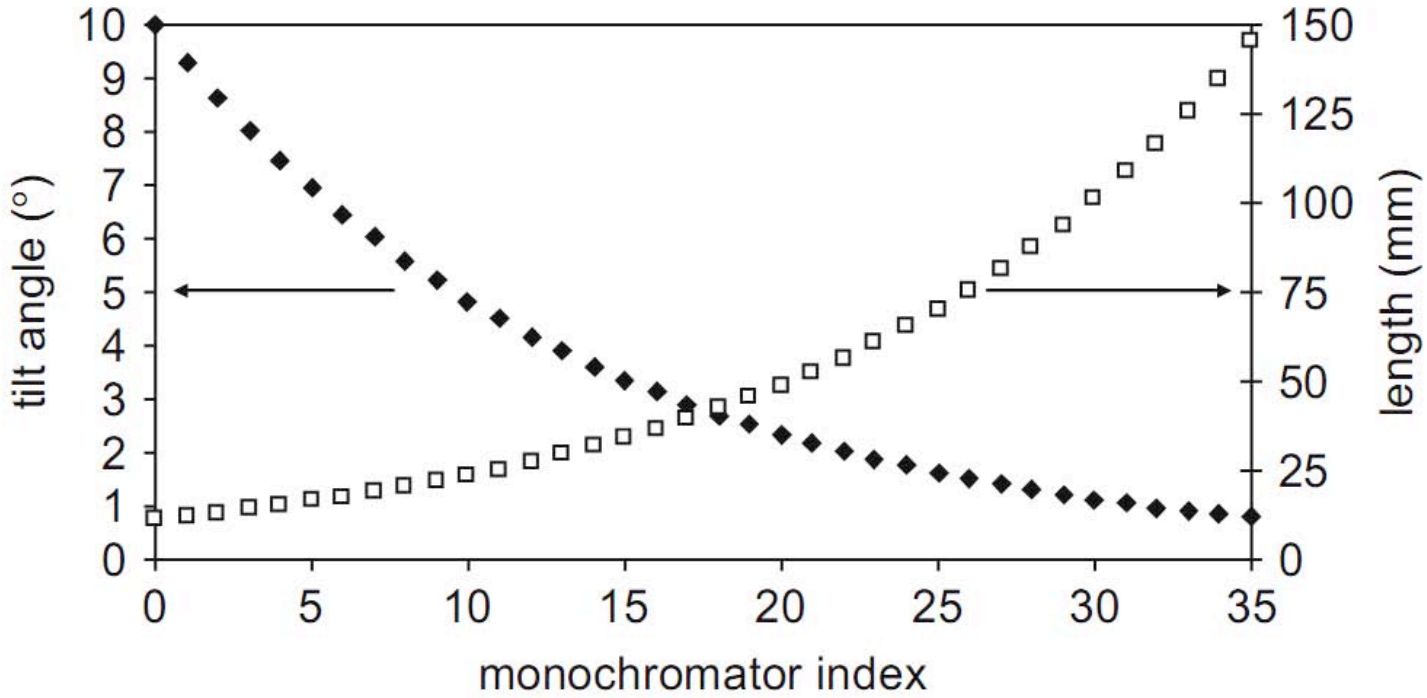


Outlook towards the future

- Year 1-2
  - Demonstration prototypes (scale 1/4 – ½)
  - Choose most promising technologies
- Year 3-4
  - Fabrication of full scale prototypes
- Year 5
  - Implementation on real spectrometers (EROS III - ILL D17)

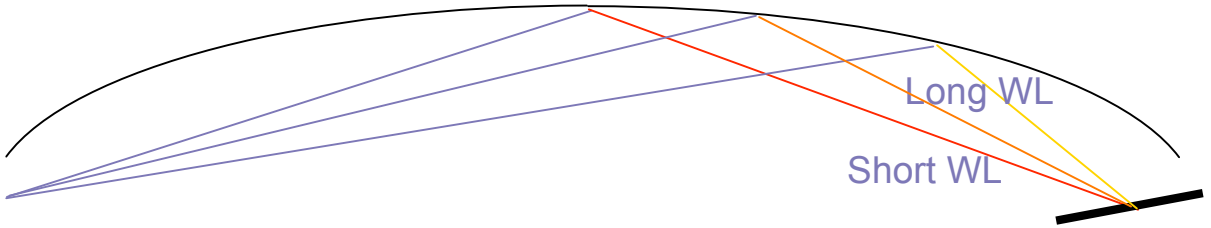
IN STORE


w
ΔX_i

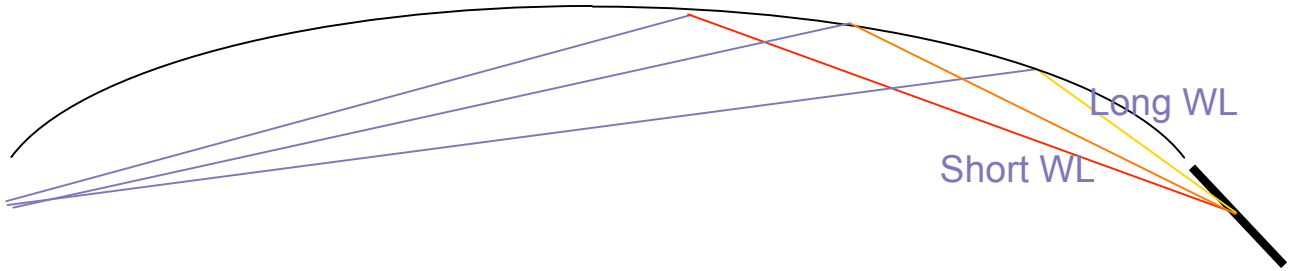

tilt angle (°)
length (mm)
monochromator index
0
1
2
3
4
5
6
7
8
9
10
0
25
50
75
100
125
150
0
5
10
15
20
25
30
35

REFOCUS

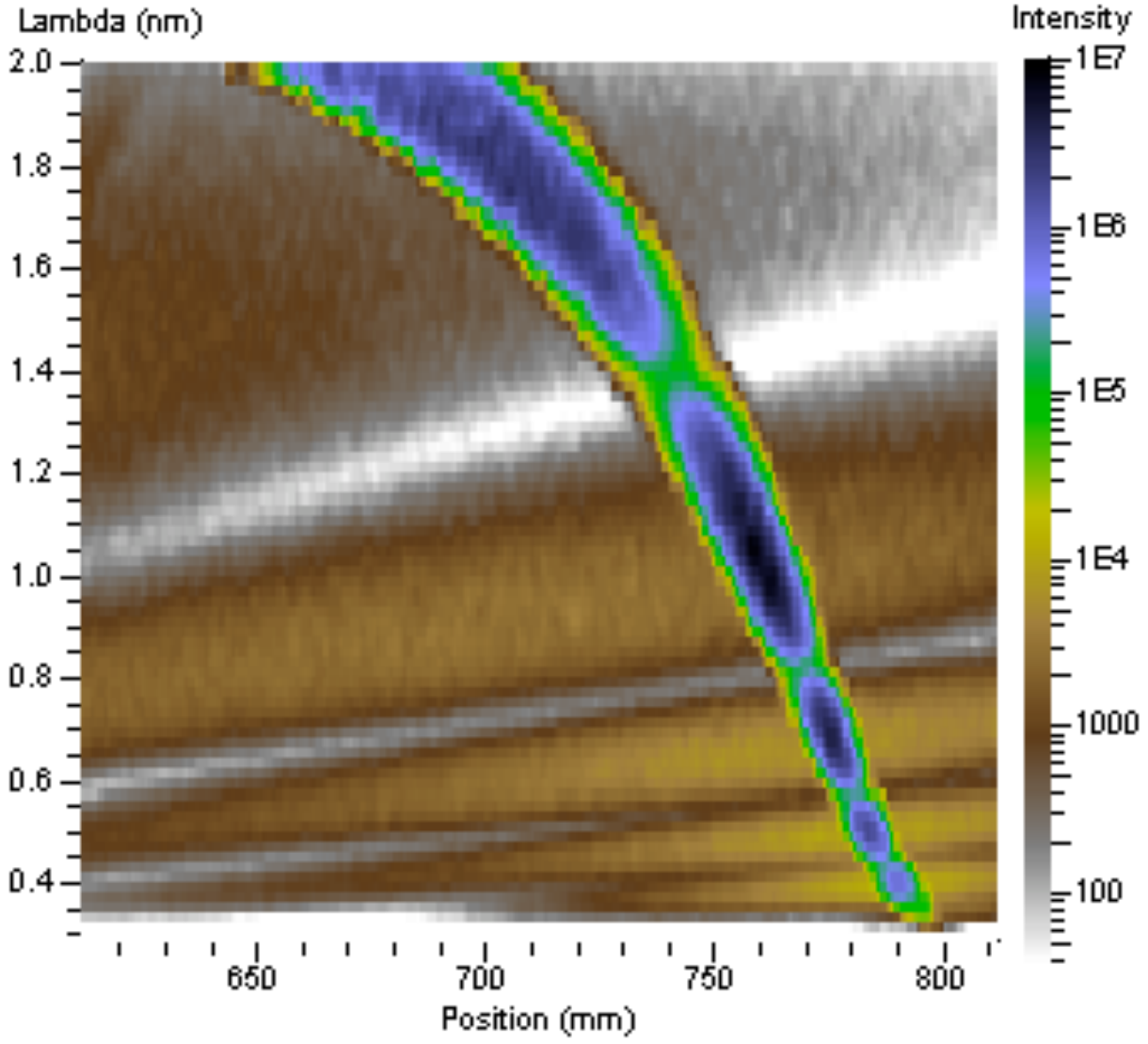
Mode 1



Mode 2



REFOCUS


Lambda (nm)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
650
700
750
800
Position (mm)
Intensity
1E7
1E6
1E5
1E4
1000
100