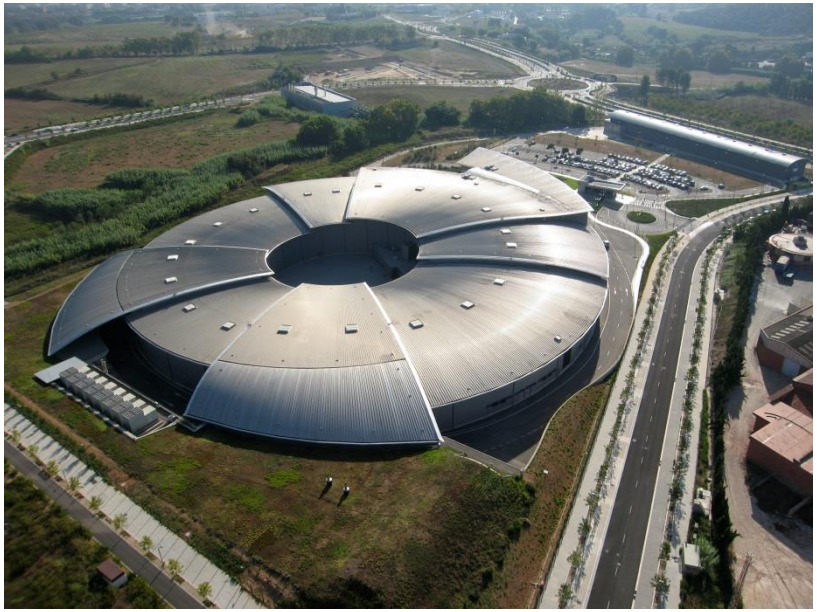
soft x-ray absorption and resonant scattering at ALBA



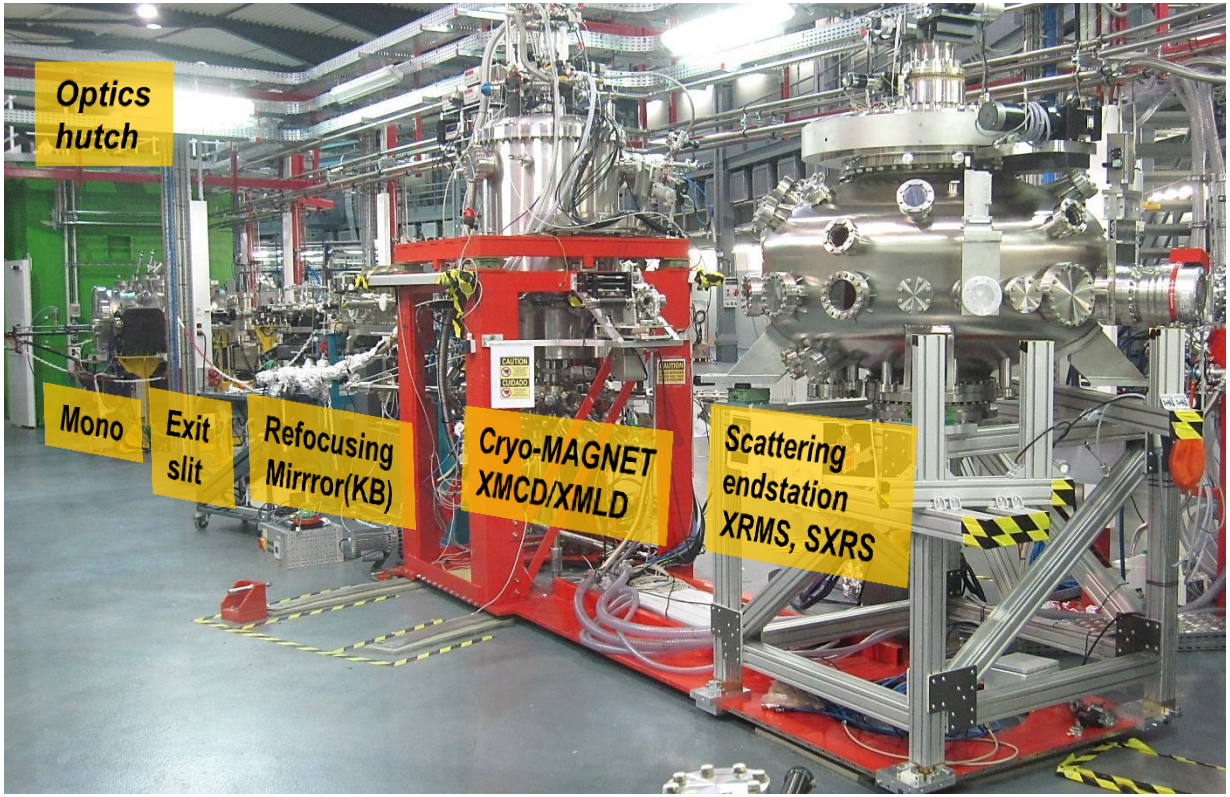
BOREAS BL29, Beamline Of REsonant Absortion and Scattering

BOREAS, Beamline Of REsonant Absorption and Scattering

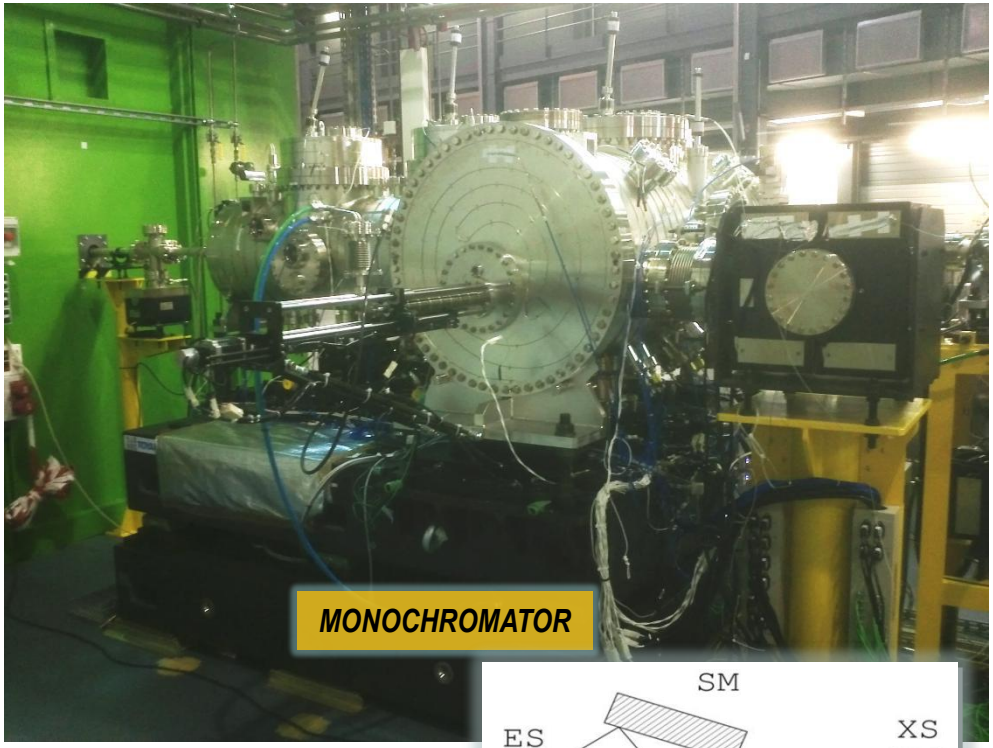
Scientific Case

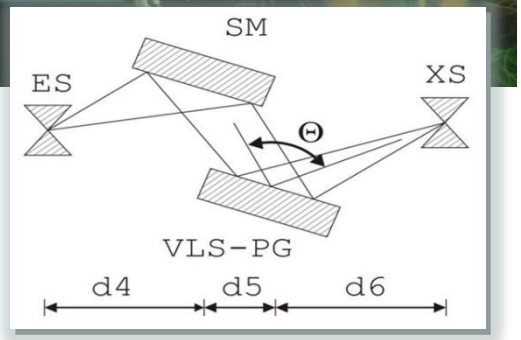
Soft x-rays: 80-4000 eV, Apple II, 3 VLS-grating mono, two endstations for XAS, XMCD/ XMLD, and XRMS

- Beamline performance, status, commissioning
- Hector endstation
- MaReS endstation
- In-house and user results



extra slides: theoretical photon flux, range

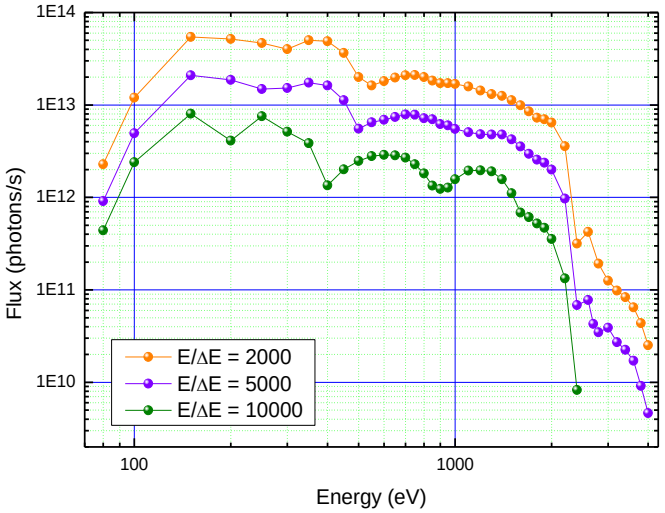




- *Monochromator chamber :*
  3 plane VLS gratings
  2 spherical mirrors
  (mechanics by Toyama co.)

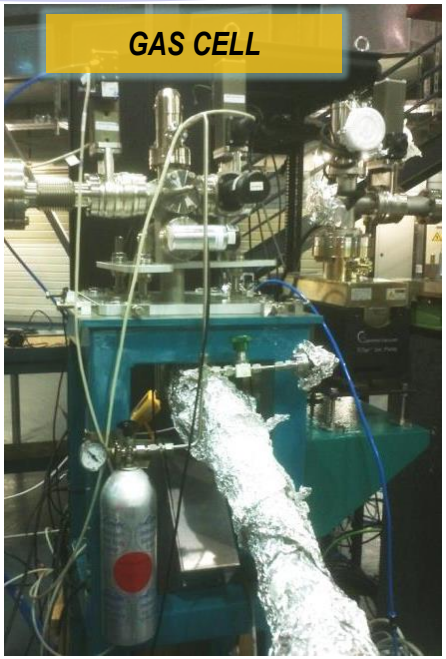
GRATING MIRROR COMBINATIONS	
80 – 300 (800) eV	SM1+LEG
250 – 600 (1400) eV	SM2+LEG
380 -1700 eV	SM1+MEG
950 - 3000 eV	SM2+MEG
600 – 2100 eV	SM1+HEG
1900 – 4500 eV	SM2+HEG

***Photon flux** (calculated)*

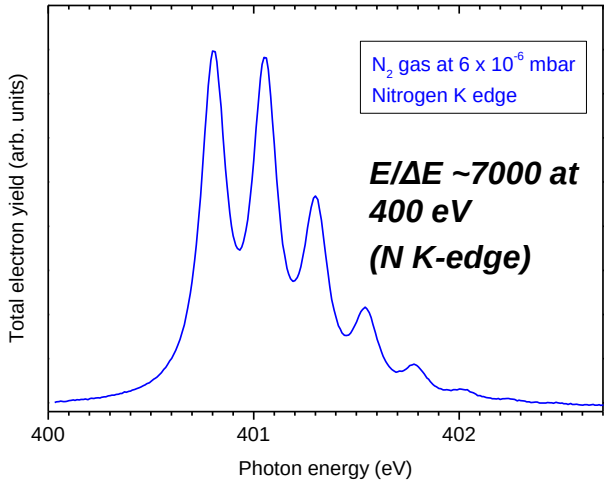


LEG: 200 l/mm, laminar, Ni coated [35nm}+Cr binding layer
MEG: 800 l/mm, blazed (mech. Ruled + ion beam etch), Rh [35nm]
HEG: 1200l/mm, blazed, Au [35nm]

BL performance – resolution



Resolving power (ES=15/XS=15)



I zero: AXUV100 (IRD) absolute diode, QE=hv[eV]/3.65

photon flux

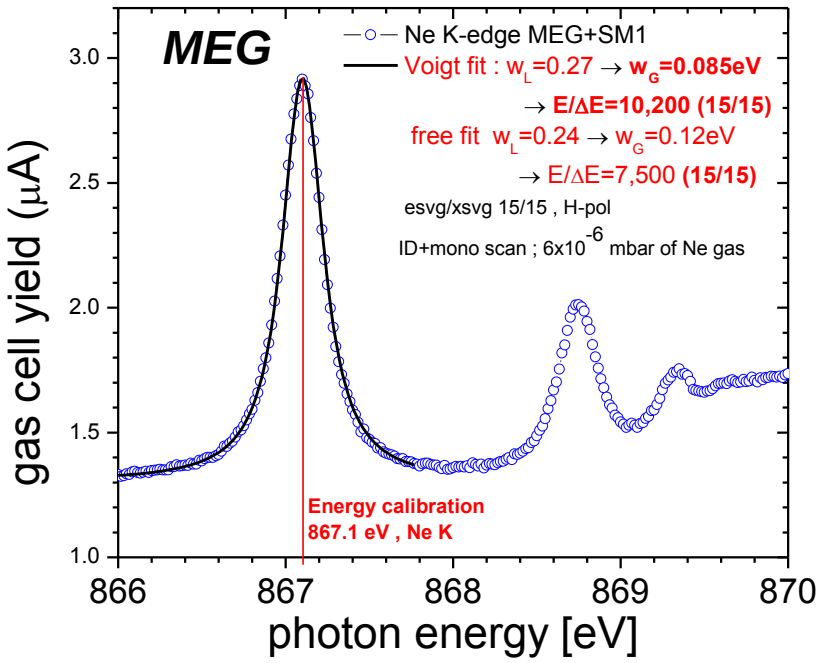
hv	I_{SR}	Diode current	flux
500eV	70μA	17.3 μA	7.8×10^{11} photons/s(*)

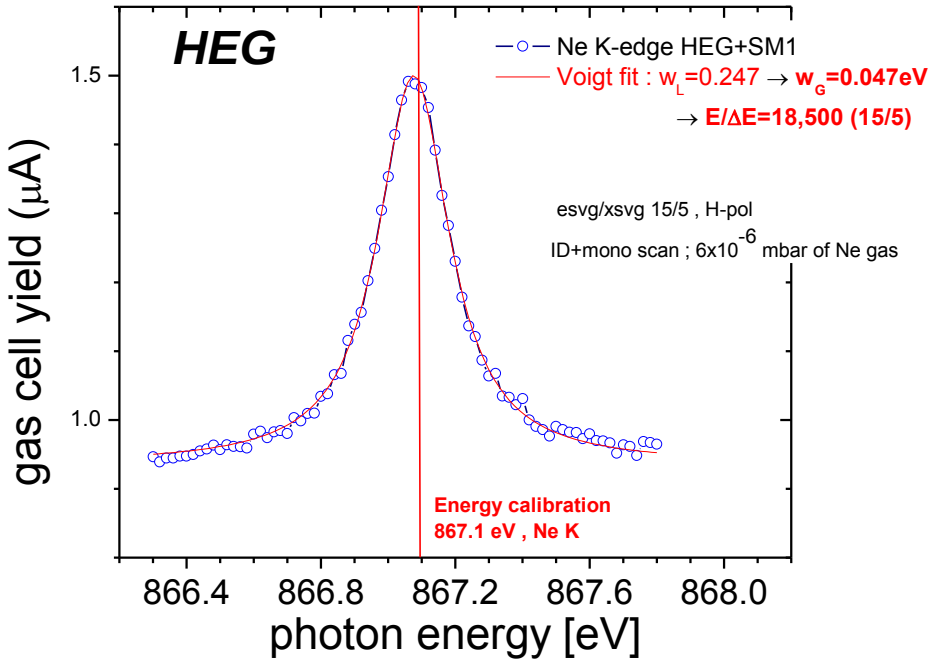
(*) : Circular polarization, ES=15um; XS=5um;
Extrapolates to 4-5x10^{12} photons/s at I_{SR}=400μA

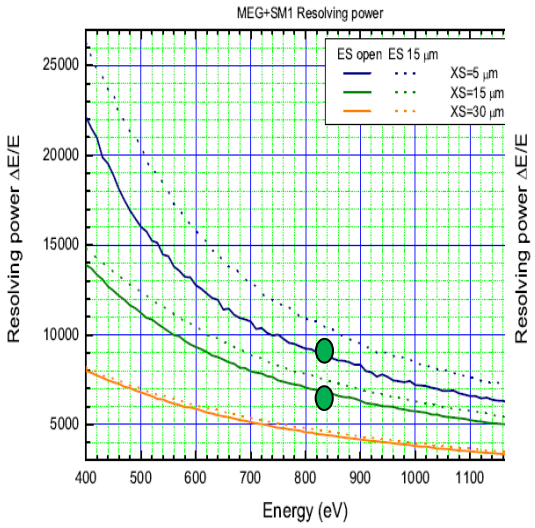
Beam size (micron)

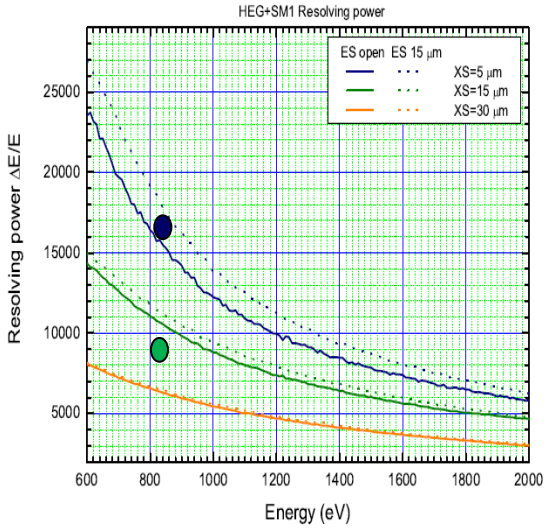
Element	Vertical	Horizontal
exit slit	10	250
ES1	600	250

BL performance–resolution MEG, HEG



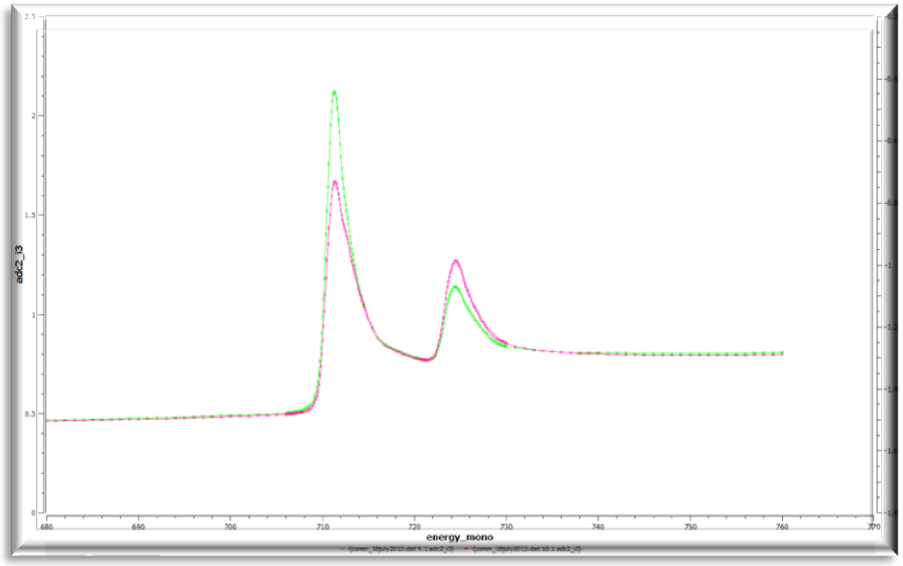


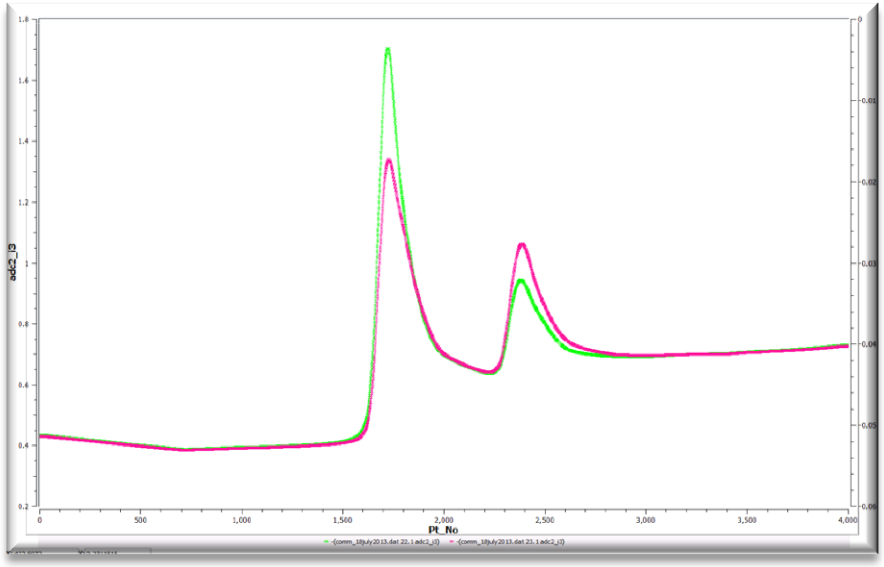




- *At 15/5 slits, MEG and HEG single Lorentzian width is 0.26(8) and 0.25(4) eV*
- *Width smaller literature Ne K natural width, 0.27+/- 0.02 eV [Floreano et al, RSI]*
- ***Instrumental resolution ~10,000** for **15/15 μm slits** and ~ **20,000** for **15/5 μm,***
- ***Confirmed resolution performance of conceptual design***

BL commissioning– continuous scans





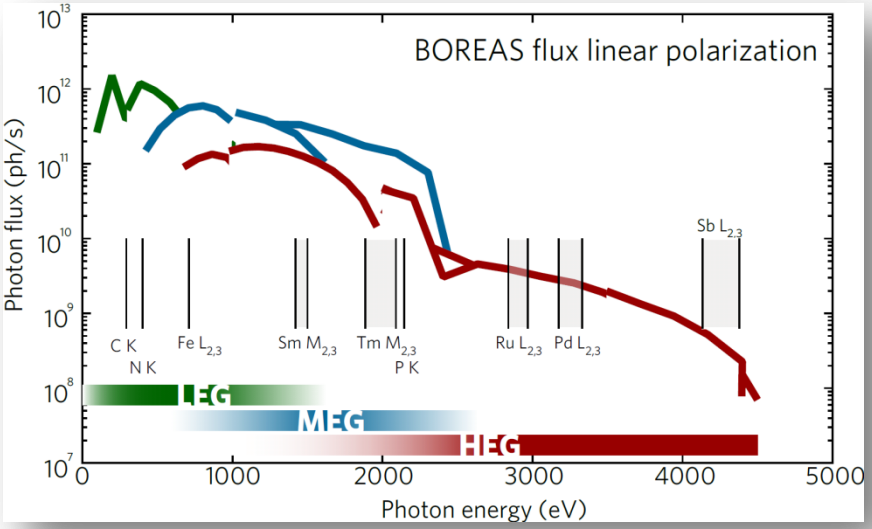
Step scan, variable step:
Finest res. 0.050 meV
Total time: 17min 30sec
Normalized

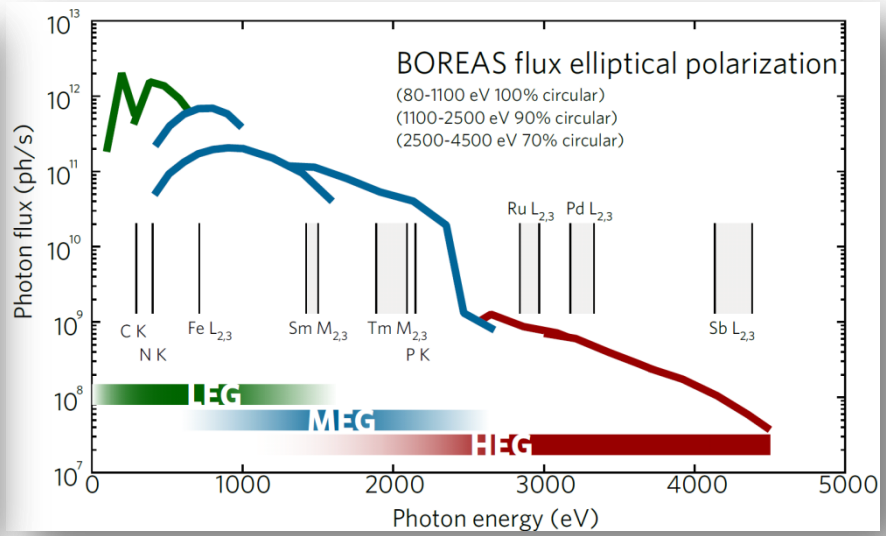
Continuous scans
0.050meV resolution everywhere
Total time : 2min
Not normalized

- Continuous scans can more efficiently use acquisition, benefiting of high frequency sampling
- As important as time saving, is quality of sucessive measurements.

Figure 2. This picture shows the first Insertion Device installed in the ALBA Storage Ring. It is an APPLE-II Undulator, with a period of 71 mm which will give light to BL29-BOREAS.

BL performance– flux (commissioning)





Linear polarization

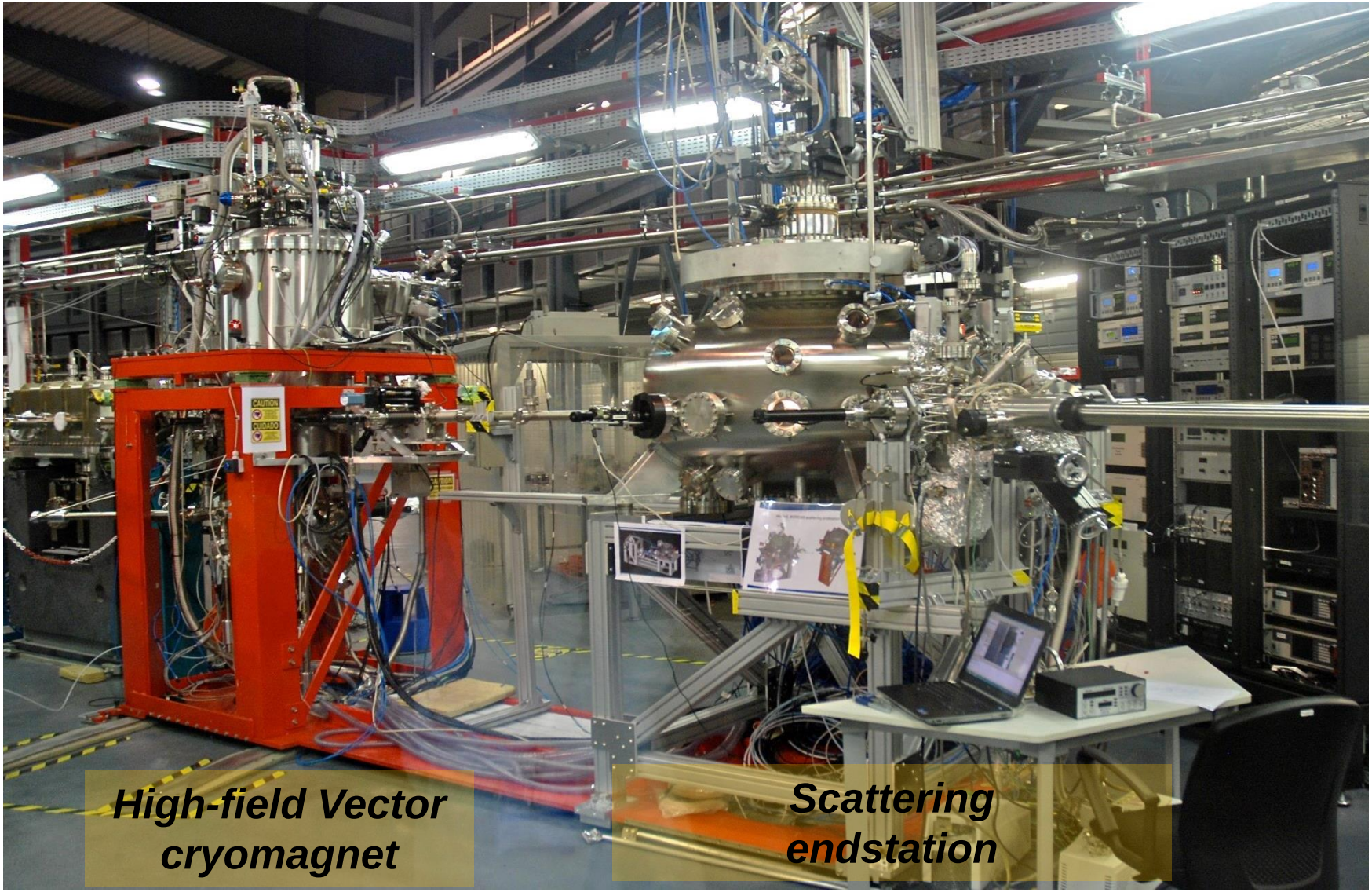
Circular & elliptical polarization

- **Considerably high flux with good resolution in the high energy range (>1.5 keV)**

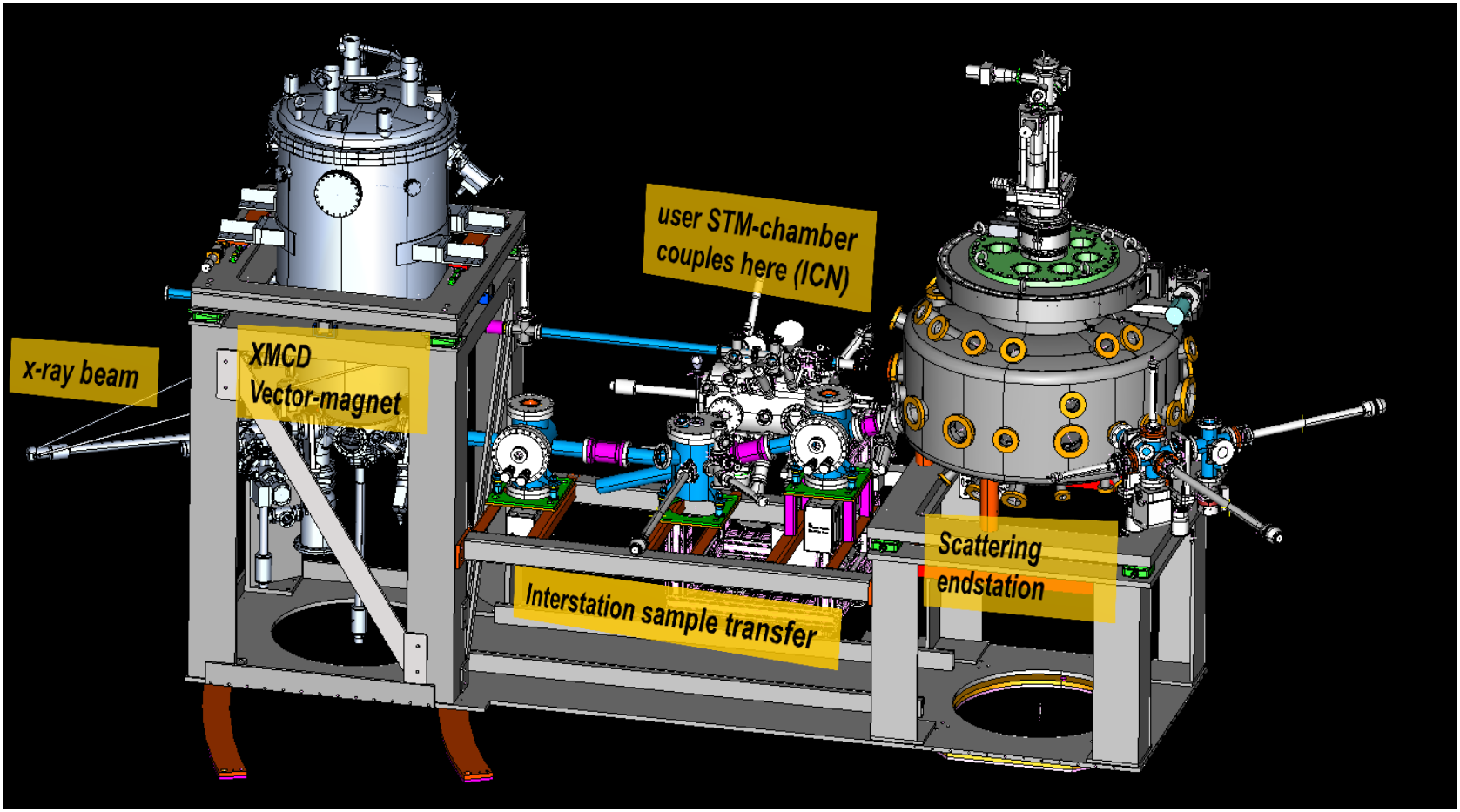
  Typically 1st ID harmonic 100-1100 eV ; 3rdh : 1000-2500 eV approx. ; 3rd, 5th , … for E>2000 eV

- **Spectral purity**: ID harmonics x grating orders coincidences can be relatively intense

BL29 endstations

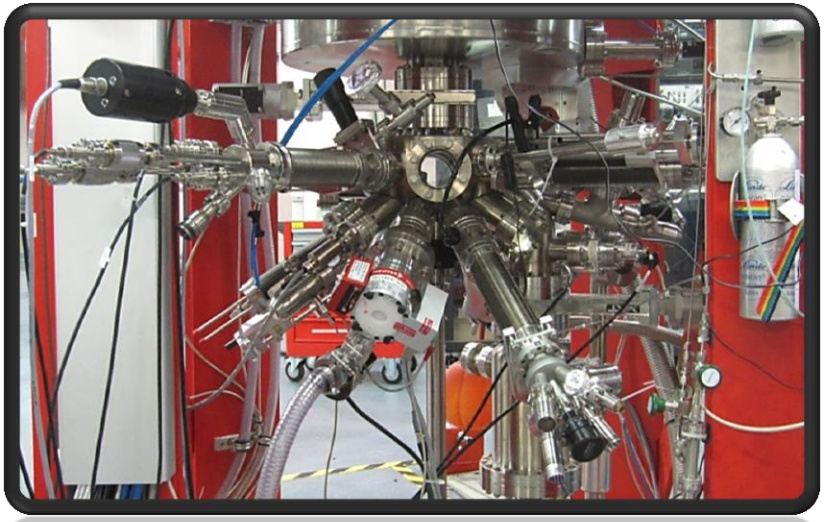


Interstation transfer line & STM– status



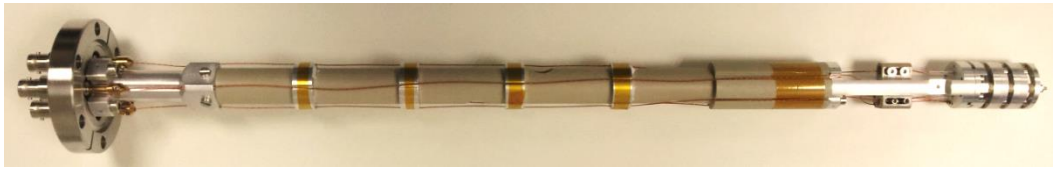
- Most elements delivered, chambers bought, support on design approval
- System linking STM and vector magnet is expected to be ready summer 2014

high-field vector magnet endstation, *Hector*



Vector magnet:
6T , 2T (3D)
Temp.: 2K – 350K
sample contacts

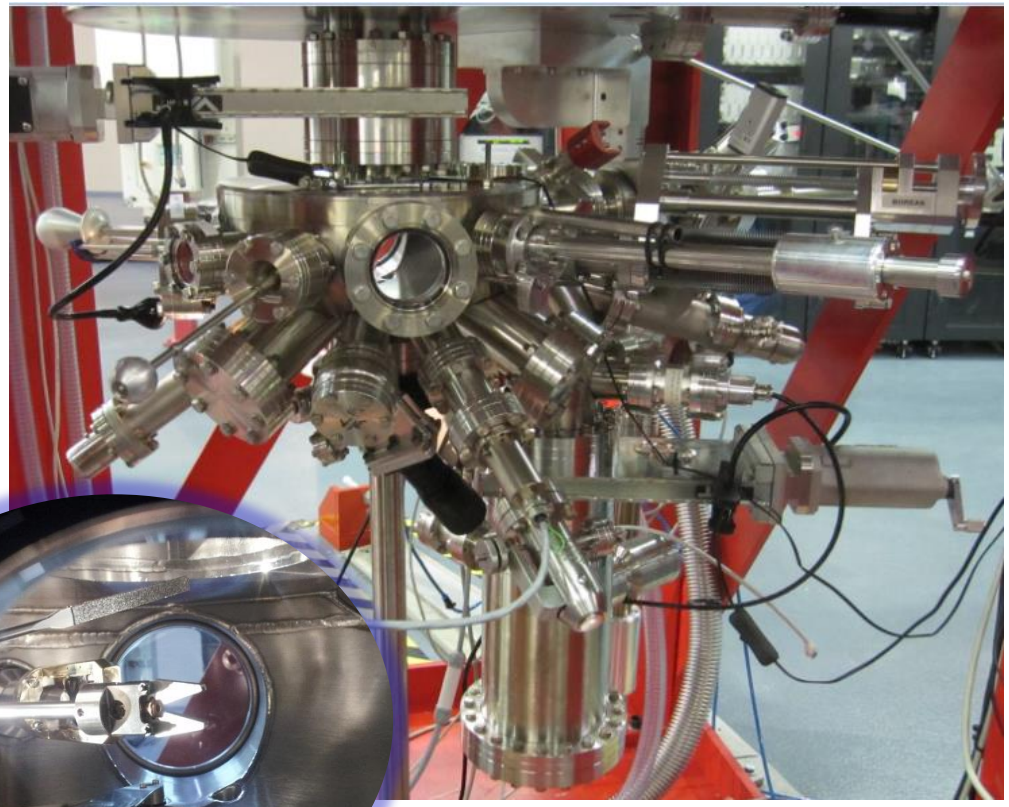
- Temperature control macros ; 3D mode integration (new gui)
- Transmission diode arm (motorized)
- Quadruple metal evaporator, organic evaporator, heating stage, ion gun
- Turbo, LEED/AES prep-ch upgrades (warranting good surface science)
- Fluorescence diode: diode + 2 HV grids for e^- repulsion (foil option)
- Many more types of sample holders, clips;
- In progress: bias, HV batteries, ...enhancing TEY detection



Fluorescence diode assembly designed and built at ALBA (installed end Feb'2013)

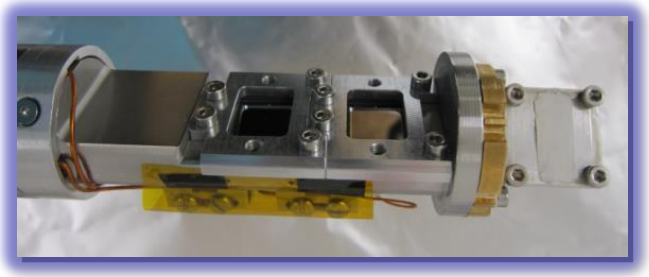
BL endstations update – magnet equipments

- ***Installed equipment: heating stage, metal evaporator, wobble stick, gas lines, leak valve, quartz balance***



In-situ cleaver, wobble stick scrapper (file), ash tray

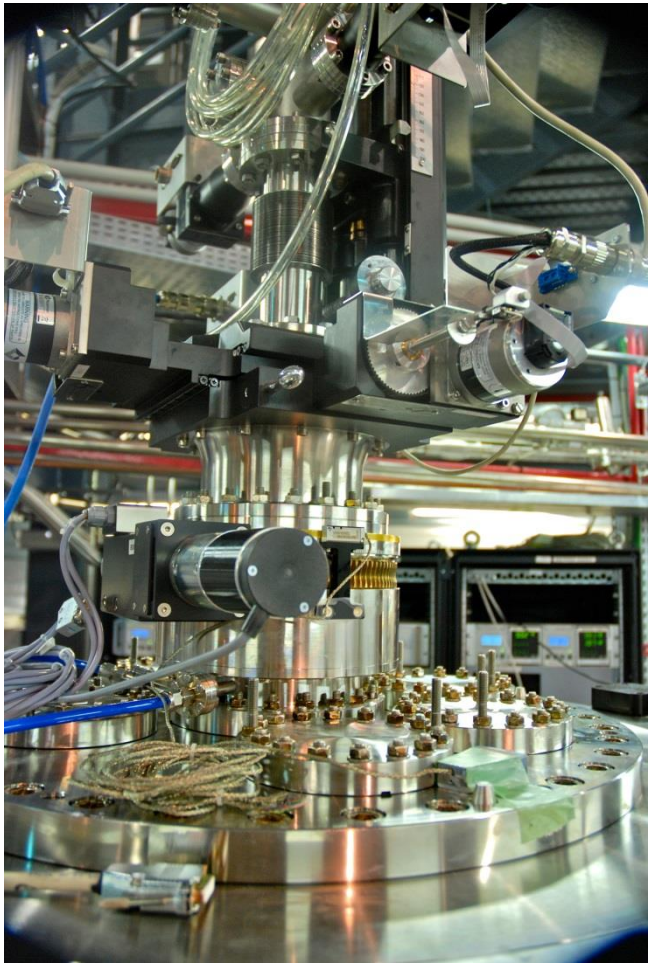
Transmission arm

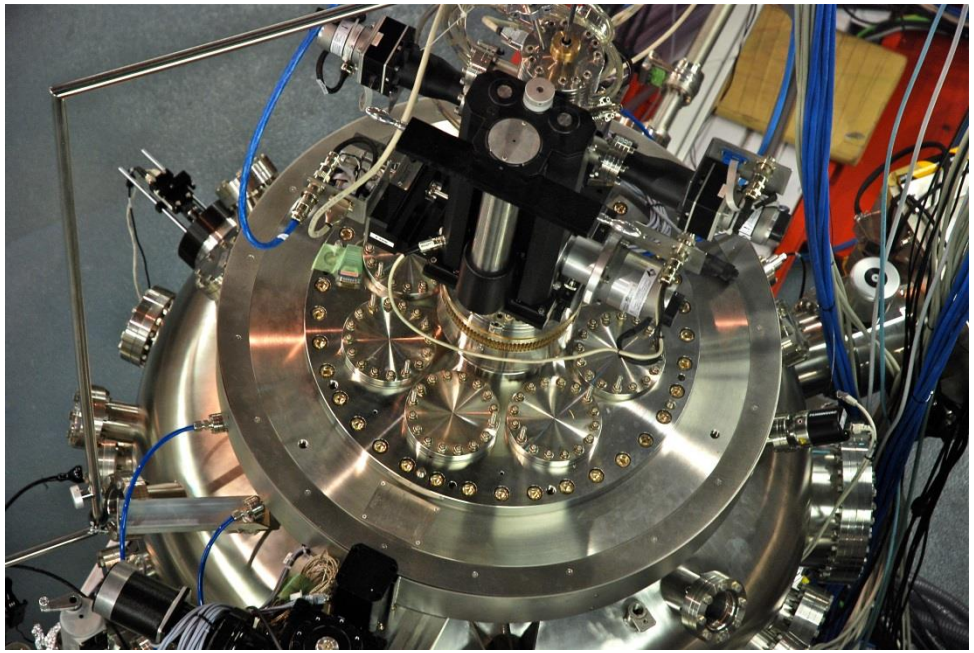


e-beam heating stage

Demanding surface science user&in-house experiments put strong needs for surface science equipment: turbo pump in preparation chamber, multi-sample loading upgrade for load-lock, LEED, evaporation screen, enhanced fluorescence detection

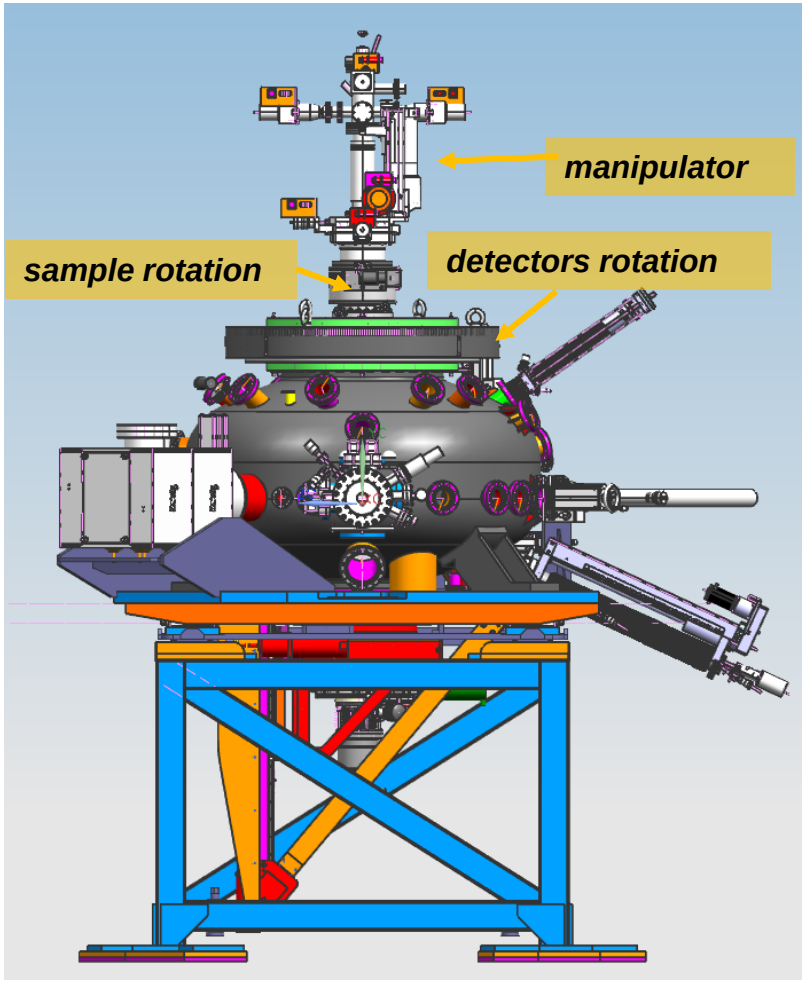
sample and detector reflectometer

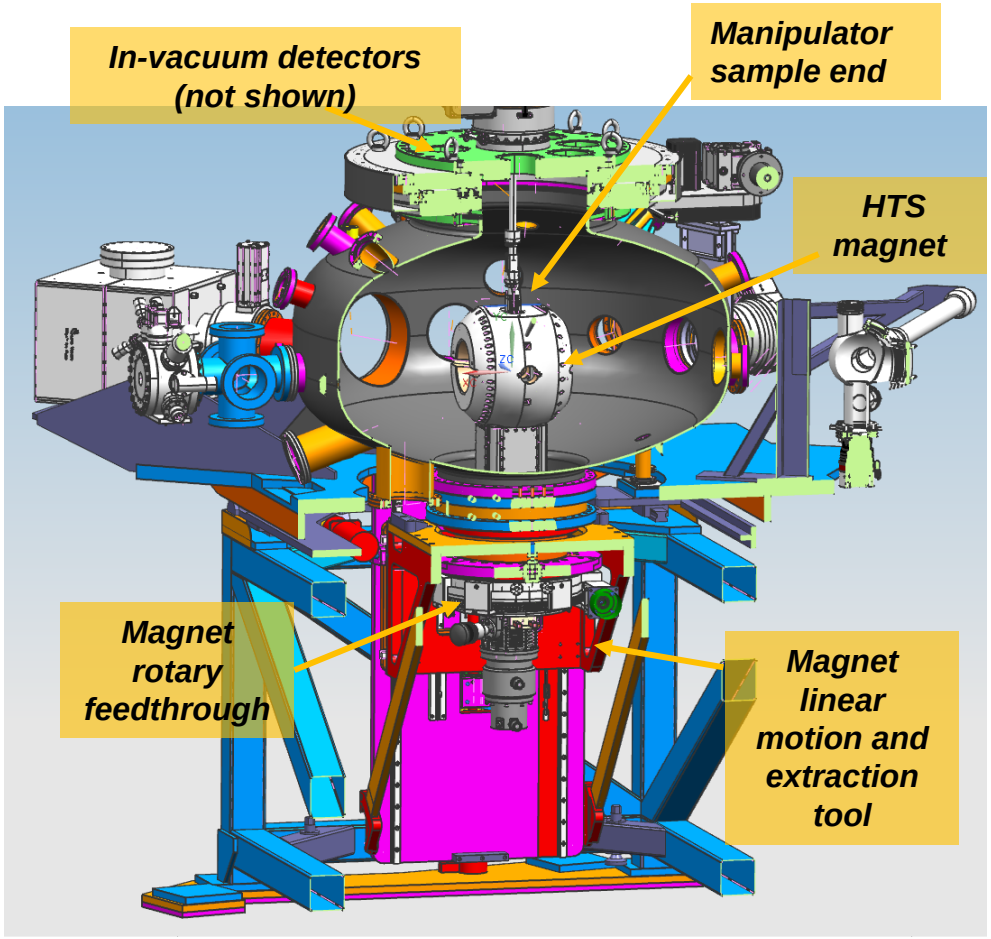




PINK manufacturing (design based on reflectometer by C. Schüßler-Langeheine and co-workers at Helmholtz Zentrum Berlin& Köln Univ.)
Acknowledgements: PINK, F. Heigl(CFT), C.Ruget, S. Ferrer, C. Schüßler-Langeheine, E. Wesche, E. Pellegrin, ALBA metrology

scattering endstation – overall concept

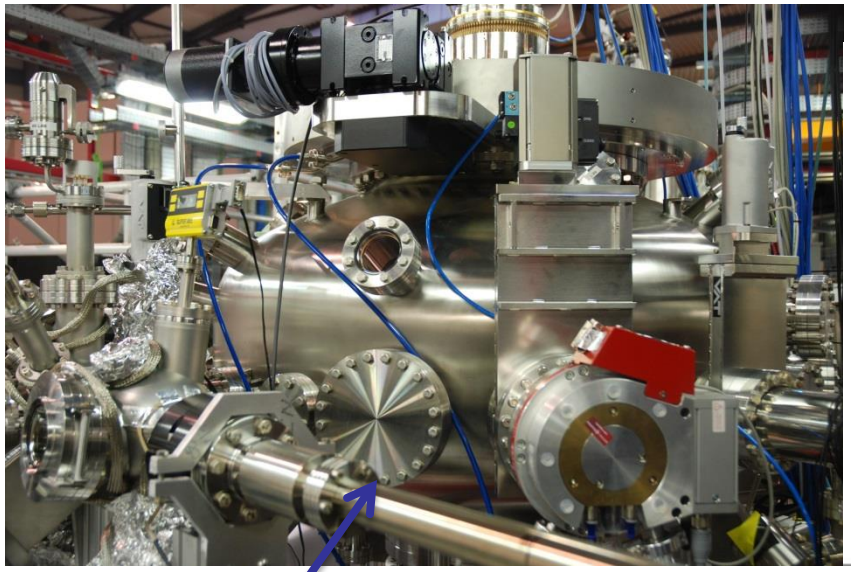


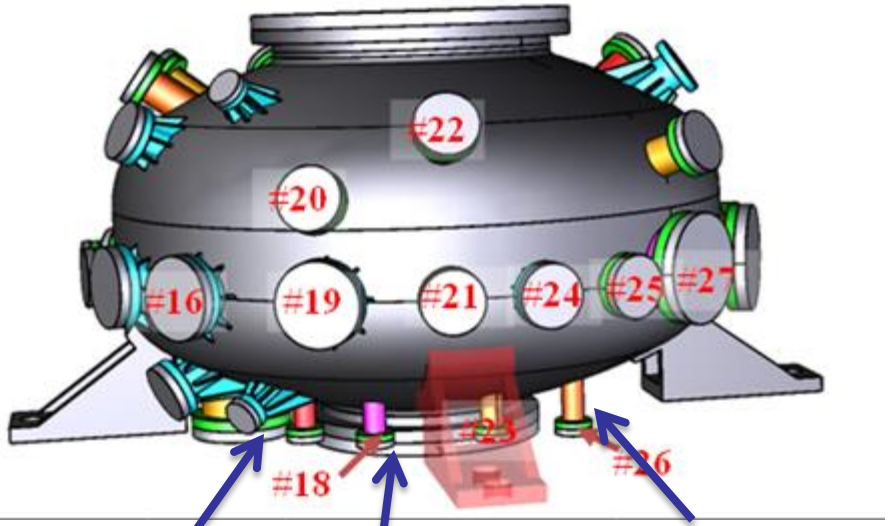


CAD design: A. Crisol. C. Colldelram and previous engineering staff (D. Barcescu, J. Moreno, R. Martin, S. Forcat, C. Ruget)

UHV vessel

Multi-port chamber allows complementary surface science techniques and upgrades for further x-ray techniques





Large beam exit flange for SAXS tube, or fluo-screen + standard CCD

Oblique ports for evaporator in GISAXS incidence

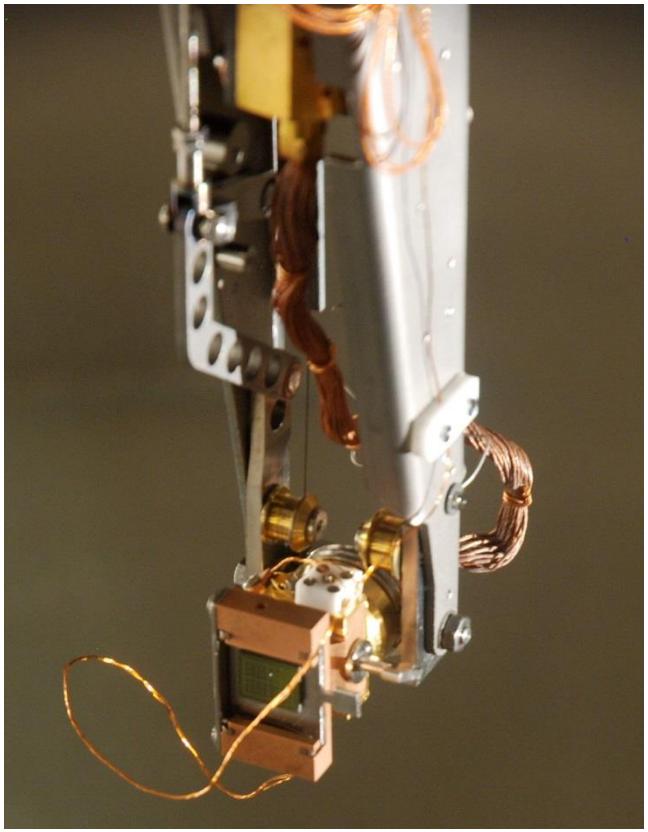
Beam stopper port at diameter between Magnet and CCD

Entrance auxiliary port can have linear tool interpositioning element on incoming beam

sample cryo-manipulator

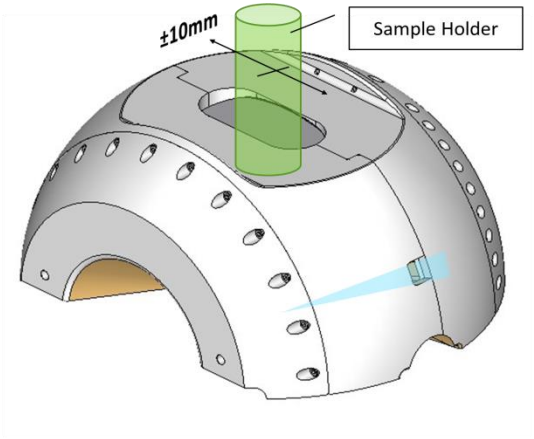
- IFW Dresden and VG Scienta design

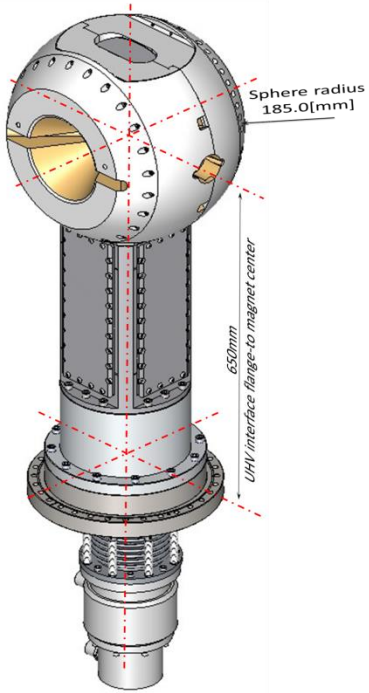
  custom modifications by VG Scienta & ALBA
- about 20K to 350 K sample temperature range
- XYZ, tilt, azimuth and polar (not used)
- in-vacuum sample transfer
- contacts for Hall probe or Temp sensor
- electron yield to be implemented
- STM plates sample holder, heating stage

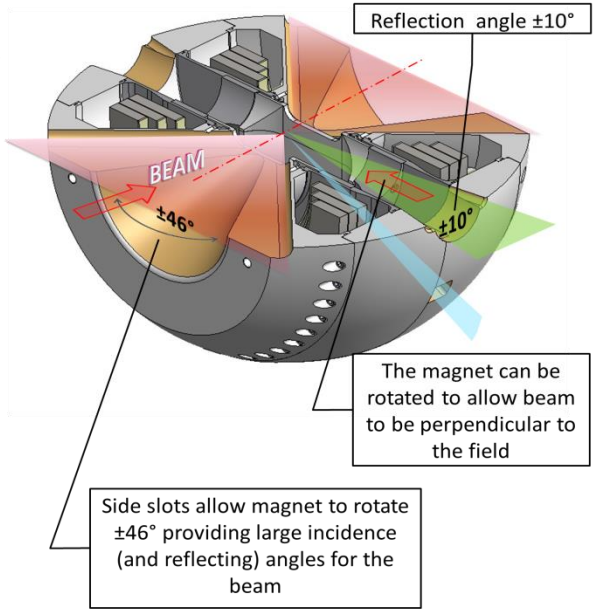


HTS Magnet

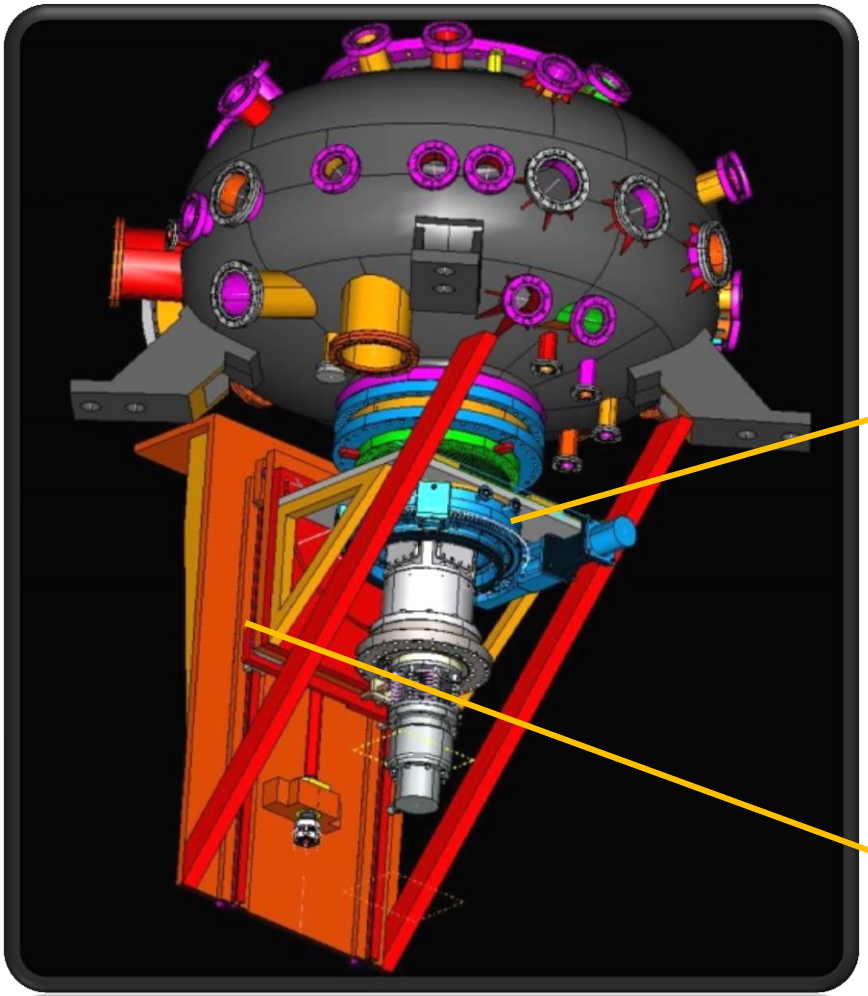
- Manufactured by HTS-110, design by HTS-110 and ALBA and ICMAB-CSIC
- 2 Tesla, 1st gen Bismuth strontium calcium copper oxide (BSSCO)
- Large-diameter coil packs for wide optical access, 50mm gap
- Cryocooler (28hours cooldown, Temp range 2nd stage 15-22 K approx.)
- Small stray field (<50G at 250mm), around 150 Kgs
- O-ring sealed, warm bore, dampening belows



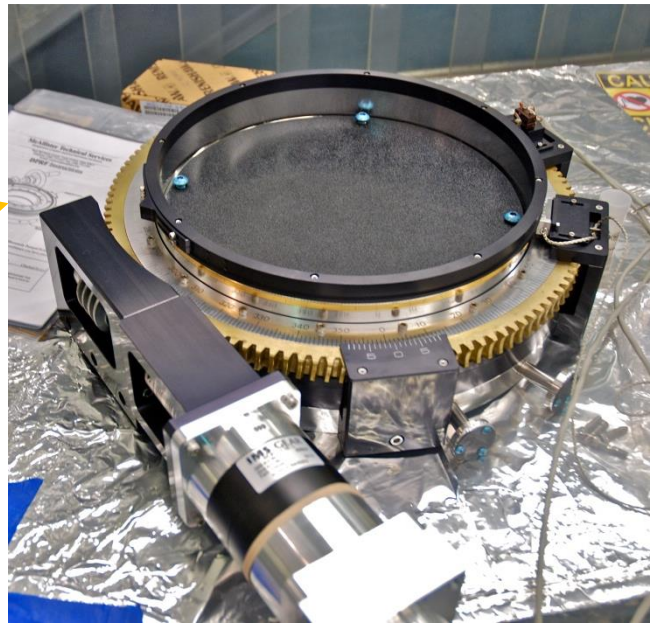




magnet degrees of freedom, bottom stack



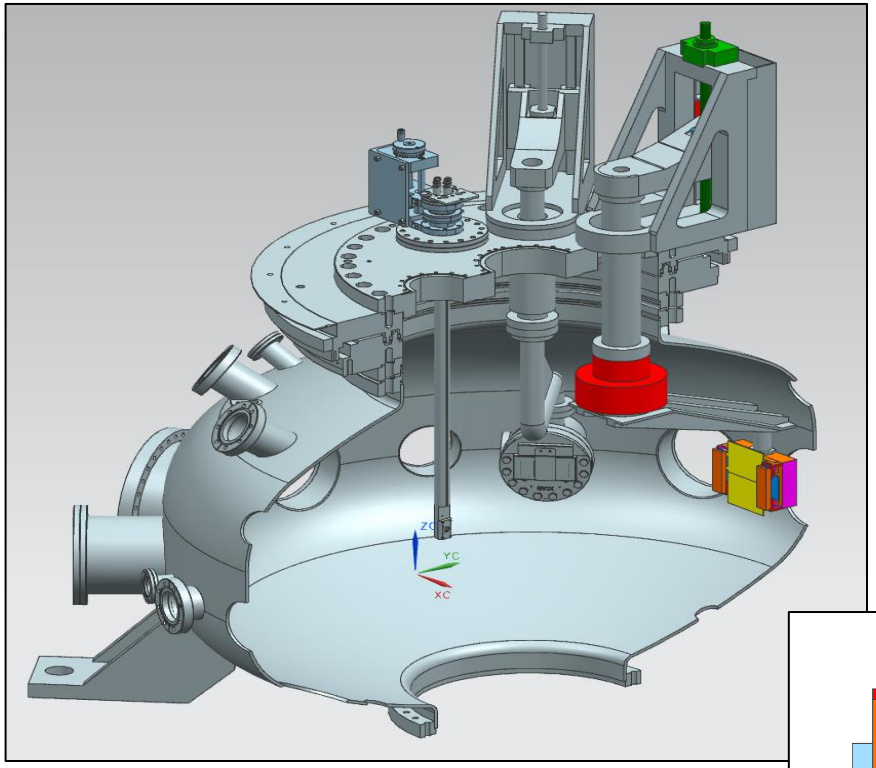
Magnet rotation (delivered July, from McAllister TS) . Under commissioning

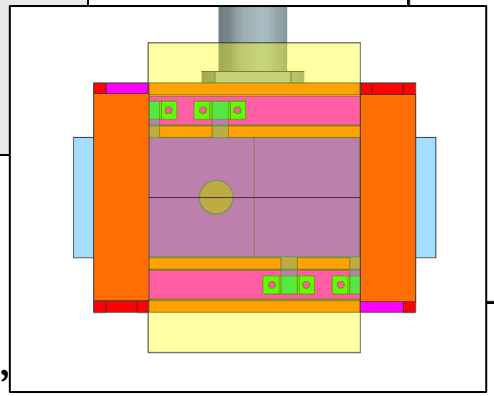


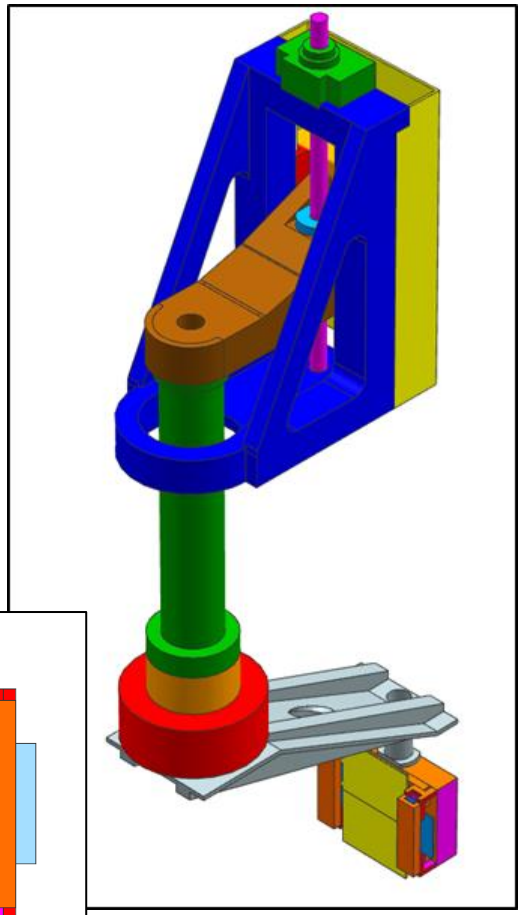
Vertical motion and extraction tool, inhouse development (status: detailed final design, expected before fall 2014)

- *includes some tilt adjustment*
- *lowers magnet for transfer*
- *gets magnet fully down and would allow to take plate with magnet into a wheeled transportation cart*

Diode/MCP/Channeltron detector arm







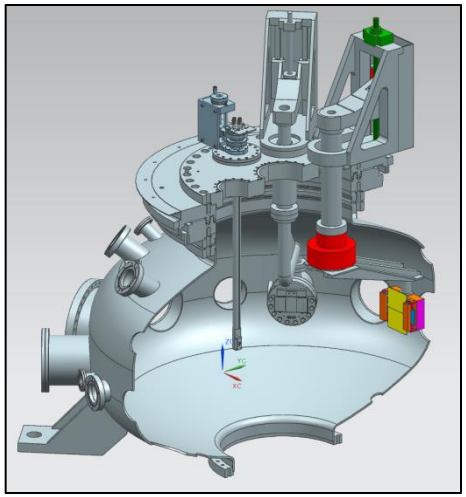
- Detectors: GaAsP diode & MCP (Hamamatsu), Channeltron (Sjuts), Si diode (Hamamatsu/IRD)
- Vertical motion: range +/- 150 mm , resolution few micron
- Detector slits: smart act actuators

In-house design in progress (summer 2014):

A. Pascual, C. Ortiz,

A. Crisol, C. Colldelram, M.Valvidares

XCAM custom CCD

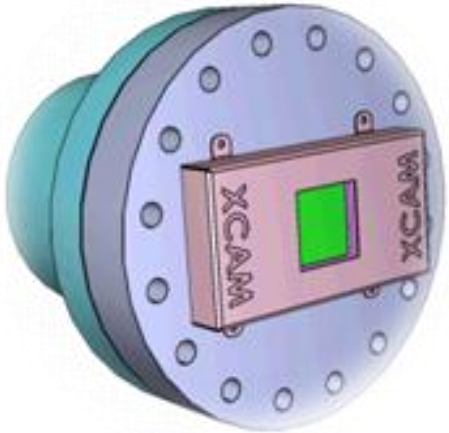


Custom design (CFT) by XCAM ltd, UK

CCD device and TEC element in-side vacuum (-50C to -70C), water cooled

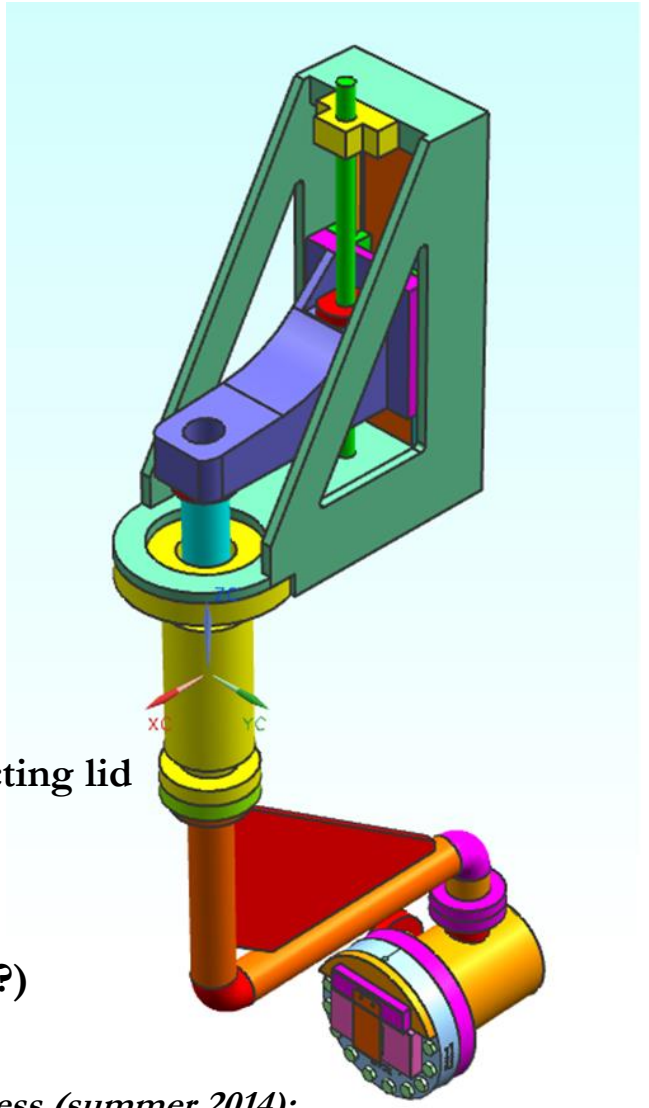
custom camera head signal feed-through with proximity electronics outside vacuum

driving electronics at 2.5m



- in-house design arm
- Smart act actuator for protecting lid and fluo/RHEED screen

- beam stopper
- msec fast shutter (PiezoJena?)

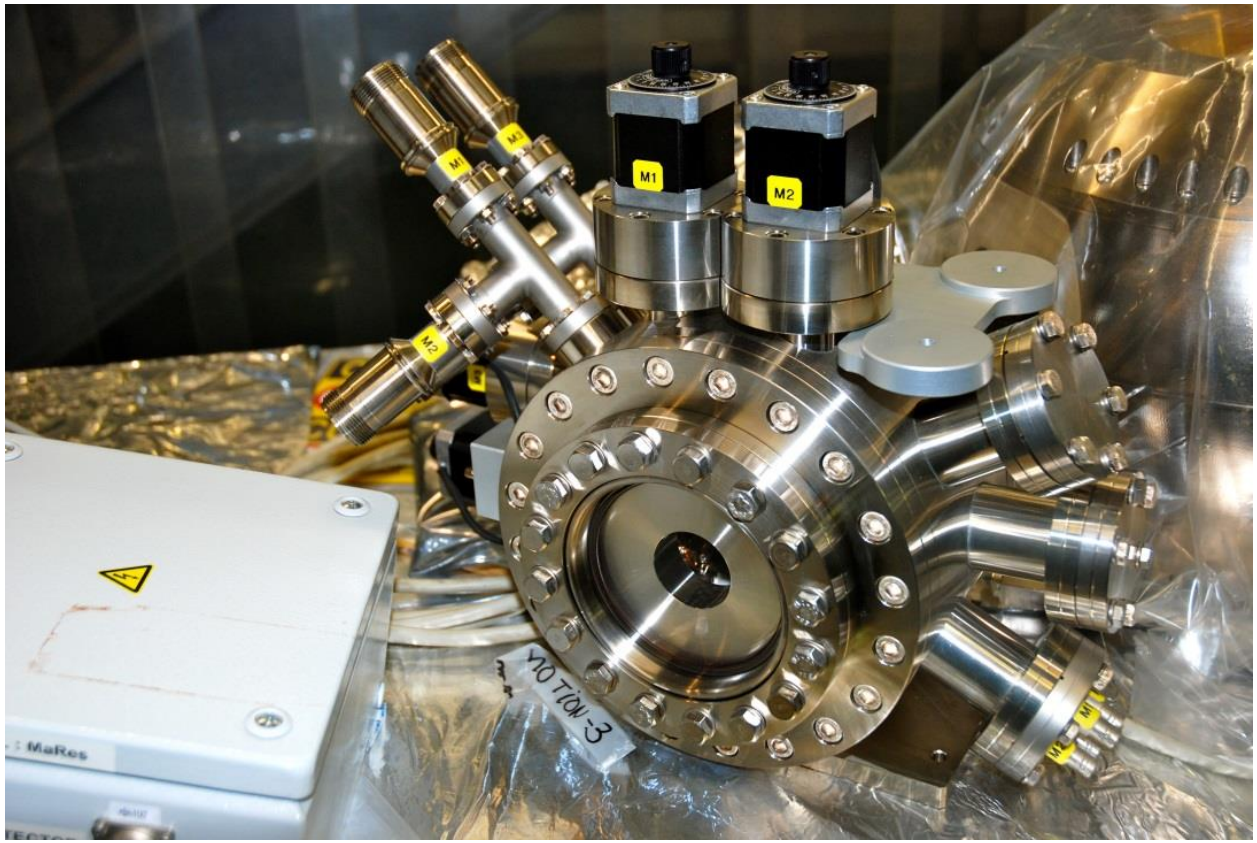


In-house design in progress (summer 2014):

A. Pascual, C. Ortiz, A. Crisol, C. Colldelram, M.Valvidares

entrance slits, I zero, filters, pinhole crosses

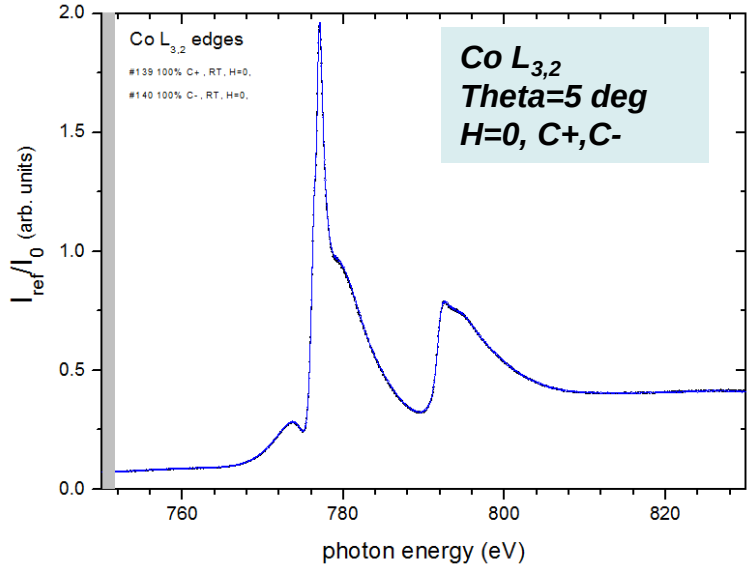
JJ-xray in-vacuum 4-blade slit system

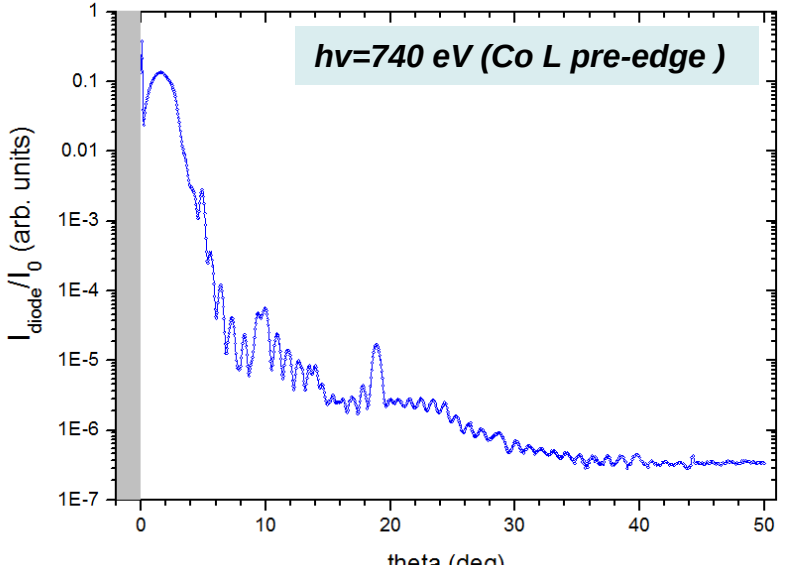


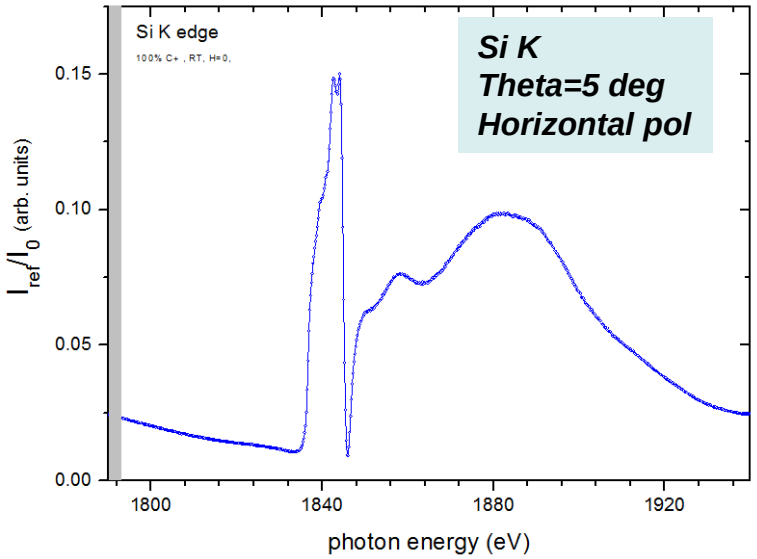
4-blade UHV slit system with manual/motorized micrometer actuators, blade drain current and in-vacuum encoders

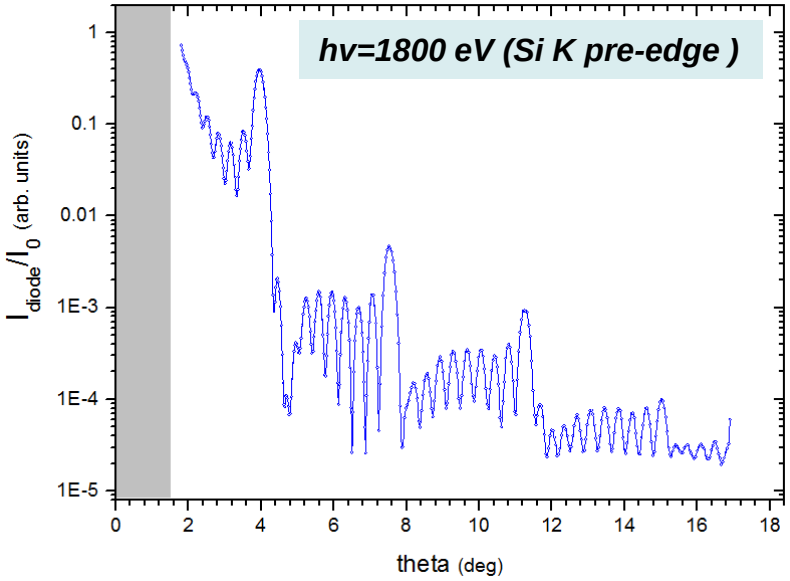
first beam tests: reflectivity of a CoSi/Si ML

[CoSi(5nm)/Si(3nm)]$_{10}$ multilayer (CSZ22)



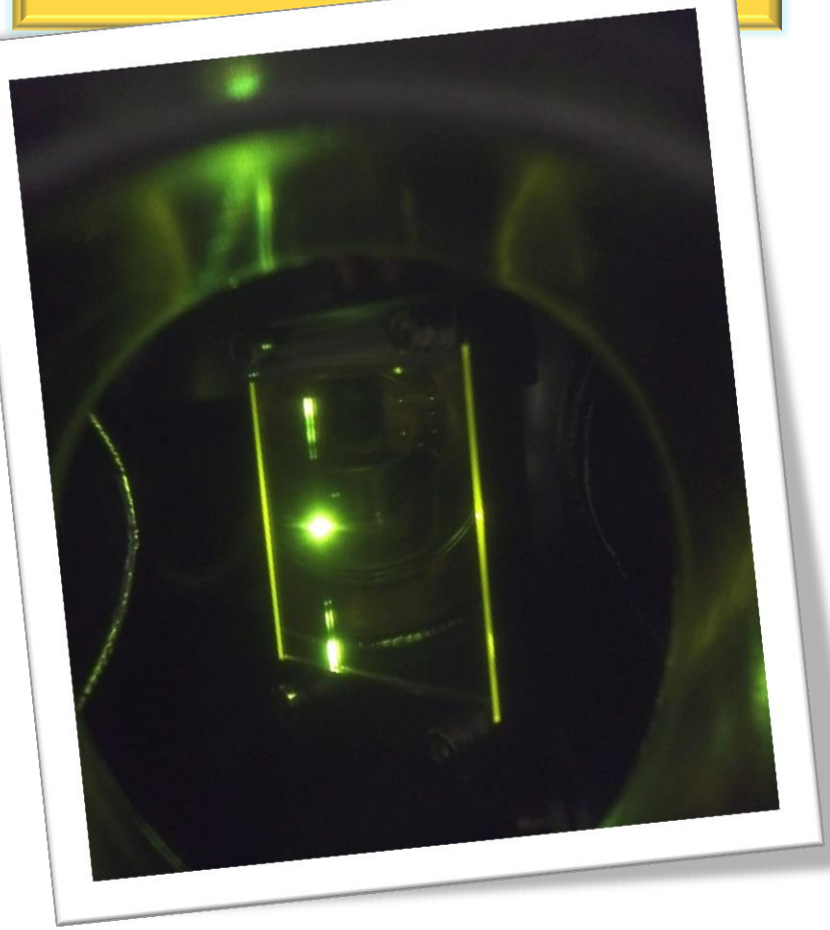






acknowledgements

THANKS FOR YOUR ATTENTION AND INTEREST ON BOREAS BEAMLINE !



BL29 Staff

J. Herrero (BL sci), P. Gargiani (BL sci), J. Moldes (control), A. Crisol (eng.), F. Farre (tech.), X. Fariña and X. Serra (electronics), and M.Valvidares

Special thanks&acknowledgement to

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