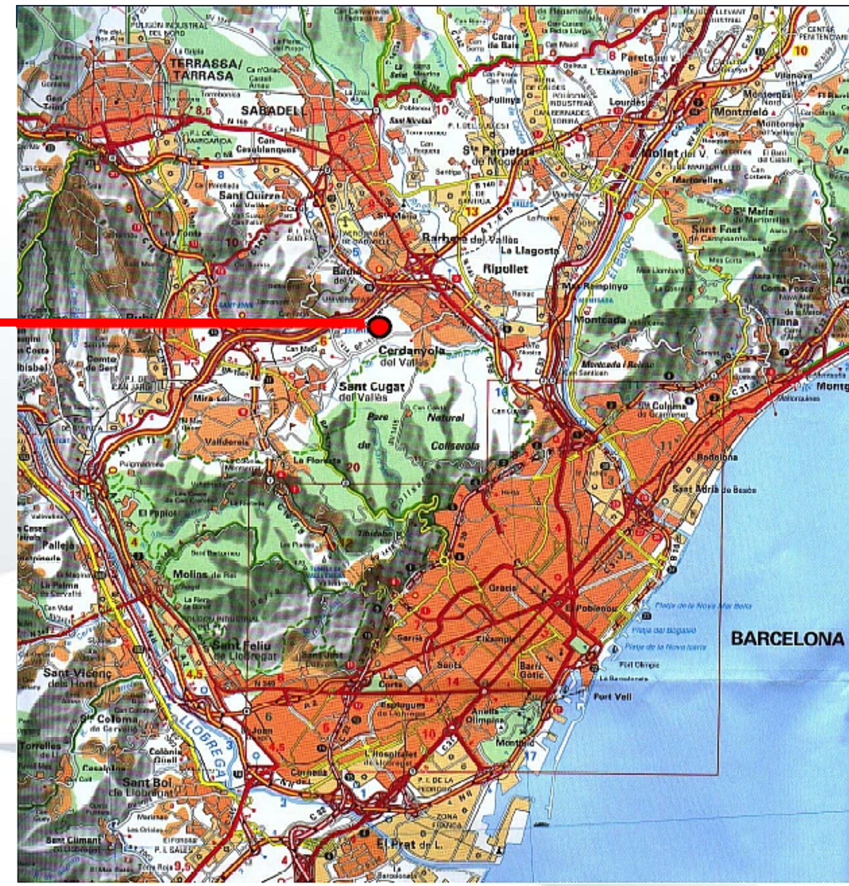
Status of IDs at ALBA and future plans

J. Campmany on behalf of ALBA team

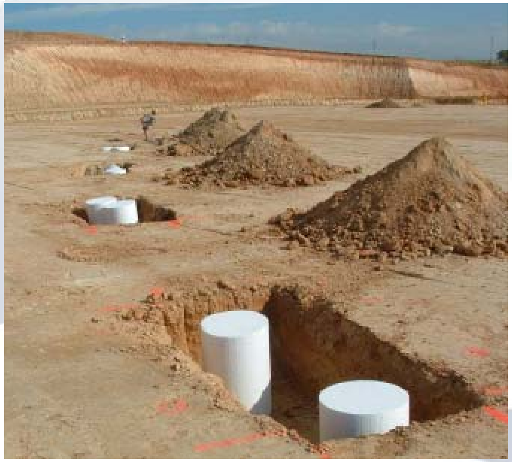
ALBA synchrotron: the site

ALBA site



ALBA site

Status of IDs at ALBA and future plans



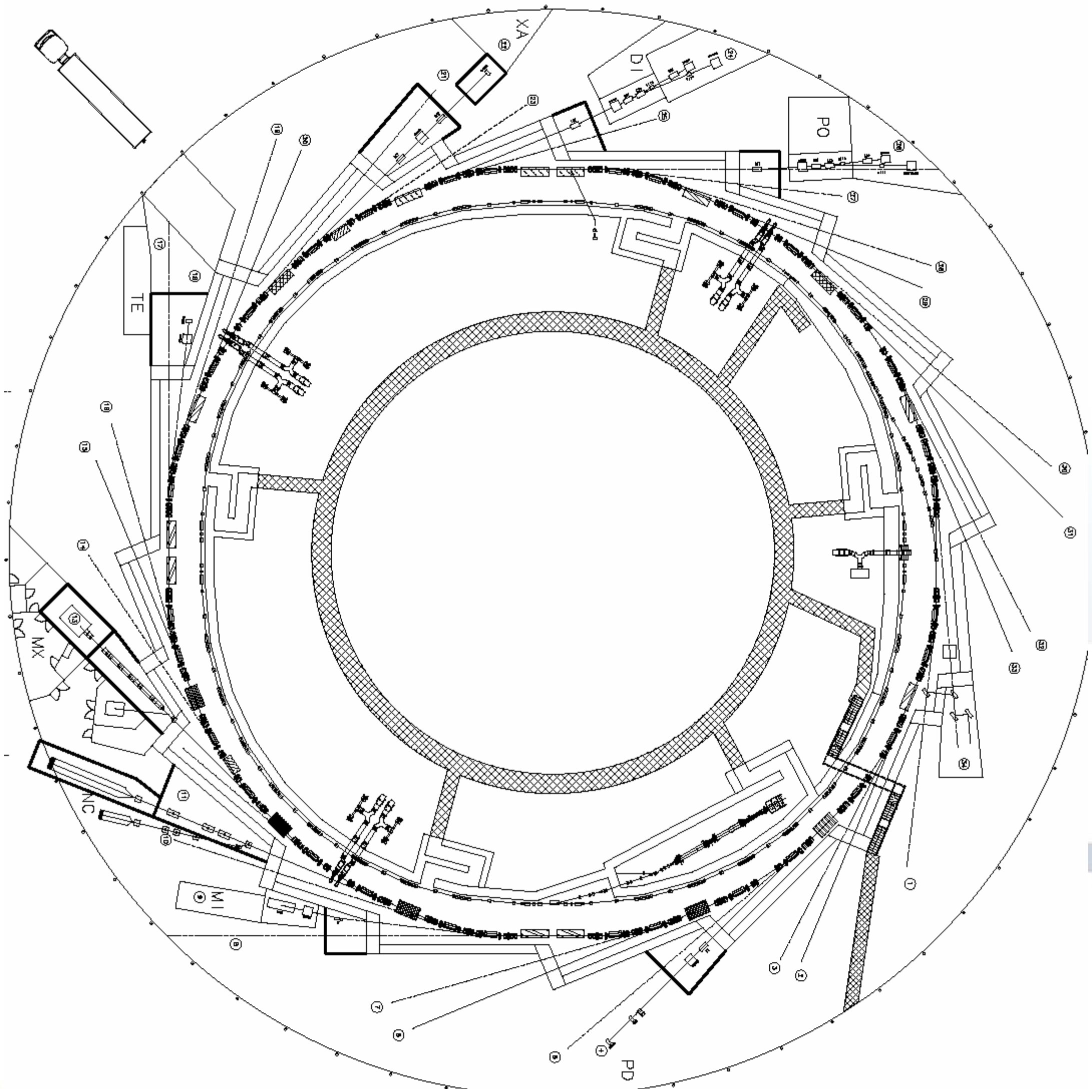
Civil works started on the 26th March 2006

ALBA management: through CELLS consortium

Main time-schedule

- 1 November 2007: Building ready for LINAC installation.
- 1 April 2008: Tunel ready for starting installation of Booster and Storage ring. Hall ready for hutch construction.
- 1 June 2008: Building finished.
- 1 October 2008: Booster and Storage accelerators commissioning. Starting of Beam line installation.
- 1 June 2009: Starts ID installation.
- 1 October 2009: Light from IDs into beamlines.

ALBA accelerators: storage ring layout

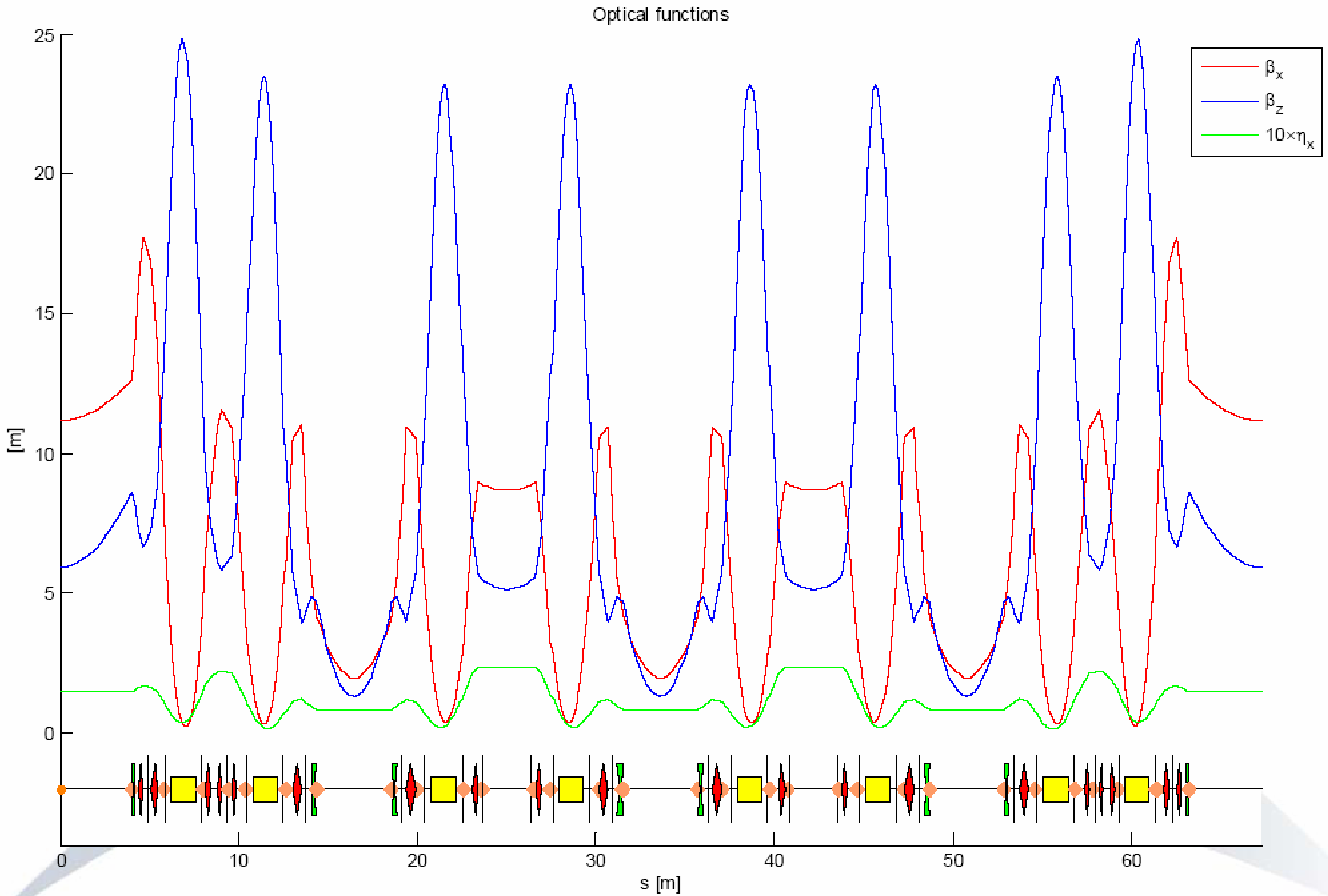


- 4 long straights
  - 3 available for IDs (1 for injection)
  - 6.95 m length
- 12 medium straigths
  - 12 available for IDs
  - 3.21 m length
- 8 short straigths
  - 2 available for IDs
  - 2.1 m length

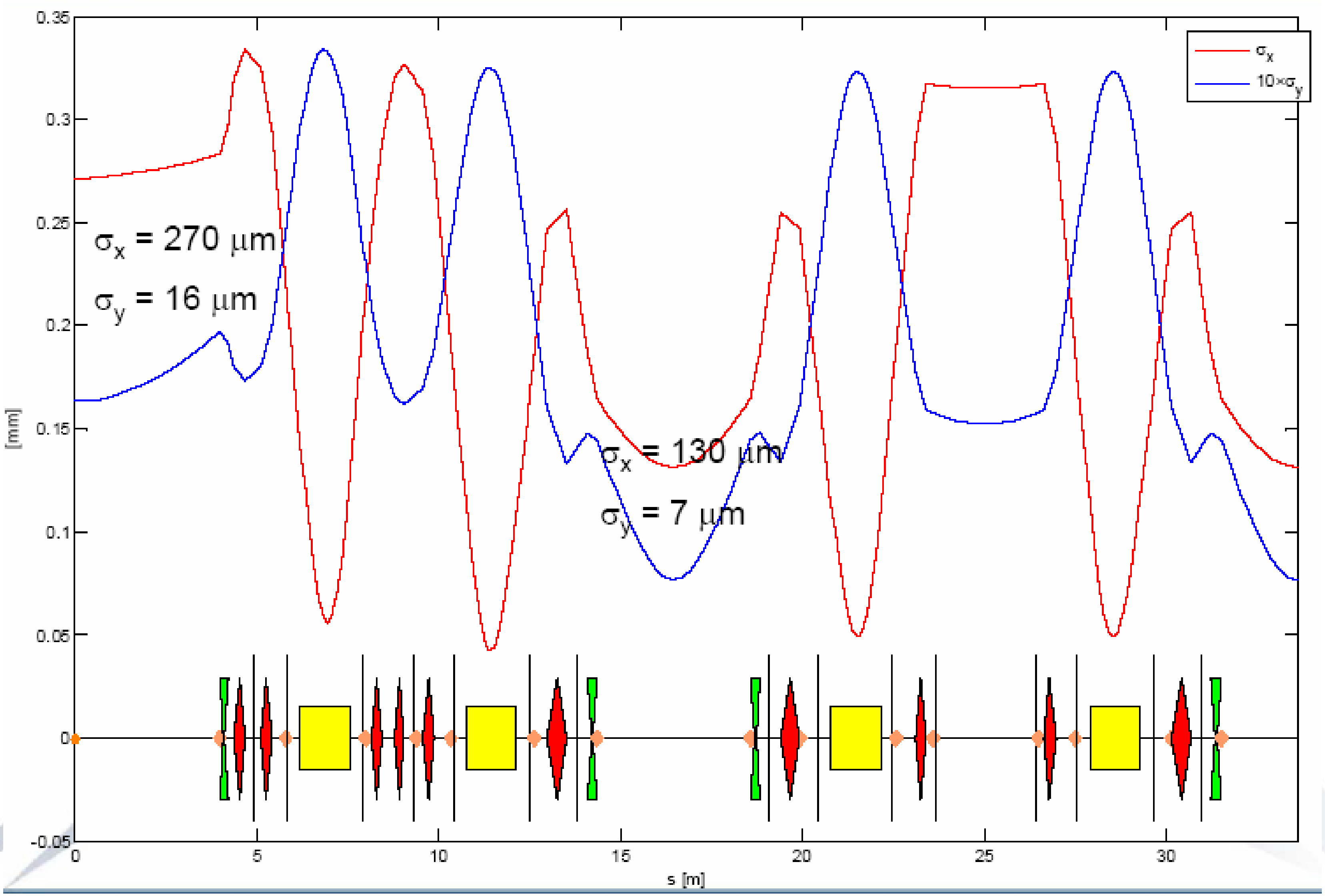
Status of IDs at ALBA and future plans

Name	Symbol	Unit	Value
Circumference	C	m	268.8
Energy	E	GeV	3
Horizontal Emittance	ϵ_x	nm-rad	4.3
Horizontal Tune	Q_x		18.178
Vertical Tune	Q_y		8.378
Natural Horizontal Chromaticity	C_x		-38
Natural Vertical Chromaticity	C_y		-27
Momentum Compaction Factor	α_p		8.8×10^{-4}
Second Order α_p	α_2		2.1×10^{-3}
Energy Spread	$\Delta E/E$		1.05×10^{-3}
Revolution Frequency	f_0	MHz	1.115
Horizontal Damping Time	τ_x	ms	4.1
Vertical Damping Time	τ_y	ms	5.3
Longitudinal Damping Time	τ_ϵ	ms	3.1
Horizontal Partition Number	J_x		1.3
Vertical Partition Number	J_y		1
Longitudinal Partition Number	J_ϵ		1.7
Energy Loss per turn	U_0	MeV	1.02

Optical functions



Beam sizes

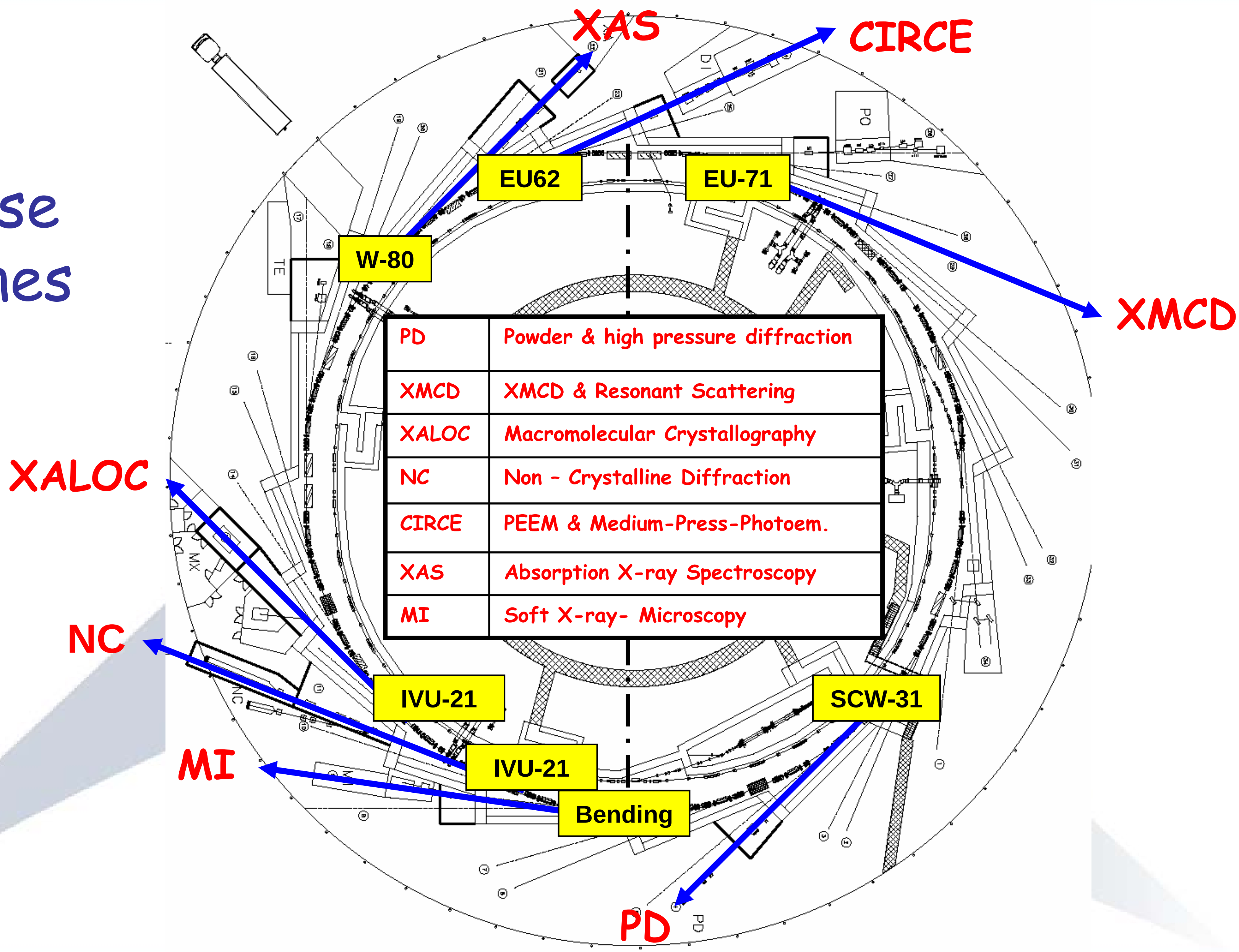


σx = 270 μm
σy = 16 μm
σx = 130 μm
σy = 7 μm
σx
10×σy
[mm]
s [m]
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
0
5
10
15
20
25
30

Source point characteristics

Name	β_x [m]	β_y [m]	D_x [cm]	σ_x [μm]	σ_y [μm]	σ'_x [μrad]	σ'_y [μrad]
Long straight	11.2	6.0	14.6	270	16	20	3
Medium straight	2.0	1.3	9	130	8	47	6
Short straight	8.7	5.1	23	310	15	22	3
Bending Mag. 1	0.4	24.8	4	55	33	105	1
Bending Mag. 2	0.5	23.2	2	42	32	94	1

ALBA 1st Phase Beamlines



PD	Powder & high pressure diffraction
XMCD	XMCD & Resonant Scattering
XALOC	Macromolecular Crystallography
NC	Non - Crystalline Diffraction
CIRCE	PEEM & Medium-Press-Photoem.
XAS	Absorption X-ray Spectroscopy
MI	Soft X-ray- Microscopy

Insertion Device status – Nov 2006

ID	Status
IVU21	Beamlines: Macromol. Christallography, Non-crystalline diff. Specs: λu=21 mm, L=2 m, Be=0.8 T, K=1.6 Status: conceptual magnetic design finished
EU71 EU62	Beamlines: Magnetic Dichroism, Low energy spectrosc. + PEEM Specs: λu=71 mm, L=1.7 m, Be=0.93 T, K=6.2 (H polarization) Specs: λu=62 mm, L=1.5 m, Be=0.88 T, K=5.1 (H polarization) Status: technical specifications finished (1st draft)
SC-W31	Beamline: High resolution powder diffraction Specs: λu=31 mm, L=1.7 m, Bo=2.1 T, K=6.08 Status: technical specifications finished (1st draft)
W80	Beamline: X-ray absorption spectroscopies Specs: λu=~80 mm, L=1 m, Bo=1.73 T, K=12.97 Stauts: technical specifications being drafted

Requirements

Beamline	Main requirement
XALOC	Reach 12.6 keV in lowest harmonic, no gaps between 3,5,7 harmon.
NC	Check if MX is suitable for NCD. Maximize flux near 10 keV
XMCD	Reach 99 eV with circular polarization, maximum flux @ 1.1 keV
CIRCE	Reach 80 eV with circular polarization, maximum flux @ 1.1 keV
XAS	Maximum flux on sample, smooth spectrum, low power
PD	Maximum flux on sample for E>20keV

Selection of periods

Elliptical undulators (CIRCE+XMCD)

Technical constraints:

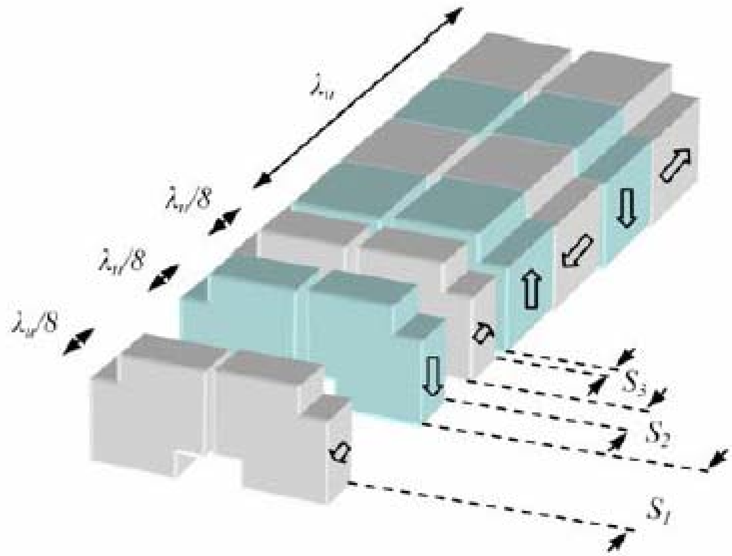
- Limitation in forces in all directions.
- Overall lenght of the device < 2.5 m
- Minimum magnetic gap = 15.5 mm

Scientific criterium:

- Reach 80 eV / 90 eV in circular mode
- Maximization of flux at 1,1 keV

Procedure: simplex algorithm

Free parameters: magnetic length, magnetic block height and width



XMCD & CIRCE beamlines: periods of 71 / 62 mm are found

CIRCE

Magnitude	*Simplex*
Period [mm]	61.8
W x H [mm x mm]	33 x 33
L [mm]	1497
Full period blocks	93
Bmax , K (V)	0.88 , 5.12
Bmax , K (H)	0.64 , 3.67
Bmax , K (C)	0.51 , 2.98

XMCD

Magnitude	*Simplex*
Period [mm]	71
W x H [mm x mm]	34 x 30
L [mm]	1650
Full period blocks	89
Bmax , K (H)	0.93 , 6.19
Bmax , K (V)	0.71 , 4.73
Bmax , K (C)	0.57 , 3.78

Table 1. *Limitation in forces produced by the device*

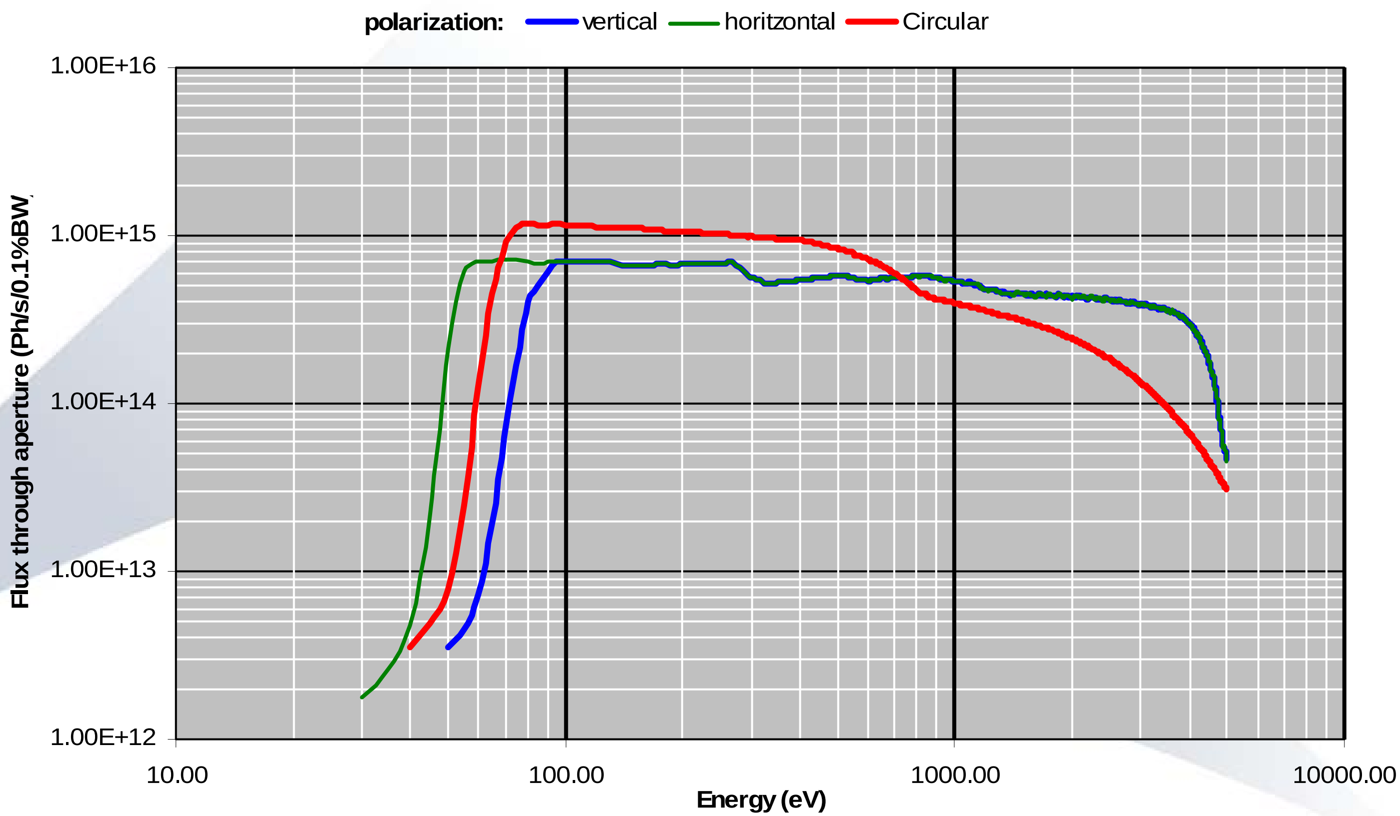
Maximum total transversal horizontal force on one fixed array.	*< 14.400 N*
Maximum total longitudinal force on one fixed array.	*< 14.400 N*
Maximum total vertical force on the set of two lower arrays.	*< 21.600 N*
Maximum horizontal force lineal density on one fixed array.	*9.0 kN/m*
Maximum longitudinal force lineal density on one fixed array.	*9.0 kN/m*
Maximum vertical force lineal density on the set of lower arrays.	*13.5 kN/m*

Flux through selected apertures

Calculations with electron energy dispersion and phase error of ~3°

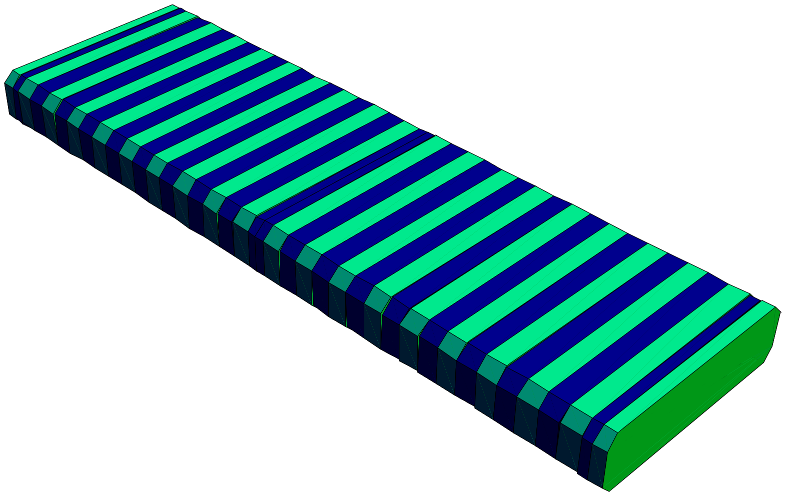
0.6 mrad H x 0.6 mrad V

EU71



Selection of periods

In-vacuum undulators (XALOC + NC)



Hybrid or PPM?

Main requirements

- Reach 12.6 keV in lowest harmonic
- No gaps between 3,5,7 harmonics

Main characteristics

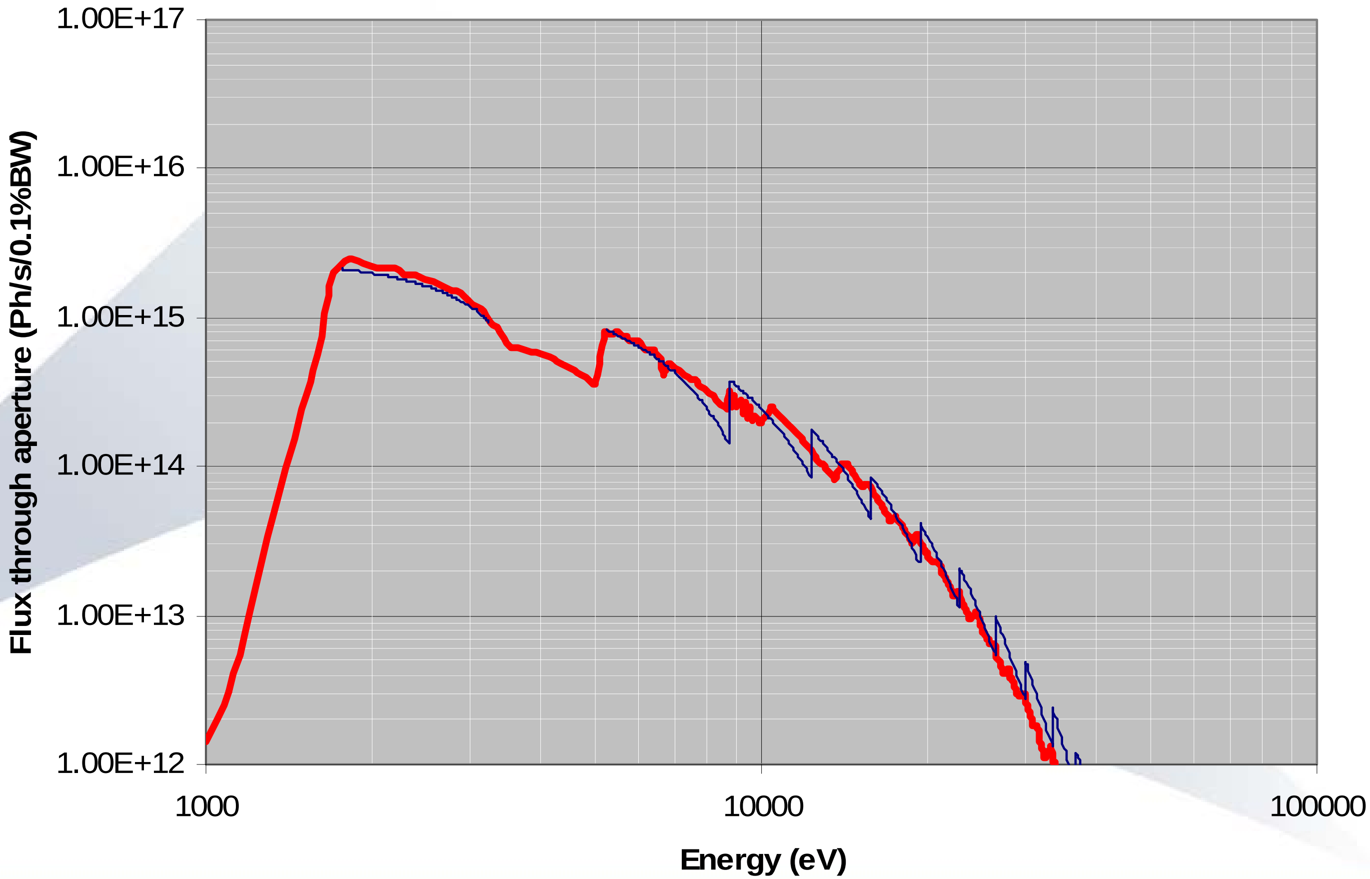
- PPM undulator
- SmCo magnet blocks.
- 5,5 mm minimum gap
- Block size: 50 x 16 mm
- Num. Periods full size: 93
- Length: 1.984 m
- Beff: 0.801 T
- K: 1.6

Flux through selected apertures

Calculations with electron energy dispersion and phase error of ~3°

0.29 mrad H x 0.1 mrad V

IVU21



Selection of periods

SC-Wiggler for PD

Technical constraints:

- Maximum power emitted, 20 kW
- Power absorbed by the first crystal of the monochromator < 700 W
- Maximum length, 2 m
- Maximum e-beam current, 400 mA
- Vacuum chamber vertical aperture, 8 mm
- Flux optimized at H aperture of 1 mrad

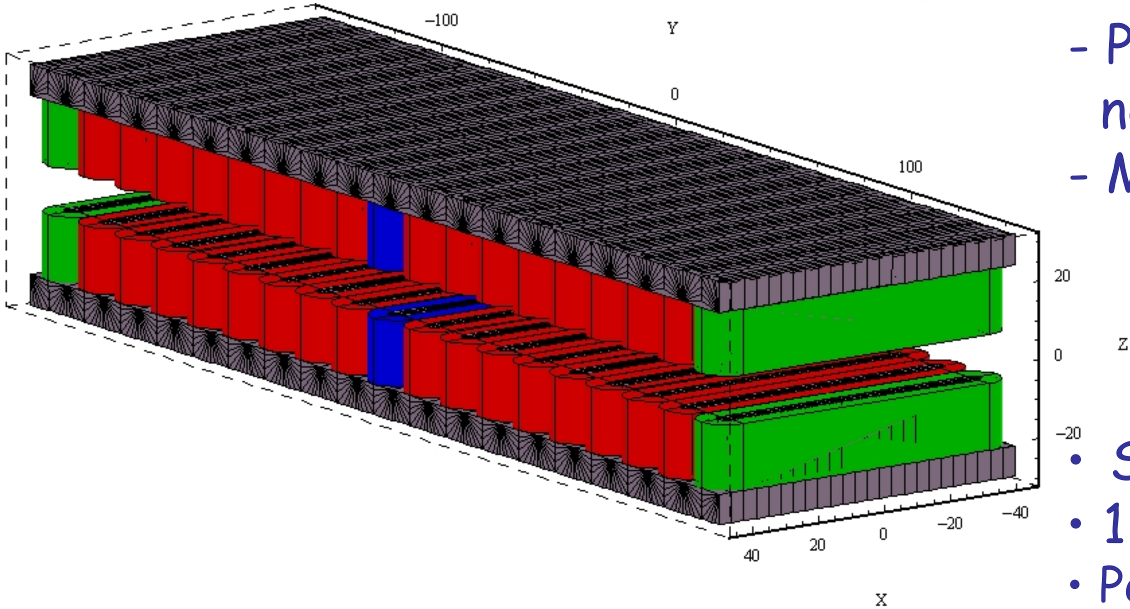
Results:

- Bo = 2.1 T
- Period as small as possible (maximize N in ~2 m length)-> 31 mm, K ~ 6.

PD beamline: a period of 31 mm is feasible

Selection of periods

SC-Wiggler for PD



Main requirements

- Power through monochromator not should exceed 700 W
- Maximum Bo with $(K/\gamma) \sim 1$

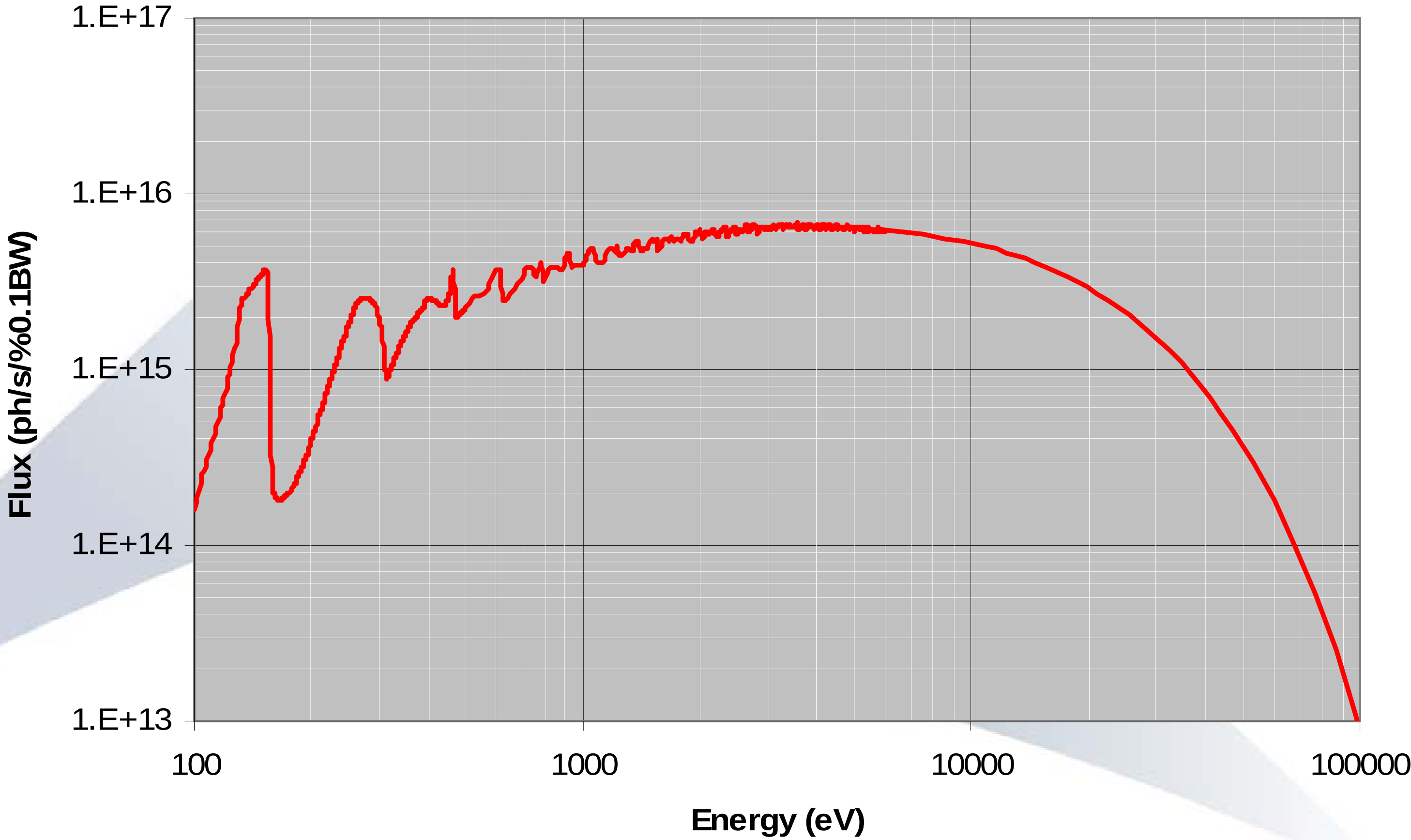
Main characteristics

- Superconducting wiggler
- 12,4 mm magnetic gap
- Period: 31 mm
- Num. Periods full size: 109
- Length: 1.720 m
- Bmax: 2.1 T
- K: 6.08

Flux through selected apertures

2.02 mrad H x 0.63 mrad V

SW31

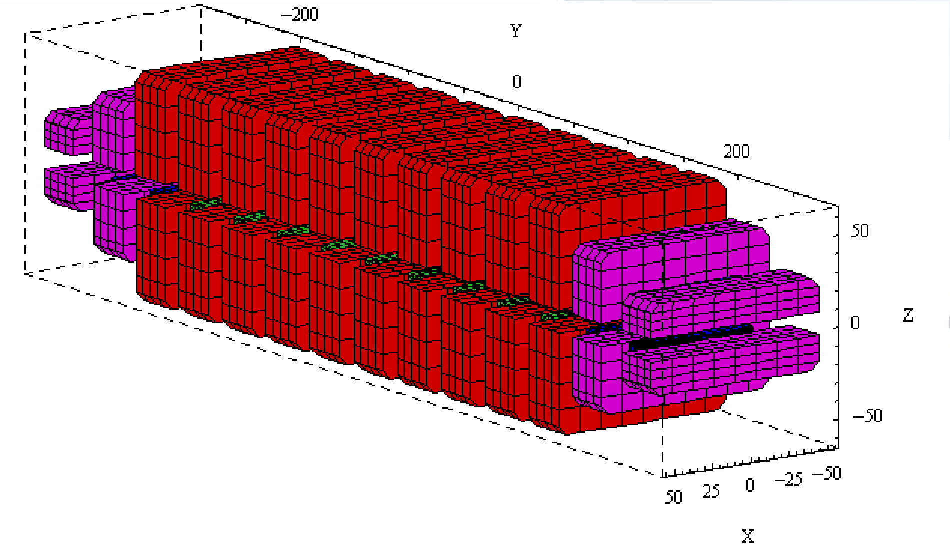


Selection of periods

Wiggler for EXAFS

Main requirements

- Power absorbed by the first crystal of the monochromator < 700 W
- Power to mirror < 1 kW
- Flux optimized at 1,50 mrad H and 0.25 mrad V
- Ripple @ low energies < 10%

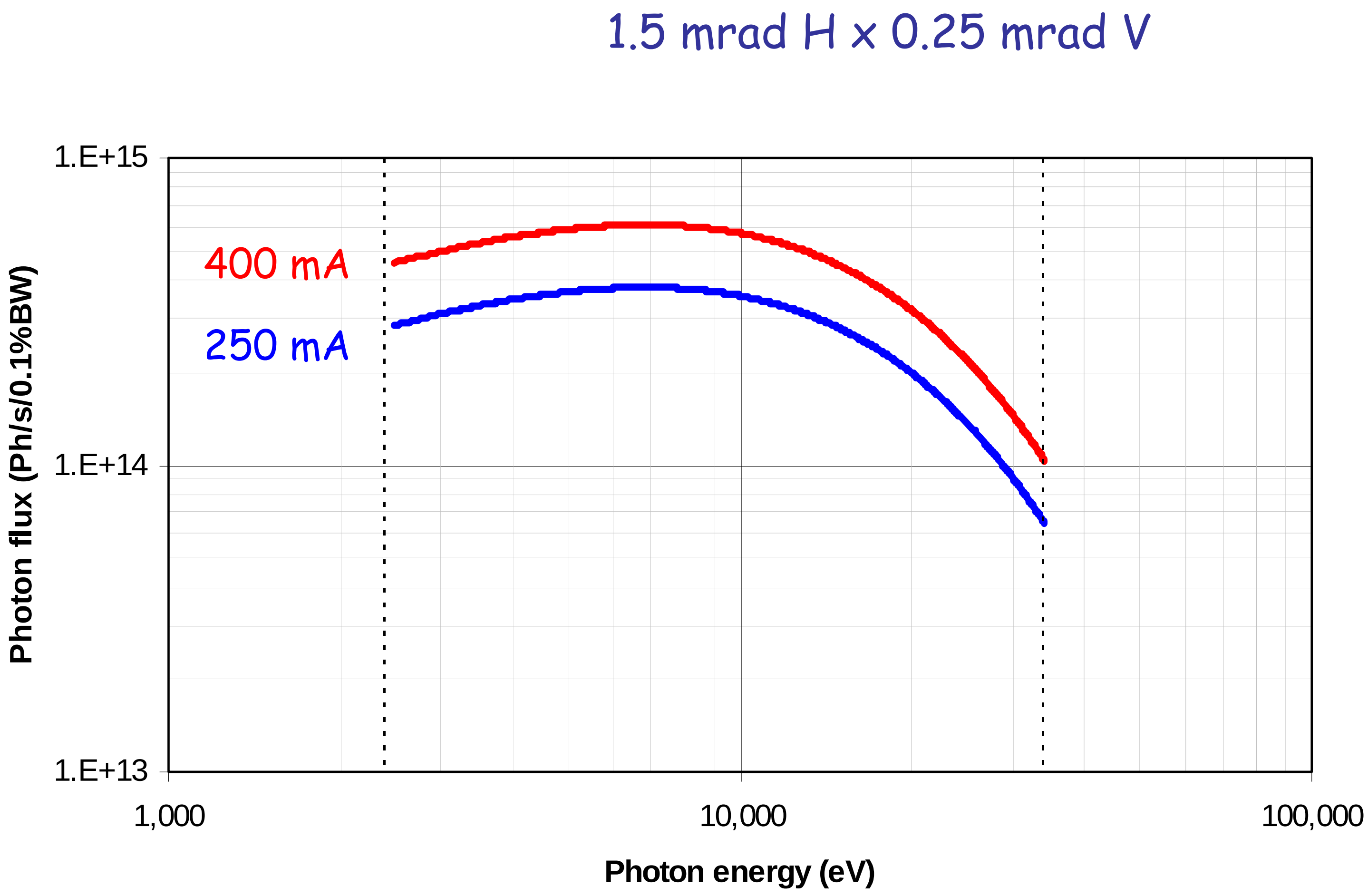


Main characteristics

- Hybrid structure
- NdFeB magnet blocks.
- 12,5 mm minimum gap
- Block size: 109 x 56 mm
- Pole size: 75 x 43 mm
- Num. Periods full size: 26
- Length: 1.027 m
- Bmax: 1.74 T
- K: 12.96
- Ripple @ low energies ~6%

Flux through selected apertures

W80



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Future plans

- «Phase B» beamlines (proposals approved but not funded)

  - Angle Resolved Ultraviolet Photoelectron Spectroscopy

    Energy range: < 100eV

    Fast polarization switching

    High resolution in energy ($\Delta E/E \sim 10^{-4}$)

    Electromagnetic helical undulator (normal conducting)

  - Surface and interface diffraction and nanoparticles

    Energy range: fixed energy ~10 keV

    Tunability is not a requirement. High photon flux peak on axis

    Possibility to operate without monochromator ($\Delta E/E \sim 10^{-2}$ or better)

    Cryoundulator (?)

Future plans

- «Phase C» beamlines (not yet evaluated)

  - Infra-red microscopy
    Bending magnet

  - X-ray absorption spectrocopy (Dispersive EXAFS and/or microfocussing)
    Conventional wiggler

  - Microfocussing
    In-vacuum undulator

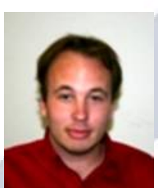
  - Biomedical beamline
    Superconducting wiggler

acknowledgements

ID Physicists

Jordi Marcos

Zeus Martí



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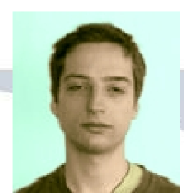

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