DESIGN OF FRONT END AND A 3-POLE-WIGGLER AS A PHOTON SOURCE FOR BEATS BEAMLINE AT SESAME

Josep Campmany,1 Ivan Cudin,2 Susanna Guiducci,3 Gianluca Iori,4 Jordi Marcos,1 Mohammad Al-Nadjawi,4 Pierre Van Vaerenbergh,5 Maher Attal.4

(1) ALBA-CELLS, Cerdanyola, Catalonia, Spain (2) ELETTRA, Basovizza, Friül-Venecia Julia region, Italy (3) INFN, Frascati, Lazio region, Italy (4) SESAME, Allan, Al Balqa governance, Jordan (5) ESRF, Grenoble, Isère Department, France

IPAC21

MOPAB086

INTRODUCTION

BEATS is an international collaboration funded by EU under Horizon 2020 programme, aimed to design and construct a hard X-ray full-field tomography beamline to be installed at SESAME synchrotron in Jordan. In this paper we present the design of the photon source and of the front end that interfaces the beamline with the accelerator. The photon source will consist of an out-of-vacuum 3-pole wiggler with a peak field of 3 Tesla; the contract for its manufacturing has been awarded to Kyma.

INSERTION DEVICE REQUIREMENTS

Scientific requirement is to have a small point as photon source. To fulfil this requirement, the solution is a out-vacuum 3-pole wiggler (3PW) hybrid type with one big pole and two small satellite poles with a device length of 755 mm The peak field is 3.1 T, enough to fulfil the requirements. Parameters are detailed in Table 1 and magnetic models in Figures 1 and 2.

Table 1: Main parameters of FAXTOR insertion device

Device type	bending
Magnetic configuration	Planar hybrid
Technology	Out vacuum
Number of periods	1 + 2
Maximum magnetic length	755 m
Magnetic minimum gap	11 mm
Minimum physical gap	11 mm
Gap range (magnetic)	11 mm to 30 mm
B_0 value at minimum gap	3T

Forces

This device, because the small gap and the amount of magnetic force cumulated, produces a huge overall force between both magnetic arrays, in this case 19000 N, this is 1900 kg. So, the mechanical design of such a device is also a challenge, and therefore a side blocks (yellow) have been introduced to compensate the force, as shown in Figure 1, resulting in a total force of 750 kg

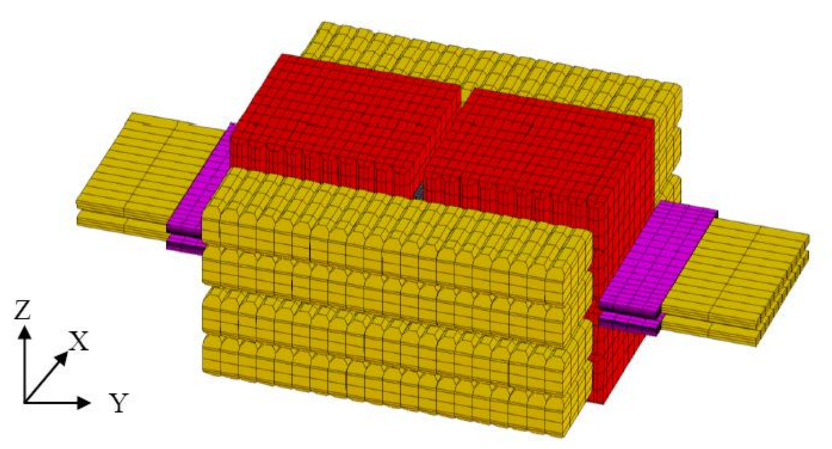

Figure 1 Magnetic model generated by RADIA.

In Figure 1, Red and orange parts are NdFeB magnets. Iron poles is in the centre and edge poles to compensate the field integral are in pink. Edge magnetic blocks are in yelow. Yellow side blocks have been introduced to compensate the huge attractive force in the device

Block and pole designs for conventional ID

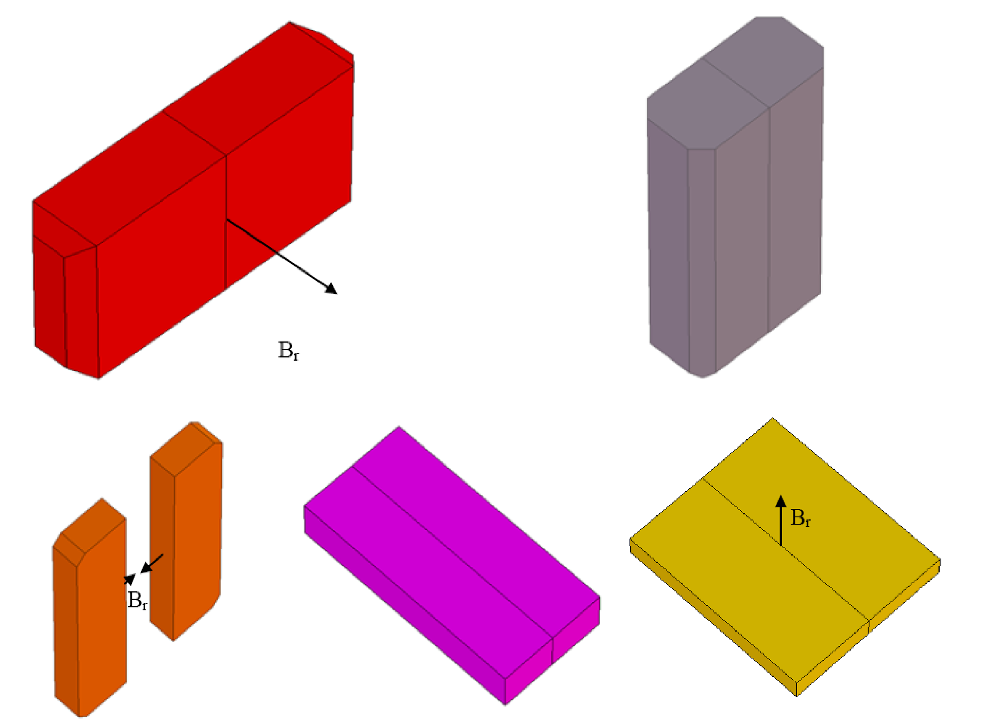

Figure 2 Shapes of the blocks: main block: 90 m width 40 mm height 20 mm thick. Central pole: 50 mm width, 80 mm height, 15 mm thick. Side blocks: 20 mm width each, 80 mm height, 15 mm thick. Ancillary poles (pink): 90 mm width, 15 mm height, 64 mm thick. Edge blocks (yellow) 80 mm width, 15 mm height, 105 mm thick.

Field

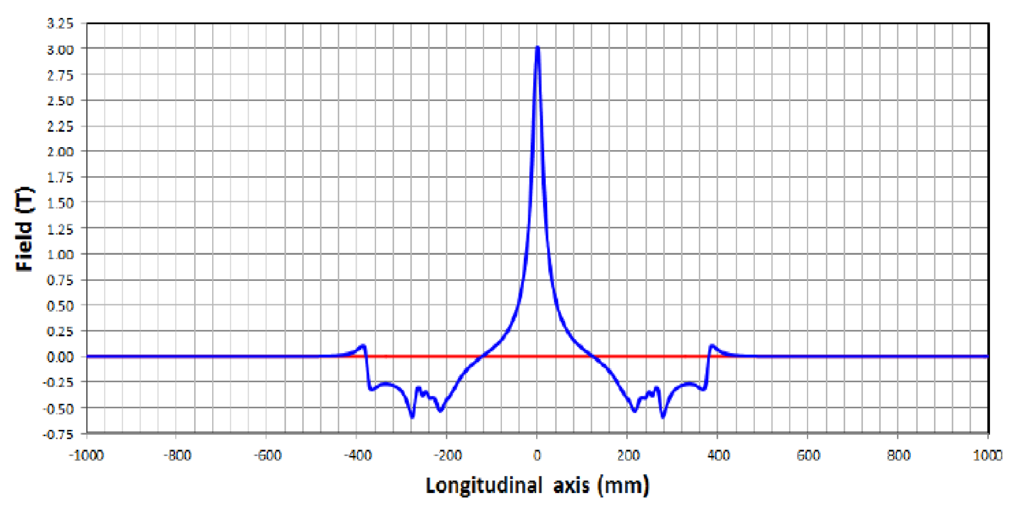

Figure 3 Magnetic field along longitudinal axis. As can be seen, the maximum field is 3 T, according to the specs.

The spectral flux through an aperture of 4×1mrad^2 obtained using SPECTRA code is shown in Figure 4.

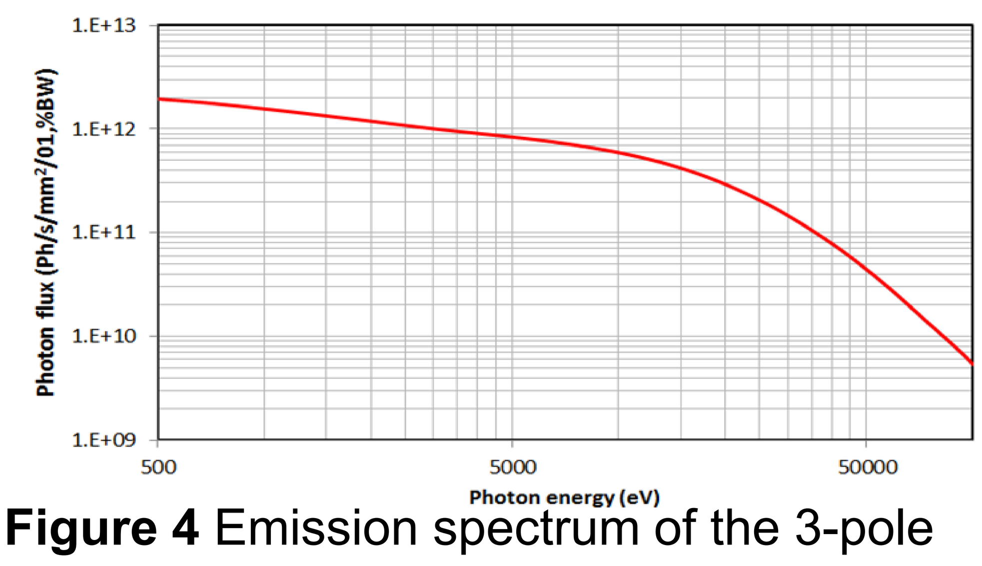

Figure 4 Emission spectrum of the 3-pole wiggler at minimum gap for an electron beam current of 100 mA

Demagnetizing field

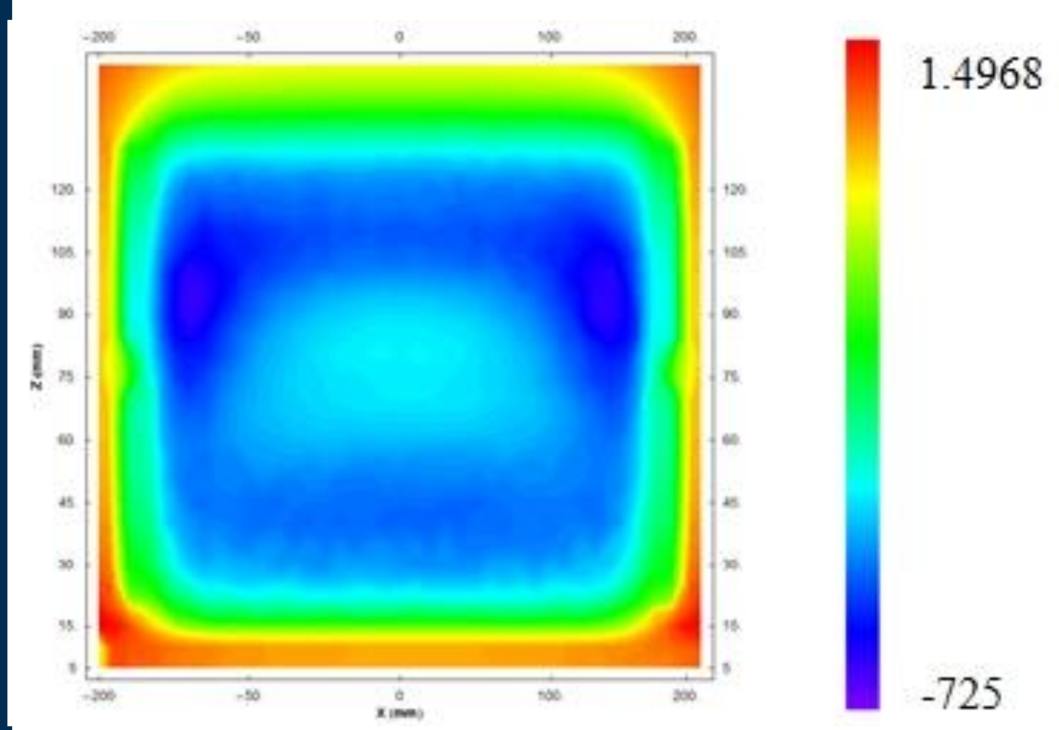

Figure 5 Demagnetizing field at Central block. Maximum demagnetizing inside the block is ~ -1007 kA/m. As shown, a minimum coercitivity of 1010 kA/m is required for the magnetic material.

MANUFACTURING

The manufacturing of this device has been awarded to KYMA and is currently being manufactured. The final design accepted is the same as proposed in conceptual design provided by ALBA, but without the side blocks to compensate the magnetic force, stating that mechanical chain can take the force. Acceptance tests will be done at KYMA premises.

BEATS FRONT END

The total power (~1kW @400mA) and the peak power density (250W/mrad^2 @400mA) associated to the 3PW source are relatively small, similar to the values corresponding to SR dipoles of medium energy (2-3GeV) 3rd generation light sources. Taking this into account, together with the requested user aperture of 1.8×0.4mrad^2, the Front End (FE) has been designed accordingly. As a reference for the design we have taken the standard configuration for bending magnet FEs at ALBA, adapting it to the particularities of SESAME. The design includes: (i) a fixed mask to protect the downstream elements and to define the user aperture, (ii) a photon shutter, (iii) a fast closing valve triggered by gauges installed on the beamline side for protection of the accelerator's vacuum, (iv) a system of primary slits (refurbished from ID19 beamline at ESRF), (v) a set of beam attenuators with 5 independent axes, and (vi) a single-block Bremsstrahlung stopper.The layout of the FE is shown in Figure below. All power absorbing elements have been dimensioned to withstand delivered by a stored electron beam of up to 400mA. Most of the FE units are being manufactured by company JJ X-ray A/S (Denmark), and will be delivered on April 2022.

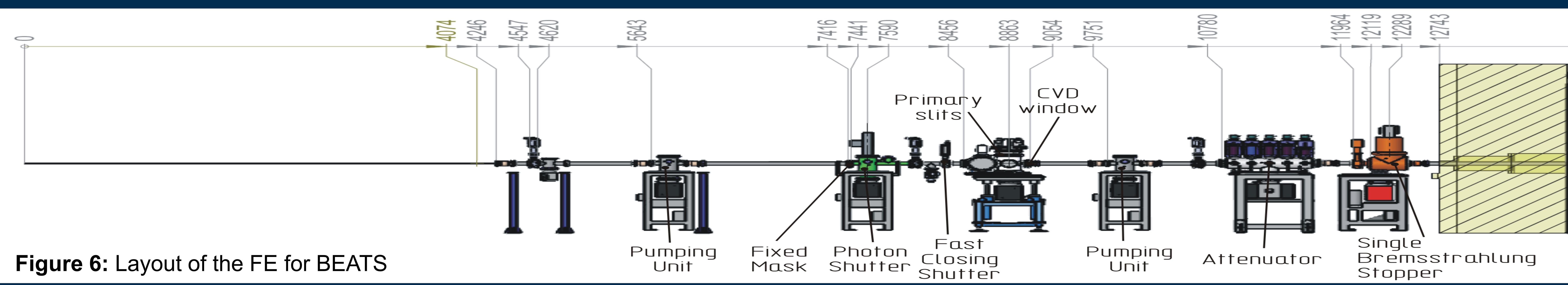

Figure 6: Layout of the FE for BEATS

CONCLUSION

Device fulfilling the scientific requirements is feasible using conventional technologies and out-vacuum.