CNPEM Brazilian Center for Research in Energy and Materials

MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATIONS — PÁTRIA AMADA BRASIL — BRAZILIAN GOVERNMENT

Status Report of Sirius Delta Undulator

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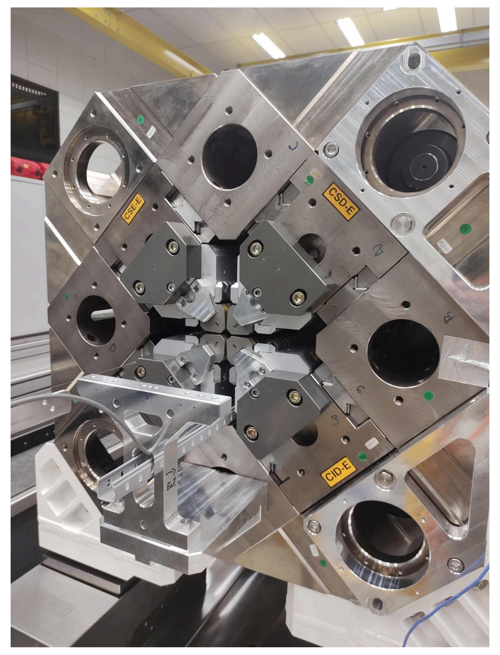
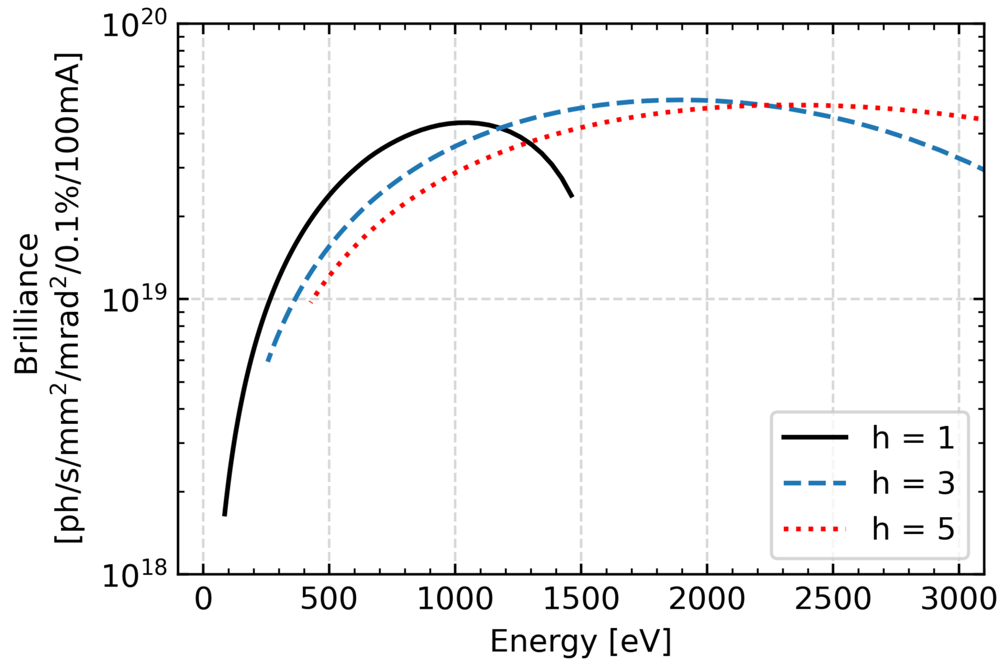
Abstract

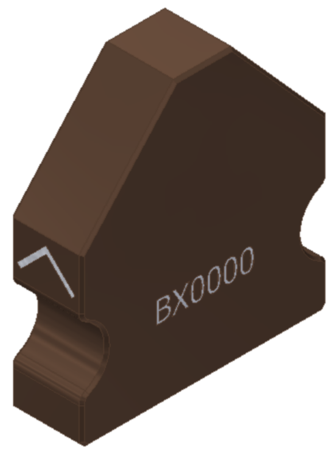
The first Delta undulator for Sirius, a 3 GeV 4th generation synchrotron light source located in Brazil, is currently being built. It will be the first undulator of this type to be used in a storage ring based light source. The undulator has a 1.2 m long pure permanent magnet structure with 21 periods of 52.5 mm, a 13.6 mm fixed gap and four magnetic arrays that can be moved in the longitudinal direction to provide full polarization control. This paper presents an overview of the Delta undulator project regarding its design, construction, measurements and field correction methods.

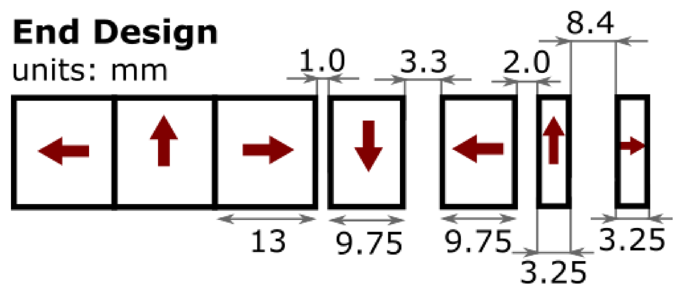


MAGNETIC DESIGN



Undulator Main Parameters	
Period length	52.5 mm
Number of periods	21
Magnetic gap	13.6 mm
Maximum field	1.25 T
Maximum K	6.1

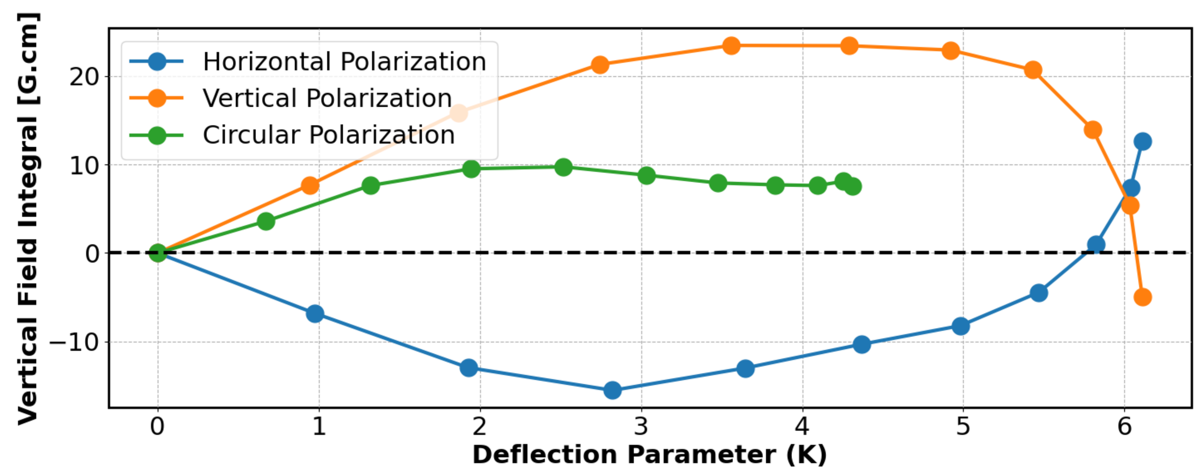




NdFeB PM Block	
Br	1.37 T ± 1%
Hcj	> 20 kOe

The python version of the Radia software was used for the field integrals calculations and the Simcenter MAGNET software, for the magnetic force simulations. A simulated annealing algorithm was implemented for the end design optimization.

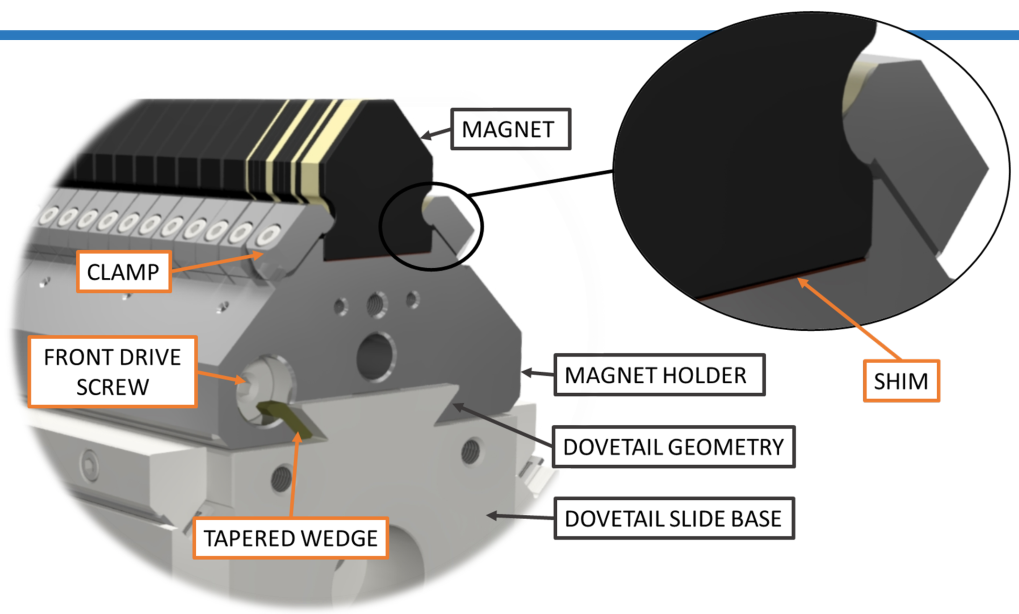
Magnetic Force Simulations	
Maximum Longitudinal Force	33 kN
Maximum Transverse Force	29 kN



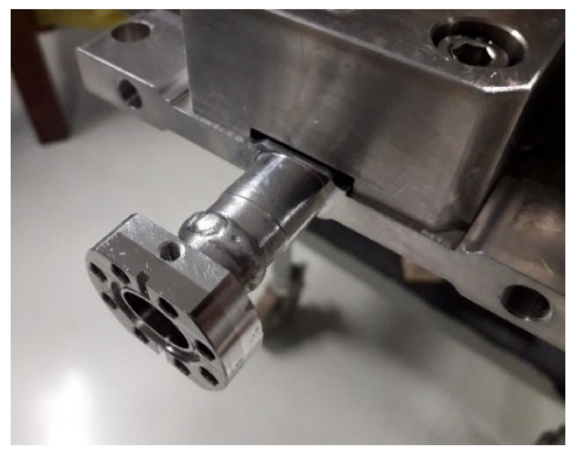
Simulated vertical field integral along the beam axis. The values for the horizontal field integrals are negligible.

MECHANICAL DESIGN: SUB-ASSEMBLY

The magnet holders (AA7075-T6) are fixed to the slide base using a dovetail type geometry and locked by a clamping system using a tapered wedge tightened by a front drive screw, in such way that the magnet holders can be sequentially mounted and bolted to each other to prevent slipping. Each magnet is fixed with two opposite clamps (AA7075-T6) by screws, enabling adjustments of ±0.25 mm by using brass shims at the magnets base.



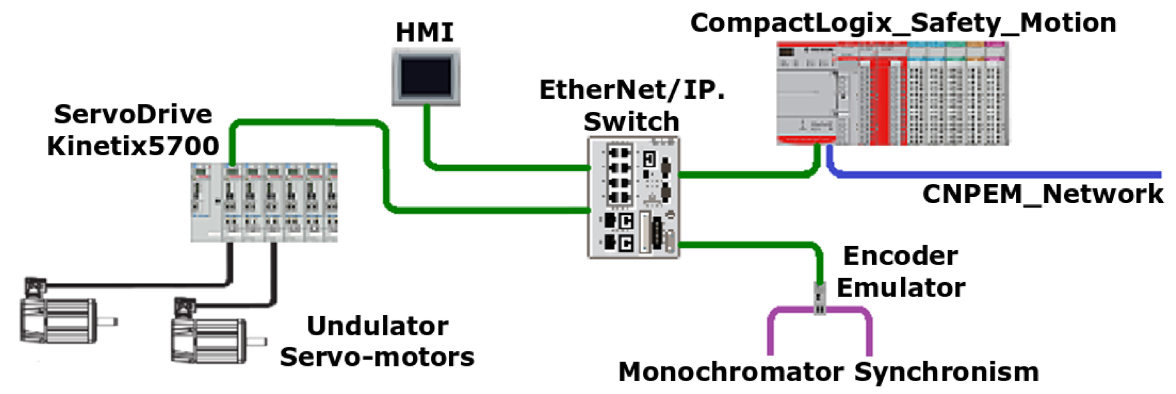
VACUUM CHAMBER



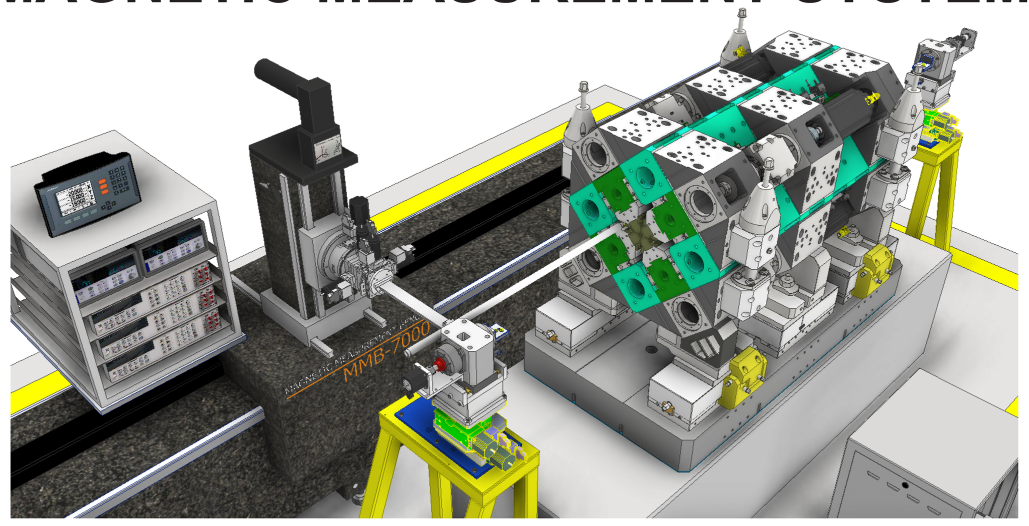
- Extruded 6063-T6 aluminum vacuum chamber
- Inner vertical aperture of 7.6 mm and inner horizontal aperture of 13 mm
- 5 mm diameter cooling channel with water flow of 1 L/min (185 W heat load)
- NEG coated with a film thickness of 0.6 µm
- Final pressure of 1.5×10^{-10} mbar achieved in the NEG activation tests

CONTROL SYSTEM

Cassettes Longitudinal Movement	
Range	±26.25 mm
Position repeatability	0.2 µm
Speed	2 to 8 mm/s
Acceleration	20 mm/s²



MAGNETIC MEASUREMENT SYSTEMS



- Individual blocks measured with a Helmholtz coil system
- Field map obtained with a 0.75 mm thickness low-noise 3-axis SENIS hall probe
- Field integrals measured with a in-house developed single stretched wire system

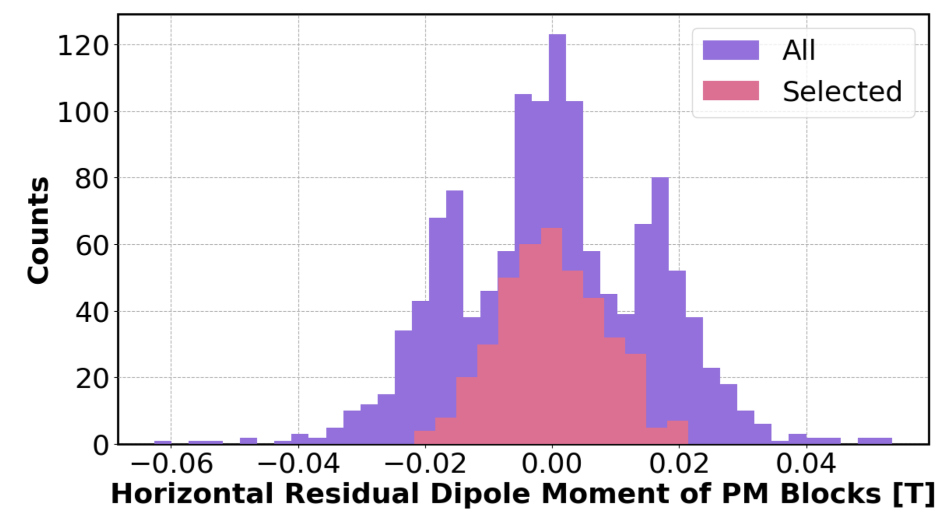
The stretched wire bench is 2.8 m long and has two vertical and two horizontal stages with positioning accuracy of 2 µm and 4 µm respectively. A low noise amplifier with low pass filter conditions the signal. The vertical stages speed is lower than the horizontal stages, leading to less precise horizontal field component measurements.

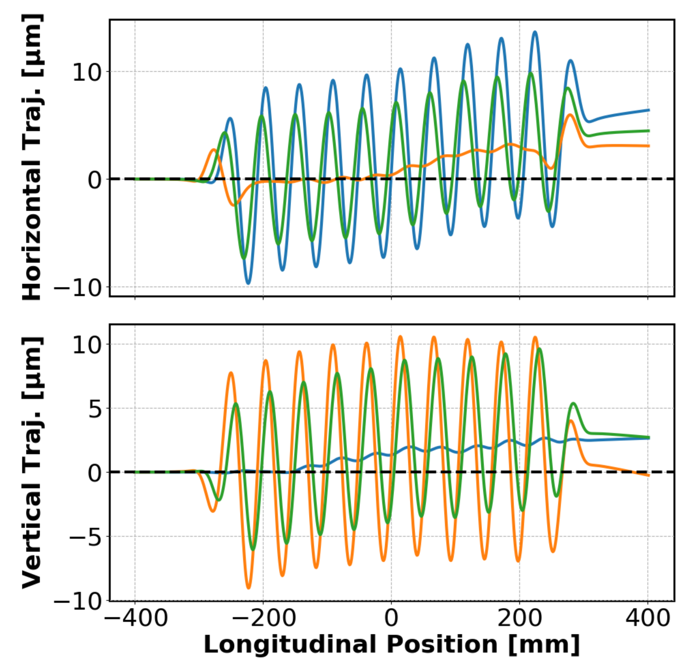
Stretched Wire Measurement Errors	
Horizontal first field integral	9 G cm
Vertical first field integral	3 G cm
Horizontal second field integral	2.8 kG cm²
Vertical second field integral	0.8 kG cm²

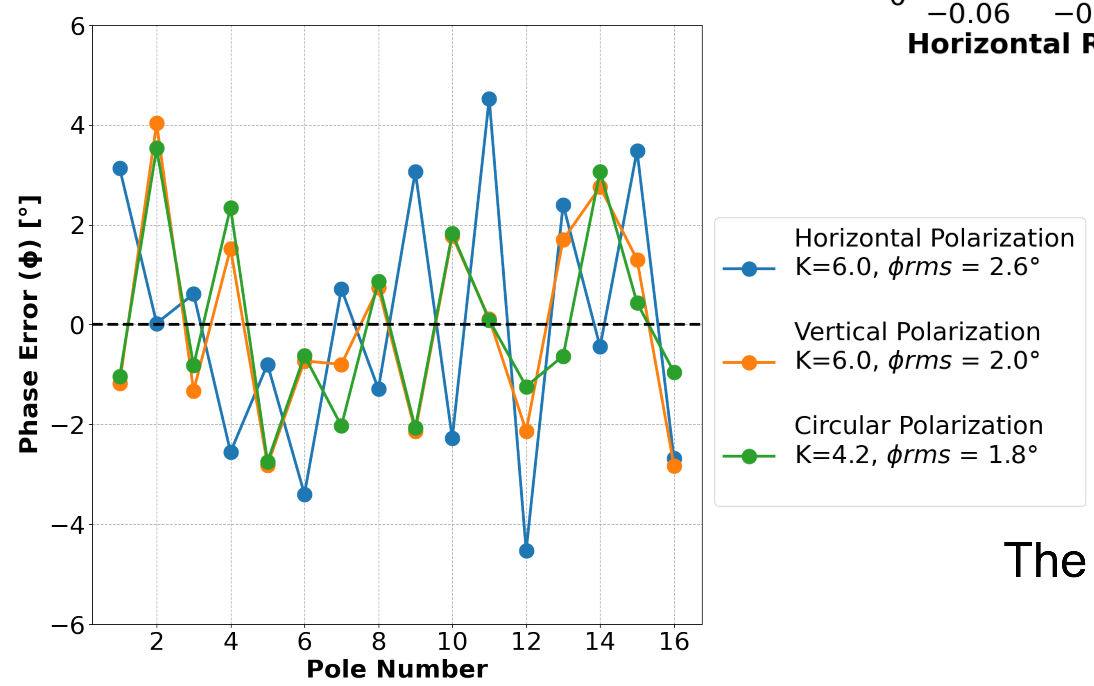
MAGNETIC FIELD CORRECTION: PRELIMINARY RESULTS

Field correction steps:

- Blocks sorted based on single block measurements
- Field integral of each magnet holder (12 blocks) corrected with block rotations and virtual shimming
- Assembly of a few periods in the undulator structure followed by field correction with virtual shimming (the current assembly has 9 periods)







Field Integrals [G cm]		
Polarization	IBx	IBy
Horizontal	−2	−70
Vertical	35	−6
Circular	16	−52

The virtual shimming corrections are still in progress.

NEXT STEPS

- Assembly of the remaining magnet holders in the undulador structure
- Magnetic field correction for the full undulator
- Instalation in the storage ring scheduled for January-2022

ACKNOWLEDGMENT

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