

MAX IV AND SOLARIS 1.5 GeV STORAGE RING MAGNETS

M. Johansson*, MAX IV Laboratory, Lund, Sweden,
K. Karas, Solaris NSRC, Krakow, Poland
R. Nietubyc, NCBJ, Otwock, Poland

Two identical storage rings



- where each double bend achromat is realized as one "magnet block".



Magnet block bottom half

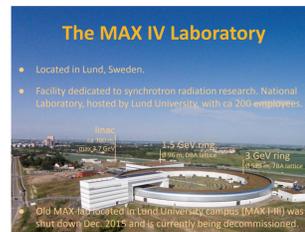
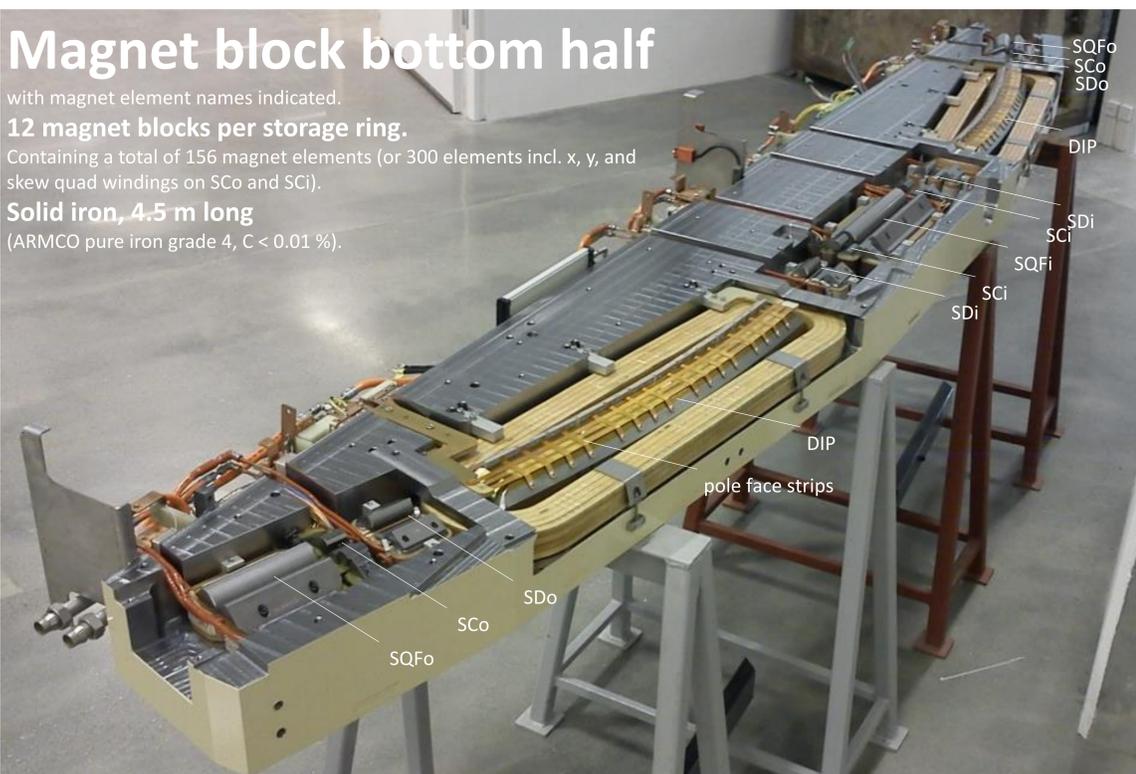
with magnet element names indicated.

12 magnet blocks per storage ring.

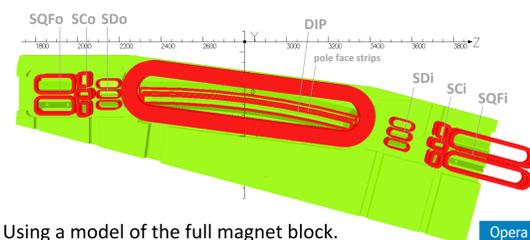
Containing a total of 156 magnet elements (or 300 elements incl. x, y, and skew quad windings on SCo and SCi).

Solid iron, 4.5 m long

(ARMCO pure iron grade 4, C < 0.01 %).



Magnet block designed using Opera-3d



- Using a model of the full magnet block.
- Exported to 3D cad format as basis for manufacturing drawings.

Specification and procurement

- Magnet blocks procured as fully assembled and tested units.
- Supplier responsible for
 - mechanical tolerances - ± 0.02 mm over 4.5 m block length!
 - performing field measurements according to MAX-lab spec.
- MAX-lab responsible for magnetic field properties.
- Contract awarded to Danfysik A/S, Denmark.
 - MAX IV contract signed fall 2012.
 - Solaris contract soon after, 12 + 12 magnet blocks to both facilities was one production series.
 - Delivery completed spring 2015.

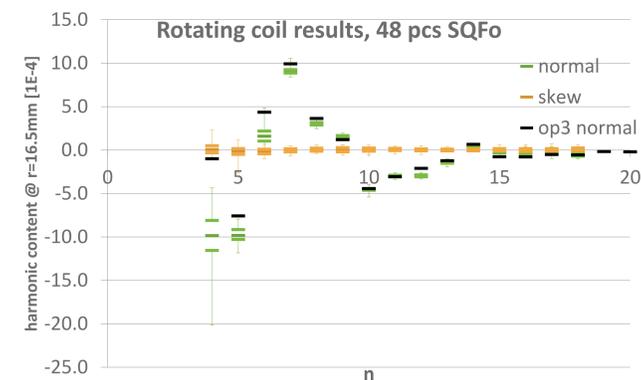
Mechanical measurement results, 24+24 yoke halves

Feature	No [pcs]	Evaluation	Tolerance [mm]	Min. [mm]	Max. [mm]	RMS [mm]
Midplane	48	flatness	0.05	0.021	0.049	0.037
SQFo	96	surface shape	± 0.02	-0.020	0.020	0.010
SDo	94	surface shape	± 0.03	-0.044	0.044	0.017
DIP	96	surface shape	± 0.02	-0.021	0.026	0.015
SDi	92	surface shape	± 0.03	-0.038	0.042	0.018
SQFi	48	surface shape	± 0.02	-0.024	0.020	0.013

Measured over full block length of 4.5 m in 3D CMM, with DIP pole shape machined in the iron block, and SQFo/SDo/SDi/SQFi pole tips assembled in place (cf \angle bottom half photo).

Every magnet element in every magnet block measured by Hall probe or rotating coil

Example, harmonic content higher order terms, for one magnet type \downarrow which is typical in that error terms directly above the main have the largest spread, and that average values agree fairly well with Opera-3d. For a full overview of field measurement results, see paper.



Status

Solaris

- Commissioning start May 2015
- First turns at injection energy early June 2015.
- Stacking late June 2015.
- 1st ramp to full energy Oct 2015.
- June 2016: 400 mA at 1.5 GeV.
- User operation Jan. 2017.

MAX IV

Commissioning started Sept 2016.
1.6 mA stored beam late Sept. 2016.



* martin.johansson@maxiv.lu.se