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Installation of the ASTRID2 Synchrotron Light Source

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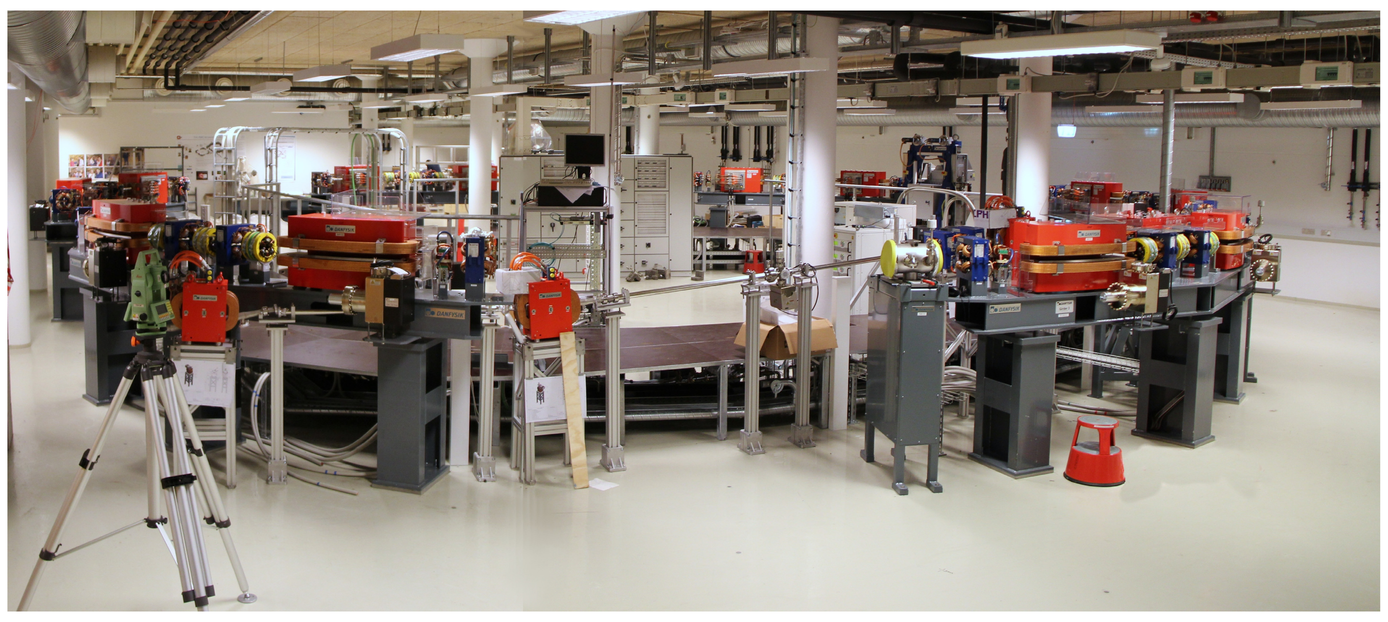
ASTRID2 is the new 10 nm UV and soft x-ray light source currently being built at Aarhus University, to replace the aging source ASTRID. ASTRID2 is now in the middle of its installation phase, and almost all components have been received. Beam has been extracted from ASTRID and commissioning of the first part of the transfer beam line has started. Commissioning of the ASTRID2 ring is expected to start early 2012.

Introduction:

The ASTRID storage ring has now been in operation for 20 years, and although the beam has a very good lifetime in excess of 100 hours at 150 mA, the relatively large emittance (140 nm), the limited stability and lack of straight sections for insertion devices has since long called for an upgrade. At the end of 2008, we obtained a grant from the National Research Infrastructure Fund in Denmark to build a new low-emittance UV and soft x-ray light source named ASTRID2. The new storage ring will be operated in top-up mode using the present ASTRID as a full-energy booster synchrotron.

Present State

All magnets for ASTRID2 have been installed and cabling for the magnets is progressing well. Most vacuum components are ready, and installation of the vacuum system has begun. The RF cavity, which has been designed by MAX-Lab and is manufactured by RI Research Instruments GmbH, is well under way and is expected to be finished this year. Installation is expected to be completed by the end of 2011, so commissioning can start early 2012. After successful commissioning of ASTRID2, beam lines will be transferred one by one to ASTRID2. The photo shows the state of ASTRID2 as of Aug. 2011.

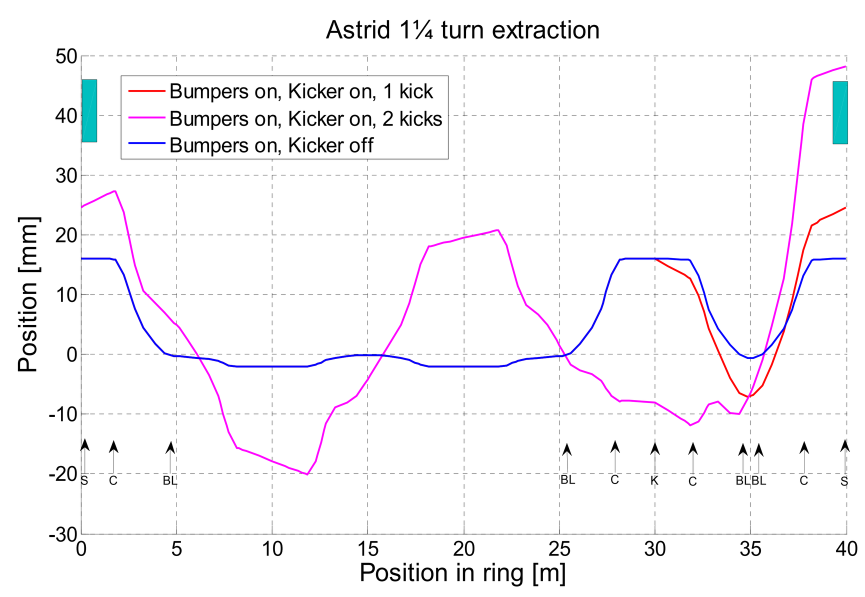


Timeline:

- 2011:
  - Installation of the ring.
- 2012:
  - Commissioning of the ring, and transfer of first beam lines.
- 2013:
  - All beam lines transferred and installed at ASTRID2.

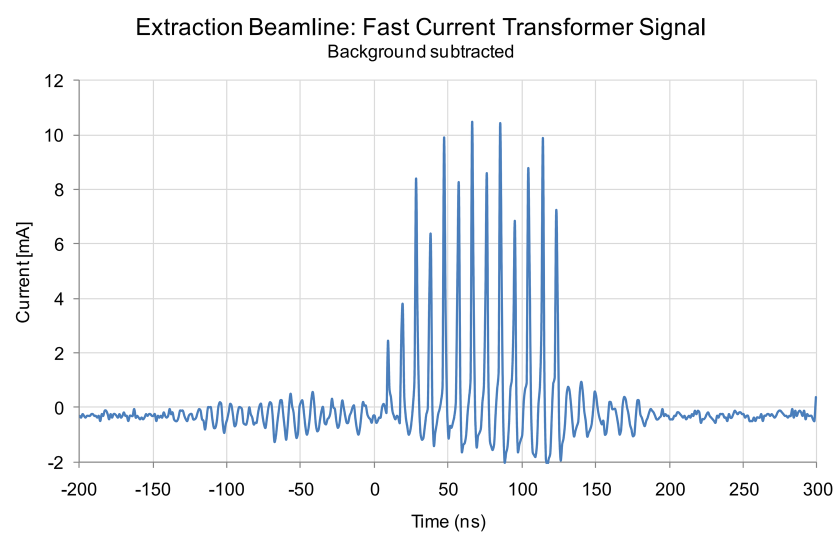
Extraction from ASTRID

Extraction from ASTRID uses a single kicker, placed ¼ turn before the thick (11 mm) DC extraction septum (which is also used for injection). The beam passes the kicker twice, effectively giving a 1¼ turn extraction. To relax the kicker strength the beam is slowly bumped close to the septum.



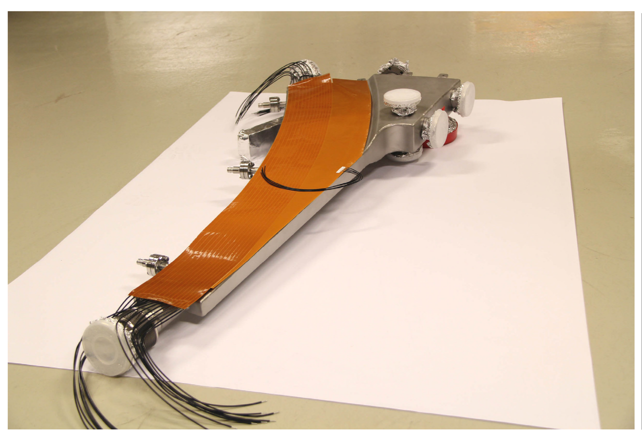
Commissioning of first part of the transfer beam line

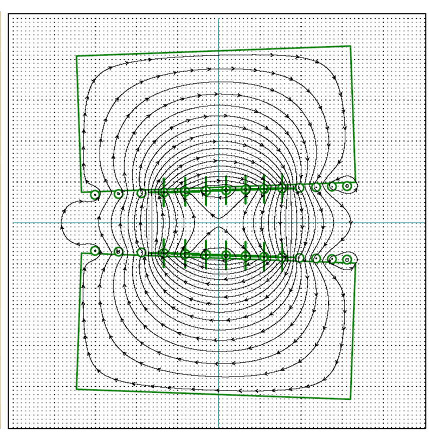
The first part of the transfer beam line (the part inside the ASTRID hall) has been installed and commissioning has begun. The beam has successfully been transport to the end of the installed beam line.

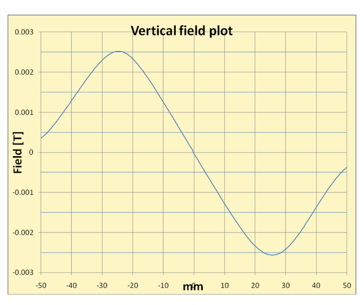


Pole-face windings

All of the ASTRID2 dipoles are equipped with a pair of pole-face windings. The pole-face windings are thin (<0.3 mm) flexible prints with 14 strips (wires) of copper, placed directly on the top and bottom of the vacuum chamber. The central 7 strips carry current in the same direction and thus generate a quadrupole field. The outer 3+4 stripes are used for the return current. The thickness of the copper strips is 0.15 mm and the width of the strips varies between 4.4 and 7.4 mm. The variation in width is necessary to compensate the varying pole gap, due to the integrated quadrupole gradient in the dipole magnets, and give a constant quadrupole gradient across the pole face. With a current of 10 A, we get a quadrupole gradient of 0.12 T/m.

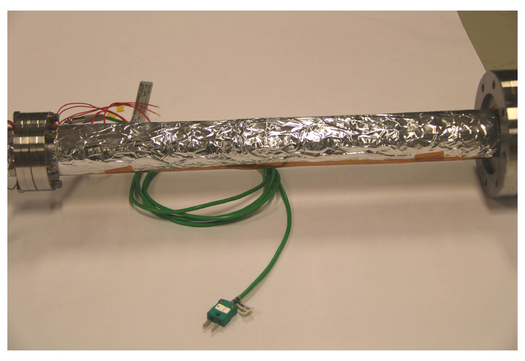






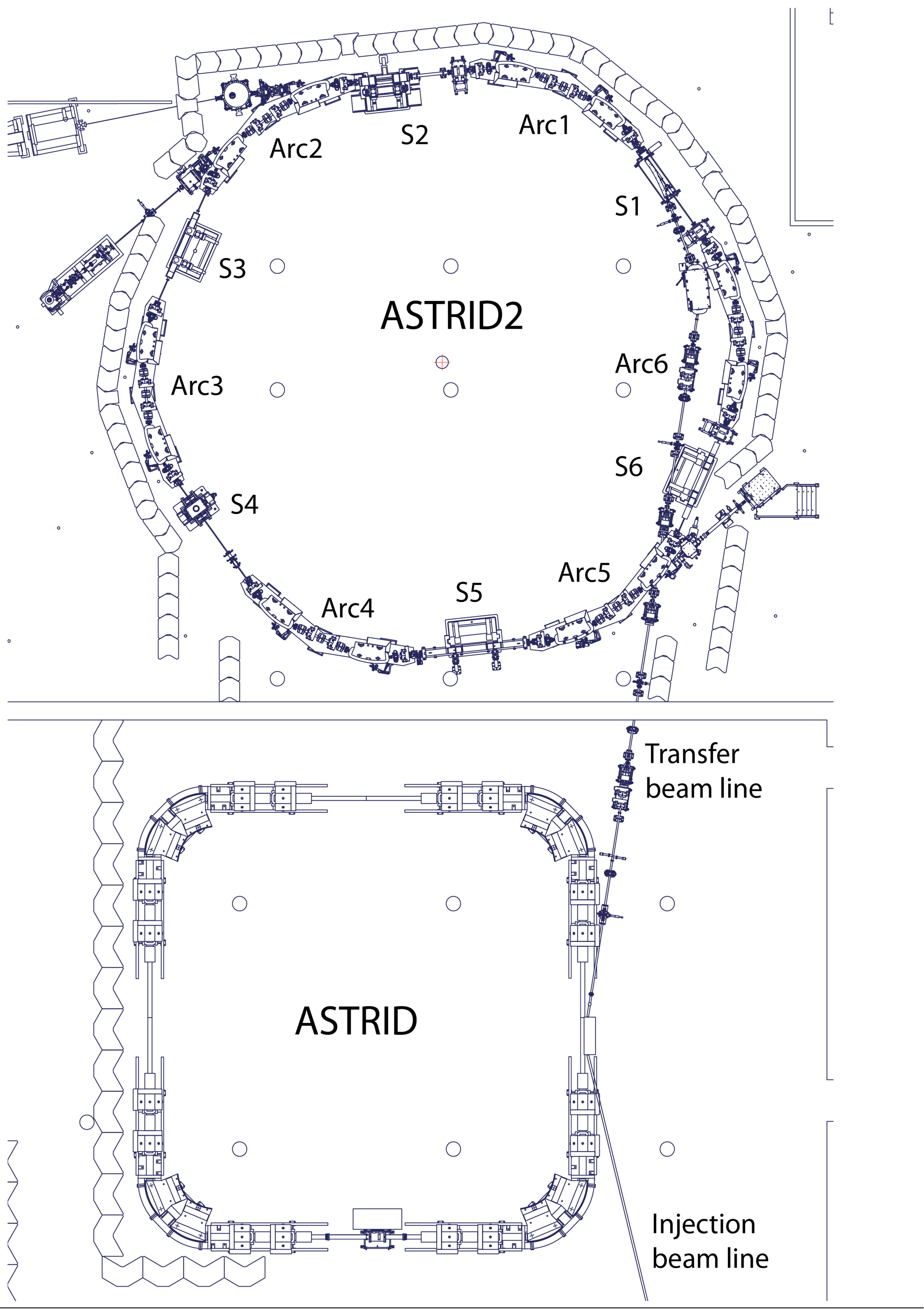
Bake-out

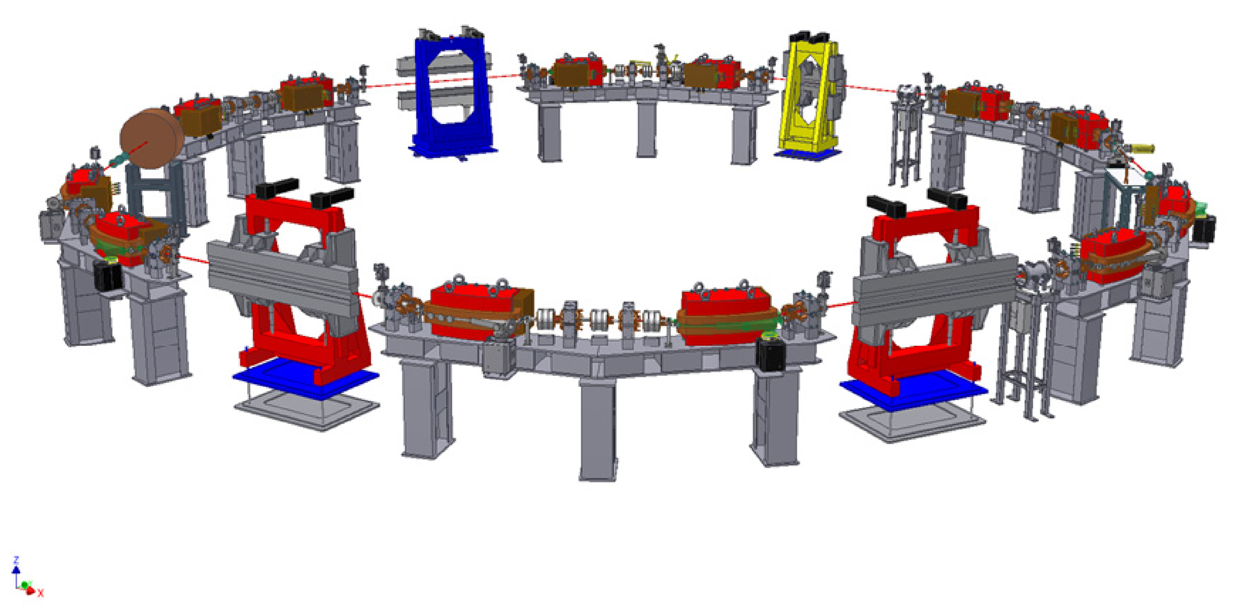
Bake-out is achieved using thin (<0.3 mm) flexible print. In the dipoles the bake-out foils are glued together with the pole-face winding prints. To reduce heat-loss the chambers are covered with a thin (~1 mm) insulating ceramic "paper", and a layer of aluminium foil.



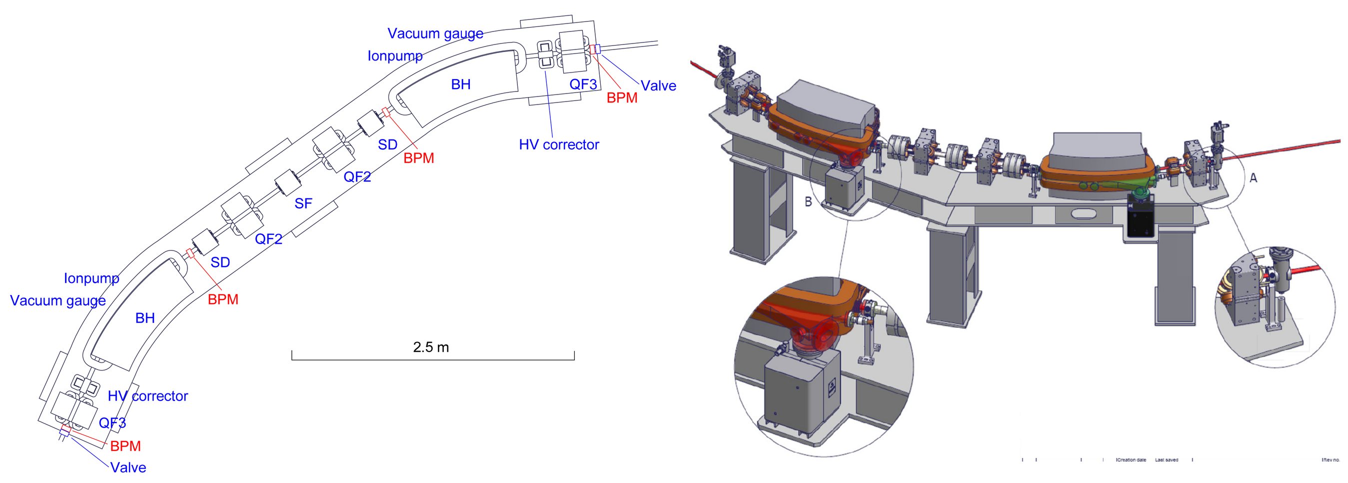
ASTRID2 layout

The magnets for ASTRID2 will be mounted on 6 girders corresponding to the 6 periods of the ring, assuring accurate alignment of elements in a given lattice period.



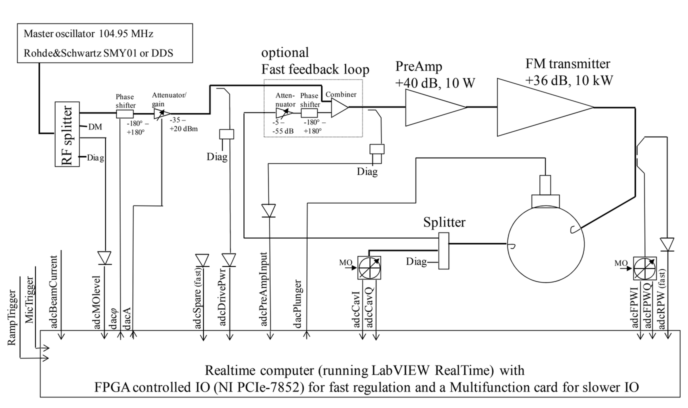


One arc (1/6) of ASTRID2, showing the magnetic elements



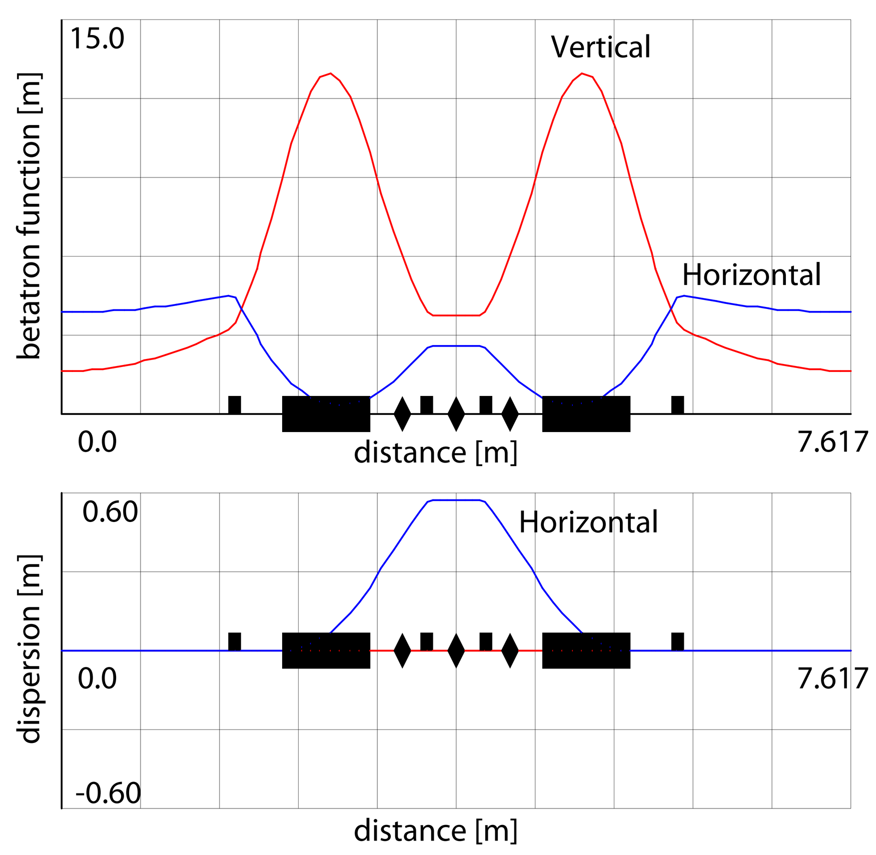
Low Level RF

A new Low Level RF system has been developed for ASTRID and ASTRID2. This system is a digitally controlled analogue system. It consists of a standard PC running LabVIEW Real-Time with a commercial FPGA equipped multifunction card (8-channel 750 kS/s ADC, and 8-channel 1 MS/s DAC). To measure the cavity and forward signals (amplitude and phase) two analogue IQ demodulators are used, and for controlling the cavity amplitude and phase, a voltage controlled attenuator and a voltage controlled phase shifter are used.



ASTRID2 lattice

The lattice is a DBA, with integrated vertically focusing quadrupoles in the bending magnets. Separated sextupoles are used as it was found that chromaticity correction using sextupole fields in the combined-function magnets reduces the dynamic aperture drastically. However, a weak positive sextupole in the CF magnets increased the dynamical aperture.



ASTRID2 parameters: machine and magnets

ASTRID2 parameters	
Energy	580 MeV
Circumference	45.704 m
Current	200 mA
Straight sections	4 × 2.7 m
Betatron tunes	5.185; 2.14
Coupling factor	<10%
Horizontal emittance	~10 nm
Natural chromaticity	-6, -11
Dynamical aperture	25-30 mm
Energy loss/turn	6.2 keV
RF frequency	105 MHz
Harmonic number	16
RF voltage	50-150 kV

Combined function dipoles	6 × 2 solid sector
Nominal (max.) dipole field	1.1975 (1.25) T
Bending radius	1.62 m
Nominal quadrupole field	-3.219 T/m
Nominal sextupole field	-8.0 T/m^2
Quadrupoles	6 × (2+2)
Magnetic length	0.132 m
Max. gradient	20 T/m
Sextupoles	6 × (1+2)
Magnetic length	0.170 m
Max. sextupole field	300 / 180 T/m^2
Nominal sextupole field	249 / 161 T/m^2
Dipole corrector angle	0 / ±1.5 mrad
Correctors	6 × (1+1)
Corrector angle	±3 mrad