FAIR HEBT System – Design and Status Report

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The main goal of the last year was to complete the detailed specifications of the magnets including vacuum chambers and supports of the High Energy Beam Transport (HEBT) system [1] needed in module 0-3 of FAIR [2]. With starting the procurement of the first batch of magnets the realization phase of the HEBT system has started. Nevertheless optimisations in the ion optical layout (IOL) were required and carried out in parallel.

Ion Optical layout

All changes since the March 2011 IOL could be done without modifying the requirements for the building planning. By the end of the year a new official IOL was released, which includes the following larger modifications:
- A conflict with a crane runway in building G004 could be solved by repositioning four dipoles in T3F1 (module 6). The original height of the building could thus be kept while in the last part of the vertical transfer section the vertical distance from T3F1 to T1X2 was reduced.
- In TXL2 all quadrupoles were shifted to reduce unused free spaces. Thereby the remaining drift spaces got longer and were equipped with diagnostics, steerers, etc.
- In T1X1 the quadrupoles had to be moved as well to provide space for the installation of diagnostics.
- The Super-FRS ring branch is not in line with the end of the Antiproton separator. This offset, which was introduced when the HESR was moved to the west, was thought to be effected by double use of two dipoles at two different bending angles. This turned out to be impractical as their good field region would have to be made much wider. Meanwhile two additional dipoles are foreseen. As TFC1 is running in this region in between two other beam lines (whose magnets largely dictated the geometry of the newly laid out part) even this change in footprint of the accelerator had no influence on the building requirements.
- The CBM/HADES focusing system is planned to be made from normal conducting quadrupoles. Originally the quadrupoles were planned to be constructed from 750mm long modules each separately connected to the cooling water. Now it is foreseen to use 2250mm long quadrupoles instead, which will minimise the influence of the quadrupole fringe fields.
- Currently the usage of the SIS100 machine setup beam dump for emergency extraction of light ions from SIS100 is considered. From the beam transport point of view all magnets in between the SIS100 and the dump would need to be ramped at the same speed as the accelerator ring. This concept is under discussion and not yet finalized.

Technical Systems Design

The major part of the HEBT magnets (338 of 356) needed in module 0-3 is split into three batches. Next to batch1 (51 dipoles) also batch2 (17 dipoles, 102 quadrupoles, 80 steerers) and batch3 (5 dipoles, 71 quadrupoles, 12 steerers) were assigned, after a visit of GSI experts at the manufacturer, by the in-kind review board to the Efremov institute, St. Petersburg, Russia (magnets including supports). The corresponding vacuum chambers will be built by the Budker institute (BINP), Novosibirsk, Russia, in close contact with the Efremov institute. The detailed specifications – comprising magnets, supports and vacuum chambers – for batch1 were completed and handed over to the FAIR company in July 2012, the contract between FAIR and BINP was signed in January 2013, the contract between FAIR and Efremov is supposed to be signed in the beginning of 2013 as well. The detailed specifications for batch2 will be available in the mid of March 2013, the specifications for batch3 in the mid of May 2013. However, the production order of the components has to follow the classification of the HEBT system into beam lines for primary and secondary beams which is not reflected in the split-up into batch1-3.

The magnets not covered by Efremov – 2 CR equivalent dipoles and 5 CR wide type quadrupoles as well as 9 Super-FRS quadrupoles – should be procured together with the magnets of the corresponding machines.

The 3D (CATIA) modelling of the HEBT system was further worked out in close collaboration between the department of mechanical integration (ENMI) and an external engineering company with the main focus on preparing 3D models and drawings for the detailed specifications of batch1-3.

A first draft concept of assembly-, alignment- and disassembly processes for the beam lines in the central transfer building G004 was worked out in an advanced design project between ENMI and the department of computer integrated design of the TU Darmstadt.

Major efforts were taken to deliver further detailed input for the building planning. E.g. 3D models of the terraced ramps for the SIS100 injection and extraction beam line as well as for the SIS100 injection beam dump were prepared. Supply units on the HEBT supply area in G017.1 were completely rearranged to optimise false floor height and provide mandatory escape routes. Positions to cross below/over beam lines as well as for firewalls were fixed. In close collaboration with the radiation protection department several mobile radiation protection labyrinths were defined, e.g. for G004A, T113 and T112.

References

[1] FAIR Technical Design Report (TDR) – High Energy Beam Transport, GSI, December 2008
[2] FAIR Green Paper – The Modularized Start Version, GSI, October 2009