Magnet Discussion Meeting

GSI, 4.161 & 4.140

Thursday 8th & Friday 9th October 2007

1 Attendance

Present for whole meeting:- Andrea Bersani (Genova), Evie Downie (Glasgow), Evgeny Koshurnikov (Dubna), Inti Lehmann (Glasgow), Yuri Lobanov (Dubna), Jost Luehning (GSI), Renzo Parodi (Genova), Andrea Pastorino (Genova), Alexander Vodopianov (Dubna)

Present for Thursday only:- Marco Macri (Genova), Herbert Orth (GSI)

Present for Friday only:- Lars Schmitt (GSI)

2 Minutes

The Magnet Group met at GSI between 17.00 and 19.00 on Thursday 8th October in room 4.161 and between 09.00 and 10.45 on Friday 9th October in room 4.140. The meeting began with a discussion of R. Parodi's draft magnet timelines which are attached to these minutes as Appendix A. During the meeting, E. Koshurnikov and Y. Lobanov made presentations which are attached to these minutes as Appendices B and C, respectively.

The Magnet Group thanked R. Parodi for his draft magnet timelines: the flow diagrams showing the interdependencies and time-ordering of the necessary magnet design decisions and the detailed notes. The group agreed broadly with the timelines and dependencies presented. It was suggested that, given clear cryostat and yoke interface guidelines, it might be possible to separate the design of the cryostat-coil complex from that of the yoke in order to allow both issues to be addressed in parallel and work packages to be allocated. The time-saving achieved by parallelisation of the design tasks is desirable. Several successful HEP magnet systems have previously been constructed in parallel by multiple institutions. However, this separation usually occurs during the construction rather than the design phase and some concern was expressed at the idea of completely separating the yoke design process from that of the coil and cryostat at this stage. These concerns could be alleviated by the designation of a single person as finally responsible for the integration of the cryostat-coil complex with the return yoke and the resulting solenoid performance. It was unclear as to how this appointment should be made, whether by a collective decision of the Magnet Group or by an appointment at the Collaboration Management level.

The Magnet Group were grateful to E. Koshurnikov for the Design Criteria that he circulated after our last meeting. After the presentation by E. Koshurnikov, it was agreed that the Magnet Group would use a safety factor of 3.0. The insulation and stabilisation of the coil was identified as a key issue in the magnet design. The coil will be subject to shear, tensile and compressive stresses and it was agreed that it is important to evaluate the coil insulation with regard to all of these factors. Resistance to these stresses should be achieved by both improving the general material properties of the coil and insulator complex to increase its strength; and by selecting the position and properties of the inter-coil spacer to minimise the stress experienced by the three coil sections.

There was debate on the best way to optimise the material properties of the coil, with some support for each of prepreg, solvent cleaning, and sand blasting of the conductor before the application of the epoxy and fibreglass. It was agreed that the group needs more data upon which to base this selection. Data should be sought which contains information on resilience to both shear and tensile stresses over several measured temperatures. The current data is deficient in the temperature region in which we expect the maximum stresses on the magnet coil. The group agreed that the allowable stress for the coil insulation material should be within one third of the ultimate stress for this material.

The presentation by Y. Lobanov showed calculations of magnetic field, the gravitational, magnetic and seismic stresses to which the laminated yoke, cryostat and coil would be subject, and the resulting physical deformations. We were happy to see that the stray field in the area of the target plumbing was of the order of 5 mT, and, although this was not calculated for the fully laminated yoke, it was anticipated that the final value will be similar. The study of the laminated magnet structure under seismic loads appears promising. However, we should define exactly how large a seismic load we should design the magnet yoke to withstand, and the exact criteria that define any other applicable “accidental” conditions for which we should plan and test.

The Magnet Group believes that the continual alteration of the suggested magnet dimensions is detrimental to the progress of the PANDA detector system design as the yoke forms the reference frame in which the detectors are placed. In a commercial engineering project of this scale, the first stage of the design would be to produce an interface document and a breakdown structure. These documents would specify, respectively, the interface criteria to be met by the project (such as structural and technical linkages) and a breakdown structure, showing the packages into which the overall structure is subdivided and designating the responsible person for each and the management structure for the project as a whole. The Magnet Group agreed to begin this process by producing a draft interface document detailing the dimensional limits of the magnet as described in the recent emails and presentations of the Technical Coordinator (to be drafted and circulated for discussion by E. Downie & I. Lehmann). Once adjusted and accepted by the Magnet Group, this document will be presented to the collaboration at the December meeting. Once approved by the collaboration, this document will form a solid baseline for the final magnet design and allow detector design to continue uninhibited by uncertainties regarding the magnet dimensions and “keep away” zones related to the magnet.

The recent proposal by the Technical Coordinator of a fully laminated magnet yoke was discussed. The Technical Coordinator stressed that muon detection capability was essential for the success of the planned PANDA physics programme, and as such, the Magnet Group should strive to accommodate the muon detectors in every way possible. He also emphasised that the "three twos" (i.e. 2 Tesla field strength, $\pm 2\%$ uniformity in the region of the drift chambers and 2 mm B_{r} integral) were essential in the design of the solenoid and that, while the Magnet Group should seek to reduce the axial force as far as possible, provided it was below 100 tonnes, it would be acceptable.

The Magnet Group expressed a strong desire for direct discussion with the muon people as to the number and dimensions of the muon chambers required and how these should be spaced through the yoke. The Group believes that it would greatly assist the mechanical stability of the yoke if the innermost and outermost steel plates could be thicker than 30mm, in the region of 60mm. Concern was expressed that the Genova calculations of the field resulting from the Technical Coordinator's design were somewhat different from the GSI calculation and that, crucially, the Genova calculation showed that the B_{r} integral was greater than that calculated by GSI and outwith the 2mm criterion. J. Luehning and R. Parodi agreed to investigate this to try to resolve the issue before the December collaboration meeting.

Several integration issues were discussed during the meeting. Aside from the muon detector issues, three important question were identified. Will there be a Helium supply available from FAIR and, if so, what type? What will be the weight of the detectors which we need to support in the cryostat? What will be the allowed tolerances in the interface regions? Several other issues were mentioned and, as a group, we will compile those issues and include the appropriate sections in the draft integration document. These questions can then be posed to the collaboration at the December meeting.

To achieve the degree of lamination suggested by the Technical Coordinator it would be necessary to use steel plates as thin as 30mm. With a flatness tolerance on steel plates of this thickness at around $\pm 10\%$, it may be necessary to increase the inter-plate separation to ensure that the gap is sufficient to accommodate the muon chambers. The Technical Coordinator said that this was possible in the radial direction, but in the forward direction we should retain the given overall dimensions as space is tight. Thus we may have to invest in substantially more expensive grade of steel to improve the flatness tolerance in the forward region. E. Koshurnikov agreed to look into the cost and technical issues related to the level of yoke segmentation with respect to the number and thickness of the yoke layers. It was decided that, as a group, we would compile a list of issues related to the segmentation of the magnet return yoke in order that the collaboration can make a fully informed decision on the degree of magnet yoke segmentation in the December Collaboration Meeting.

The Magnet Group discussed the fact that, when a magnet of this size is completed, it is usual that the magnetic and geometric axes of the magnet are not exactly coincident. This discrepancy is usually of the order of a few mm. Therefore it is essential to leave sufficient space between the yoke and cryostat and within the cryostat itself to adjust the exact positioning of the coil in order to align the magnetic and geometric axes of the system and facilitate beam transport.

It was suggested that a slight lengthening of the yoke offered greater magnetic field stability against small misalignments, and a reduction in the axial force. It was accepted that the forward end of the magnet should remain unaltered. However, there is some flexibility in the upstream region and it was suggested that we might lengthen the yoke in this direction by 8 cm. If the Cerenkov Group were able to effect the readout of the barrel DIRC in a magnetic field, this additional 8 cm of upstream space within the yoke would allow them to move the barrel readout inside the yoke (assuming it retains the dimensions shown in the Technical Coordinator's recent sketch), reducing the required length of the barrel and the attendant costs. If it proves impractical to read out the barrel DIRC inside the magnet yoke, the barrel would gain only 8 cm in length, but the magnetic field would be more robust against misalignments and the axial force would be reduced. It was agreed that both Dubna and Genova groups would look into the effect of lengthening the yoke in this way and, if desirable, we will present the suggestion at the December Collaboration meeting.

3 Required Actions

Individual / Group Responsible Agreed responsibility.

I. Lehmann & E. Downie Preparation of draft interface document for circulation to the Magnet Group & Technical Coordinator in order to allow agreement of basic criteria at December Collaboration Meeting.

E. Koshurnikov Investigation of both cost and technical issues to do with the number and thickness of laminated steel layers used in the magnet yoke.

J. Luehning & R. Parodi Investigation of difference in B_{r} integral for both calculations of the current proposed magnet design.

Dubna & Genova Groups Discuss & investigate magnet yoke length issues to inform the final decision at the next collaboration meeting.

Entire Magnet Group Discuss & investigate concerns with regard to the effect of full lamination in order that we can compile a list of possible relevant issues for consideration at the December Collaboration meeting. Produce a list of integration information that we can request from the collaboration at the December collaboration meeting.