Minutes of the PANDA Magnet Meeting
Torino, 16 June 2009

Inti Lehmann

Last edit: 27 July 2009

Participants

Magnet Session Andrea Bersani, Mariusz Domagała, Tibor Keri, Inti Lehmann, Bernd Lewandowski, Edward Lisowski, Yuri Lobanov, Alexander Olshevski, Herbert Orth, Renzo Parodi, Philippe Rosier, Alexander Vodopianov, Andrea Wilms, and some people I missed.

Joint Session with Muon Group I didn't note down all participants. Most participants from the previous session except Edward Lisowski and Philippe Rosier were present. In addition I became aware of: Gena Alexeev, Ingo Augustin, Maria-Pia Bussa, Marco Destefanis, Livio Ferrero, Michela Greco, Marco Maggiora, George Serbanut and Lars Schmitt.

Agenda

The meeting was split in two parts. The first part was a "pure" magnet session concentrating on magnet-only issues, while the second part was a joint magnet-muon session which allowed to address, in particular, the issue of the Muon Filter.

- Approval of Minutes
- Detailed coil & cryostat design (Renzo Parodi)
- News on the yoke design and 3D calculations (Yuri Lobanov)
- Solenoid movement and 3D calculations (Edward Lisowski)
- Support of EMC upstream end cap (Bernd Lewandowski)
- Mentioned but further discussion skipped for time reasons:
  - Remaining topics from the TDR review (Inti Lehmann)
  - Archiving progress, specifications and interfaces (Inti Lehmann)

  Coffee break
- Design of the Muon Filter (Gena Alexeev + all)
- Calculations for Muon-Filter and Field-Clamp (Lars Schmitt on behalf of Jost Lühning)

Please find the talks for the Magnets and Muon Detector sessions in the following sections of the PANDA Indico system.
Magnet: `https://indico.gsi.de/conferenceDisplay.py?confId=608` ,
Muon: `https://indico.gsi.de/conferenceDisplay.py?confId=609` .

Minutes

This agenda and the minutes of the previous meeting were approved.

Detailed coil & cryostat design (Renzo Parodi)

Renzo showed that significant progress in the design of the cryogenic system has been made. In particular, the design was completed to a much higher level of detail than previously. He pointed out that one outside limitation still remains unclear, namely if the liquid helium will be supplied "on tap" by FAIR or a cryogenic plant will be used. This would imply some changes in the flow scheme. Among other things, an appropriate cable has been selected, the joints have been defined and a concept for their arrangement was shown. Renzo stressed that this details can only be seen as a concept, in the end the manufacturer will decide on those details. The support structures are now also designed in detail, such that all forces are suspended from the same suspension points. A factor of 3 safety factor on top of a maximally 10 mm displaced coil is achieved in this design.

A detailed thermal model has been prepared for the tie rod design. From the calculations one would expect 8×0.13 and 16×0.07 W heat loss for 8 axial and 16 radial rods, respectively. Experimental tests have been performed, resulting in 0.14(10%) and 0.06(5%) W for these rods, hence agreeing perfectly with the model calculations. Using those model calculations it has been deduced that the max. temperatures in the coil former and in the winding will be 4.7 K and 4.55 K, respectively. This allows for safe operation.

Renzo reported on a clash at the cutout for the cryostat chimney in the yoke's barrel. He recalled that 7 cm more to each side and possibly a couple of cm in z would be required.[1] Yuri stated that such a change could cause some problems with the stability of that upper beam. He pointed out that this is the beam which has smallest contact with the end cap and forces will be very high already in the present design, in particular for the inner layers. Unfortunately the space would be required exactly there (probably the first 3 layers). An extension along z seems difficult because of the mounting. One possibility to regain the stability would be to reduce the width of the cut out for cable routing in this segment. Bernd said that we would need to keep the overall cross section for cable routing and any change there should be communicated as soon as possible. We had a lengthy discussion on how the space could be reallocated by increasing other cutouts. It was also pointed out that we, most likely, won't have muon counters in this region. Therefore, additional stability could be achieved by adding iron in the gaps. Yuri agreed to check together with his colleagues what, if at all, is needed to keep the stability of this segment. Proposals should be circulated as soon as possible, such that this can be fed back into the cable routing schemes.

News on the yoke design and 3D calculations (Yuri Lobanov)

Yuri showed work on details of the yoke design and new FEM calculations. The design remains basically unchanged compared what has been shown in the TDR. There have been slight changes to the arrangement of spacers between the iron layers in order to facilitate the accommodation of muon chambers. The platform has been reinforced by additional beams and widening some beams. Furthermore, the fixation of the doors has been improved. The long screws originally foreseen have been replaced by shorter and more sturdy screws. Such a small gap (in the order of 0.5 mm) between the yoke and the doors can be closed when tightening these screws. In addition, screws are foreseen to tighten both doors against each other. This does not make the spacers and/or an inclination of 1% of the door opening obsolete. Yuri reminded us that the

[1] In a later mail by Renzo he detailed this: in fact there is an overlap of 48 mm to each side and no overlap in z (20 mm space remaining). Assuming 15 mm clearance the gap would have to be widened by 65 mm on each side.

doors must be safely tightened before any movement of the platform. He stressed that access to those screws must be kept free. He also expects that additional supports under the door rails will be used whenever the doors are opened.

New calculations with the 2D model have been performed and a 3D model of the yoke has been developed. This is a very detailed model taking into account weights of cryostat and detectors. The resulting maximum deformation is 3 mm while it stays below 0.23 mm within one beam and even below 0.1 mm if considering the corners of the beam (where most equipment is likely to be attached). The upstream end of the upper beam is most crucial, due to the small contact areas because of the additional cutout for the cryostat chimney. The beams are found to be safe against buckling.

Solenoid movement and 3D calculations (Edward Lisowski)

Edward showed a refined design of the carriages for the solenoid movement and 3D calculations for the full solenoid. The details of the carriages have been significantly improved, including larger areas for contact and a optimised lifting construction.

He also showed results from 3 full 3D models of the solenoid including the yoke, doors and all support structures. The variants are: all doors closed, all doors open, and doors open on one end of the yoke. These can be used for all analyses, including seismic studies which are planned as next step. In his model he uses the same support points for the parking position and movement. However, it is taken into account that in the parking position these points are fixed in a all coordinates while x is left free when moving.

The findings are that the design is generally safe, but in some points the stresses are rather high. Generally the stresses are highest below the doors. With open doors he obtains a deformation of up to 4 mm, but remaining in the elastic limit of the material. He believes that the design can be further optimised such that these local peaks are balanced better. The design of the carriages has been refined further. This leads to even reduced stresses and deformations. Also the stress on the platform has been minimised by distributing the load on large mounting plates. He points out that for the construction of all structural elements (frames, platform, *etc.*) steel for construction should be used as opposed to steel 10 which is used for the yoke. Yuri confirmed that this would be indeed intended.

Support of EMC upstream end cap (Bernd Lewandowski)

One additional topic was brought up by Bernd. He briefly flashed an idea on how to connect the EMC backward end cap from the upstream side outside the yoke. The aim would be to support the device (about 1 t end-cap itself, possibly 2 t including support) by a structure upstream of the yoke. The design is at a very early stage and it was agreed to have a brainstorming session on the next day.

Further Topics (Inti Lehmann)

Inti mentioned that there are 2 ongoing activities:

- We have detailed answers to the questions and comments raised by the reviewers. Though these do not need to be formally addressed we should make sure to collect these answers in a central place, such that we profit from the input provided during this exercise. Inti proposed to collect all answers on the Wiki.
- The Interface Document has been neglected for the time of the writing of the TDR. The goal would be to update and extend this document, such that it can be used for the tender.

Glasgow will try to update this document and everyone is welcome to add to it. It can be found on the SVN server (for the TDR) in the directory “Inter”.

Muon Filter (Gena Alexeev)

Gena showed his proposal for the Muon Filter (MF), which he stressed to be very conceptual. He also made clear that this design does not imply that it should be attached to the doors of the solenoid and move with them. We had a lengthy discussion. Lars argued that it would be much more comfortable if the MF would move with the doors. The Magnet Group expressed their concerns regarding the mechanical stability of the system. It was pointed out that the design of the magnets and their support structures is at a high level of detail. With 45 t the MF is not a small addition to the existing doors. In order not to impose significant further delays we cannot redesign yet again the whole system. This is particularly important as we are in the process of seeking for funding and should pursue the tendering process as soon as possible.

Lars argued that the platform cannot be considered final as planned now, because additional items need to be placed there (e.g. the support of the EMC upstream EMC end-cap and electronics). In addition, he thinks that air-pads are a better solution. These would allow to produce a solid large platform which would, according to him, not deform significantly. The Magnet Group should consider to be responsible only for the construction above the level of the door rails (i.e. below the main frame of the solenoid). He believes that the platform could be completely disentangled, and we should assume this level as just solid. It was pointed out that we, the Magnet group, need to be kept informed; and we may need to have some iterative procedure as we believe that the stresses and forces are not completely independent on the design of the platform. Unfortunately, Edward was not present. According to Lars, he would be the person to design this platform.

It was agreed to keep the MF as independent part which should not influence the design and operation of the magnets. Though the Magnet Group is not, by principle, opposing disentangling the solenoid and platform there remain some doubts whether this is feasible in practise.

Dipole Field Clamps (Lars Schmitt on behalf of Jost Lühning)

Lars showed a write-up of Jost Lühning. He realised that in the current scenario the field from the dipole magnet reaches far into the muon filter region. This imposes strong forces on the MF and creates an unwanted field in that region. Most importantly, this solution would mean that the MF would need to be in place when the field is mapped or HESR is operated, as the field would change dramatically. This is clearly not an option. He proposes to use a 6 cm thick field clamp also on the upstream side of the dipole. He has designed such a clamp and could show that this would make the MF almost completely independent and almost force free (0.3 kN on each half). An additional small frame (few cm iron) could be installed when the MF is not in place to compensate the remaining few per cent of field modification by the MF. The Magnet Group gladly acknowledged this proposal.