Minutes of the PANDA Magnet Meeting
GSI, 3 March 2009

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Agenda

1. Andrea Bersani: Cryostat Mechanical Analysis - Very Preliminary
2. Yuri Lobanov: Deformations and stresses in the flux return yoke
3. Edward Lisowski: Lifting of Target Spectrometer and 3D FEM for yoke
4. Further topics:
   (a) Jost Lühning's announcement: Field clamps for the dipole
   (b) Herbert Loehner (not present): Design for the support of the downstream end cap
   (c) Yuri Lobanov: Minor modification of spacers between layers

Minutes

Andrea showed a detailed 3D FEM model of one half of the cryostat of the solenoid. For the purpose of the simulation the bottom 4 attachments are fixed but the remaining ones can move freely in x and y but not z. The results are very promising. He assumed 10 t load on the top and 20 t load from the magnetic pressure. The maximum stress obtained in these calculation is 20 MPa which should be compared to the maximum allowable stress, which is claimed to be 200 MPa for the considered steel and aluminium. The deformations are calculated to be 0.27 mm for Al, i.e. 0.01% relative to the radius, and below 0.1 mm for steel. In a more pessimistic scenario he uses 20 t load from the top, which corresponds to the full weight of the upper yoke beam resting on the cryostat and 80 t for the magnetic load. Even in this scenario the stresses stay below 30% of the maximum permissible. He points out that he would feel more comfortable if someone cross checked his analysis.

Jost asked whether 16 points are actually needed for the suspension of the cryostat. A discussion on details of the mounting points evolved. The idea of fixing all 16 mount pionts rigidly to the yoke seems to be disfavoured against using just 4 (lower or upper) supports as fixed attachement points, while the others would only prevent a movement in z. Yuri thinks that this should be feasible and agreed that this could be looked at in more detail in Dubna.

Yuri showed stress calculations for the yoke and support structure in a 2D model. This is a model where the real structure is represented by changing effective parameters.

It has been refined compared to the model used for the TDR, using both beam and shell structures. It is assumed that during movement and measurements the full weight of the doors would be suspended by the yoke barrel. In order to fulfil that, they would need to be bolted rigidly to the yoke and the rails for the doors would require additional suspension (jacks or alike) when the doors are to be opened. The model takes doors into account by adding the weight and changing material properties. In result, the maximum deformations of the yoke are in the order of 1 mm in all scenarios. The level of stresses is found to be acceptable in any case. However, deformations of the yoke must be taken into account when designing all detector components and in particular the target pipe.

Bruno pointed out that the deformations in inner height are lower in case of a 2-point support. Though this seems counter intuitive at first, it obviously reflects the fact that the sag of the magnet top is accompanied by a simultaneous sag of the bottom in the case of a 2-point support. The discussion lead to the conclusion that the placing of support points can probably be further optimised. Concerns that the dipole magnetic force on solenoid could affect the system were dismissed, as the forces should account to only few kilogrammes, according to Jost. It was debated whether the friction is sufficient to stabilise the magnet on its rests in case of an earthquake.

Edward presented two topics. He showed full 3D FEM model calculations for the yoke and support (without doors). This seems to be a very detailed model. The maximum deformations stay almost in all scenarios below 1 mm. This seems very similar, even a bit better, than in the 2D model presented by Yuri. He pointed out that, even though, the deformations seem tolerable in all cases, optimisation of several details would be useful to reduce stresses and make sure that no long-term deformations appear.

Edward showed studies on different options for the supports using this 3D model. It seems that hydraulic jacks can only be operated with a relatively poor precision in height of ± 1 mm (guaranteed by the manufacturer). This could only be improved by additional gauges which, however, are so bulky that they would not fit below the carriages in their present design. Jost mentioned hydraulic jacks which would have an additional nut. Another drawback of a hydraulic computer controlled system is the high price (about 60k for the full system). His proposal is to use mechanical jacks or dedicated manufactured blocks in addition. Both can be adjusted to very high precision in height but you have no force control. The former would be driven by motors, while the latter would be manufactured the first time after evaluating the necessary dimensions. He expects that it is not necessary to redo the blocks when coming back to the position. He proposes to use a combination of a simplified hydraulic lifting system which could be re-used for the forward platform and mechanical jacks or blocks for permanent support.

Inti stressed that the most crucial quantity is the change of geometry during movement and adjustment. He does not see a point in optimising further deformations in the order of 1 mm which will remain unchanged after first installation. It seems not clear why it is not best to keep the same points for movement and permanent placement. No immediate conclusion could be drawn. It was agreed that this will be followed up. In the next meeting we will continue our discussion on the concept of lifting and alignment of the solenoid.

It was mentioned that Jost has designed field clamps downstream of the dipole which reduce fields in the forward spectrometer.

Herbert Loehner's proposal for the end-cap design was briefly flashed by Inti as Herbert couldn't attend. This naturally restricts the muon counter acceptance for the first layer. Marco will think about it.

Yuri notified us that minor changes in the arrangement of spacers have been done to facilitate the accommodation of muon counters. This should not affect the dimensions relevant to any other system.