Magnet Station Workshop in Krakow (Sep 26-28):

EXECUTIVE SUMMARY

The first project organization chart and timeline were presented in my slides on Monday morning. The draft proposes four main branches: panel construction, mechanical structure, readout electronics and software. Another branch was proposed by Marcin on testing which could be attractive to some new Institutions. Names are assigned to most of the tasks with the understanding that once new Institutions get on board the responsibilities may change. Few blocks are empty and are direct opportunities for new comers: panel assembly sites, fiber, trays, cooling, SiPM and electronics racks, power supply, slow control, tracking and calibration.

There was an overall agreement with the timeline proposed. The first task is to get the TDR ready in a year from now which will include the report of a prototype test, institutions and funding agencies defined and Gantt charts for each task. Installation will happen in 2026-2027 and debugging in 2028. Uli pointed the need for a prototype installed in the magnet during Run3, one of our original ideas which didn't happened because of the busy schedule during the last LS.

Matteo Palutan presented the plans for LS3 which, besides MS, includes work in SciFi, installation of MAPS modules, RICH, ECAL and RTA. Magnet Station will have as referees Marcel Merk, Paula Collins and Tim Gershon. LHCC may need to be communicated soon on our intensions to deliver a light-weight TDR. Suggested date is this November.

Eric Thomas brought the good news that the removal of the beam pipe and its services in the magnet have been considered. This would make the installation process way much easier and safer. Eric guided us through the CERN procedures for a new detector installation. One idea which came out during the session was to place clear fibers in the magnet during the next winter shutdown. Eric warned that this can be done as long it is out of the acceptance and a dosimeter is next to the fibers. Question on which materials (3D plastic ?, PVC ?) are accepted inside the cavern. Eric will provide a list of forbidden materials.

Uli Uwer reported on the SciFi experience and challenges they had to face. The SciFi involved around 80 people from the beginning with strong Institutions involved. Modularization is important for the design, QA database turned to be essential, meticulous and time-consuming checks (fiber links were the worse) pay off, paperwork approval can take a year, prototyping and mockups are important.

A well advanced mechanical design for the structure inside the magnet was presented by the ICP and PL folks. Shifts in the panel modules was proposed and should be verified how that can affect the detector performance in simulation. Very good discussion on the clearance needed for the screws and bolts. The fiber tray in the middle of the detector should be moved to the top and the structure should allow magnet moves expected during field quenching or polarity changes. Mockups are expected to be built in Krakow to assure the installation of panels and fibers are safe in periods when there is no access inside the magnet. The space between the magnet and the SciFi is a concern. SciFi can move only in the A-side.

Hubert van Hecke presented the design and prototyping of the panels with all challenges posed by the bar segmentation inside the module. The current design and prototype are still based on triangular bars.

A modification to parallelogram bars is expected which will significantly reduce the degree of difficulty in assembly the panel. The assembly process is expected to be tedious requiring many people involved in different production sites.

The beam tests performed in Krakow with 10 kGy irradiation on clear fibers indicated total healing after 3 weeks. Expected radiation in the top and bottom parts of the magnet are expected to be < 2 kGy, but a factor of 3 safety margin needs to be considered.

There was a long discussion on the readout electronics, especially on the bit pattern and rates expected in the cluster and online tracking boards. A decision was made to preserve all the information that the detector can provide, not only the information needed for the goal of the momentum resolution. The position in Z has 0.6mm resolution requiring 9 bits. Cluster size (4 bits), y segment (3 bits) and total cluster ADC(5 bits) complete the 21 bits carrying the cluster information in the streaming. Clustering is performed only in the Z direction and is performed by the cluster board. The online tracking board contains a look-up table for online tracking which just tag clusters used in these tracks. A reduction of a factor of 5 is observed in simulation which still preserves the efficiency. It is expected 200 clusters/panel/crossing in Run5. A new study on the LUT performance is needed with a cluster algorithm. A dynamical LUT considering the cluster sizes was also proposed. Expected rates per LpGBTX are on the order of 2-3 Gb/s if adopting 46 links per panel. To be reevaluated with the clustering.

The status of simulation was presented by Jakub Malczewski. The current MS is implemented as a branch in the standard LHCb simulation, including DD4Hep and Gauss in Gaussino. There is no magnet field implemented in the current version of the U1 LHCb simulation which prevent us to use it for now. The middle bars which support the beam pipe spiderweb inside the magnet are not implemented yet which may produce another hot spot of hits in the MS once it is implemented. The number of hits and clusters per crossing is still based on the triangle bars. Jackub proposes the implementation of sub-panels with 7 different sizes to fit the edges of the magnet and therefore maximize acceptance. After a discussion on the engineering aspects of the idea, a compromise is to preserve the number of y segments for the electronics design, where the last bar on top and bottom change size between different sub-panels.

Jakub also proposed a parallel offline tracking for upstream tracks which would incorporate either a multidimension polynomial designed by Pierre Biloir or a machine learning regression for the upstream track projection on the magnet station online track. This parallel procedure would not affect the LHCb tracking framework for long tracks and solve the problem of particles bending backwards inside the magnet. A strong coordination with RTA was suggested.

Mariola Klusek-Gawenda made an introduction on gamma+gamma scattering and projections in the LHC forward direction. She indicated that calculation for VDM-Regge and 2-gluon exchange processes for pT<200 MeV/c, well suitable for MS, are coming. Jamal Jalilian-Marian introduced color-glass condensate that describe gluon distributions at small-x and small-Q2. Despite its name and the semi-classical treatment of multi-interactions which dominates this region, CGC has nothing to do with condensates. The available calculations, almost 10 years old, were the basis for the interest of the HI community in LHCb. Jamal is looking for updated predictions given the imminent results coming from LHCb on direct gamma+hadron correlations.

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