Forum on Tracking Detector Mechanics 2021 - ONLINE

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Book of Abstracts

Contents

1

Results from second test runs with a compact, low price, commercial CO2 cooling unit

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As first results with customized commercial CO2 cooling unit have been promising,
we started further test runs with a changed test setup to investigate operational behavior in detail.
We inserted capillary heaters to achieve a two phase CO2 cooling environment more similar to the Belle II PXD and upgraded the control structure.
We focused on temperature stability, response to load changes, and stability with 'active subcooling'.
Results of these test runs will be reported and possible applications of such commercial chillers will be discussed.

4

Thermal Simulations of a Proton CT Calorimeter Detector

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The development of a proton computed tomography (pCT) detector is motivated by proton therapy, which is a novel treatment against cancer, based on the cell-killing effect of proton radiation. The planning of this treatment requires the 3D Relative Stopping Power (RSP) map of the patient, which is converted from Hounsfield Units, measured by X-ray computed tomography (X-ray CT). This conversion increases the uncertainty of RSP values, which can be avoided, by direct imaging with protons, called pCT.

The Bergen pCT Collaboration was established to develop a prototype proton CT system, which overcomes the main limitation of nowaday systems, as data taking speed. This detector will be built of alternating sensitive and absorber layers. The sensitive layers are built of silicon pixel detectors and measure the deposited energy in their material. A Bragg-curve is fitted into these energy deposits, which gives an accurate enough measurement of incoming proton energy for pCT imaging.

This presentation demonstrates the thermal simulations of this detector. The main task of the cooling system is to transfer away the 1.4 kW heat generated by the silicon pixel detectors and ensure a homogeneous temperature distribution inside the sensitive area without components, which would impair the homogenous material budget of the same area, so only external components are allowed. This presentation shows the comparison of two cooling concepts, and the more accurate modelling one of theme, including the investigation of the effect of the contact resistances and inhomogenous loads.

5

Mechanical design of the TBPX detector for phase 2 upgrade of the CMS Inner Tracker

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A new silicon Tracker will be built for the phase 2 upgrade of the CMS experiment to fully exploit the increased luminosity delivered by HL-LHC.
The TBPX detector is the barrel of its innermost part, called Inner Tracker (IT), and it is made out of four cylindrical layers, each 400 mm long, located between 30 mm and 146.5 mm away from the beamline.
Its mechanical design, starting from the nominal position of pixel sensors defined by the CMS tracker layout developed for phase 2 upgrade, will be presented.
All the mechanical aspects of the project will be shown, taking into account the assembly phases, the services, the insertion procedures, and the connections with the rest of the IT.
The construction of the first prototypes of the carbon fiber ladders, which hold the pixel modules, and the carbon fiber external cylinder, which supports all the structure, will be described. Stainless steel pipes, with a
thickness of 0.1 mm, properly welded in the juctions, follow precise
cooling loop design inside the barrel and along the other detectors to
ensure the correct temperature on the pixel modules.
Finally, we report preliminary results of a comparison between the first thermal tests performed on ladder prototypes and thermal simulations, using different tube housing materials and stainless steel pipes.

6

Mechanical characterisation of thin-walled cooling pipes and connections for the CMS tracker upgrade

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In order to meet the increased thermal load associated with the enhanced detector chip designs, the CMS tracker upgrade will be cooled using two-phase CO2. In order to minimise radiation shadowing, 2 mm diameter thin walled (100 µm) cooling pipes will be used within the detector. This system operates at low temperatures (-35℃) and high pressures (typical operating pressures of 30 8 bar to 70 bar, max test pressure 163 bar). Previous designs for these pipes have been based on CuNi alloys which do not possess the mechanical strength or reliability required for this new system. For this reason, investigations are currently ongoing into the suitability of new piping materials, and pipe joining mechanisms.

A range of characterisation techniques have already been employed to investigate previous piping materials, as well as a range of commercially available options. An overview of this work will be presented, including the results from microscopy, energy-dispersive X-ray spectroscopy, profilometry, Computed Tomography (CT) and grain size analysis. This analysis has provided insights into the pinholes observed in CuNi pipes and has revealed that although Ti64 has suitable mechanical

properties, the difficulties associated with welding and soldering this material limits its applicability. Stainless steel 316L has emerged as the most likely candidate for use, as it has a good balance between mechanical properties and joinability.

Space limitations within the tracker mean that pipe soldering will be required to connect thin-walled cooling pipes in at least one location. As a result, preliminary testing is being performed to optimise this production technique which will also serve as potential option for use elsewhere within the system. One of the main challenges with this approach is that 'low aggressive'flux must be used order to prevent long-term corrosion. This presents difficulties in soldering conventional materials such as SS316L, and therefore investigations are ongoing into the suitability of thin-film coatings of Ni, Ni+Au and Ni+Cu. The results of mechanical tests, CT, microscopy and focused ion beam residual stress analysis on these samples will be presented.

One of the additional challenges with the design of these thin-walled connections, is that the system will be regularly pressured and depressurised during use. This will lead to cyclic loading of the connections and therefore the fatigue response of these connections needs to be understood. In order to facilitate these tests, a high pressure (200 bar) pressure testing rig has been designed and installed at the University of Bath. An overview of the equipment design and capabilities will be presented, along with initial results.

One of the longer-term goals of this project is to improve understanding of the failure modes of soldered, orbitally welded and laser welded thin-walled pipe connections. A recent synchrotron proposal has been accepted at beamline B16 at Diamond Light Source, UK in order to perform high resolution tomography and microscale strain mapping of these connections during in-situ loading. This experiment has been delayed due to the pandemic, however significant work has been accomplished to design specimens, create an appropriate testing programme and complete preliminary testing and analysis. An overview of this work will be presented in this talk.

The overall aim of this discussion will be to provide a comprehensive summary of the results of our results and improved understanding of thin-walled pipes and connections. It will also serve as an important opportunity to gather feedback from the CMS community in order to guide future research.

7

Design and prototyping of support mechanics with integrated cooling for the Endcaps of the CMS Tracker Upgrade

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The CMS Tracker upgrade, to be installed prior to the high luminosity phase of LHC operation (HL-LHC), will require novel approaches to overcome the challenges posed by the extreme radiation environment. In addition, the tracker must remain extremely lightweight and at the same time provide an efficient cooling system (evaporative, CO2) capable of evacuating more than double the overall power of the present detector, at lower temperatures. The CMS Tracker Endcaps Double-Disk (TEDD) concept will be presented. The basic support structures of the TEDD, on which the silicon modules are directly mounted, are half-disks known as 'Dees'; the two Tracker Endcaps will contain 40 Dees. A Dee consists of lightweight foam layers sandwiched between carbon-fiber skins. Small-diameter (2.5mm) cooling pipes are embedded within the foam and are connected thermally to the silicon modules via inserts in the skins. A Dee has a diameter of 2.2 meters and its construction presents significant engineering challenges. Approximately 700 positioning inserts, which ensure

the proper location of the silicon modules on both sides of the Dee, must be precisely glued within the structure. Cooling contacts to the pipes must be accurately placed in order to provide effective cooling for each of the ˜170 modules on the Dee. The Dee must conform to stringent stiffness and flatness specifications, while its mass must be reduced to a minimum. Full-size prototypes have been produced in collaboration with industry. Experience gained and problems encountered with these prototypes will be described. Results of tests of the mechanical precision and of the thermal contact between the cooling pipes and the modules will also be presented.

9

Silicon Sensor Air Cooling for the CBM-STS at FAIR

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As the core detector of the CBM experiment at the under-construction FAIR facility, the Silicon Tracking System (STS) located in the dipole magnet ($1T \cdot m$) provides track reconstruction ($> 95\%$) & momentum determination ($< 2\%$) of charged particles from the beam-target interactions (11 AGeV Au-Au).

Due to the expected non-ionising irradiation damage at the end-of-lifetime ($10^{14} n_{eq}(1MeV)/cm^2$), the innermost silicon microstrip sensors will dissipate up to $6mW/cm^2$ at $\sim -10°C$. So, it is crucial to keep the silicon sensors at temperatures $\sim -10°C$ at all times to avoid thermal runaway and reverse annealing by introducing minimal material budget in the detector acceptance. Therefore, cold gas (at $\sim -10°C$) will be carried via thin carbon-fibre (CF) perforated tubes to directly cool the innermost silicon sensors.

The first part of this contribution will primarily touch upon the thermal aspects. This will include: [1] the CFD Analysis of the sensor cooling concept with a 'toy model', [2] manufacturing of the perforated CF-tubes and, [3] construction of the thermal dummy components (sensors modules and the CF support structure ladders) which will experimentally demonstrate the cooling concept.

The second part of this contribution will focus on the mechanical aspects. This will include: [1] the construction of a mechanical dummy ladder (sensors and CF support structure ladders), [2] its optical metrology, [3] the vibration study conducted at the University of Oxford under the AIDA-2020 project and, [4] the vibration study under gas-flow at GSI Darmstadt.

12

Module Prototyping for the Phase II Upgrade of the CMS Outer Tracker

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In preparation for the High Luminosity LHC, the whole tracker of the CMS experiment will be exchanged within the Phase-II Upgrade until 2027.
The new outer tracker will be made of approximately 13000 silicon sensor modules called 2S modules (consisting of two parallel mounted silicon strip sensors) and PS modules (one pixel and a strip sensor combined in a module).
These modules provide tracking information to the Level 1 trigger by correlating the hit information of both sensor layers and, thus, allowing to discriminate particle tracks by their transverse momentum.
To guarantee a successfull operation of the CMS detector, the production of the outer tracker modules has to fulfill strict requirements.
This talk will present the various assembly and test concepts for the large scale production on the basis of 2S modules and will present the latest module prototypes.

14

Support Tube Manufacturing Trials, Simulation, and Validation for the CMS Inner Tracker Phase II Upgrade

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Purdue's Composites Manufacturing and Simulation Center is responsible for manufacturing the inner tracker support tube (ITST) for the CMS high luminosity upgrade. Predicting the mechanical performance of the manufactured tube is necessary to ensure the success of the structure and guide preemptive redesigns. As preliminary validations of the modeling and simulation methods, scaled down ITST sections of 100mm length have been manufactured and subjected to a compression-like loading scenario. Matching Finite Element Models (FEMs) are validated against the experimental test data, specifically comparing the load-displacement curves, effective tube stiffness and eventual failure point. Two cases are used to validate the data; (I) a simple tube with 6 plies thickness (1.5mm) and no track support, (II) a complete model with 12 plies thickness (3mm) and the track support with a foam core.
FE simulations are dependent upon proper mesh quality, physical phenomena, and material inputs, so simplified mode I interlaminar fracture models were created and compared for solid and shell elements to determine the appropriate finite element mesh dimensions and confirm the crack propagation behavior in the FEM. Shell elements were found to be significantly more efficient and provided adequate representation of delamination failure behavior. Experimental material tests, performed to the ASTM standards, provide inputs for tensile, flexural and shear properties.

The multiaxial loading FEM iterations were then performed to capture the phenomena observed during experimental deformation and failure at the joint and surrounding regions of the two-piece tube. Two specific behaviors critical to accurate simulation of this structure are: adhesive delamination of the bonded joint in a peeling type failure mode, and delamination in the composite structure surrounding the joint. The influence of these behaviors is isolated and presented using cohesive modeling in consecutive FEMs. All final models have close agreement to experimentally determined behavior. These sub-component simulation and validation results provide confidence that similar FEMs of the full ITST assembly and loads can be used to minimize mass and maximize structural performance.

15

Integration and assembly of the CMS phase-2 tracker endcap

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For the high-luminosity LHC (HL-LHC), CMS will install a completely new silicon tracker. The future tracker will consist of two barrel parts and two endcaps (TEDD), one on each side. One endcap is made of five double-disks. One double disk is assembled from four half disks (Dees) on which the detector modules are mounted.

Dees are large and fragile objects, particularly after modules are mounted in the first integration step, thus they need to be supported throughout the whole integration and assembly procedure. A semi-circular arc frame will be used for this purpose. They need to be stiff enough to support the Dees, stress free, and precise to allow merging during double-disk assembly. Various prototypes have been produced and their stiffness and manufacturing precision have been studied. Both features have to be balanced against weight and cost of the arc frames.

The integration and assembly procedure has significantly matured. For integrating modules on the Dees a rotation stand is under development. It also serves as transport tooling and allows to load Dees into the following assembly stations. A first implementation of the disk assembly tooling has been built and tested for the achievable alignment precision. The full assembly procedure is exercised using dummy structures. Two full size Dee prototypes are available, which are used to test the disk assembly procedure and demonstrate the Dee to Dee alignment and connection procedure.

The full TEDD assembly requires not only further tooling design, but also places requirements on the detector mechanics such as metrology and mechanical stability in a non-final load case. The talk will give a complete overview of the full TEDD production procedure. A focus is given on the various toolings, available or in development, needed for the assembly.

16

Thermal performance tests of petals for the ATLAS ITk strip end-cap detector

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The ATLAS Inner Tracker (ITk) of the phase-II upgrade programme is designed to meet the challenges at the high-luminosity LHC. The ITk silicon strip end-caps will cover the forward directions of the detector and consist of six disks populated with wedge-shaped silicon micro-strip sensors, divided in modules containing the readout, power and control electronics.
The main building blocks are the so-called petals consisting of likewise wedge-shaped local support structure called petal cores with sensor modules in six different shapes directly glued on them.
The core is made of a carbon fiber-based sandwich structure with an embedded titanium cooling

pipe for evaporative CO2 cooling and provides data and power buses to connect the modules to the off-detector electronics.
For the thermal QC during production, the petal cores will be evaluated by infrared thermography. The thermal performance results from several prototypes will be discussed together with the influence of the dual-phase CO2 coolant, such as heat load or mass flow rate, on the cooling performance. Furthermore, the first petal prototype loaded with fully electrical modules is used to validate the petal cooling concept using dual-phase CO2. At different set points of the cooling system, electrical tests are performed on the modules evaluating the corresponding noise behavior. Also, the thermal load from the different readout ASICs and the module powering is systematically studied by infrared thermography and measuring the module temperatures by NTC sensors. The experimental results are finally compared to thermal FEA studies of the petal.

20

Cylindrical CGEMs mechanical structure's investigations and improvements for the BESIII experiment

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An innovative CGEM cylindrical Gas Electron Multipliers detector with charge and time readout is foreseen to be installed in the BESIII Experiment in Beijing, China, to replace the present inner driftchamber.
The new detector will be able to match the drift chamber tracking performance while improving measurement of the polar angle and the rate capability. The material budget must stay within 1.5% of X0 in order to minimize the multiple scattering. To achieve that, the structure is hold by permaglass rings placed outside the active area and a light sandwich of Kapton and Rohacell (a PMIfoam) gives the mechanical rigidity to the central part of the cylinders. The mechanical design scheme is inherited by the KLOE2 inner tracker.
A quality assurance protocol has been developed during the studies of the prototypes in Italy to check the status of the detectors after every major operation involving touching or moving the structure. They consist in checks of the whole system, gas leakage, HV distribution and shortcuts, readout checks.
To ship the detectors to IHEP, Beijing, an air cargo with custom designed boxes has been used. After the shipment the quality control pointed out some malfunctions compatible with GEMs deformation inside two of the detectors.
Investigation performed to understand the issues include: gas leakage, laser surface measurement to check if malformation on the external surface happened due to the shipment, computed tomographyscan to look inside the detector and check the status of the internal layers and mechanical opening of two detectors to deeply understand the weak points of such mechanical structure.
As result of these investigations, new supporting structure has been chosen for the final detectors. This consist on a carbon fiber and honeycomb sandwich. Its properties have been deeply investigated with respect to the Rohacell by means of tests and simulations. It provides robustness beyond the purpose of a detector for high energy physics and guarantees the strength for the shipment allowing to stay within the material budget requested by the experiment.
The first detector with the new design has been built and safely transported to China. In this talk a review of the construction process, the shipment and the mechanical investigations, tests and simulations that led to the final layout of the detector together with the operating results in laboratory (current stability, discharges, temperature and humidity correlation) will be presented.

21

Construction and installation of the LHCb Velo RF-boxes

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The LHCb VELO detector is undergoing an upgrade, in which all its silicon sensors and electronics are being replaced, in order to cope with a triggerless readout scheme which also runs at 5 times higher luminosity compared to the previous LHC run. To achieve a better vertex reconstruction performance, the detector will be placed as close as 5 mm to the LHC beams protected against RF-pick up by a thin foil. The amount of material in the foil contributes to multiple scattering which deteriorates physics analysis parameters. Therefore the foil thickness is of extreme importance for the experiment and has been designed to be as thin as possible, being machined to a thickness of 250 microns from a solid forged aluminium block and further chemically etched to an average of 180 micron thickness at its closest region to the beam. In this presentation details on the construction, etching, coating and final installation of the foils will be shown, including the milling process.

22

Micro-Orbital Welding in ATLAS ITk upgrade

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The decision to use small diameter, thin walled Titanium tubing for the ATLAS ITk upgrade detector cooling systems has presented ATLAS engineers with many challenges.

We at the University of Sheffield have been required to orbital weld Titanium tubing as small as 2.275mmn in diameter and with wall thicknesses at 160 microns. Titanium itself although being a strong and robust material is difficult to work with as it is extremely prone to oxidisation which can easily contaminate the weld, so extreme cleaning steps are taken in its manufacture and we follow up with rigorous preparation throughout the welding process.

Even with these procedures in place we have done rigorous R&D to limit the porosity in these tiny welded joints by performing multiple alterations in the machine weld procedures (WPS) until we have achieved an acceptable level of result, as seen in CT scans of the sample welds we are now producing. These welds mimic the production joints we will soon be doing on mass.

In addition to these points, the need for a high yield in welding process, due to the expensive nature of the final components has led us into developing techniques and bespoke geometries (sleeves) for the parts to be welded. We have also had to consider the need for testing of sub-assemblies through the manufacture of the systems with one eye on QA & QC, and have developed specialised test fittings that can be used in conjunction with the welded sleeve terminations. These parts have been tested to hold high pressure and vacuum and to deal with various testing mediums at different sites.

The lessons learned from the R&D and pre-production work carried out so far will go forward into further work needed for integration welding work and possible repair scenarios for final joints. The information is also being shared throughout the community through regular communication and by the ATLAS ITk Welding Task Force who have produced a steering document soon to be on EDMS.

25

Cooling system test of ATLAS ITK strip end-cap at BABY-Demo CERN plant

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The Large Hadron Collinder (LHC) during its High-Luminiosity phase (HL LHC) is expected to deliver an integrated luminosity up to 4000fb^{-1} and to reach an instantaneous luminosity between 5 and 7 times larger than the design LHC luminosity.

The ATLAS detector needs to upgrade its current subsystem in order to cope with this new experimental conditions. One of the most relevant improvement of the ATLAS detector consists of replacing the actual inner tracker with a new all-silicon tracker called Inner Tracker (ITK). The innermost layers of ITK, closest to the beam pipe, it is composed by pixel sensors, while a strip tracker it is used for the outer layer.The ITk strip tracker consists of a central section, the barrel, composed of 4 concentric cylinders in the central region, and two end-caps in the forward regions, each containing six disks of silicon modules. The modules of the end-cap are mounted on support structures, called petals, with embedded cooling and data lines. Each disk contains 32 petals, each of them with 18 silicon modules. The cooling for ITK system is provided by bi-phase CO_2. In particular, each strip end-cap is cooled in 12 half disk segment, and each half disk cools 16 petals for an average power consumption of 1100-1300 W.

This contribution describes the first results obtained from testing 1:1 scale mock-up of one half-disk cooling system of the ITK strip end-cap. The test was performed at CERN using the BABY-Demo cooling plant, and the performance of the cooling system in term of temperature stability and pressure has been measured at different CO_2 flow rate and set point of the cooling plant.

26

Welcome and Introduction to the Forum

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27

LHCb VELO Microchannel cooling and Module Construction

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The upgrade of the LHCb experiment, currently being installed for the LHC Run 3, will transform the experiment to a trigger-less system reading out the full detector at 40 MHz event rate. All data reduction algorithms will be executed in a high-level software farm with access to the complete event information. This will enable the detector to run at luminosities of 2 x 1033 /cm2/s and probe physics beyond the Standard Model in the heavy flavour sector with unprecedented precision.

The Vertex Locator (VELO) surrounding the interaction region is used to reconstruct the collision points (primary vertices) and decay vertices of long-lived particles (secondary vertices). The upgraded VELO will be composed of 52 modules placed along the beam axis divided into two retractable halves. The modules will each be equipped with 4 silicon hybrid pixel tiles, each readout by 3 VeloPix ASICs. The detector assemblies are operated cooled to -30degC, while consuming around 3W each.

The VELO upgrade modules are composed of the detector assemblies and electronics hybrid circuits GLUED onto a cooling substrate, which is composed of thin silicon plates with embedded micro-channels that allow the circulation of liquid CO2. This technique was selected due to the excellent thermal efficiency, the absence of thermal expansion mismatch with silicon ASICs and sensors, radiation hardness of CO2, and very low contribution to the material budget. The front-end hybrid hosts the VeloPix ASICs and a GBTx ASIC for control and communication. The design and construction techniques of the VELO upgrade Modules will be presented with the results from the latest R&D.

The material budget of the pixel modules is minimised by the use of evaporative CO2 coolant circulating in microchannels within 400 µm thick silicon substrates. Microchannel cooling brings many advantages: very efficient heat transfer with almost no temperature gradients across the module, no CTE mismatch with silicon components, and low material contribution. This is a breakthrough technology developed for LHCb; the microchannel plates will be inaccessible once the run begins and must be capable of operation in vacuum and to reliably withstand up to 200 bar pressure. The development has been carried out hand in hand with industry and has required many specialised quality control techniques, as well as a novel fluxless soldering technique to attach the connectors to the microchannel plates to allow the delivery of the coolant. The production of the first complete set of 52 microchannel plates will be described, highlighting the way in which the perfection of the cooling channels, bonding and surface quality has been maintained over the large area plates, how the construction is achieved, and the performance of the microchannel plates when fully loaded with heat dissipating electronics.

28

ATLAS Patch Panel 01 (PP1) Services, Mechanics and Eddy current effects

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To be completed

30

Cold detectors-Monitoring environmental parameters for operational purposes and integration in the control scheme

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With the ever-increasing use of Si-based detectors, balanced standalone environmental monitoring that can be also part of the detector DCS/DSS systems becomes a key issue both at the experimental cavern and at integration/production centers. We are presenting our work on one way of approaching this, based on the rapid progress of sensor conditioning circuitry and microcontrollers. We shall present the status of the MTRS (Multi Temperature Readout System), built for RTD sensor implementation and the Capacitive Relative Humidity project, meant for relative humidity monitoring sensors. We will discuss the choice of sensors, the readout circuitry, irradiation tests, software and hardware implementation and current use. We will also refer to future plans and integration issues as well as maintenance and documentation.

The next generation of "cool" detectors have strong requirements on monitoring the dewpoint of the detector inert gas at different locations. To ensure a compact detector structure and combined and integrated services, this analysis can and should be combined with any other gas analysis already in a design phase for CMS. We present the current status of the project and its foreseen evolution for the next two years

32

R&D Session Introduction, Goals of the session

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33

Challenges and R&D for the mechanics ALICE ITS 3

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34

R&D considerations on lightweight mechanics

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35

Challenges and R&D on cooling for tracking detectors

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36

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37

Finite Volume thermal analysis for the CMS Phase II Tracker Modules

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The CMS detector is going to be substantially upgraded during LS3 in order to exploit the increase in luminosity provided by the HL-LHC. The CMS Tracker for the Phase II will be populated by silicon sensors which are expected to operate at a temperature of about -20°C. The cooling system have to maintain this setpoint value and remove the total power dissipated in the tracking volume by electronics and sensors (i.e. modules), avoiding the thermal runaway. Because of the high granularity of the sensors and the associated electronics in the new Tracker, the total power dissipated in its volume and the heat leaks coming from the surroundings is expected to be about 100 kW for the Outer Tracker and about 50 kW for the Inner Tracker. Within this framework, finite volume simulations can offer a useful tool to predict the thermal behaviour of the system when the boundary conditions vary and to guide the design choices in selecting the optimal engineering solutions to achieve the desired conditions. For the purpose of predicting the thermal runaway, a model withheat generation dependent from point by point sensors temperature is implemented, so allowing to take into account of the radiation dose received over time in the various CMS structures.

38

ATLAS Patch Panel 01 (PP1) Services, Mechanics and Eddy current effects

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The ATLAS PP1 patch Panel 01 is one of the most critical element in the ITK detector that has to guarantee the services interface, the gas tightness of the detector volume and the Faraday cage requirement. This talk presents the services design of manifolds and harnesses as well as the integration procedure. The sealing techniques and data-feedthrough leakrate measurements are presented and discussed.

To maintain the Faraday cage, the patch panel must be made of electrical conductive material and than it is subject to the eddy current effect in case of magnet quench.The FEA of the PP1 to study the effects of the eddy current in term of forces and power loss are presented and discussed.

39

The Mu3e Detector and prototyping and tooling for the Mu3e vertex detector

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The Mu3e experiment searches for the lepton flavour violating decay $\mu \longrightarrow eee$ with an ultimate aimed sensitivity of 1 event in 10^{16} decays. This goal can only be achieved by reducing the material budget per tracking layer to $X/X_0 \approx 0.1$ %. For this purpose, gaseous helium is chosen as coolant, while High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) thinned to 50 μm constitute the baseline for the vertex detector.

This talk will show the detector concept, focusing on the technical aspects of the pixel tracker and its several challenges. As the construction phase is now approaching, this talk will also provide an overview of the prototyping phase. Details on the custom tooling for chip placement, ladder and module construction are shown, along with results on the recent chip submission, MuPix10.