

CEPC Detector TDR Meeting (Feb. 27, 2024)

09:00 - 11:50 (Beijing Time)

Meeting agenda and minutes

- indico page: <https://indico.ihep.ac.cn/event/21639/> (<https://indico.ihep.ac.cn/event/21639/>)
- Participants
 - Present in the meeting room:
 - Shanzhen Chen, Shaojing Hou, Ling Zhao, Jinyu Fu, Huaqiao Zhang, Xinchou Lou, Mingyi Dong, Gang Li, Feipeng Ning, Haoyu Shi, Shengsen Sun, Zhijun Liang, Quan Ji, Yong Liu, Zhaoru Zhang, Jianchun Wang, Mingshui Chen, Jingbo Ye, Manqi Ruan, Yiming Li, Jingzhou Zhao, Guang Zhao, Yunyun Fan, Hengne Li, Wei Wei
 - Online
 - Hongyu Zhang, Yubin Zhao, Zijun Xu, Mei Zhao, Meng Wang, Chengdong Fu, Ying Zhang, Xin Shi, Jinfan Chang, Haijun Yang, Fei Li, Junsong Zhang, Xiaolong Wang, Shang Xia, Haoyu Shi, Joao Guimaraes da Costa, Ye Chen, Jun Hu, Suen Hou, Miao He, Sha Bai, Yang Zhang, Huirong Qi, Lei Zhang, Zhen-An Liu
- Minutes: Yong Liu, Zhaoru Zhang

News: Jianchun Wang

- Keep updating information about conference abstract to Zhaoru
- CEPC Day: all the L2 groups will report status and plan

Software: Shengsen

- Brief status report by Shengsen
 - CEPCSW Status
 - Geometry, inputs from hardware
 - To be integrated into CEPCSW: DC stand-alone software, dN/dX simulation of endcap part

- ECAL performance optimisation
 - Arbor porting
 - Auto-Validations
- Critical questions on TOF
 - Detection capacity
 - To compensation the kink 0.7 - 1.1 GeV
 - Particles that can not reach barrel TOF ($0.8 \text{ GeV} < p < 1.54 \text{ GeV}$)
 - Material loss
 - TOF at 0.6m?
 - Event start time (collision time) is necessary?
 - Accuracy
 - Physics requirements?
- Beam background: discussions with Haoyu
- Discussions
 - Manqi: TOF coverage both barrel and endcaps
 - Jianchun: list 1-2 physics benchmarks to evaluate the gain in performance
 - Jingbo: particles that can not reach calorimeters important to physics?
 - Jianchun: soft pions in D^* in flavour physics
 - Haoyu: 10.6mm beam bunch length (along Z)
 - Jianchun: sigma? Haoyu: to be confirmed with accelerator colleagues
 - Shengsen: $\sim 33 \text{ ps}$ uncertainty, but needs to be divided by $\sqrt{2}$ since for two beams
- Xinchou:
 - Should focus global PID including dN/dX and TOF

Electronics: Wei Wei

- Status report by Wei
 - TDAQ system: framework, cost estimates
 - References from TDAQ systems in ATLAS and CMS
 - Cost estimates of CMS TDAQ: quantity of standard modules -> scaling
 - Wire-less data transfer: internal discussions
 - mm-wave option: moderate data speed, short distance, antenna can be integrated
 - Laser option: high data speed, long distance, but large form factor of optical component
 - Exclude WiFi option

- Rad. hard powering: discussions during Mauro Citterio's visit to IHEP
- Questions
 - HV system, grounding
- Considerations on the powering scheme for CEPC
 - All custom PoI modules + All custom power controller (local near detectors)
 - > (48V/12V DC in 40m?) -> Custom DC-DC power/crates + COTS power supplies <-(480 AC)
- Discussion
 - Question about who should be responsible for HV system
 - Jianchun: Electronics take care of it
 - Jingbo
 - Experiences from ATLAS/CMS Phase-2 upgrades can answer many of open questions for CEPC -> suggest prepare a few talks to summarise
 - Consider to provide widely used (standard) voltage levels: 1.2V, 1.8V, 2.5V and 3.3V
 - Jianchun: Electronics should set the standards and instruct the sub-detectors on how to use them.
 - Jianchun: It is OK to increase L3 leaders, but the necessity should be considered.

Mechanic: Ji Quan

- Status report by Quan
 - Discussions
 - Tracker and yoke
 - Other scheduled discussions with calo and MDI
 - Global detector design
 - With updates of tracker and yoke ("spiral" design, asymmetric in phi segments)
 - Boundary of barrel-endcap: needs a more clear definition
- Discussion:
 - Feipeng: no requirements on iron yoke thickness or magnet leakage from magnet group
 - Manqi: (1) HCAL of 6 lambda to minimise hadron shower leakage, less requirements on muon thickness; (2) seems not necessary to have 7-layer muon detector
 - Xiaolong: inner radius of muon detector, with updates from HCAL thickness
 - Xiaolong: suggest adjusting the thickness of each layer to be the same during the TDR phase for ease of simulation and to reduce questions.

Vertex: Zhijun

- Status report by Zhijun
 - Status and plans
 - Got background input from MDI group -> will estimate background hit density distributions in vertex detector
 - Finalise vertex electronics design in end of March, considering major concerns on readout speed and buffer size
 - Finalise vertex geometry and mechanics in end of March

Tracker: Meng

- Compared TPC/DC performance, DC simulation is still on going
- Yiming: CMOS cost estimate: Area vs cost distribution, but only consider sensor cost
- Discussion:
 - Jianchun: Question about Z-resolution of outer layer of silicon tracker
 - Meng: delata Z edge=184mm, double layer silicon strip meet requirement
 - Manqi: need to quantify SET performance (resolutions with 5 paras), using muon to scan all phase space
 - Manqi: 20% improvement in high momentum region, based on CDR baseline
 - Gang: 10-20% track momentum resolution in 60-100 GeV, only impact $H \rightarrow \mu\mu$ (with 4M Higgs, less requirement on this channel) negligible impact to BMR
 - Xinchou:
 - Research on the SET should involve calculating the tracking resolution and analyzing the impact of tracks entering the ECAL/HCAL on particle flow algorithm (PFA). A one-page note should be prepared and shared with the committee as a basis for decision-making.
 - Study the relationship between dN/dx and electronics: Analyze the cost scale of electronics, assess the benefits of dN/dx compared to dE/dx, and present the results for the committee's decision.
 - Reviewing the costs is challenging, and it is recommended to invite Jie Gao to share his experience. This will help to clarify which factors are important.

Calorimeter: Jianbei

- Brief updates (oral) by Jianbei
 - Updates the criteria table for option comparison
 - Added separation capability, intrinsic hadronic energy resolution
 - Updated geometry dimensions
 - Summary of calo options
 - In 3 aspects: performance, cost and technical readiness
 - Critical issues
 - Boundary conditions: inner radius of 1.9m (1.8m+0.1m gap)
 - Endcaps cover barrel
 - Action item: update each calo-option
 - Calo-Weekly Meeting fixed in Friday morning at 9AM
 - Extra information on the meeting and minutes (Yong)
 - Topics: Follow-up discussions on CEPC calorimeter option down-select
 - Indico: <https://indico.ihep.ac.cn/event/21619/> (<https://indico.ihep.ac.cn/event/21619/>)
 - Minutes:
https://indico.ihep.ac.cn/event/21619/contributions/149902/attachments/76094/94038/Minutes_CaloOptions_20240223.pdf
(https://indico.ihep.ac.cn/event/21619/contributions/149902/attachments/76094/94038/Minutes_CaloOptions_20240223.pdf)
- Discussion:
 - Jianchun: for B/E bounday structure, should consider electronics, and check CMS mechanic design
 - Jianchun: Study the impact of the outermost layer tracker on the calorimeter

Muon: Xiaolong

- Status report by Xiaolong
 - Organising R&D activities on module prototyping, WLS, electronics, Geant4 simulation, RPC R&D
 - GNKD preparing plastic scintillator (strips) production
 - Open question
 - Inner radius of muon detector: to be determined after discussions
- Discussion:
 - Jianchun:
 - Prioritize and clearly distinguish between TDR and future R&D tasks.

- Compare the two options as soon as possible and make a decision promptly.
- Close communication is essential for electronics discussions.

Magnet: Feipeng

- Status report by Feipeng
 - Ultra-thin magnet design (150mm): feasible in an ideal scenario
 - Thermal radiation: 300-500 W (heat leakage), but with a large uncertainty that requires experimental tests for validation
 - Cost increase: cryostat station (10M CNY); 200kW power consumption
 - Space considerations
 - 150mm space very limited
 - 200mm could reduce an order of magnitude lower heat leakage
 - Future projections in cost reduction for HTS
 - Cost estimates
 - HCAL inside magnet: saving of 36M CNY
 - Will update other aspects (yoke, coil, cryostat) and the scenario of HCAL outside magnet
 - New version of yoke
 - Symmetric design
- Discussion:
 - ■ Manqi: heat leakage without dimension constraints?
 - Feipeng: an order of magnitude lower heat leakage
 - Jianchun: no need to wait for final parameters from HCAL and Muon, update the table asap

MDI: Haoyu

- Status report by Haoyu
 - LumiCal updates: from Geant3 to CAD and CEPCSW; plan to electronics
 - Beam-induced backgrounds
 - Background estimate table
 - Table updated for 1st vertex layer
 - Action items
 - Mechanics schematic drawings with accelerator
 - Update background table
 - Migrate to CEPCSW

- Discussion:
 - Jianchun: check acc TDR for integrated luminosity values, directly use them
 - Lei: beam telescope required for further R&D
 - Jianchun: existing telescope(s) from AMS
 - LumiCal: 10^{-4} resolution (1 mrad) due to multiple scattering

Physics: Manqi

- Updates from Manqi
 - Ongoing discussions with sub-detector teams
 - Software update: Arbor can work in CEPCSW
 - Benchmark analysis: H->cc; particle net, jet origin ID; PID if person power is sufficient