

# CEPC Reference Detector TDR Meeting (Apr. 30, 2024)

09:00 - 12:00 (Beijing Time)

## Meeting agenda and minutes

- indico page: <https://indico.ihep.ac.cn/event/22433/>
- Participants
  - Present in the meeting room (M.B. 112)
    - Miao He, Zhijun Liang, Haoyu Shi, Feipeng Ning, Yifang Wang, Zheng Wang, Huaqiao Zhang, Quan Ji, Huirong Qi, Jingbo Ye, Manqi Ruan, Wei Wei, Mingyi Dong, Mingshui Chen, Qi Yan, Jianchun Wang (chair), Yong Liu; Jinyu Fu, Shanzhen Chen, Ling Zhao, Yunyun Fan, Yiming Li, Shaojing Hou
  - Online
    - Xinchou Lou, Shengsen Sun, Shang Xia, Fangyi Guo, Tao Lin, Mei Zhao, Suen Hou, Gang Li, Hengne Li, Jingzhou Zhao, Ye Chen, Guang Zhao, Chengdu Fu, Boxiang Yu, Zhaoru Zhang, Xiaolong Wang, Yao Zhao, Jun Gao, Xin Shi, Meng Wang, Yang Zhang, Zhan Li, Lei Zhang, Xiongbo Yan, Jinfan Chang, Ying, Fei Li
- Minutes: Yong Liu, Zhaoru Zhang

## Software : Shengsen Sun

- Status report: [slides](#)
  - Release the version tdr24.4 of CEPCSW soon (in 2-3 days)
  - Tracking functionality
  - Beam background mixing
  - Plan: next release towards PID (target next month)
  - Progress in calorimeter simulation and progress
- Discussions
  - Manqi: lepton ID implemented in CEPCSW?
    - Shengsen: person power issue
    - Yifang: should wait until fundamental parts are ready

## Electronics: Wei Wei

- Status report: [slides](#)
  - Input parameters on data link and power
  - Irradiation test of GaN transistor samples
  - Discussions with sub-detectors: e.g. calorimeters
  - FEE data rate of each sub-detector: summarised table
  - Further considerations on data link and power supplies
  - International collaborations: DRD7, French institutions
- Discussions
  - Jianchun: back-end electronics -> common standard (specs, cost) ?

- Wei: indeed the goal; cost mostly depends on number of modules
- Jingbo: still a big question mark in event rate
  - Yifang: the threshold has to be safe while limiting data volume
- Yifang
  - **Try to reduce the number of fibers for digital data readout in crystal calorimeter**
  - **Good to have alternative options included in TDR, esp. for novel technology options**
- On vertex detector
  - Wei: **65nm TowerJazz could be an option in the future**; Zhijun: need to evaluate the power consumption reduction
  - Yifang: SMIC 65nm CMOS could be another option
  - Jianchun: SMIC 55nm is a scale-down from 65nm design

## Mechanics: Quan Ji

- Status report: [slides](#)
  - General updates in detector dimensions
  - MDI boundary
    - ECAL endcap inner diameter  $\mathrm{\Phi}=700\text{mm}$
    - HCAL endcap inner diameter  $\mathrm{\Phi}=800\text{mm}$
  - Gap of sub-detectors and space for cabling
  - Yoke
    - Total thickness 1750mm
    - Gap between yoke and muon: 50mm
    - TO investigate/survey yoke production capability in Luoyang Mining (" ")
  - HCAL
    - Connection of barrel HCAL to yoke
  - ECAL:
    - Dimensions of the boundary
    - Fix barrel ECAL to barrel HCAL?
  - TPC and outer tracker
    - Connection flange: needs to be removed
    - Outer tracker "tied" on TPC/DC (do not need its own mechanics structure)
  - Silicon tracker and vertex: pending on endcap designs
- Discussions
  - Yifang
    - Endcap acceptance near  $\cos\theta=0.99$  regions
      - **Need to carry out studies on the EM/hadronic calorimeter acceptance in the endcap regions**, by taking into accounts of EM/hadronic shower developments
    - ECAL dimensions
      - **Do not include ScW-ECAL option in the mechanics design, only consider crystal option** -> ECAL diameter remains at 4400 mm
    - **Need to further reduce gap**

- Gap between barrel detectors: 10mm
- ECAL endcap and tracker: 100mm -> 50mm
- HCAL endcap and ECAL endcap: 60mm -> 30mm
- Xinchou:
  - **The first CEPC reference detector TDR review expected in July;** please be reminded to prepare supporting materials for defense

## MDI: Haoyu Shi

- Status report: [slides](#)
  - Beam-induced backgrounds
    - ROOT files done, except for synchrotron radiation, generated in CEPCsoft
    - Ongoing to the second version (in CEPCSW)
  - LumiCal:
    - Data rate estimate -> electronics group
    - Geometry implementation in CEPCSW
  - Overall design and IR
    - Started re-design of cryostat modules and anti-solenoid

## Magnet: Feipeng Ning

- Status report: [slides](#)
  - Reduction in yoke weight to 4323 ton
  - Two cooling schemes
  - Yoke and stray field
    - B-field 1m on barrel: 0.12 T -> needs to be reduced (with holes)
- Discussions
  - Yifang: should not increase the number of gaps and keep the gap minimum to suppress stray field
    - Feipeng: stray field already saturates at 2T
    - Yifang: think about other materials (with higher saturation points)?
  - Yifang: cooling system
    - **Need to organise a review on the cooling option selection** (performance, cost, impacts to other system costs)
  - Feipeng: B-field gradient more important than uniformity (for impacts to tracking precision)
    - Will update the mapping of B-field gradient
  - Manqi
    - Anti-solenoid included in B-mapping measurements?
    - B-field mapping before/after switch-on:
      - Yifang: measurements with closed endcaps, without calorimeters (assuming non-magnetic calorimeter components); crucial to equip all non-magnetic components in calorimeters
  - Shengsen

- Could use a few probes to monitor B-field variations along with time? -> Feipeng/Yifang: Yes, feasible.
- Xinchou
  - **Could learn from previous detectors at previous e+e- colliders** (e.g. SLD, MarkII; detectors at LEP: ALEPH, DELPHI, L3, OPAL)

## Vertex: Zhijun Liang

- Status report: [slides](#)
  - Meeting with TowerJazz management team
  - Beam background estimate: 10MW (Low-Lumi Z) vs. 50 MW (High-Lumi Z)
    - 10MW: higher priority
  - Vertex detector assembly
  - Cooling scheme:
    - Power dissipation: 50 mW/cm<sup>2</sup>
    - **Will first focus on 65nm technology**
  - Cabling and services: optical fiber connectors

## Tracker: Meng Wang

- Status report: [slides](#)
  - Ongoing simulation
  - TPC
    - Cost update: 110M CNY
    - FEA preliminary results: deformation
    - DESY Beamtest in Sep.
  - DC cost: 8.7M CNY
- Discussions
  - Yifang
    - Need to have endcap designs
    - **Should plan to call for an option selection review (TPC/DC)**
  - Xinchou: crucial to have documentations
    - Meng: meeting minutes available

## Calorimeters: Yong Liu

- Status talk: [slides](#)
  - Updates on ECAL and HCAL dimensions, esp. the total thickness
  - First designs of endcap calorimeters
- Discussions
  - Yifang
    - HCAL: top/bottom cassette thickness and necessity of bottom cassette (all made from steel)
      - Yong: cassette and thickness can be further optimised
    - **HCAL: longitudinal/transverse granularity in outer layers (more as a tail catcher) -> to be optimised for performance/cost, e.g. coarser granularity in outer layers**

## Muon: Xiaolong Wang

- Status report: [slides](#)
  - Front-end electronics R&D for scintillator-SiPM option
  - Software training for new students
  - RPC option R&D at SJTU
  - Brief review of option comparison: scintillator versus RPC
- Discussions
  - Yifang
    - Should have reliable cost estimates in option comparison
    - Plastic scintillator via injection moulding in China: potentials of cost reduction and performance
    - **Should include consistent comparisons in the table:** e.g. gas systems (excluding unnecessary functionalities), power supplies (e.g. CAEN HV modules)
    - Should have integrated table including all information
    - Electronics R&D: TDR needs framework design asap, and match with performance indicator

## Physics: Manqi Ruan

- Oral updates by Manqi
  - Dedicated discussions on physics benchmarks
    - Exercises in CEPCsoft: Higgs->invisible,  $\$V_{\text{cb}}\$$
    - Key performance parameters: BMR, PID, jet origin ID
    - Long Live Particle (LLP) and related new physics
- Discussions
  - Yifang: BMR of 4.5% -> can be further improved?
  - Shengsen: better BMR could be achieved, ongoing studies
  - Yifang
    - First replace HCAL with glass, perform studies on jet performance; then replace ECAL with crystals
      - Manqi: the HCAL studies done in this way and confident on glass HCAL simulation results
    - **Goal: 1-5 CNY/cc for scintillating glass**
      - 1 CNY/cc as the best scenario