

CEPC Detector TDR Meeting (Jan.30, 2024)

- Time: Jan. 30, 2024 (9:00 - 11:55 AM)
- Participants:
 - Management team: Jianchun Wang (chair), Miao He, Mingshui Chen; Joao (as a senior scientific/technical advisor);
 - Organising team: Gang Li, Yong Liu, Zhaoru Zhang
 - Other participants in meeting room: Mingyi Dong, Gang Li, Xinchou Lou, Zheng Wang, Jingbo Ye, Quan Ji, Hui Zhang, Ling Zhao, Feipeng Ning, Haoyu Shi, Shanzhen Chen, Zhijun Liang, Xin Shi, Wei Wei, Huaqiao Zhang, Manqi Ruan, Shengsen Sun, Jinfen Chang, Yubin Zhao, Xiongbo Yan, Jun Hu, Jie Zhang, Jinyu Fu, Zheng Wang, Yiming Li, Huirong Qi
 - Online participants: Jianbei Liu, Yunpeng Lu, Haijun Yang, Xiaolong Wang, Suen Hou, Jun Guo, Qibin Zheng, Yunyun Fan, Zhen-An Liu, Zhi Deng
- Minutes: Yong Liu, Zhaoru Zhang

Introduction by Jianchun Wang

- A brief summary of CEPC Steering Committee Meeting in Jan. 30
 - Detector R&D should converge to TDR for reference detector (TDRrd thereafter)
 - TDRrd to be ready before the 15th five-year plan: draft before end of 2024, final version in Jun. 2025

Opening remarks by Xinchou Lou

- 11 years R&D for CEPC
 - HL-LHC running till 2042 -> a good opportunity for CEPC
 - Important reminder: 15th five-year plan starts in 2026
- Accelerator TDR published in end 2023
 - Technical system review in Hong Kong
 - Cost estimate review
 - Civil engineering review
- Detector TDR
 - Covering a workable design, costs, etc.
 - The first version in end of 2024
 - Parallel efforts: to prepare "项目建议书" (proposal for government)
 - References based on the publications from existing detector R&D -> encourage more publications
- Bear in mind: planning on detector EDR (Engineering Design Report) process
 - (Timescale) beyond TDRrd
 - Scope to be discussed and defined
 - Including MDI, site selection, engineering
- Talks presented at Tuesday TDRrd meetings
 - Should clearly specify each topic is targeted for TDR or beyond (EDR)
 - "Excited states" for discussions and arguments

- Everyone is encouraged to join/visit
 - CEPC accelerator EDR preparation meetings, HEPS and JUNO sites
- Aim to make sensible decisions
 - After collective discussions
- Reference detector TDR is expected to distinctively reflect CEPC features
 - Based on the detector R&D efforts

Management structure: Jianchun Wang

Talking: 多學科 228

Subsystem	L2 Leader	Topics	L3 Leader
Organizing	Miao He	Minutes of the CEPC Tuesday meetings	Zhaoru Zhang
		TDR document	Yong Liu
			Gang Li
Physics Studies	Manqi Ruan	Higgs	Yaquan Fang
		Flavor	Shanzhen Chen
		EW	Zhijun Liang
		QCD	Zhao Li
		BSM	Xuai Zhuang
Software & Simulation	Weidong Li	Simulation	Gang Li
		Software / general	Weidong Li
		Software / applications	Shengsen Sun
		Software / reconstruction	
Electronics & TDAQ	Wei Wei	Common components	Wei Wei
		Subsystem electronics	see subsystems
		TDAQ	Fei Li / Zhenan Liu
Mechanical & Integration	Quan Ji	General mechanical + Integration	Quan Ji
		Subsystem mechanical	see subsystems
MDI & LumiCal	Haoyu Shi	MDI	Haoyu Shi
		Accelerator liaison	Sha Bai
		Radiation background	Haoyu Shi
		LumiCal	Suen Hou (IPAS)
		Electronics	Lei Zhang (NJU)
		Mechanical	?

Subsystem	L2 Leader	Topics	L3 Leader
Vertex	Zhijun Liang	CMOS Pixel Vertex	Zhijun Liang
		SOI	Yunpeng Lu
		Stitching technology	Meng Wang (SDU)
		Electronics	Jun Hu
Tracker	Meng Wang	Mechanical	Jinyu Fu
		SPD Tracker	Yiming Li
		SSD Outer Tracker	Xin Shi
		LGAD ToF (+OTrk)	Yunyun Fan
		Pixelated TPC	Huirong Qi
		PID Drift Chamber	Mingyi Dong
		Electronics (TPC)	Zhi Deng (THU)
		Electronics (Silicon)	Yubin Zhao
		Electronics (DC)	Xiongbo Yan
		Mechanical	?
Calorimeter	Jianbei Liu	4D Crystal bar ECAL	Yong Liu
		Stereo crystal ECAL	Huaqiao Zhang
		PS+SiPM+CuW ECAL	Yunlong Zhang (USTC)
		GS/PS+SiPM+Fe HCAL	Yong Liu
		RPC HCAL	Jun Guo (SJTU)
		Electronics	Jinfan Chang
Muon	Xiaolong Wang	Mechanical	?
		PS bar muon	Xiaolong Wang (FDU)
		RPC muon	Jun Guo (SJTU)
		Electronics	Qibin Zhen (USST)
Magnet	Feipeng Ning	Mechanical	?
		HTS magnet	Feipeng Ning
		LTS magnet	Ling Zhao

1/30/2024 2

- Management structure (): sub-system, L2 leader; Topics, L3 leader
- Created new category in indico, including sub-categories for all L2 groups:
 - Indico category for all TDR-related meetings
 - <https://indico.ihep.ac.cn/category/1041/>
 - All make sure indico pages include full information, especially **minutes** for every meeting
- Software/reconstruction L3 Leader: candidate to be determined
 - Weidong and Shengsen will discuss about this
- Each sub-system will include
 - An L3 leader on mechanics and an L3 leader on electronics
- Further discussions
 - Remarks by Manqi: two crucial issues to be addressed
 - Realistic designs -> implement them into simulation -> reconstruction
 - Fair comparisons of different sub-detector options to address same set of questions and in the same standards
 - Remarks by Joao
 - Important to make clear assessments and go through options
 - Should be able to scientifically justify selection of each sub-system option
 - Remarks by Haijun
 - Suggest set up timelines for milestones esp. for down-select of subsystem options -> full simulation and performance studies -> converge to the reference detector design in 2-3 months
 - Remarks by Manqi

- Now can prepare the Table of Contents (TOC) for TDR

Physics: Manqi Ruan

- Will prepare a list of benchmark physics and benchmark performance (sub-system)

Software: Shengsen Sun

- Person power of each subsystem devoted to software developments -> connection (contact person) between software and sub-system.
- Need an L3 manager for event reconstruction.
- Jianchun's feedback
 - * L3 leader of each sub-system serves as the contact person to software
 - * University students -> training -> software developments
 - * Postdocs training curve: compatible with TDR timeline (1-1.5y) or not -> need to consider
- Further discussions
 - Haijun's feedback
 - Existing graduate students (3-4th year) and postdocs from universities get involved (after necessary training)
 - Joao
 - Full simulation is crucial to TDR
 - Need to go through each detector option and decide

Electronics: Wei Wei

- A brief summary of sub-detector requirements
 - Overall scheme of electronics
 - Started to discuss with each sub-detector system
- Key target: from R&D to engineering goals
 - Different specs on data throughput from CDR to the latest simulation
 - Feasible and scalable designs/schemes from R&D to TDR
- Person power requirement and planning
 - Short-term: more rely on experienced staff (less on student) on electronics designs/schemes
 - Long-term: realise some of designs during TDR (more person power)
- Feedback/questions from Jingbo
 - Collect requirements/inputs from each sub-detector
 - Data throughput estimate
 - Detector signals: trigger interface? buffer?
 - Power supply: standard voltages or special bi-polar voltage?
 - Converge to common needs/projects: e.g. SiPM readout, ADC for calorimetry, TDC for fast timing
 - Powering scheme: high-efficiency power, local DC-DC converters

Mechanics: Quan Ji

- Plan to set up a mechanics team
- Start from iron yoke
 - Need to communication with the muon group to determine parameters

- Jianchun: management structure
 - General mechanics and integration: Quan Ji
 - Arrange a mechanics engineer in each sub-system
- Jingbo: cooling as part of mechanics? -> Quan: yes
 - Cooling simulation of front-end chips given the power dissipation: air vs water cooling?

MDI and LumiCal: Haoyu Shi

- LumiCal: design by Suen, discussions ongoing today; more to come
- Key questions to MDI
 - Impacts of backgrounds to detector signals and IP region irradiation
 - Radiation hardness issues
 - Quantitative results will come out in 1-2 months
 - Reply on realistic detector simulation: hit density -> software
- Discussions
 - Jingbo: irradiation mapping for CEPC Detector?
 - Haoyu: ongoing updates according to the accelerator TDR design
 - Manqi: concerns about (reliable) tools on simulation of "hot bath" of gammas and neutrons in the real collision environment
 - To arrange topical workshops for in-depth discussions
 - Jingbo: radiation hard technology
 - SMIC 55nm CMOS

Vertex: Zhijun Liang

- Major change from CDR to TDR
 - Beam pipe diameter; instant luminosity per IP
- Action items
 - To consider full physics programs: H/Z/WW/top
 - Connections to physics, MDI and front-end electronics/DAQ
- Discussions
 - Wei: need to define clearly the task responsibility of connection parts between the vertex sensor and front-end electronics
 - Jianchun: to be decided, pending on the global design
 - Jingbo: depends on the design of the connection (FE chip digital part and back-end chip)
 - Jingbo: vertex cooling scheme? -> Zhijun: air cooling by fans (10 degrees), but also depends on the background simulation results from Haoyu
 - Meng: to define clearly the interface between vertex detector and electronics after option selection

Tracker: Meng Wang

- Presented 3 major questions on the tracker system
- Q1: what is tracker aimed for?
 - TDR: Higgs + Z + W
 - Xinchou: as a summary of CEPC SC meeting, the consensus is that we should aim for all physics programs (H/Z/W/top), existing possibility of first TPC and later DC+silicon, but

- need to justify and minimise detector upgrade needs
- Jianchun: Higgs as the highest priority
- Q2: how to choose a technology?
 - Criteria: performance, cost, ...
 - Timeline: one or two months?
 - Jianchun: max. two months
 - Silicon, DC for dN/dX, ToF
- Q3: what are we lack of ?
 - Simulation for tracker
 - Different options
 - Fast and easy for configuration
 - Both stand-alone and connection to full simulation
 - Person power: to be sorted out

Calorimetry: Jianbei Liu

- Calorimetry options
 - Options from ILD
 - New options for the 4th concept detector
 - Many in-depth R&D activities: large prototypes and beamtests
- Key questions: more demanding on the electronics, mechanics and cooling
 - No R&D on electronics -> how to address this issue in TDR? -> Chip design
 - Electronics fully integrated in calorimeters
 - Need to invest more person power on mechanics design (heavy) and cooling scheme (high integration)
- Discussions
 - Quan Ji: HNU students work on calorimeter mechanics
 - Wei: Most probably we have to design the front-end chip by ourselves
 - Jingbo:
 - Global trigger scheme: calo as part of L1 trigger -> considerations?
 - A large trigger buffer -> how to implement?
 - Yong
 - Suggest define clear and comprehensive criteria for down selecting different calorimetry options and also timelines -> Jianbei: agree and options should converge soon (full simulation,)
 - Xinchou
 - Senior people should come up with a template of criteria to compare detector options
 - Mingyi
 - Barrel detector length: need to be fixed and referred by all sub-systems -> Manqi will give a talk on this topic
 - Suen
 - Technical connection of LumiCal to calorimetry system

Muon: Xiaolong Wang

- Scintillator-SiPM option

- Prototyping and publications
 - R&D plans
- Discussions
 - Manqi: suggest consider physics benchmarks on LLP searches in muon detector
 - Jianbei: focus on the major physics goals
 - Jianchun: Need to consider the interface of electronics, and muon system should talk to yoke
 - Quan Ji: three yoke designs

Magnet: Feipeng

- Ongoing R&D for small-scale cabling
 - Full-scale cabling-> needs investments in both LTS and HTS
 - Ultra-thin magnet (150mm) R&D: needs person power from mechanics team (more on testing, not only the design)
- Discussions
 - Xinchou: timeline of cabling selection (significantly less than a year), suggest consider the mature option for TDR
 - Feipeng: yes, select a baseline option for TDR
 - Manqi: we need to decide the HCAL location (within vs. outside magnet)
 - Xinchou: put all information (timeline and tech. readiness) together for further discussions and final decision, before the detector review

Electronics group

- Jingbo
 - Inputs from sub-detector and more discussions on requirements
- Wei introduced colleagues of electronics group to be involved in the TDR preparations on sub-system electronics

Topics for next Tuesday TDR meeting

- Physics benchmarks: Manqi
 - Involvements from the high energy frontier group: Manqi and Mingshui
- Overview of previous studies on the barrel/endcap dimensions: Manqi (20min talk)
- Xinchou: to arrange a candidate to present the template of criteria for the sub-system option selection
 - Expected progress with less options after applying selection criteria

Key action item

- To prepare a first template of criteria for down-selecting sub-system options, co-led by Miao He and Yong Liu.

