Study Plan of
Physics and Performance

Future Research Plans, Challenges, and Management Support Requirements

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Detector & Physics Performance activities

- Based on the CEPC reference detector, iterate closely with detector design and optimization, update relevant object/benchmark performance

- Work closely with software group, MDI group for studies with more realistic conditions: beam-induced background, mis-alignment, noise, non-uniform magnetic field, etc. (IDRC recommendation)

  - Some tools to be further developed and integrated into CEPCSW, e.g. ACTS
  - Computing speed to be improved for beam background simulation
  - Independent cross checks for certain major issues, e.g. alternative beam background generator

- Further develop existing physics benchmarks and add new benchmarks

  - E.g. H->ss, Z->ss (IDRC recommendation)

- Explore further AI/ML/QC to improve sensitivities

- Investigate LEP dada, to validate some CEPC performance

Plans documented in the TDR

- **Strategy for measuring absolute luminosity**

  — Collaboration with MDI/LUMI group

- **Application of the resonant depolarization method for the W/Z boson mass determination**

  — Collaboration with Accelerator team

- **Methods and considerations for calibration, alignment**

  — Strategy outlined in the TDR, need to be demonstrated: develop ancillary analysis techniques for in-situ alignment and calibration of final-state objects

Strategy Overview

› Compact EM calorimeter as luminometer
› Si-tracking plane for micron-level position resolution
› Laser-based position monitoring system
› e⁺e⁻→γγ for offline luminosity determination

R&D plans for next few years exist

Further design optimization listed in the TDR

Work closely with detector groups needed

- ECAL transverse granularity for boosted π^0/γ separation

- HCAL thickness versus the polar angle for jet energy resolution

- Muon system optimization for long-lived particle searches

- Low-momentum charged hadron PID with AC-LGAD timing layers

- Pixel versus strip ITK for PID requirements

- TPC versus Drift Chamber at the high-luminosity Z pole run

- High Temperature Superconductor (HTS) ultra-thin magnet feasibility

High Level Reconstruction

Work closely with software groups needed

- Complete the software & analysis toolkit to ease detector performance evaluation

- Develop **analysis-ready** particle flow reconstruction chain in full simulation: tracking, e/μ/γ, jets, flavor/τ

- With realistic modelling of operational conditions :
  - Beam background, mis-alignment, noise, non-uniform magnetic field, etc.

Potential Issues & Challenges

Organizational

Personnel Appointment
Subsystem conveners not yet appointed during transition period

Structure Planning
Group organization awaits convener appointments

Scope Definition
Division between Physics Program and Performance needs clarity

Resource

Sustainability
"Bring your own resources" model

Is this model sustainable long-term?

Key Concerns
- Career opportunities for young researchers
- Long-term funding stability

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Management Support Needed

Organization

1 **Appoint Conveners**

Establish clear leadership structure for Physics Performance Group

2 **Define Scope**

Clarify division between Physics Program and Performance
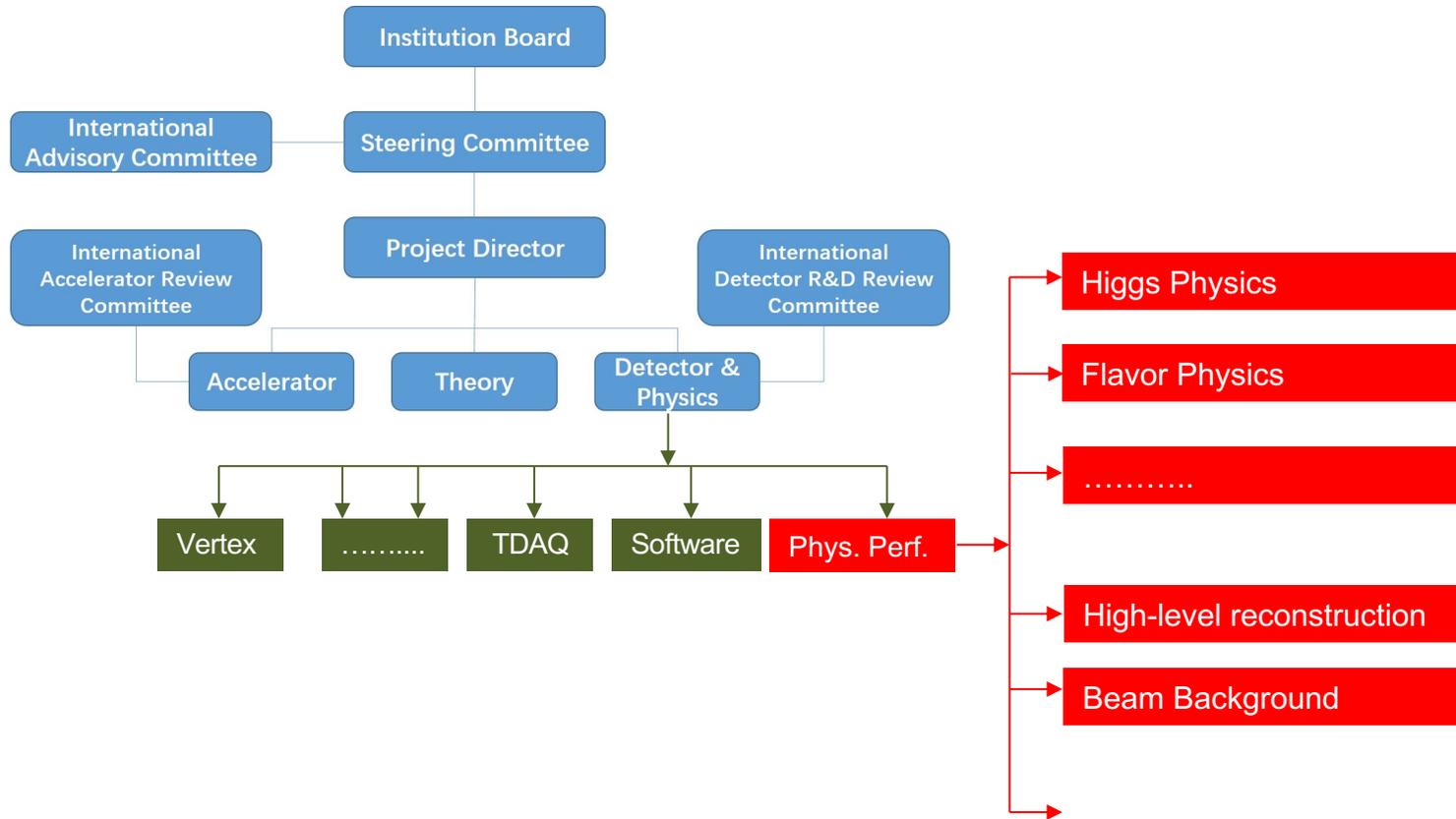
Personnel

Expand Team

Involve more from domestic and international institutions beyond IHEP

Support Mechanism

Establish sustainable funding, avoid "bring your own" model

Backup

Potential structure

- Higgs physics
- BSM physics
- Flavour physics
- Electroweak physics
- Top-quark physics
- QCD physics

- High-level reconstruction: Objects
- Monte Carlo tools
- Analysis and visualisation tools

- Beam background

IDRC Recommendations

- While the detector performance section (15.1) is well advanced, the physics benchmark studies (15.2) — and in particular the treatment of essential experimental aspects such as luminosity determination, resonant depolarization, and alignment strategy (15.3) — remain at an early stage. The committee recommends that, following the established roadmap, the promising work already initiated be further developed to achieve a more comprehensive qualification of the Reference TDR detector performance, including realistic modelling of operational conditions.

- The TDR places notable emphasis on the new JOI algorithm compared with the standard BDT XGBoost approach. The quark-flavour separation power achieved by JOI, as illustrated in Figure 15.15, is particularly promising. The committee encourages the collaboration to demonstrate its impact on sensitivity to the $H \rightarrow s\bar{s}$ decay channel — a novel and distinctive measurement beyond the reach of current LHC experiments.

- Since Figure 15.7 indicates that charged kaons can be efficiently identified at the Z pole, the committee further recommends exploring the potential for measuring the forward–backward asymmetry (A_{FB}) in the $Z \rightarrow s\bar{s}$ channel.