Comments/Recommendations on Performance

- The planned list of channels looks a bit too high for a few months of work, better to focus on demonstrating that the reference detector reaches adequate performance for physics
  - **Select fewer channels, aimed at demonstrating that the reference detector reaches adequate performance for physics. Include some simple topology (e.g. Z→mumu). Encompass H, Z, W and top physics.**
  - **Foresee in the TDR results and figures about performance on basic objects (leptons, photons, jets) as a function of energy and polar angle**
  - A measurement of V_cs during the WW run is probably a more relevant benchmark than V_cb ;
  - The channel to be used for the electroweak mixing angle measurement should be clarified

Plans:

Priority: working closely with software team for the development and performance studies of basic objects

H→ss/cc/sb
H→inv
Vcb
W fusion Xsec
α_S
CKM angle $\gamma-2\beta$
Weak mixing angle
Higgs recoil
H→bb, gg
H→μμ
H→γγ
W mass & width
Top mass & width
Bs→$\nu\nu\phi$
Bc→$\tau\nu$
B_0→2π^0
H→LLP
H→aa→4γ

	Process @ c.m.e	Domain	Relevant Det. Performance
Z→μμ	Z@ 91.2 GeV	Z	lepton ID, tracking
H→γγ	qqH	Higgs	photon ID, EM resolution
Higgs recoil	$\ell\ell$H	Higgs	Lepton ID, track dP/P
H→ss	ννH @ 240 GeV	Higgs	PID, Vertexing, PFA + JOI
H→inv	qqH	Higgs/NP	PFA, MET
Vcs/Vcb	WW→$\ell\nu$qq @ 240/160 GeV	Flavor	PFA, JOI + PID (lepton, tau)
H→LLP	$\ell\ell$H	NP	TPC, TOF, calo, muon detectors
H→μμ	qqH	Higgs	lepton ID, tracking, OTK
Top mass & width	Threshold scan @ 360 GeV	EW	Beam energy
Weak mixing angle	Z→bb @ 91.2 GeV	EW	JOI

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  - **Foresee in the TDR results and figures about performance on basic objects (leptons, photons, jets) as a function of energy and polar angle**
  - A measurement of V_cs during the WW run is probably a more relevant benchmark than V_cb ;
  - in addition which channel to be used for the measurement of the electroweak mixing angle should be clarified.
- Strategy for the measurement of absolute luminosity
  - which is necessary for absolute cross-sections and has relevant applications
  - Is the measurement of absolute luminosity based only on Bhabha, how the measurement complemented by ee→$\gamma\gamma$ events ?
  - **Clearly outline the strategy for measuring absolute luminosity in the Ref-TDR**

Discussing with LumiCal team

- The use of resonant depolarization to measure the Z mass and W mass with high precision.
  - These are key observables, whose precision must be improved in measurements (e.g. Higgs couplings)
  - **Include in the TDR at least a brief description of the plans**

1. a brief introduction to the operation scheme of polarized beams @ Z & W, for resonant depolarization measurements (refer to TDR for detailed description)
2. the R&D of a Compton polarimeter at BEPCII, and demonstration of resonant depolarization technique at BEPCII in the coming 2-3 years.

From Zhe Duan

Comments/Recommendations on Performance

- **(longer term)** Outline the primary areas where detector configuration optimizations could be further explored beyond the initial Ref-TDR results, acknowledging the time constraints of the current study.
- **(longer term)** Consider how performance study results could influence technology decisions, especially as they relate to detector component specifications and configurations.
- Explain how calibration for each sub-detector will be achieved through physics processes, and document specific calibration methods in the Ref-TDR.
  - Alignment, calibration
- The performance of crystal ECAL on boson mass resolution and Jet Origin ID should be simulated in a consistent way. The impact of crystal ECAL on PFA and jet flavor tagging capability should be estimated.

Backup

Other related feedbacks from IDRC review

- It is not clear if there will be any physics Z pole runnings during ZH period (the first 10 years) or if running at the Z will just be required for calibration.
- Further justify the decisions on the detector technologies and demonstrate how these technologies will enhance the detector's physics capabilities. This will require achieving the necessary level of simulation to evaluate low-level object performance, which is critical and should be prioritized.
- Tracking: Assess the Outer Tracker (OTK) influence on the global momentum resolution and its impact to PID. To achieve this, a realistic full simulation is needed that accounts for the following aspects: Alignment between ITK and OTK , Quantifying the Overall PID Improvement (OTK to PID in forward regions outside TPC coverage is particularly important)

Other related feedbacks from IDRC review

- Ecal: Developing and perfecting the Particle-flow algorithms including the effective pattern recognition and minimization of ambiguity issue;
- Calo: Design choices should be thoroughly justified by physics goals achieved with simulation of a full detector model. Alternative parameter choices should be considered and evaluated for physics outcomes. For example, ECal crystals of 1 cm (transverse) x 2 cm (depth) would reduce channel count and cost. Does it impact physics performance?
- Calo: Some specific performance issues that would be interesting to more fully understand. These include higher energy pi zero reconstruction, which may benefit, for example, from a staggered bar arrangement or finer granularity in the first few layers. Also electron ECal resolution when the bending of electrons match the 12 degree incline angle. Does this impact electron measurements?

Other related feedbacks from IDRC review

- Muon: Momentum global resolution (combined muon and tracking tracks); Muon Identification and Fake Rate Studies
- Software:
  - Ensure that the reference detector model used for the full simulation uses realistic material budgets in the tracking region containing/representing supports, services, cooling etc.
  - **Focus on a complete and well tested full reconstruction for the reference detector in time for the RefTDR in order to demonstrate that detector/software performance goals like tracking and jet energy resolutions have been met.** Where needed, one could fall back for now to already existing software for alternative technologies (e.g. use pad based TPC reconstruction if pixel based will not be available on time). Use full reconstruction to create basic detector performance plots, with realistic assumptions on detector resolutions, such as (non exclusive list)
    - Track momentum resolution (single muons) as function of p_t for different values of cos(theta)/ or theta
    - Impact parameter resolutions in r-phi, z
    - (jet) energy resolution as a function of cos(theta), e.g. w/ uds di-jet events w/o ISR
    - Flavour tagging performance
    - PID performance (using dN/dx and TOF) including separation power for K/pi, K/p

General information

2024.10.14

- Current computing time for Sim+Digi+Tracking+Reco in V240901
  - still missing digi+reco of endcap calo
  - ~1 minute/event, for vvH(gg)
  - at least 200 events/job is OK
    - speed and memory seems manageable
    - **1 million events feasible with 1000 CPUs in a single day**
    - will test 4jets events
- Objects performance studies and physics analyses are encouraged
  - Tracking of full acceptance available
  - Analyses can begin with barrel region selection
  - Recipes for PID and Jets will be provided
- Two task forces created, please join the studies
  - Tracking/PID: contact Chenguang Zhang
  - Jets/Clusters: contact Zebing Wang/Kaili Zhang

Tracking/PID performance studies

- **Differential tracking efficiency/resolution**
  - Tracking efficiency/resolution vs pT and/or cosθ
    - @different level: Vertex+ITK+TPC+OTK, Vertex+ITK, TPC only, etc.
  - Tracking angular resolutions vs pT and/or cosθ
  - detector design requirements: pT>~100MeV, |cos(θ)|<0.99, δ(pT)~0.1% in barrel
- **Differential resolution of track impact parameters**
  - dx, dy, dz, $\delta(d0/z0)$ vs pT, etc.
  - detector design requirements: in the barrel δ(d0/z0)~3 micro meter at 20 GeV
- **Differential PID capability: eff, mis-ID rates, purity**
  - 1d/2d distributions on eff/mis-ID vs. pT/cosθ
  - and for different particles (π,k,p,e,μ)
  - with/without TOF
  - relative resolution of dE/dX
  - detector design requirements: eff*purity>90% for all charged Kaon with E>2GeV(**@Z pole**); ~relative resolution of dE/dX better than 3%.; ToF of 50ps; efficiency >99% for 3-prong tau
- **vvH(μμ)**: H invariant mass resolutions in barrel and endcap
- **Z(μμ)H**: recoil mass resolutions in barrel and endcap

Jet/Clusters performance studies

- **Differential efficiency, and energy/angular resolution for photon, neutron, charge hadrons**
  - detector design requirements:
    - EM resolution: $3\%/\sqrt{E} \otimes 0.5\%$ (Ref:JHEP12(2022)135)
    - Had resolution: $50\%/\sqrt{E} \otimes 2\%$ (Ref:CDR baseline performance)
- **Differential efficiency and energy/angular resolution for jet**
  - and for different jet reconstruction algorithms
- **H->diphoton** mass resolutions for barrel and endcap
- $\boldsymbol{\pi^0}$ eff and resolution vs. pT/cosθ
- **dijet** resolution for different flavors, versus pT/cosθ