Tracking Integration Challenges

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@ILD meeting

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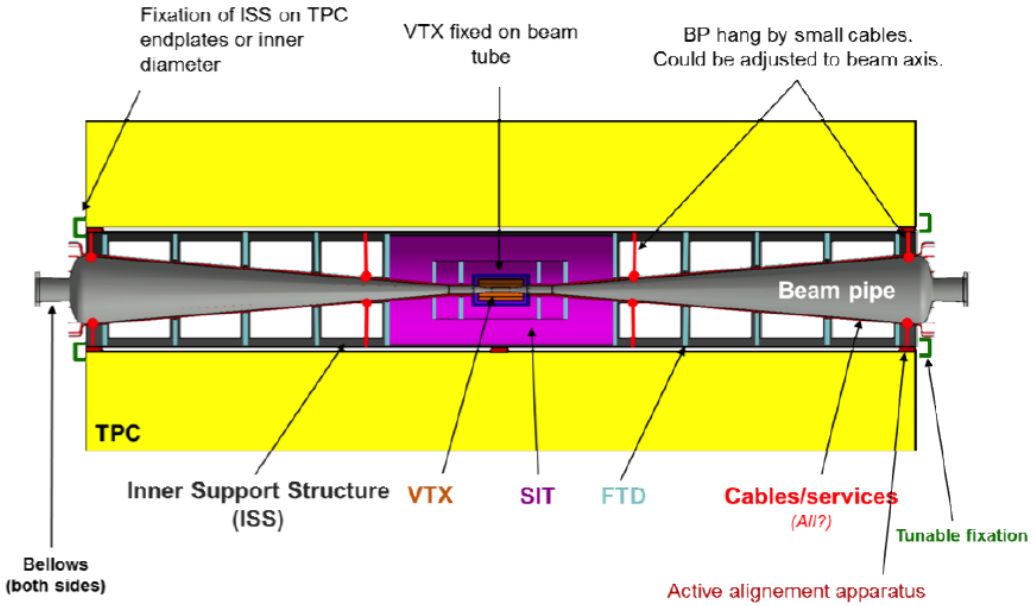
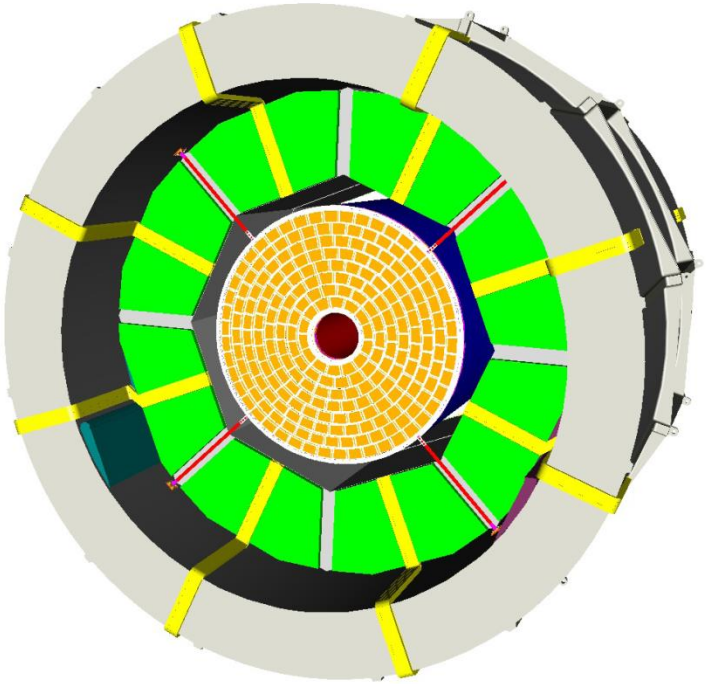
- Support
- Alignment
- Cooling
- Cabling
- Assembly scenario

Support for trackers

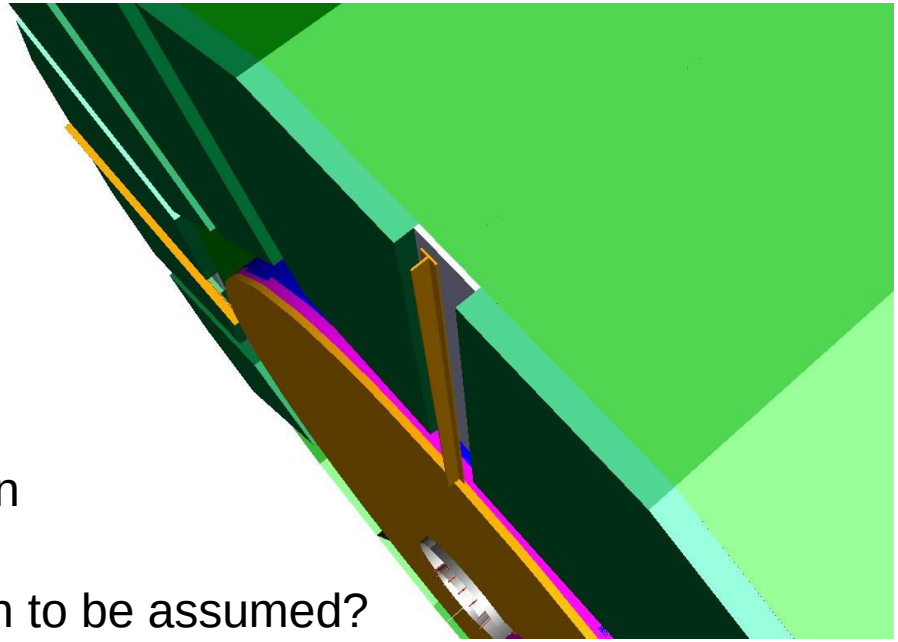
- TPC from solenoid
- Inner Support Structure (ISS) from TPC
- Beam pipe (BP) from ISS
- SIT from BP
- FTD 3~7 from ISS 1~2 from BP
- VTX from BP
- ETD/SET ?





TPC support

- Two options have been studied
  - CFRP T-beam
  - CFRP ribbon
- Another option
  - CFRP rectangular pipe
  - Any other options?
- Design criteria
  - Free space
  - Deformation due to seismic motion
- Questions
  - What is the maximum acceleration to be assumed?
    - Without seismic isolation → 1.5 m/s^2
    - But the seismic force is not static
    - Vibration analysis necessary?
  - Deformation of solenoid cryostat? (to be answered by solenoid group)
    - Magnetic force
    - Vacuum v.s. Open
    - Cold v.s. warm
  - 4 points/side not over-constrained?



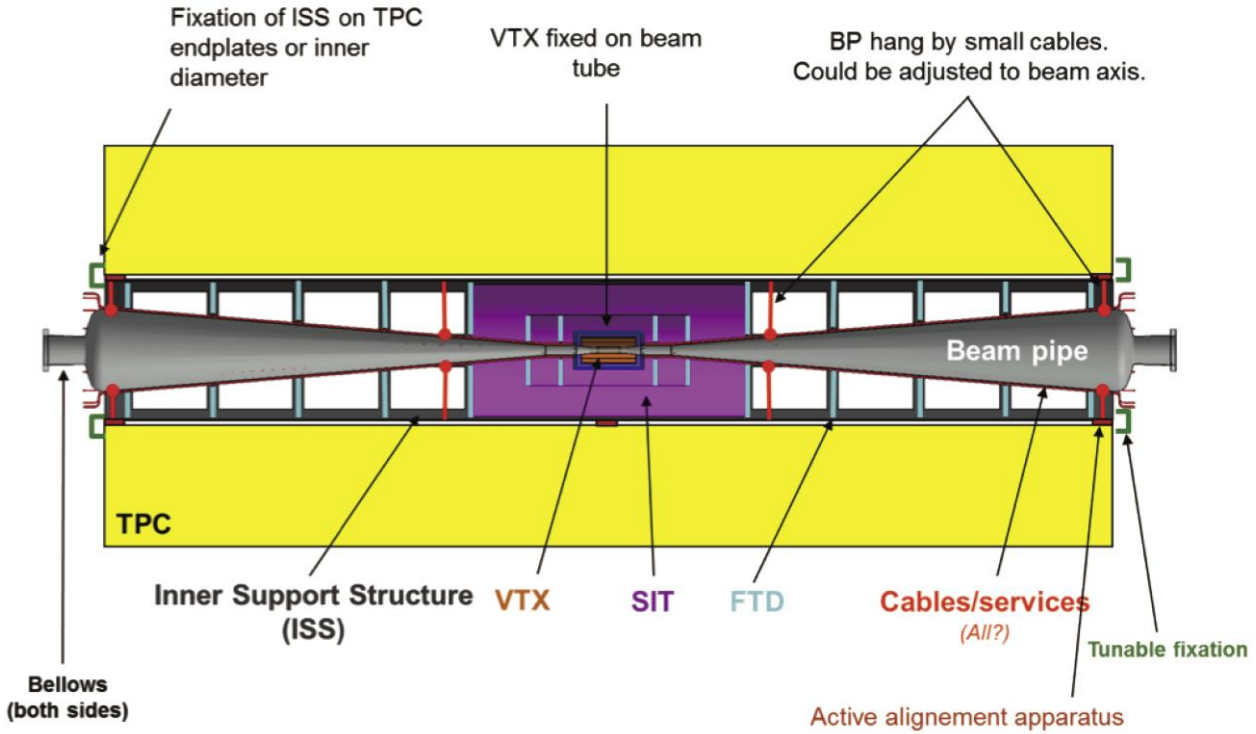
ISS support

- Inner Support Structure houses SIT, FTD, Beam pipe, and VTX
- ISS is made of CFRP tube, and supported from TPC end-plate using a remote-controlled mover
  - Beam pipe should be aligned within 1mm after every push-pull operation w.r.t. the beam
  - It may not be possible to align the whole detector so precisely by adjusting the platform
  - Beam pipe and inner trackers can be aligned using the ISS mover
- Design of such a mover has to be made with minimum X0
- ISS should be air-tight and filled with dry air in order to prevent cooling system from condensation

- Some collaborative work including all relevant detectors (TPC, SIT, FTD, VTX, Beam pipe) would be necessary

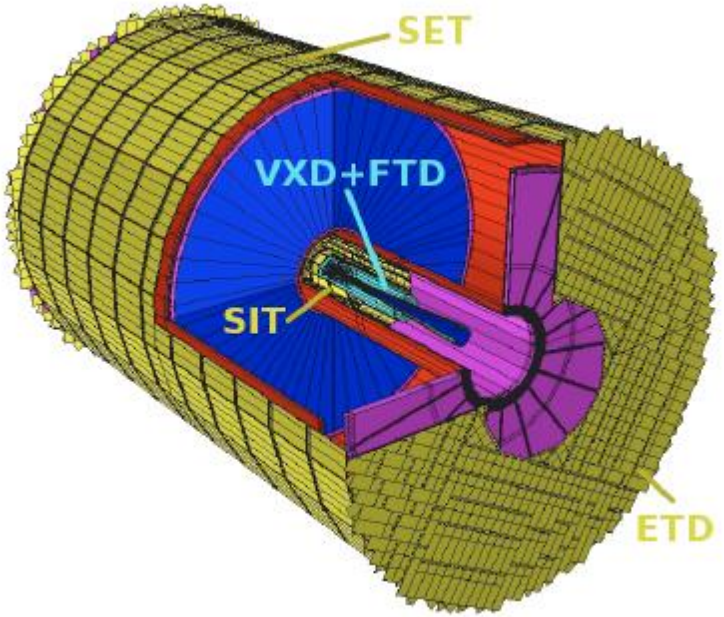
Inner trackers support

- No realistic design of supporting system is given in TDR
- Detailed design of the supporting system for each sub-detector has to be made, and integrated into the whole inner tracker system inside the ISS



ETD/SET support

- From which detector are ETD/SET supported?
  - ETD: TPC end plate? Or end-cap ECAL?
  - SET: TPC outer cylinder? Or barrel ECAL?



Alignment

- We need detector alignment at every phase
  - Construction
  - Installation
  - Operation
- Alignment during operation
  - Frequent detector movement for push-pull
    - Beam pipe (and inner Si detectors) has to be re-aligned w.r.t. the beam at every push-pull operation
    - Relative alignment could be changed due to vibration and re-alignment of ISS
  - We need the alignment system which enables easy and quick re-alignment during the experiment

Alignment

- How to achieve?
  - 3D coordinate measurement machine during sub-detector construction
    - Better accuracy than the intrinsic resolution of sensors inside the sub-detector
  - Standard survey technique during installation
    - Accuracy ~ 100um
    - Gives just initial values
  - Several techniques for the run-time alignment
    - IR LASER track for Si strip detectors
    - Fiber Bragg grating (FBG) sensor for ISS
    - Track-based alignment (Time consuming?)

Track-base alignment

- Available tracks
  - Collision data
    - What is the minimum run period between push-pull to get enough data for alignment?
    - Do we need dedicated Z^0 run? How much data?
  - Beam halo
  - Cosmic ray
    - What is the intensity of the cosmic ray at 200m underground?
    - Is ILD compatible with cosmic-ray data acquisition?

Cooling

- Comparison of possible coolant

Coolant	Specific heat / Latent heat	Flow rate for 1 kW	@ΔT
Water	4.2 J/gK	12 g/s	20 K
Gas (N2)	1.0 J/gK	50 g/s = 2400 L/min	20 K
2-phase CO2	320 J/g (-40℃)	3.1 g/s	0 K
	150 J/g (+20℃)	6.7 g/s	

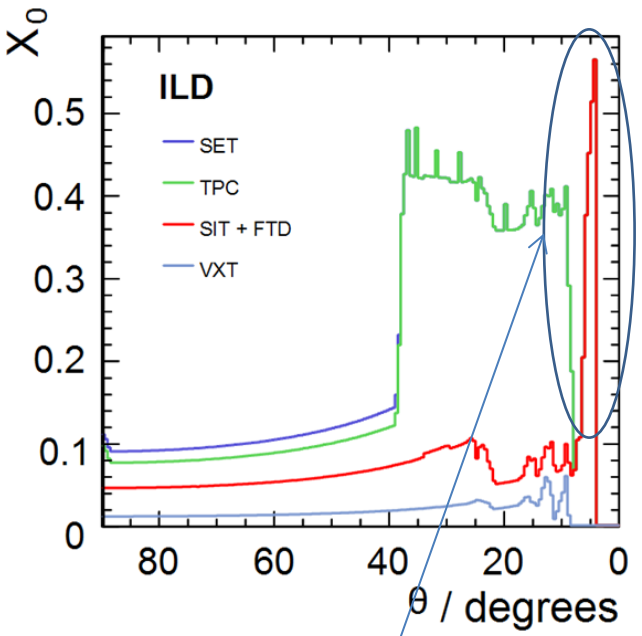
- Baseline design
  - TPC: 2-phase CO2
  - SIT,FTD: Gas
  - VTX: Gas or 2-phase CO2

Cooling

- Challenges
  - Gas flow
    - Possible sensor oscillation due to gas flow
    - Thickness of the gas tube (space)
  - 2-phase CO2
    - Handling of thin cooling tube (joint, welding, etc.)
    - Regulation (tube wall thickness)
    - (Experience at Belle-II will be beneficial)
  - Thermal isolation between sub-detectors if necessary

Cabling

- Where do cables inside ISS run?
  - Along the beam pipe?
  - Along the wall of inner support tube?
- Do we need Al cables to reduce material budget?



Mainly due to conical part of beam pipe (not VTX)

Assembly scenario

- In ILD, each sub-detector will be built by an international collaboration
- We should clarify what kind of jobs will be done on site
  - TPC
    - Final assembly on site?
  - ISS
    - Installation of sub-detectors into ISS on site?
- These information is necessary for design of assembly hall