Workflow

(1.Draft Physics part)

to design
HCAL barrel absorber structure
for the ILD

for engineers only ?

Step1: HCAL barrel material

- the absorber and detection material should have a optimized Z, λ and X_0 for hadronic interactions
  - the HCAL absorber structure must have a suitable absorption and interaction length for the ILC beam energy

  Decision:
    - absorption length: >5,0 λ increasing from the x/y plane to the beam axis up to 7 λ

    decision arguments:

    calculations, simulation, test beam measurements , other detector results
  - possible absorber materials are steel and copper
    - steel Z=26, λ=131,9 g/cm², X_0 =1,76 cm, ρ=7,87 g/cm³
    - copper Z=29, λ=134,9 g/cm², X_0 =1,43 cm, ρ=8,96 g/cm³

  Decision:
    - absorber material: stainless steel 1.4404/1.4435

    decision arguments:

    strength, strain, antimagnetic, treatment, material cost, machining cost

Step 2: HCAL barrel dimensions

- the HCAL absorber structure will be mounted inside a solenoid to get a homogeneous and straight field through the ILD detector.
  - the HCAL barrel absorber structure must have a suitable size to fit into the cryostat and must give the inner detector components enough space for the installation and fixation points

Decision:

- Outer radius: *3000 ?* mm – X mm (X: installation clearance, barrel shape design)
- 2 x barrel half length: 2 x 2350 ? mm

decision arguments:

solenoid costs, HCAL-, ECAL-, TPC-performance calculations, barrel shape design, supply volume (cables, pipes, …)

Decision

- Inner radius: *2010 ?* mm

calculated from absorber plate thickness t_A, detector layer thickness t_L, detector layer installation clearance t_C, number of layers n_L

decision arguments:

absorption length, stability, deflection, type of sensitive detector, barrel shape design

Step 3: HCAL barrel shape

- the HCAL absorber structure must give the sensitive detector layers as much volume as possible by using the maximum of the given HCAL barrel volume
  - the optimal shape of the given HCAL barrel volume is cylindrical. Due to production reasons the sensitive detector layers will be made from flat panels.

decision

- barrel shape: octagonal shaped structure, split in the middle of the total volume

decision arguments:

total sensitive volume, structure stability, resolution simulation, supply volume, ECAL interface (shape), solenoid interface (shape)

By using a octagonal shaped structure you will have non sensitive cracks between each octant module. To increase the resolution you have to vary the module geometry.

decision

- module shape: 2 modules will build one octant, cracks between the sensitive volume will be 30 mm wide and they are pointing to the detector centre

decision arguments:

module stability, resolution simulation, ECAL interface (support), solenoid interface (support), installation process, production costs

Step 4: HCAL sensitive layer

- the sensitive layers inside the HCAL absorber structure has to detect particle showers with a stable resolution within a reasonable time constant.
  - the HCAL barrel absorber structure must have a suitable size to fit into the coil and give the inner detector components enough space for the installation

  - The resolution of the HCAL is mostly driven by the number of the readout channels. You can get the total costs of the HCAL by multiplying the total number of the channels by the relative costs of one channel.

  decision

    - type of sensitive layers: scintilator plates readout by SiPM
    - or (GEM,RPC)

    decision arguments:

    test beam measurements, production costs, resolution, stability, time constant, supply volume

  repeat from step 1

  after you converge to less than 25% start “detail design workflow”

  after you finished the “detail design workflow” you have to repeat the “physics workflow”