# Personal Reflections on Detector Concepts

This reflection is motivated by the following physics studies

1) B physics and CP violation ($B_s \to D_s K,\ J\psi\phi\ , \phi\phi\ , B^+ \to (K_s\pi^0)_{D^0}K^+$)
2) Electroweak studies ($Z^0 - \nu_e$ coupling) at 160 GeV
3) Search for invisible axion at Z-pole

Furthermore , since FCCee will cover a wide range in energy, it is desirable to have a magnetic field, which can be increased

$$\boxed{\text{From } \mathbf{2\ T} \text{ @Z-pole to } \mathbf{4\ T^*} \text{ @ Top threshold}}$$

* Need to verify whether possible from accelerator point of view

# Considerations on detectors requirements from $B_s \to \phi\phi$

| Parameters | Errors scaling |
| --- | --- |
| $\phi_{\phi\phi}$ | $\frac{1}{\eta_{\phi\phi}(1-2\omega)\sqrt{N}}$ |
| $\lvert\lambda_{\phi\phi}\rvert$ | $\frac{1}{(1-2\omega)\sqrt{N}}$ |
| $\Delta\Gamma$ | $\frac{1}{\eta_{\phi\phi}\sqrt{N}}$ |

$\sqrt{N}$ : increase statistics

- Increase Instant. Lumi
- Increase $\int Ldt \Rightarrow$ 4 IP, more time @Z-pole
- Increase acceptance and recons. Efficiency ($\phi \to K^+K^-$)
  - Large tracking volume with many meas. points (2tr-sepa)
    - ⇨ SVD + gaseous tracking detector
- Excellent momentum resolution (for background rejection)
  - Very good point resolution but even more important
  - Very low material budget
    - ⇨ gaseous tracking detector

$(1-2\omega)$ : decrease wrong tagging fraction ω

- Excellent vertex resolution
  - to identify secondary + tertiary vertices
  - Also mandatory to study $B_s$ time dependence
    - ⇨ state-of-the-art pixelized vertex detector
- Excellent overall Part. Ident. (at least for e,μ,K) up to at least 25 GeV
  - Ideally specific PID system (but difficult to cover large p range
  - Alternative is de/dx with cluster counting + ToF
    - ⇨ gaseous tracking detector

$\eta_{\phi\phi}$ : disentangling the polarizations (gain of factor 2 in sensitivity)

- Angular dependent analysis needed
  - Test of QCD Factorization with precise measurement of $f_L$, $f_\parallel$, $f_\perp$
  - Polarization dependent CP violating phases ⇒ deeper test of CP sector (unprecedented) and better sensitivity to BSM physics
    - ⇨ Good angular resolution of tracking and control of acceptance

# Other considerations on detectors requirements

$\sqrt{N}$ : increase statistics further and background rejection

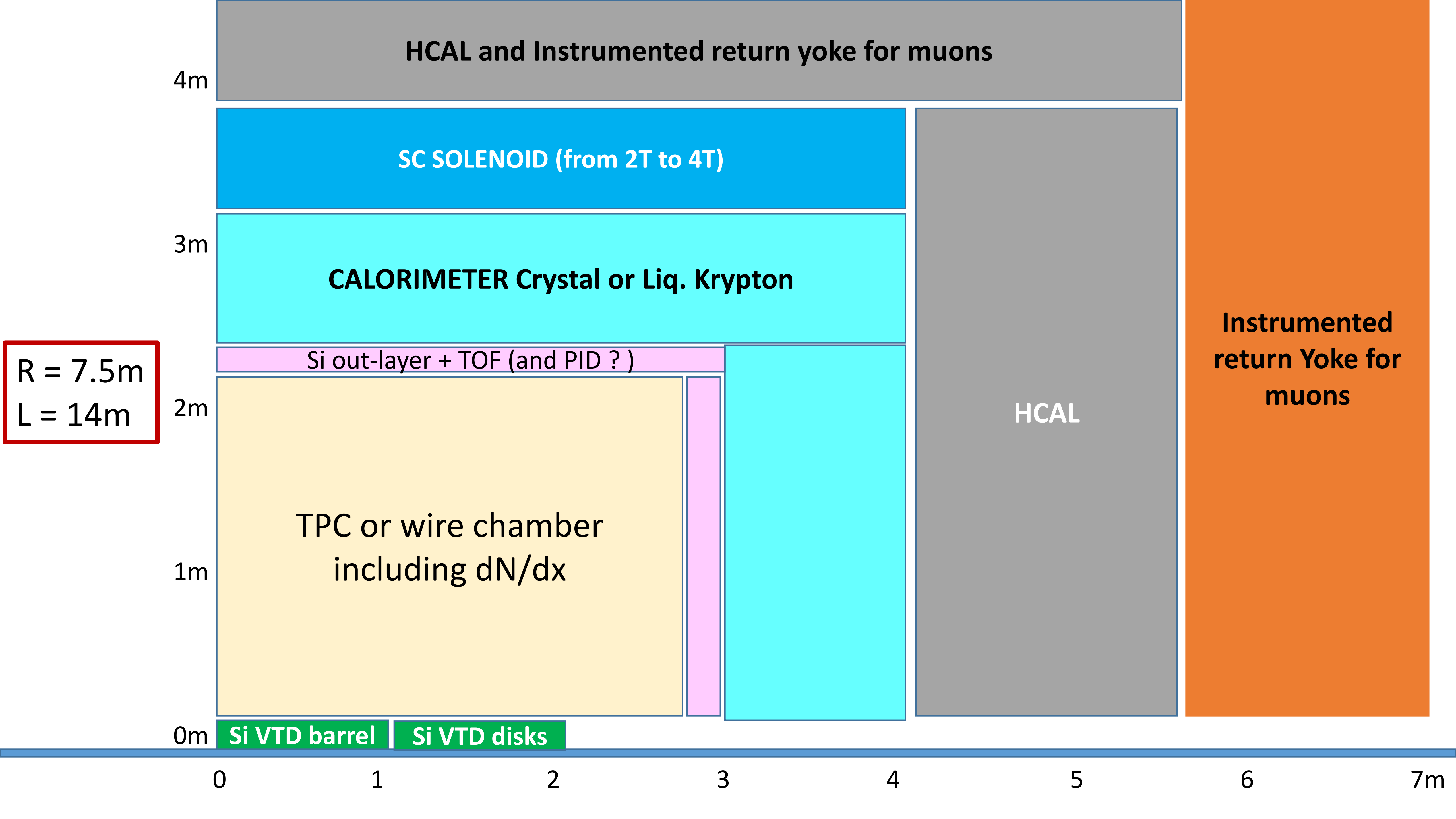
- Using neutral Kaons ($K_s$ , $K_L$) in B decays (i.e. long live particles)
- using neutral particles ( $\gamma, \pi^0, \eta$ ... ) in B decays
- $\gamma$ for $e^+e^- \rightarrow \gamma\nu_e\overline{\nu_e}$ and $e^+e^- \rightarrow \gamma\ a$(invisible)

## *Tracking*

- **Large tracking Volume**
- **No holes in tracking and increased acceptance in forward region and recons. Efficiency for tracks**
  - **Many measurement points (redundancy)**
    - ⇨ **gaseous tracking detector (TPC preferred but wire detector is probably OK)**

## *Calorimeter*

- **Increased EM acceptance in forward region and recons. Efficiency in large range 0.5 -> 50 GeV**
- **Excellent EM Energy resolution (for background rejection) in B events and electroweak studies**
  - **Very low material budget in front of Calorimeter**
    - ⇨ **gaseous tracking detector in front of calorimeter**
    - ⇨ **calorimeter inside magnet**
    - ⇨ **energy resolution toward** $\frac{\sigma(E)}{E} \approx \frac{3\%}{\sqrt{E}} \oplus 0.005 \oplus \frac{\sim 0.03}{E}$
      - **constant > stochastics @ > 36 GeV**
      - **Electronic noise > stochastics @ < 1 GeV**
- **Reasonably Good Hadronic Calorimeter**



HCAL and Instrumented return yoke for muons
SC SOLENOID (from 2T to 4T)
CALORIMETER Crystal or Liq. Krypton
Si out-layer + TOF (and PID ? )
TPC or wire chamber including dN/dx
HCAL
Instrumented return Yoke for muons
Si VTD barrel
Si VTD disks
R = 7.5m
L = 14m
4m
3m
2m
1m
0m
0
1
2
3
4
5
6
7m