General Considerations for the Detector of STCF

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Physics Requirement

- STCF will work at the c.m energy of 2-7GeV and reach the luminosity of L=10 ^{35}cm-2.s-1.
- The major physics interests are the charmonium physics, particularly searching for hybrid states; tau production and decay, the CP violation study, etc…
- Detector requirements must be matched to event characteristics, with emphasis on what is required to search the most important physics objectives ?

General Consideration

For efficient make the event reconstruction , background discrimination , and reduce the detector related systematic error ,the general requirement relate to :

- Nearly 4π detector solid angle coverage for both charged and neutral particles, and high detection efficiency for low momenta particles;
- High resolution of momentum and angular for charged particles;
- High resolution of energy and position for photons ;
- Superior PID ability (e/u/pi/k/p);
- Reasonable efficiency for other neutral particles;
- Precision Luminosity measurement.
- ***Uniform response for all particles!***

Detector Requirements

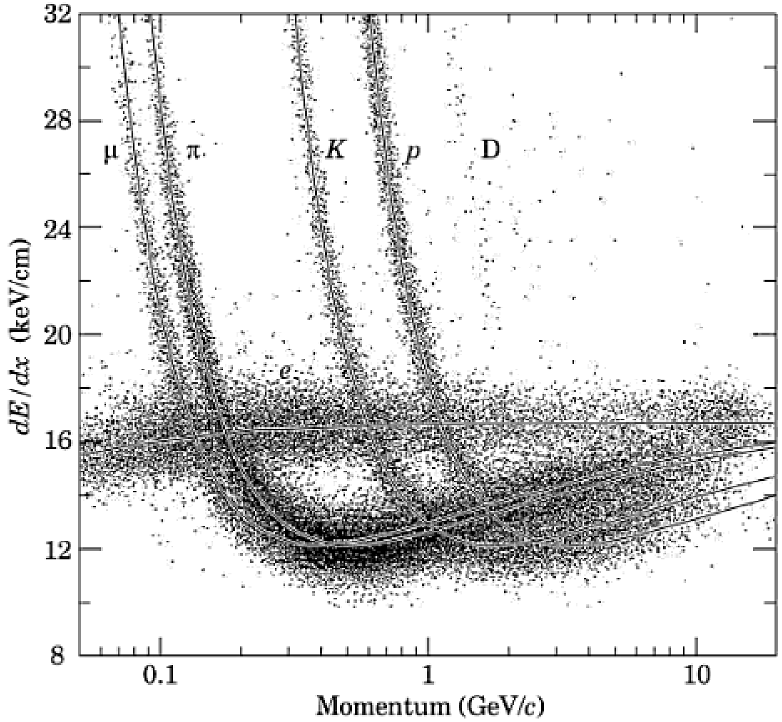
- Tacking: Because most of the particle to be measured are <1Gev, so the multiple scattering will dominate the momentum, which requires at a thin and light beam pipe, and light tacking system, also for the low energy gammas before EMC.
- PID: Update to 1.5GeV/c may required RICH or ACC
- EMC: With fast response to match the high luminosity, despite many crystal material can be chosen as EM calorimeter.
- Superconducting magnet : required to produce a changeable field from 0.5- 1.0 Tesla.
- Muon counter: RPCs between many steel plates for magntic flux return is chosen as the muon counters and to provide the suppression power of μ/π .
- The detector will face bigger radiation dose to work at high luminosity, especially near the IP and forward regions. So, the detector and electronics components chosen should withstand the expected dose.
- The detector should be reliable and be with reasonable cost.

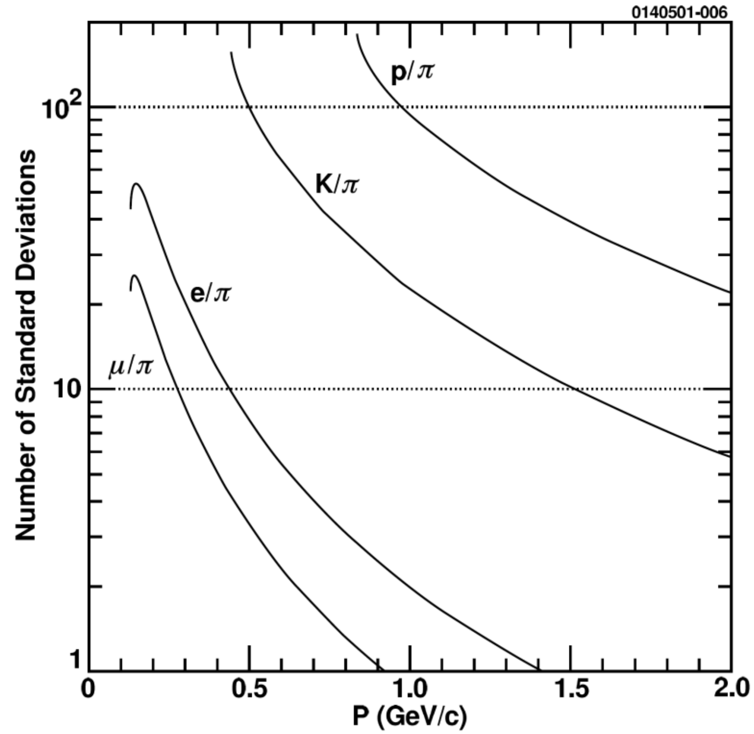
Tracking Detector

- Must balance momentum resolution with curling of low momentum tracks
  - Lower *B* field (~1T) is required, should be re-optimized
  - Typical resolution $\Delta_t p/p_t$ = 0.5% at 1 GeV/*c*.
- Multiple coulomb scattering is an important determinant of momentum resolution
  - low mass helium-based gas, wires
  - Small cells are needed for speed – more wires in tension with low mass
  - Carbon fiber support structure to minimize effect on PID, EMC behind the DC endplates
- Particle ID via *dE/dx* assumes increasing importance at lower momenta
  - *BABAR dE/dx* resolution was 6%
  - With cluster counting, which was intensively studied for Super*B*, resolution using both *dE/dx* and cluster counting, can be ~3%.

    Improves particle separation at low momenta and extends usable range to higher momenta, Can one do better?

PID@CLEO: *dE/dx*, RICH





- μ/π separation at low momentum is crucial for $\tau \rightarrow \mu\gamma$ sensitivity
  - μ tagging at low momentum can nearly double the tagging efficiency
  - $\tau \rightarrow \pi\pi^0\nu$ is largest background. Requires efficient, clean pion ID

Electromagnetic calorimeter

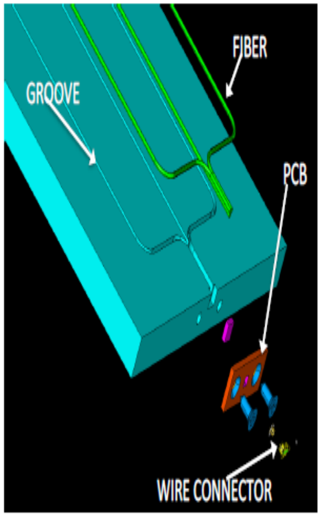
- *CsI calorimeters (BABAR, BES-III, CLEO-c) are a reasonable first-order* match to a 10^{35} collider in the 4 GeV region

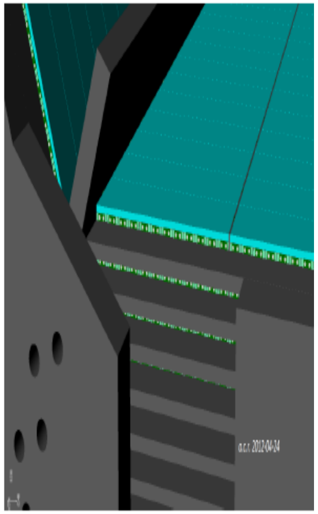
Parameter	BESIII	CLEO-c	BaBar	Belle
$\Delta\Omega/4\pi$ (%)	93	93	90	91
Active media	CsI(Tl)	CsI(Tl)	CsI(Tl)	CsI(Tl)
Depth (X_0)	15	16	16–17.5	16.2
σ_E at 1 GeV (MeV)	$\sim$25	$\sim$20	$\sim$28	$\sim$17
σ_E at 100 MeV (MeV)	3.3	4	4.5	4
Position resolution at 1 GeV/c (mm)	6	4	4	6

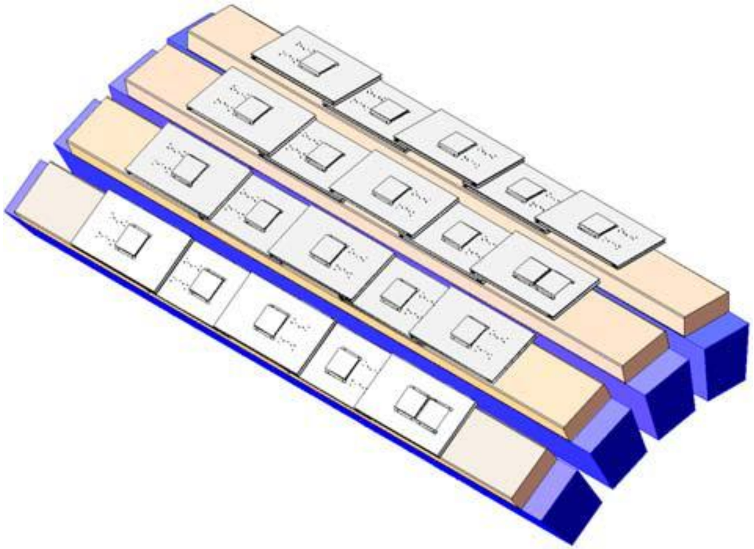
- The situation is similar to that of Super*B*
  - With adjustments to electronics time constants, the barrel calorimeter may be adequate
  - Other alternatives, such as pure CsI, which were considered for the endcap at Super*B* , could be re-evaluated. In this case which need for a fast, efficient readout device that works in a magnetic field.

Muon identification

- A low momentum threshold is important, examples
  - Highly segmented *BABAR* flux return is well-suited to the task
  - BES-III flux return is also highly segmented (not quite as well)
- Current and past generations typically used some type of large area RPCs, scintillator strips with wavelength shifting fiber and pixelated APD or SiPM readout
- ***Novel Timing RPC has chosen as Muon detector for STAR.***





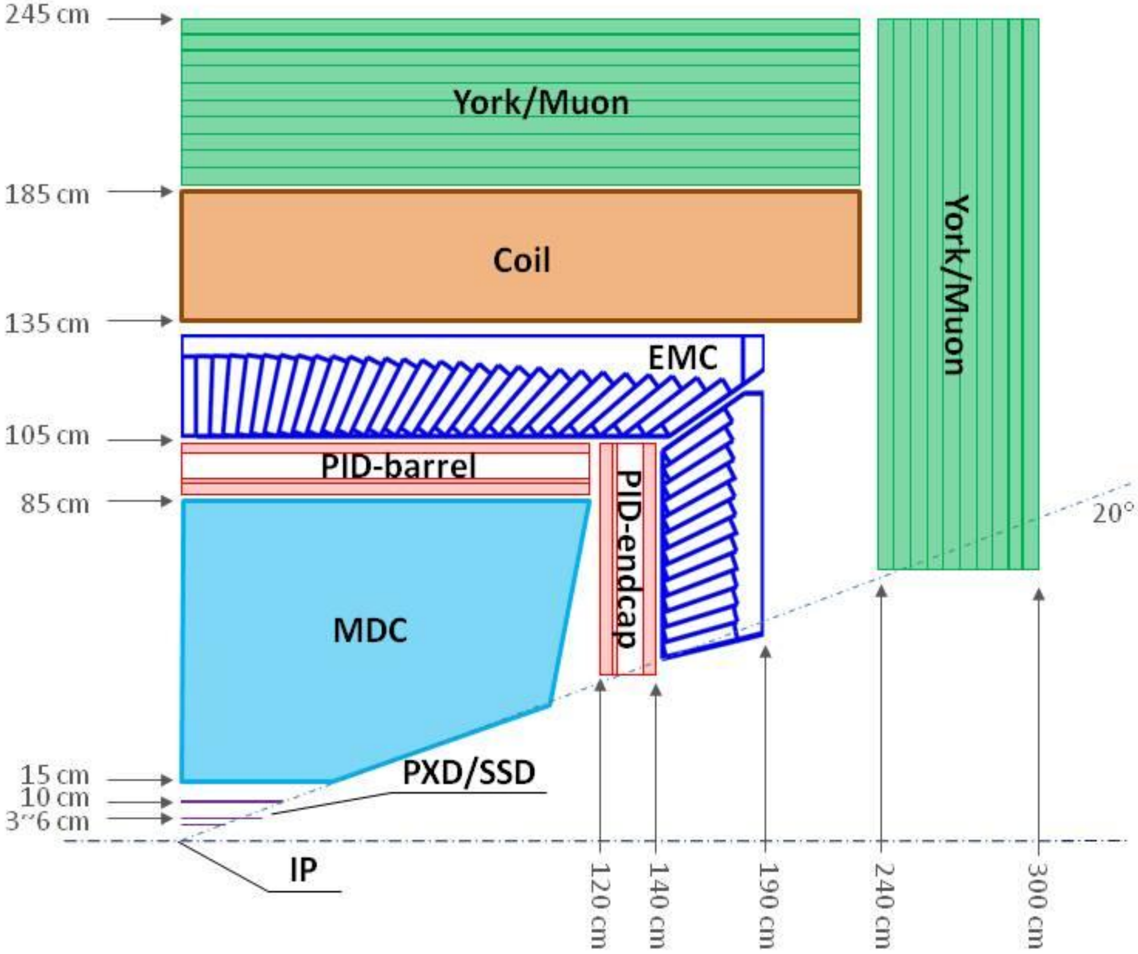


Summary: Detector meeting in USTC

- **Main tracking**
  - Lower *B* field (0.5-1T) is required. Multiple coulomb scattering is an important determinant of momentum resolution - low mass gas, wires, support structure
  - Small cells needed for speed
- **Particle ID**
  - It is important to extend hadron/muon PID to lower momenta: improved *dE/dx* via cluster counting, Fast RICH, or ACC+ToF
- **EM calorimetry**
  - Existing CsI(Tl) barrels with shorten integration time are likely OK , pure CsI readout by fast PMT readout and newly crystal require to be R@D
  - Forward endcap may need a faster, more radiation hard crystal, such as PWO
- **Muon Identification**
  - RPCs (or timing RPC)add a highly segmented flux return may extend muon ID to lowest possible momentum.

- **Vertex detection**: is it needed? Low radius tracking is required, whether with SVT, low mass DCH or TPC,GEM. Is SVT precision beneficial?

Preliminary Detector Design for STCF



Expected Key features

- SVT – very low material budget ~0.15%X_0/layer, <50μm position resolution?
- MDC – pT resolution @1GeV/c 0.5~0.7%, dE/dx resolution <7%, low material budget ?
- PID – π/K (and K/p) 3-4σ separation up to 2GeV/c, low material (<0.5X_0?)
- EMC – stochastic term <2%/$\sqrt{E}$, constant term <0.75%?
- MUD - μ/π suppression power >10?

MORE THOUGHTS AND SUGGESTIONS ARE WELCOME!

THANKS !