Detector discussion

What information we could have

- ✓ **Event: a collection of final state particles**
- ✓ **A particle: 4 + 3 + 3 variables at most**
  - ➢ **P4: (E, m, θ, ϕ) … ($E^2=p^2+m^2$, if m is known。PID 是 质量鉴别)**
  - ➢ **Starts: Impact parameters (r,z), not available for neutrals (assumptions).**
  - ➢ **Ends: Ks, Λ, B, D, … , only for long lived particles (c τ >= $\mathcal{O}$ (10 μm))**

Take mass as an example
0 → 1 +2

$$
\begin{aligned}
m_0^2 &= (p_1 + p_2)^2 \\
&= m_1^2 + m_2^2 + 2\left(E_1 E_2 - \vec{p}_1 \cdot \vec{p}_2\right) \\
&= (m_1^2 + m_2^2) + m_{12}^2
\end{aligned}
$$

$$
\begin{aligned}
m_{12}^2 &\approx 2E_1 E_2 (1 - \cos\theta) \\
&= 4E_1 E_2 \sin^2 \frac{\theta}{2}
\end{aligned}
$$

- 括号里代表 PID 的贡献，剩下的是能量或者动量测量的贡献、方向测量的贡献
- 低能情况下 PID 贡献显著
- 高能情况下方向测量贡献增大

$$\delta_{ij} \equiv \frac{\delta m_{12}}{m_{12}} = \frac{\delta E_1}{2E_1} \oplus \frac{\delta E_2}{2E_2} \oplus \cot\frac{\theta}{2}\frac{\delta\theta}{2}$$

例子：高能 π^0 出来的光子 的夹角

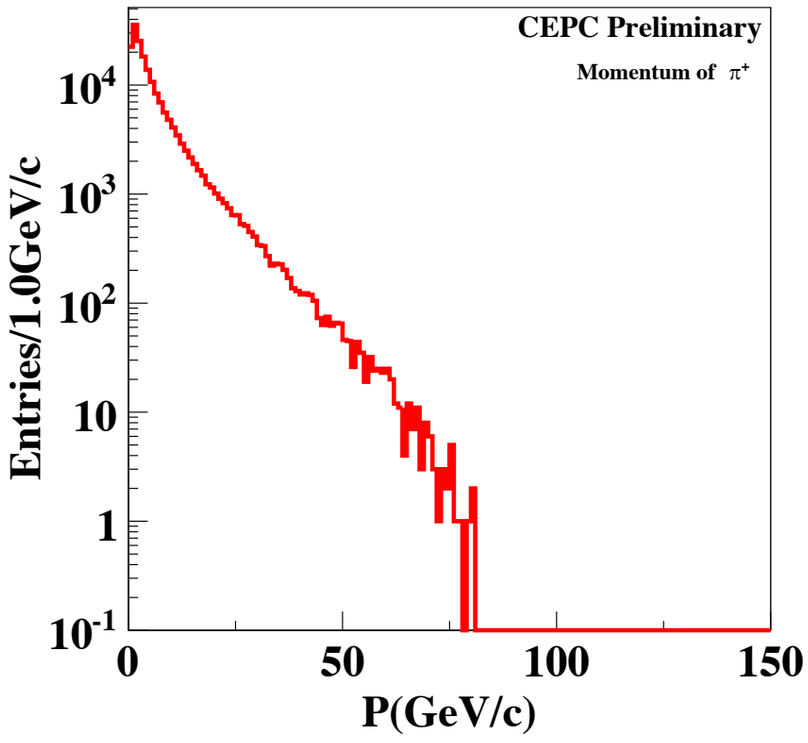
Jet mass or boson mass

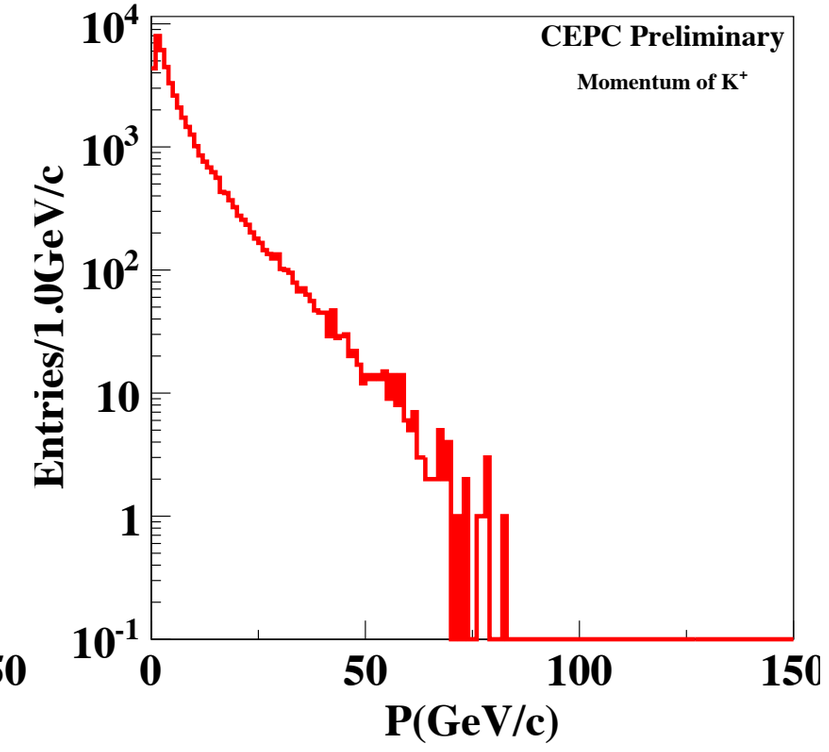
0 → 1 + 2 +3 + …

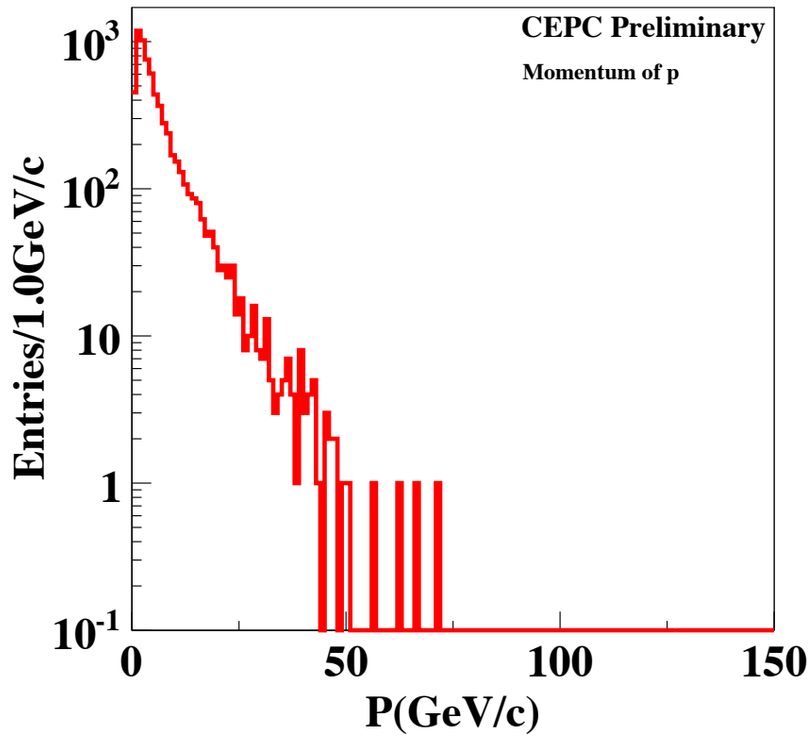
$$
\begin{aligned}
m^2 &= \left(\sum p_i\right)^2 \\
&= \begin{pmatrix}
 & m_1^2 & +m_{12}^2 & +m_{13}^2 & \dots & +m_{1n}^2 \\
+ & m_{21}^2 & +m_2^2 & +m_{23}^2 & \dots & +m_{2n}^2 \\
+ & m_{31}^2 & +m_{32}^2 & +m_3^2 & \dots & +m_{3n}^2 \\
+ & & & \cdots\cdots & & \\
+ & m_{n1}^2 & +m_{n2}^2 & +m_{n3}^2 & \dots & +m_n^2
\end{pmatrix}
\end{aligned}
$$

- 对角元: **PID** 的直接贡献
- 非对角: **PID** 帮助重建 **heavy meson**，运动学约束可以提高分辨
- 多个两体过程的贡献
- 与上两页的结果一样：能量，角度测量; 高能情况下小角度贡献显著

Momentum distributions in Higgs signal





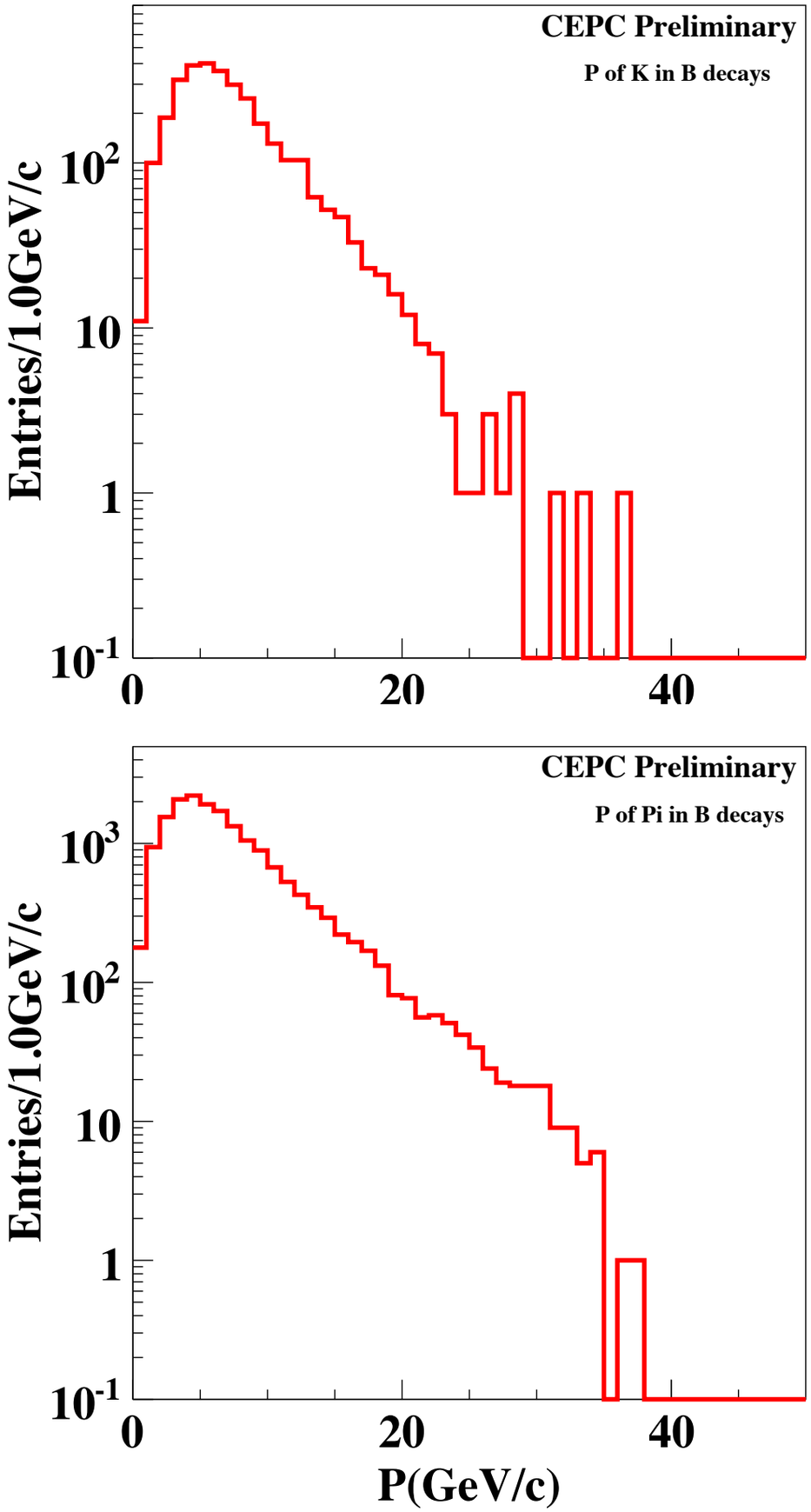


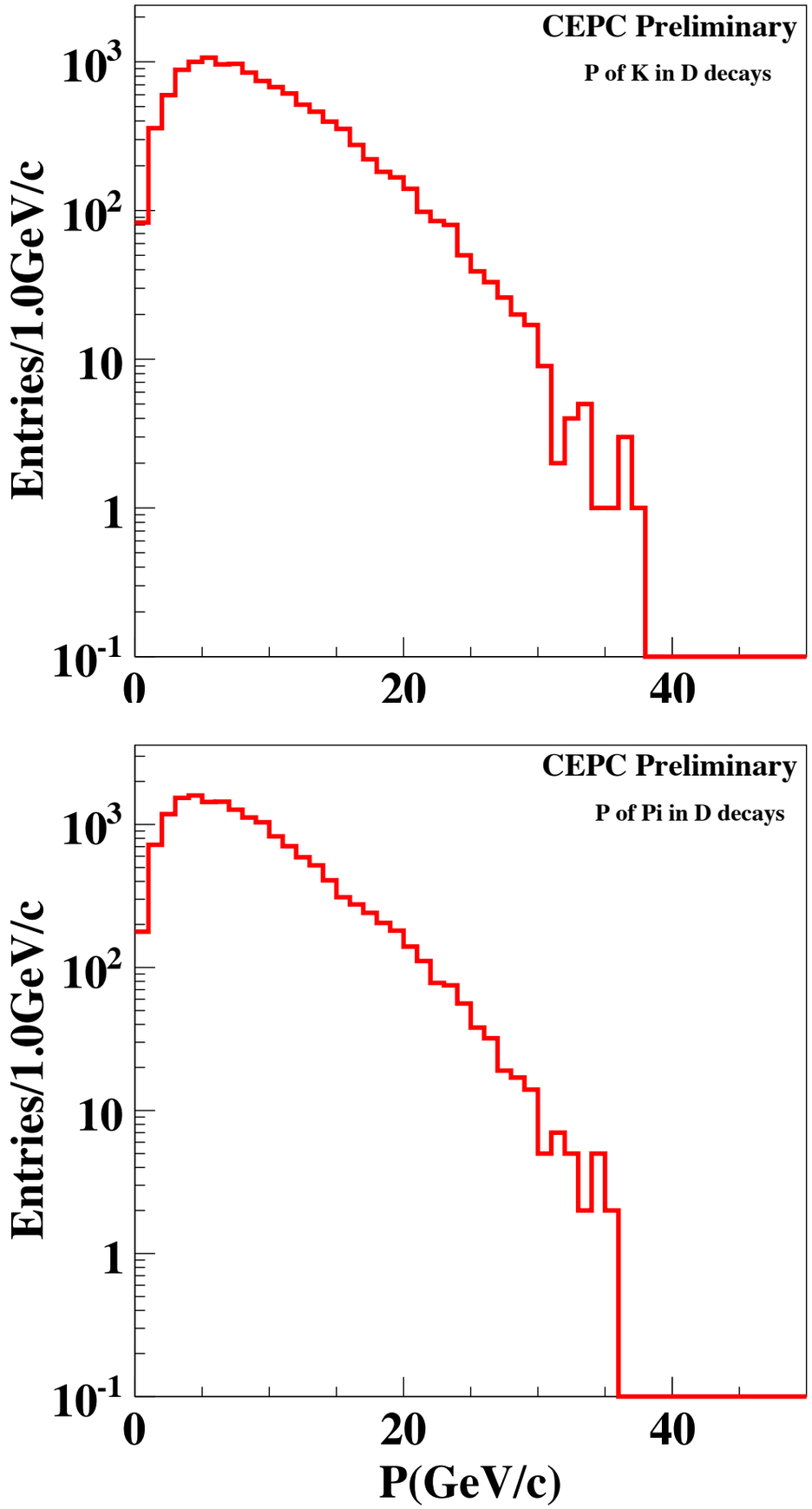
PID capability up to 20 GeV or 30 GeV is natural requirement

Jet-substructue && flavor physics

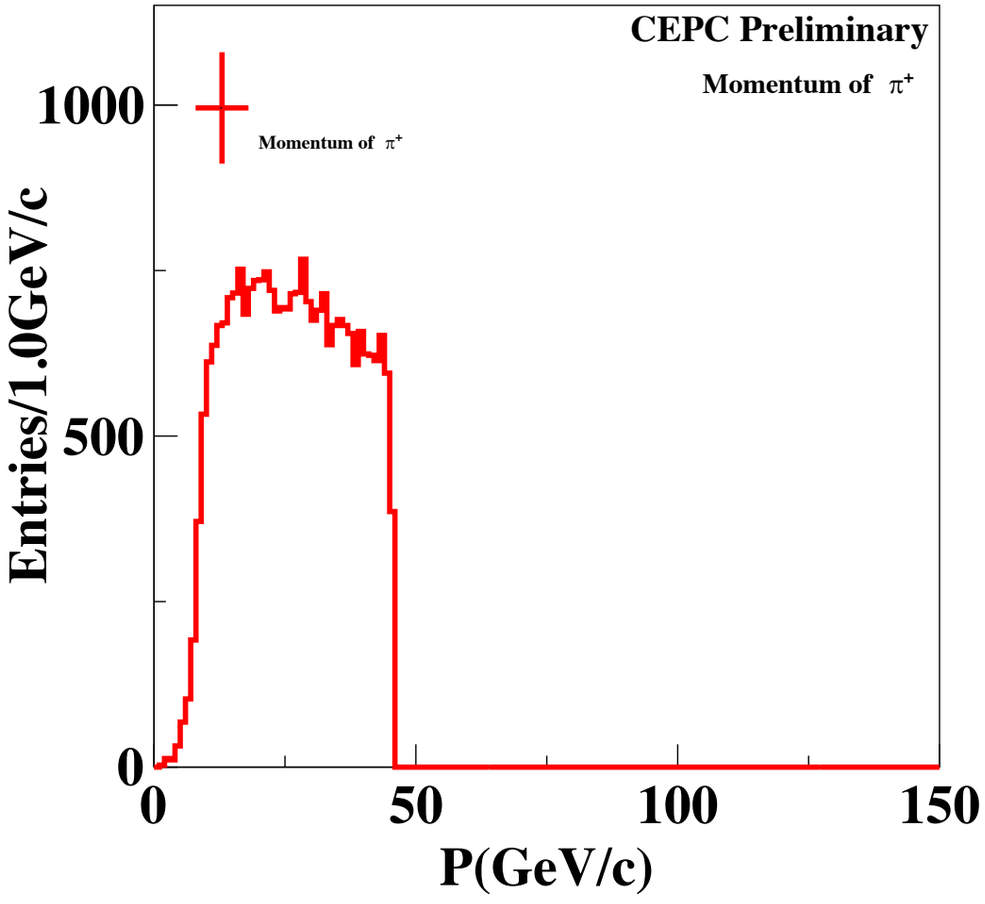
Jet mass, vertex mass, narrow resonances

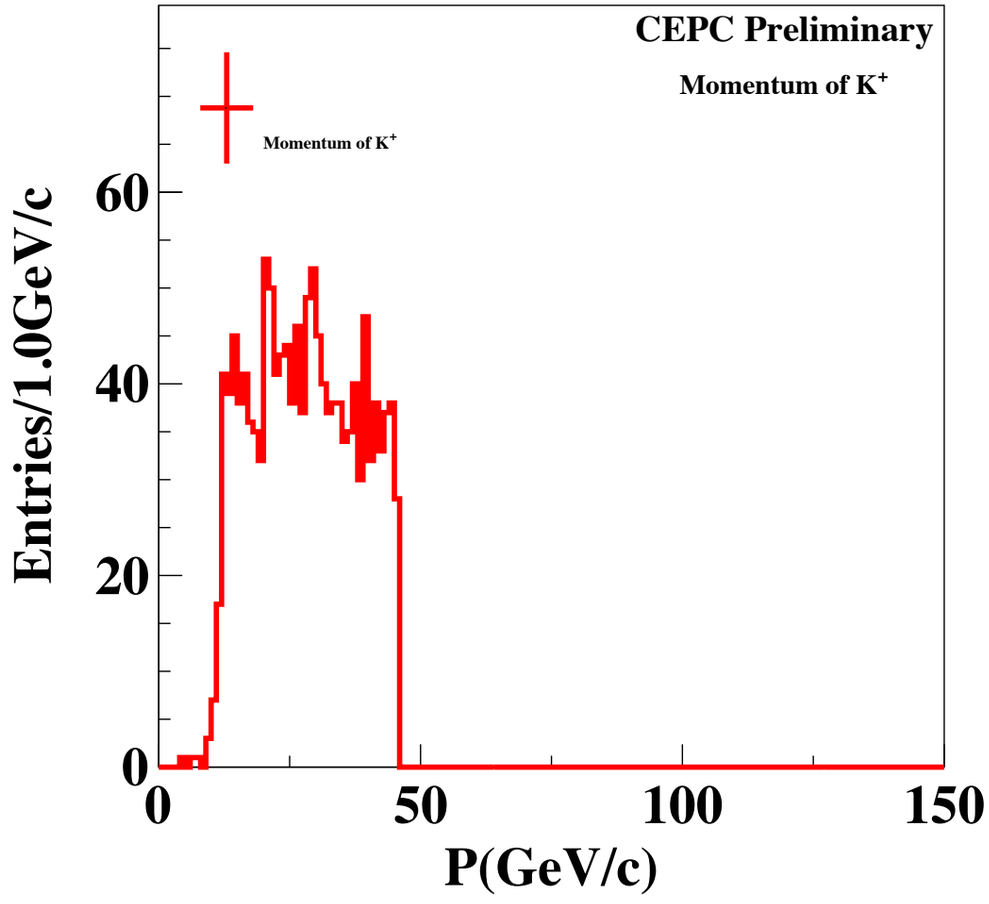
Momentum distributions in B&D decays at Z pole





Momentum distributions in $\tau\tau$ at Z pole





Flavor physics, Challenge from τ study

i.e, spectrum function study

Baseline detector vs. CRD

	Baseline	CRD	comments
Track p	good	good?	Ryuta&Linghui
Track ip	good	good?	Ryuta&Linghui
Angle	good	good?	Ryuta&Linghui
Hadron ID	no	being evaluated	Linghui&Shuiting&Guang
Lepton ID	good	as good as?	? ?
photon	(0.01, 0.17)	(0.01, <0.03)	Multi-hit?
JER	< 4%	to be evaluated	? ?
JFT	Good	To be evaluated	? ?

- Photon/neutral direction crucial at high energy – high granularity calos
- PID helps narrow resonance reconstruction and mass resolution