INTT-Calo Tracking

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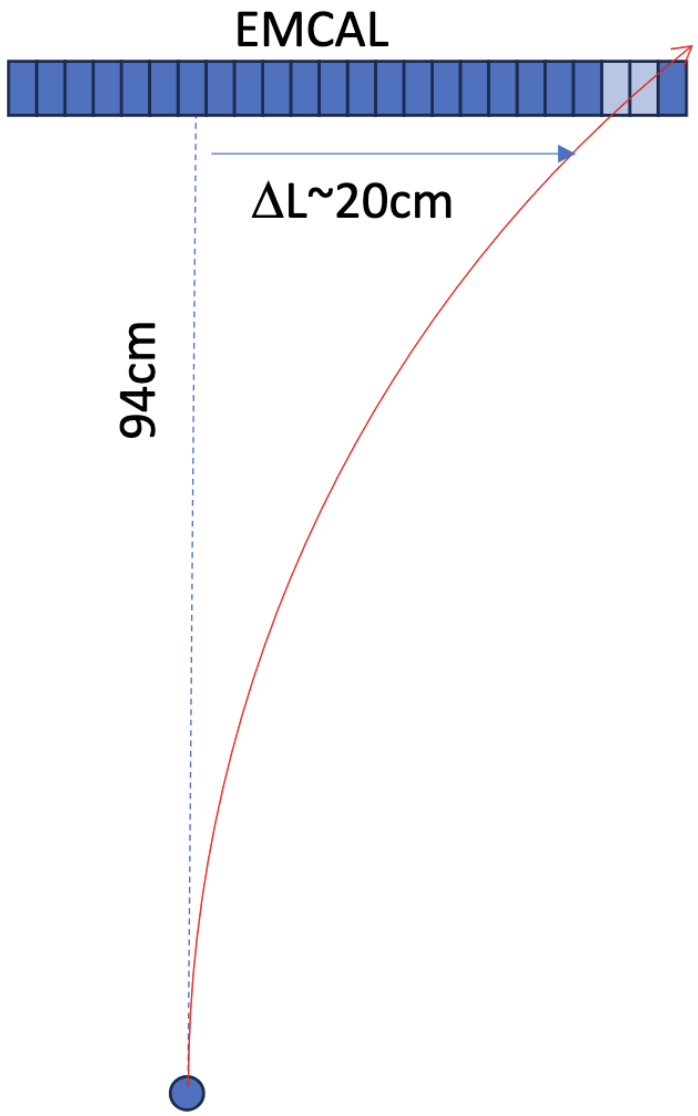
Motivation

- The TPC was not operational in the early period of pp collisions.
- A large dataset from the Calorimeter + Silico is available.
  - Calorimeter+Silicon: 107 pb-1 (0mrad+1.5mrad)
  - All detector: 13 pb-1 (triggered, 1.5mrad)
  - Streaming: 3 pb-1
- Silicon detectors (INTT + MVTX) alone have a short lever arm, leading to poor momentum resolution (~10%).
- The EMCAL is not a tracking detector, but it can provide an outermost position measurement.
- It might enables following studies:
  - Invariant mass spectrum of J/ψ and Y
  - Direct photon
  - Asymmetry in particle production
  - pT differential flow

INTT+Calo tracking



- By connecting the outer EMCAL (R=93.5 cm) with silicon tracks, a few percent momentum resolution can be achieved.

$\int B\,dl$ = 1.4Tm

pT_{kick} = 0.4GeV/c → ΔL ~ 20cm for 1GeV/c particle

Position resolution for punch through hadrons

$$\sigma \sim \frac{2.5cm}{\sqrt{12}} = 0.72cm \rightarrow \frac{\sigma_p}{P} \sim 3.6\%$$

Could be improved by multi-towers w/ E weight

For e±, σ can be better, need to be checked by MC

Takuya's simulation study

- Takuya made a framework and estimated that pt resolution can be a few percent using Monte Carlo simulations as expected.
- https://wiki.sphenix.bnl.gov/index.php?title=INTT_AnalysisWorkshop2024_TakuyaKumaoka

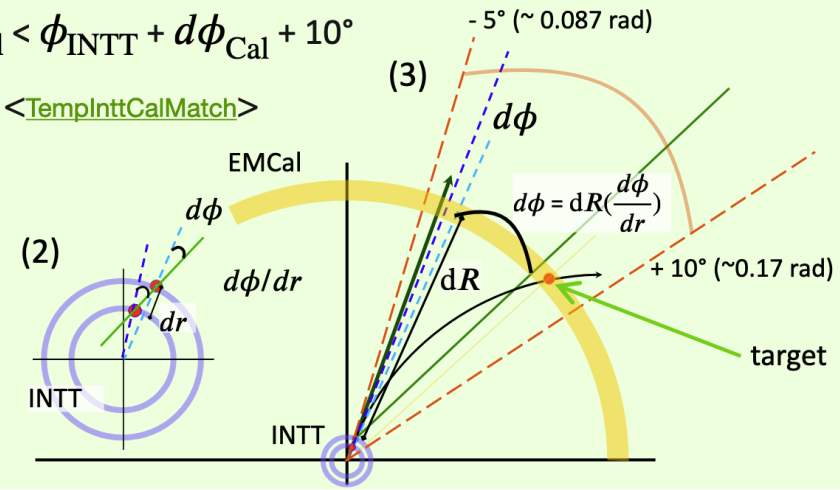
INTT + EMcal Hit Matching Algorithm

(1) Find a inner INTT cluster having the closest $\phi_{\text{outer INTT}}$ <TempINTTIOMatching>

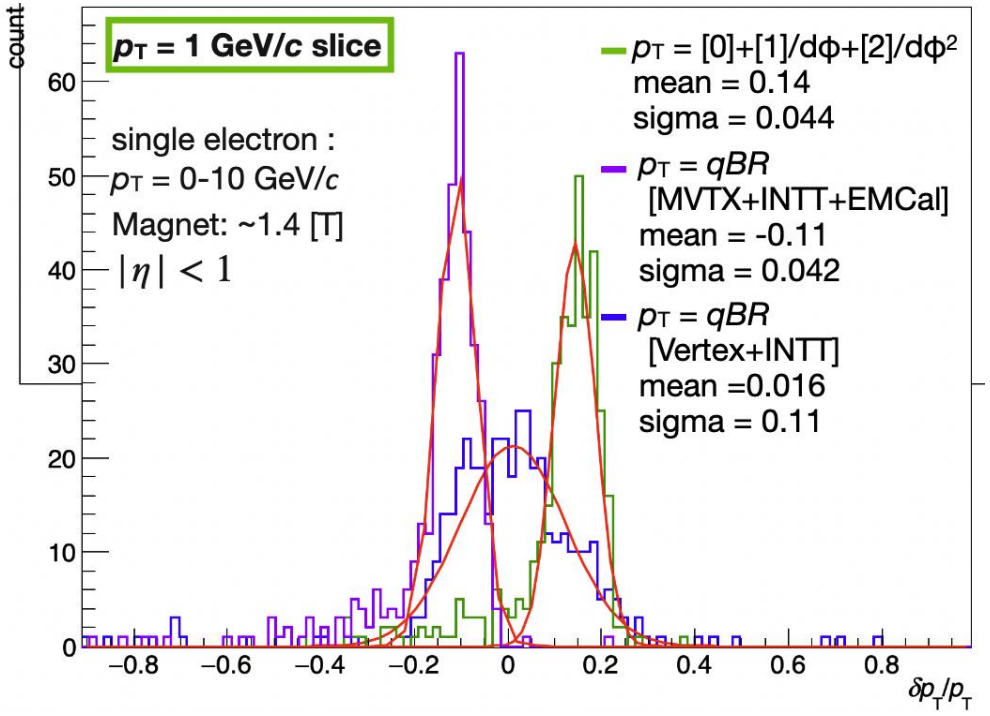
(2) Caclulate $d\phi/dr$ (outer INTT - inner INTT) <TempCalcdPhidR>

(3) Searching for an EMCal cluster (> 0.1 MeV) having the highest energy in the ϕ_{Cal} range $\phi_{\text{INTT}} - 5° < \phi_{\text{Cal}} < \phi_{\text{INTT}} + d\phi_{\text{Cal}} + 10°$

$d\phi_{\text{Cal}} = d\phi/dr * (R_{\text{EMCal}} - R_{\text{INTT}})$ <TempInttCalMatch>

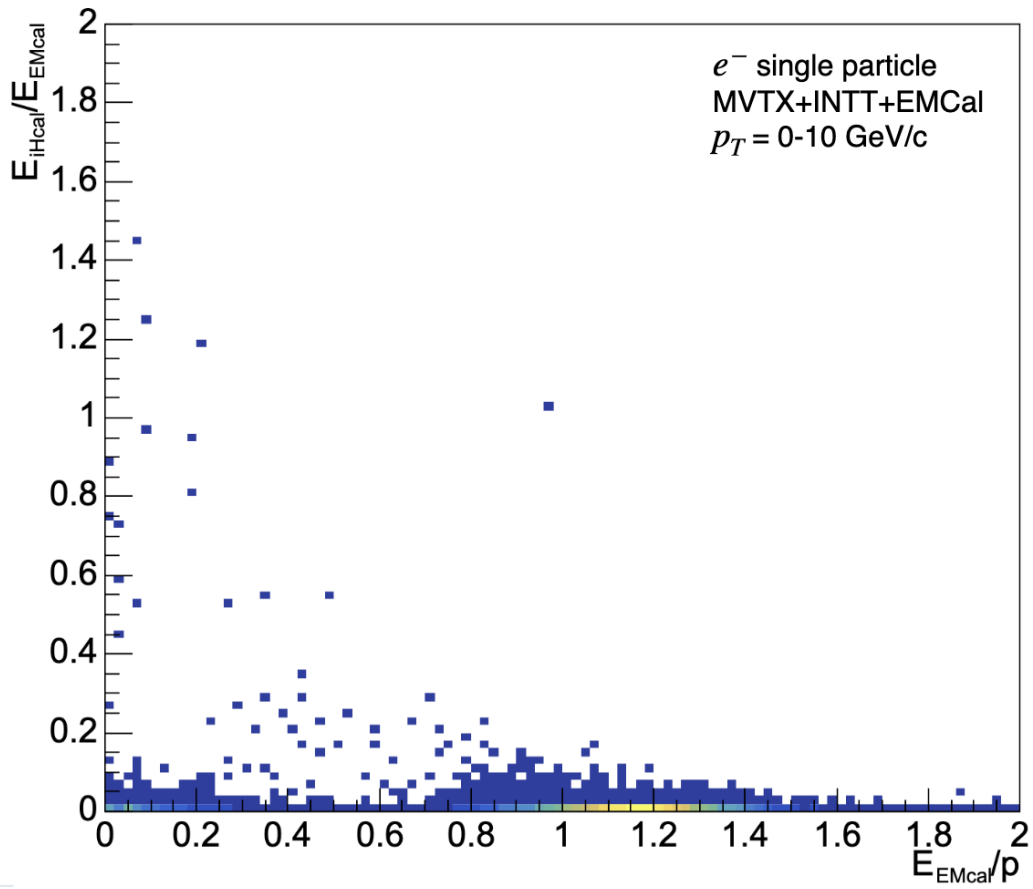


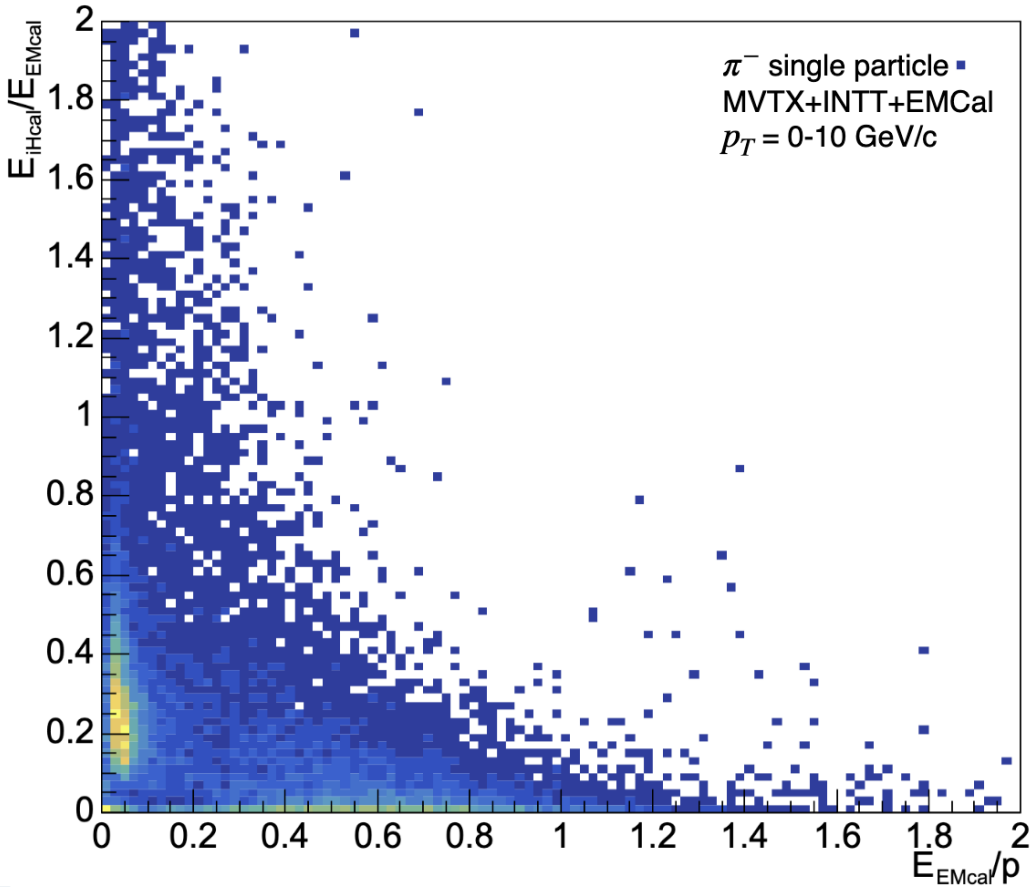
~4 % pT by Calo+Silicon in pp



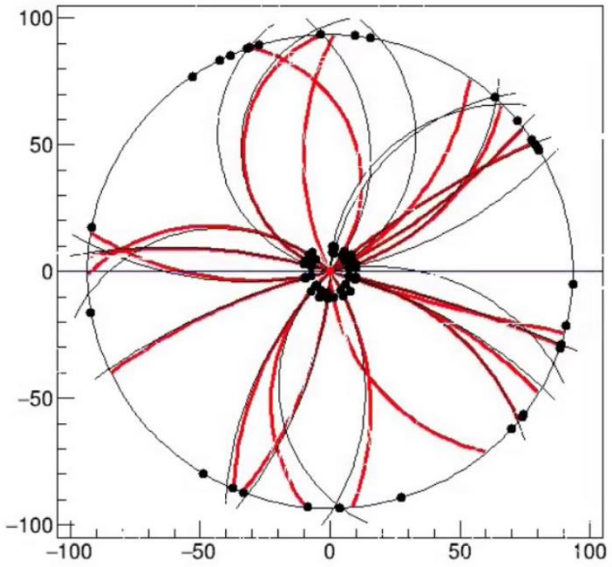
Difference between electron and hadron (Jaein)

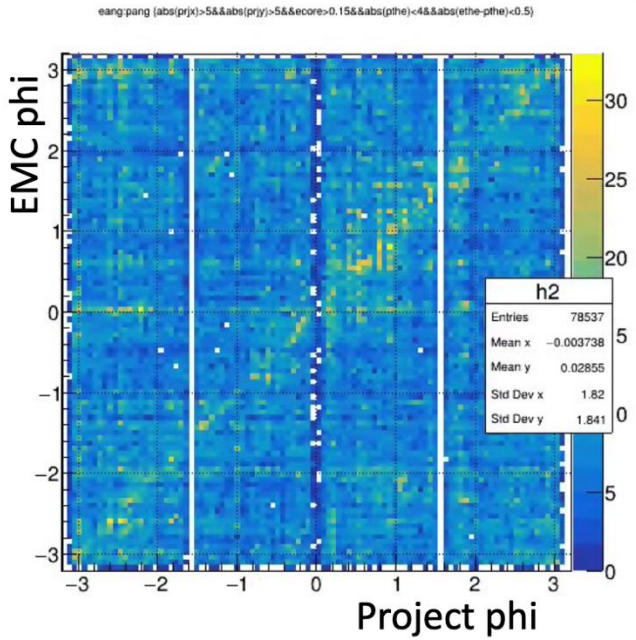
- E/p is much smaller for hadrons than electron

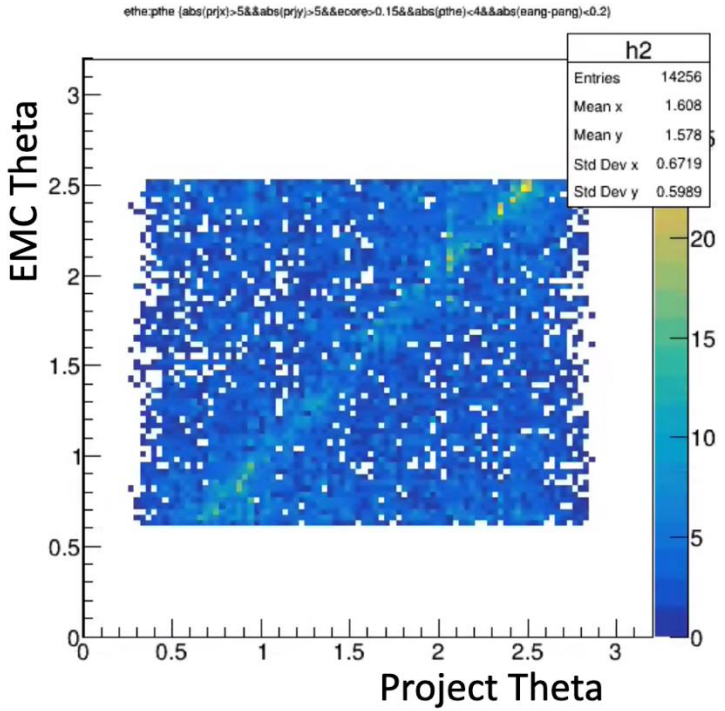




INTT+EMCAL matching (Takashi)







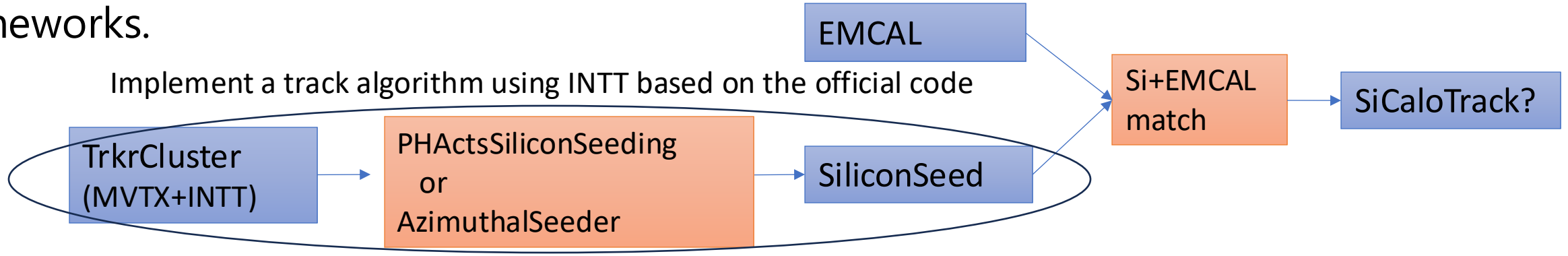
- MC(PYTHIA p+p MB)
  - Black line: INTT tracklet, Red: MC truth track
- INTT Tracklet is projected to EMCAL surface and search for the closest EMC cluster
  - INTT tracklet : 2 INTT clusters + XY vertex
  - Simple circle projection
- INTT + EMC matching works in p+p. Can be improved with MVTX

Slide from INTT WS in Korea

To Do List

- Calorimeter Clustering (Jingyu)
- Simulation for other particles such as charged hadrons and muons (Jaein)
- Silicon-Calo matching (Takashi)
- Silicon tracking (Yuko)
- Vertex Finder
  - Identify events with multivertex? separate vertex from extended time.
- Single electron simulation to extract L vs pT (Jingyu, Genki)

Our goal is to make this framework one of the official tracking algorithm options for sPHENIX, so we need to develop the code in the same style as the existing frameworks.



Meeting

Frequency: Every other Wednesday

Time: 2:00 PM in JST (24:00 in EST)

Indico

https://indico2.riken.jp/event/5165/