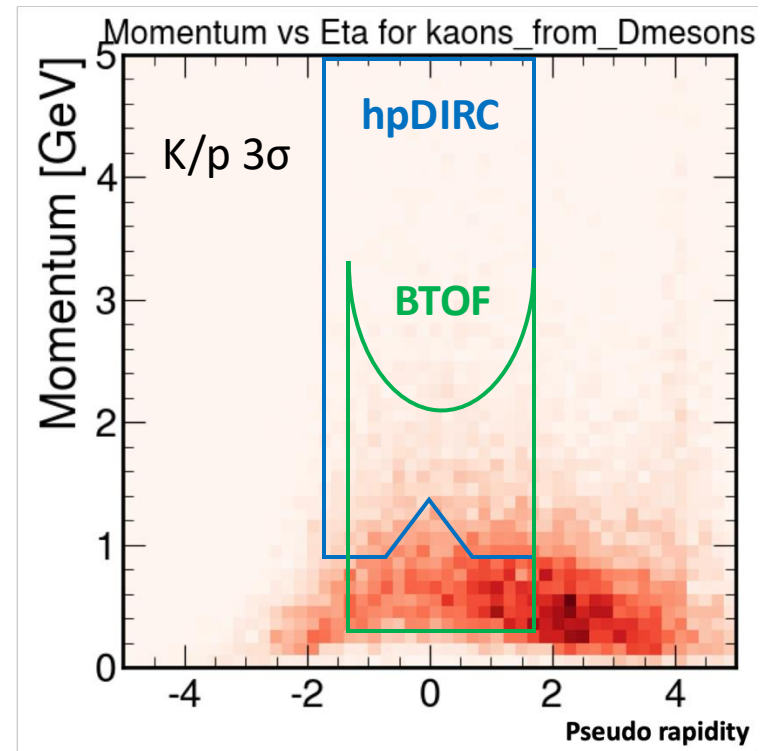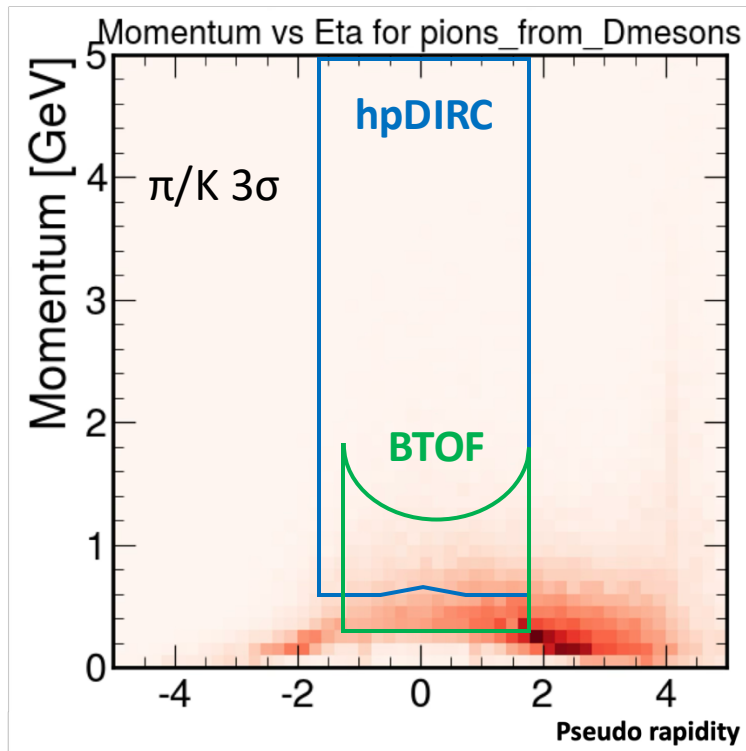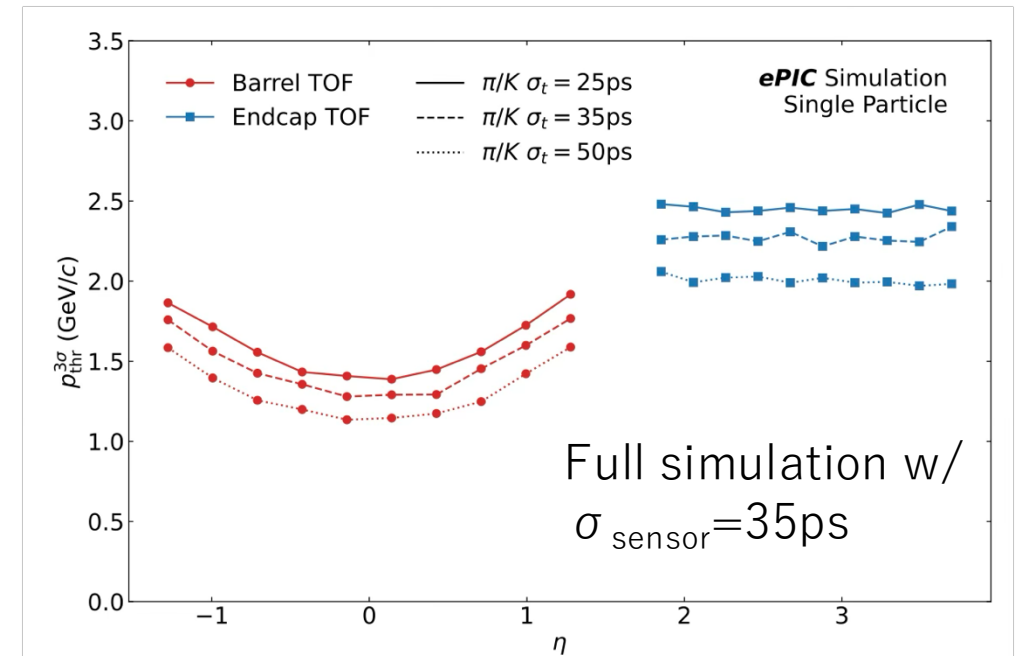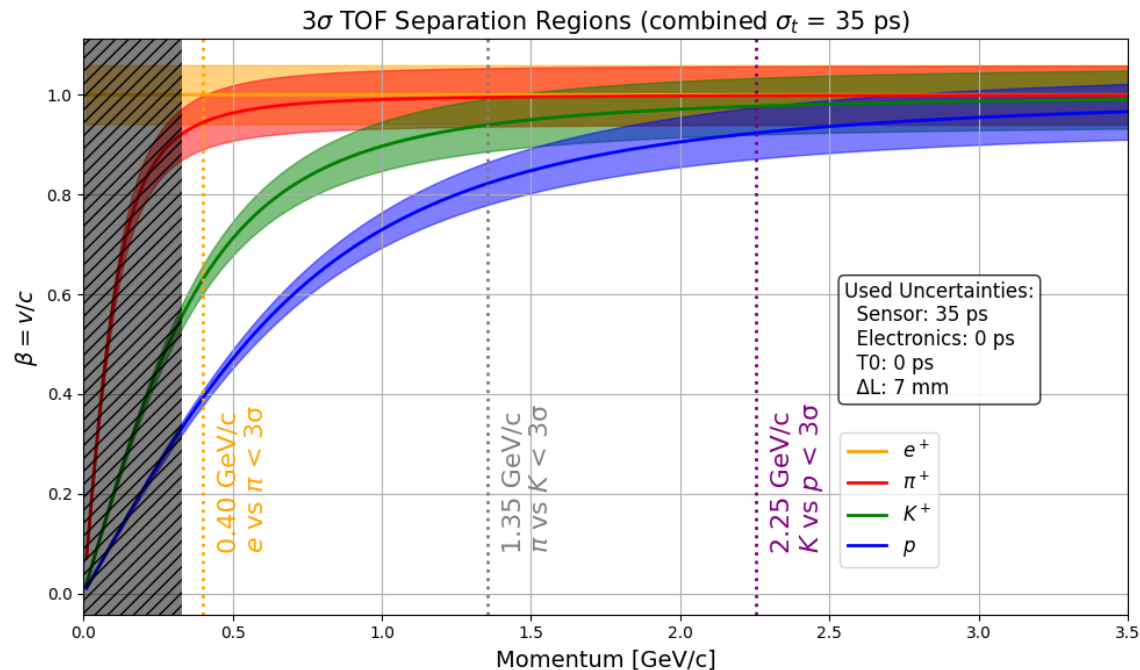# Barrel Time-of-Flight

Satoshi YANO

Importance of TOF at ePIC

- HF measurement is the most important subject at EIC
- Decay products, π and K, from HF hadrons are mainly distributed in TOF region
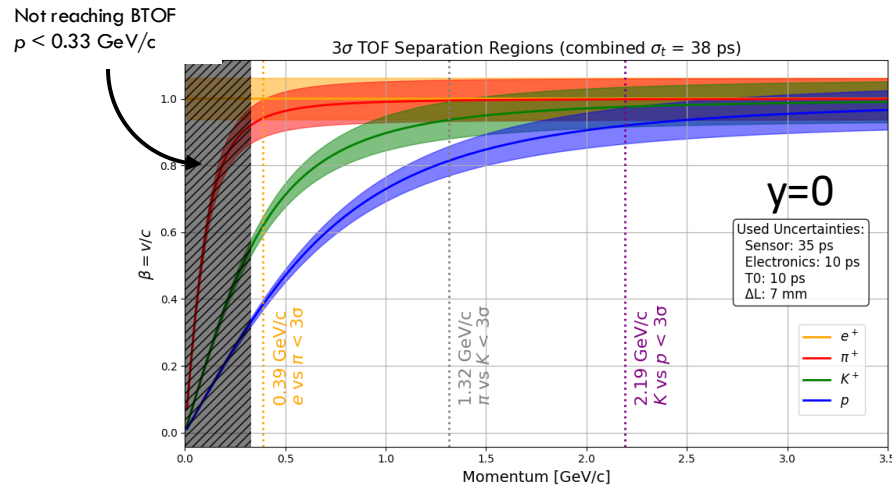- Light hadrons can be expected to be distributed over a lower momentum region

ΔL calibration

- The right panel simulation contained only the σ_{sensor} and ΔL
  - (If I remember correctly,) this plot is calculated full tracking simulation + smeared hit timing which means $\sigma_{electronics}$ = 0 and σ_{T0} = 0
- The performance of $p^{3\sigma}_{thr}$ = 1.35 GeV/c (η=0) when σ_{sensor} = 35ps can be described with ΔL~0.007m (σ_L~ 1.1% @ 0.64m)

3σ TOF Separation Regions (combined σ_t = 35 ps)

β = v/c

Used Uncertainties:
Sensor: 35 ps
Electronics: 0 ps
T0: 0 ps
ΔL: 7 mm

0.40 GeV/c
e vs π < 3σ

1.35 GeV/c
π vs K < 3σ

2.25 GeV/c
K vs p < 3σ

e^+
π^+
K^+
p

Momentum [GeV/c]

Barrel TOF π/K σ_t = 25ps   **ePIC** Simulation Single Particle
Endcap TOF π/K σ_t = 35ps
π/K σ_t = 50ps

$p^{3\sigma}_{thr}$ (GeV/c)

η

Full simulation w/
σ_{sensor}=35ps

Beta v.s. σ_{total} (y=0)
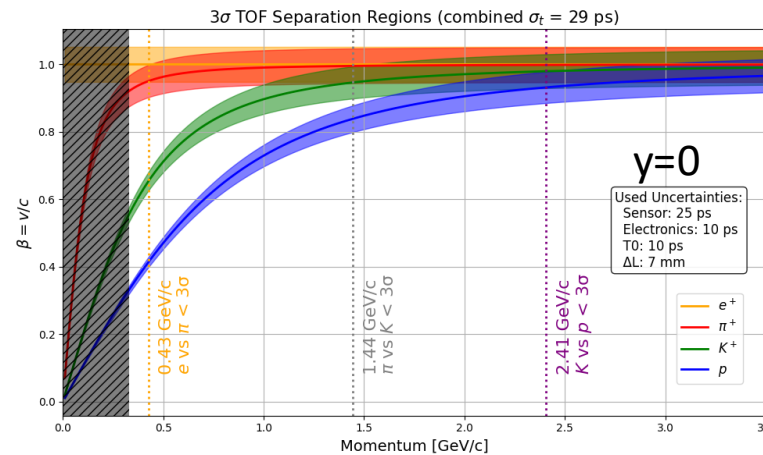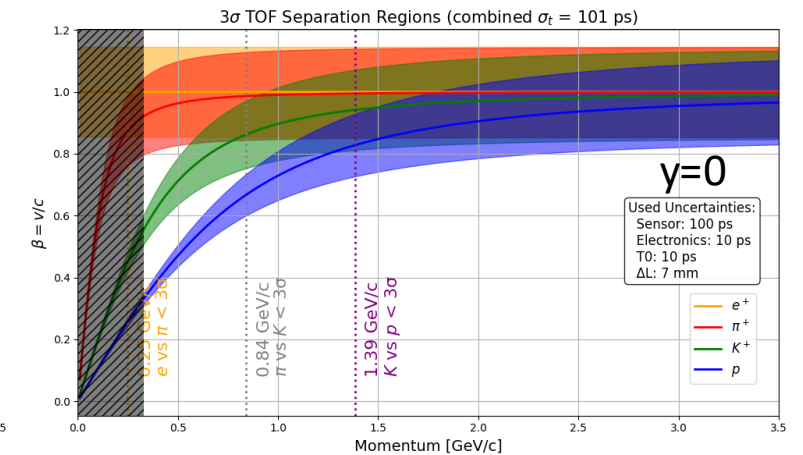
- Some resolutions: σ_{ele} = 10 ps, σ_{T0} = 10 ps and σ_L = 7 mm

- Default case: σ_{sensor} = 35 ps (σ_{total} = 38 ps)
  - pion/kaon overlapping 0.7<p<1.32 GeV/c, Kaon/proton overlapping 1.4<p<2.19 GeV/c with hpDIRC

- Better case: σ_{sensor} = 25 ps (σ_{total} = 29 ps)
  - pion/kaon overlapping 0.7<p<1.44 GeV/c, Kaon/proton overlapping 1.4<p<2.41 GeV/c with hpDIRC

- Worst case: σ_{sensor} = 100 ps (σ_{total} = 101 ps)
  - pion/kaon overlapping 0.7<p<0.84 GeV/c, NO overlapping for Kaon/proton separation with hpDIRC

3σ separation v.s. σ$_{sensor}$

3σ TOF Separation Cutoff vs Sensor Time Resolution

Legend:
- π vs K
- K vs p

Parameter Ranges Used:
σ_{elec}: 5-15 ps
σ_{T0}: 5-15 ps
ΔL: 5-10 mm

$\Delta p = 0.5$ GeV/c

$\Delta p = 0.5$ GeV/c

hpDIRC limit for K/p sep.

hpDIRC limit for π/K sep.

Y-axis: Max Momentum for 3σ Separation [GeV/c]
X-axis: Sensor Time Resolution σ_t [ps]
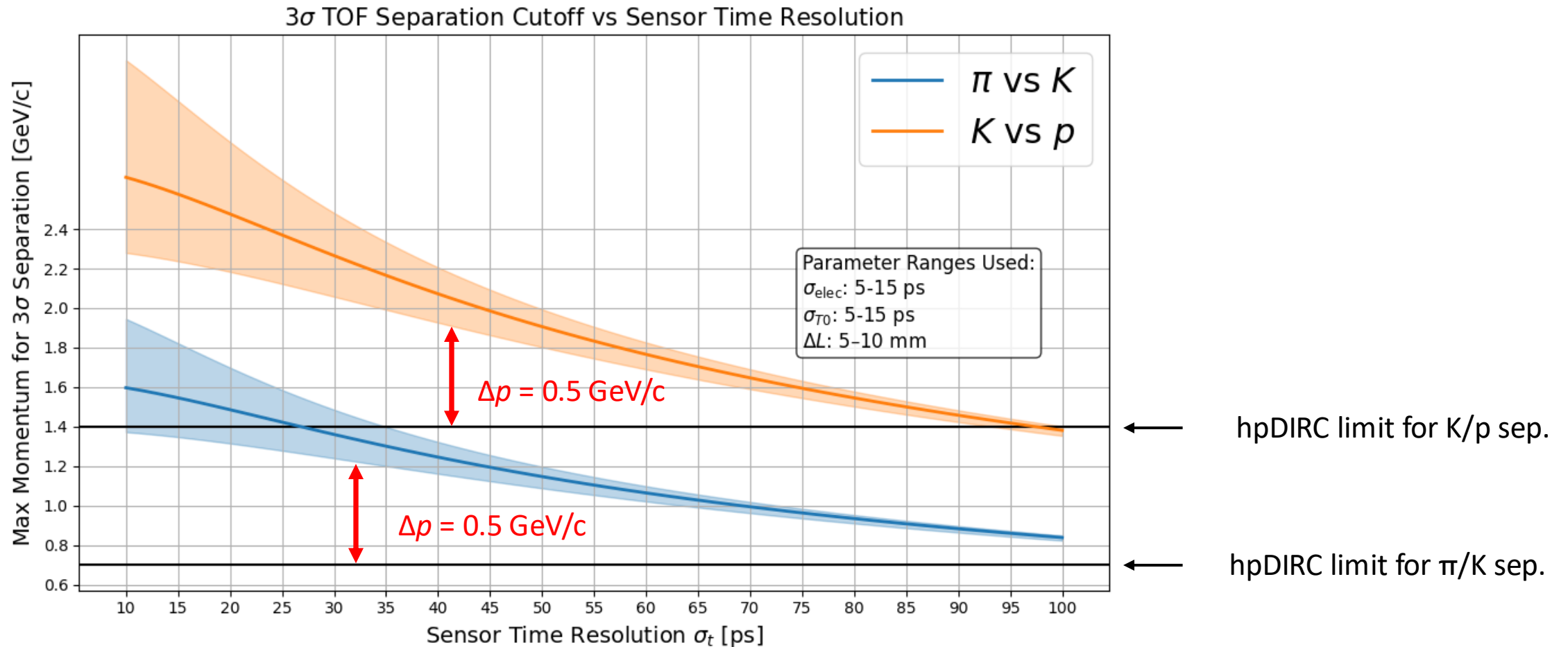
Considering the worst case (σ_{elec}=15ps, σ_{T0}=15ps, ΔL=10mm),
32ps sensor timing resolution is required to be 0.5 GeV/c overlapping for π/K separation

Stave Structure (Modularization ver.)

Half-Stave = 1408 [mm]

Front-side

Back-side

Acceptance = 1386 [mm]

Module (Stavelet) = 176 [mm]

22 [mm]

x $\boxed{8}$ x $\boxed{2}$ x $\boxed{288}$
=4608

x 8 x 3 x 2 x 288
=13824

(2 x 8) x 2 x 288
=4608
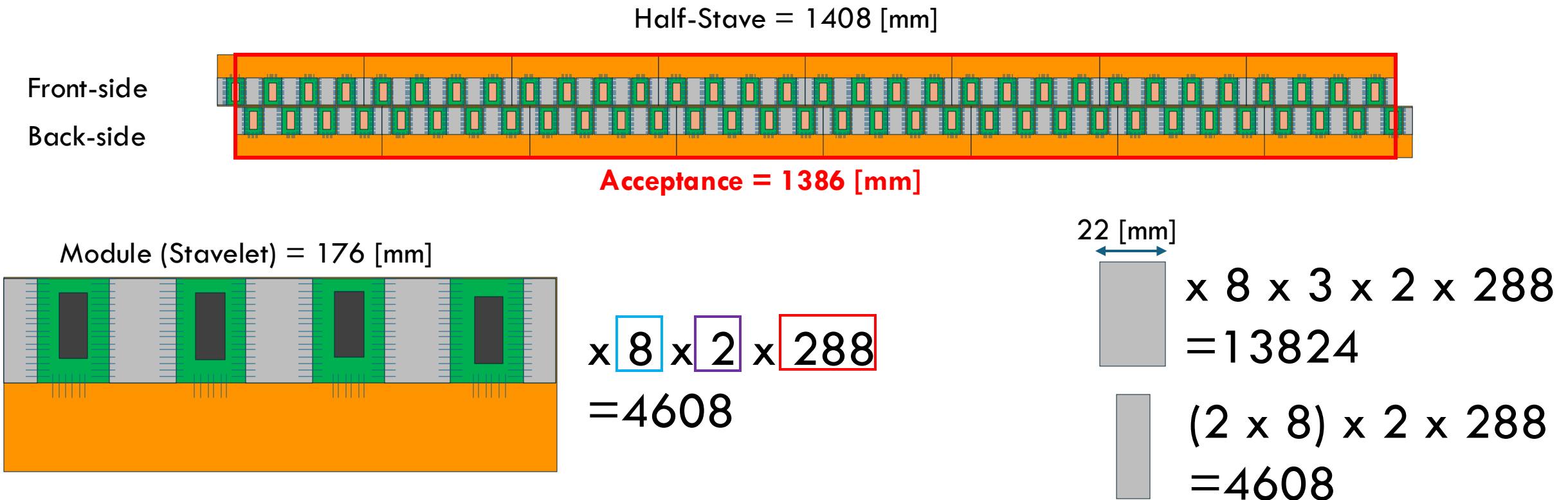
- Envelop length for BTOF in z direction is ΔL = 2,675mm

- Current design is ΔL=2,816mm, so it must be 141mm shorten

Module Connection Method

ACF

Wire

TAB