# Cose Relative al Software

Stefano Spataro

il rivelatore cgem di besiii con uno sfondo di bit di dati
in stile matrix e dei fulmini intorno – secondo l'IA

BESIII Italia – Torino – 14/04/2025

What's going on?

The CgemBOSS developments substantially in stand-by in the last six months

➢ Merging of CgemBOSS into standard BOSS

➢ Digitization speed-up

➢ Checking time calibration algorithms in MC simulation

➢ CGEM+ODC alignment

➢ Small updates on tracking
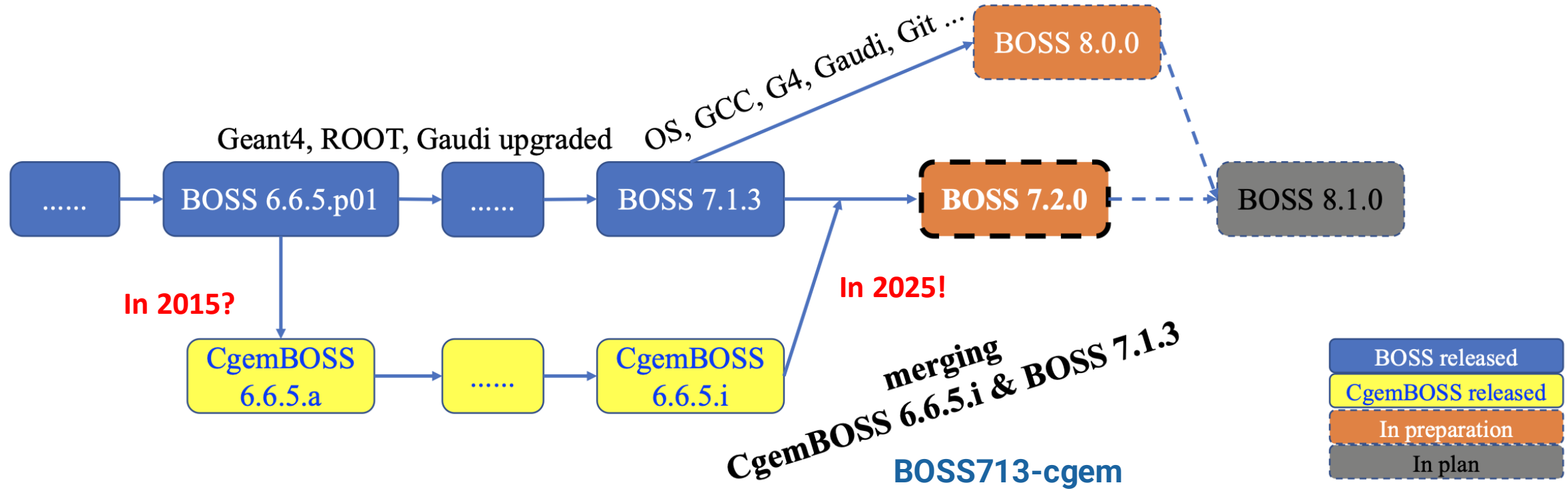
BOSS 7.2.0 (in preparation, not yet released)

- **Comprehensive Software Integration:** includes all software developed for the inner tracker upgrade (CGEM)
- **First round of data processing** after CGEM installation
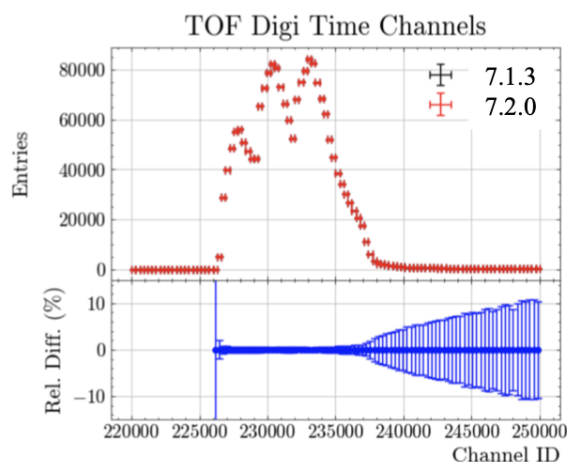- **Backward Compatibility:** compatible with previous data processing (MDC)
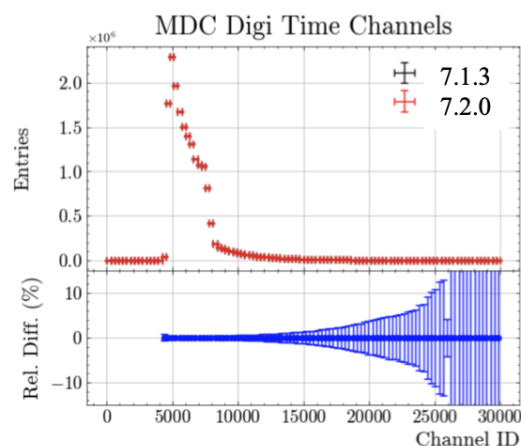
BOSS 7.2.0
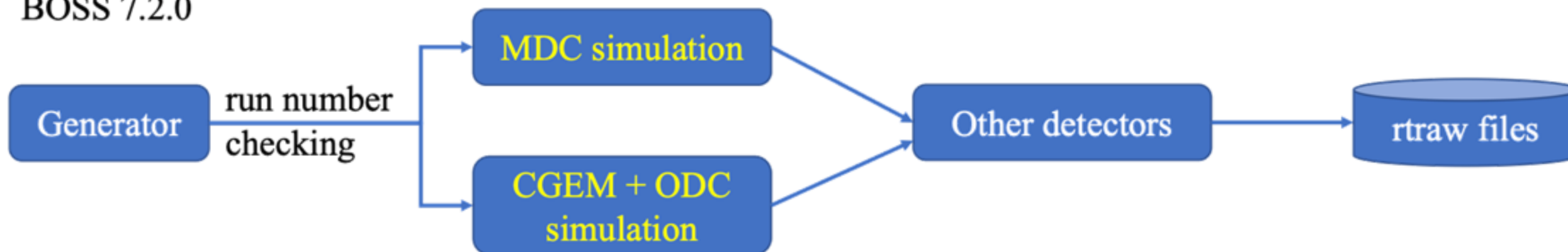
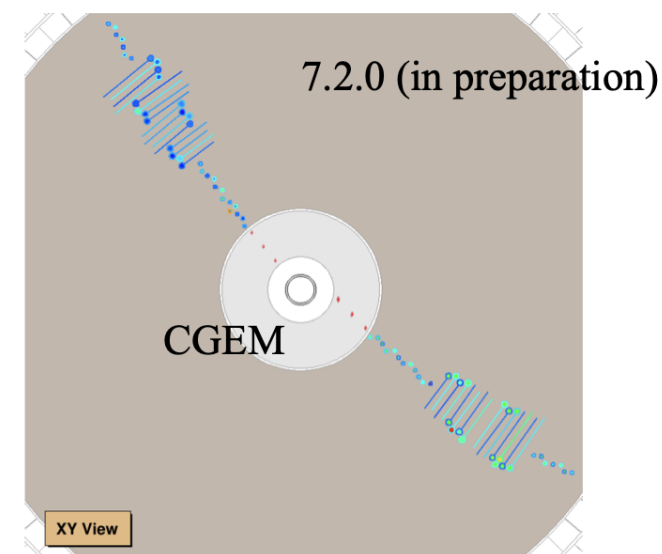- ● No change in simulation job-option file

✓ Test of MDC simulation: almost *identical* between BOSS 7.1.3 and BOSS 7.2.0 (in preparation)
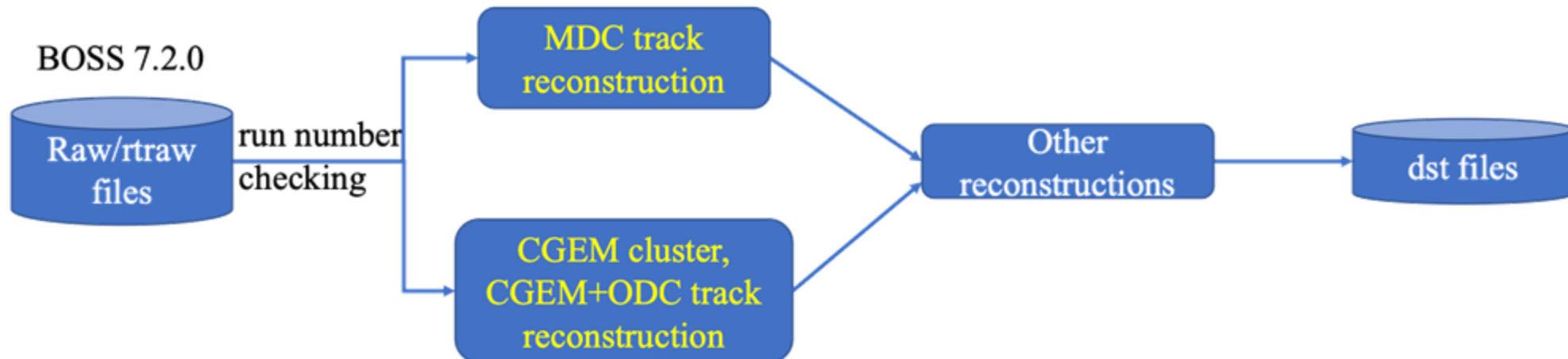
✓ Test of CGEM+ODC simulation: *running properly*

More checks in progress

by Mingrun Li, Xiaobin Ji *et al.*

7.2.0 (in preparation)

CGEM

XY View

BOSS 7.2.0

Raw/rtraw files → run number checking → MDC track reconstruction

CGEM cluster, CGEM+ODC track reconstruction

Other reconstructions → dst files

MDC case

✓ Small change in MDC track reconstruction

✓ Analysis test *by Xiaobin Ji et al.*

channels	7.1.3	In preparation 7.2.0	Efficiency Relative Difference %
$\rho\pi$	20306	20336	0.15
$K_S K\pi$	51963	52049	0.17
$p\bar{p}$	42319	42288	-0.07
$e^+ e^-$	38244	38245	0
$\mu\mu$	40569	40564	-0.01

Consistent within statistical errors

CGEM+ODC case

✓ CGEM cluster reconstruction and CGEM+ODC track reconstruction: running properly

✓ Analysis test

In preparation BOSS 7.2.0

$\psi(3686) \rightarrow \pi^+\pi^- J/\psi \rightarrow \pi^+\pi^-\mu^+\mu^-$

χ^2 of 4C kinematic fit

J/ψ mass from 4C kinematic fit
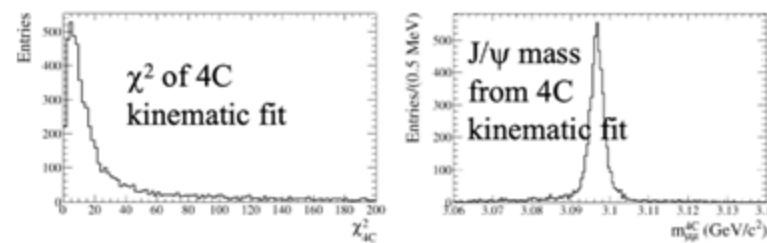
Reasonable

✓ Step 1: data model, conversion, input/output

✓ Step 2: simulation

✓ Step 3: reconstruction

In progress:

● Step 4: calibration and alignment + Event Display

● Step 5: careful check and tuning of codes (with simulation & data in iterations)

Previous time consumption
(to simulate one cluster)

- *Drift & avalanche part involves huge samplings due to multiplication of 3 GEM foils*

- *Induction & electronics part involves many convolutions & accumulations*
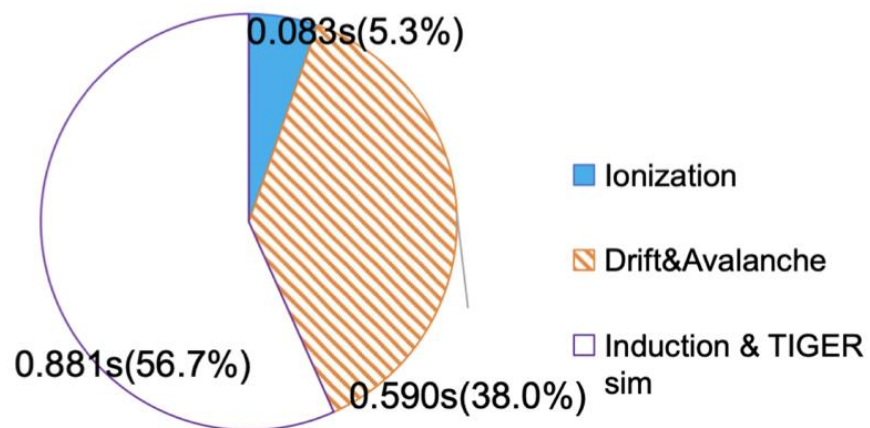
Some optimization and simplification

- *Sampling → convolution
  sampling of drift and avalanche around GEM foil 3 for an ionized electron simplified to the average result*

- *Induced current obtained by a numerical convolution with Fast Fourier Transform
  Accumulation of induced current in time domain → accumulation in frequency domain
  Faster and only one inverse Fourier transform after*
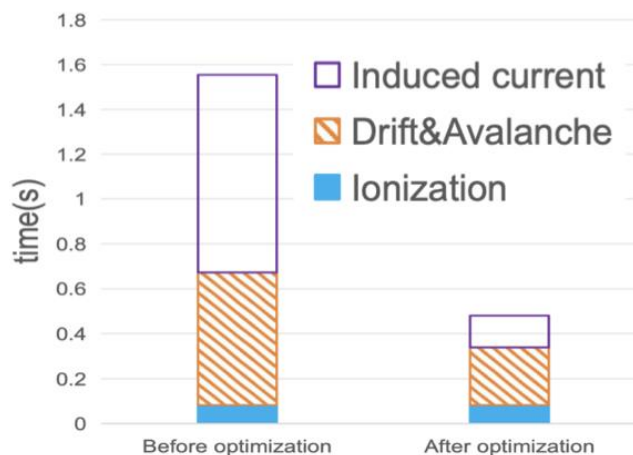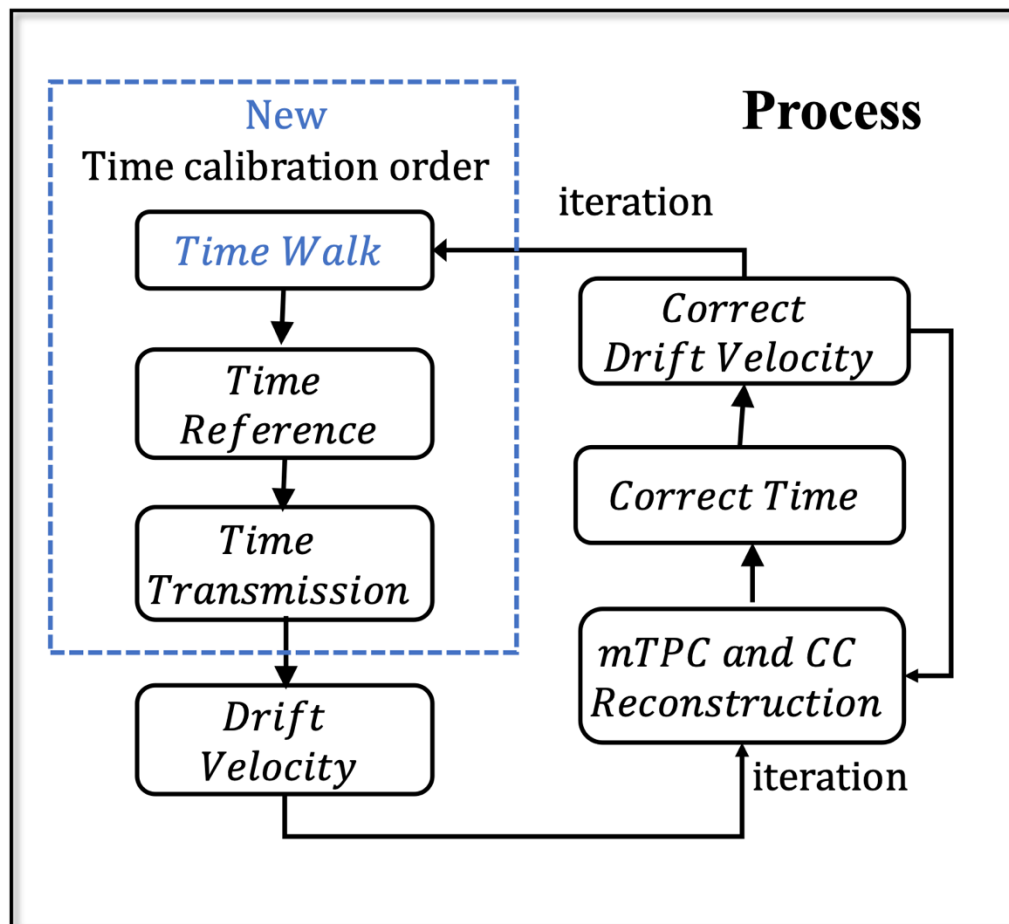
A threefold
improvement
in speed!

by Yimin Li *et al.*

For 1.5 GeV/c normal incident electron
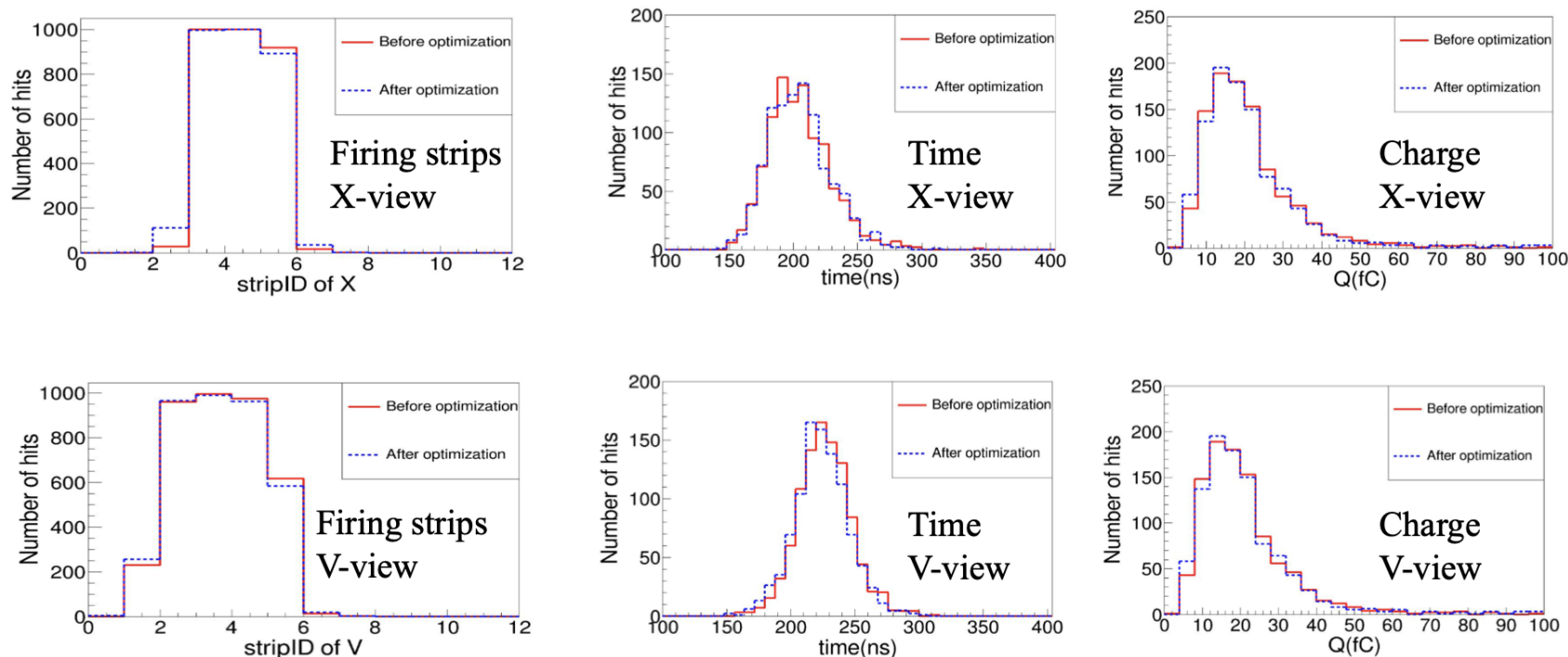
Comparable with previous results

a check is needed with real (new) data
which will require new tuning

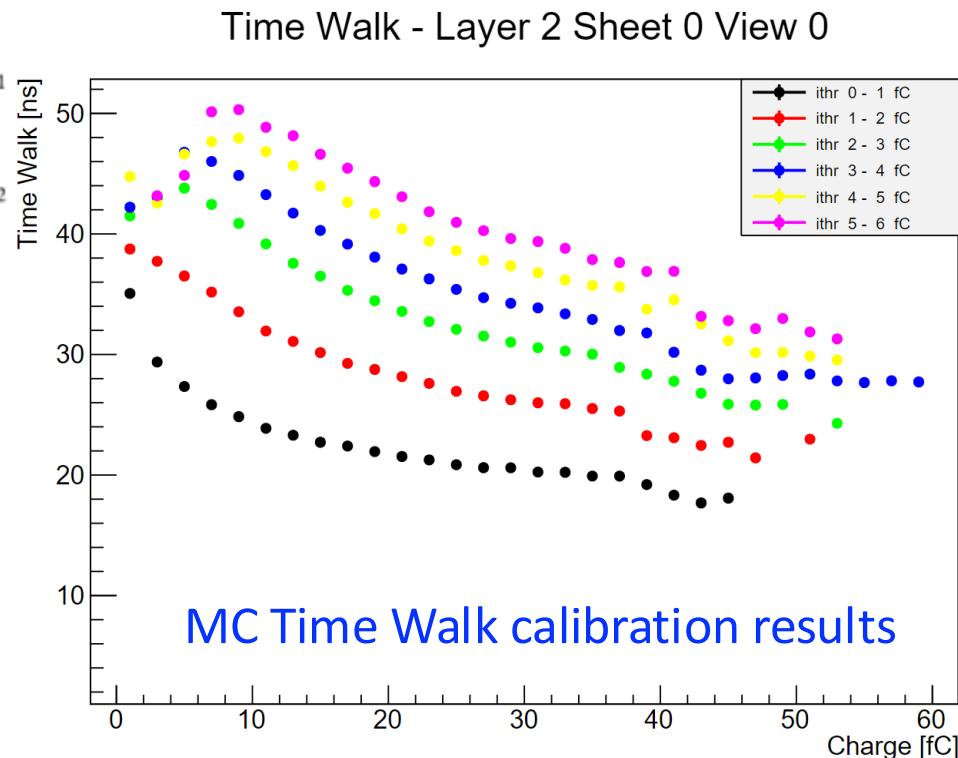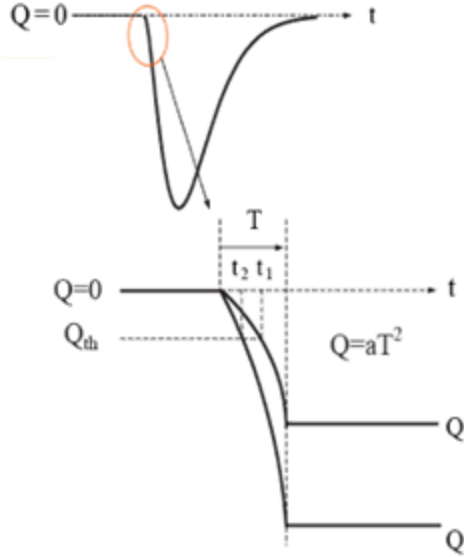# New time calibration scheme

Calibration data source:

➢ Cosmic Ray data (No magnetic field)

➢ Cosmic Ray MC (No magnetic field)

Calibration object:

➢ 3 layer

➢ 2 sheet
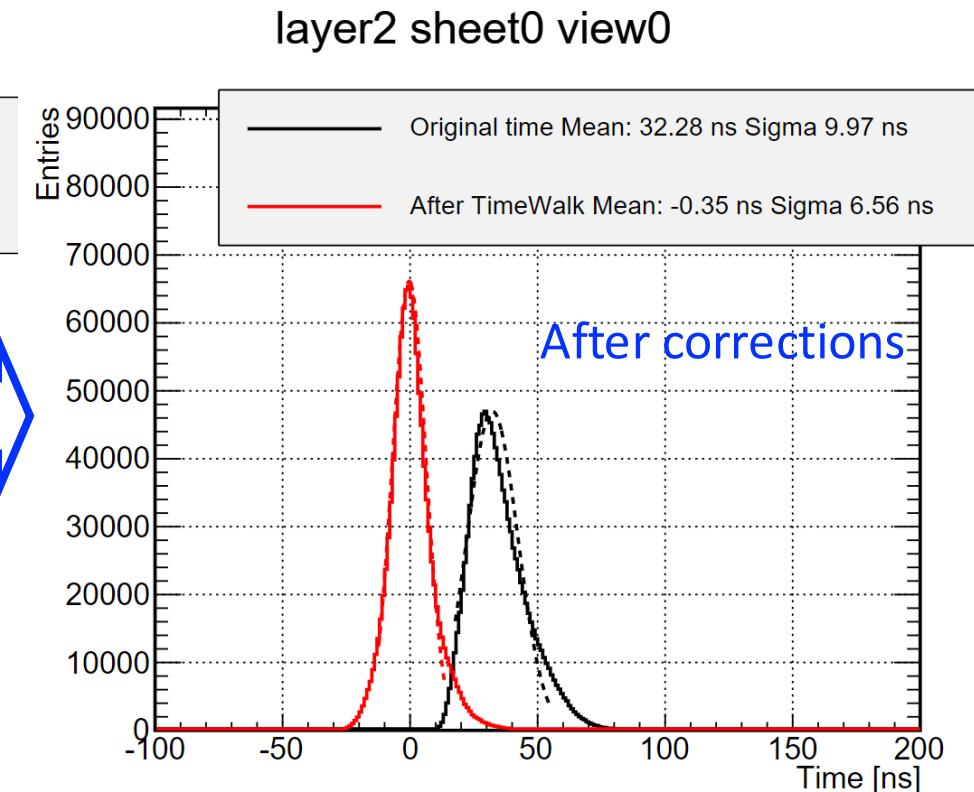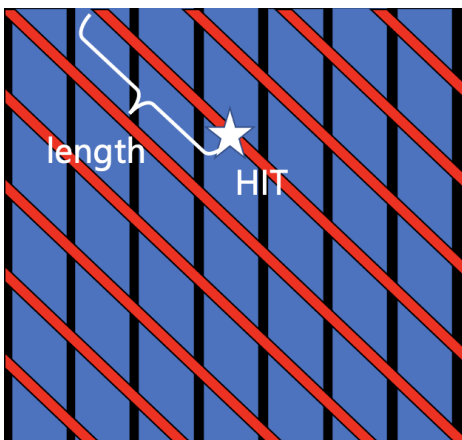
➢ 2 view(XV)

➢ 160 Tiger

➢ 9879 strip

Studies based on MC simulations by Ye Yuan

"Time Walk" correction for MC

➤ After correcting the time walk, improvements in the time resolution

➤ Seen similar curves by Riccardo with real data

Time Walk - Layer 2 Sheet 0 View 0

ithr 0 - 1 fC
ithr 1 - 2 fC
ithr 2 - 3 fC
ithr 3 - 4 fC
ithr 4 - 5 fC
ithr 5 - 6 fC

MC Time Walk calibration results

This is "measured" charge

layer2 sheet0 view0

Original time Mean: 32.28 ns Sigma 9.97 ns

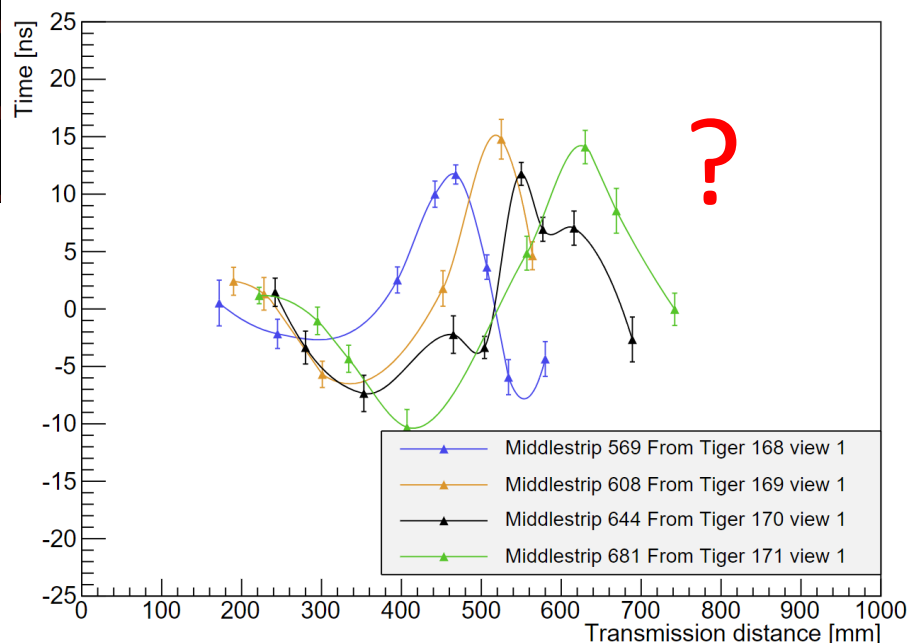After TimeWalk Mean: -0.35 ns Sigma 6.56 ns

After corrections
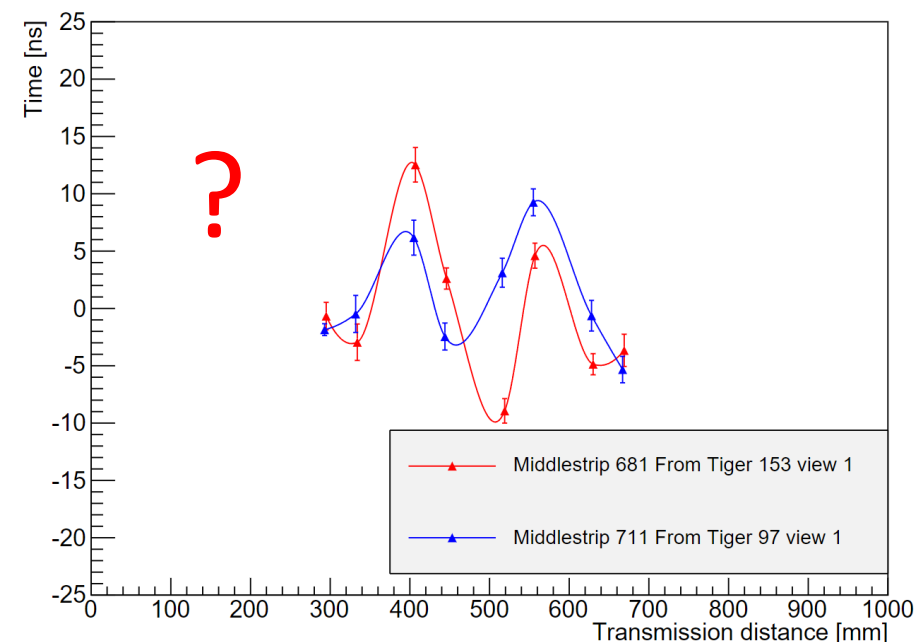
Transmission Time

Calibration results of adjacent tigers in space

layer2_sheet1_view1

Calibration results of spatially symmetric tiger

layer2_sheet0_view1

➢ An oscillation relation between time calibration result vs transmission length of strip is found
➢ The waveform difference between adjacent tigers is about 50 mm
➢ The waveforms of two spatially symmetric tigers are similar (I don't now what this means)
➢ They guess it may because of some electronic features

Some nice visualization from MC
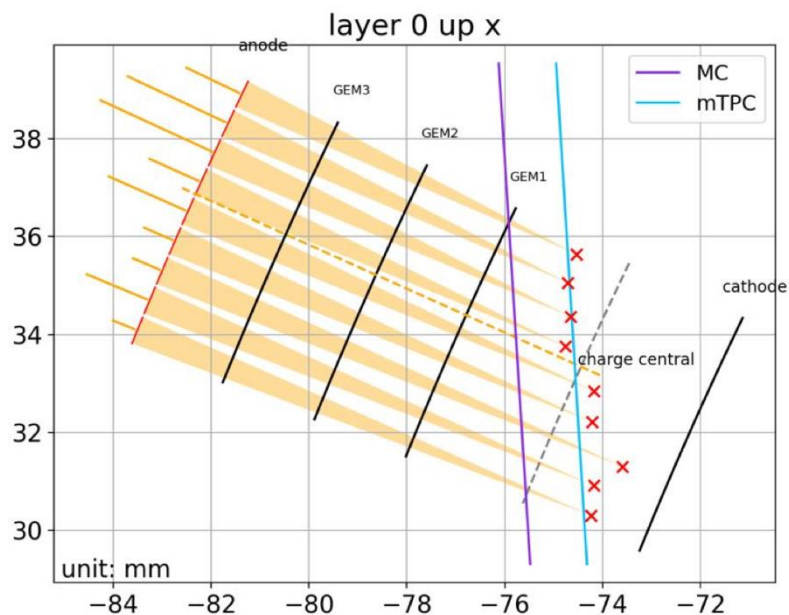
Without time walk and iterative T0 modification
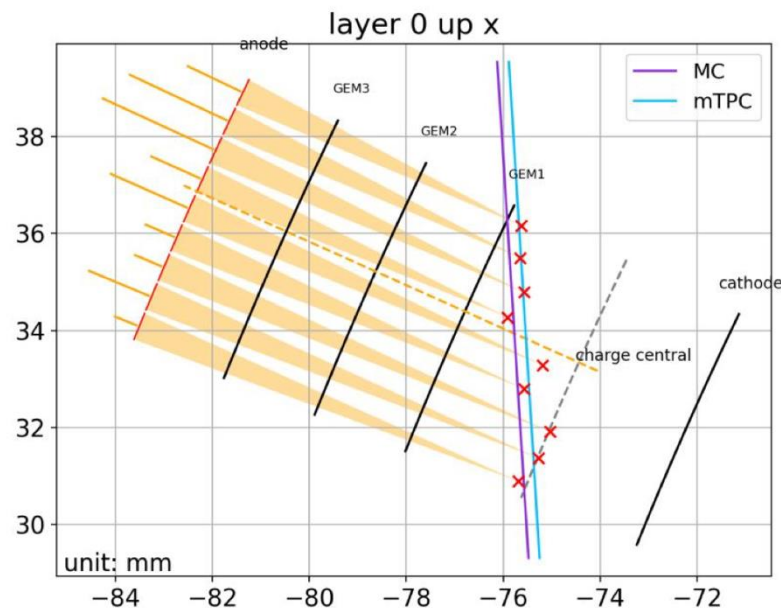
With time walk but no iterative T0 modification
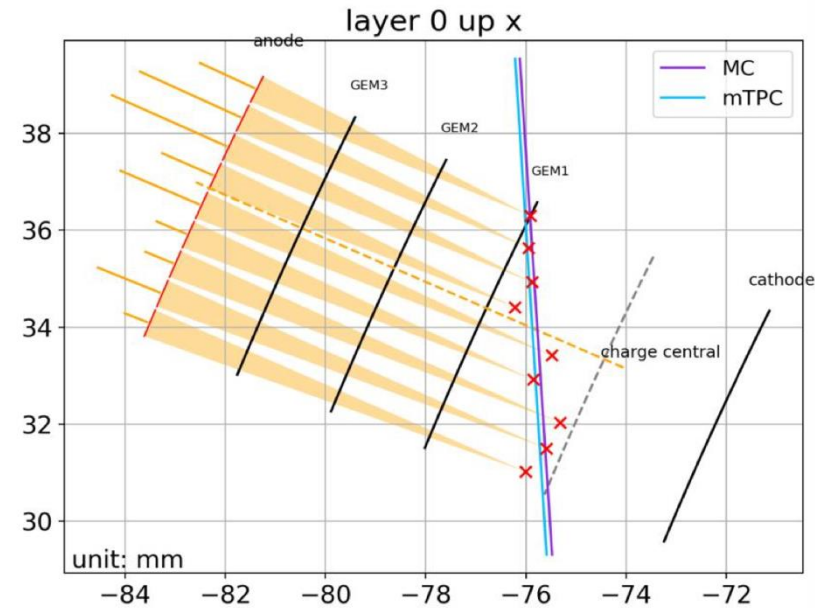
With time walk and iterative T0 modification

After time walk calibration and iterative correction, the initial ionization position calculated through drift time and drift velocity matches the true track more closely

16

All the "magnetic" parts never tried or tested

CGEM+ODC Alignment

- Test sample:
  simulated single 1 GeV/c muon
- Configuration:
  - CGEM with ~500μm shifts
    in x and z directions
  - ODC perfectly aligned

✓ Calculation of misaligned geometry in simulation

✓ Track fit with misaligned geometry

   ✓ For collision data: implemented

   ✓ For cosmic data: implemented

✓ Simulation study of misalignment effect performed

✓ Alignment algorithm for CGEM+ODC

   ✓ Preliminary validation with MC for translation corrections

   ➤ Further validation ongoing
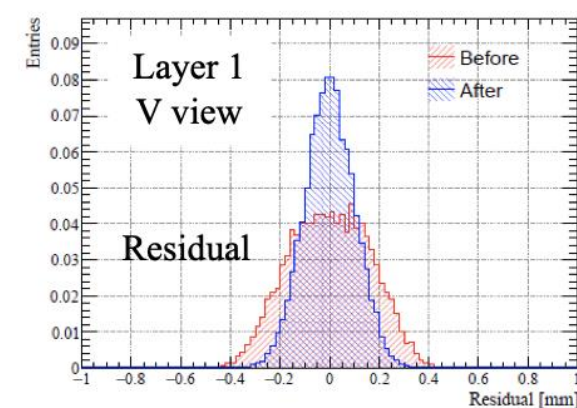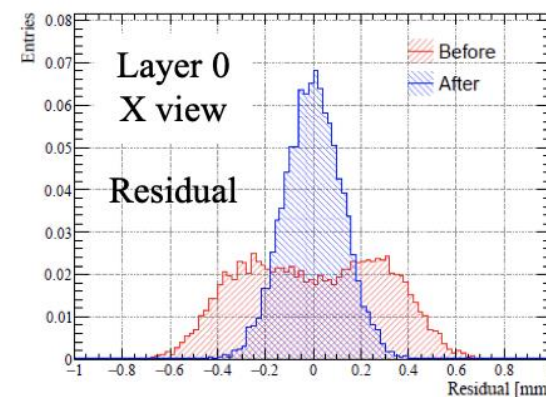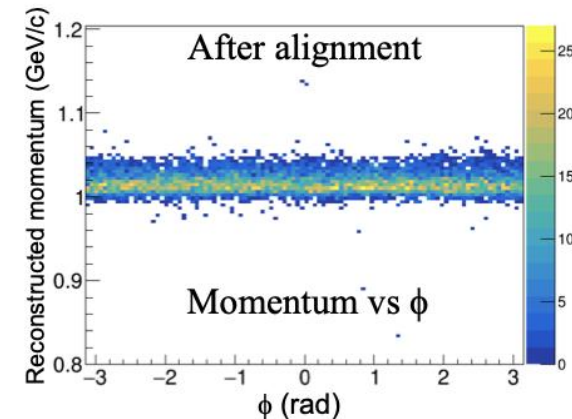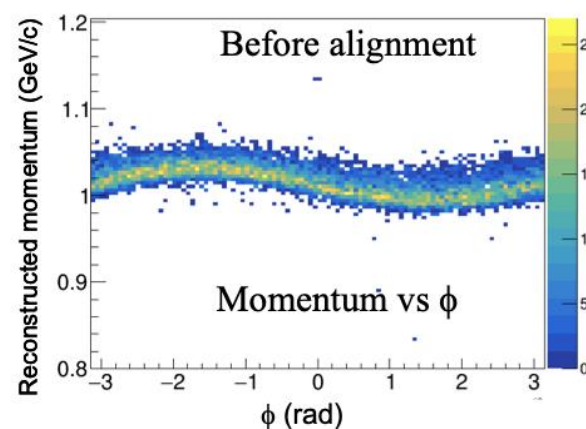
- ➢ Several minor optimizations of Hough Transform algorithm
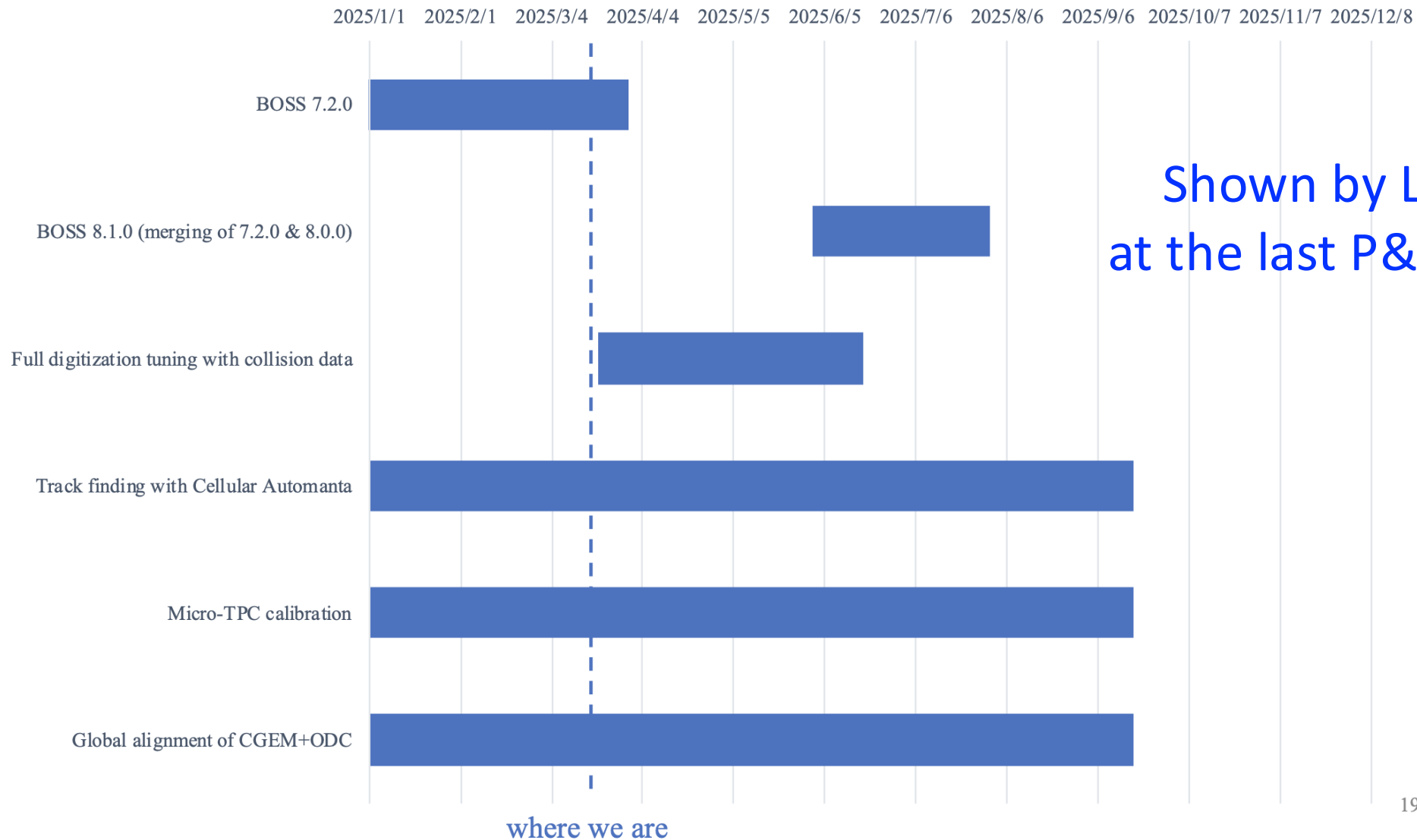- ➢ No progresses on the local method

$$e^+e^- \rightarrow \pi^+\pi^- \psi(3686)[\rightarrow \pi^+\pi^- J/\psi[\rightarrow \mu^+\mu^-]]@4.612 \text{ GeV}$$

Liangliang Wang

Good charged tracks ($|dr|<1.0$cm, $|dz|<10$cm, $|\cos\theta|<0.93$)

Cut flow	MDC	CGEM+ODC (previous version)	CGEM+ODC (new)
>=6 good tracks	64.2%	65.9%	68.6%
=6 good tracks, Q_{total}=0, kinetic PID ($4\pi\mu^+\mu^-$)	47.6%	44.8%	50.3%
ψ(3686), J/ψ mass window, 4C kinematic fit successful	41.7%	37.6%	42.0%
χ^2_{4C}<100	39.5%	35.5%	39.0%

CGEM software working list (2025)

Shown by Liangliang
at the last P&S workshop

where we are

19

Manpower?

Substantially no software contribution from the Italian side

All the software activities are performed by Chinese colleagues

Not clear all the activities which are performed right now

At the regular software meeting substantially random discussions

Due to our "negligible" software manpower, I presume we have to live with this