



# Status of ACTS at CEPC

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On behalf of CEPC-ACTS group

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CEPC Workshop, Shanghai



### Introduction

- CEPC ACTS activities
  - Implementation
  - Performance study
- Summary and next

## Introduction

- Tracking is key essence for physics performance
  - Excellent impact parameters measurement for 2nd vertex finding, so for tagging jet flavor, τ lepton, and reconstructing long lived mesons, such as B, D, and so on
  - Precise momentum resolution to reconstruct Higgs/Z, etc, mass peaks
  - Essential for a particle flow oriented detector to achieve much better jet energy resolution: precisely measuring momentum & extrapolating tracks to the entrance of ECal

Particles in jet	Fraction of E	Measured by	$\sigma^2$
Charged tracks	~60%	Tracker	Negligible
Photons	~30%	Ecal	0.11 <sup>2</sup> E <sub>jet</sub>
Neutral hadron	~10%	~10% Ecal+Hcal	
Conclusion	Required for 3	0%/sqrt(E)	0.20 <sup>2</sup> E <sub>jet</sub>





2nd vertices in a jet

## **Tracking System Options**

- Several CEPC detector concepts
  - Baseline detector (silicon + TPC)
  - Full silicon detector
  - Reference detector (silicon + drift chamber)
- Requirement of accurate and efficient tools for detector studies
  - Flexibility in layout optimizations and material studies
  - Evaluating the performances of different designs
  - With the potential of becoming the future tracking software











## **Introduce ACTS to CEPC**

#### > Derived from ATLAS, driven by the core idea to become **A** Common **T**racking **S**oftware

- Encapsulating the well-tested ATLAS tracking code high performance in the past
- Independent from detectors and framework
- Modern technologies
  - Dealing with the CPU problem in dense tracking environment
  - Generic programming with C++ 17
  - Thread-safe design and efficient memory allocation
- Active group for the developing
  - Potential to become the future ATLAS tracking software
  - Other experiments are also trying
    - BELLE-2, sPHENIX, FASER, CEPC ... \*
- In term of CEPC, our activities started from last year
  - Participate in the ACTS development
  - Implement different detector designs
  - Detector details and tracking performance studies
  - Layout optimization and framework integration

## **CEPC ACTS Activities**

#### https://gitlab.cern.ch/jinz/acts-framework-cepc



## Implementation



**Baseline tracker** 

- DD4hep based geometry to describe CEPC inner tracker and built with XML file
  - Easy to modify the detector parameters
  - Good readability
  - Easy to integrate to CEPCSW
  - One of the standards in the future •





#### Propagation

A powerful tool to debug the geometry





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## Implementation



#### Resolutions of sub-detectors

Sub-detector		loc0_res [μm]	loc1_res [μm]		
Barrel		1	3	3	pixel
	Vertex	2	4	4	pixel
		3	4	4	pixel
	SIT 1, 2		5	250	strip
	TPC		100	5000	TPC
	SET		5	250	strip
Endcap	FTD 1, 2		3	3	pixel
	FTD 3, 4, 5		5	250	strip
	ETD		5	250	strip



TPC layer

Silicon module



#### FATRAS (Fast ATLAS Track Simulation) to do the simulation

Smear true position  $\rightarrow$  hit 



**Baseline tracker** 



- Particle gun: 800,000 single  $\mu^{-}$  from (0, 0, 0)
- Magnetic field: (0, 0, 3T)
- $p_T$ : 100GeV,  $\theta$ : 85°,  $\varphi$ : uniform distribution
- Kalman Filtering
  - Pull distribution of track parameters



#### Following standard normal distribution

#### Smear resolution in FATRAS

#### Tracking Residuals





• Result in ACTS (  $p_T$ : 100GeV,  $\theta$ : 85° ) •  $\sigma_{r\varphi} = 1.67 \ \mu m$ 

 $\sigma_{1/p_T} = 2.93 \times 10^{-5} \ c/GeV$ 

- Full simulation resolution in CDR
  - $\sigma_{r\varphi} = 1.89 \ \mu m$

$$\sigma_{1/p_T} = 2.75 \times 10^{-5} \ c/GeV$$



## Generally match with full simulations in CDRFurther validation

## **Working Group**

	<b>CEPC ACTS</b>	working group	(mainly from	IHEP,	other	institute	S
sh	owing their	interested)					

- > 1 year bi-weekly meeting to share the tracking experiences from ACTS
- More than 10 people attend the regular meetings
- Increasing number of people starting to work on the CEPC-ACTS integration part and some have interest in contributing to ACTS project

A S a	ACTS discussion Saturday, October 10, 2020 from <b>15:00</b> to <b>18:05</b> (Asia/Shanghai) at 多学科大棱( <b>618)</b>			
	Saturday, C	Dctober 10, 2020		
	15:00 - 15:15	Update on ACTS development <i>15'</i> Speaker: jin 张晋 (bes3 software)		
	15:20 - 15:40	ACTS for the CEPC tracking 20' Speaker: HAN Yubo (IHEP)		
	15:40 - 16:00	CEPC ACTS checks 20' Speaker: 刚 李 (高能所) Material: Slides 哲		
	16:05 - 16:25	kalman filter study 20' Speaker: Yebo Chen (高能所) Material: Slides 顧 愛マ		
	16:30 - 16:55	Kalman filter study 25' (618) Speaker: Shulting Xin Material: Slides 🔁		

Octobe	r 2020
	10 Oct ACTS discussion
Sentem	her 2020
weeksern	
	29 Sep ACTS discussion
	07 Sep ACTS discussion
August	2020
	25 Aug ACTS discussion
July 20	20
	30.Jul ACTS discussion
	21 Jul ACTS discussion
	07.Jul ACTS discussion
@	
June Zu	120
	29 Jun ACTS discussion
	29 Jun ACTS discussion
	16 Jun ACTS discussion
	15 Jun ACTS discussion
	15 Jun - 15 Jul Confluence of the ACTS For CEPC
	09 Jun ACTS discussion
	01 Jun ACTS discussion
May 20	20
	18 May ACTS discussion
	18 May ACTS discussion
	04 May ACTS discussion
	04 May ACTS discussion
April 20	20
	20 Apr ACTS discussion
	06 Apr ACTS discussion
March 2	2020

23 Mar ACTS discussion

#### Summary

- ✓ CEPC baseline detector tracker and FST2 geometries implemented with DD4Hep
- ✓ Validations of baseline design and Kalman filter done with truth tracking
- ✓ Ready for CEPC tracker design and optimization

#### Next

- Optimization and more details of geometry
- Detector layout and physics study
- Integration to CEPCSW framework

Anyone interested in ACTS and tracking studies are more than welcome

# Thanks!

BACKUP

## **Other experiments experience**

➢ BELLE-2

https://indico.cern.ch/event/917970/contributions/3861757/attachments/2044358/34 24508/acts-belle2.pdf

> sPHENIX

https://indico.cern.ch/event/917970/contributions/3861759/attachments/2044370/34 24557/Acts\_sPHENIX.pdf

> FASER

https://indico.cern.ch/event/917970/contributions/3861959/attachments/2044384/34 24550/FaserExperience\_keli.pdf

> CEPC

https://indico.cern.ch/event/917970/contributions/3861761/attachments/2044401/34 24582/actsworkshop-cepc-final.pdf