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EDs Mass Testing Status

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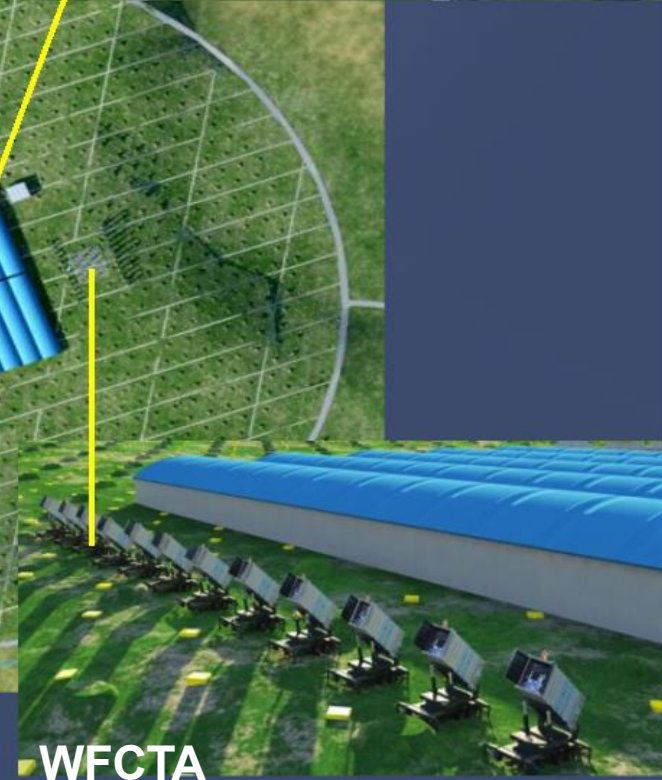
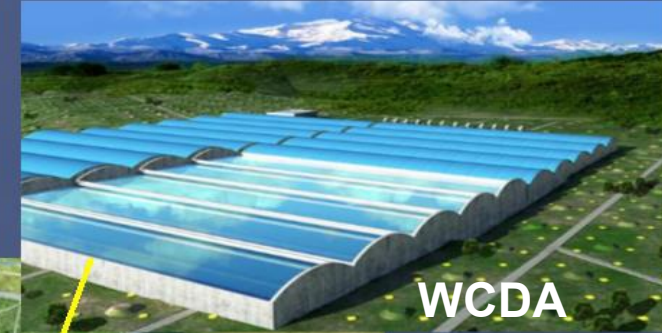
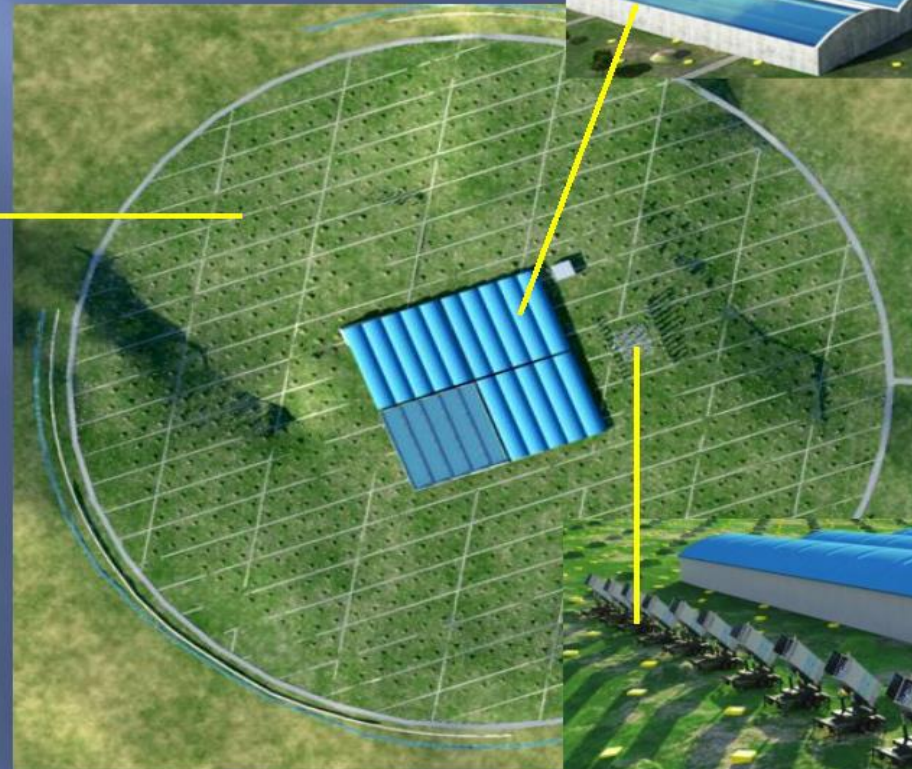
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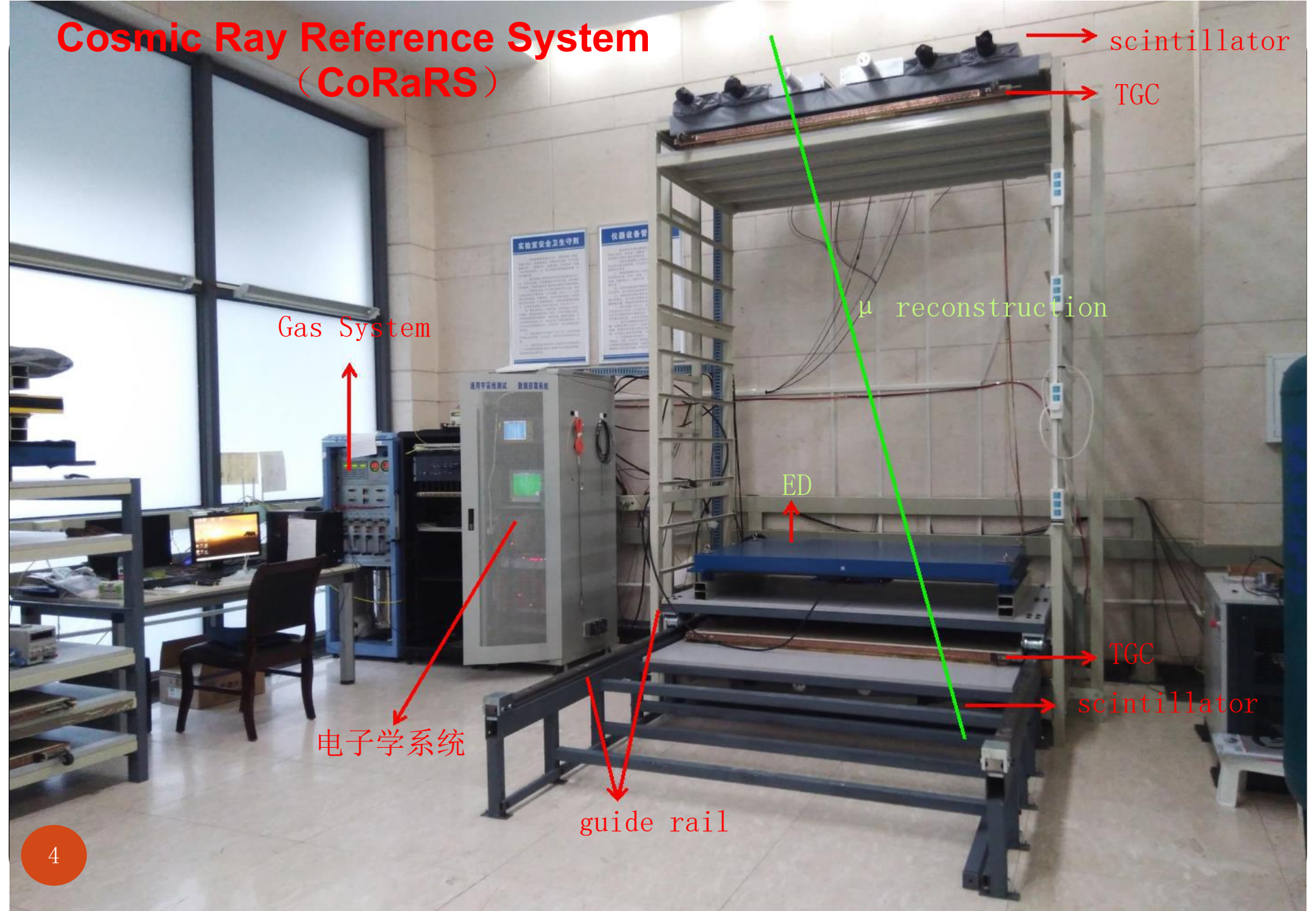
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➤ LHAASO



ShanDong University
takes testing the 5242
EDs

Cosmic Ray Reference System (CoRaRS)



→ scintillator

→ TGC

μ reconstruction

ED

→ TGC

→ scintillator

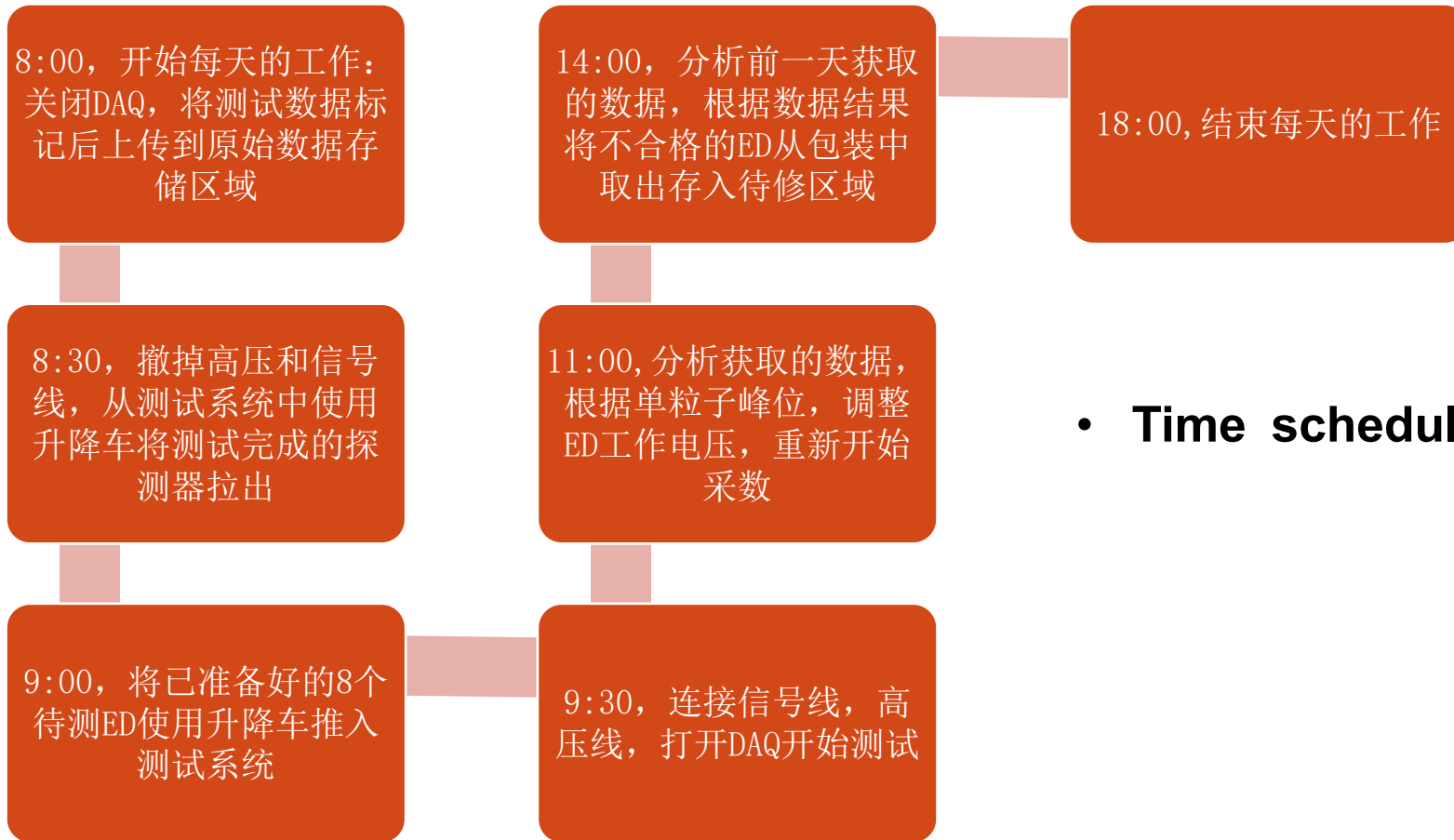
Gas System

电子学系统

guide rail



➤ Test Process



- **Time schedule**



➤ Performance requirements

requirements for ED

探测效率 Detection Efficiency	>95%
时间分辨率 Time Resolution	<2 ns
能谱分辨 Energy Resolution	25% (single electron)
单道计数率 Single Rate	<1KHz

CORARS

时间分辨率 Time Resolution	670 ps
质量扫描 Plane Scan	yes
测试进度 test progress	156 per month



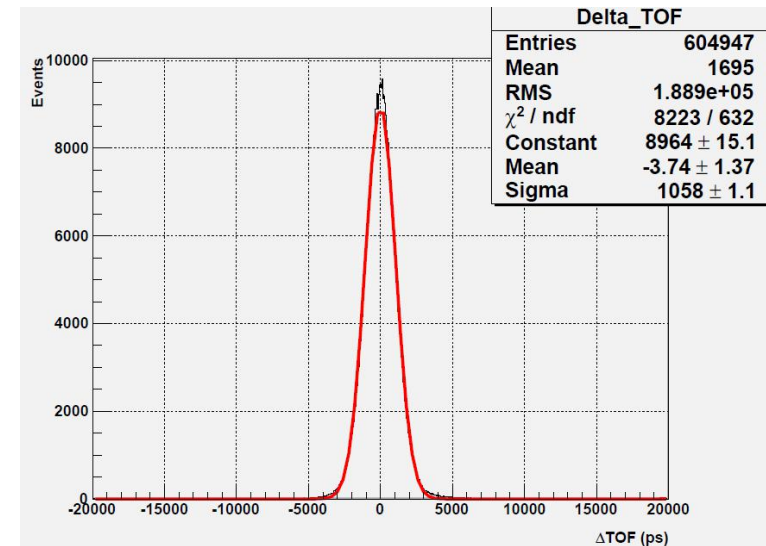
➤ Characters

1. 时间分辨 Time Resolution
2. 探测效率 Detection Efficiency
3. 单粒子峰 Single Particle Peak
4. 单道计数率 Single Rate
5. 时间延迟 ED Time Delay



➤ Time Resolution for System

- The time delay in each scintillator is calibrated
- Time Resolution = 670ps



Validation:

1. Two high speed scintillator are used to measure time resolution.
2. Set the High speed scintillator as standard, system time resolution = 640 ps.
3. CORARS time resolution is 670ps.

➤ Time Resolution



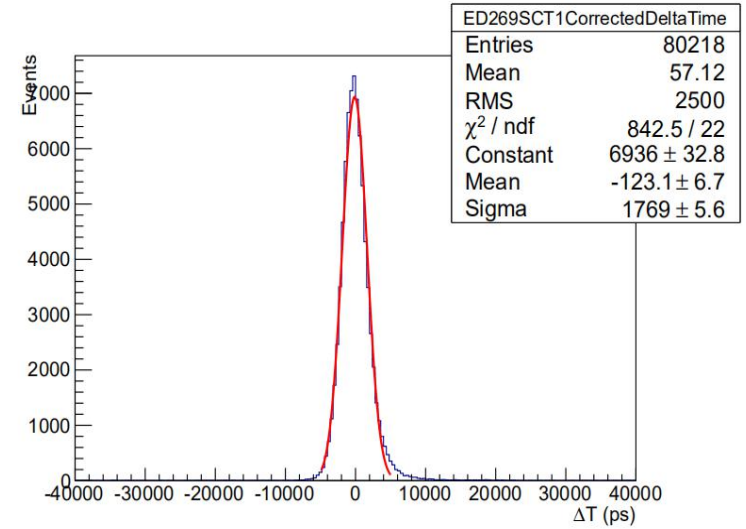
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1. ED Time Delay

$$\Delta T = T_{ED} - T_{rec}$$

2. Time Resolution for ED

$$\sigma_{T_{ED}} = \sqrt{\sigma_{\Delta T}^2 - \sigma_{T_{rec}}^2}$$



ED269 Time Resolution is 1.77 ns



► Detection Efficiency

$$\mathcal{E}_{ED} = \frac{N_{hit,signal}}{N_{hit}}$$

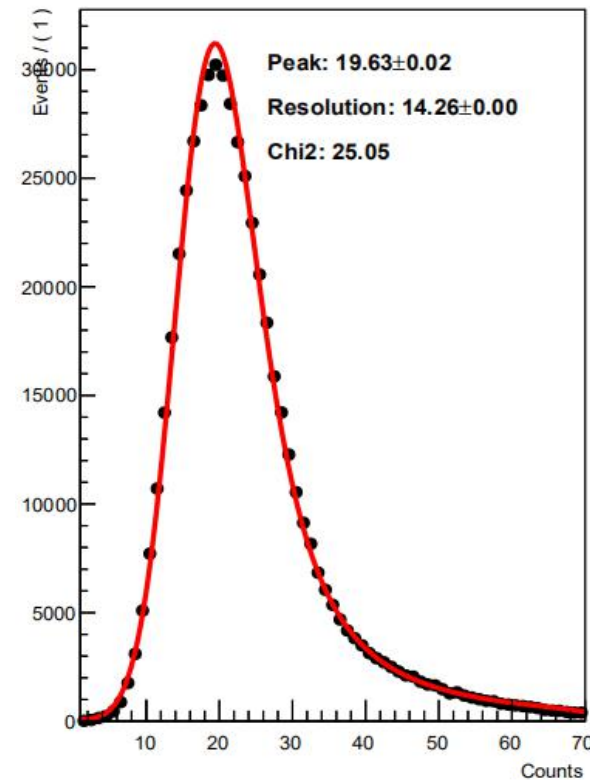
$N_{hit,signal}$ number of ED fired event,
event

N_{hit} number of ED hitted

► Single particle Peak

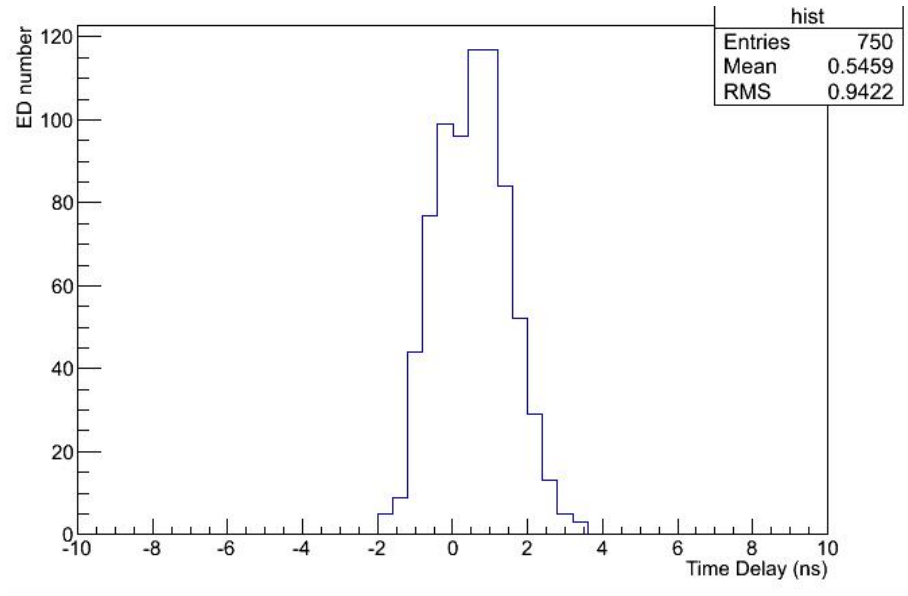
landau \otimes gaus is used to fit the
histogram

ED269 Charge





► Time Delay

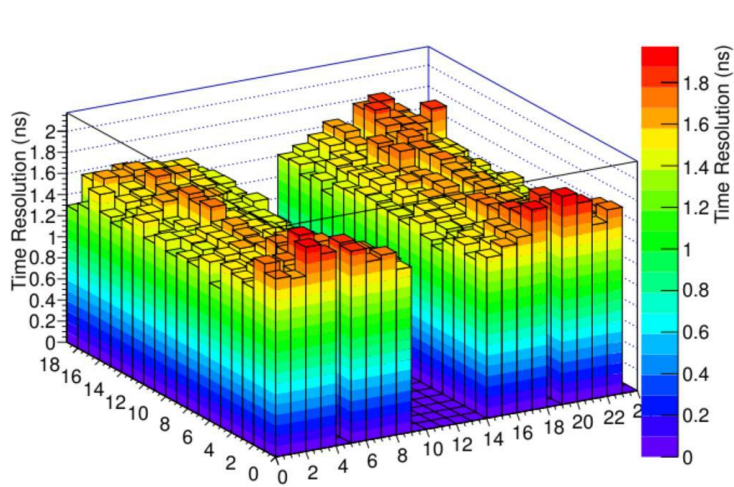


- Set ED0038 as standard
- It is all EDs' Time Delay distribution.

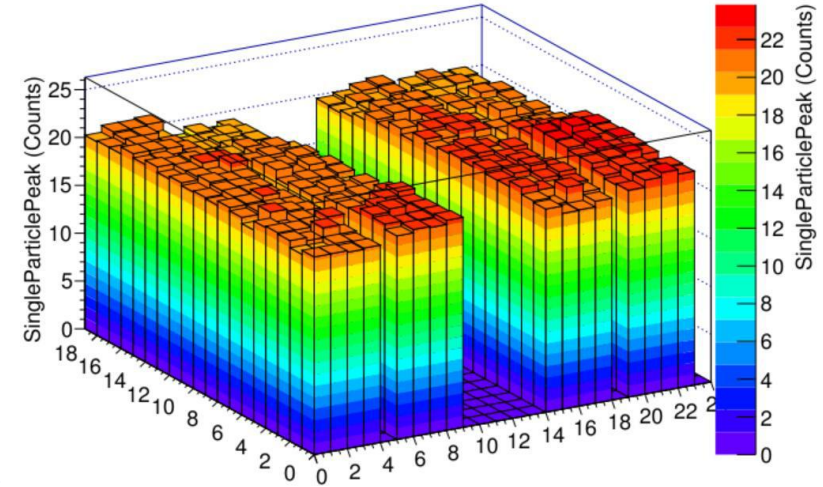


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ED Plane Scan Result

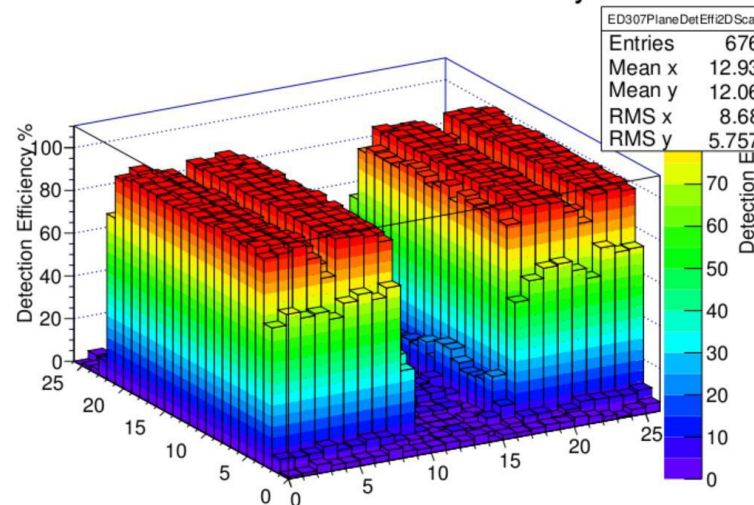


Time Resolution



Single Particle Peak

Detection Efficiency





➤ Testing progress

Batch	testing time		Unqualified ED
	begin time	finish time	
First	2018-10-29	2018-11-21	11.0%
second	2018-12-10	2019-01-09	7.1%
3th	2019-01-16	2018-02-27	4.0%
4th	2019-03-01	2019-03-25	5.5%

From October 29th 2018 to March 25th . we finished the test of 4 batches about 728 EDs.

All unqualified EDs were repaired .

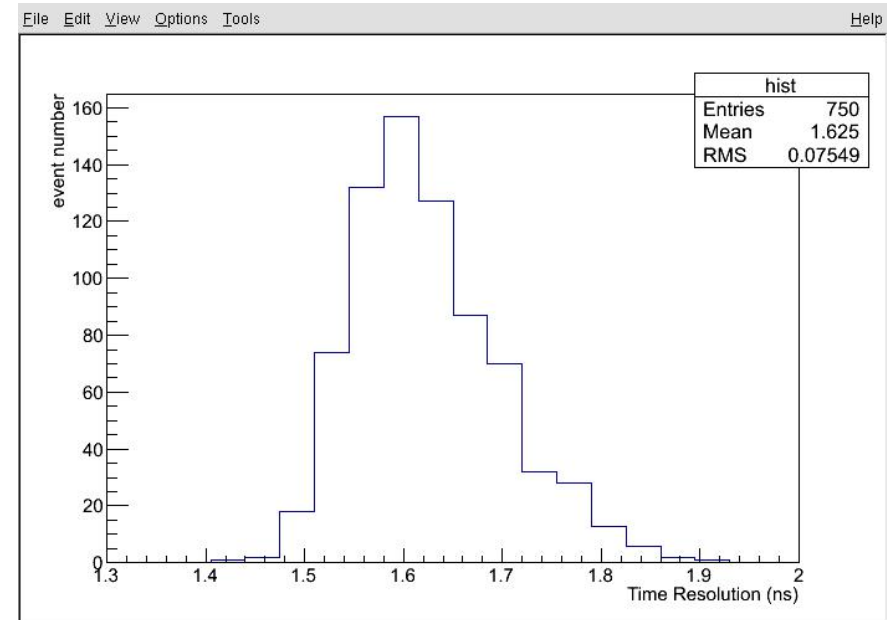
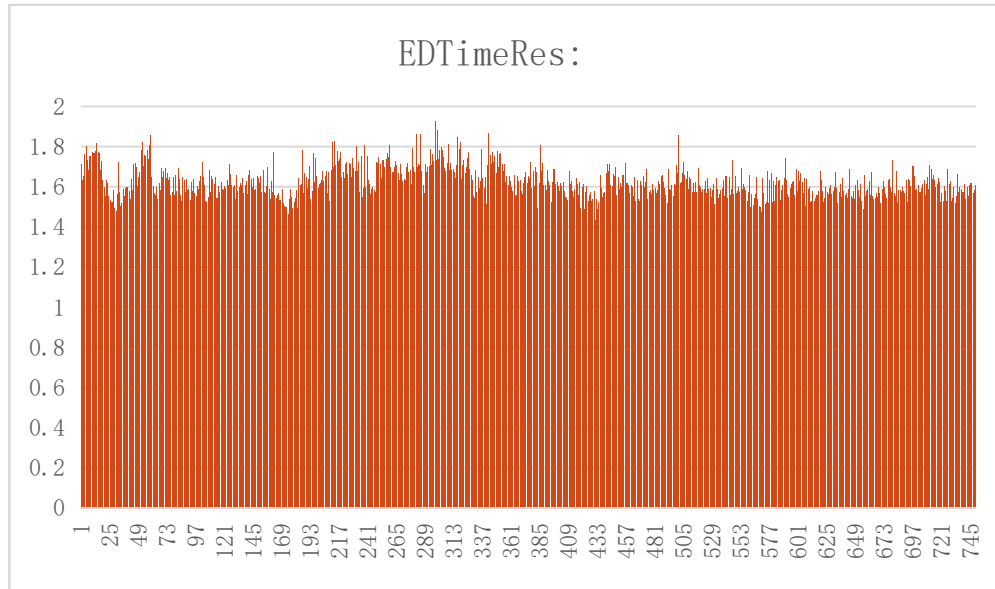


Unqualified EDs

problem	
电源 power supply	34%
电子学 electronics	17%
PMT	32%
其他 others (connection , shell ...)	17%



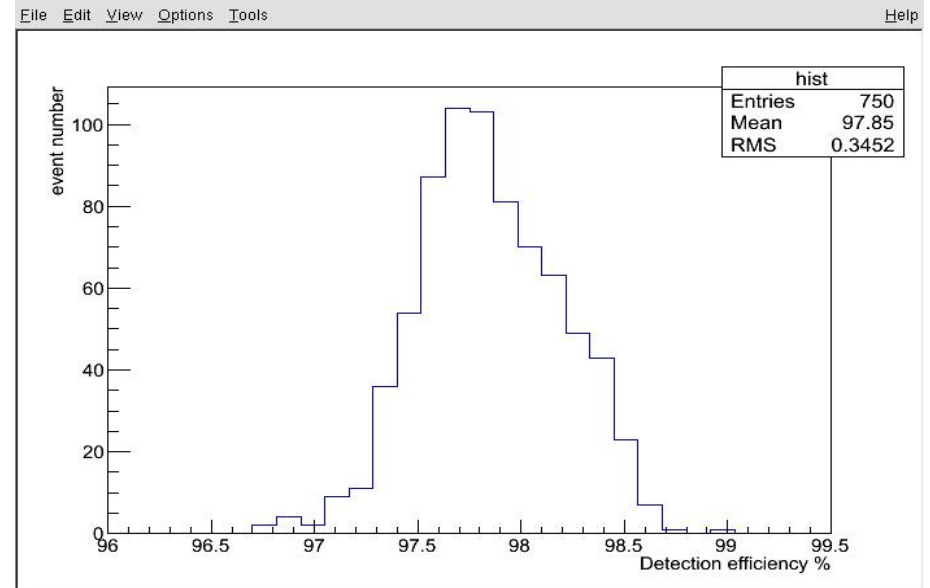
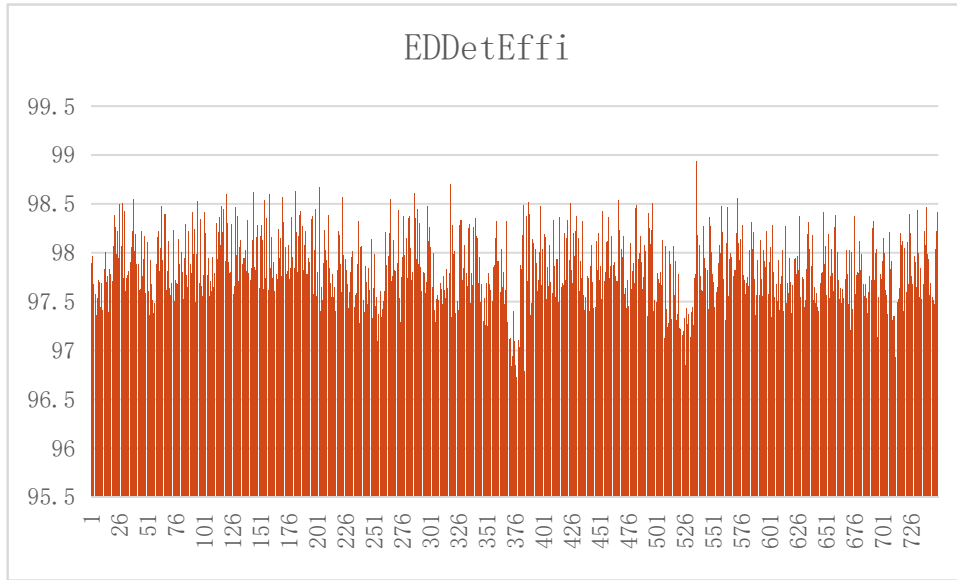
Time Resolution



After repair, all the EDs' Time Resolutions are less than 2 ns.



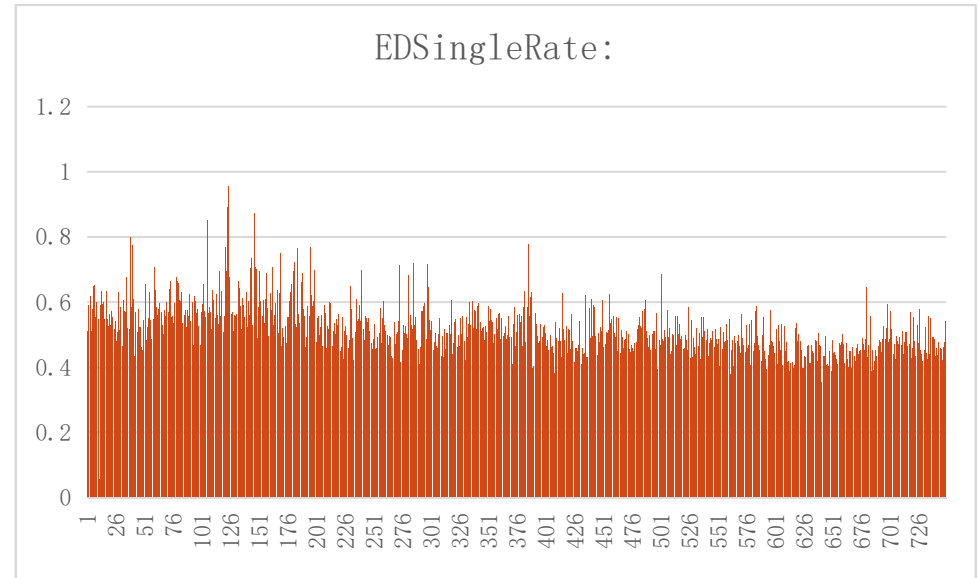
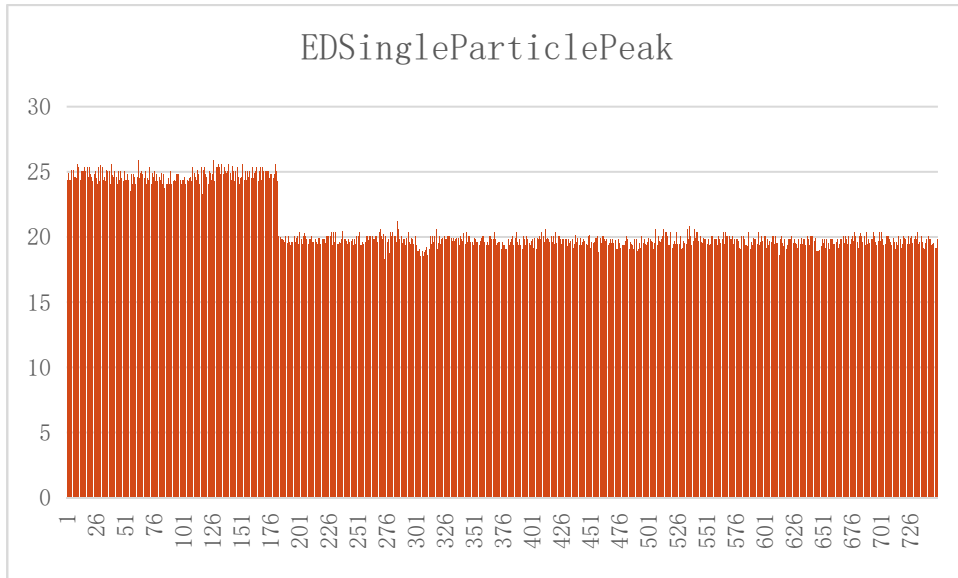
➤ Detection Efficiency



Detection Efficiency is larger than 96% ,
satisfying the requirments.



Single particle Peak & SingleRate



- The first 182 EDs' Single particle peak are adjusted to 25 counts
- The others are adjusted to 20 counts
- All the EDs' Single Rate are less than 1KHz, statisfying requirements.



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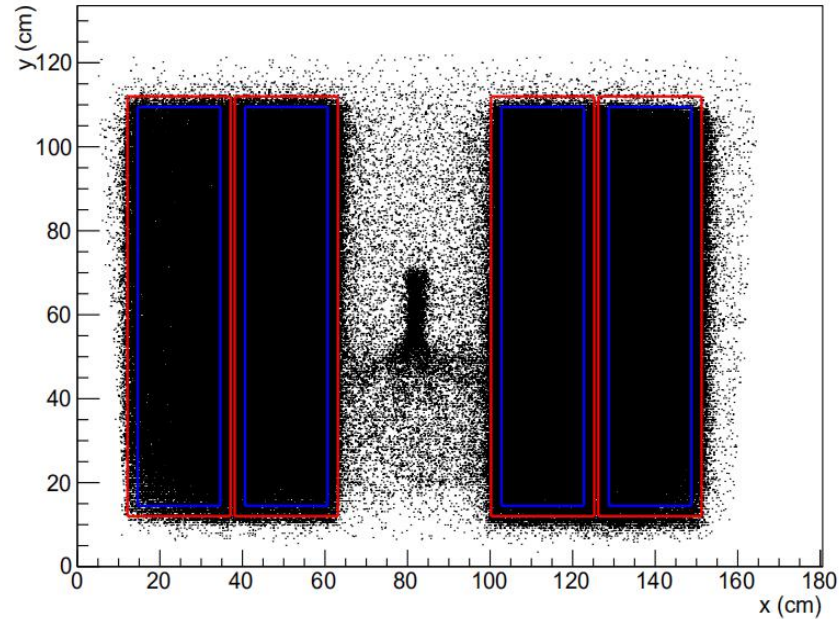
➤ System Stability monitoring

1. TGC stability monitoring
2. Trigger Rate stability monitoring
3. CoRaRS Time Resolution stability monitoring
4. Sample ED Stability monitoring



➤ Stability monitoring

1. TGC stability



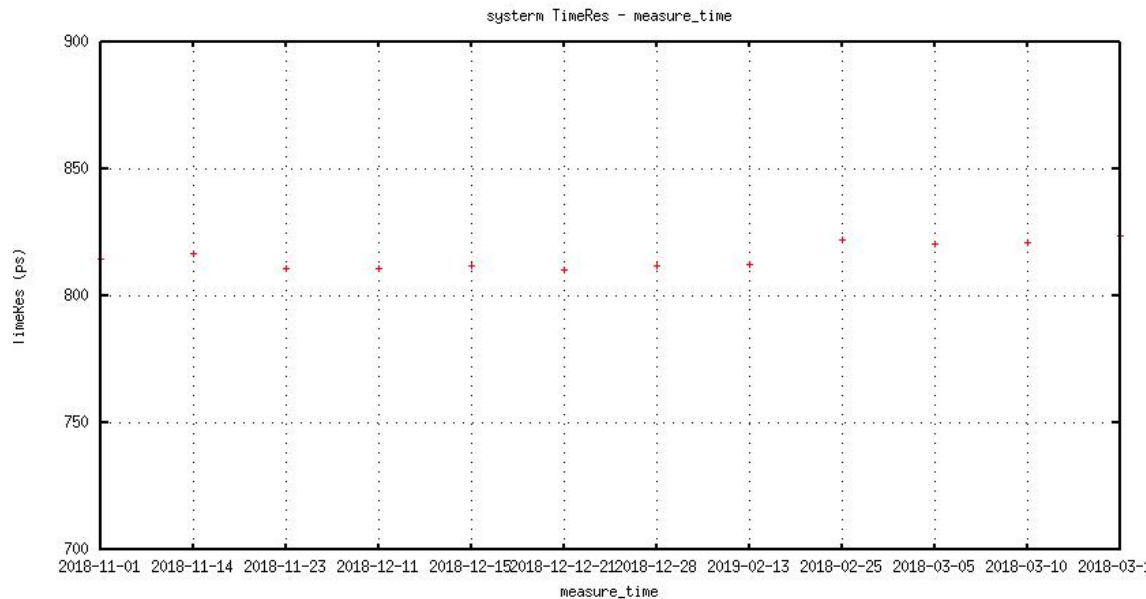
- Check TGCs' status include : number of signal wires and signal strength
- Reconstruction of all the signals.
- It should show the internal structure clearly

➤ Stability monitoring



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1. CoRaRS Time Resolution

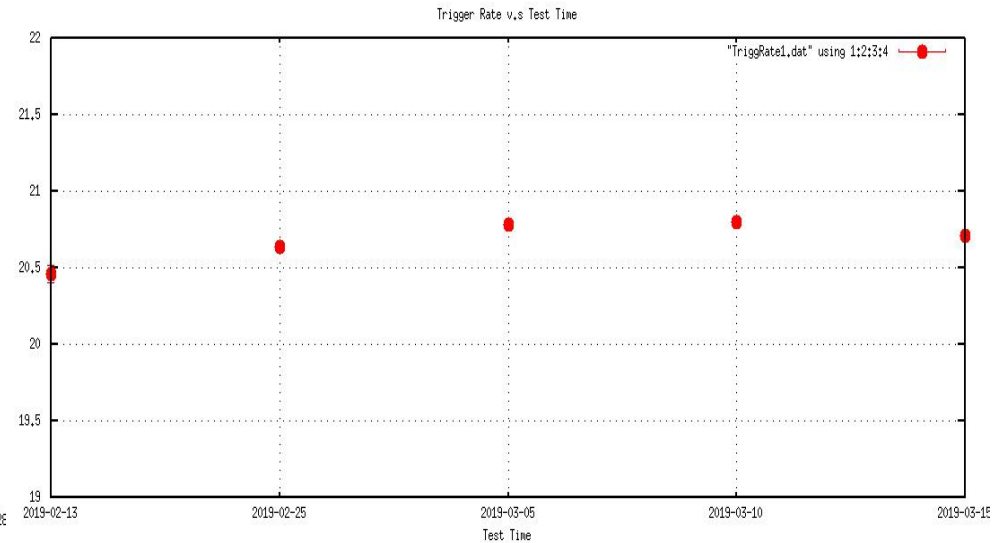
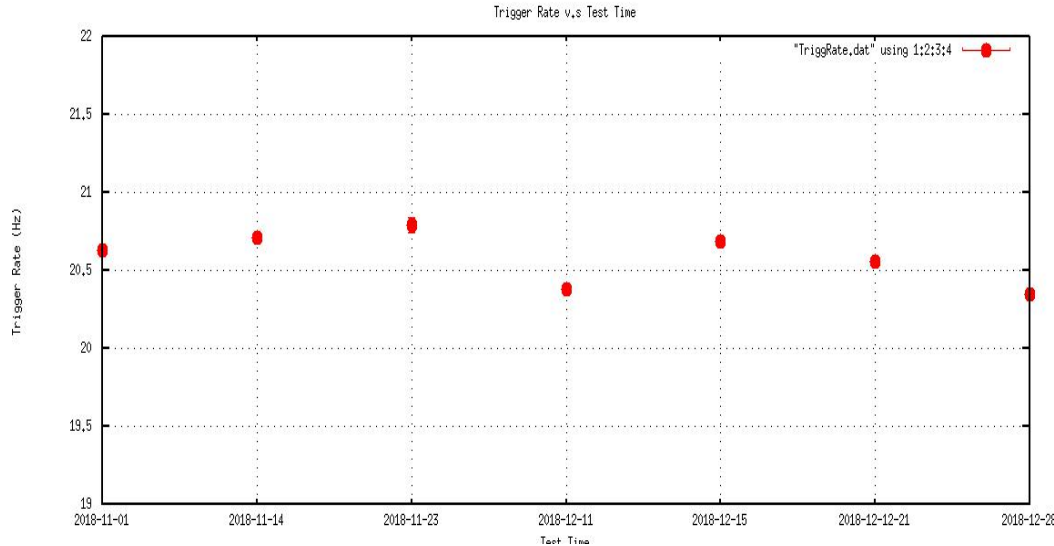


- The time resolution of the system shows good stability, it proves that the reconstruction of particle is correctly.



➤ Stability monitoring

1. Scintillator stability: Trigger Rate v. s. Test Time



- trigger rate v. s. time for more than 4 months from November 2018 to March 2019,
- It is between 20.3 to 20.6, shows a good stability.

➤ Stability monitoring



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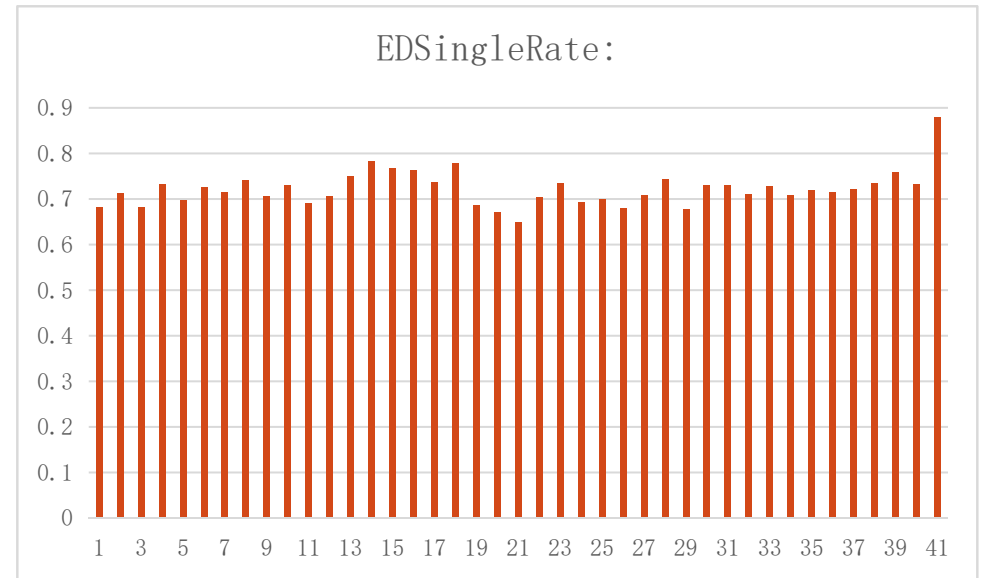
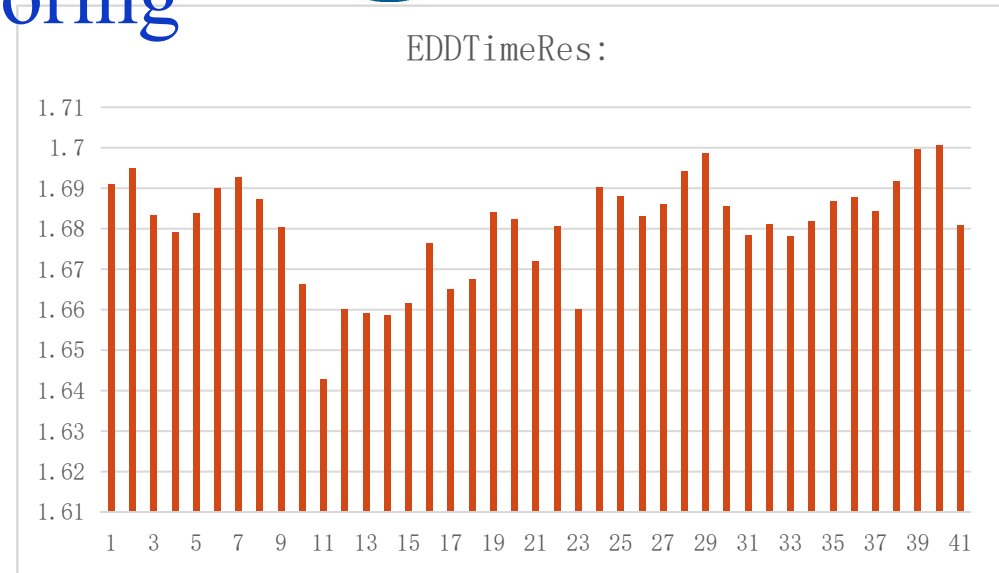
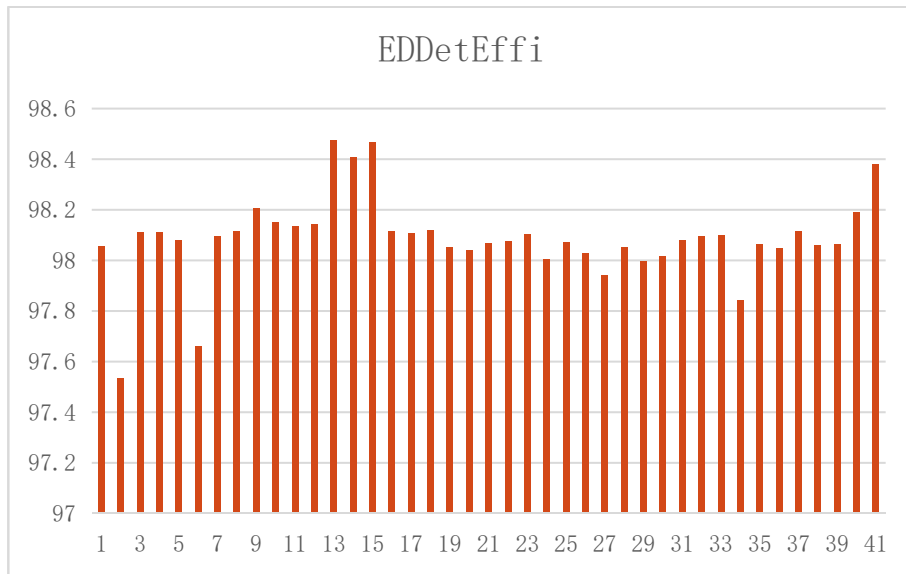
1. One Sample ED

- ED0307 as part of the system provides an important way to judge whether the system is stable.
- Every time some EDs show unqualified, ED0307 will be checked firstly.
- During last 4 months, the result of ED0307 shows our system is credible.





➤ ED0307 Stability monitoring





Summary

- System performance satisfies requirements. We have finished test of more than 700 EDs.
- System is credible without exception during the test. We can finish the test ahead the deadline.
- The number of unqualified EDs is less and less, the test will go better and better



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➤ BackUp

