WCDA二号水池20吋PMT和时间刻度系统

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Outline

- The MCP-PMT work

    - MCP-PMT work @ Nanjing

    - Transportation

    - Retest @ Daocheng

    - Installation @ Haizishan
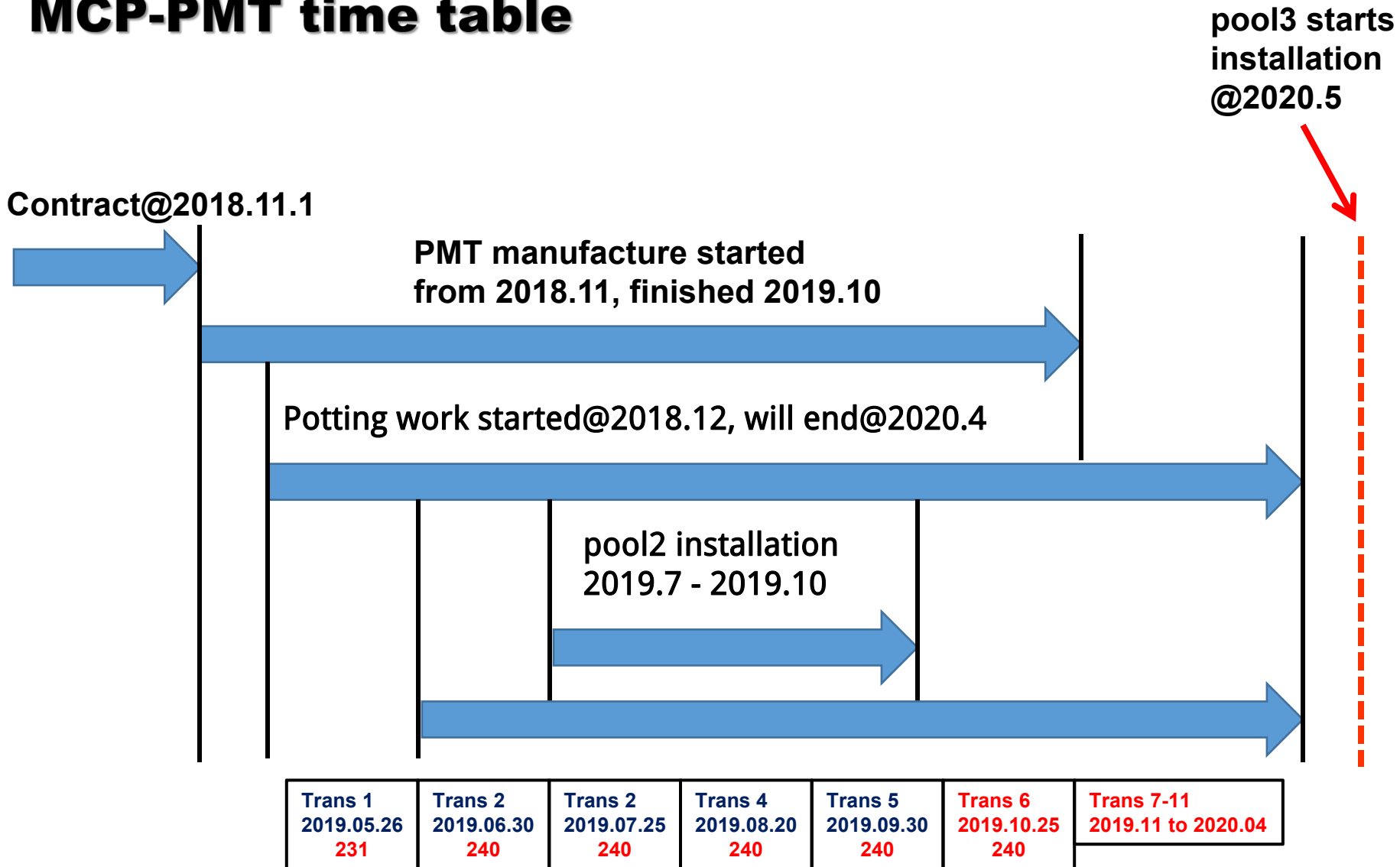
    - The "Dry-running"

- The calibration work

    - System updates from pool1

    - Installation & check

   - Calibration work flow

MCP-PMT work

MCP-PMT time table

pool3 starts installation @2020.5

Contract@2018.11.1

PMT manufacture started from 2018.11, finished 2019.10

Potting work started@2018.12, will end@2020.4

pool2 installation
2019.7 - 2019.10

| Trans 1 2019.05.26 231	Trans 2 2019.06.30 240	Trans 2 2019.07.25 240	Trans 4 2019.08.20 240	Trans 5 2019.09.30 240	Trans 6 2019.10.25 240	Trans 7-11 2019.11 to 2020.04

MCP-PMT work @ Nanjing

- **WCDA requirements**
  - 2270 water-proofed PMTs required, **≥ 240** PMTs / month
  - **900** for 2019, **1370** for 2020

- **Changes**
  - the high-vlotage divider circuit design changed, single cable is changed to double cables

- **Other work**
  - PMT test with FEEs should be passed
  - the quality check (PMT / HV circuit / potting)
  - packaging & transportation

- **Man power**
  - one and a half men (You Xiaohao, Gao Bo) from IHEP, with 4 native employees

- **Difficulties**
  - all work must be done in less than **40 m^2** space
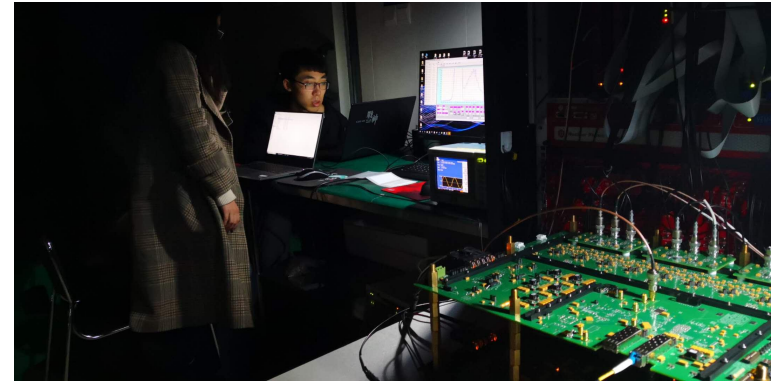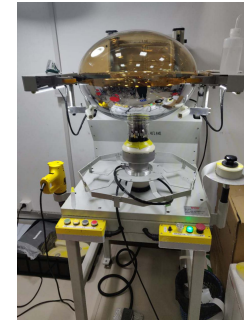
The potting work
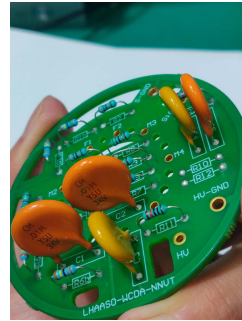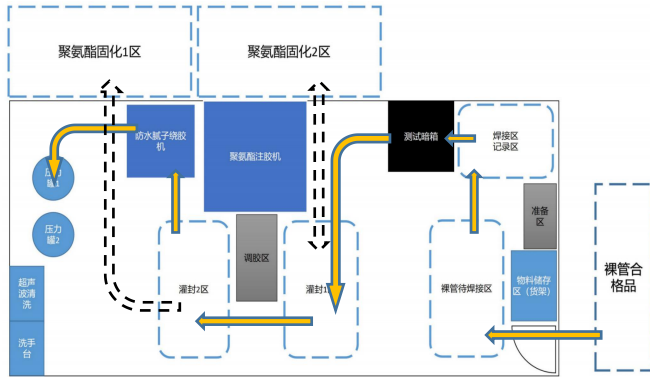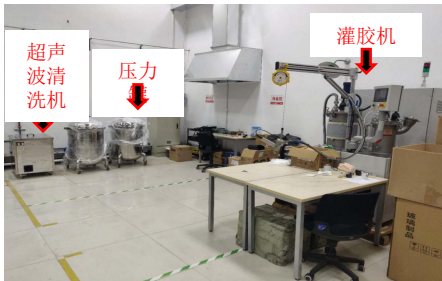

HV circuit check & solding

Potting

Shirnking tube
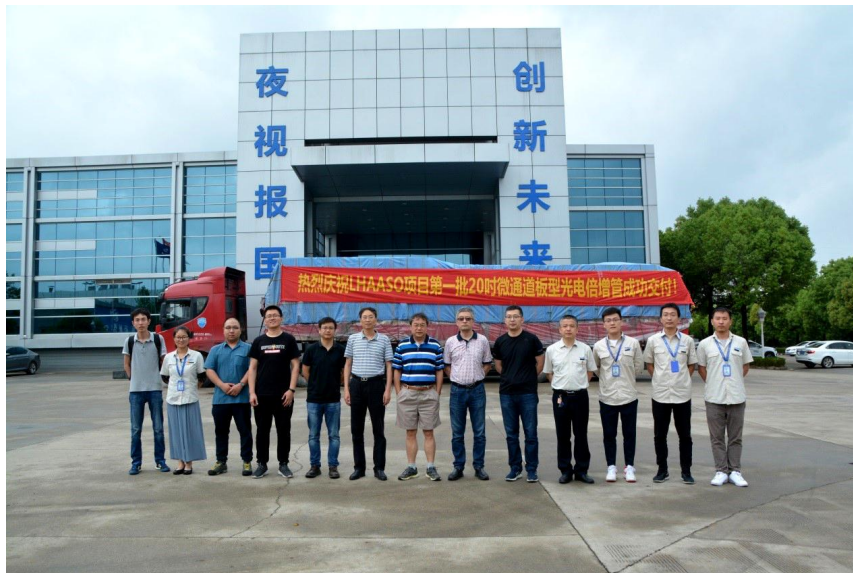

Pressure test (sampling test)

Ready for retest @ NNVT

if (retest passed)
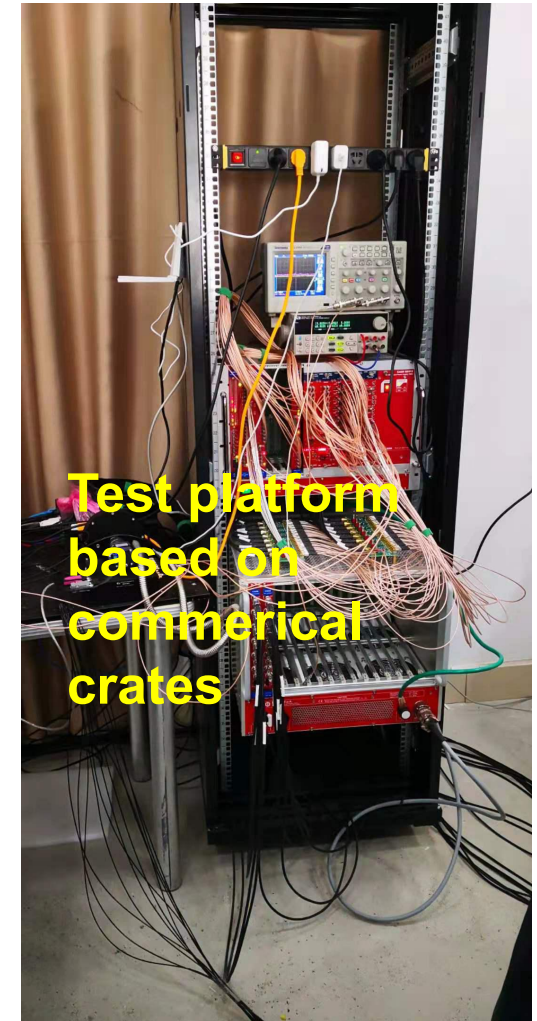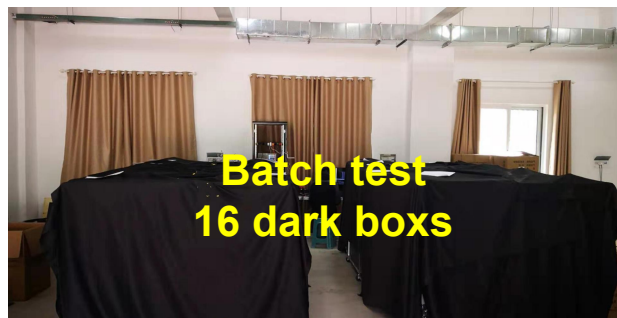 go packaging;
else
  kept for re-check;

Transportation

- Day from 2019/05/26 to 2019/10/20, **1203** PMTs have been sent to Haizishan, Daocheng.

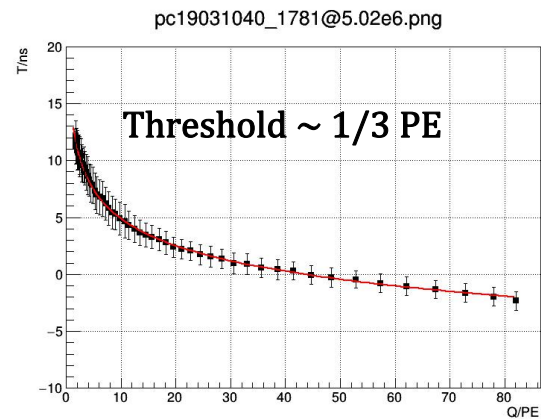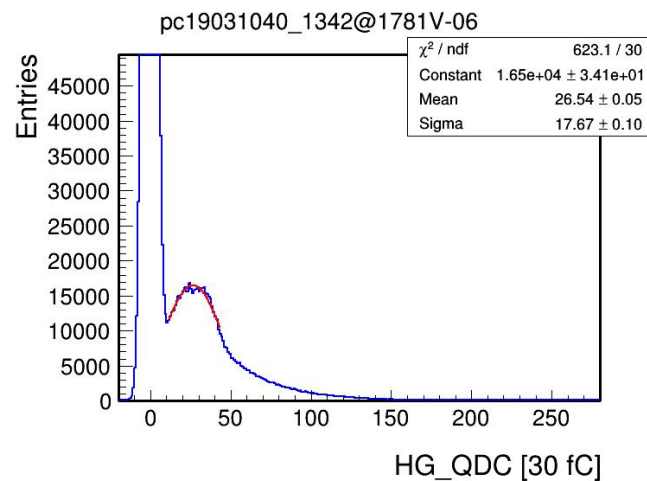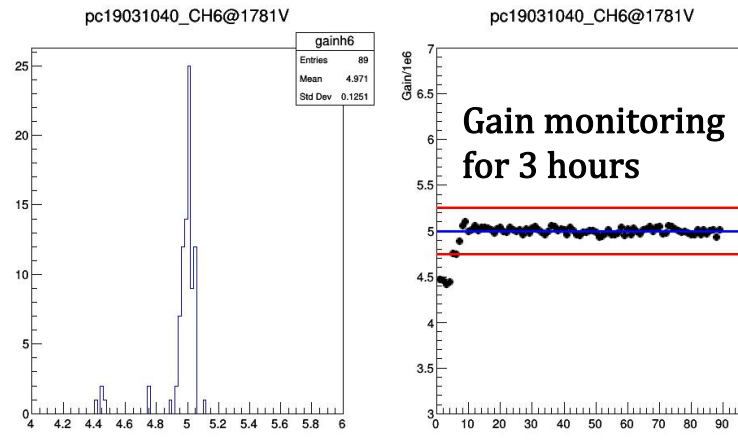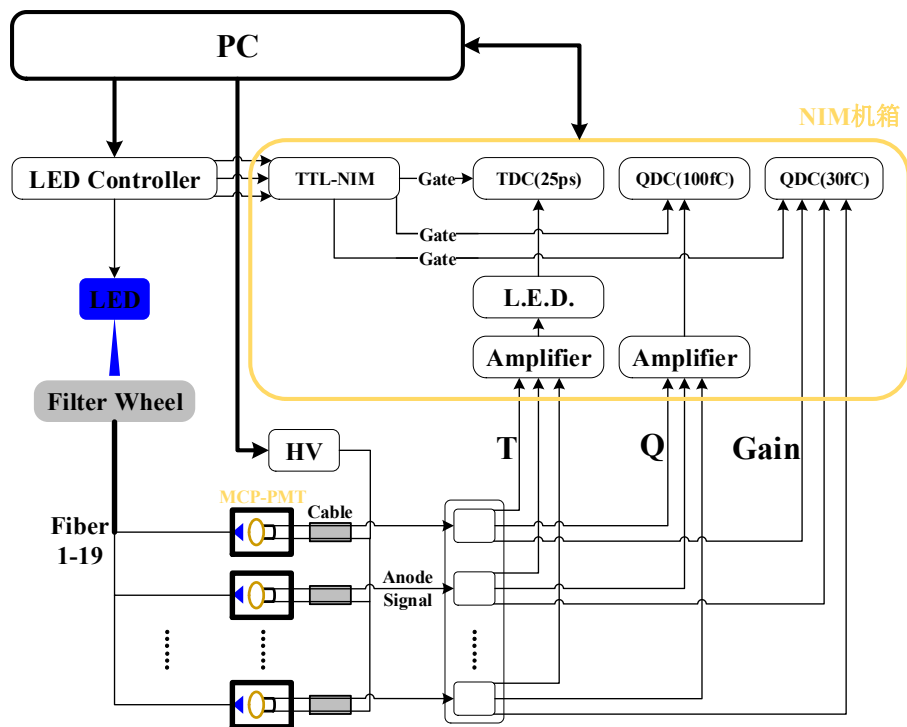- **1930** PMTs will be accomplished by the end of 2019.

Retest @ Daocheng

- The storage (500 PMTs in the hall)
- Freezing test (sampling @ -5)
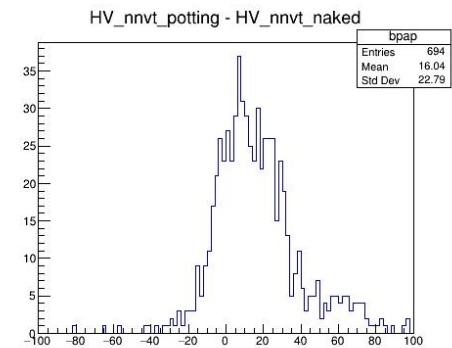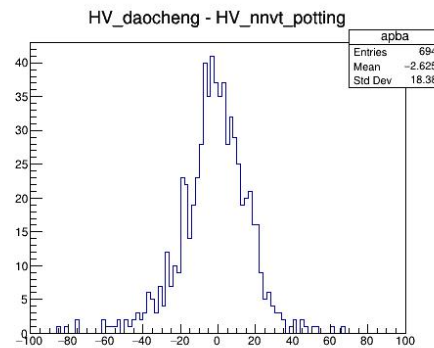- Water pressure test (all)
- Parameters test with HV
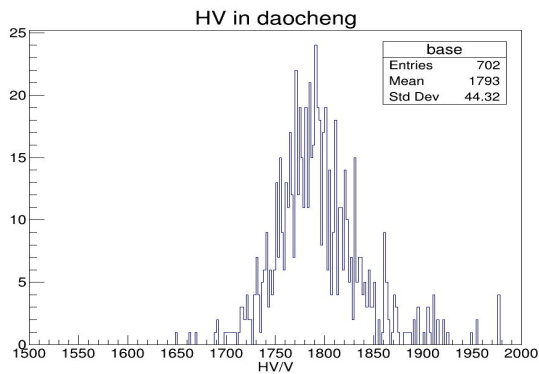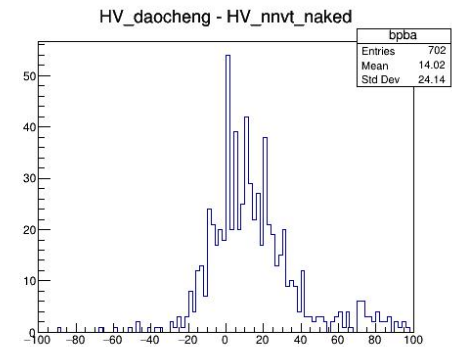

Storage

Pressure test

Freezing test

Batch test
16 dark boxs

Test platform based on commerical crates

Test flow

- HV value @ Gain = 5×10^6

- Q-T curve

Gain monitoring for 3 hours

HG_QDC [30 fC]

Threshold ~ 1/3 PE

Some results

HV differences

Installation @ Haizishan

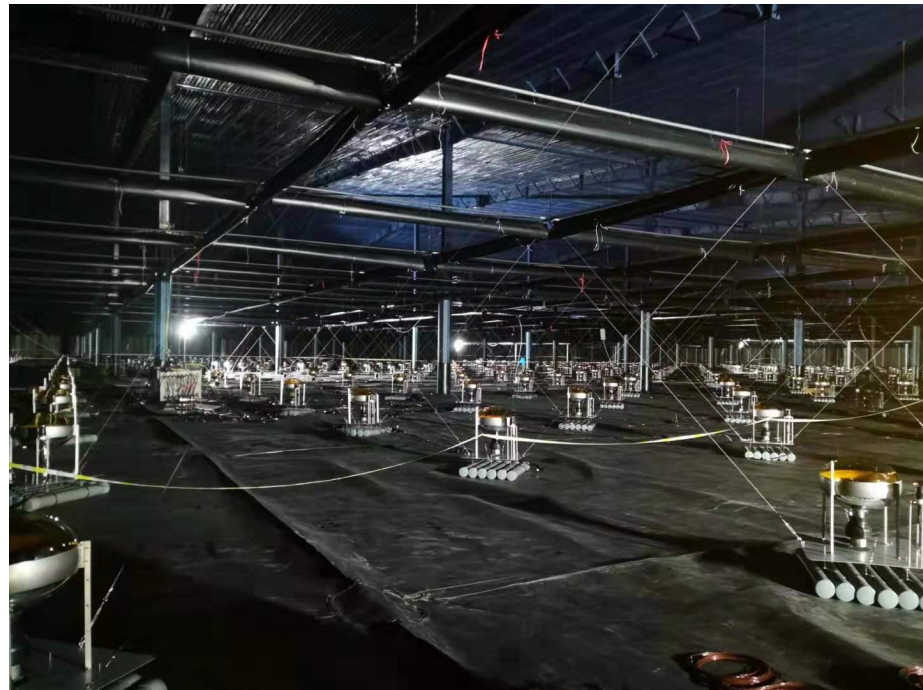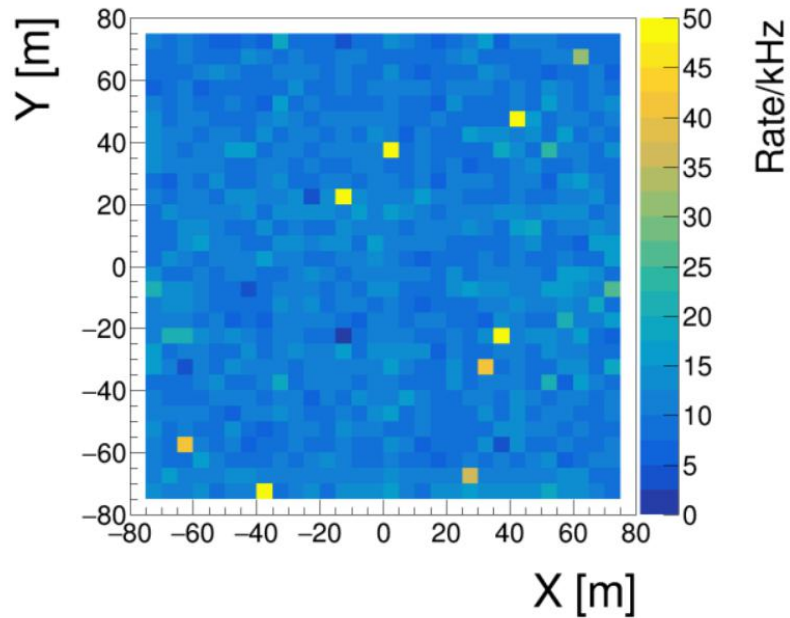| PMTID	CableID	HV1	Hv2	testch	ClusterID	Cell id
pc19045187	290	1811	1814	7		6
pc19045009	0552	1748	1750	6		8
pc19012525	0101	1723	1750	8		7
pc19045032	0531	1724	1764	2		5
pc19041031	555	1755	1767	11	C24G1	4
pc19045120	634	1750	1770	8		2
pc19033026	611	1757	1770	15		1
pc19041034	669	1746	1775	1		0
pc19045037	633	1775	1775	9		3
pc19033052	390	1751	1775	12		6
pc19045023	609	1763	1776	6		7
pc19012539	0348	1756	1780	3		5
pc19045049	686	1762	1782	4		8
pc19041033	479	1723	1793	2	C24G2	3
pc19045028	621	1781	1795	7		4
pc19045179	333	1862	1870	5		1
pc19041021	0675	1859	1870	4		0
pc18103023c	13	1788	1815	10		2

- Test speed @ Daocheng is 30 PMTs/day, 30 PMTs send to Haizishan for installation everyday;

- 2 PMTs share 1 HV channel, the difference is controlled within 5V, all PMTs paired work is done in pool2.

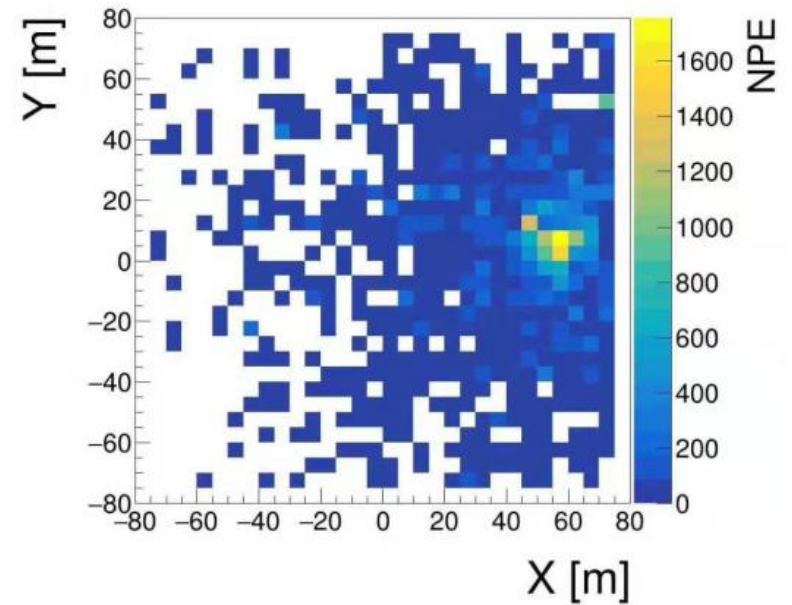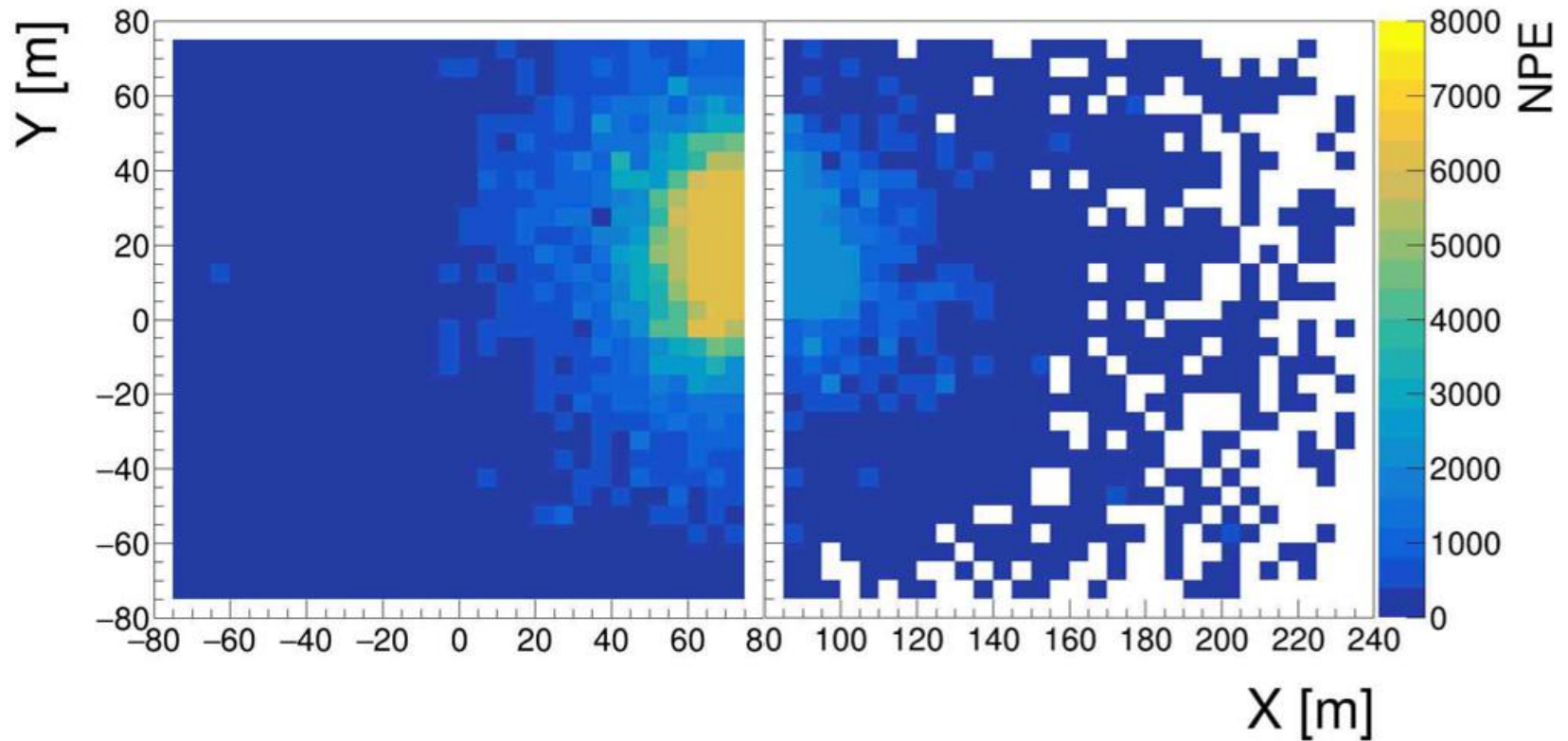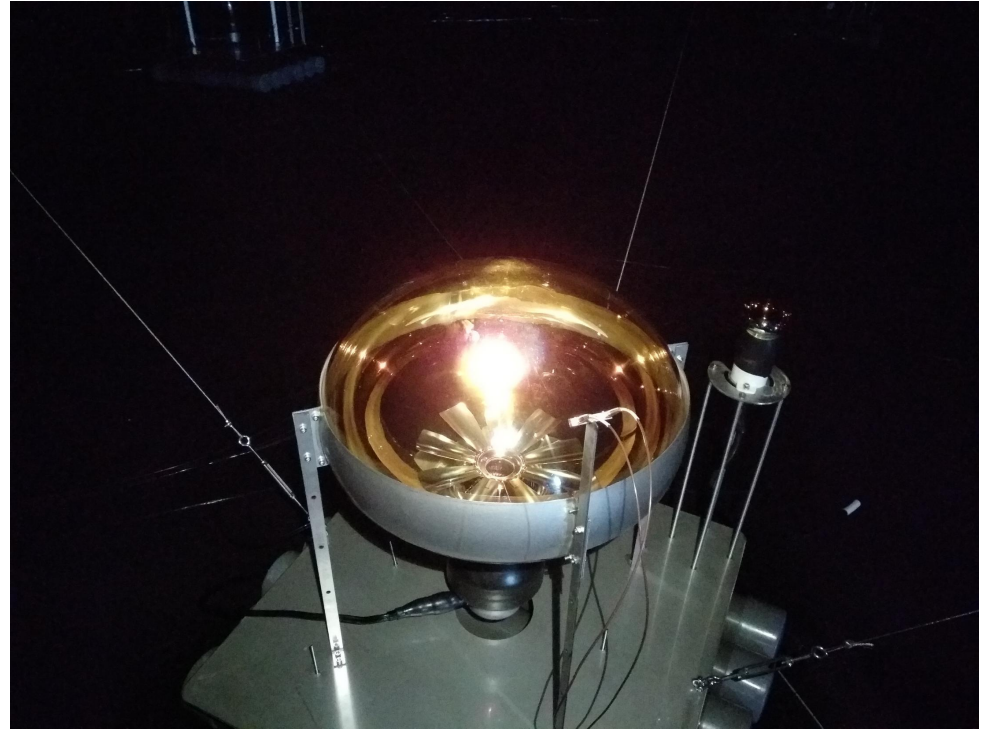# The "Dry-running"

Single counting rate
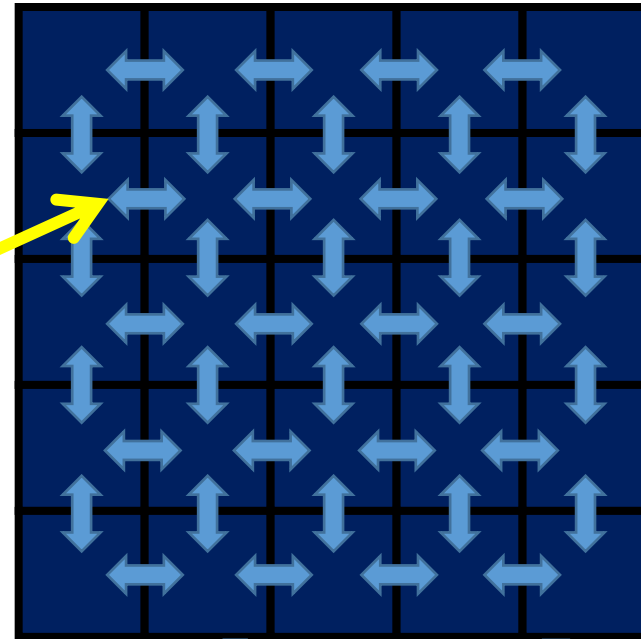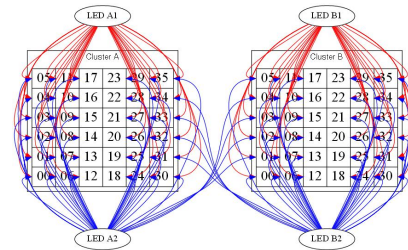
Shower event without water
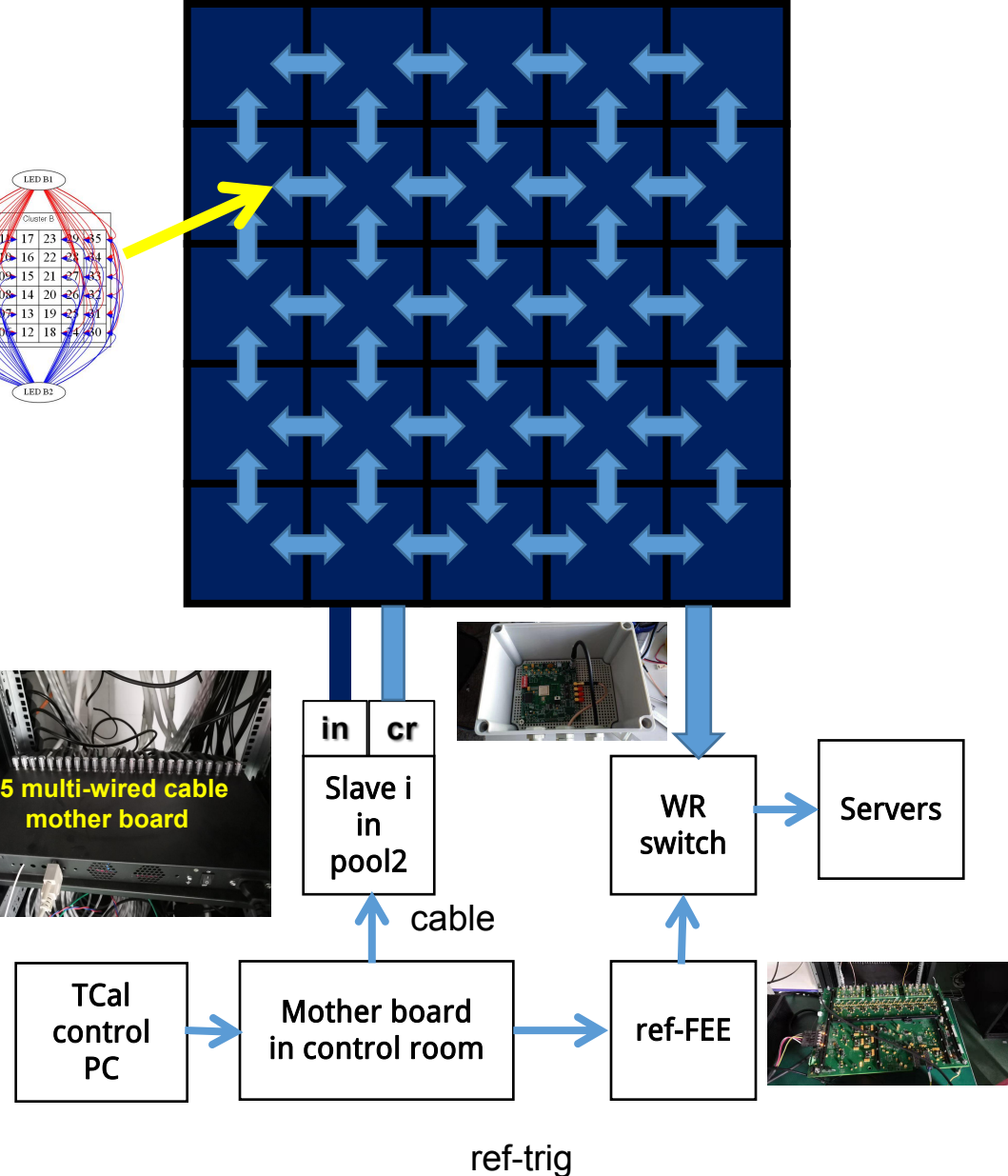
A shower event detected by pool1 & pool2

Calibration work

System layout

- **Updates**

- **Cable**
  - Use multi-wired cable, include electric power / 485 signal / trigger signal, from mother board to slave, easy to do installation & maintenance

- LED driver
  - LED driven voltage can be adjusted in 0.1V resolution

- **Slave board**
 - Sealed in an ABS water-proof box, independent of FEE box

25 multi-wired cable mother board

| in | cr |

Slave i in pool2

cable

WR switch

Servers

TCal control PC → Mother board in control room → ref-FEE

ref-trig

Installation & fiber check

left : inside fiber
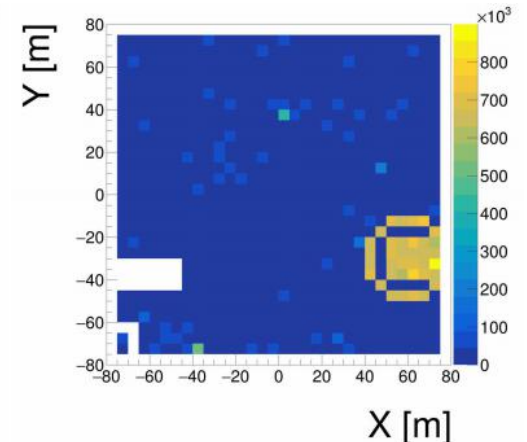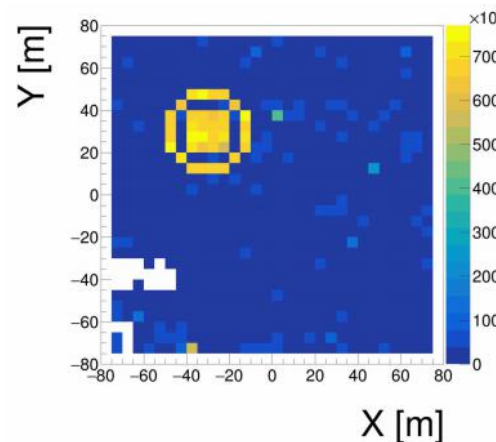right : cross fiber

in-fiber check

cr-fiber check

- 2 fibers (in/cr) are installed on 1 PMT, 1800 fibers in total;

- After all fibers installed as "in-fiber" mode, than cross fibers between neighbour clusters;

- Check fiber work status & fiber installation;

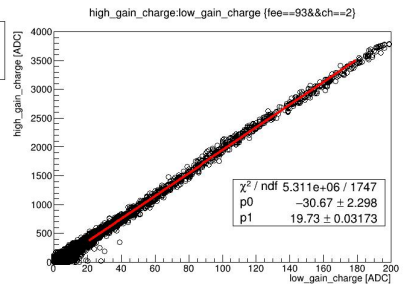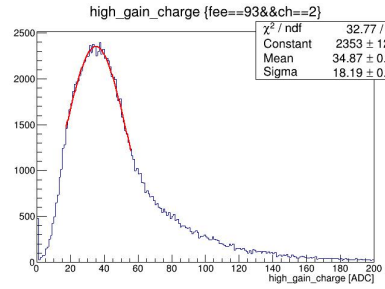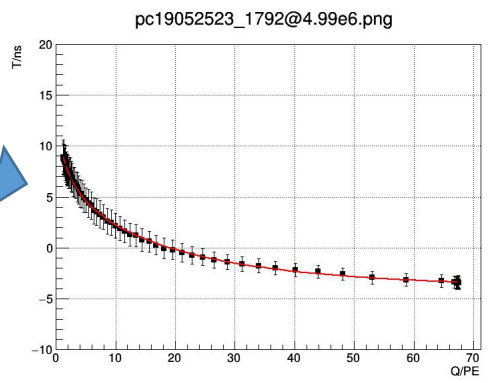- Pull up the slave board & LED tube with FEE box.
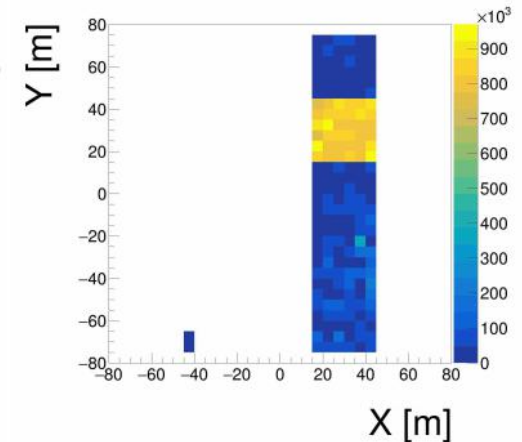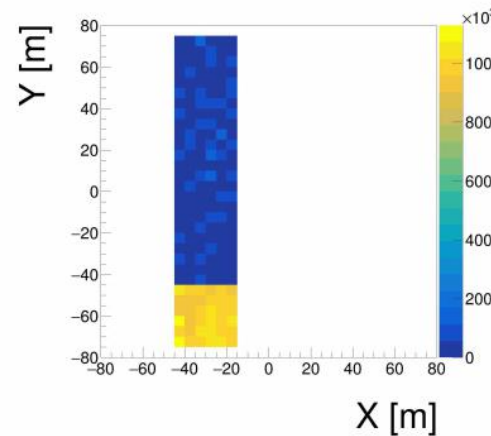
Time calibration work flow

Run DAQ in "single-counting" mode, get SPE & H/L ratio value for each PMT.

Restart DAQ run in "event" mode, change LED trigger voltage during the test, to get the "Q-T" curve for each PMT.

Restart DAQ run in "stable tcal" mode, at different light intensity (eg. 50 / 200 / 400 PE), now the data for time calibration.

Data analysis : get PMT time offsets, do shower reconstruction, moon shadow, Crab ... check the result
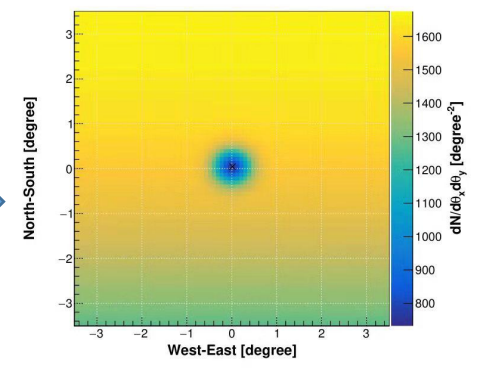
Data analysis

- data selection
  - select LED   data
  - get Q/T value
  - get rid of the fiber time offsets on each PMT
- Q-T correction
  - should for every PMT
  - to normallize to a selected PMT charge
- cross algorithm
  - with 8 cross fibers' data between neighbour clusters
  - different path

cr fiber

in fiber
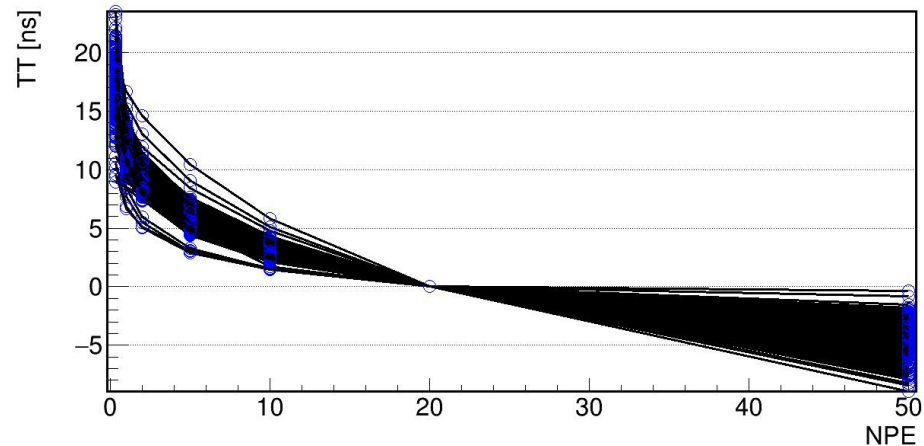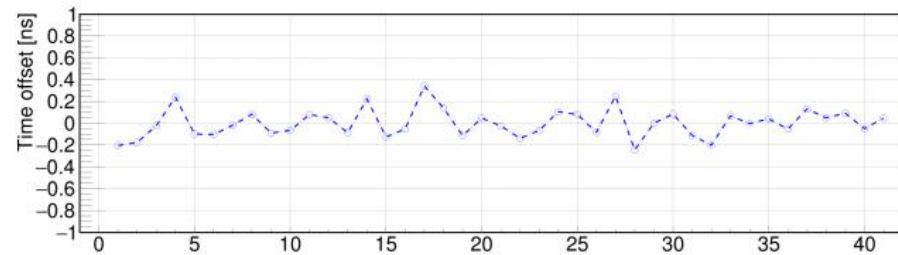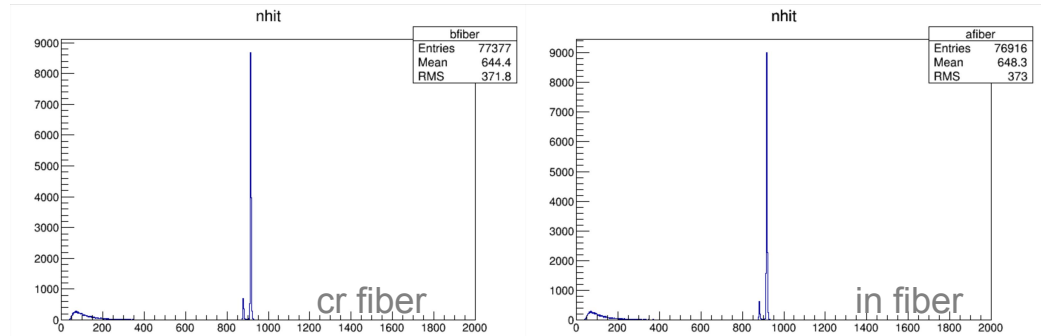
Conclusion

- **MCP-PMT work**
   - The gain uniformity needs to adjusted, after that the detail work of time caibration will carried out ;
    - The water level now is 120 cm, the PMT work status, single rate & shower event will be monitored during water injection.

- **Calibration work**
    - pool2 tcal system has updates from tcal system in pool1, will give more detail calibration result;
    - the "Q-T" curve for each PMT will be used in pool1 & pool2, try to understand time calibration difference under different light intensity and between P-shower & γ-shower.

Thank you !

- cross calibration
    - 2 fibers on 1 PMT
    - 8 fibers between clusters (4 pairs)
    - caculation : A-C = (A-B)+(B-C) (B as jumper)
- neighbour cluster ci/c0，c0 as reference cluster
- CELL ci_chi TO c0_ch0，there are 8 time offsets value
- use cross fiber ci_chx，得到
    - $T_{ci\_chi} - T_{c0\_ch0}$

      $= (TIN_{ci\_chi}-TIN_{ci\_chx})-(TCR_{ci\_chx}-TCR_{c0\_ch0})$
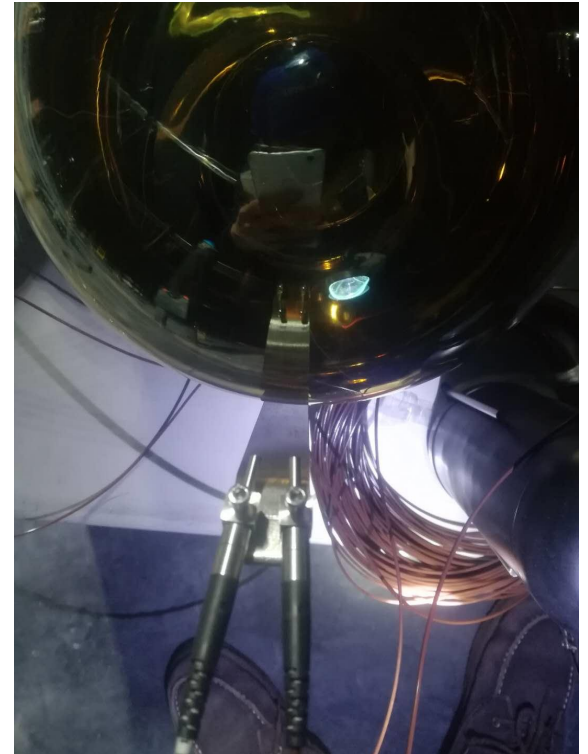
- the data
  - LED signal selection
    - LED triggered seperatly
    - event mode (nhit > 900)
    - LED charge & time
  - Q-T recorrection
    - $T(q) = 20.*pow(q,-1.2)+10.*pow(q,-0.8)$
    - normalized to 30 PE