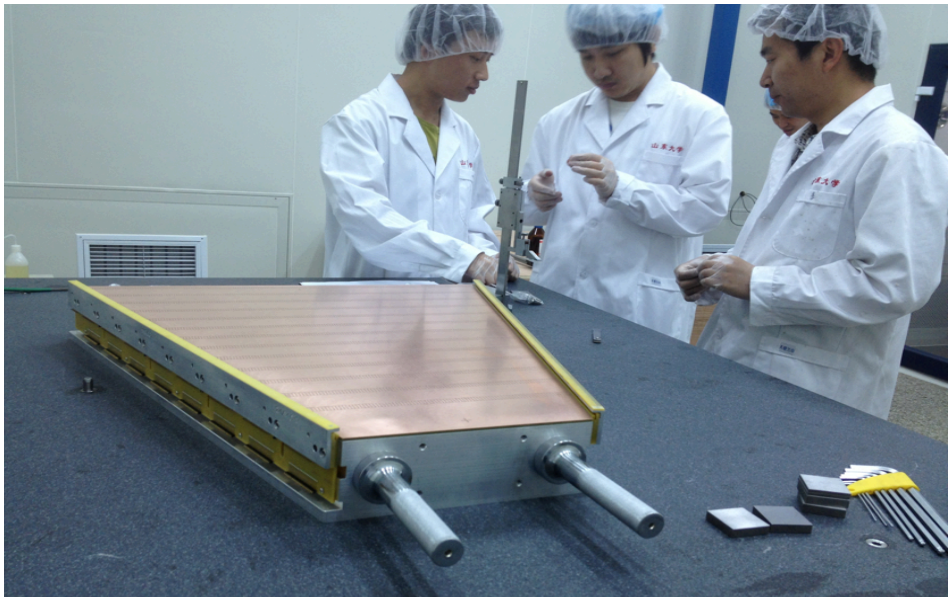
MWPC & iTPC prototyping at SDU

Qinghua Xu(Shandong University)

STAR Regional meeting @ USTC, Sep. 21, 2015



Thanks to my colleagues:

Changyu Li, Jian Deng, Peng Lu, Yansheng Sun, Chengguang Zhu,

Xu Wang, Fuwang Shen, Shuai Wang, Chi Yang (USTC)

+ many other iTPC colleagues

iTPC laboratory at Shandong

New building in 2000 for ATLAS Thin Gap Chamber (TGC). Produced 400 modules of high quality TGC for ATLAS during 1999-2004.

The lab is ~400m^2 , recently refurbished. New clean room built for iTPC project.

Wiring machine imported from Israel.

Laboratory hall

Clean room

Cosmic ray test system

Funding update- MWPC part from NSFC

- MWPC part of iTPC proposal submitted to NSFC in March.
- Officially approved by NSFC in August, with 3.45M RMB in the following 5 year starting 2016.

关于国家自然科学基金资助项目批准及有关事项的通知

徐庆华　先生/女士：

根据《国家自然科学基金条例》的规定和专家评审意见，国家自然科学基金委员会（以下简称自然科学基金委）决定批准资助您的申请项目。项目批准号：11520101004，项目名称：RHIC/STAR时间投影室的升级和能量扫描二期的实验研究，直接费用：290.00万元，项目起止年月：2016年01月至2020年12月，有关项目的评审意见及修改意见附后。

请尽早登录科学基金网络信息系统（https://isisn.nsfc.gov.cn），获取《国家自然科学基金资助项目计划书》（以下简称计划书）并按要求填写。对于有修改意见的项目，请按修改意见及时调整计划书相关内容；如对修改意见有异议，须在计划书电子版报送截止日期前提出。**注意：请严格按照《国家自然科学基金资助项目资金管理办法》填写计划书的资金预算表，其中，劳务费、专家咨询费科目所列金额与申请书相比不得调增。**

计划书电子版通过科学基金网络信息系统（https://isisn.nsfc.gov.cn）上传，由依托单位审核后提交至自然科学基金委进行审核。审核未通过者，返回修改后再行提交；审核通过者，打印为计划书纸质版（一式两份，双面打印），由依托单位审核并加盖单位公章后报送至自然科学基金委项目材料接收工作组。计划书电子版和纸质版内容应当保证一致。

向自然科学基金委提交和报送计划书截止时间节点如下：

1、提交计划书电子版截止时间为**2015年9月11日16点**（视为计划书正式提交时间）；

2、提交计划书电子修改版截止时间为**2015年9月18日16点**；

3、报送计划书纸质版截止时间为**2015年9月25日16点**。

请按照以上规定及时提交计划书电子版，并报送计划书纸质版。未说明理由且逾期不报计划书者，视为自动放弃接受资助。

附件：项目评审意见及修改意见

国家自然科学基金委员会
数理科学部
2015年8月17日

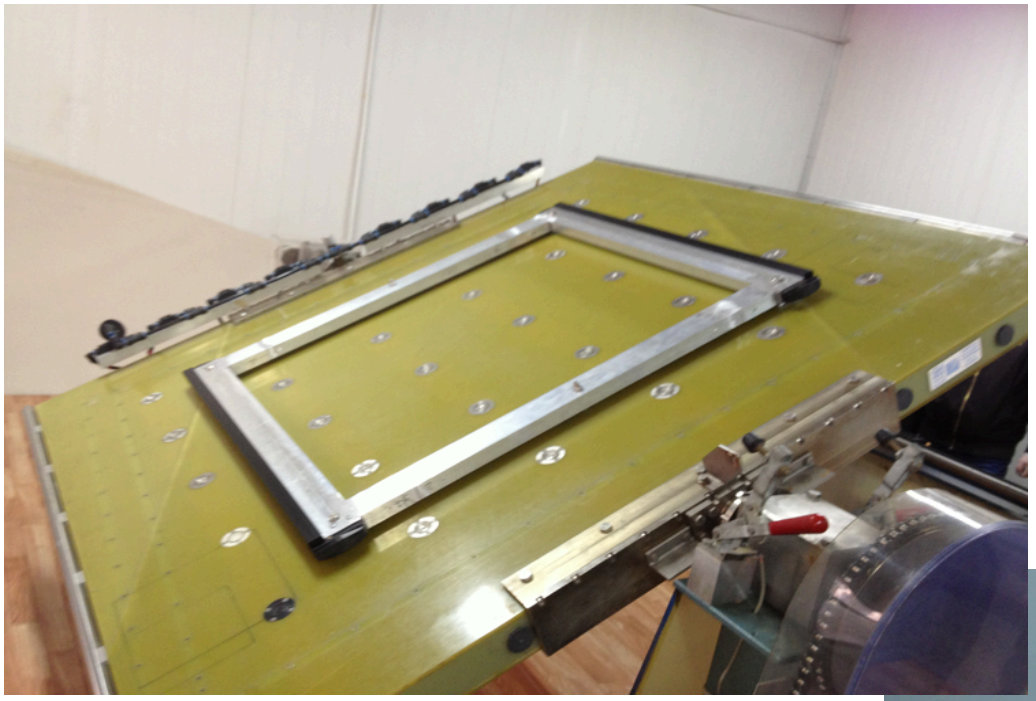
Wire winding for MWPC

- **Three layers of wire for iTPC MWPC:**

Wire	Diam. (μm)	Pitch (mm)	Composition	Tension (N)
Anodes	20	4	Au-plated W	0.50
Anodes—last wire	125	4	Au-plated Be–Cu	0.50
Ground plane	75	1	Au-plated Be–Cu	1.20
Gating grid	75	1	Au-plated Be–Cu	1.20

Wire pitch and tension controlled by winding machine (SDU)

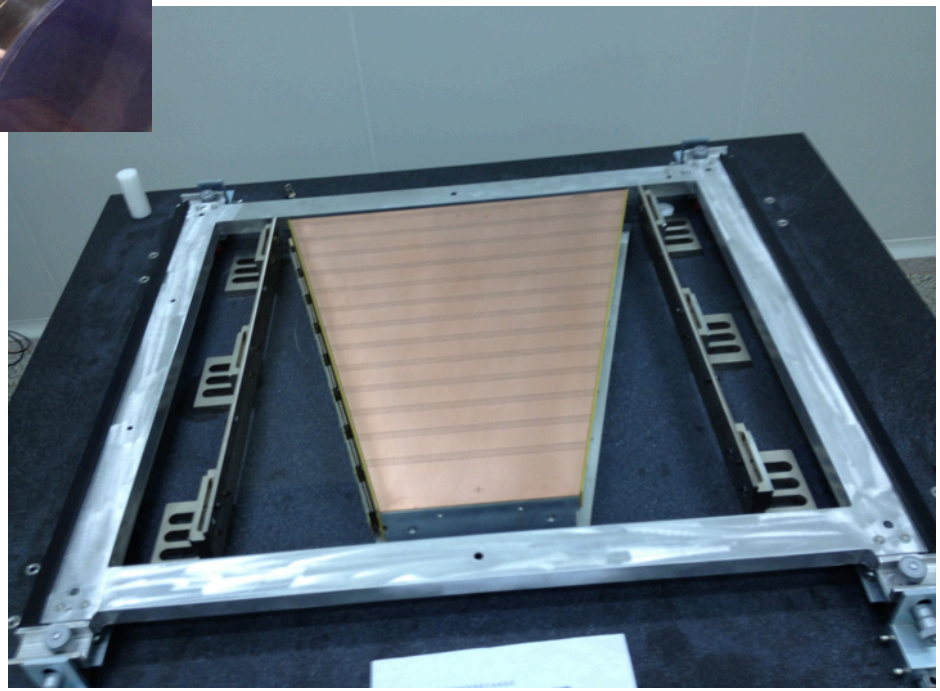
Winding wire on wire frame



Wires first wound on frames

10 wire frames made so far,

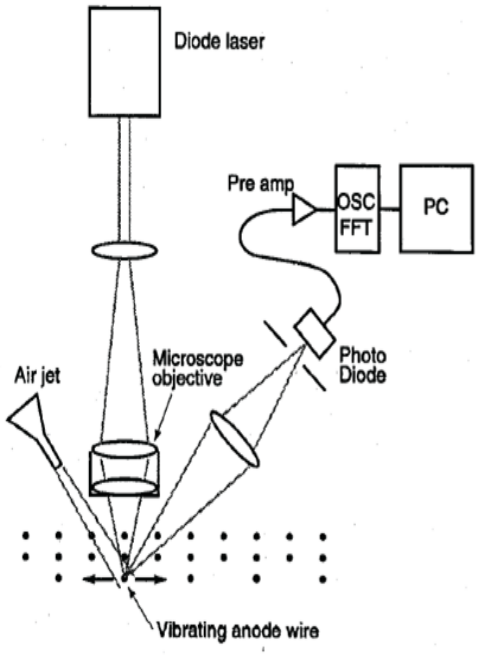
76cm x 90 cm (inner size).

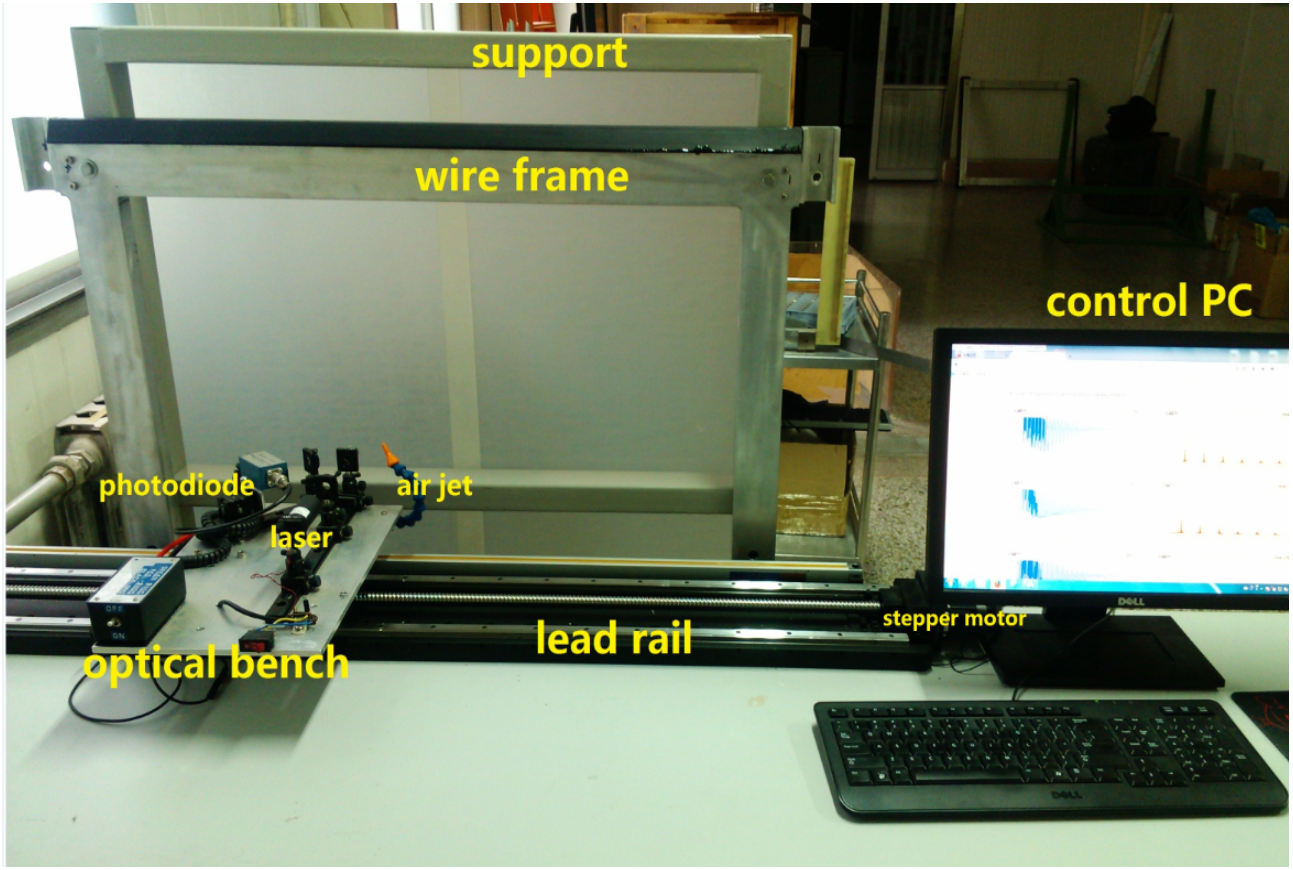


Wire frames will be used for 3 layers of wire plane with wire combs.

Wire tension measurement

- Determine wire tension by optically measuring the vibration frequency:



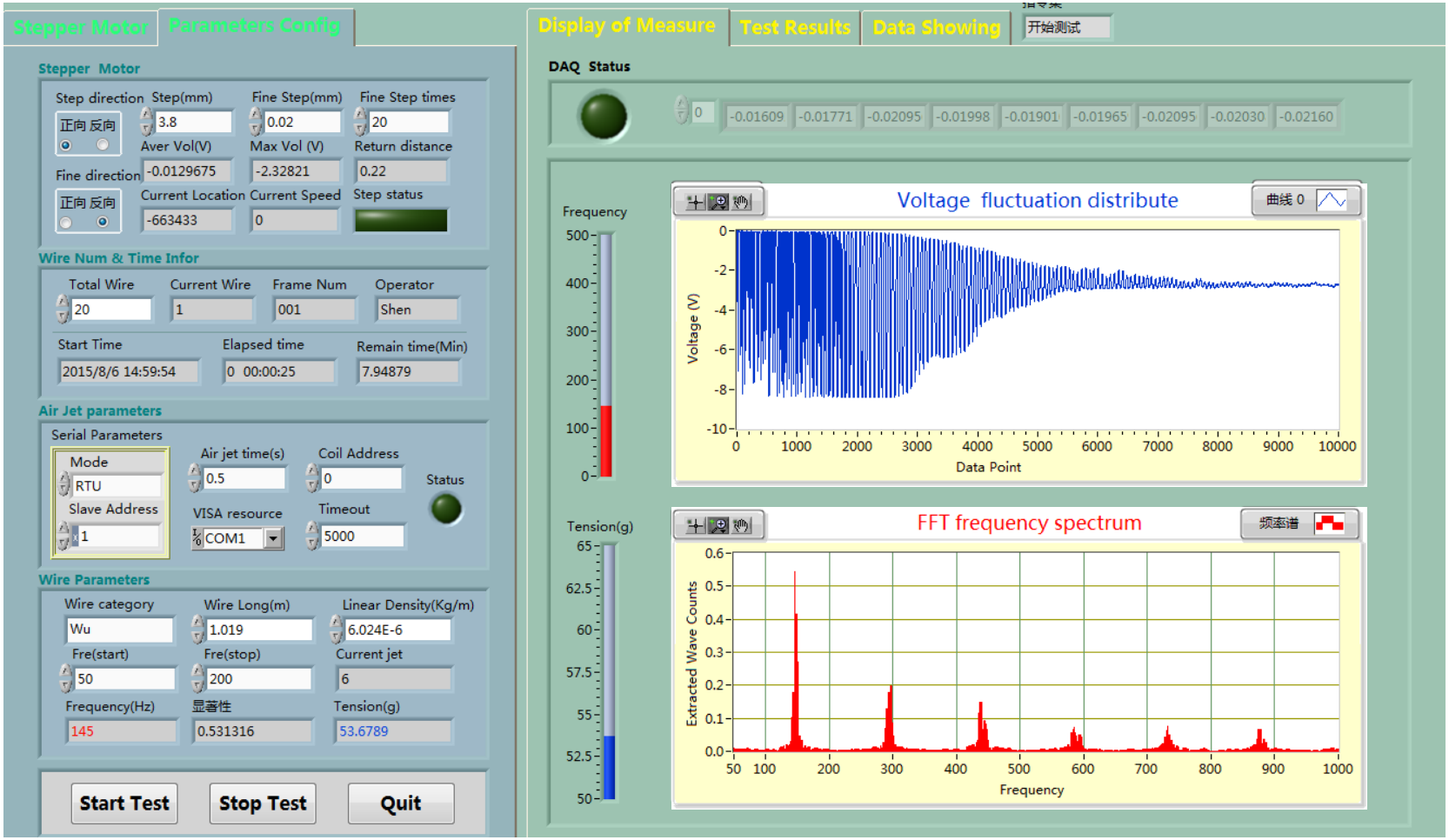


Laser will locate on each wire，synchronized with gas jet, and the base frequency will be extracted from voltage fluctuation transformed of laser absorption.

Control panel for wire tension measurement

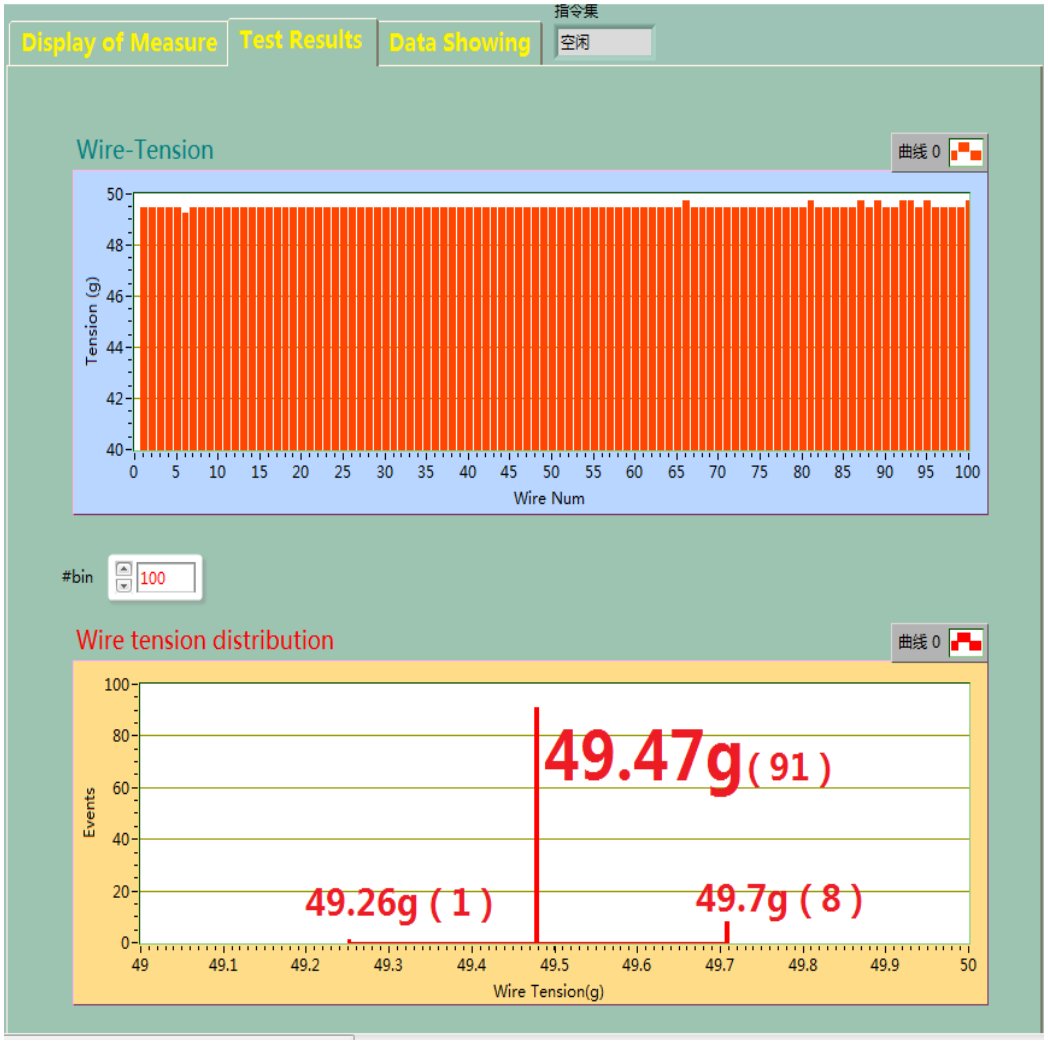
Left: interface for measurement configuration;

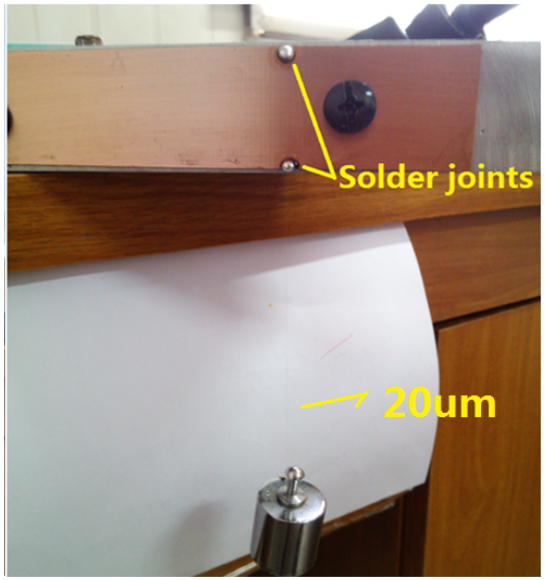
Right: results on voltage fluctuation, frequency spectrum from FFT.



Wire tension measurement

- **Cross-check of the method with fixed tension wires:**





Fixed tension for checks

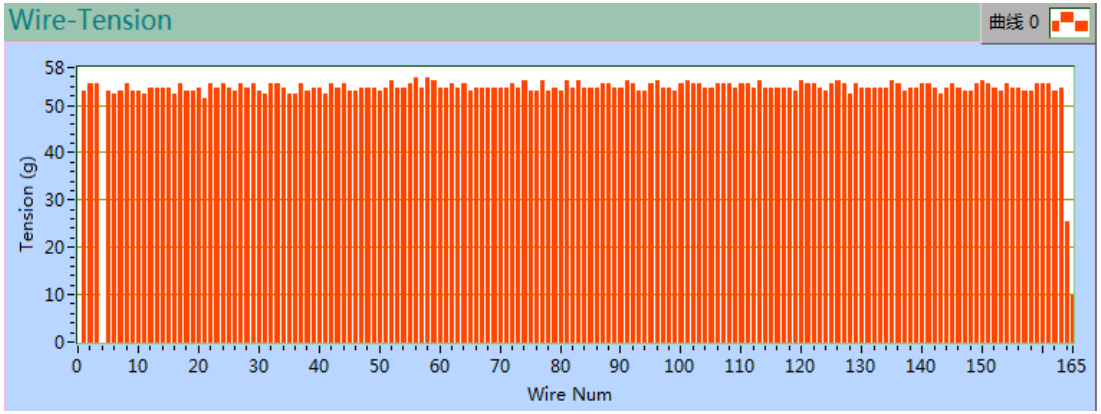
Measurement with fixed tension: (<2%)

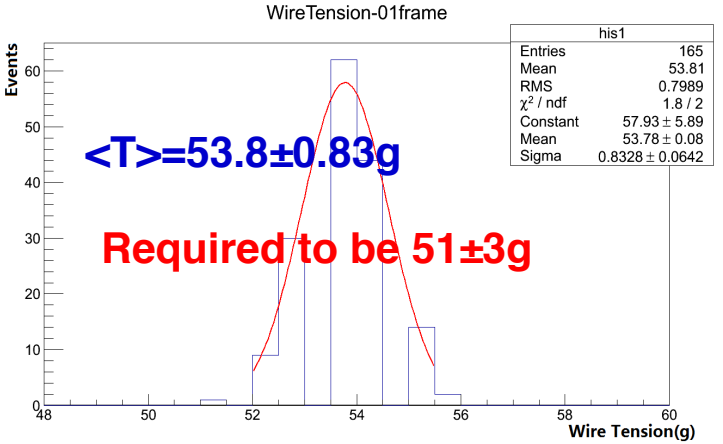
Wires	1	2	3
50g	49.5g	50.8	50.6
60g	60.9	60.6	60.4

Precision transferred from the frequency (integer) is ~0.5%

Wire tension measurement –Test frame #1 （20um)

- 165 wires in total, one broken, two got loosen



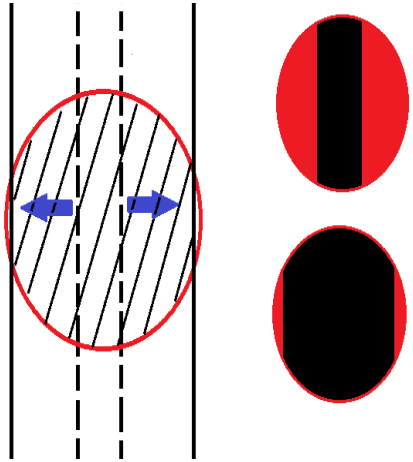


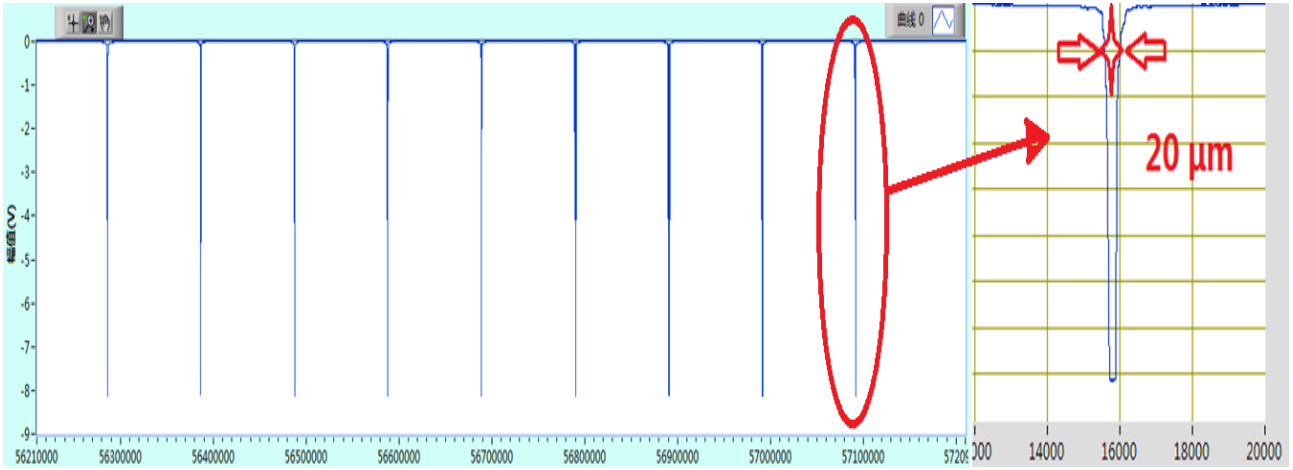
- Database documentation for each wire frame:

Wire Num	Step Position (pulse)	Frequency (Hz)	Fre Events	Tension (g)	Wire Num	Step Position (pulse)	Frequency (Hz)	Fre Events	Tension (g)
1	349285	147	0.545567	55.17	2	338998	147	0.443188	55.17
3	328865	144	0.629200	52.94	4	318527	146	0.243367	54.42
5	308291	147	0.487429	55.17	6	298158	146	0.370758	54.42
7	287922	147	0.157271	55.17	8	277737	144	0.303067	52.94
9	267501	145	0.214873	53.68	10	257265	146	0.164062	54.42
11	246978	146	0.432643	54.42	12	236691	145	0.418611	53.68
13	226506	145	0.434826	53.68	14	216321	146	0.347759	54.42
15	206188	146	0.427094	54.42	16	195850	147	0.428311	55.17
17	185563	146	0.522824	54.42	18	175174	146	0.298631	54.42
19	164938	147	0.336174	55.17	20	154907	146	0.647207	54.42
21	144620	146	0.453637	54.42	22	134435	147	0.138649	55.17
23	124199	144	0.543704	52.94	24	113861	146	0.184656	54.42
25	103779	147	0.392001	55.17	26	93390	146	0.211932	54.42
27	83257	145	0.294806	53.68	28	72919	145	0.522486	53.68
29	62683	147	0.408204	55.17	30	52498	146	0.539394	54.42

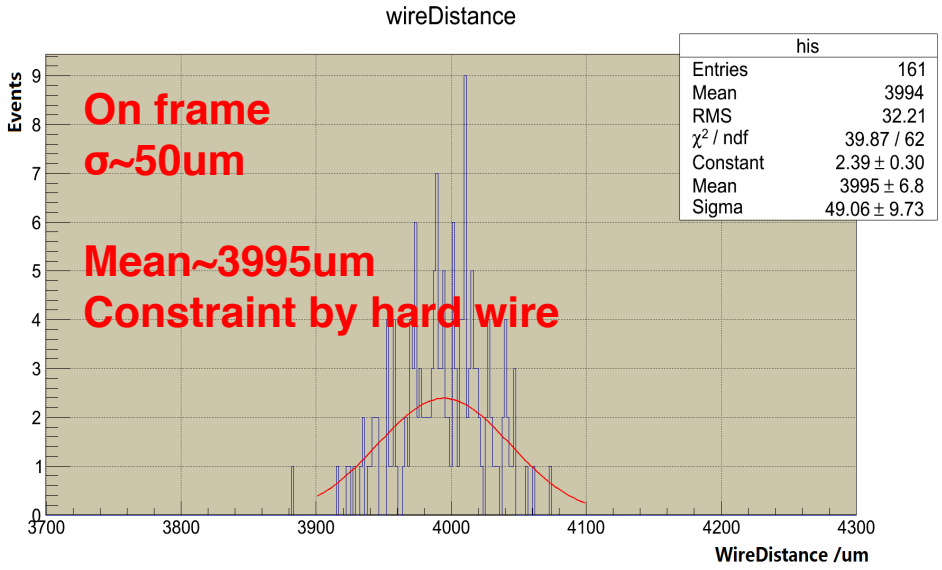
Measure the pitch of wires using the same laser system

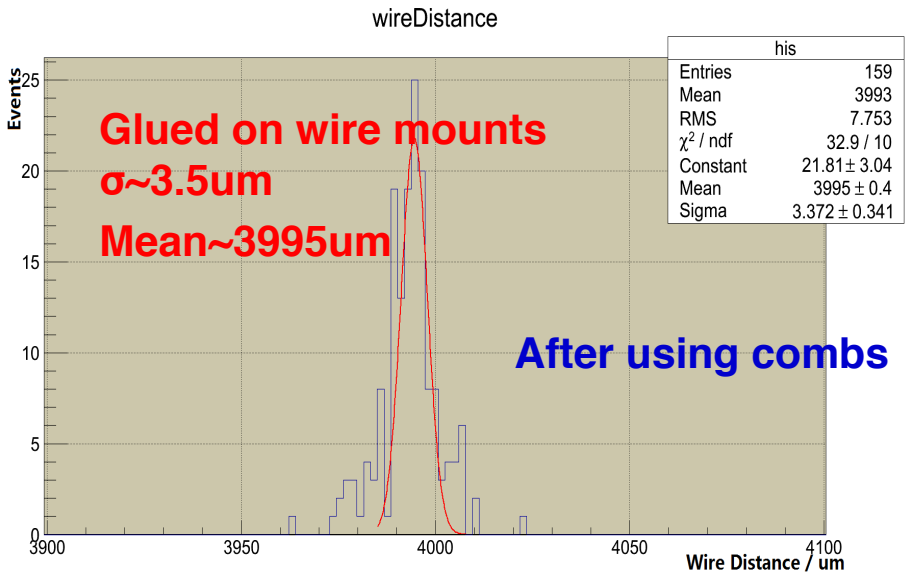
- **Focusing the laser on each wire, width of response is the wire diameter**





- **Distance between wires :**

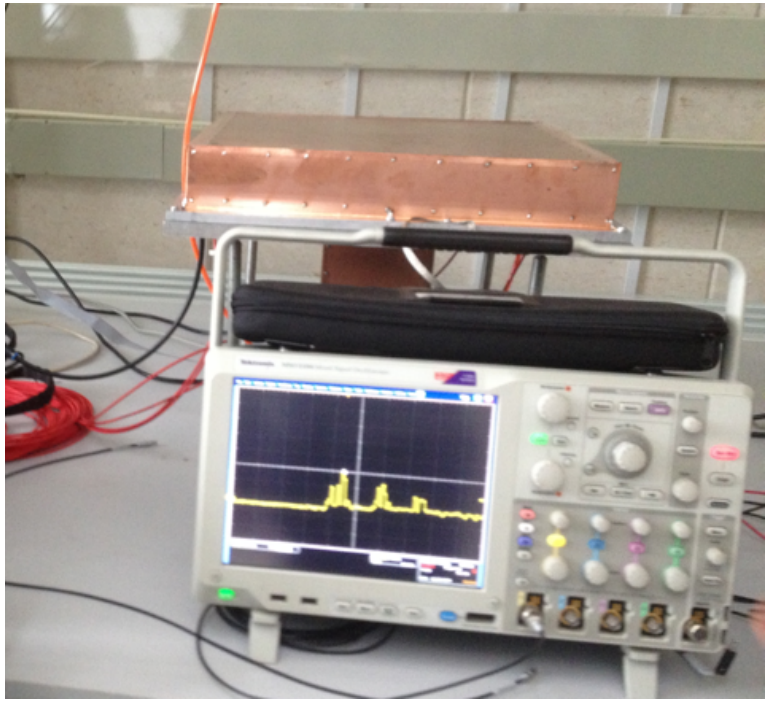




Test small TPC prototype with the cosmic ray system

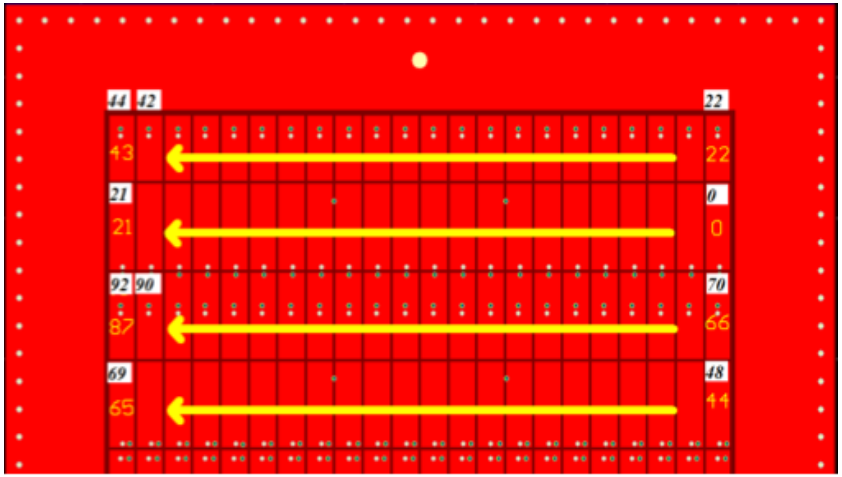
Cosmic ray test system

- Two layers of scintillators served as trigger system. Coverage of TPC very small (~1%).
- One V550A+two GassiPlex07 as readout. Signal from pad observed.
- Started the first test in June, 2014

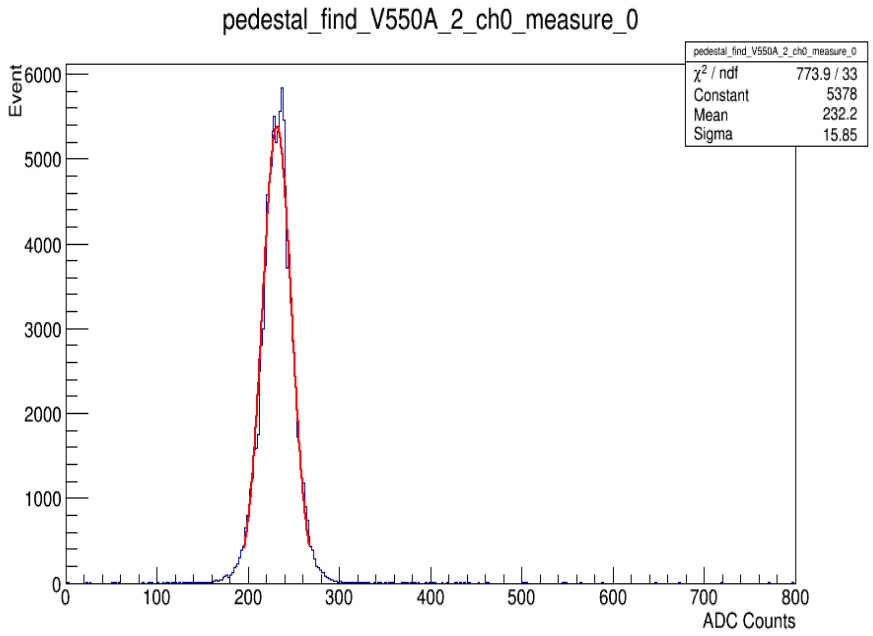


Test results of small TPC at SDU

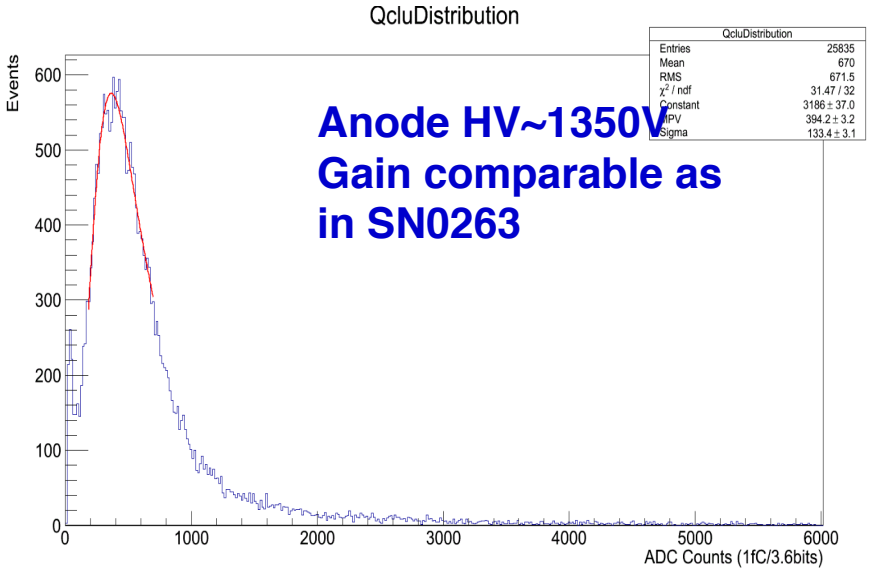
- **Now only reads out the charge of 88 pads of 176 in total with simple electronics (one V550A board), without time information.**



- **Pedestal seen for the charge of single pad**



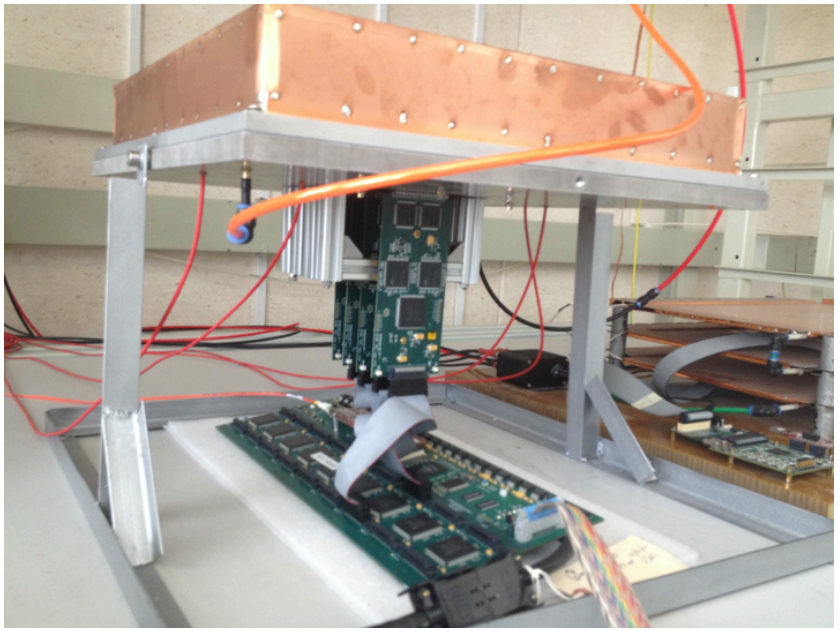
- **Signal after subtracting pedestal**



New Test with STAR DAQ system

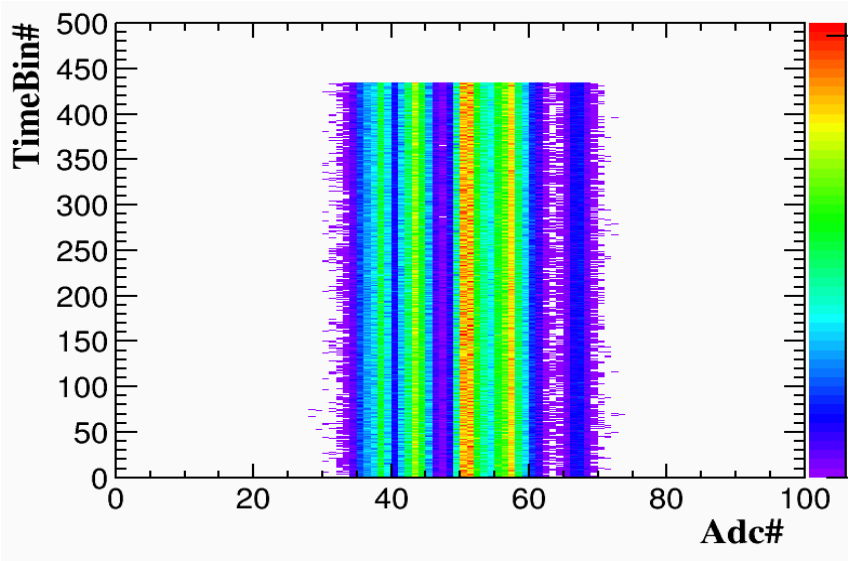
- **Whole DAQ set obtained from BNL in Feb: Fee card, RDO board, TCD, PCI card**

- **Control PC configured by Tonko (thanks!), the whole DAQ setting up is close to be ready for data taking.**



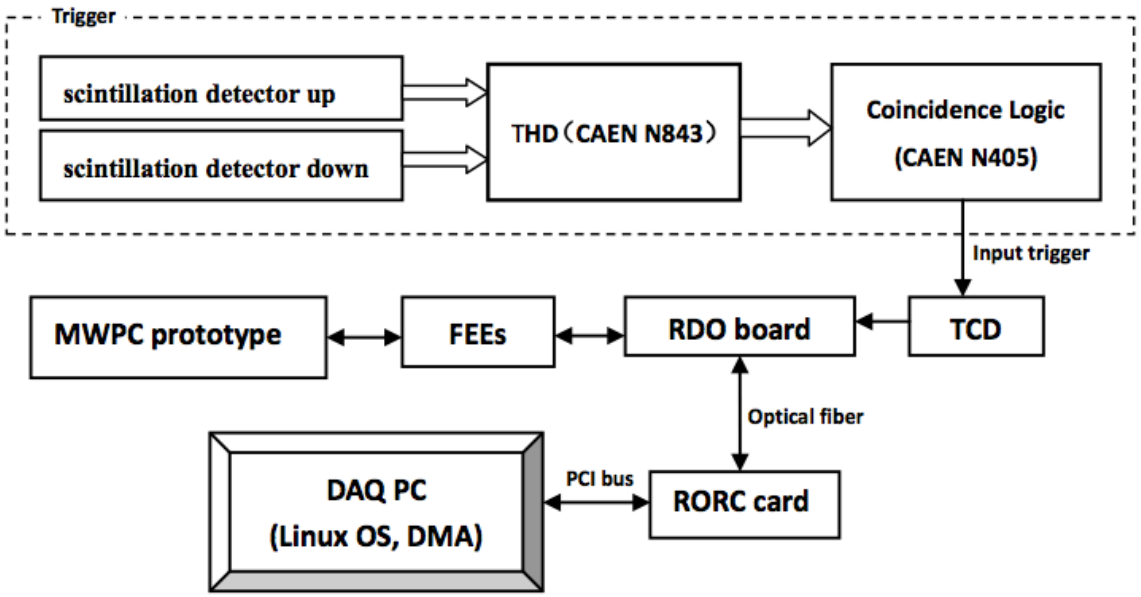
- **1st test file with random triggering (pulsar), taken by Tonko in Aug.**

- **Final step on date-takig instruction**



Trigger system design

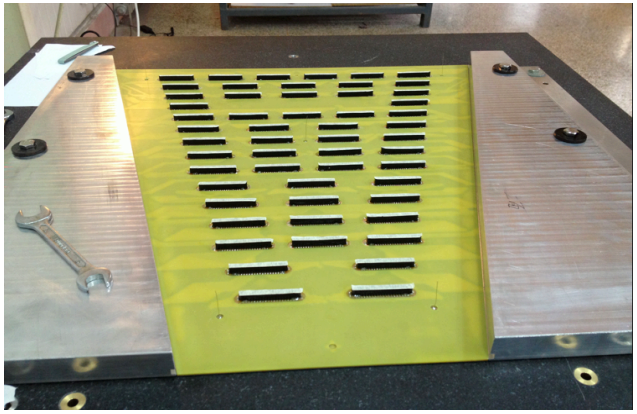
- **DAQ setup:**



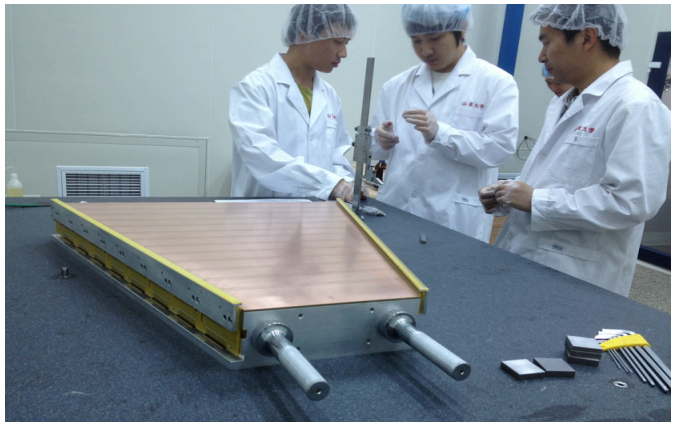
- **Trigger system with two scintillator detectors:**
  - ✓ **scintillator-up: R11102-A52628, Voltage supply: -1107.92V @ gain of 1.0*10e+06**
  - ✓ **PMTs: Hamamatsu R11102 1.5'' diameter**

Full size iTPC prototyping

- **Started the full size iTPC prototyping since September 2014. Several tools were made.**

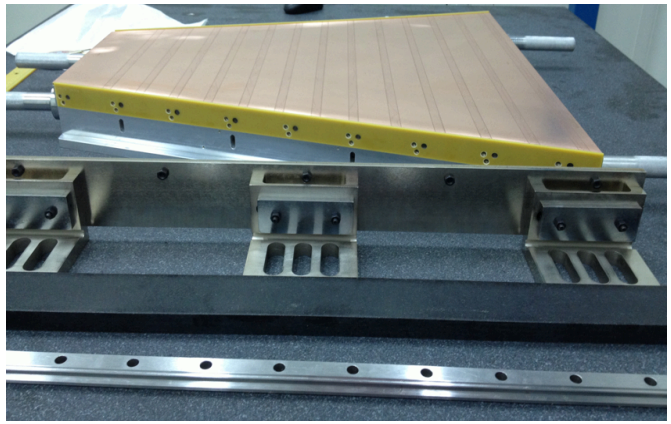


PCB bonding



Side wire mounts

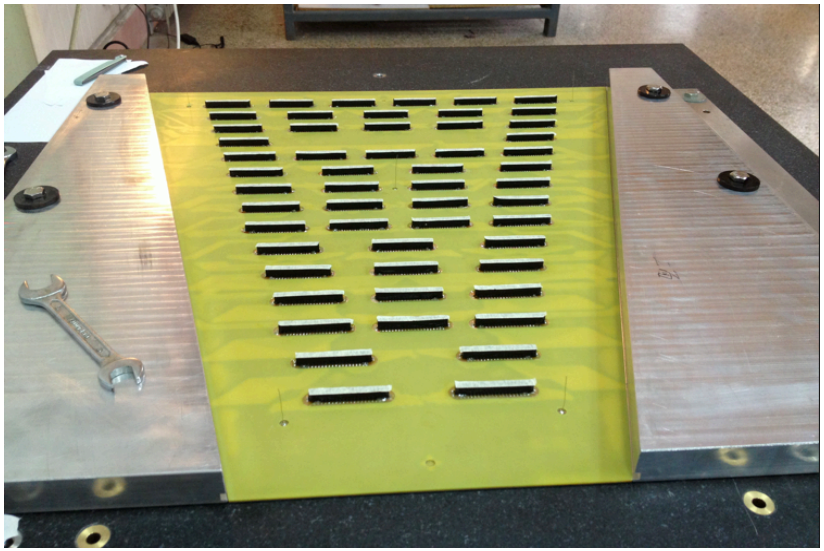
Pining station for wire mounts



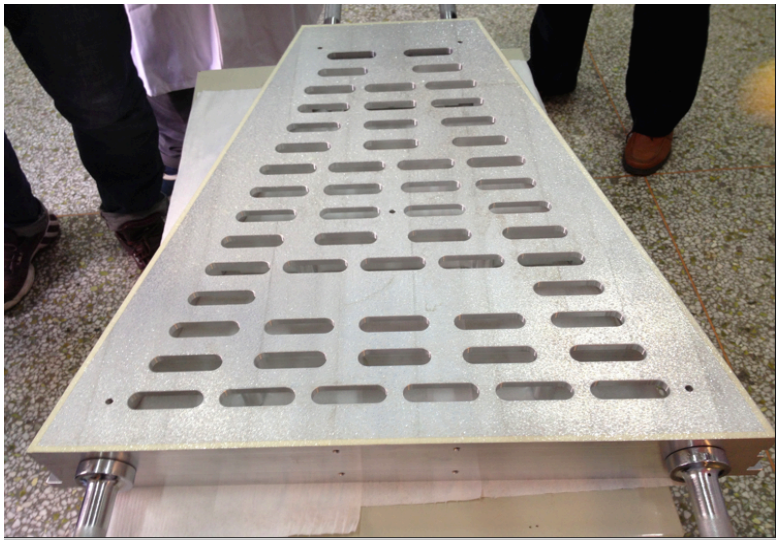
Wire combs

Gluing pcb to strongback

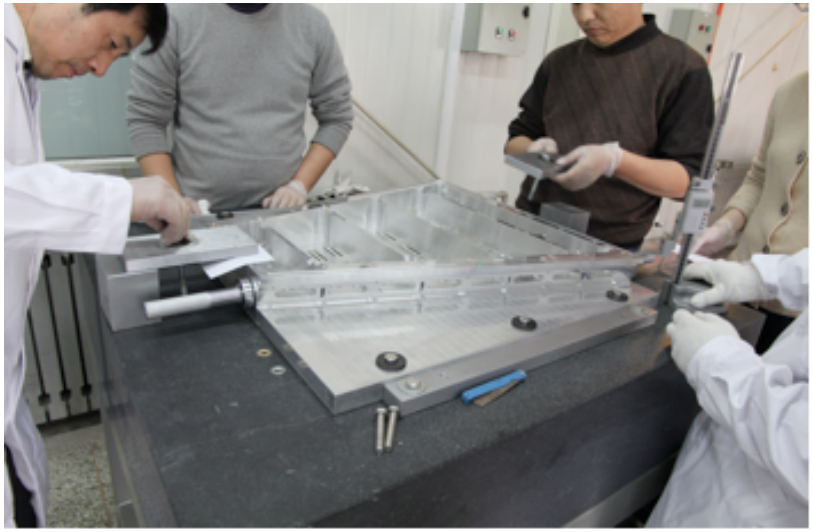
March, 2015



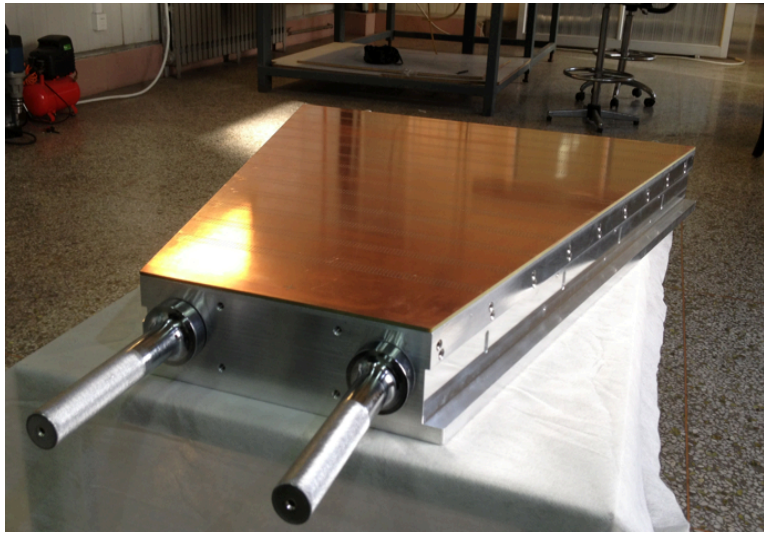
Pad plane vacuum tight to granite table



Expensing epoxy to strongback



Lower strongback to pad plane

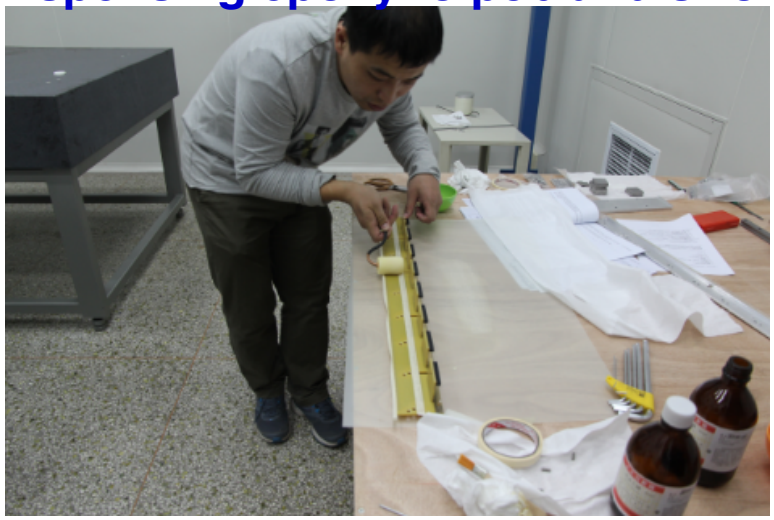


Let the epoxy cure for 40 hours

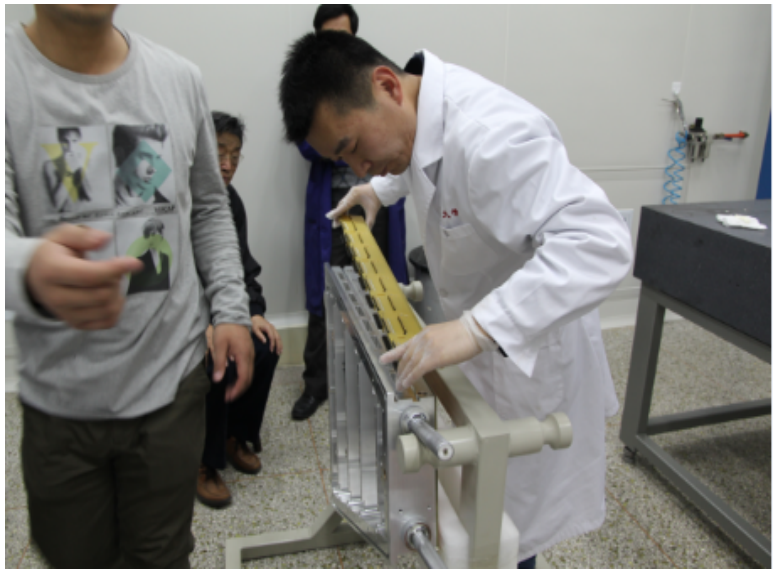
Epoxying the anode wire mount (1)

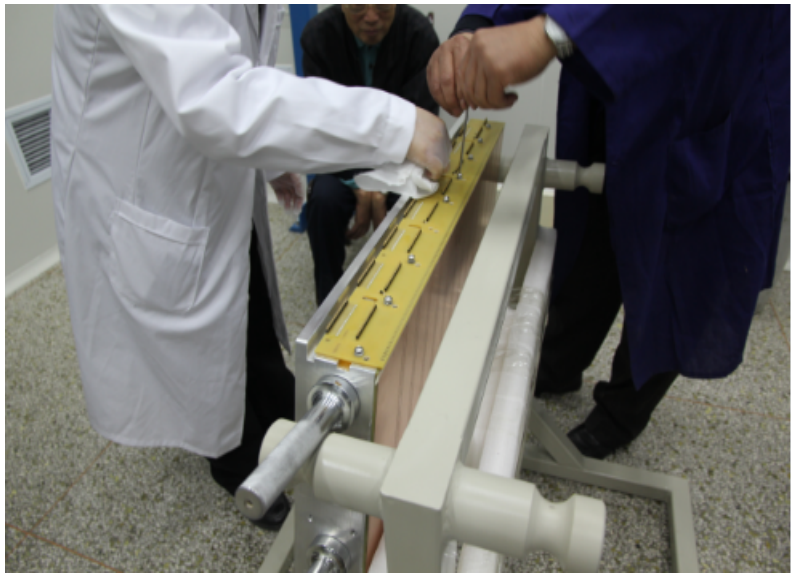
April, 2015

- Dispensing epoxy to pcb and strongback



- Put wire mounts in place with screws

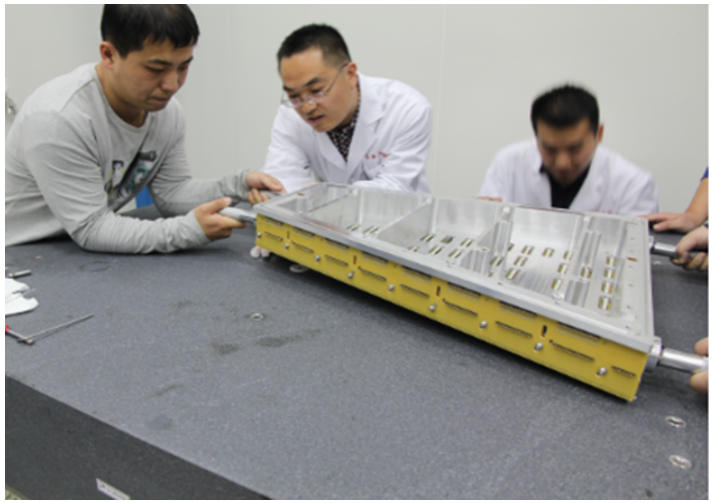


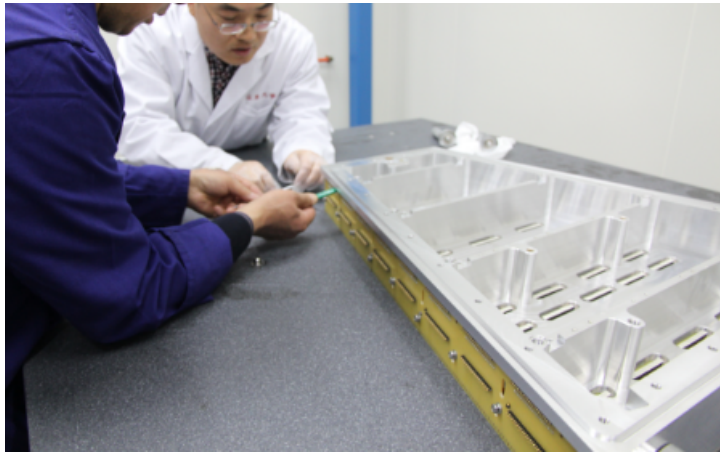


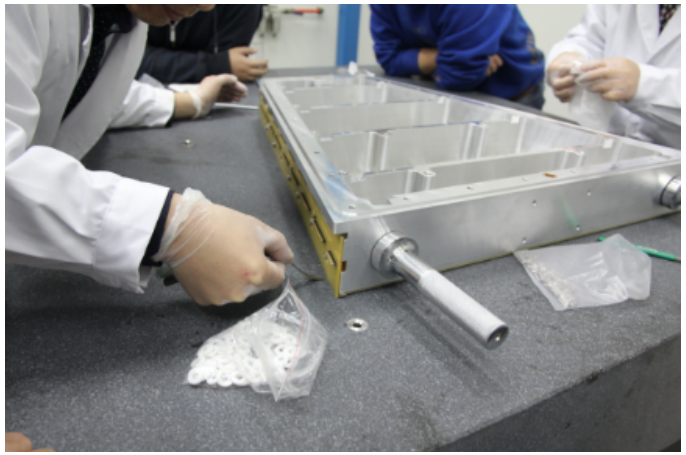
Epoxying the anode wire mount (2)

April, 2015

Put the strongback on granite table over 4x1.85mm spacers, pad plane facing down, positioning plate on the narrow end.

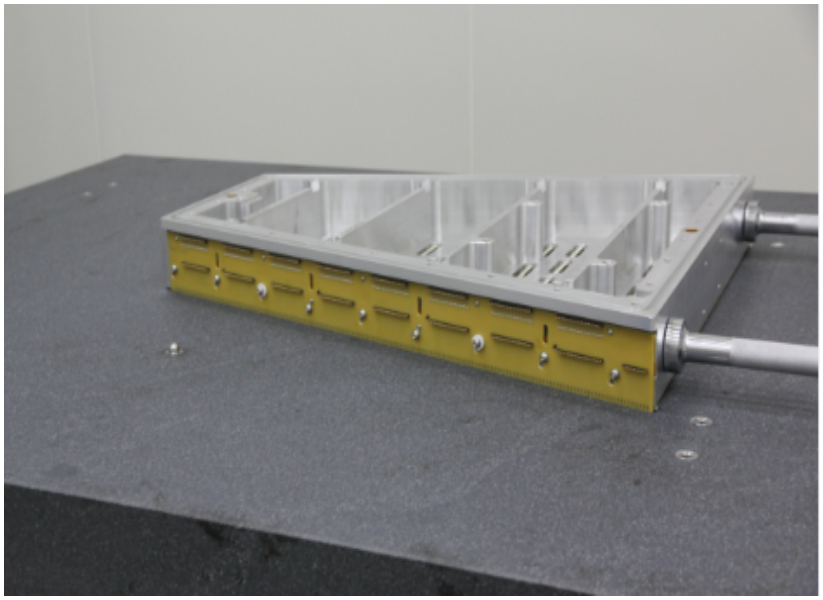


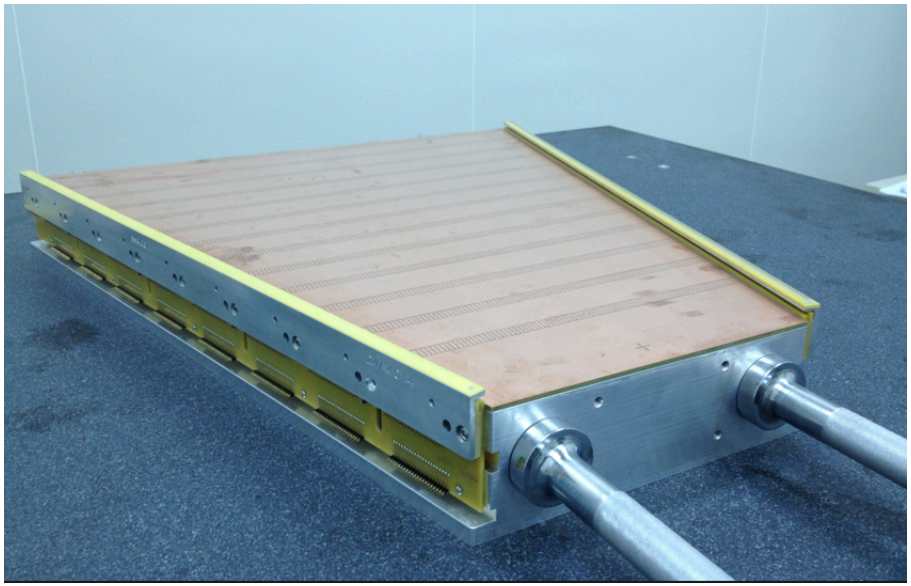




Install the shield & gated wire mounts

Install the shield and gated wire mounts similarly using 3.85mm and 9.85mm high spacers and tighten them with screws while keeping the wire mounts resting on granite table tightly.





Drill/pin fixture

May, 2015

Drill 17/64" first

Flat bottom drill 17/64”

5 hand reamer

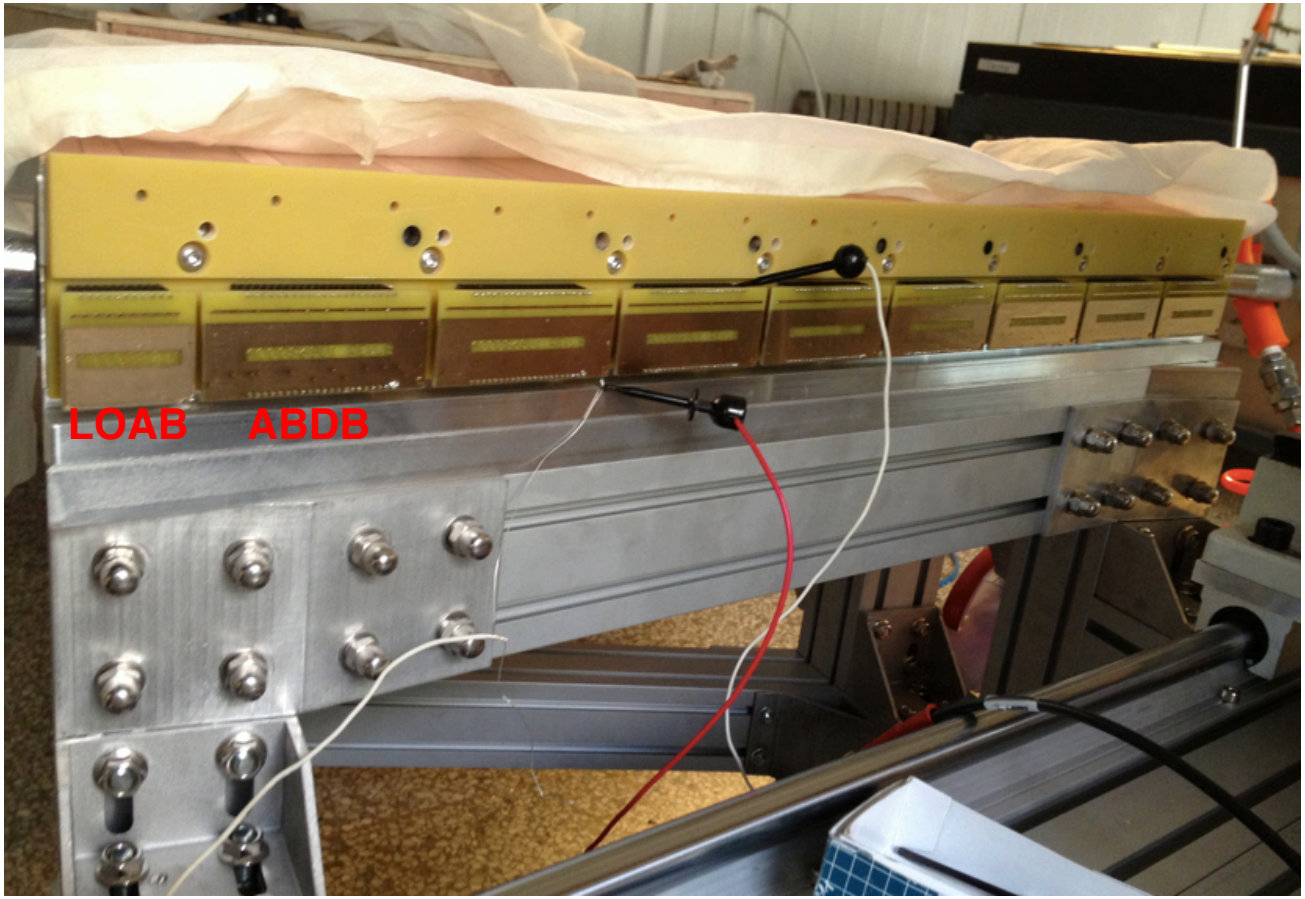
All fixed on track

Tooling ball used to fix strongback in the fixture

The #5 American standard tapered pin. Steel pins used for this prototype. Si-Bronze one from US will be used for production.

Leakage current, continuity, open test

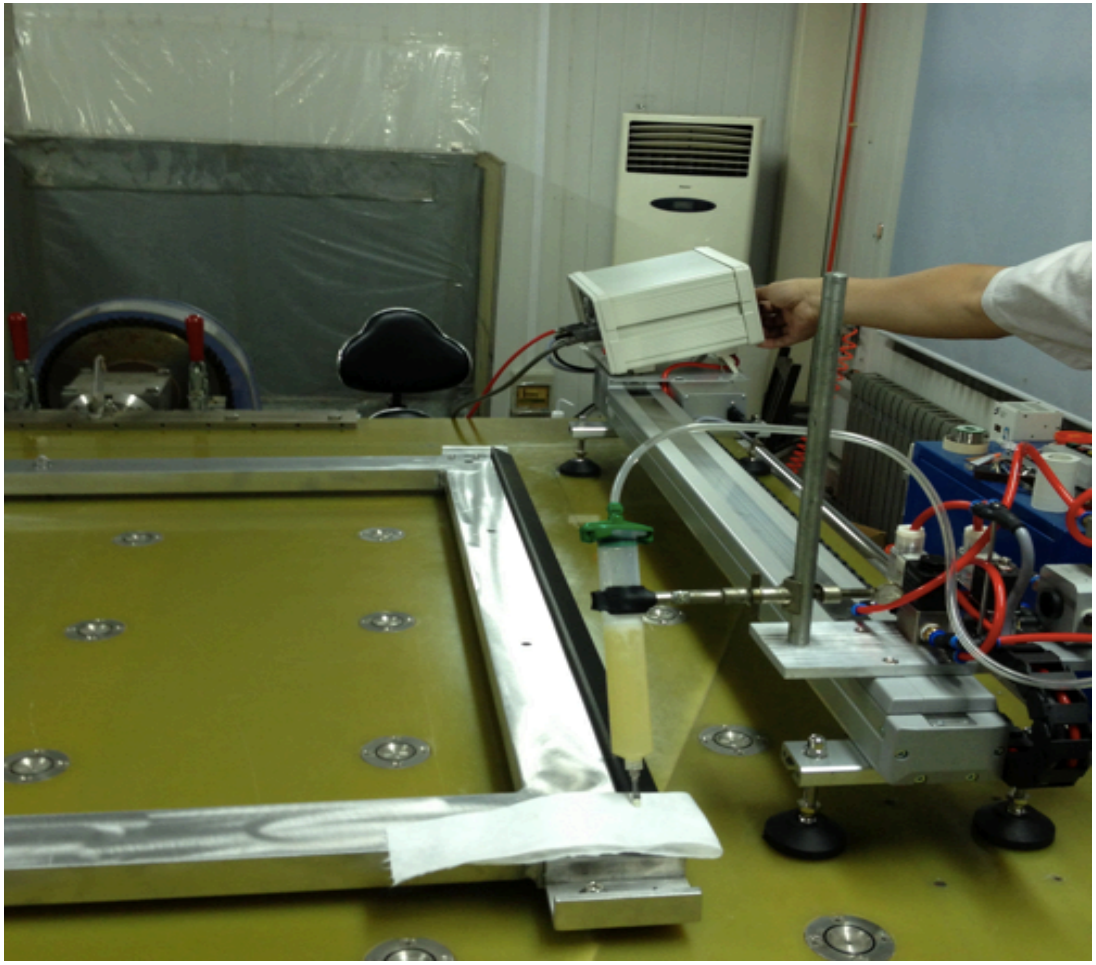
June, 2015



Gluing machine

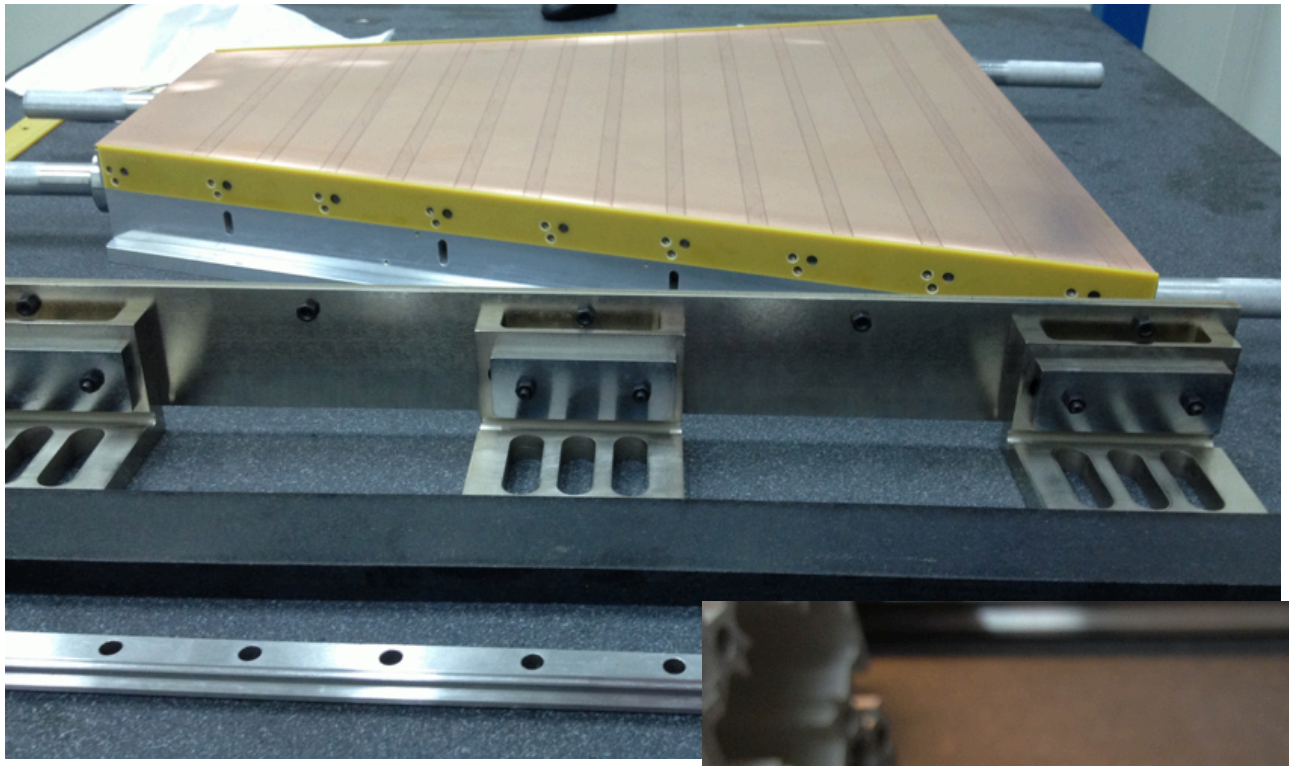
June, 2015

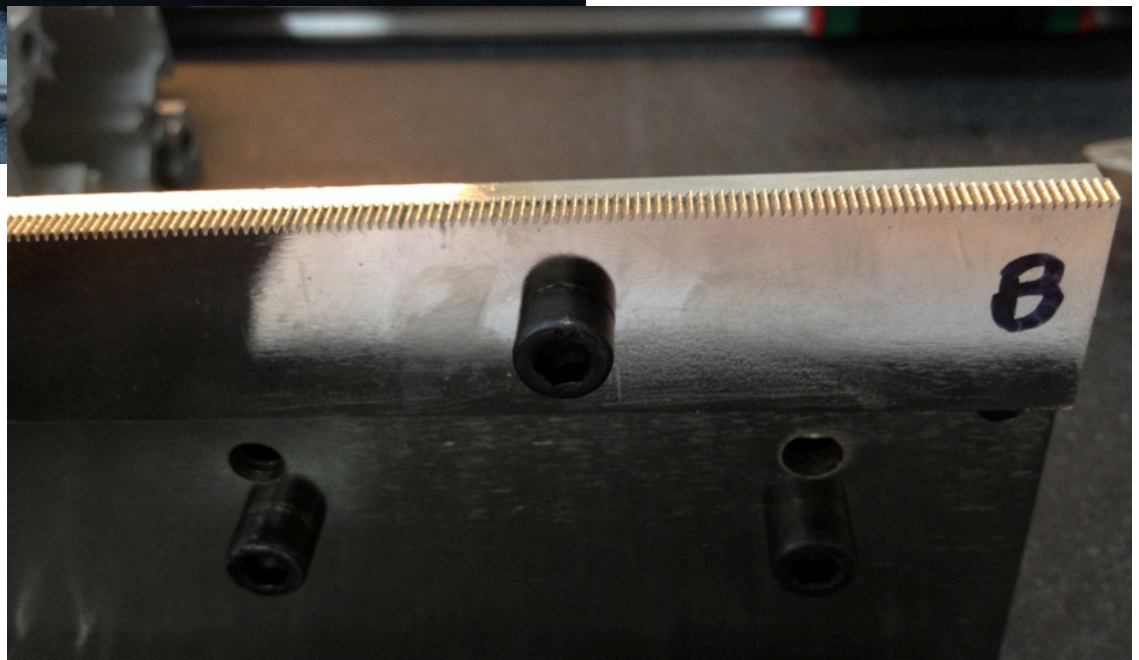
- Gluing machine designed to dispense epoxy uniformly:



Wire comb reproduced

July, 2015





The flatness of straight edge is ~10um.

Pitch of wire comb

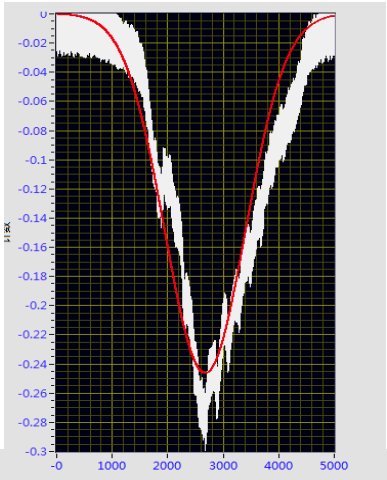
July, 2015

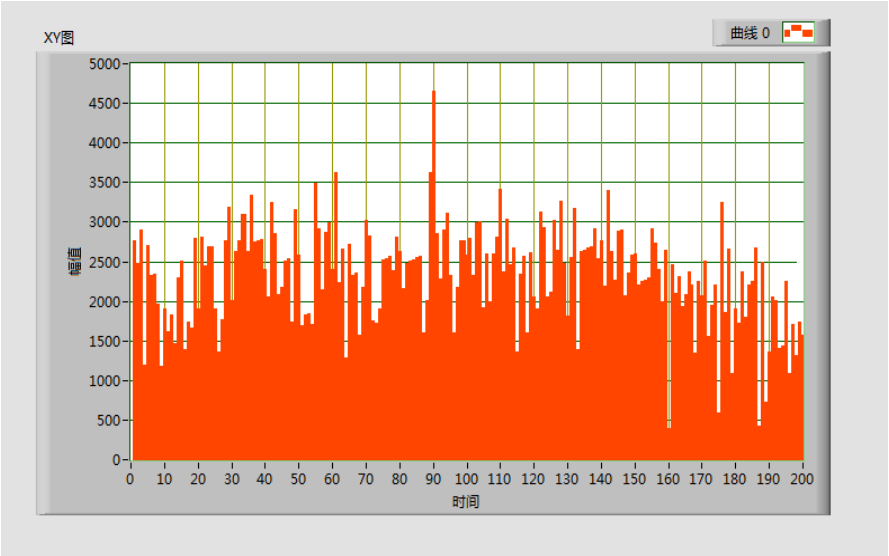
Check the comb pitch using the laser system:

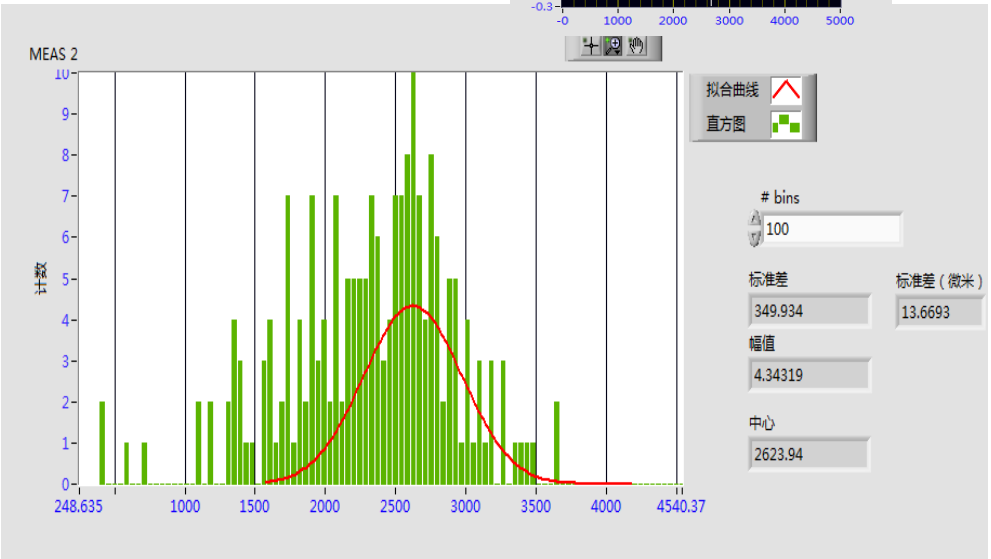
Each piece of 1mm, and get the lowest point,

i.e., the distance from the left edge.

The width is ~14um.





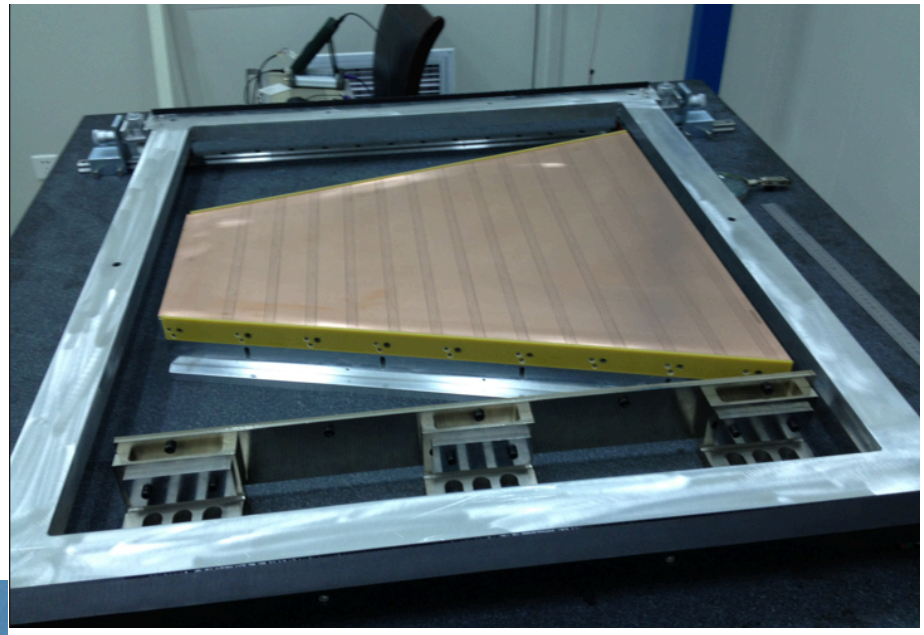


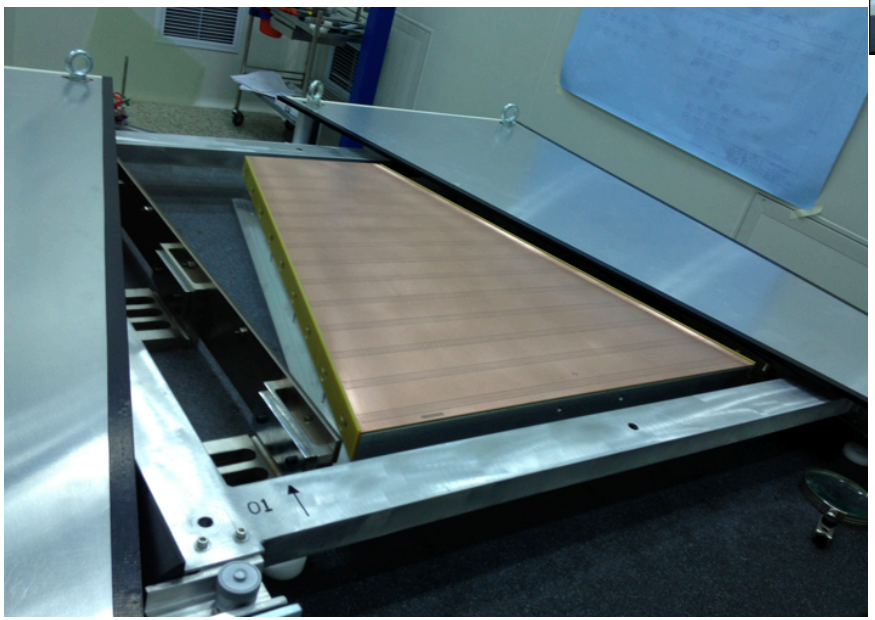
Received the original combs from LBL in August, and will be used in later prototyping.

Four combs produced by LBL, will arrive shortly (thanks!).

Mounting the combs

- One of the key steps: mounting wire combs using height standard (tolerance~10um) and micro-meter, height indicator (~1um)





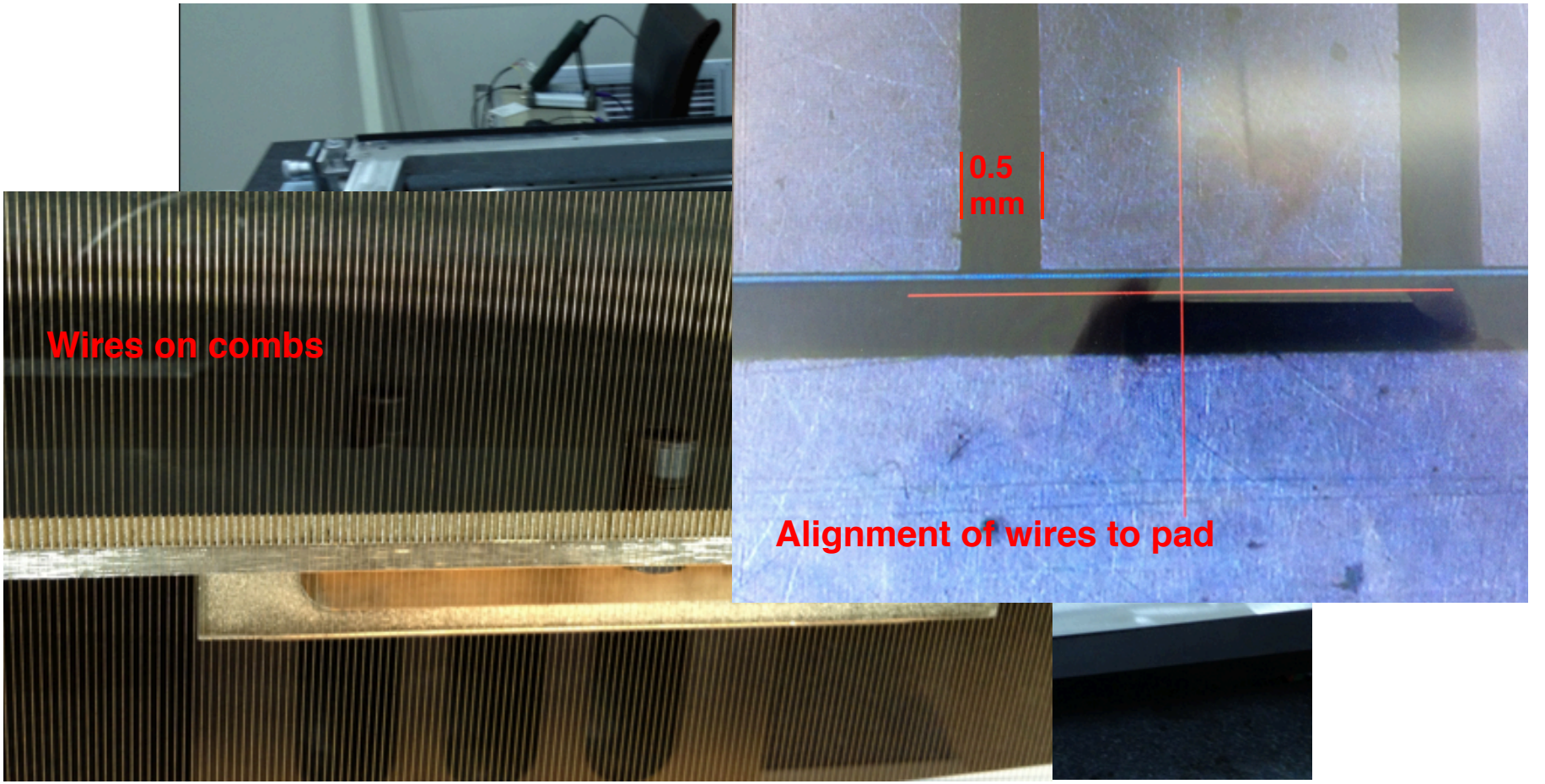
The tolerance on the height of anode wire plane needs to be <10um, which is realized by the wire comb straight edge.

The height of the frame is adjustable (20um), to let the wire just touch the straight edge.

Mounting the combs

August, 2015

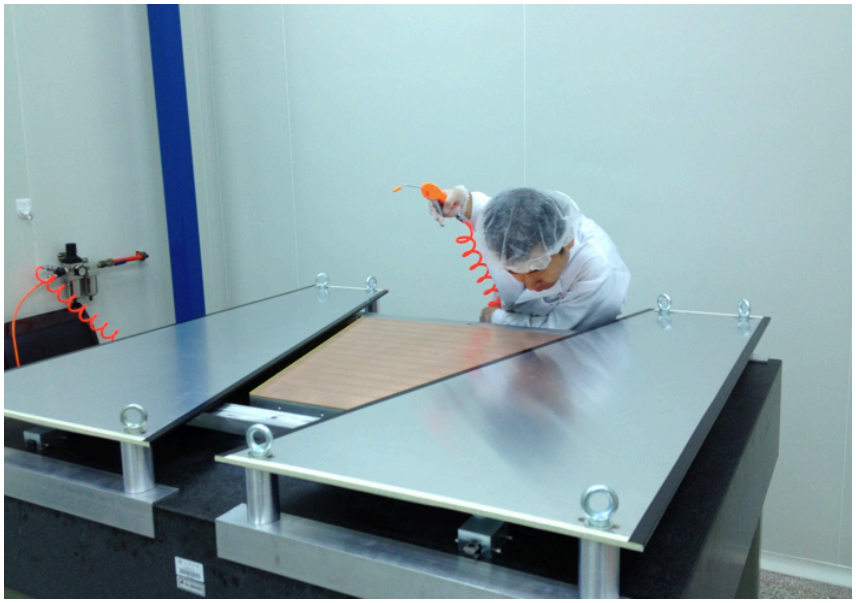
- One of the key steps: mounting wire plane with wire combs:



The tolerance on the height of anode wire plane needs to be <10um, which is realized by the wire combs.

Epoxying the anode wires

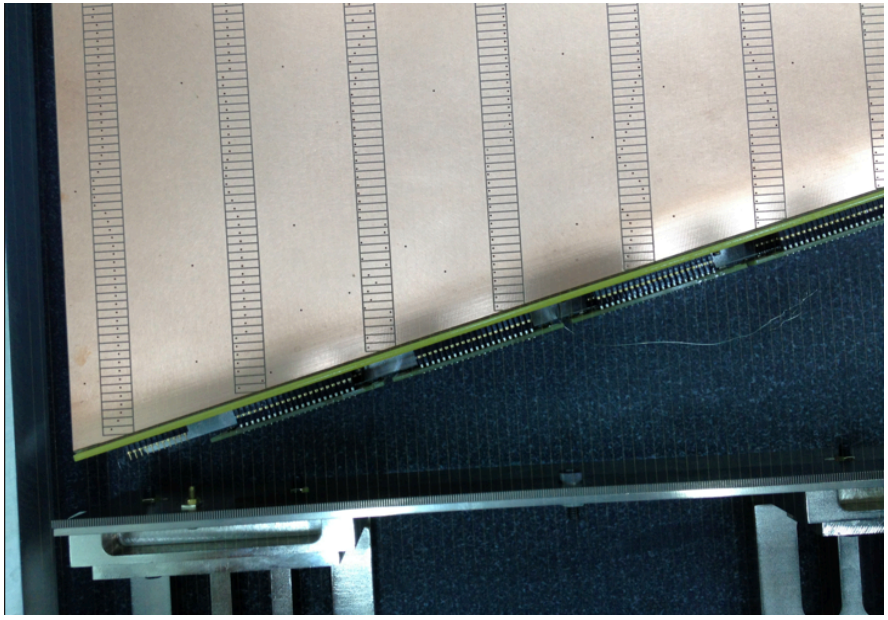
Sep, 2015



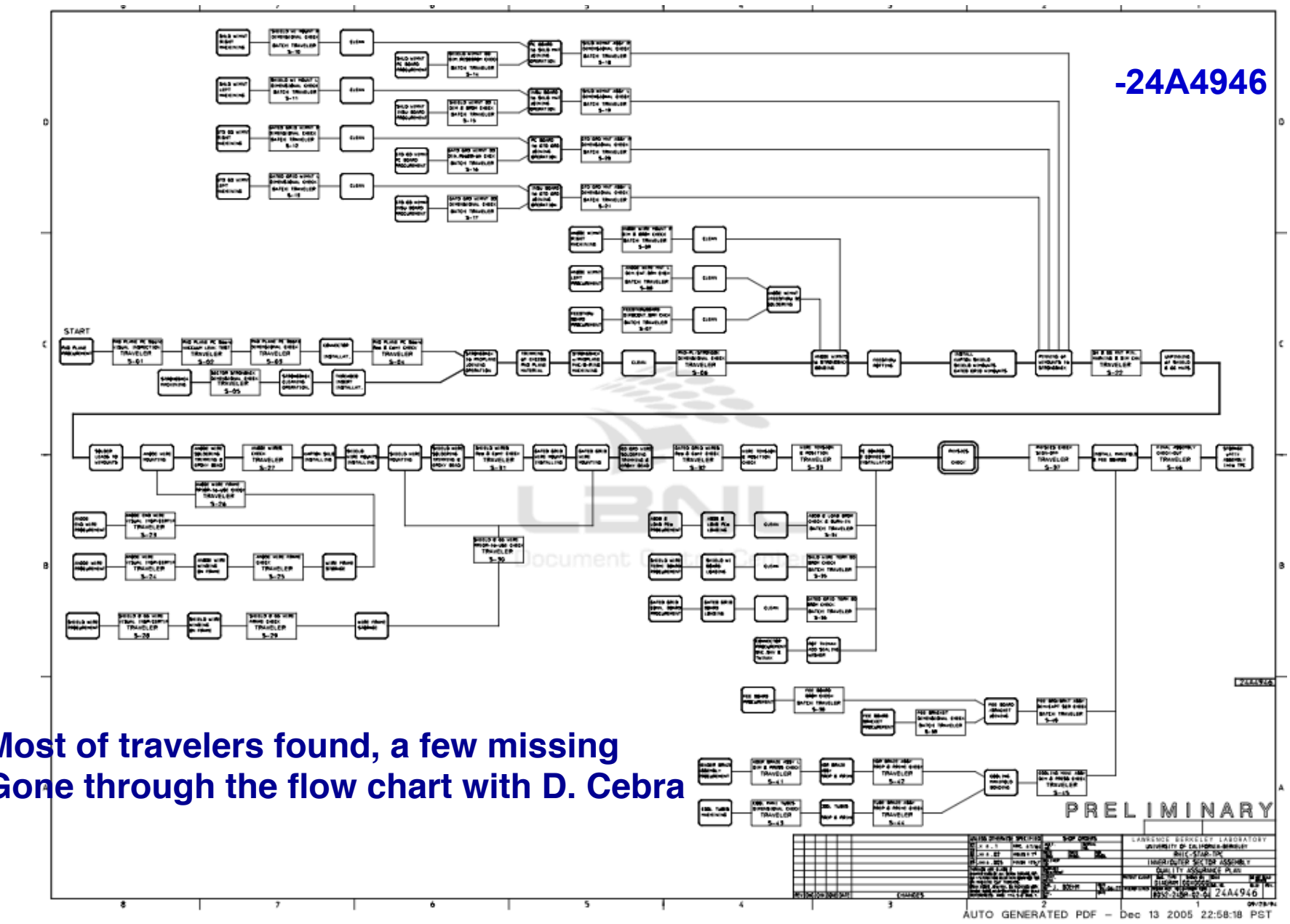
Mounting the protecting cover

Adjusting the gluing robot

Just finished soldering the anode wires, gained experience. A soldering table is needed.



Original QA plan for assembly- flow chart with travelers



Most of travelers found, a few missing
Gone through the flow chart with D. Cebra

Reproduce word file of the QA travelers

- **Now reproduced S10-30, with English & Chinese version:**

TRAVELER S-10

NOTE: This is a Batch traveler

注意：这是一个批处理检验文档。

SHIELD WIRE MOUNT, RIGHT – Q.A. CHECK

右侧地丝落丝件，Q.A.检验

SHIELD WIRE MOUNT RIGHT, INNER SECTOR, dwg # 24A3974

右侧地丝落丝件，内扇区，dwg # 24A3974

总计：_____/每个

SHIELD WIRE MOUNT RIGHT, OUTER SECTOR, dwg # 24A3874

右侧地丝落丝件，外扇区，dwg # 24A3874

总计：_____/每个

J.O.#: _____ J.O.date: ____/ ____/201__

After answering each of the following questions please initial your name.
完成下列检查后请签名。

CERTIFICATION CONFIRMATION

认证确认

1. Dose each part in this batch conform to the dimensions and tolerances of it's drawing, as verified by the LBL inspection department and STAR lead tech. John Wirth?
   是否这个综合检验的每个部分都经过 LBL 检验部门与 STAR 技术总监 John Wirth 的确认，符合各自的尺度及公差要求？

Yes____, No_____

IF THE ANSWER TO QUESTION 1 ABOVE IS **NO** BAG AND TAG BOARDS with "NO CERTIFICATION" AND NOTIFY COGNIZANT ENGINEER
如果上述问题 1 的答案是 **NO** 收起并把板打上**"未通过检验"**的标签，同时通知相关的工程师

Sep.2015 **CHI YANG** **TRAVELER S-10~S-30**

Summary

- Funding secured for prototyping and production of MWPC from NSFC.
- A small TPC prototype was made at SDU and test results obtained.
- Wire tension measurement system designed & tested.
- The full size TPC prototype is progressing well, and just finished putting on the anode wire. The test/DQA system is also being designed.