Next Asian LP GEM-Module

Study by a Mockup

The Monthly Meeting
of
The ILC Physics and Detector group of Japan
on
May 22, 2014 at KEK

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The Current Asian LP GEM-Module

With Gate GEM
In March 2010

With Field shaper
In Dec 2012

Next Asian LP GEM-Module

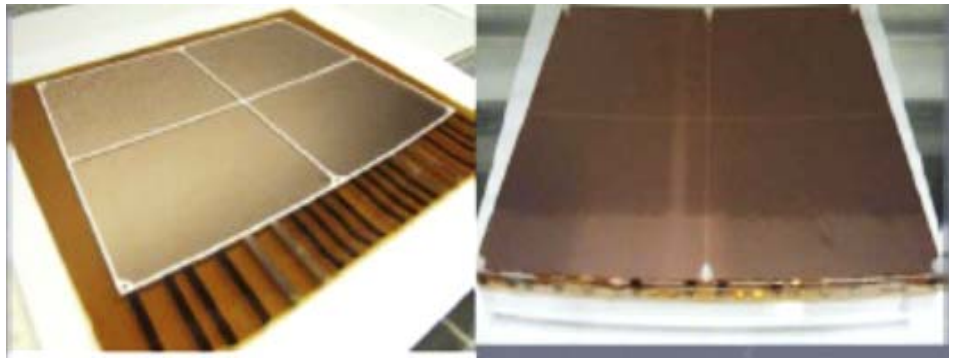
One step toward the ILD TPC module

(A) Two possible structures of the GEM module :

(1) With pre-tensioned GEMs glued on an all-sides thin frame (a la DESY),
(2) With a GEM stretched on the pad plane (a la Asian)

- ← **Which gate device, a GEM gate or a wire gate? (Mechanical issue)**
- ← **How much dead (distortion) region on the sides of the modules and at the additional crosspieces (a la DESY) allowed?**
- ← **Do we need thin side frames to ensure no ion leak, and to add field shaping electrodes on the both sides to minimize the local distortions below the gate GEM?**
- ← **How do we proceed the collaboration with the DESY/German group when our man power is so much limited?)**

DESY GEM module: Triple CERN GEM with thin (1mm) ceramic GEM frame (white).



Next Asian LP GEM-Module

One step forward to the ILD TPC module

(B) Our final choice of GEM?

- ← **The high rate of the micro discharge of the current GEM**
- ← **Why 2 layers of GEMs instead of 3 layers?**
- ← **Why 50/100 micron GEM?**
- ← **The best shape of GEM hole, and the best production process?**
- ← **The issue of mas production and price of GEM.**

(C) The issue of the many HV connections is common to the GEM modules.

(Is the current DESY solution reliable enough though seems not to be very elegant? Can be able to accommodate more HV connections ?

For (A) and (B) still no clear answers exist yet.
Nevertheless, we (the Japanese TPC group) decided to continue on (2). It is the complementary solution to that by the DESY/German group .

The Current Asian LP GEM-Module

(a) Module structure (of the the common fan shape of about 17cm x 22cm):

Minimize the dead/distortion regions in rϕ between modules,

while tolerate the minimum (significant?) dead regions in the radial direction:

- → **Stretch two GEM and a gate GEM on the pad plane between its upper and bottom sides:**
- → **No side frames of GEM, though we have never tested its advantage yet (*),**

(*) **After we had the HV breakdown in March 2010 we have used the field shaper which covers all sides of the module, and made unable to test the advantage. A test under preparation with a laser beam. Also a seimulation?**

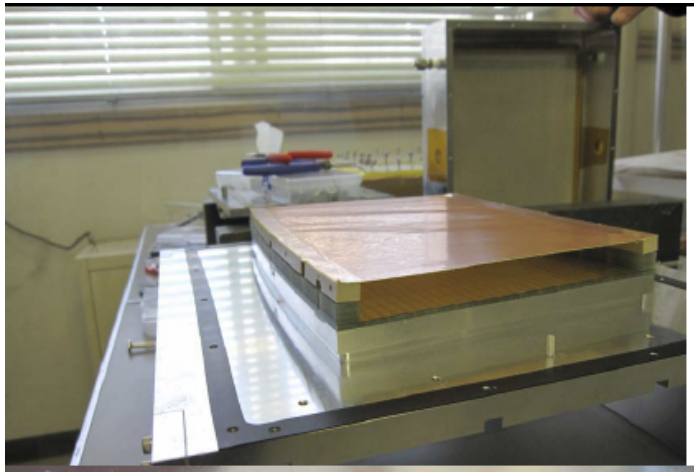
(b) GEM: **Use two layers of a 100micron think GEM (LCP). The GEM with straight GEM holes is produced by a process of laser etching + de-smear (chemical). The issue of the HV breakdown and high micro discharge rate.**

(c) Gate GEM: **Mount a thin Gate GEM (the electron transmission of about 50% at 1T). Damaged in the major module breakdown in March 2010. Not tested in the beam.**

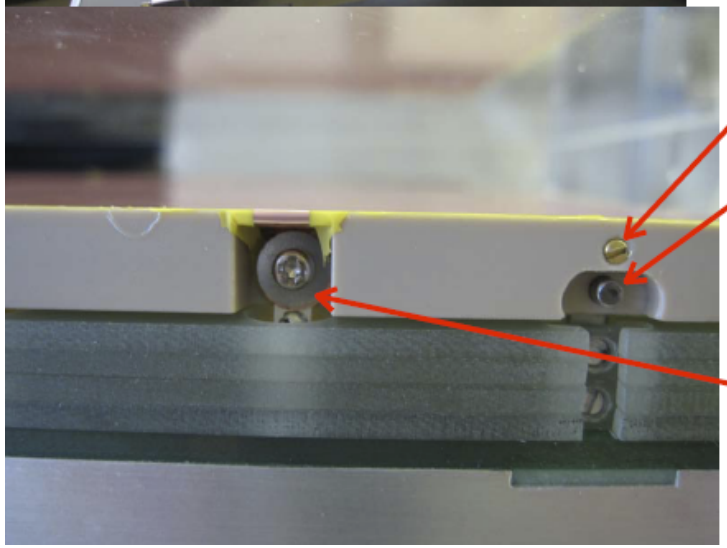
(e) HV supplies to GEMs/Gate GEM:

The complication due to the GEM stretching on the pad plane.

The Current Asian LP GEM-Module



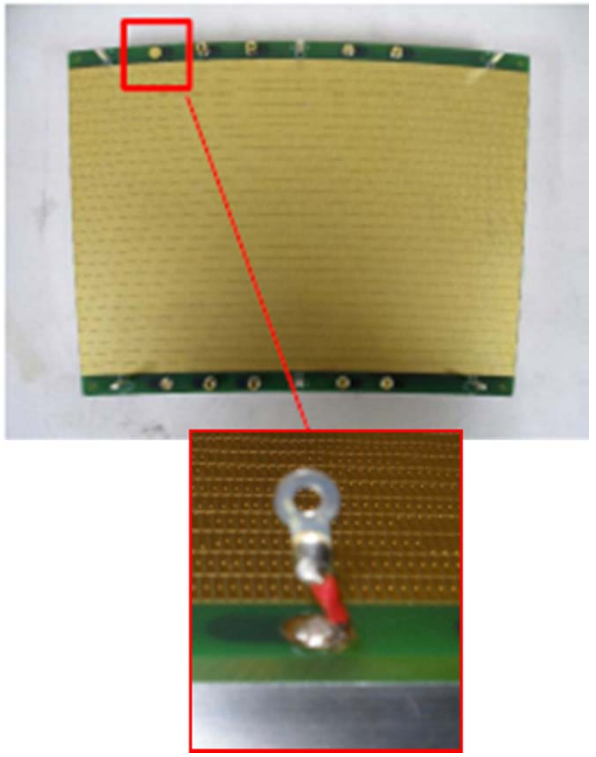
Stretch test on GEM module
without GEM



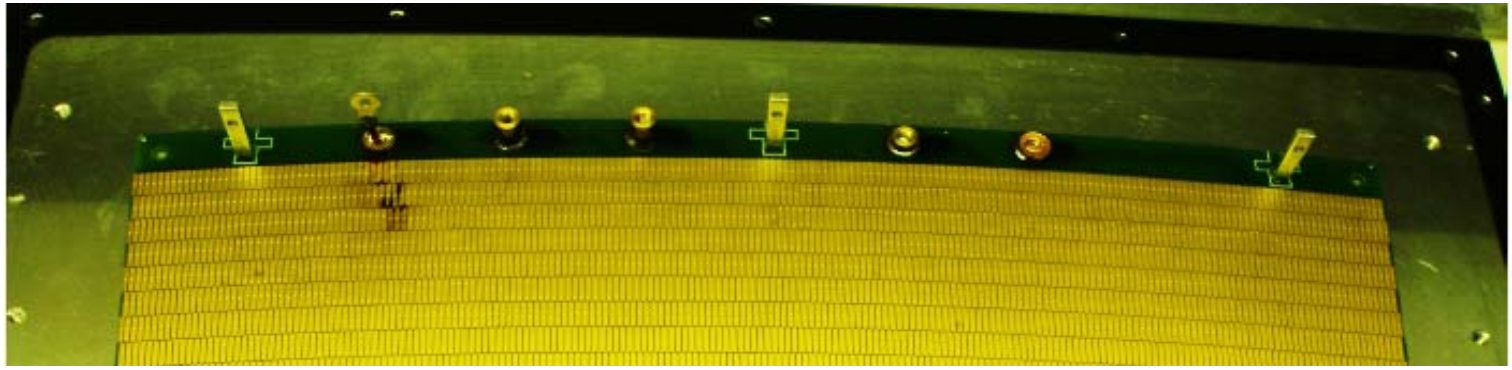
adjusting screw

position/lock pin

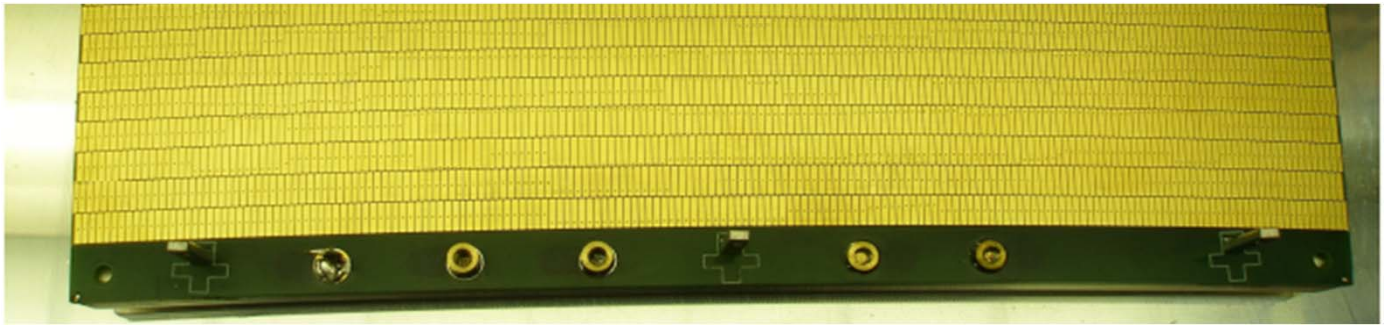
HV connector



The Current Asian LP GEM-Module



The top side of the pad plane



The bottom side of the pad plane

Problems & Issues of the Current Asian LP GEM-Module

(a) HV breakdown of GEM and module:

Destroy significant No. of the PAC16 amplifiers in 2009 & 2010.

- ← **(i) Higher micro-discharge rate of the GEM.**
  (ii) Large segmentation of the GEM electrodes (cured in 2012)
- ← **Limited mechanical (position) precision of GEM on the pad plane (discharges to the filed cage/dummy modules/filed cage) (not occurred in 2012)**
- ← **Independent components which triggered a large scale HV breakdown. (only happened in the March 2010 beam test)**

(b) Distortion due to the metal posts for the GEM stretching on the pad plane using

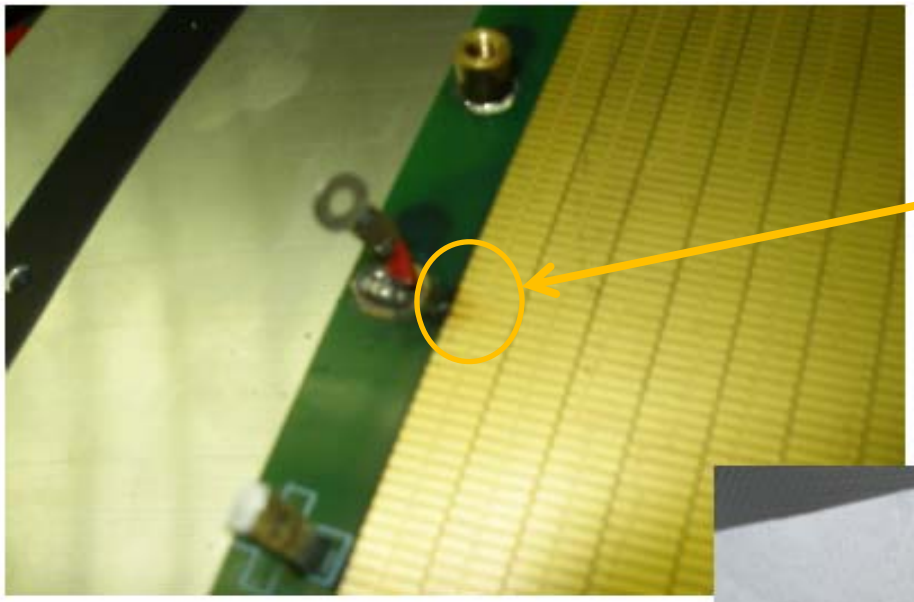
(c) Limited No. of HV connection due to the large components.

(d) Mechanical precision of module due to the way of the GEM streaching.

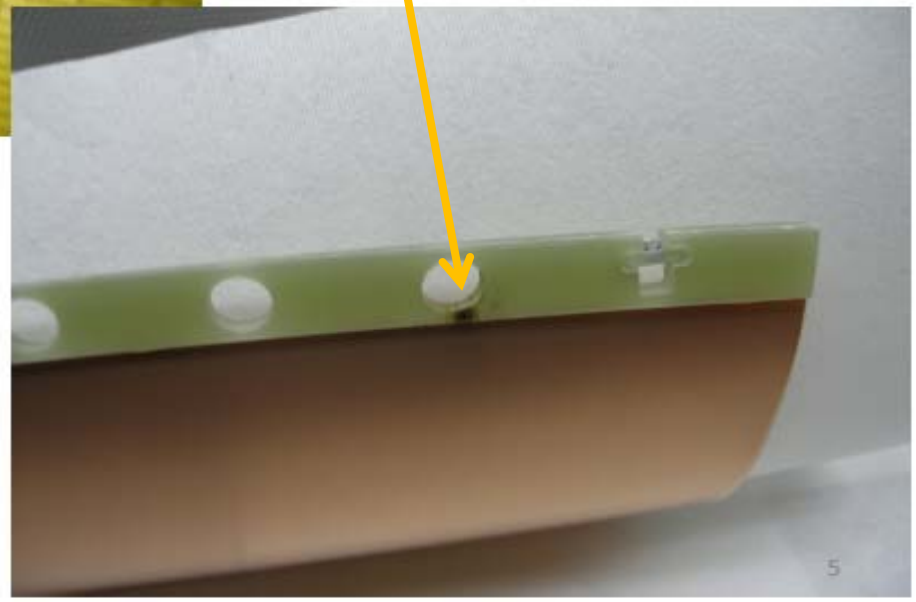
(e) Mass production and reliable operation in ILD may require simpler and reliable structure with less components.

The Current Asian LP GEM-Module

The accident in March 2010



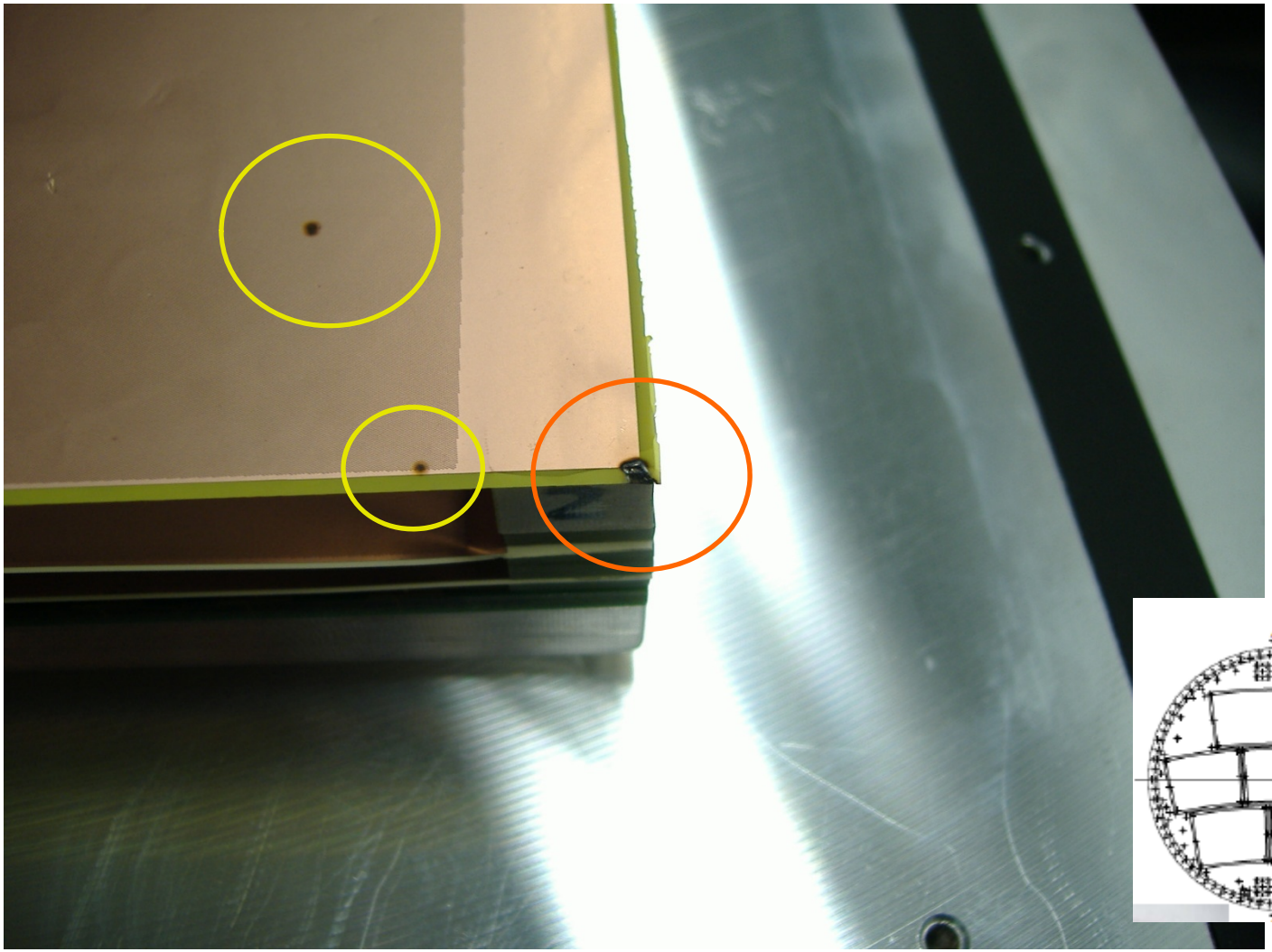
Traces of spark



Pad plane:
Where the Cu washer was
(HV terminal – D30: a few MΩ)

The Current Asian LP GEM-Module

The accident in March 2010



Mockup Study in JFY2013-2014

Goals:

(a) Miniature GEM HV connections (commercial components molded in the GEM frames:

(b) The frame d GEM? - NO! → Fixed positions of the GEM frames on the pad plane while we still stretch GEMs on the pad plane.

Can we accommodate 2/3 layers of GEMs: yes).
A simple structure with less components but still stretching GEMs on the pad plane.

Our approach in the current mockup (with no gate device at this stage)

(i) The first trial: the standard 50micron GEM (easier) in the three layers .
(→ 100micron GEM might be too strong?)

(ii) Apply some pretension of GEM when glued with the top/bottom fames on a flat jig: → How do we control the pretension? What accuracy of gluing?

(iii) Stretch and pile up the framed GEMs by using steps made on the GEM frames . No adjustment to stretch GEMs on the pad plane.

(iv) Hold the framed GEMs by non-metal screws.

(v) Insert the HV pins.

The Current Status

After the long delay of > a half year !

All the components are in hands (at Rinei and Raytech) :

- **Dummy and real GEMs (with GEM holes and the through hole connections for HV).**
- **GEM frames.**
- **Tools to glue the frames on GEM (with a proper precision to keep the GEM tension – flatness on the pad plane).**
- **GEM frame and components for the HV connection.**
- **Dummy pad plane.**
- **Al backplane**

The miniature HV conceptions was tested in last summer with small test pieces.

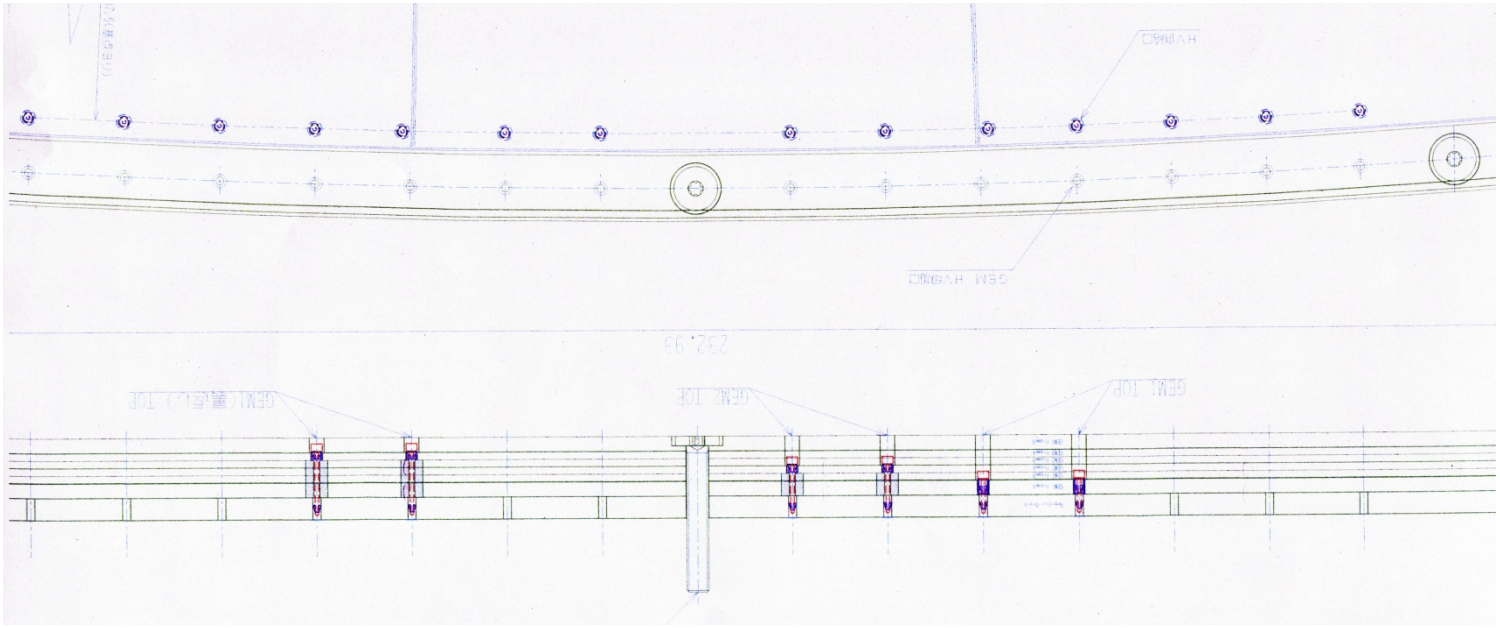
After a test assembly with the dummy GEMs, we need to make small corrections on the back plane to ensure the HV isolation from the backplane.

The key issue of the mock up study is if we might be able to keep the tension (or the flatness) of GEMs on the pad plane by gluing the GEM frames on GEM with necessary precision on the jig.

We hope that we finally test the new structure with real GEM in June-July.

HV connections

HV supply to the bottom electrode by through holes.



GEM for the Mock Up

GEM (with GEM holes) for this Mockup.
50micron/polyimide with the standard GEM pattern, the chemical process.
Fabricated by RAYTECH.