Mechanical Design, Fabrication, and Installation

W.J. Llope
Rice University

System	MRPCs	"Tray" Design	Electronics	Installation
STAR TOF	excellent	complicated	new & complicated	simple
STAR MTD	excellent	simple	commodity	complicated

Outline:
- MTD "tray" mechanical design
- MTD11 prototype assembly
- MTD11 testing
- MTD9 and MTD11 in STAR
- Full System design and installation

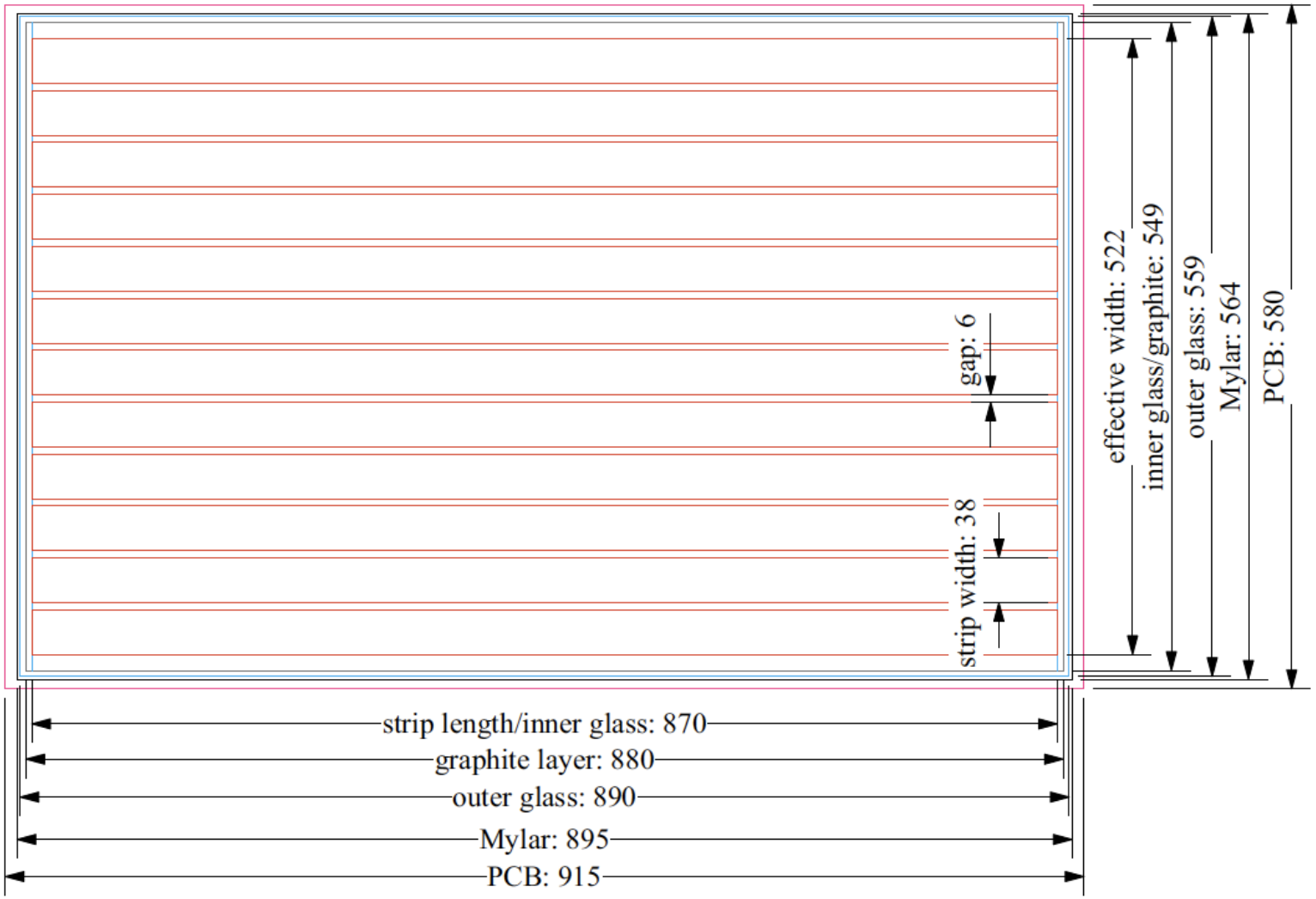
"MTD9" is the older run-9/10 prototype
"MTD11" are new prototypes for run-11

Assumed MRPC Dimensions for MTD11 Prototypes

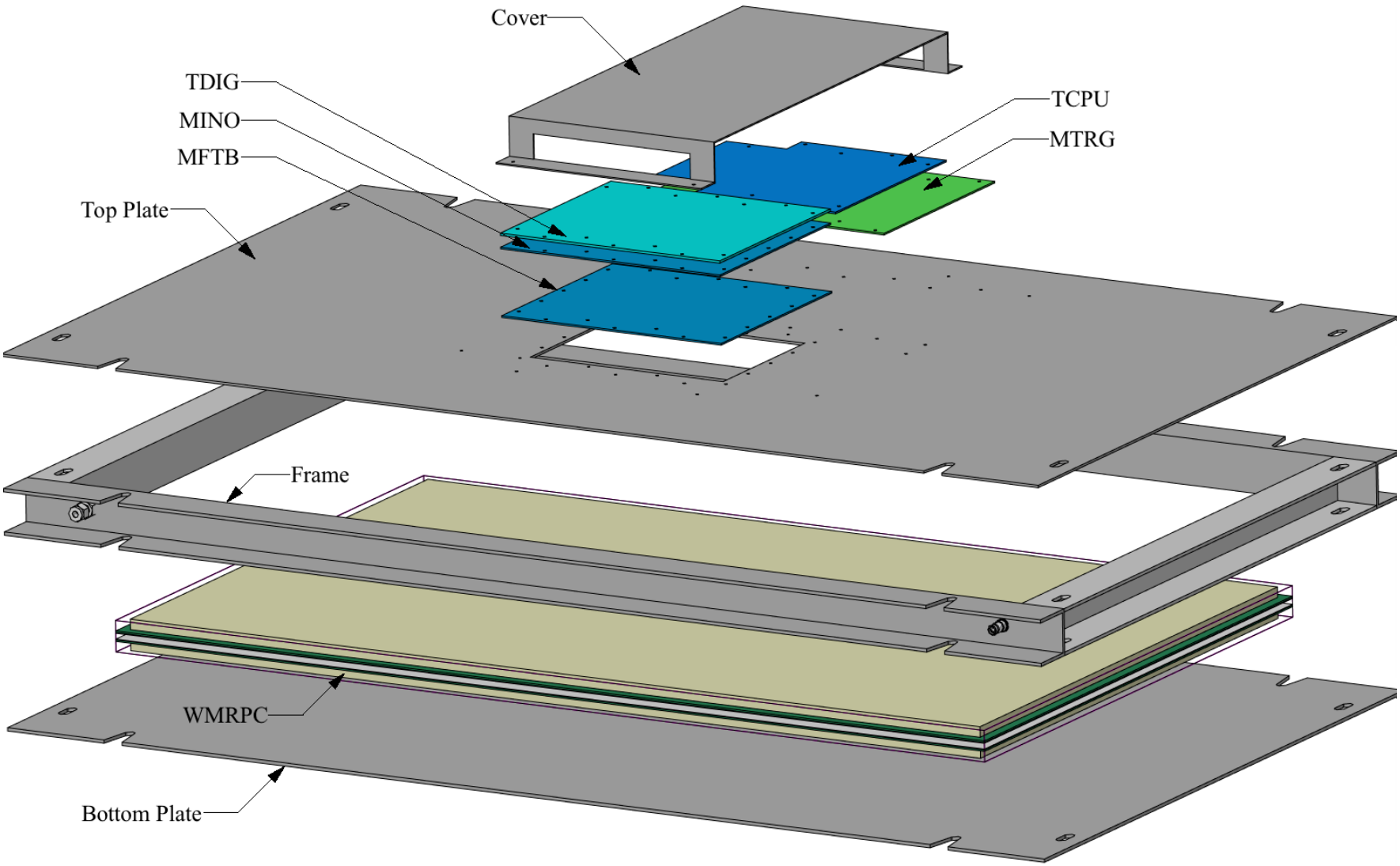
USTC Prototype

Outer (PCB) 58.0cm x 91.5cm ← Tsinghua MRPCs were 93cm long… Prefer 91.5cm

Active (Pads) 52.2cm x 87.0cm Height = 3cm Weight = 13kg (29lbs)

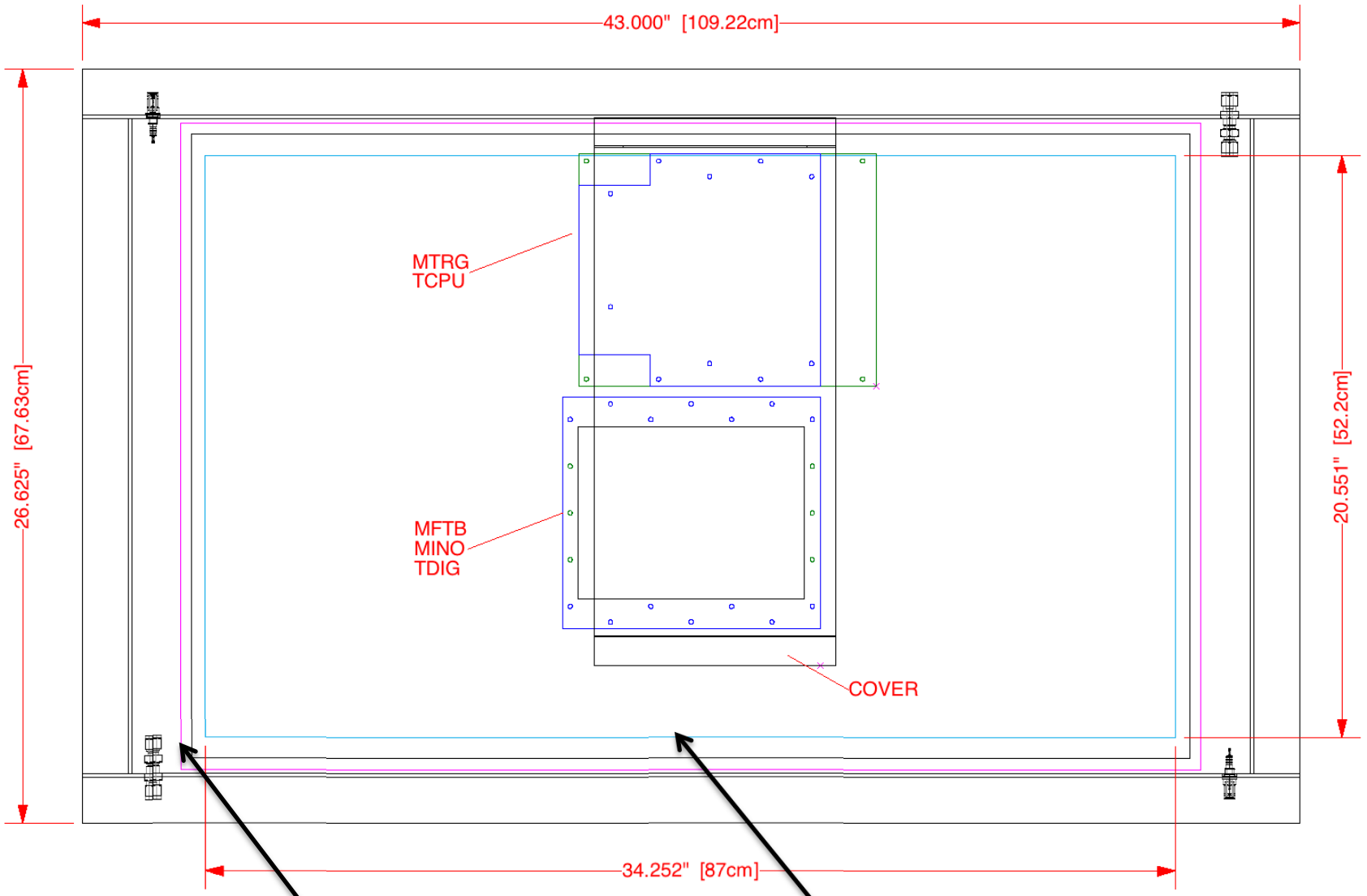


MTD11 Tray Design (Exploded View)



no reason known (yet) why the MTD11 tray design cannot be “final” for full system

MTD11 Tray Design (Top View)

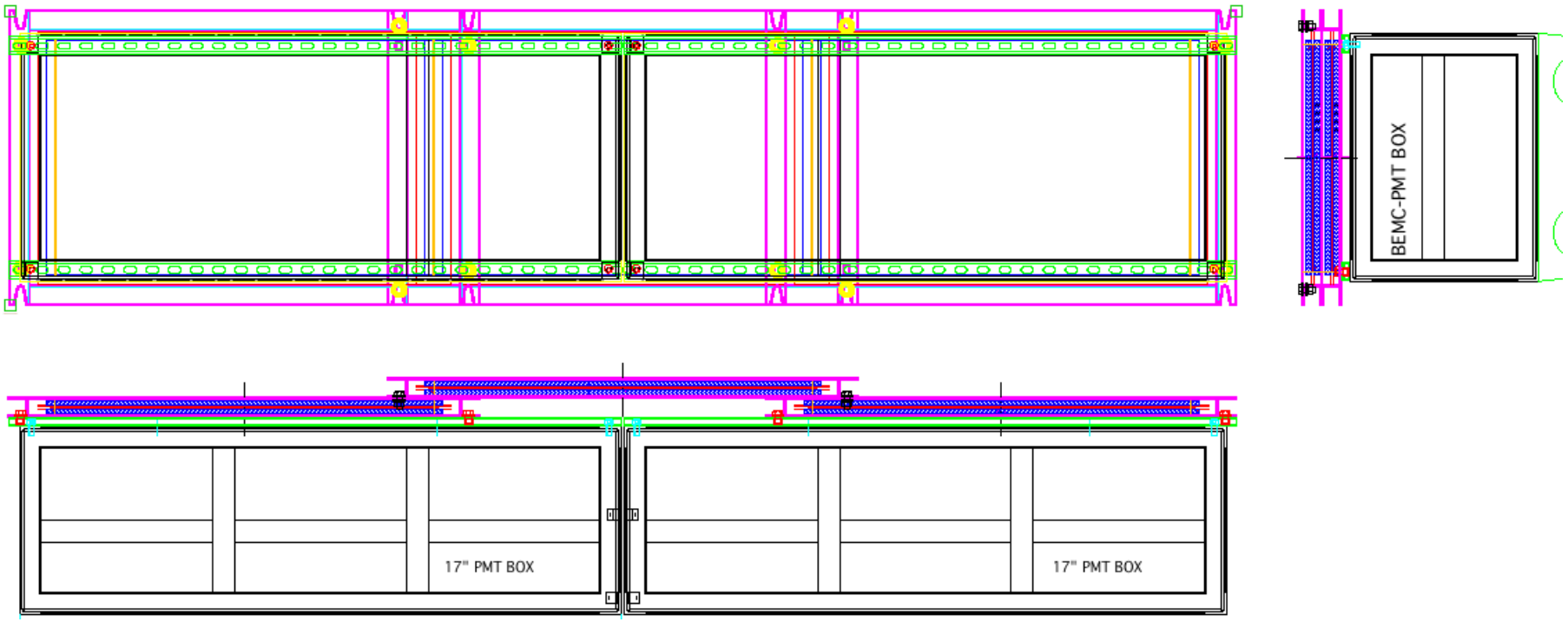


MRPC "footprint"

inner glass stack = "active area"

Initial Design for MTD11 Stacking in STAR

The three MTD11 Trays mount directly onto BEMC PMT boxes
The Trays overlap so that the MRPC active regions meet end-to-end in “Z”



lower row of trays bolt to unistrut on the BEMC PMT boxes
upper row of trays bolt to the lower row of trays

this won’t work for the full system – more on this later in this talk…

The MTD11 Project

Rice and UT-Austin received ~155k$ STAR R&D funds for a MTD patch for Run-11

Design and fabricate three "production prototype" mechanical structures

We actually built four full trays (one still at UT-Austin)

Two Tsinghua MRPCs (two with 6×250 μm gaps, 58cm×93cm outer)

Two USTC MRPCs (6×250 μm gaps & 5×250 μm gaps, 58cm×91.5cm outer)

Develop and fabricate new front-end electronics: MFTB, MINO, & MTRG

Assemble & test the trays with final electronics

Detectors arrived December 13, 2010 & were installed immediately

Being operated throughout the run

gain operational experience and study timing & triggering performance

Develop new "tight timing" (VPD+MTD) triggers

Also accomplished:

"MTD9" moved to a different location, operating throughout the run

New MTD-specific THUB and DAQ interface

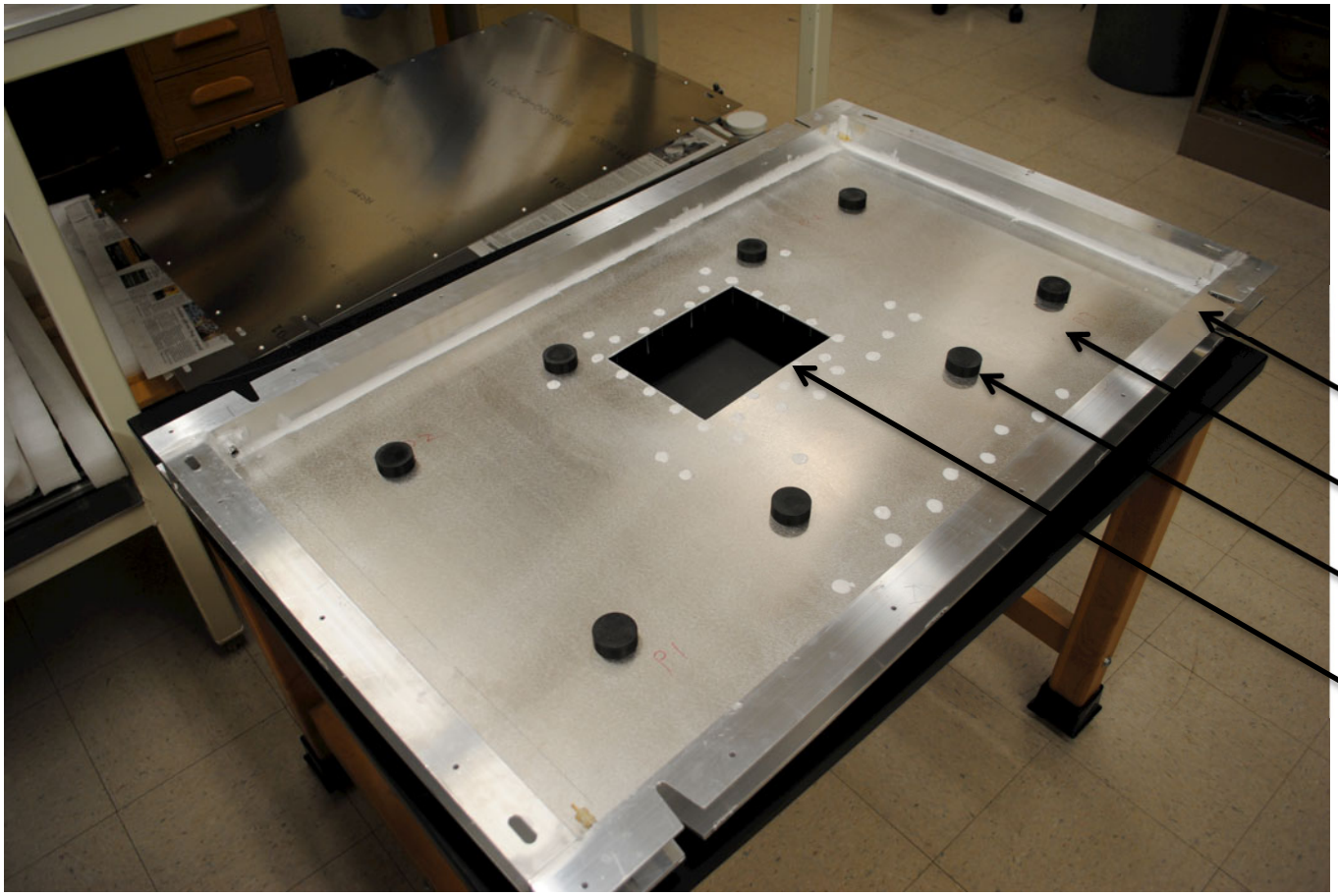
On the following slides:

Assembly and Test of MTD11 trays at UT-Austin

Installation and operation in STAR during present Run-11

MTD11 Tray Assembly

Tray “top” (holds electronics) is complicated… Fabricated at Oaks Precision in Houston
Delivered to UT-Austin in the back seat of my car



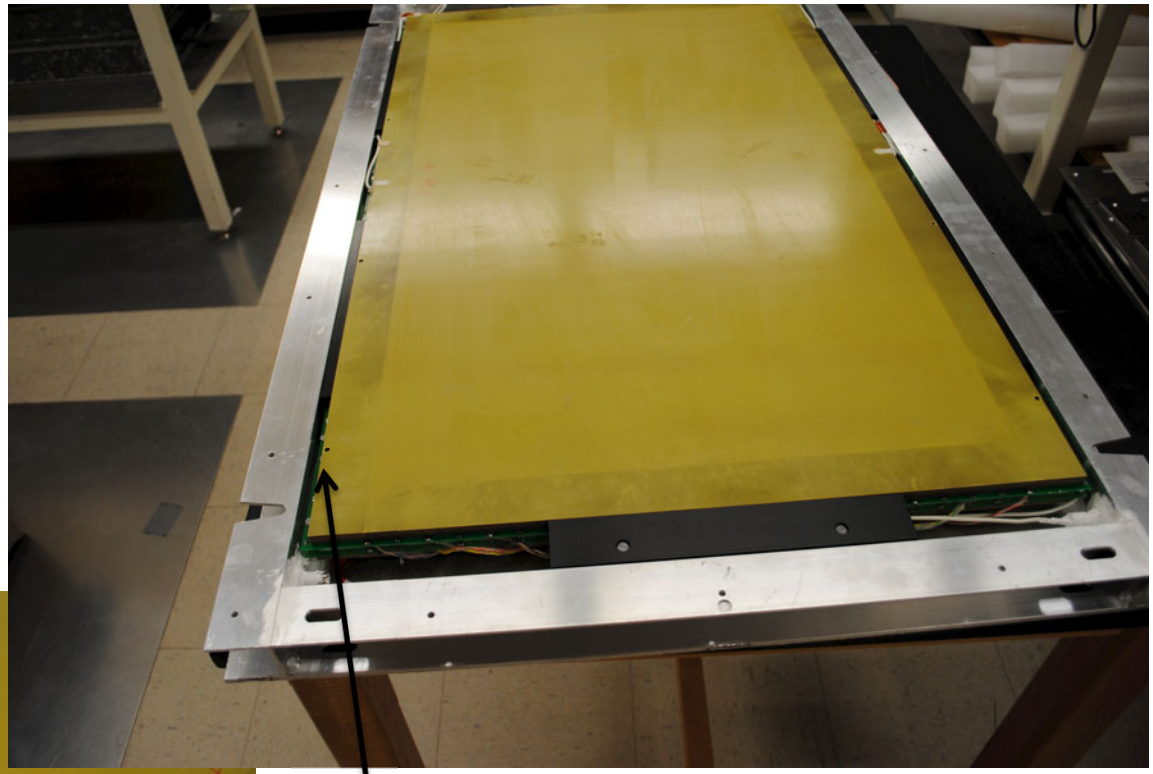
top tack-welded to (welded) frame, sealed with DC730 freon-resistant sealant
bottom bolts to frame in countersunk holes, also sealed with DC730

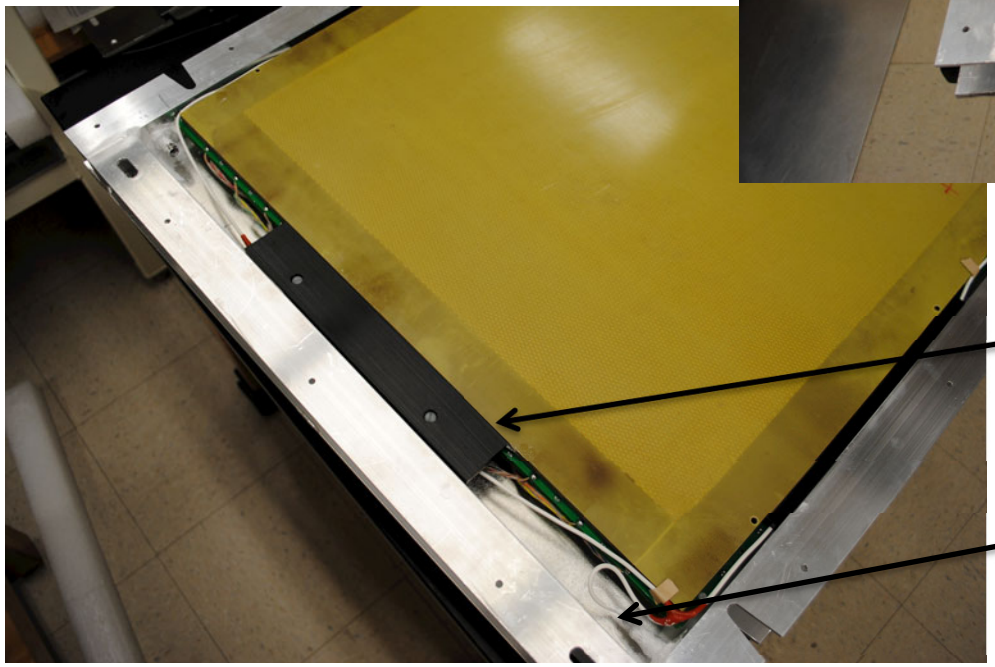
MTD11 Tray Assembly

MRPCs inside the tray…

bottom of MRPC is flush with the bottom of the tray

correct upper spacer thickness is thus important!

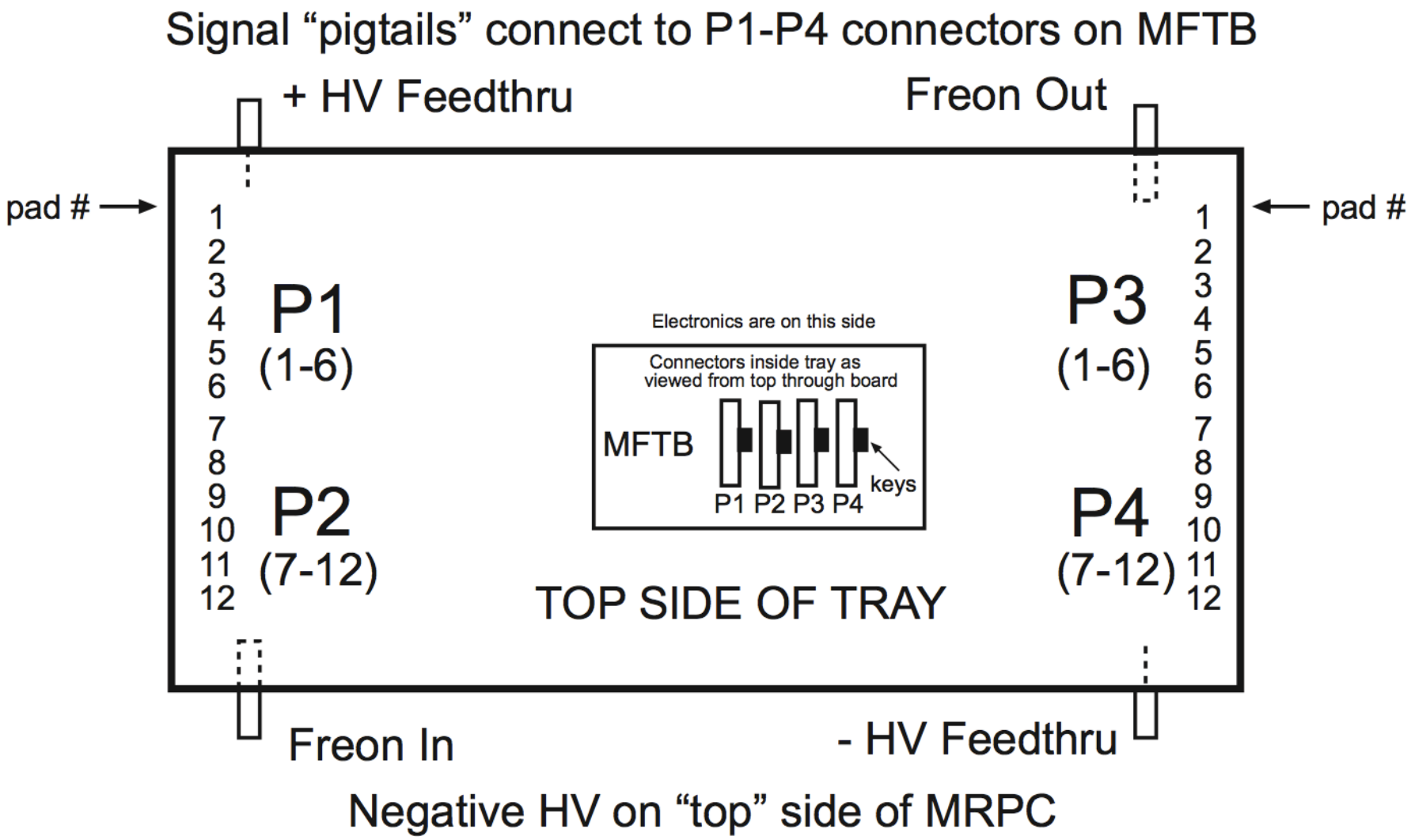




side spacers hold MRPC laterally w.r.t. the frame…

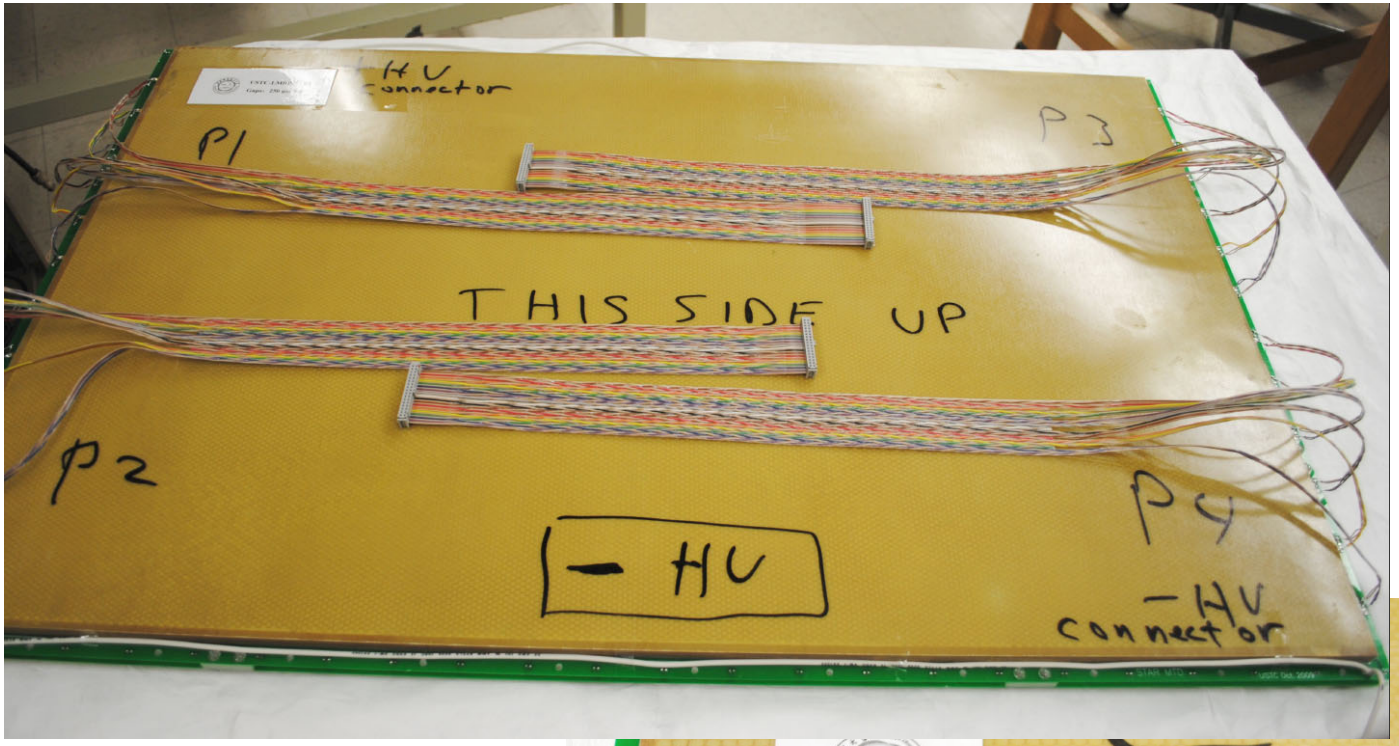
HV wiring connected to bulkhead connector

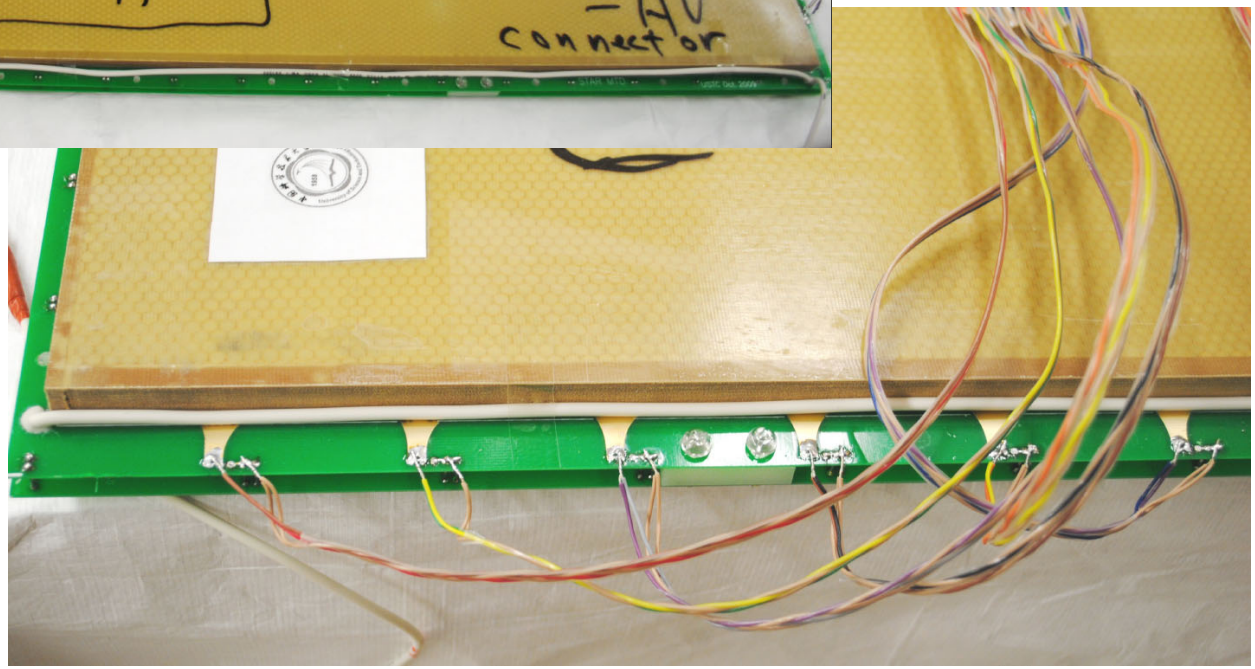
MTD11 Tray Assembly (Connections Schematic)



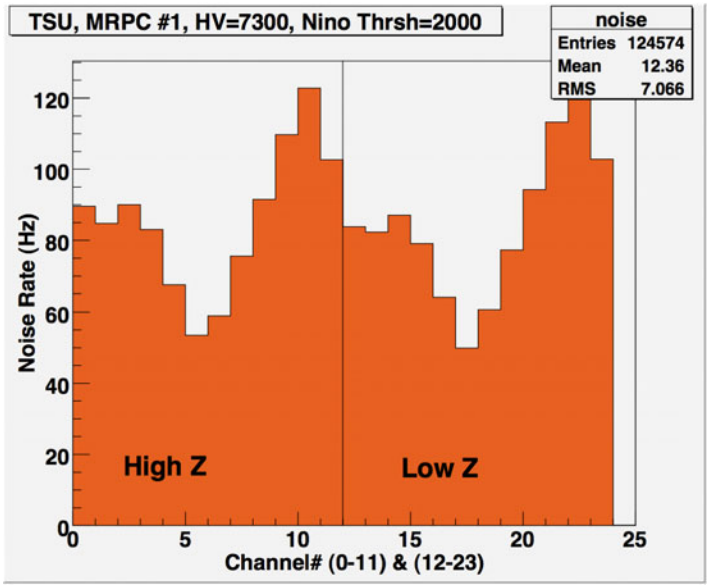
UT will make the signal pigtails and ship them to China/India…

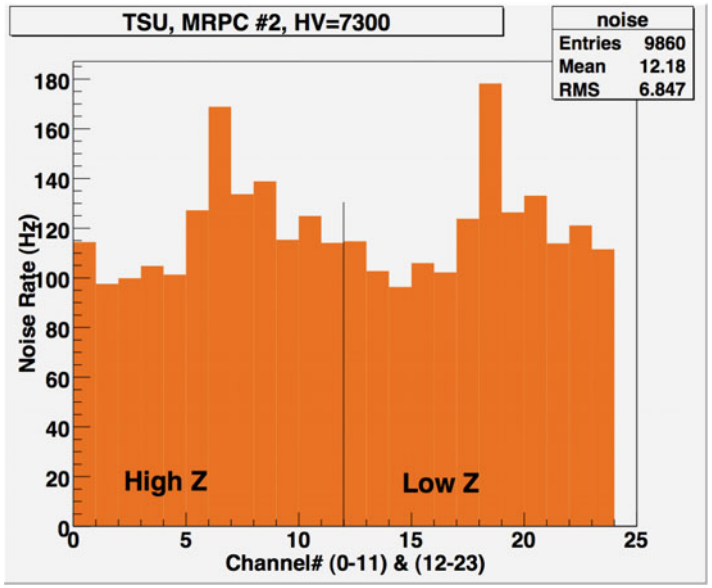
MTD11 Tray Assembly

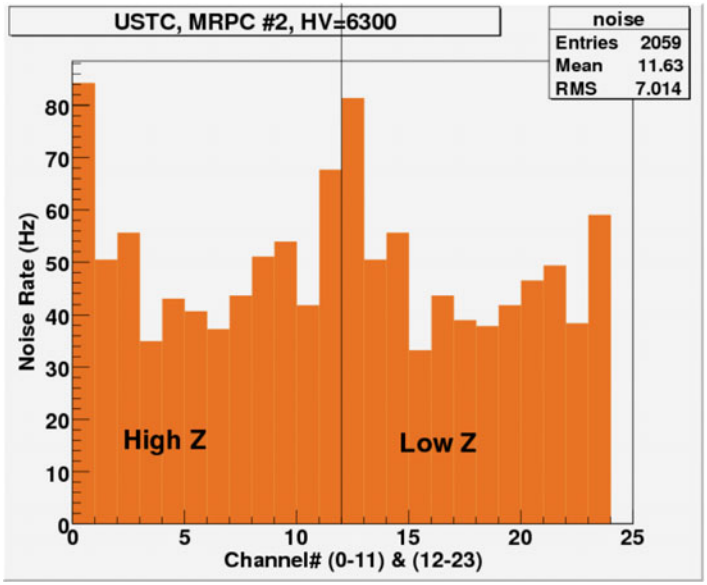




MTD11 Test Results at UT-Austin – Hit patterns





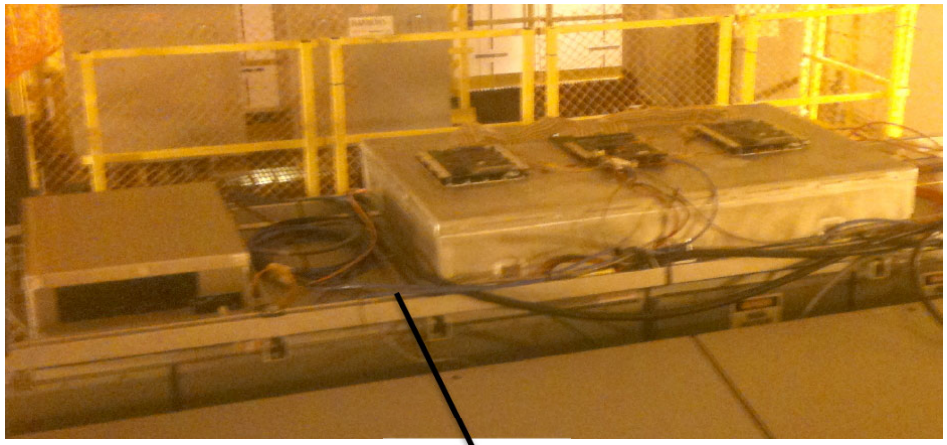


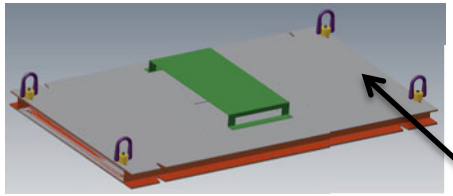
Untriggered cosmics
freon-only
6×250μm gaps: HV = ±7300V
5×250μm gaps: HV = ±6300V
Read-out via full chain of final electronics

➔ reasonable noise rates…
(strip area = 331 cm^2, so <0.5 Hz/cm^2)
➔ no dead channels…

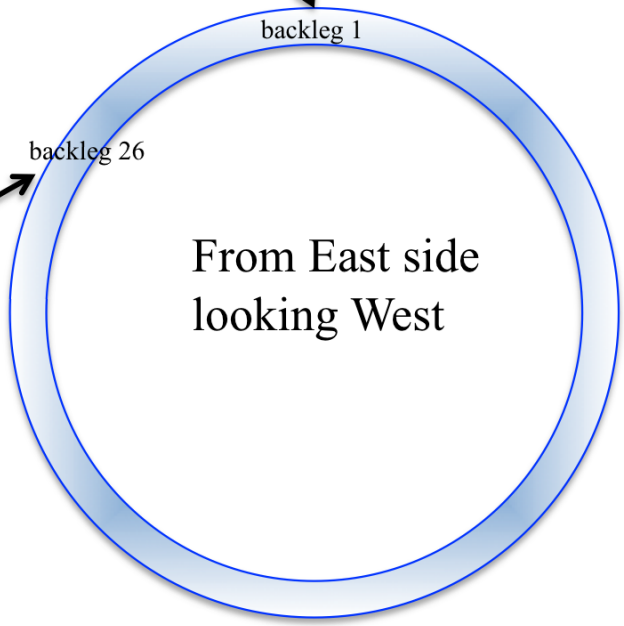
MTD9 and MTD11 Trays at BNL, December 2010

MTD9 & MTD THUB

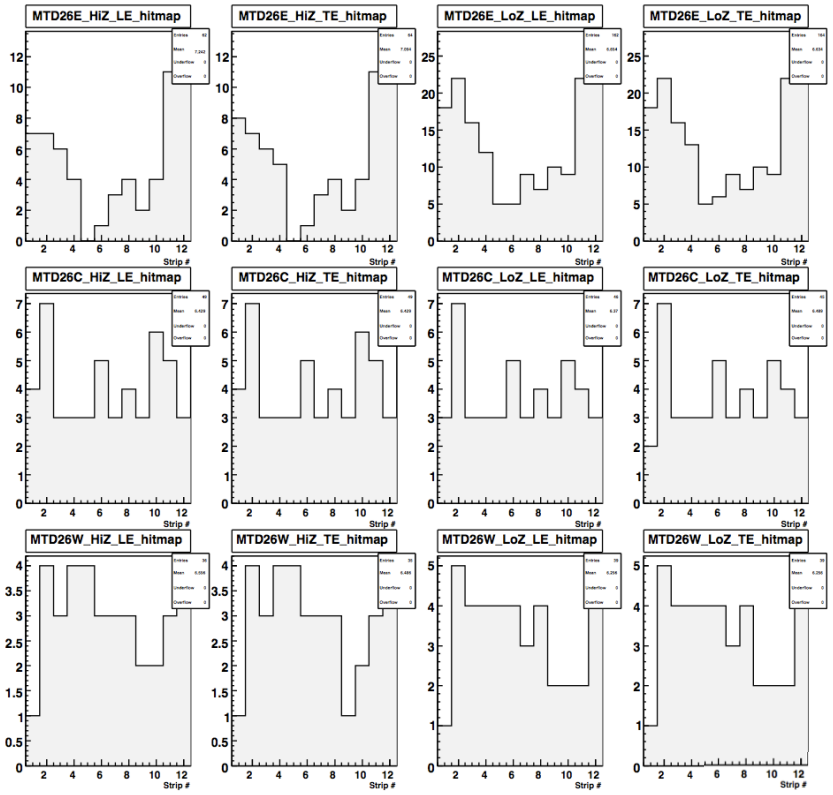




Three MTD11 trays (craned into place)

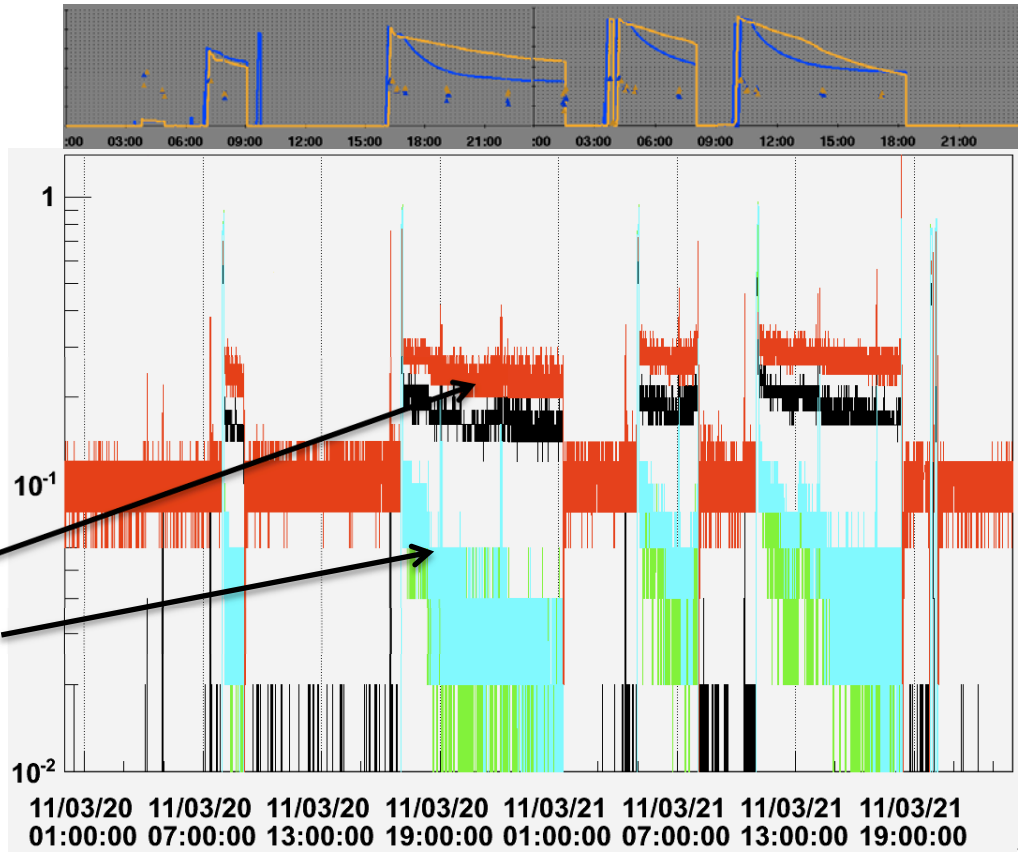


Run 11 Online hit patterns (untriggered) and HV information



online hit patterns look reasonable
(3 MTD11 trays × 2 strip ends × 2 signal edges)

low rate per 1M events because
- this is p+p… ($\sqrt{s_{NN}}$ = 500 GeV)
- MTD11 trigger still being developed…
  (see Lijuan's talk in this workshop)

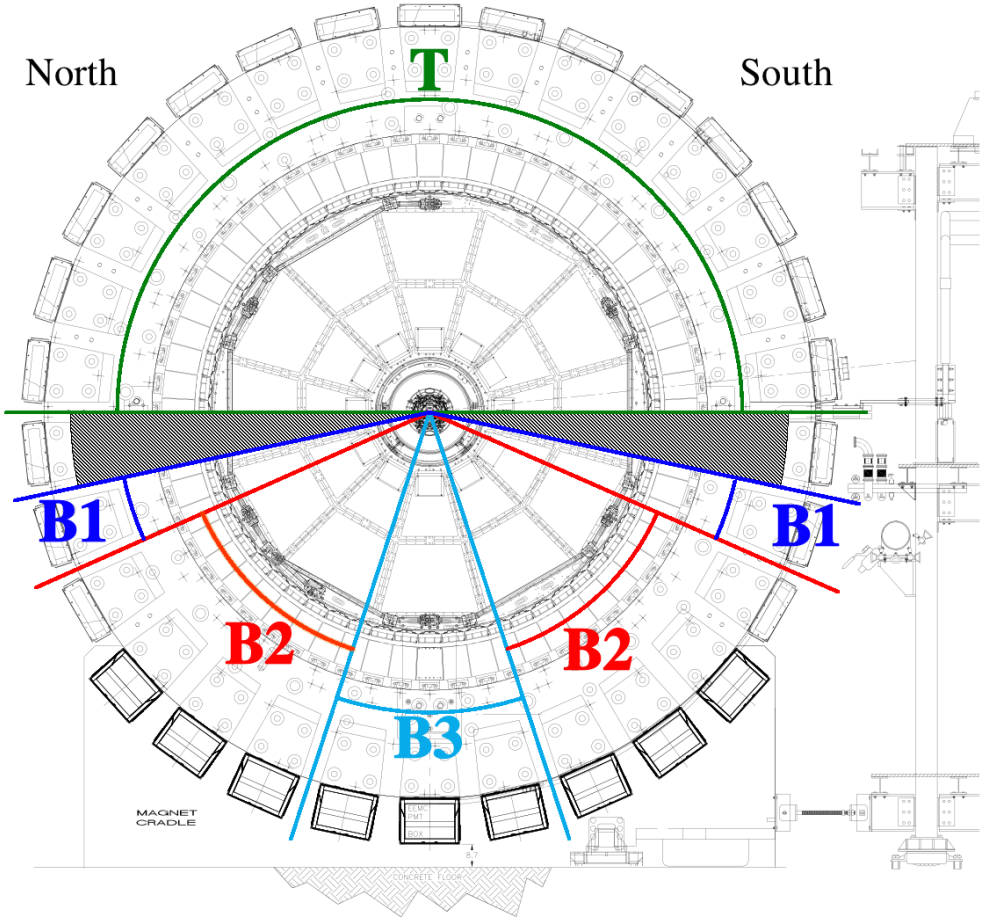


HV monitoring

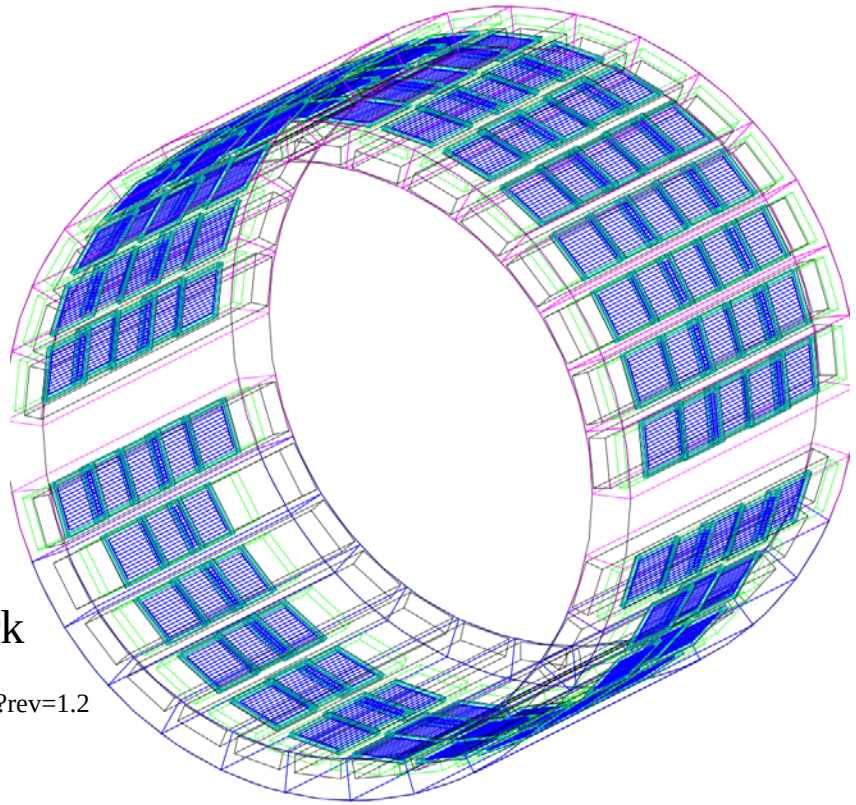
line 1: 6×250 μm gap MTD11 trays, ±7200V
line 2: 5×250 μm gap MTD11 tray+MTD9, ±6200V

Geometry of the Full System

also see http://wjllope.rice.edu/~MTD/MTDintegration.pdf



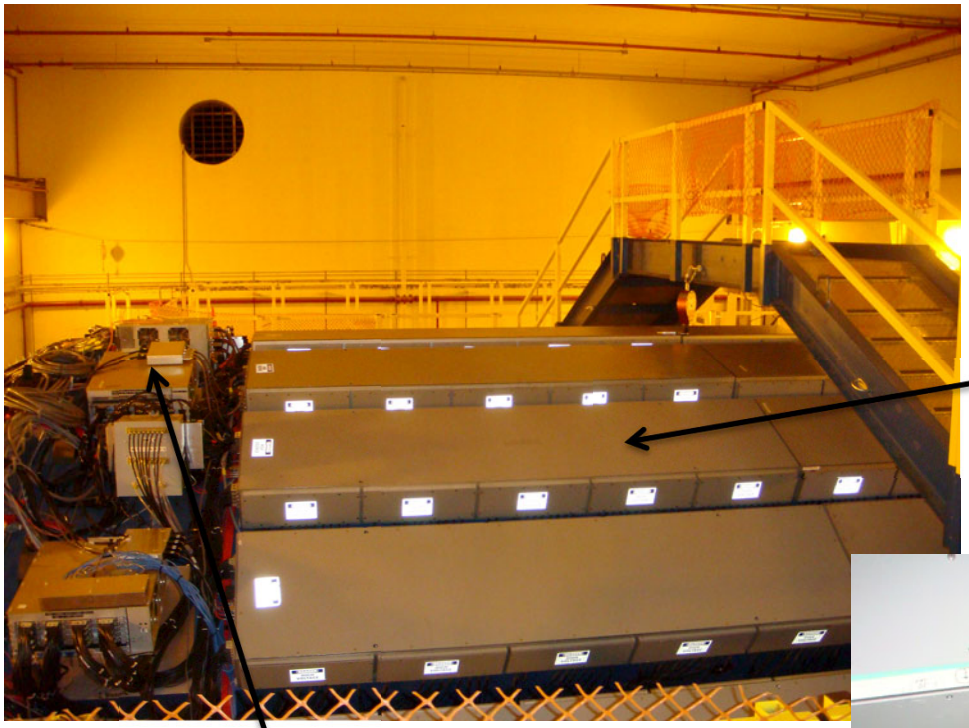
15 “5-packs” over the top
2 “5-packs” just under equator
11 “3-packs” below
…**118 MTD trays total**
…N/S & E/W symmetric



implemented in STAR geant simulations framework

http://www.star.bnl.gov/cgi-bin/protected/cvsweb.cgi/pams/geometry/mutdgeo/mutdgeo4.g?rev=1.2

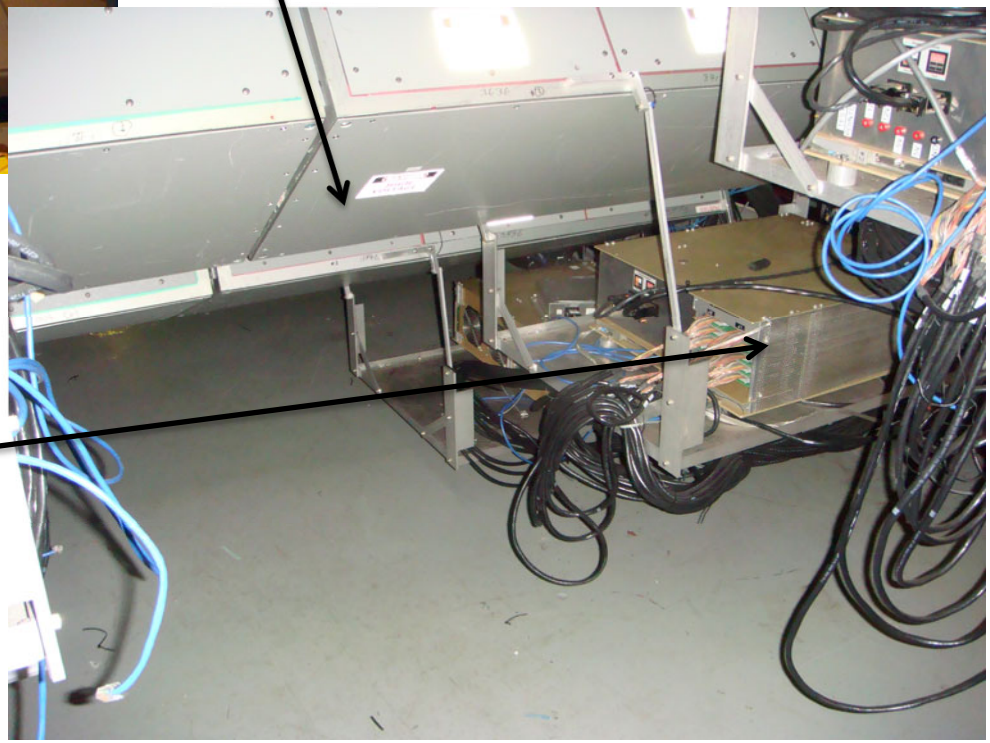
Full System Installation Scheme



above STAR

BEMC PMT boxes

below STAR



BEMC crates

Full System Installation Scheme

The mounting scheme for the MTD full system trays is actually a difficult problem!

MTD trays must mount on top of BEMC PMT boxes…

- access to these some number of these boxes is needed during every shutdown to repair BEMC channels
- typically this work is done by laying down on neighboring PMT boxes
- this implies that 2-3 backlegs of MTD trays would need to be removed to access a single BEMC box!

Scheme used in Run-11 worked, and was the simplest possible for us, but it would be a nightmare for a full system…

- tray positioning is a little too sloppy because of imprecise positioning of unistrut nuts
  - difficult to install the upper layer of trays onto lower layer of trays…
- too much work for STSG (Bob Soja and his expert technicians) to remove/reinstall MTD trays
- too much cabling (dis)connecting & stresses on MTD modules – increased failures & gas leaks?

There is another problem too - how do *we* get access to a random tray on top of STAR?

- one cannot simply walk on the MTD layer like one can walk on the PMT boxes
- how do we replace a cable or sniff for gas leaks on a random tray when everything is installed?!?

And yet another problem are obstructions hanging from the boxes below STAR…

This is clearly going to be the hardest part of the total system design….

Full System Installation Scheme

We want: MTD (de)installation by STSG to be rapid, repeatable, and safe
- Reasonably quick access any MTD tray at any time
- Efficient access to any EMC PMT box w/ minimal MTD deinstallation
- Some way around the obstructions below STAR w/out moving those obstructions

Several face-to-face meetings have been held to discuss the various issues…
- MTD reps: Bill Llope, Lijuan Ruan, Zhangbu Xu
- BEMC rep: Oleg Tsai
- STSG reps: Bob Soja, John Scheblein
- STAR Operations Manager: Bill Christie

Most recent meeting was on 2/22/2011
- Summary & action items: http://www.star.bnl.gov/HyperNews-star/protected/get/mudet/245.html

General agreement on the “basic idea” – which I will describe on the following slides

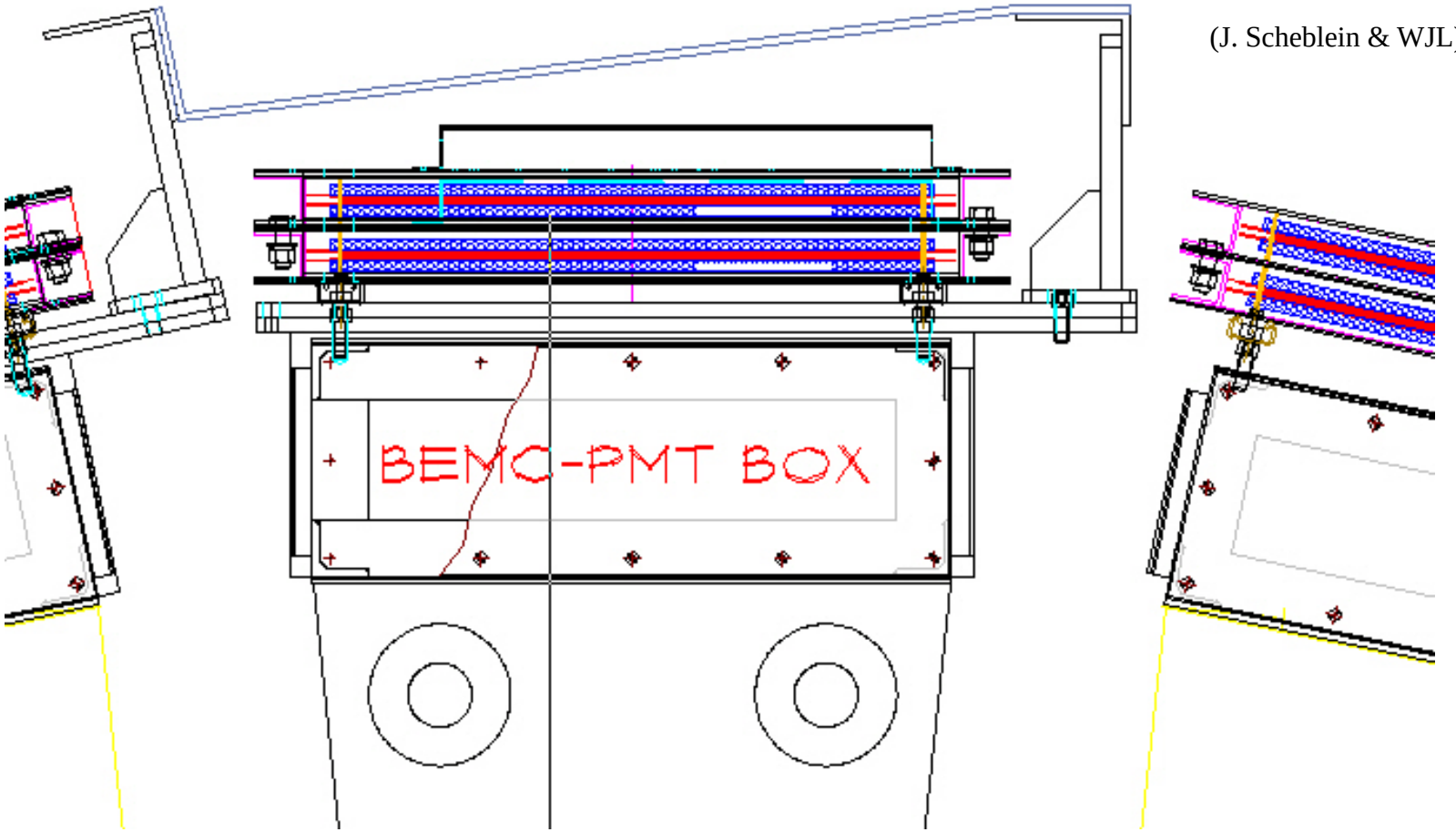
…consider “above STAR” and “below STAR” cases separately…

Full System Installation Scheme

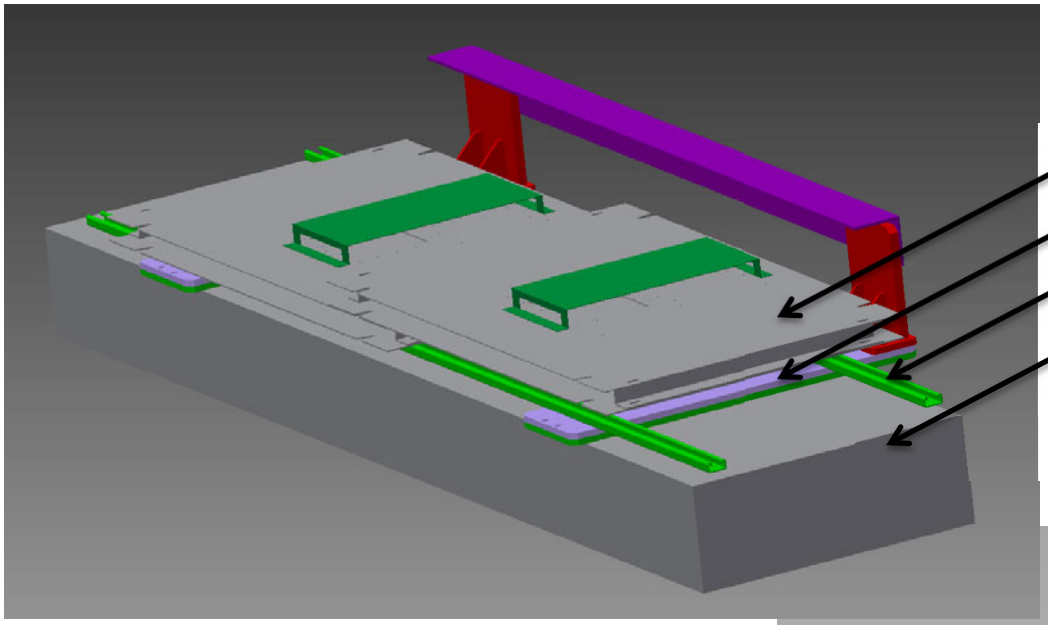
new approach: Make mounting more complicated to make integration easier…

- unistrut mounts to two layers of “cross-pieces”
- use available space between backlegs
- install “diamond plate” covers over the top (heat retension?)

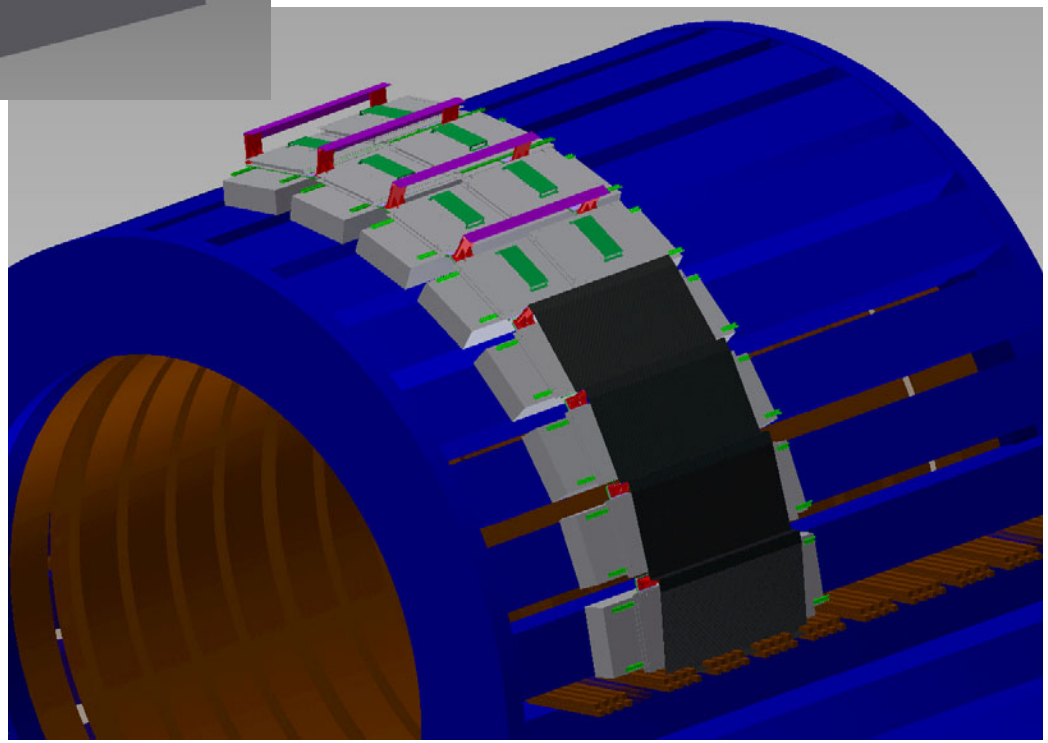
(J. Scheblein & WJL)



Full System Installation Scheme

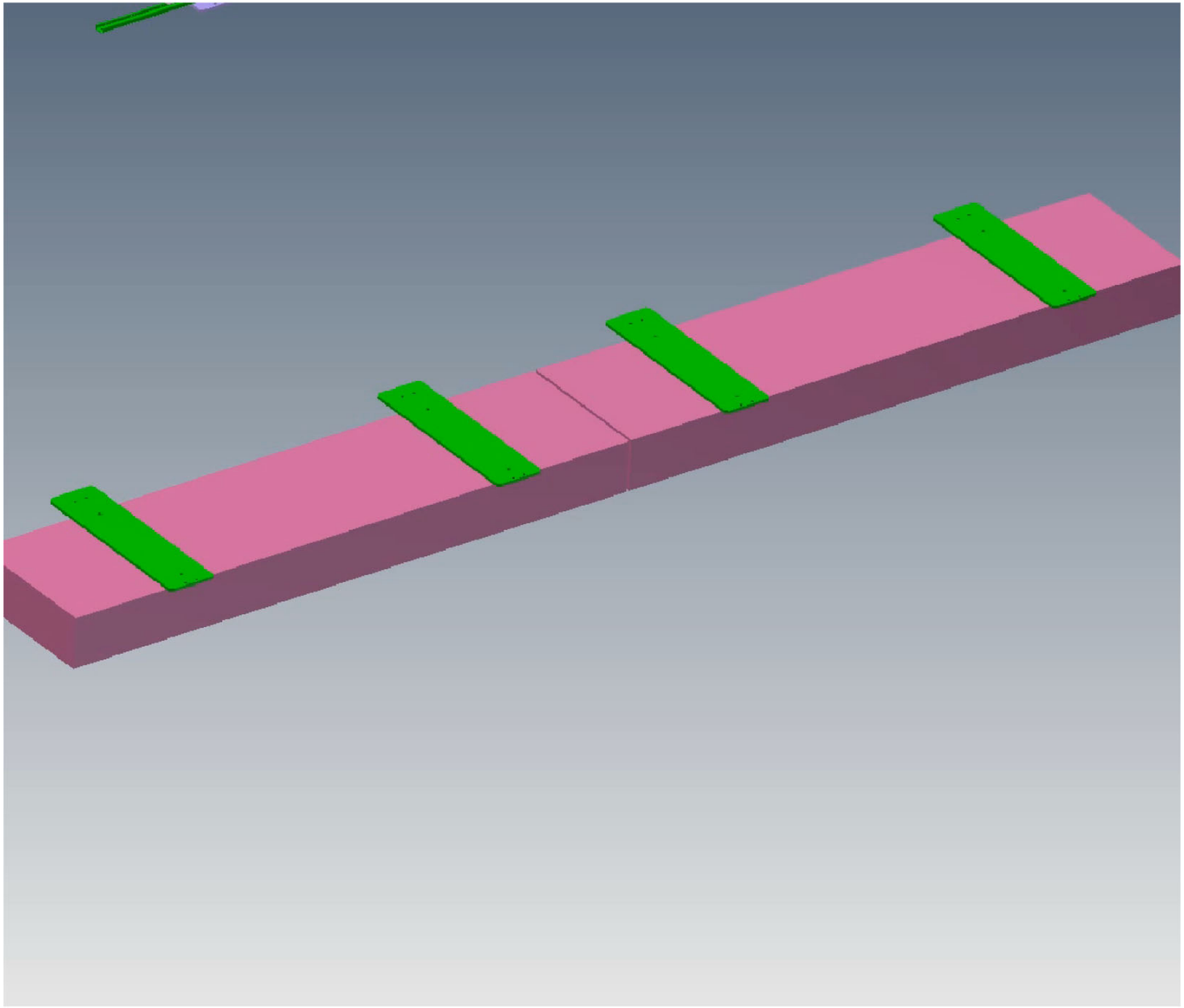


Two PMT boxes per backleg
one "2 pack" on each PMT box
5th MTD tray joins two "2 packs"



Full System Installation Scheme (Above STAR case)

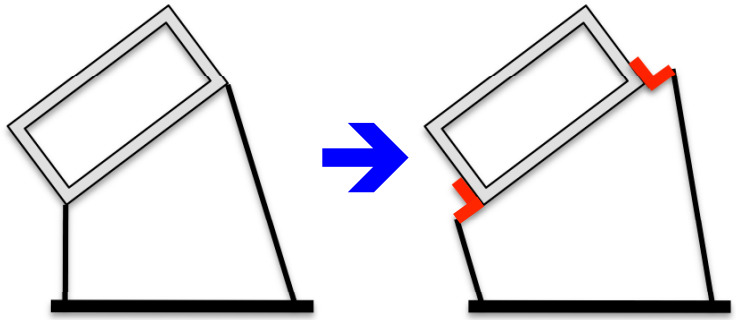
movie:

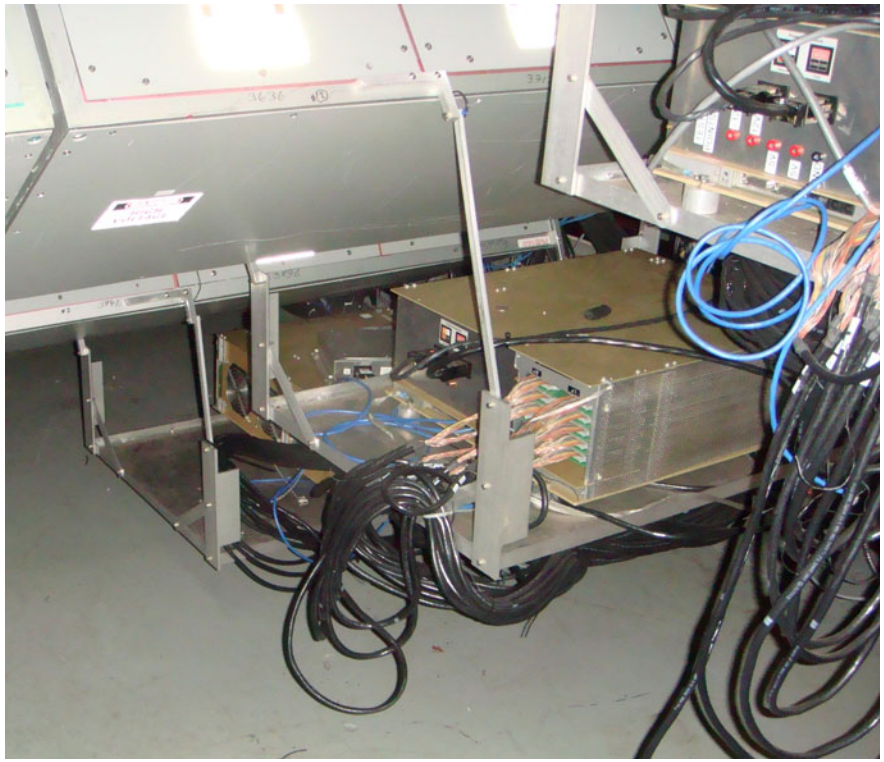


Full System Installation Scheme (Below STAR case)

Under STAR…
not a lot of room down there
not enough slack in BEMC cabling
to move these crates

only viable option known is to
"widen the hangars"





Other items:
fittings and fixtures should be plug and play (limit # of small nuts/bolts)
allow for "foam" filler pieces between PMT boxes

locate local tray testing and storage area
locate space and define fixtures for 2-pack assembly in the AB/WAH

Summary and Conclusions

MTD11 prototype project has been successful so far…

- Fabricated trays and USTC & Tsinghua MRPCs fit together nicely
- Test results after fabrication look very good
- Detectors installed on-time.
- Collecting untriggered data throughout Run-11
- Hit patterns and noise rates in STAR are reasonable
- Looking forward to resolution results & add'l development of timing triggers

MTD11 tray design is "final" if MRPC footprint stays at **58cm × 91.5cm × 3cm**

- Negative HV side has the signal pigtails
- UT will produce the pigtails (Jo brought examples to this meeting)

The critical issues in terms of system design involve installation scheme

- Above STAR: "2+1+2" approach with semi-permanent covers
- Below STAR: widen the hangars, leave BEMC crates where they are

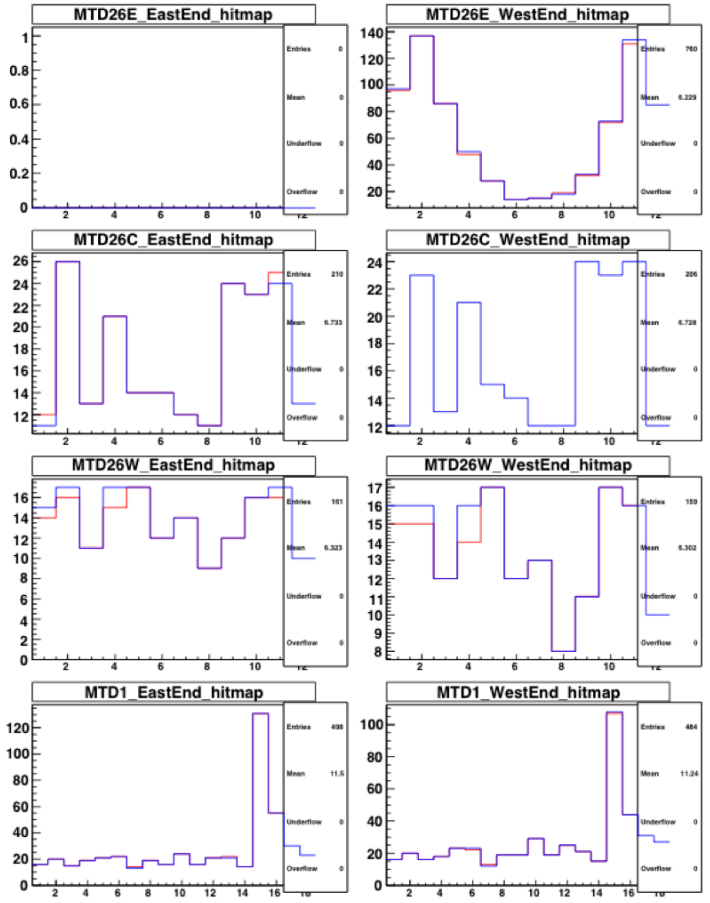
Still need to optimize these designs but the basic idea is in place I think...

感谢您的款待

Some Slides on Software Status from Frank Geurts

MTD Online

- MTD DAQ reader
  - decoupled MTD reader from TOF: separate THUB and DAQ node
  - Data format remains similar to TOF
  - Both online and offline follow the same procedure in retrieving data banks and decoding data
- Basic online QA plots
  - run of a local event pool, typical sample rate 0.1%
  - work in progress
    - Based on newly decoupled MTD unpacking
    - Provide low level QA
  - Example (run 12079003)
    - LE/TE Hit maps back leg 26 trays
- Future developments
  - Prepare for full MTD
  - Consistent naming scheme
  - Include more data consistency checks



MTD Offline: reconstruction chain

- Migrate from prototype test environment within BTOF classes to final full MTD infrastructure
- Goal: provide MTD specific data objects
  - Relevant data structures are removed from existing BTOF classes
  - no more TOF "ghost trays", e.g. tray 124 …
  - StMtdRawHit and StMtdHit classes ready for StEvent
  - Provide equivalent classes for MuDST framework
- Status: basic data unpacking class ready for inclusion into STAR StRoot framework
  - Pending review (confirmed by S&C leadership)
- Fast Offline
  - standard reconstruction chain at a significantly reduced fraction of the data sample
  - Based on very recent STAR library, i.e. DEV or newly tagged version.
- Future developments:
  - Develop and prepare databases
  - Include data consistency checks (until now only part of private stand-alone code)
  - Further update basic MTD hit info: combine double-sided readout, apply INL corrections, reconstruct Time-over-Threshold
  - Develop matching and calibration classes

MTD Offline: simulation

- Integrate MTD simulation in STAR simulation and StMcEvent framework
- Status:
  - GEANT geometry in place
    - Full MTD geometry
    - Year 2011 geometry
    - pending finale MTD numbering scheme
  - STARsim: relevant tables, structures, and classes prepared
    - Ready for review by S&C
  - StMcEvent framework StMtdSimMaker
    - No slow simulator yet (need further studies with existing MRPC slow simulator used for BTOF)
    - Basic class allows hit information to be accessible at higher level ROOT-based data structures (e.g. MuDSTs)
- Future developments:
  - Fast and Slow simulator components
  - Prepare for use in the STAR Embedding environment