ND280upgrade WP1 Mechanics Workshop Summary

Thorsten Lux

Institute for High Energy Physics

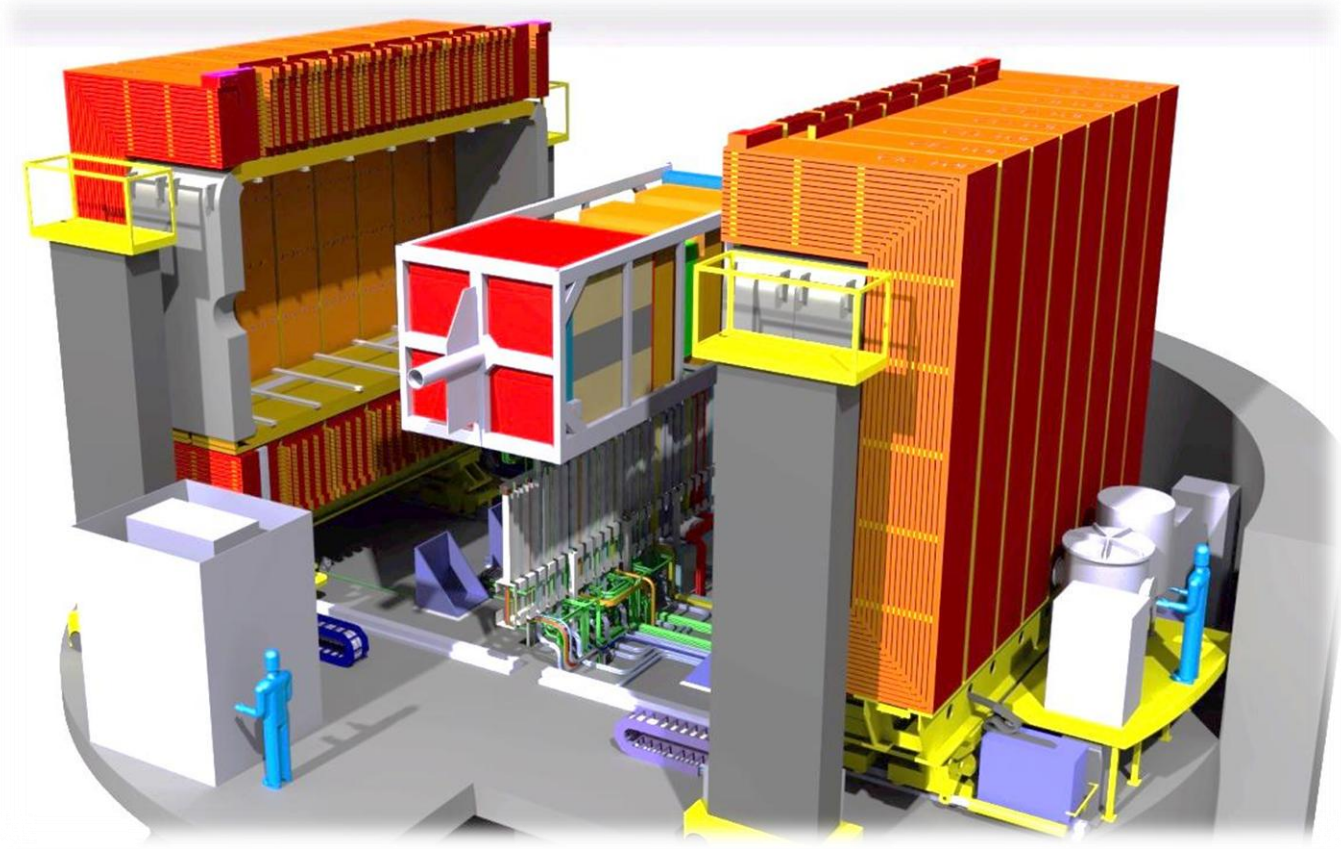
Tasks of this workshop

- Define a list of urgent questions to be addressed concerning the mechanics and integration tasks eg
  - Set up a 3D model of the basket with the new detectors (see F. Cadoux)
  - Define the detector envelopes (needed for detector design)
  - Specs of the support structure inside the basket, and interfaces with the basket
  - Specs of the TOF support structure and interfaces with the barrel ECAL and magnet
  - First discussion about accessibility of detectors and electronics (do we need to remove the top TPC ?)
  - First discussion about the services routing
  - First discussion about the integration plan and schedule
- Define the team and the work plan
- Allow discussions and interactions between the various groups
- Plan for the preparation of the TDR (see Thorsten)
- If time allows, discussion about the prototypes

from M. Zito's talk

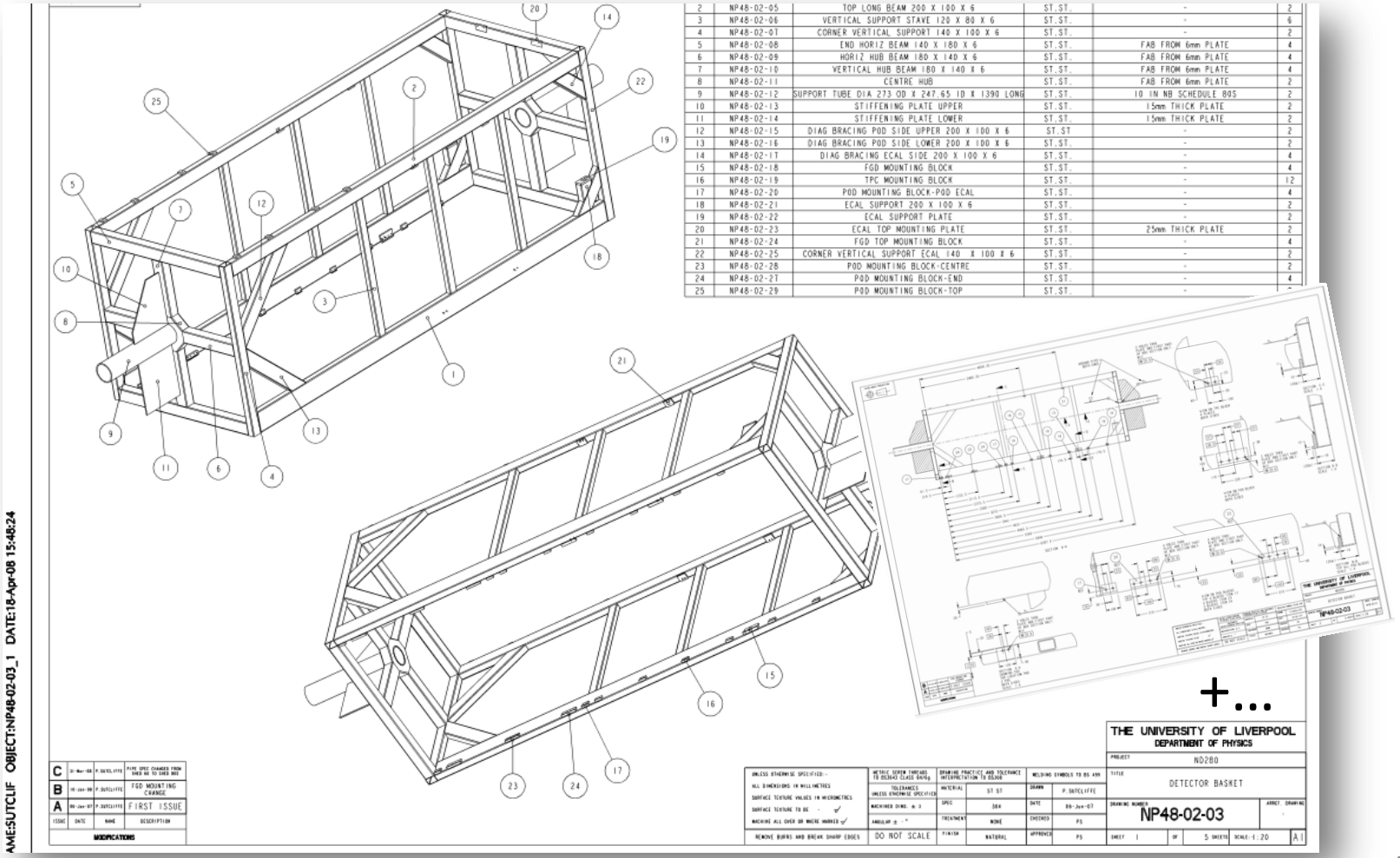
New Detectors into the basket

by F. Cadoux (Uni. Geneve)



Overview of the current situation

Thanks to *Peter Sutcliffe (Liverpool)*, basket fabrication dwgs are all available (needed for modifs)



2	NP48-02-05	TOP LONG BEAM 200 X 100 X 6	ST.ST.	-	2
3	NP48-02-06	VERTICAL SUPPORT STAVE 120 X 80 X 6	ST.ST.	-	6
4	NP48-02-07	CORNER VERTICAL SUPPORT 140 X 100 X 6	ST.ST.	-	2
5	NP48-02-08	END HORIZ BEAM 140 X 180 X 6	ST.ST.	FAB FROM 6mm PLATE	4
6	NP48-02-09	HORIZ HUB BEAM 180 X 140 X 6	ST.ST.	FAB FROM 6mm PLATE	4
7	NP48-02-10	VERTICAL HUB BEAM 180 X 140 X 6	ST.ST.	FAB FROM 6mm PLATE	4
8	NP48-02-11	CENTRE HUB	ST.ST.	FAB FROM 6mm PLATE	2
9	NP48-02-12	SUPPORT TUBE DIA 273 OD X 247.65 ID X 1390 LONG	ST.ST.	10 IN NB SCHEDULE 80S	2
10	NP48-02-13	STIFFENING PLATE UPPER	ST.ST.	15mm THICK PLATE	2
11	NP48-02-14	STIFFENING PLATE LOWER	ST.ST.	15mm THICK PLATE	2
12	NP48-02-15	DIAG BRACING POD SIDE UPPER 200 X 100 X 6	ST.ST	-	2
13	NP48-02-16	DIAG BRACING POD SIDE LOWER 200 X 100 X 6	ST.ST.	-	2
14	NP48-02-17	DIAG BRACING ECAL SIDE 200 X 100 X 6	ST.ST.	-	4
15	NP48-02-18	FGD MOUNTING BLOCK	ST.ST.	-	4
16	NP48-02-19	TPC MOUNTING BLOCK	ST.ST.	-	12
17	NP48-02-20	POD MOUNTING BLOCK-POD ECAL	ST.ST.	-	4
18	NP48-02-21	ECAL SUPPORT 200 X 100 X 6	ST.ST.	-	2
19	NP48-02-22	ECAL SUPPORT PLATE	ST.ST.	-	2
20	NP48-02-23	ECAL TOP MOUNTING PLATE	ST.ST.	25mm THICK PLATE	2
21	NP48-02-24	FGD TOP MOUNTING BLOCK	ST.ST.	-	4
22	NP48-02-25	CORNER VERTICAL SUPPORT ECAL 140 X 100 X 6	ST.ST.	-	2
23	NP48-02-28	POD MOUNTING BLOCK-CENTRE	ST.ST.	-	2
24	NP48-02-27	POD MOUNTING BLOCK-END	ST.ST.	-	4
25	NP48-02-29	POD MOUNTING BLOCK-TOP	ST.ST.	-	-

+...

THE UNIVERSITY OF LIVERPOOL
DEPARTMENT OF PHYSICS
PROJECT: ND280
TITLE: DETECTOR BASKET
DRAWING NUMBER: NP48-02-03
DRAWN: P.SUTCLIFFE
DATE: 08-Jun-07
CHECKED: PS
APPROVED: PS
SHEET 1 OF 5 SHEETS SCALE:1:20 A1

C	31-Mar-08	P.SUTCLIFFE	FIXD SPEC CHANGED FROM SHEE NO 10 SHEE NO2
B	19-Jan-08	P.SUTCLIFFE	FGD MOUNTING CHANGE
A	08-Jun-07	P.SUTCLIFFE	FIRST ISSUE
ISSUE	DATE	NAME	DESCRIPTION

MODIFICATIONS

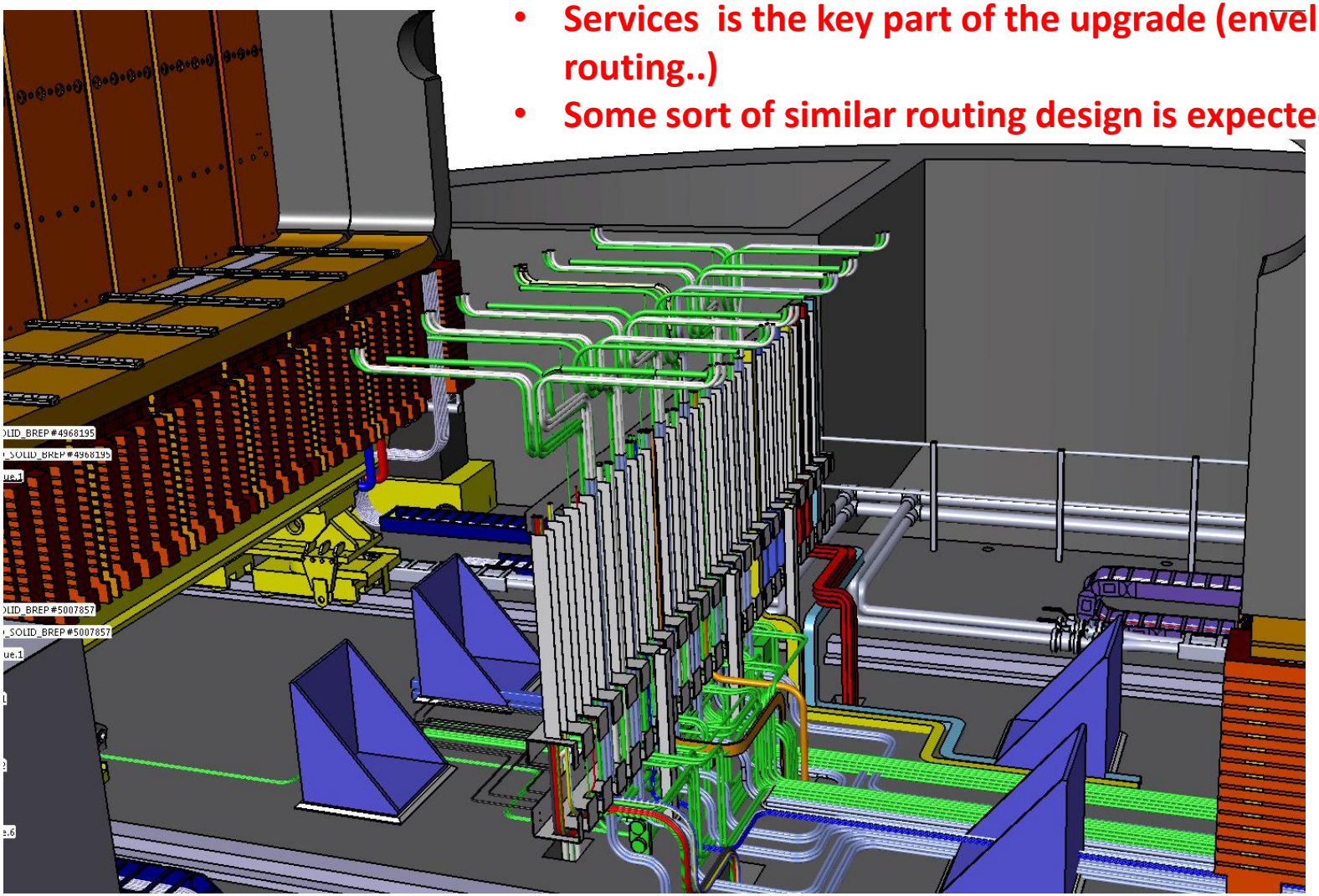
NAME:SUTCLIF OBJECT:NP48-02-03_1 DATE:18-Apr-08 15:48:24

Overview of the current situation

Services are organized downward
(basket support removed for clarity)

Overview of the current situation

- **Services is the key part of the upgrade (envelopes, routing..)**
- **Some sort of similar routing design is expected !**



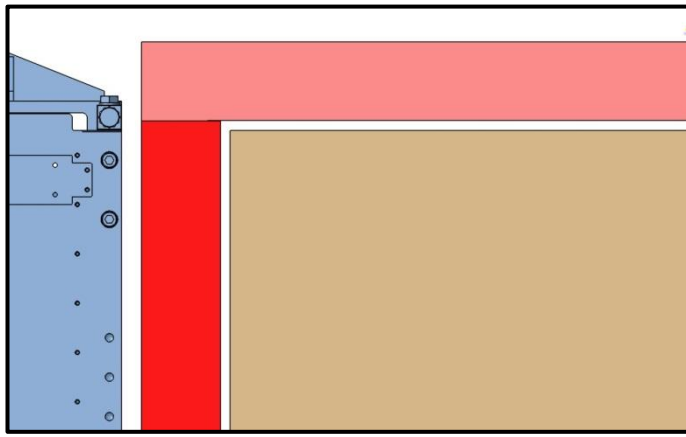
New Detectors into the basket

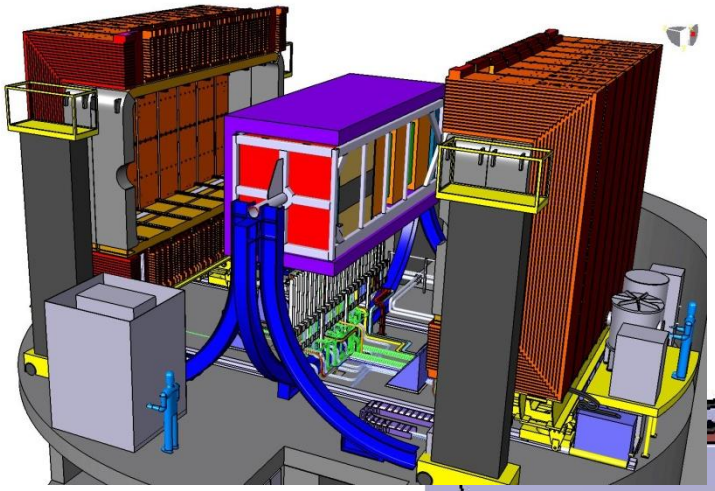
Before showing the CAD designs…

…Rules to define the Detector envelopes (TB Discussed):

- Each detector volume includes: sensitive parts, frames, some services & readout system… like the current ones.
- **10mm** gap is assumed between detectors "blocs" to account for deformations, insertion, handling…and more margin of safety!
- Brackets, fixation points are not considered yet
- ToF overall thickness (80mm) is given as a starting point…

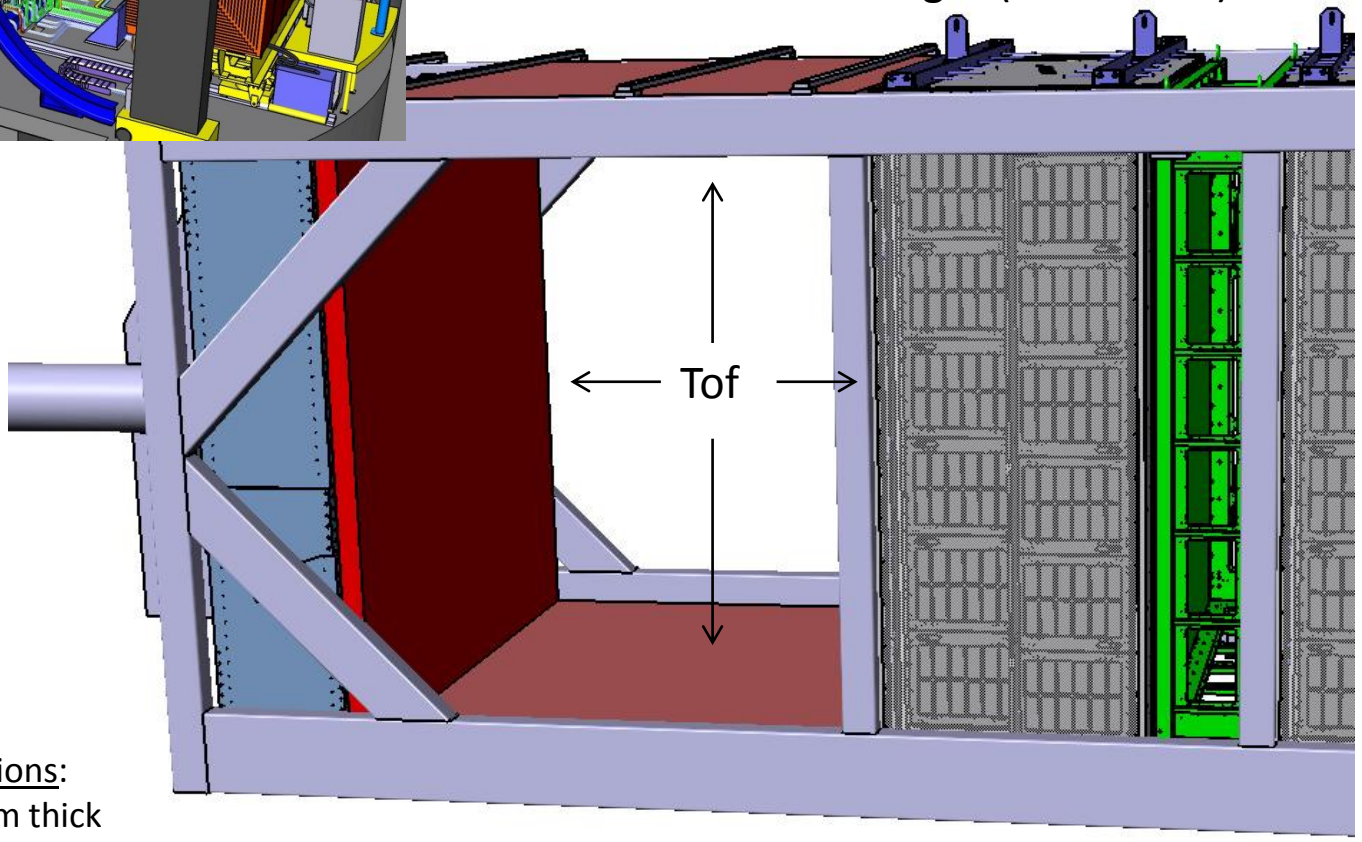
The idea is to iterate to get the right envelope sharing!





New Detectors into the basket

New Time of Flight (ND280 Tof)

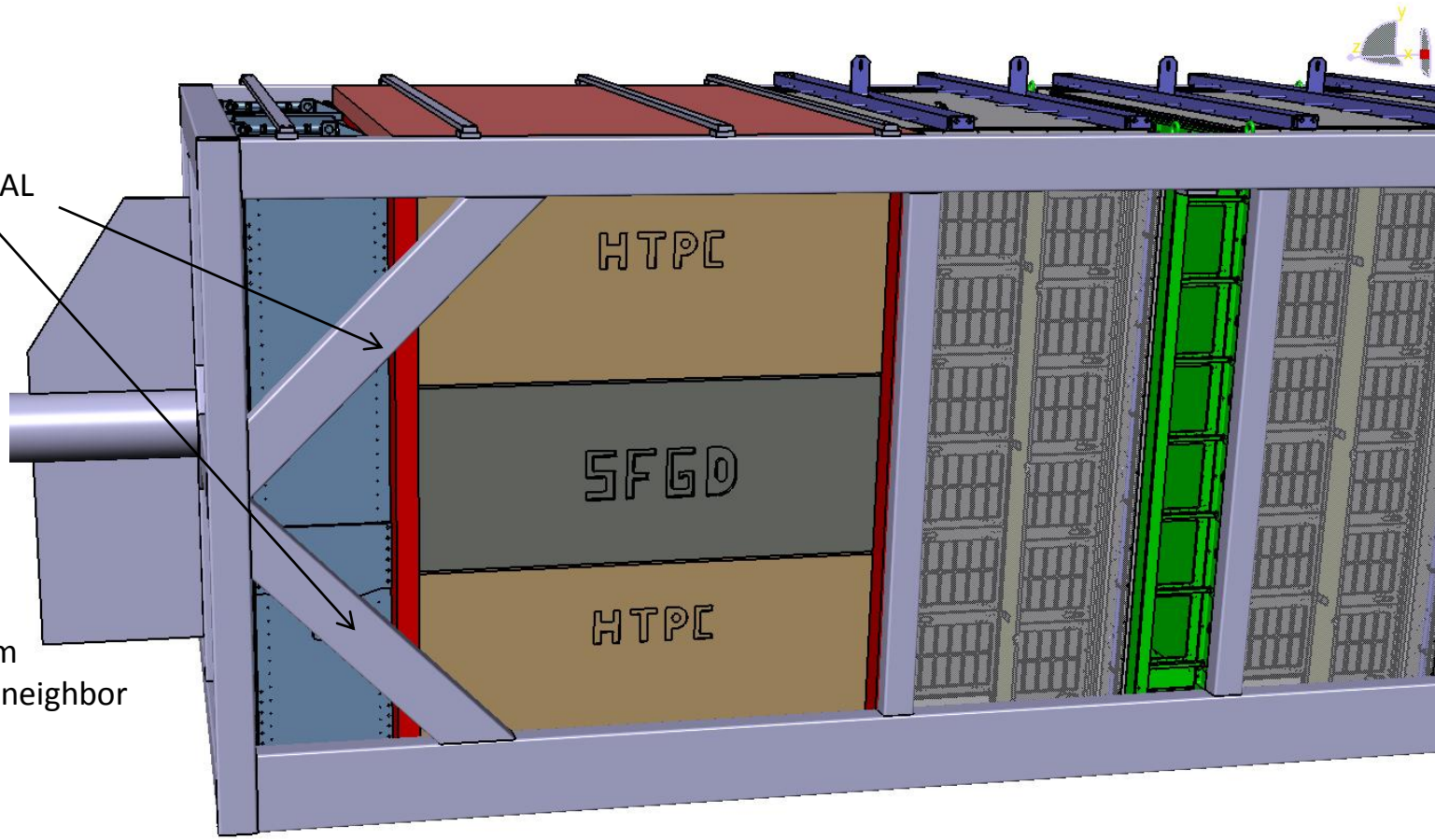


Assumptions:

- 80mm thick
- Design with fixation INSIDE Basket frame
- 2 sides not shown (in total 6 sides: 2230x2320x80mm / 2320x1910x80 / 2390x1910x80)
- OPTION: Tof could be mounted OUTSIDE the Basket (careful with unprotected parts!)

New Detectors into the basket

Beams prevent
µmegas
from access
+ new Upstream ECAL

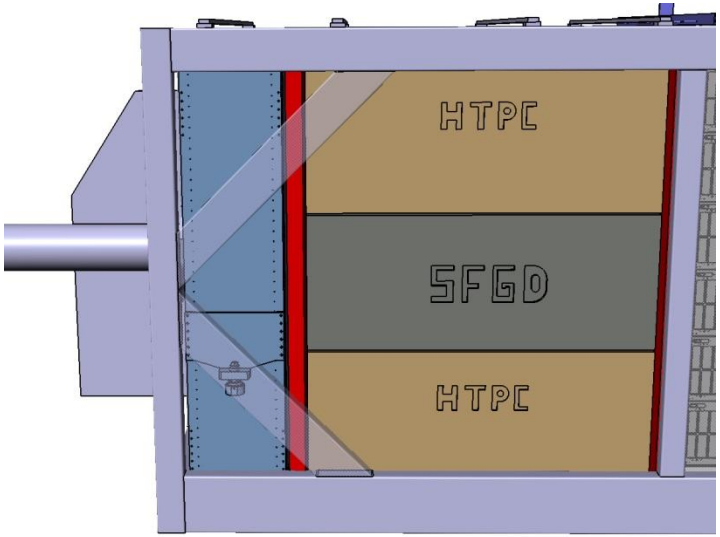


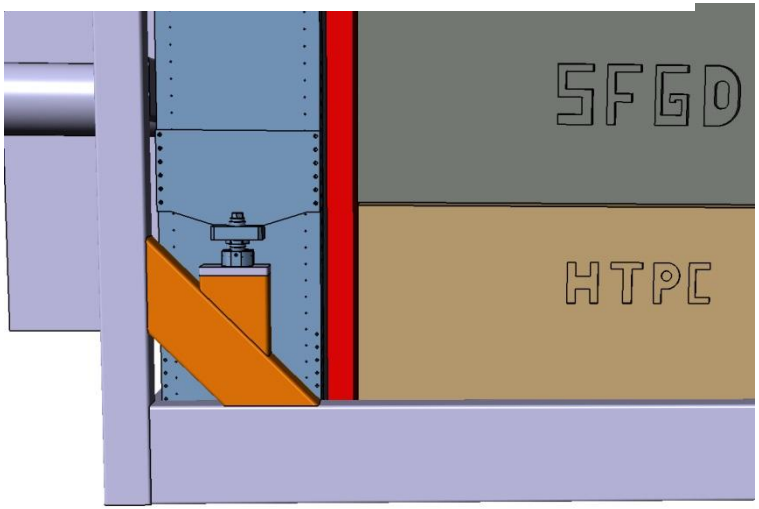
TPC Size:
- 1730x2140x800mm
- 10mm clearance / neighbor

Super FGD Size:
- 1730x2140x600mm
- 10mm clearance / neighbor

Upstream ECAL might be thinner in reality
=> actual CAD files will be provided

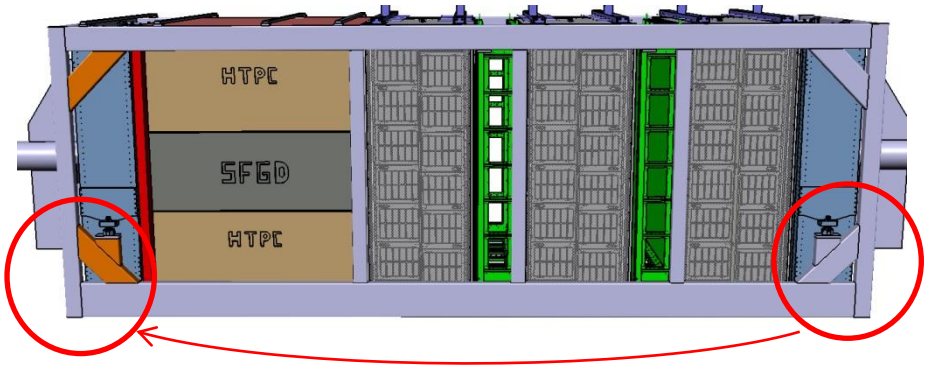
New Detectors into the basket





Clear the access for HTPC µmegas (oblique beams)

- Reuse the current beam sys for Downsteam ECAL (below)
- See next slide…



Guidelines for I/F & Integration

- Clearly identify the technical coordinator for each part:
  HTPC, TOF, sFGD, Upstream ECAL, global services…
  Provide CAD models, and in case FEA's to the resp. for Integration

- Organize a sort of inner Data Base for the Upgrade in which the latest CAD versions are saved (to ease exchanges)… STEP model is OK for exchanges (even using the same software!!)

- Perform the updated FEA on the Basket with new config. (see wrt proposed modifs and new weights)

- Services are a key issue (as always!)…to be tackled soon! It may drive some design choices.

- **To do so.. an Engineer is requested to take the lead on integration…**

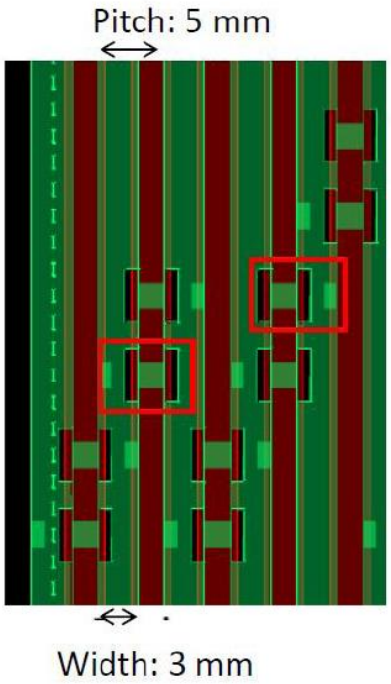
- **Open question: Which basket modifications are possible and how can they be done in-situ?**

from J. Mundet's talk

TPC Field Cage

Strip Design

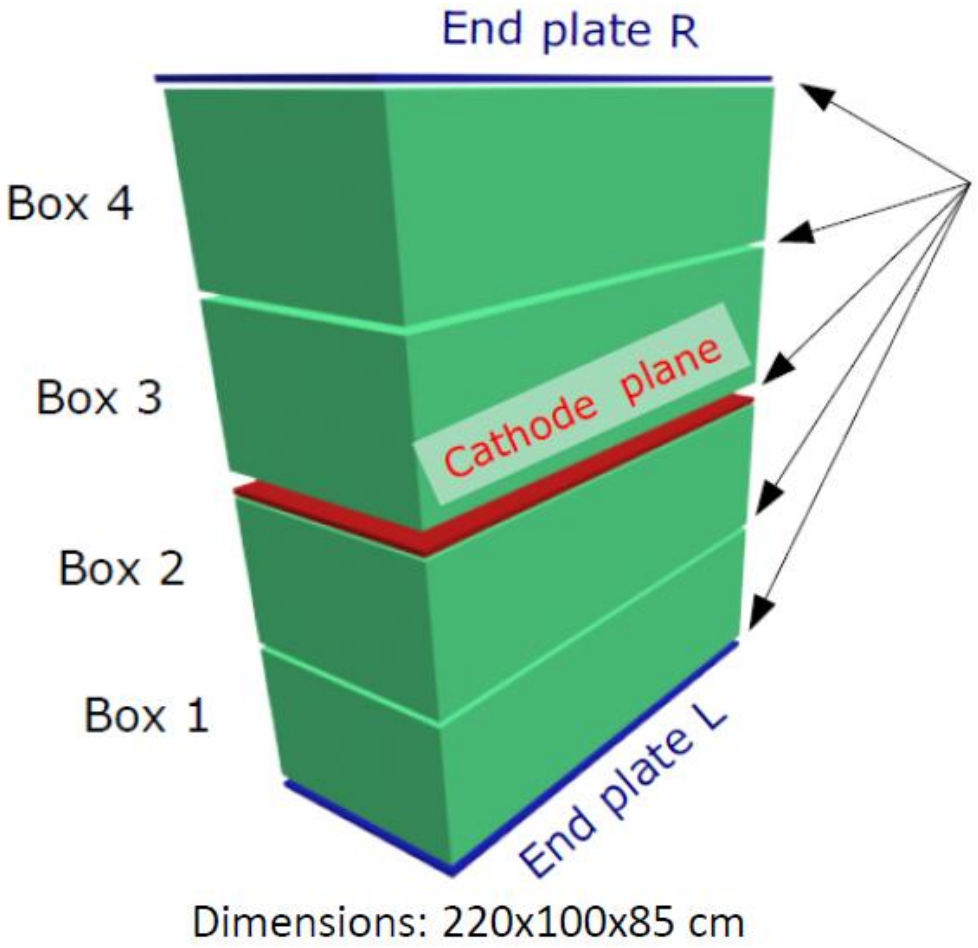
- double sided
- mirror strips
- all resistors on inner side
- cut marks all 5 cm on inner side
- cross marks for alignment on mirror strip
- foil dimensions currently: ~55x220 cm



ILC TPC Design

Figure 5.13: *Resistor chain in the field cage at the central connection between the half boards*

TPC Field Cage

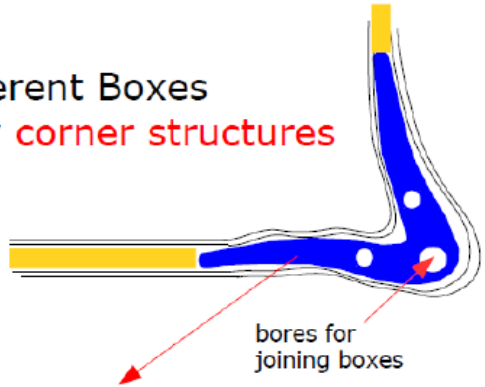


- different concepts under consideration
  - 4 modules of 50 cm
  - 2 modules of 1 m
- discussions about gas tightness, HV stability, field quality, … of options ongoing
- Fall back solution: 4 full size flat panels for construction

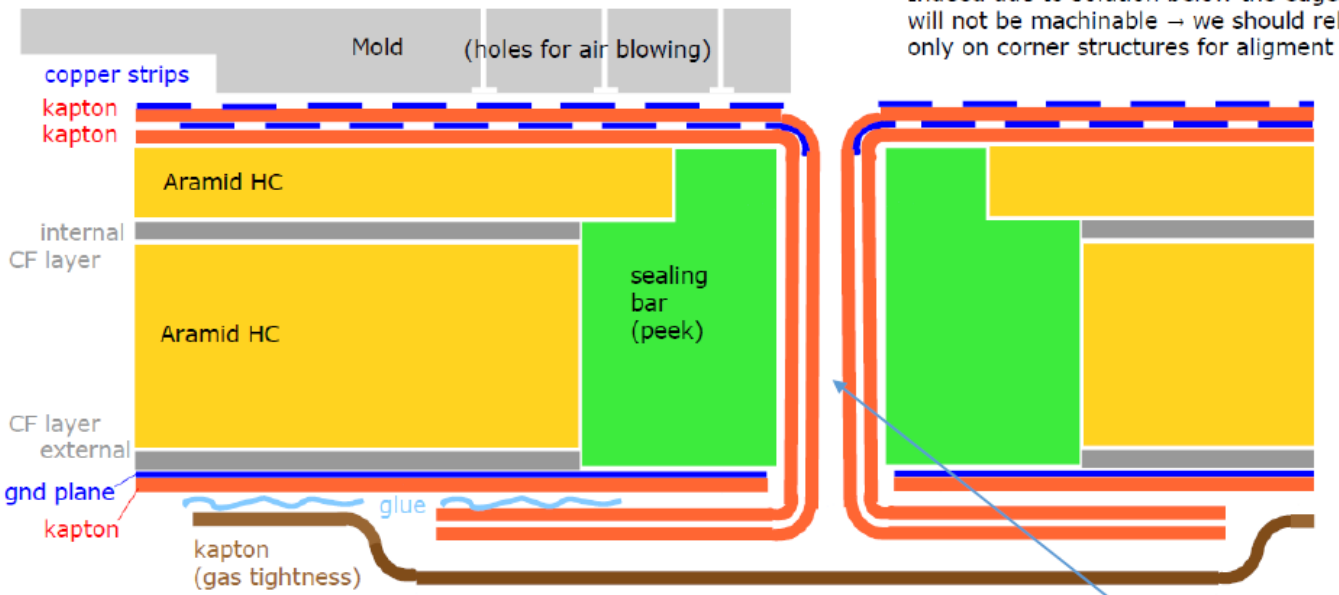
TPC Field Cage

Mechanical stiffness + alignment of strips of different Boxes provided by corner structures

- ? corner structure shape ?
- ? corner structure to be easility machined → peek



Dielectric and gas "sealing" at Box edges



BOTH OPTIONS ARE UNDER CONSIDERATION

"soft" gas sealing (illustrated in picture) vs "hard" sealing (by gluing here)

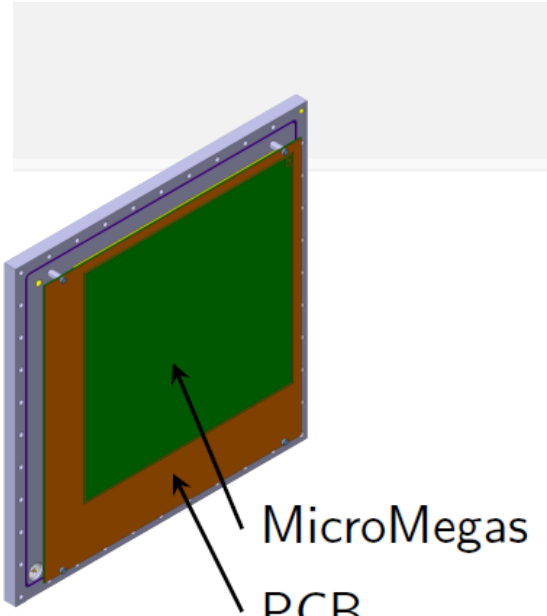
MM Frame

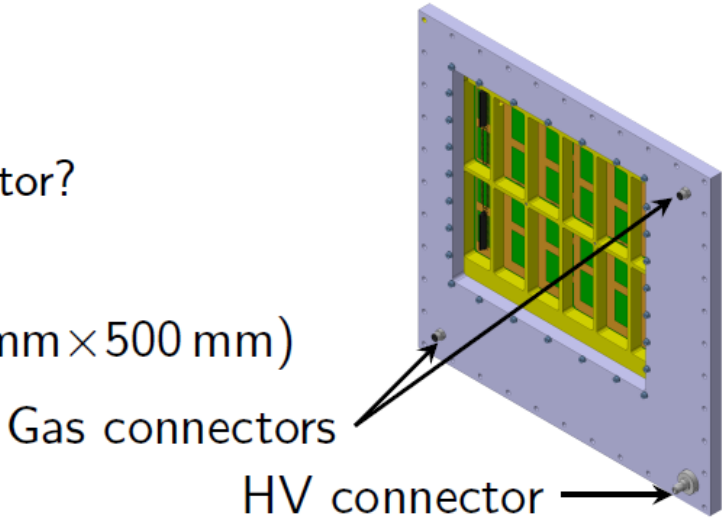
Prototype

- Min. size of an available magnet (ϕ87 cm)
- Min. outer dimensions (50 cm×50 cm)
  - Current MicroMegas prototype (340 mm×357 mm)
  - PCB plate
  - Gas inlet / outlet
  - High voltage connector?

Our workshop

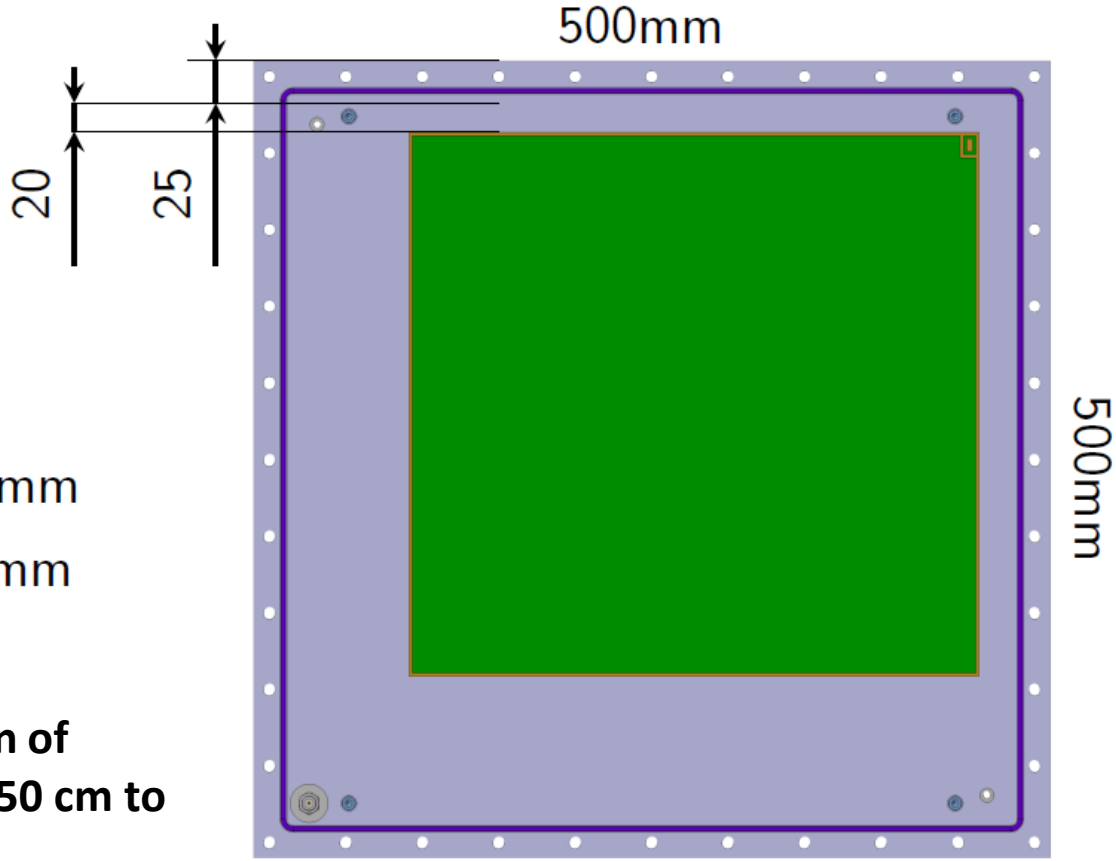
- Milling machine (1000 mm×500 mm)





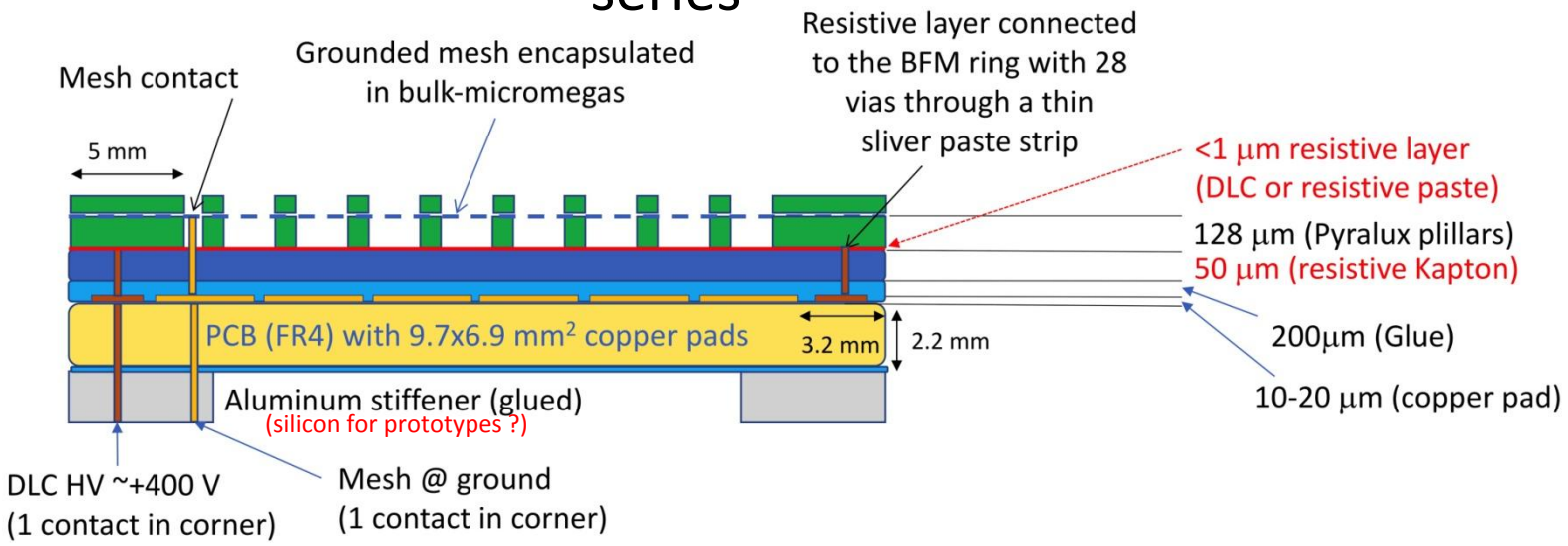
MM Frame

- Frame dimensions (500 mm × 500 mm)
- Wall thickness = 25 mm
- Gap wall/MM = 20 mm



Would like that outer dimension of prototype is not more than 50x50 cm to be able to produce in-house!

The resistive bulk-micromegas first prototype : MM0 series



The restive Kapton foil restivity should be **around 500 kOhm/square** for optimal charge spreading both resistivity and glue thickness to be adjusted for the desired pad function (sigma ~ 2,6 mm)

Four T2K/TPC PCBs were produced @ CERN : 2 were used to produce DLC bulk-micromegas

2 DLC kapton resitive bulk-micromegas prototype **MM0-DLC1 & 2** are finished and ready for tests with cosmics

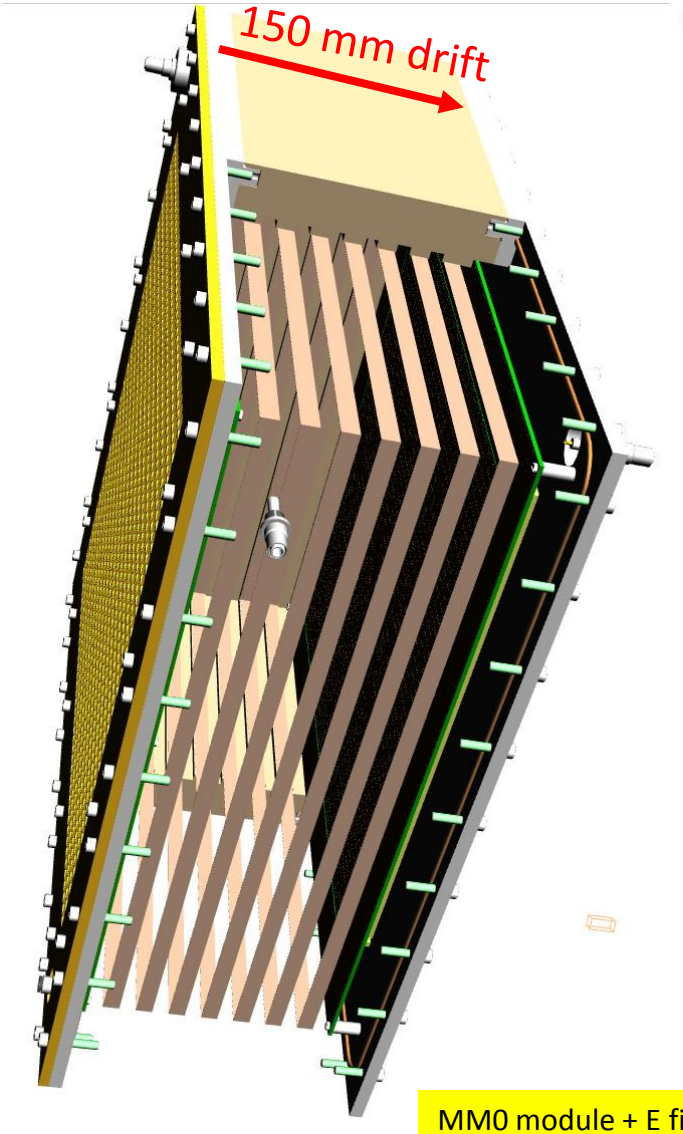
MM0-DLC1 & MM0-DLC2 were done with a DLC kapton foil ordered for 2 Mohm/square : it was measured to be 2,5 Mohm/square and the 200°C annealing for 1 hour did not change this too high value ! (→ sigma ~ 1,3 mm)

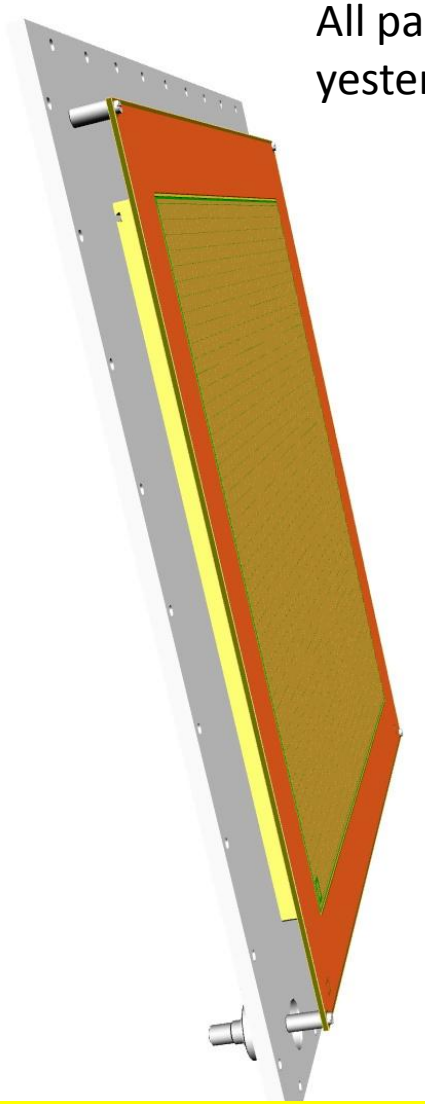
from A. Delbart's talk

The 2 remaining PCBs will be used to realise 2 other prototypes

- **with a ~500 kOhm/square screen-printed resistive paste layer on Kapton : MM0-SP1**
- **with a lower resistivity DLC Kapton if it can be achieved by the manufacturer (Japan)**

TEST CHAMBER FOR PROTOTYPE TESTS WITH COSMICS





MM0 module + E field termination guard ring on module frame

All parts ordered in january and received yesterday (!) Assembly to start next week

MM0 module with specific Stiffener for test chamber

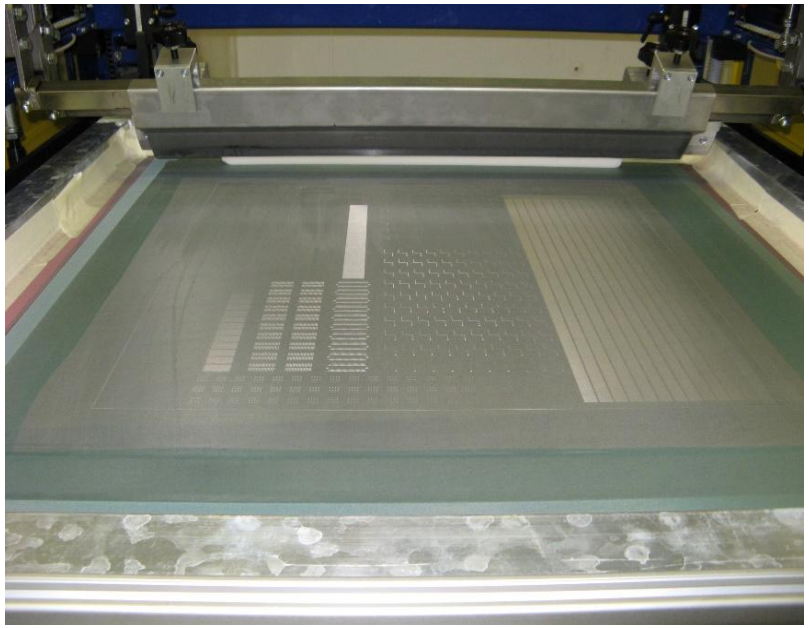
RESISTIVE INK SCREEN-PRINTING FOR MM0-SP1 PROTOTYPE

Screen-printing machine @ Irfu

- 2 years experience in screen-printing of resistive inks on Kapton and glass for resistive micromegas and RPCs

- Use of masks for pattern printings (such as mircomegas 250 μm strips)

- Up to 50x60 cm^2 surfaces were done



from D. Calvet's talk

TPC Electronics

Micromegas detector

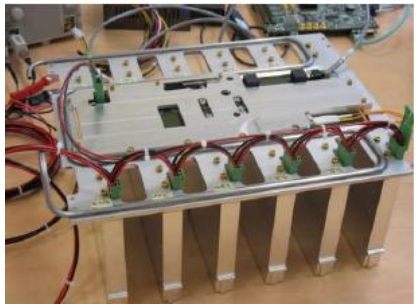
- 1726 active pads
- Rear-side: 24 * 80-pin connectors, 1.27 mm pitch (ERNI)

Front-End Card - FEC

- 288-channel; 6 cards per detector
- **Perpendicular** to detector
- 4 * 80-pin connectors, **right angle** 1.27 mm pitch (ERNI)
- 1 * 80-pin connector, **right angle**, Hirose, FX2

Front-End Mezzanine Card

- Reads out **6** FECs
- **Perpendicular** to FEC; **parallel** to detector
- 6 * 80-pin connectors, **straight**, Hirose FX2

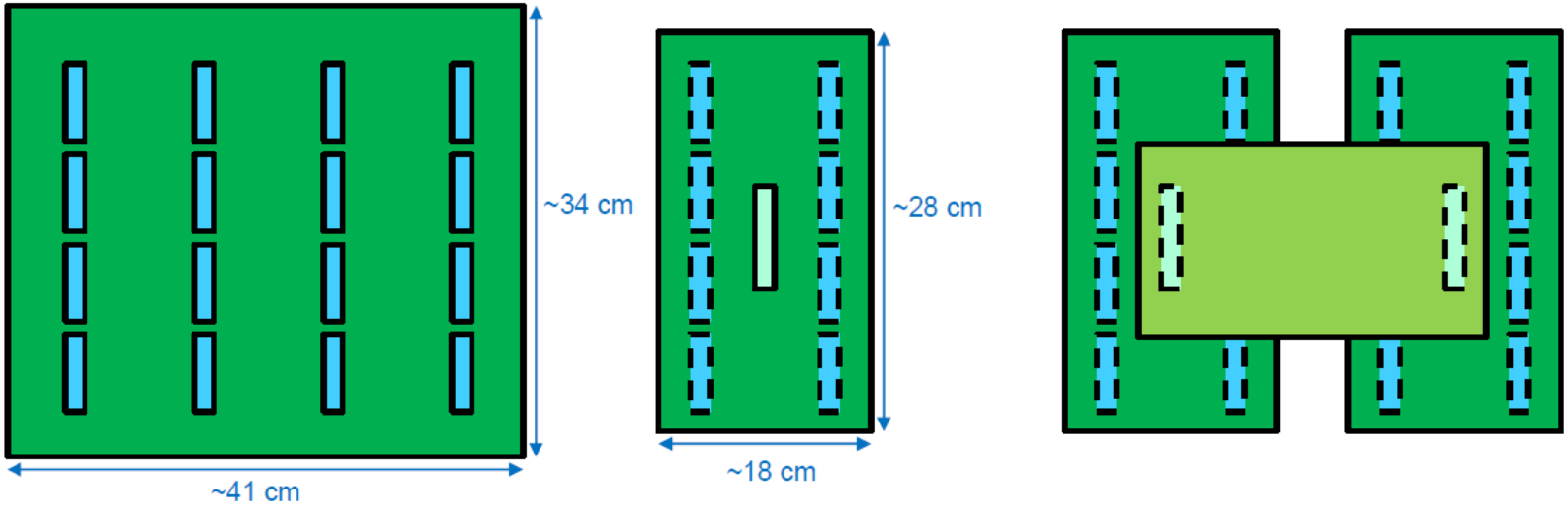


Assembled readout module

- Mechanics for precise positioning
- Shielding and water cooling

→ 72 of these modules in operation since 2009

TPC Electronics



Micromegas detector Gen II

- **1152 pads**
- Rear-side: **16** * 80-pin connectors, (or 8 * 160-pin, or 4 * 320-pin)
- **32 units** to build and deploy

Front-End Card Gen II

- **576-channel** (**2** per detector)
- **Parallel** to detector
- **8** * 80-pin connectors, **straight**
- 1 * 80-pin connector for connection of Front End Mezzanine card

Front-End Mezzanine Gen II

- Reads out **2** FEC Gen II
- **Parallel** to FEC Gen II and detector
- 2 * 80-pin connector, **straight**

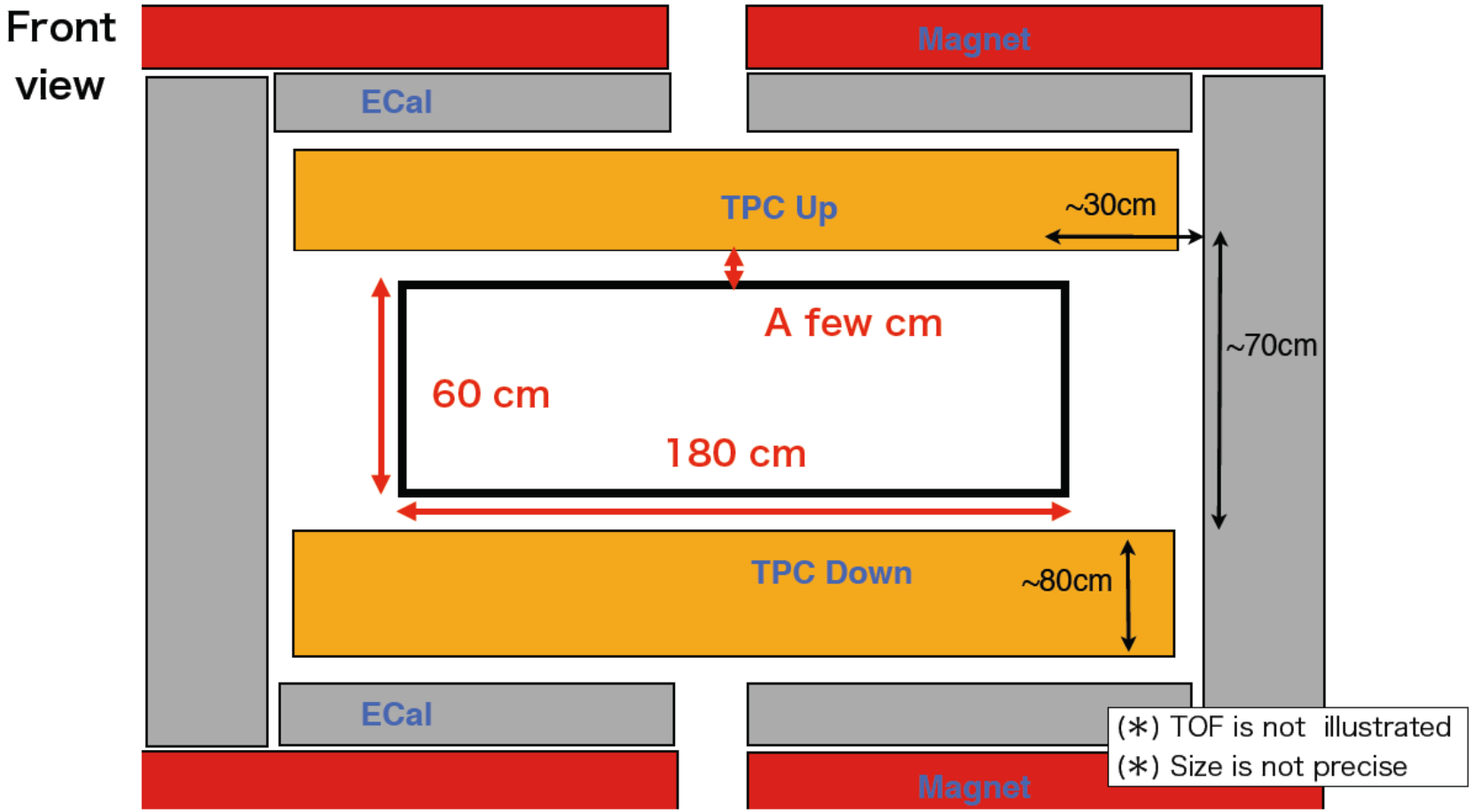
Families of solutions for interconnection

- Classical rigid connectors: simplest, but require precise positioning in multi-connector per board setup
- Floating connectors: less common products, structure of the connector absorbs misalignment in X and Y
- Flexible conductors: misalignement absorbed by cables, flexible PCB, etc. Signal degradation, higher cost

from Davide's talk

Placement of SuperFGD

Drawing from D. Sgalaberna



To be integrated with other detectors in limited space

(Please refer to Franck Cadoux's slide for available space in the basket)

SuperFGD

General requirements in mechanics

What we have to archive:

- Mechanical robustness w/ easier assembly & integration
- Accurate & stable connections

What we then have to challenge:

- Minimal material not to stop particles between cubes & TPC
- Minimal space for better acceptance between cubes & TPC
- Less noise & cooling system for electronics
- Maintenance (e.g. Access to electronics in the basket)

Goal of this talk:

- To share current conceptual design & status based on past experience or other experiments
- To share preliminary prospects to make it reality

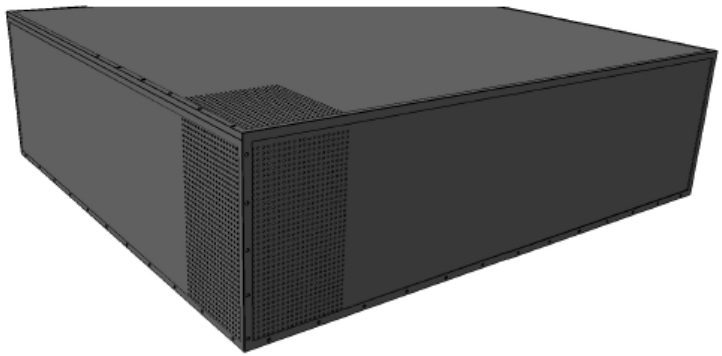
→ Start of discussion to optimize whole & interface structure

→ There could be better ideas. Feedbacks are welcome

・Original idea was all cubes compressed in a container

→ Now assuming more realistic case with several modules

Original idea
(no modularization)
Assume more realistic case with several modules



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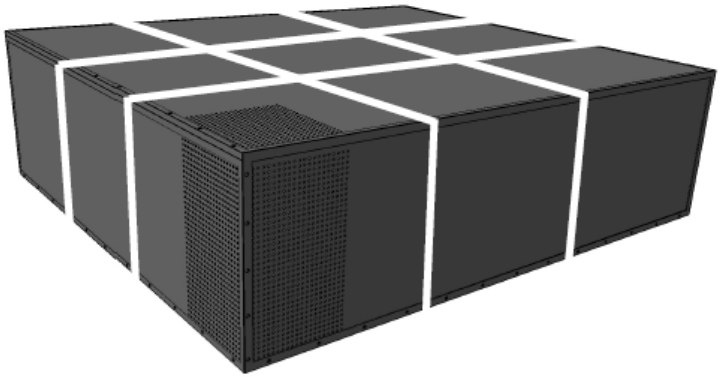
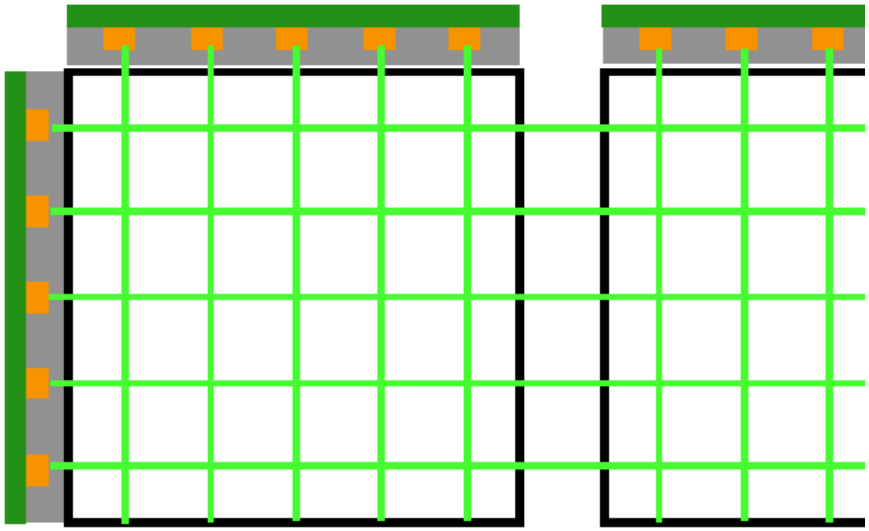
Modules w/ 60 x 60 x 60
as another option

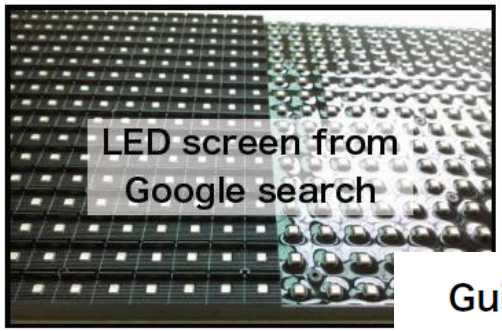


- discussion about problems of modular design
  - alignment to feed fiber through several modules
  - risk of damaging fibers in zone between modules

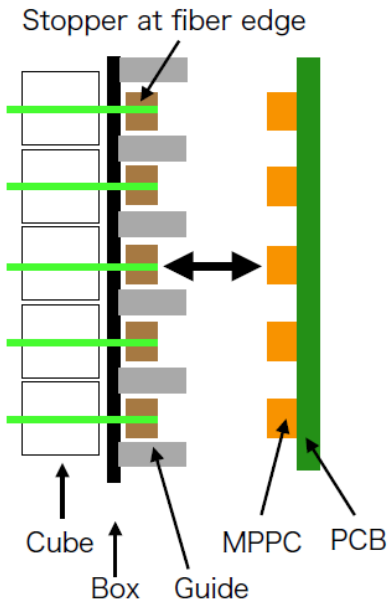


Alignment of MPPC PCB + Fiber

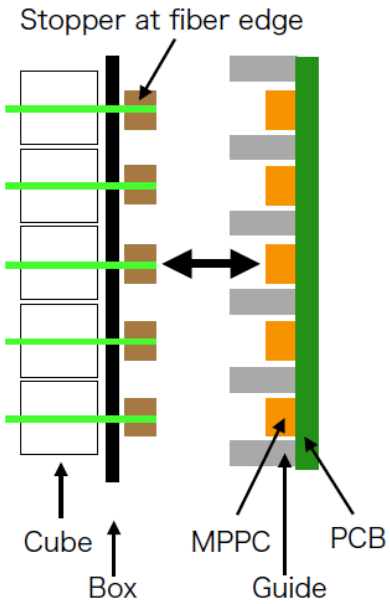
An images of PCB panel (& guide)



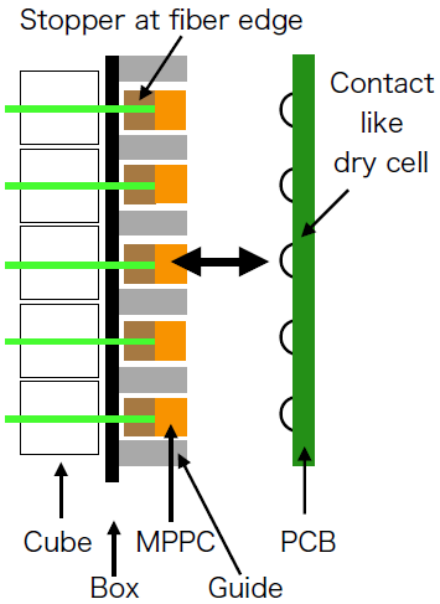
Guide on module



Guide on PCB



Embedded MPPC



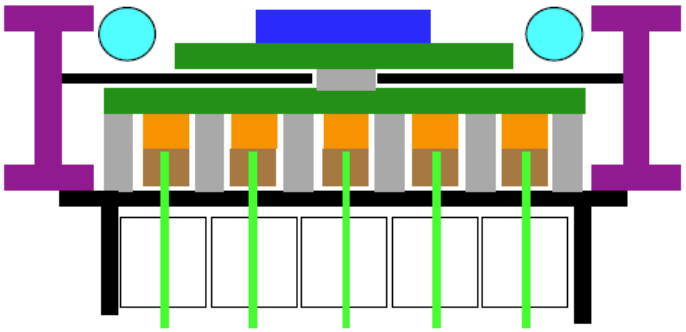
・How to fix fiber? Box design? Mechanical robustness?
Small space & materials? Maintenance capability for MPPC/FEE?
Light tightness?
→ To be designed considering above

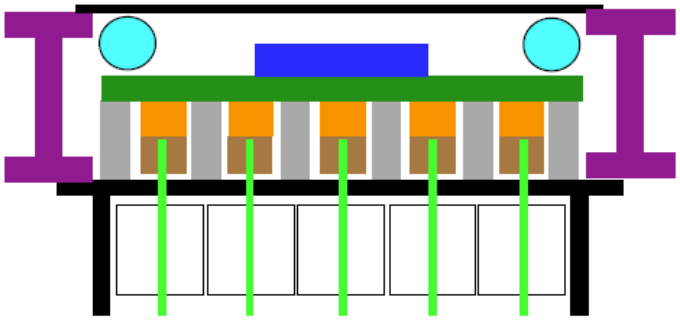
Possible Design of the Frontend Card

Possible design (To be discussed carefully)

- 2 PCB layers along with separated structure → FGD-like structure
- 1 PCB layer of MPPC+FEE on same board → More aggressive design

(Compact & less material but concerns in heating, light tightness and maintenance capability)



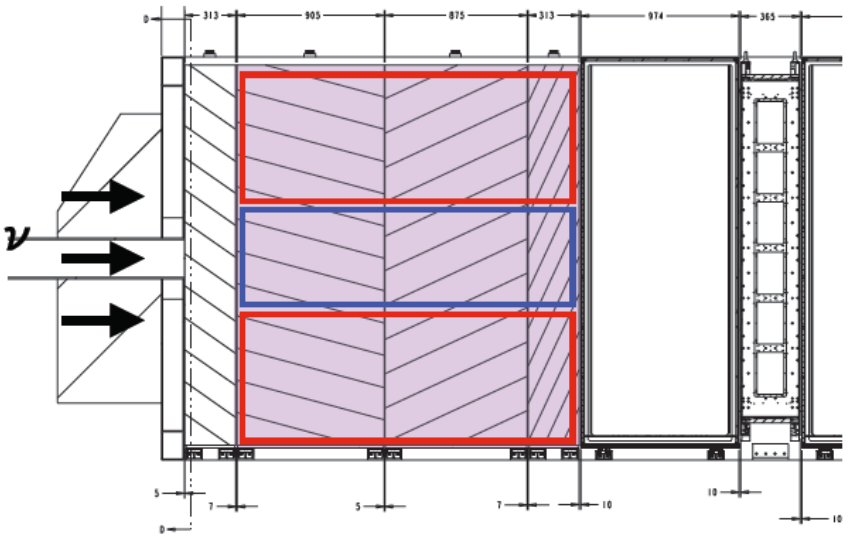


- In FGD, a water circulation system operating at sub-atmospheric pressure cools in the mini-cartes
- Chilled water flows through hollow aluminum extrusions mount on the inside of each I-beam

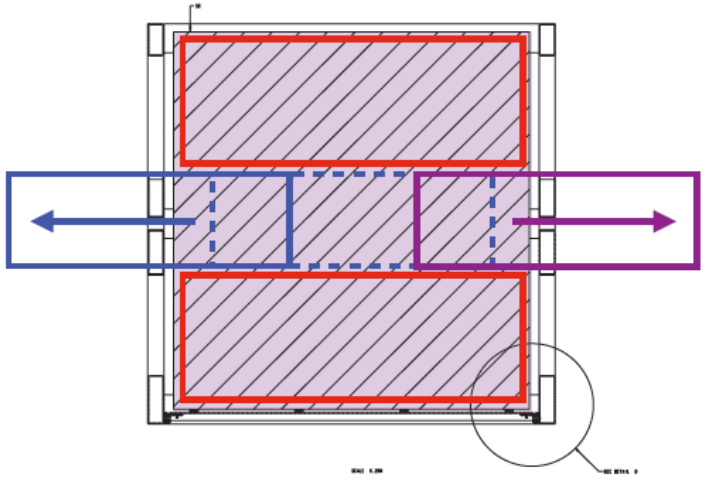
Amount of material and electrical power between target and TPC has to be carefully studied => talks at future WG1 sessions!

Option: Rail to take SuperFGD out?

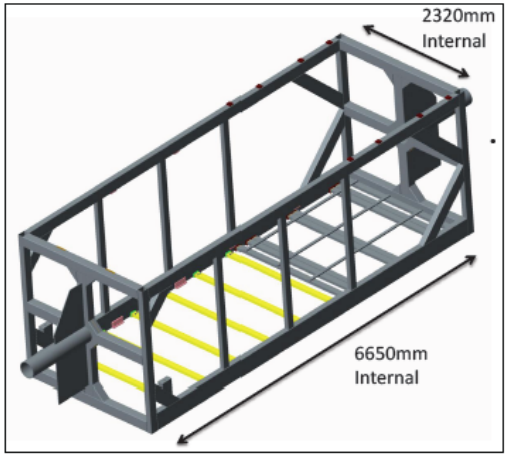
Side view



Front view



- Rail to take SuperFGD out from the basket for the access to electronics, MPPCs, etc…
- Several constraint to verify
  e.g. Difficulty to modify basket, TOF counter



Things to be addressed

When & how to access for maintenance?

- MPPC (e.g. Replacement "during Install" but "not after operation")
- Frontend (e.g. Replacement during "Install" or "Operation")

  → We can fix design based on those constraint

  → Installation & integration procedures are also to be considered

Connection from frontend to backend?

- Cabling (routing & connector) & power supply are not yet considered
- Hoses for water flow system is necessary if we want

  → To be discussed with WP1

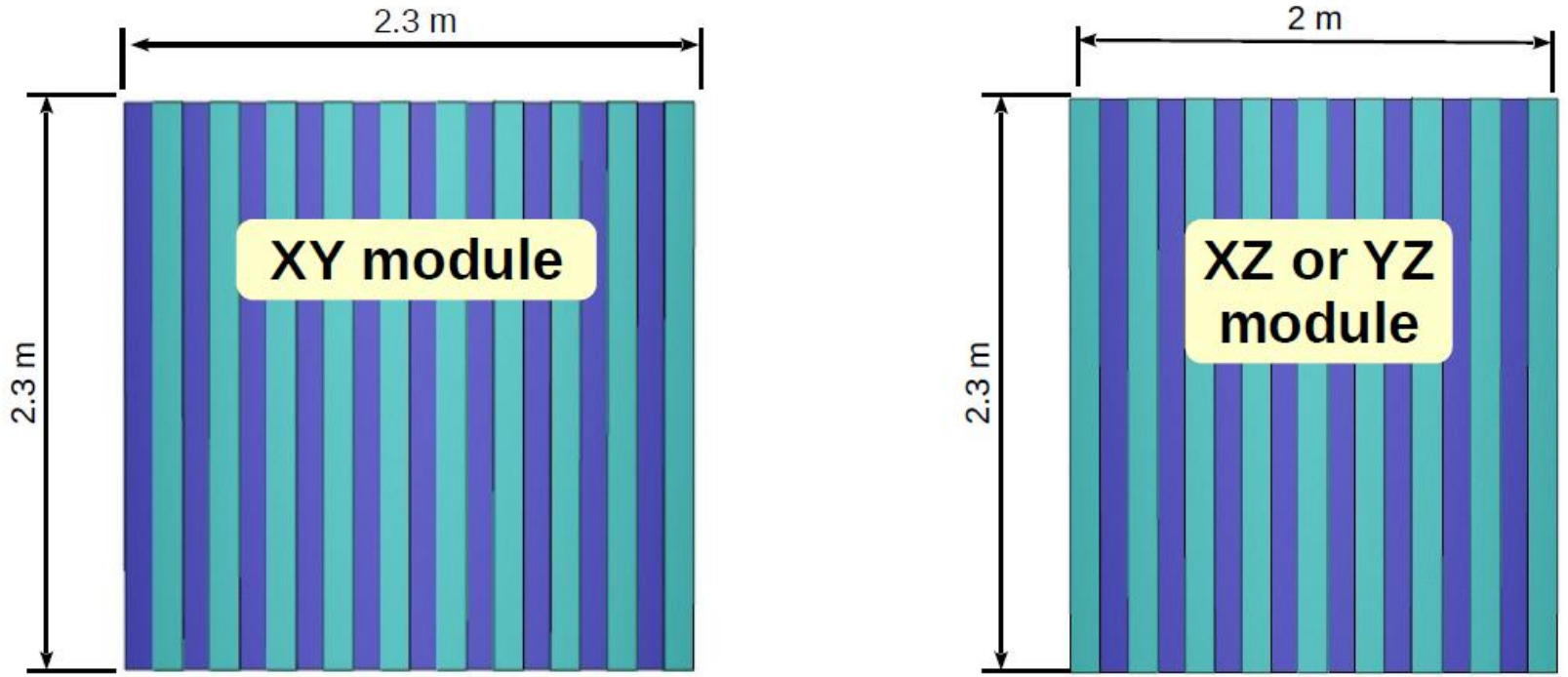
Calibration?

- Light injection system?
- Comics & Sand muons are enough?

  → No dedicated study so far. Need to be addressed.

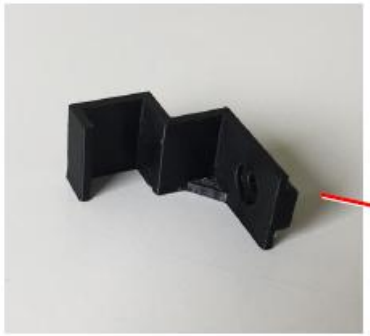
from Alexander's talk

ToF modules



- All bars are identical: 2.3 m x 12 cm x 1 cm
- In total: 3 modules XY + 4 modules XZ
- Total weight ~360 kg
- The ~5 mm overlap between bars was assumed
- At least 3 cm slit is requited for the installation

The bar fixation used for the prototype



Multiple hooks should be foreseen (earthquake)

DAQ system

- Electronics is developed in LAL (Dominique Breton)
- 16ch SAMPIC chip. All channels independent/self-triggered
- One crate is 256 ch = 64 ch x 4 VME modules
- Is there space inside the basket? or we need to pull outside 256 cables for the analog signal
- If inside, the issue of cooling to be solved.

based on M. Zito's talk

Urgent tasks-1

- Get P0D Upstream Ecal CAD model
- Ask Liverpool engineers about modifications to the basket in situ
- Define TOF configuration
- Concept of support structure
- Define SuperFGD, TPC and TOF envelopes
- Define SuperFGD, TPC and TOF engineers (each responsible for CAD model of each detector)
- Set up a directory of ND280 Upgrade Internal Technical Notes
- Check availability in situ ("survey" team to Tokai in ~June ?)

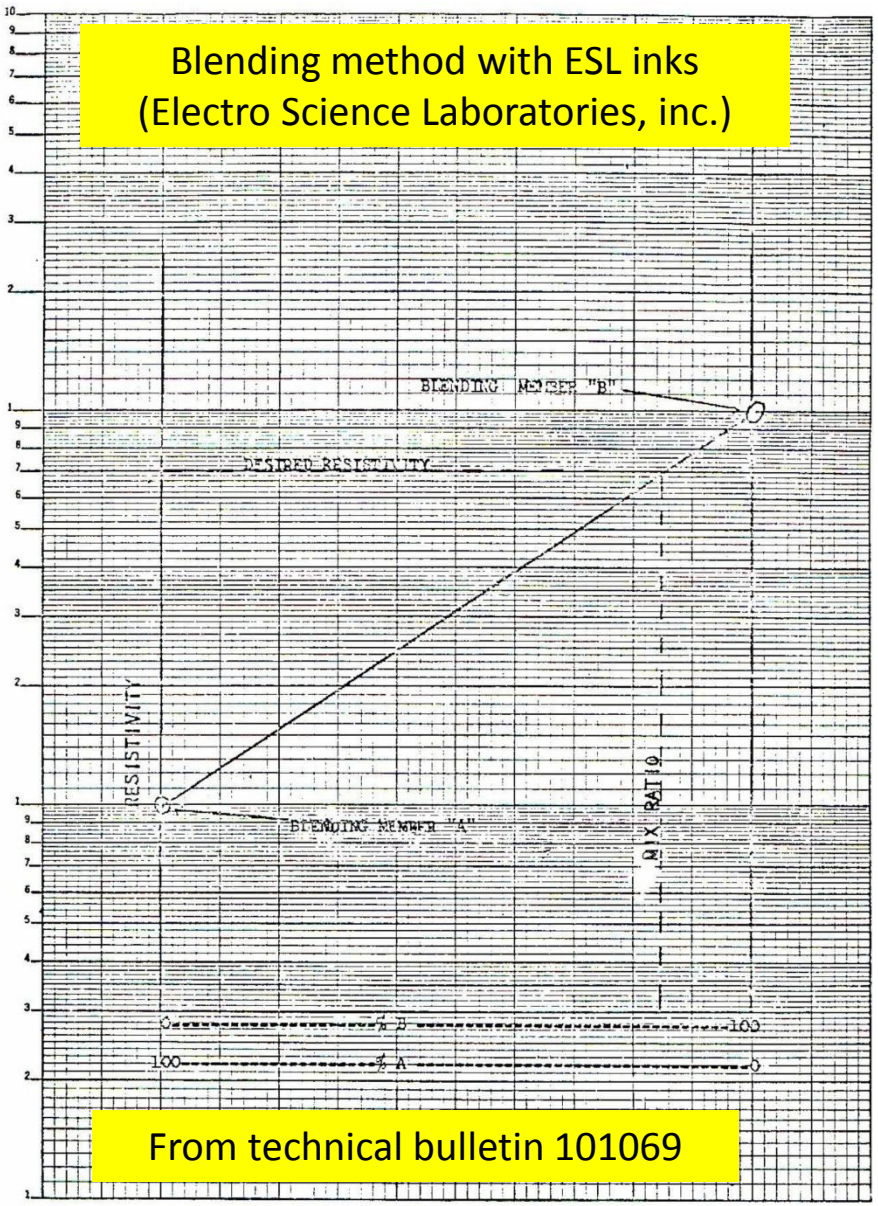
• Define overall Integration engineer responsible for maintaining EDMS + CAD drawings

Urgent tasks-2

- Define conceptual design of SuperFGD with a dedicated discussion/workshop
- Includes preliminary concepts about the electronics
- Timeline: July (??)
- Aim is to define a baseline design
- Describe design in a technical note

Backup

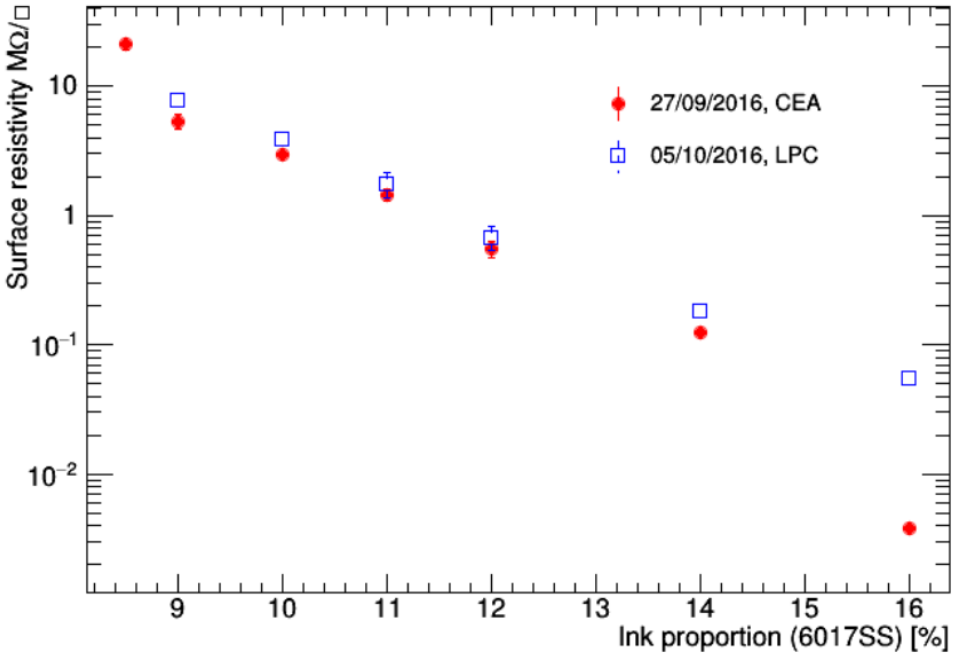
RESISTIVE INK SCREEN-PRINTING @ SACLAY
TUNING OF THE PASTE RESISTIVITY



Tuning of resistivity by blending 2 inks of low and high resistivity. Tuning of the complete process is needed for MM0-SP1

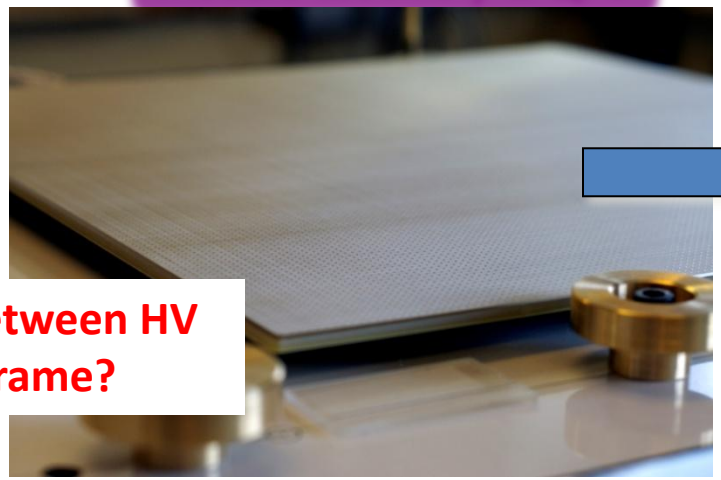
Tomuvol RPC (with CNRS/IN2P3/LPC)

5 Mohm/square on 1 mm thick 50x60 cm^2 glass plates obtained with a bi-component Electrodag 6017SS+PM-404TM ink



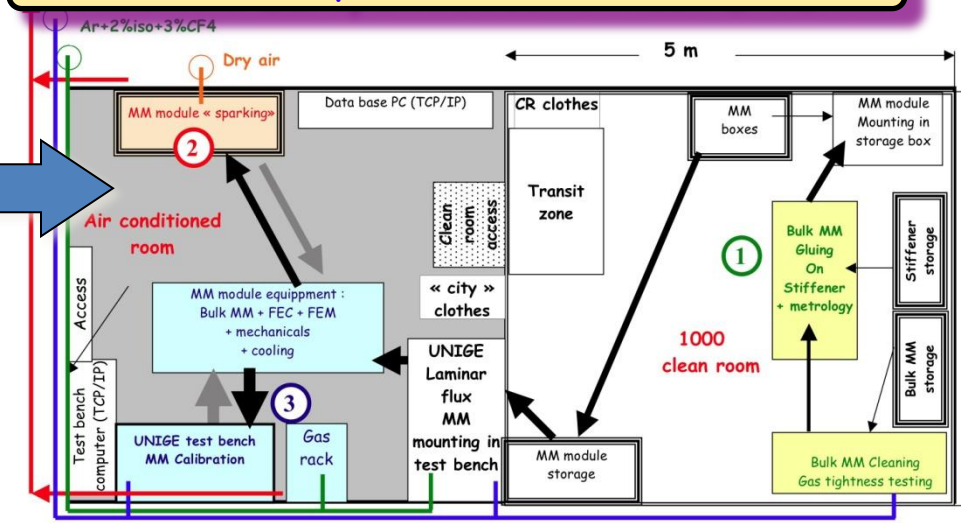
Control of the micromegas mesh alignment with the field cage last strip : use same gluing procedure as for the current ND280 TPCs ?

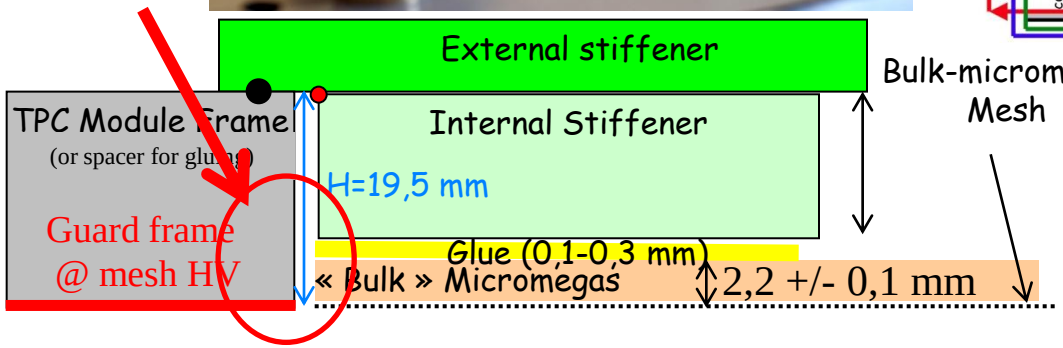
Module assembly & Q/C

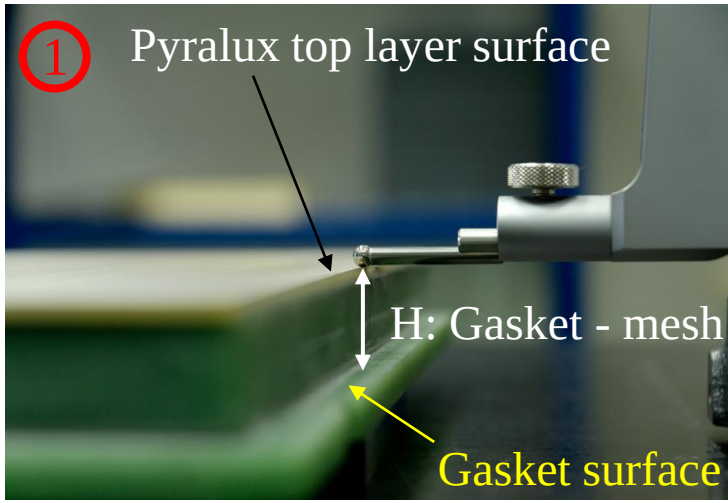


Safety between HV and alu frame?

T2K/TPC Europe Production lab. @ CERN







This gluing procedure was used to position at +/- 50 μm the micromegas mesh with respect to the field cage (control of the H distance between gasket & mesh)