# Pre-review of mechanical designs for the MPPC-PCB & LGP module toward mass production

7 December 2020

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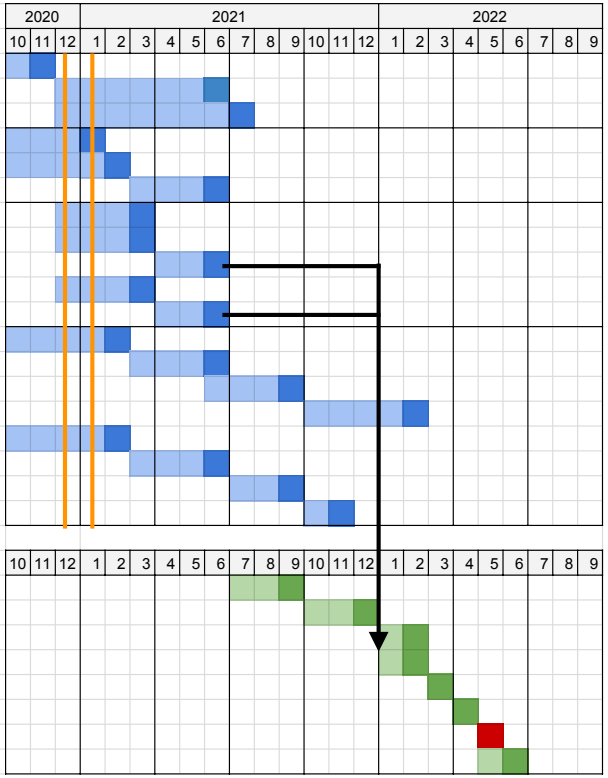
# Production schedule (ver. Oct. 2020)

| Hardwares | Start | End |
|---|---|---|
| Box design + prototyping | - | Nov. 2021 |
| Box production (first 3 plates) | Dec. 2020 | May 2021 |
| Box production (another 3 plates) | May 2021 | July 2021 |
| Cube production + layer assembly | - | Jan. 2021 |
| Platform design | July 2020 | Feb. 2021 |
| Platform production | Mar. 2021 | May 2021 |
| Fiber assembly + QC/QA | Dec. 2020 | Mar. 2021 |
| MPPC board assembly | Dec. 2020 | Mar. 2021 |
| MPPC board QC/QA | Apr. 2021 | June 2021 |
| Calib. system assembly | Dec. 2020 | Mar. 2021 |
| Calib. system QC/QA | Apr. 2021 | June 2021 |
| FEE prototype design | - | Feb. 2021 |
| Systematic test | Mar. 2021 | May 2021 |
| FEE final design | June 2021 | Sep. 2021 |
| FEE production + QC/QA | Oct. 2021 | Feb. 2022 |
| OCB/Backplane prototype design | - | Feb. 2021 |
| Systematic test | Mar. 2021 | June 2021 |
| OCB/Backplane final design | June 2021 | Sep. 2021 |
| OCB/Backplane production (+ QC/QA?) | Oct. 2021 | Nov. 2021 |

| Works | Start | End |
|---|---|---|
| Integration - Cube+Box (CERN) | June 2021 | Aug. 2021 |
| Integration - Fiber (J-PARC) | Oct. 2021 | Dec. 2021 |
| Integration - MPPC (J-PARC) | Jan. 2022 | Feb. 2022 |
| Integration - Calib. system (J-PARC) | Jan. 2022 | Feb. 2022 |
| Integration - Electronics (on surface) | Mar. 2022 | Mar. 2022 |
| Integration - Commissioning (on surface) | April 2022 | April 2022 |
| Installation of SFGD | May 2022 | May 2022 |
| Commissioning (in the basket) | May 2022 | June 2022 |




- Due to our budget restriction, we need to start mass production from 15 Jan.
- Can we ensure no change of the mechanical design by the time?
- Small internal review has to be done for that in a month.
- Here I tried to check a list to be reviewed.

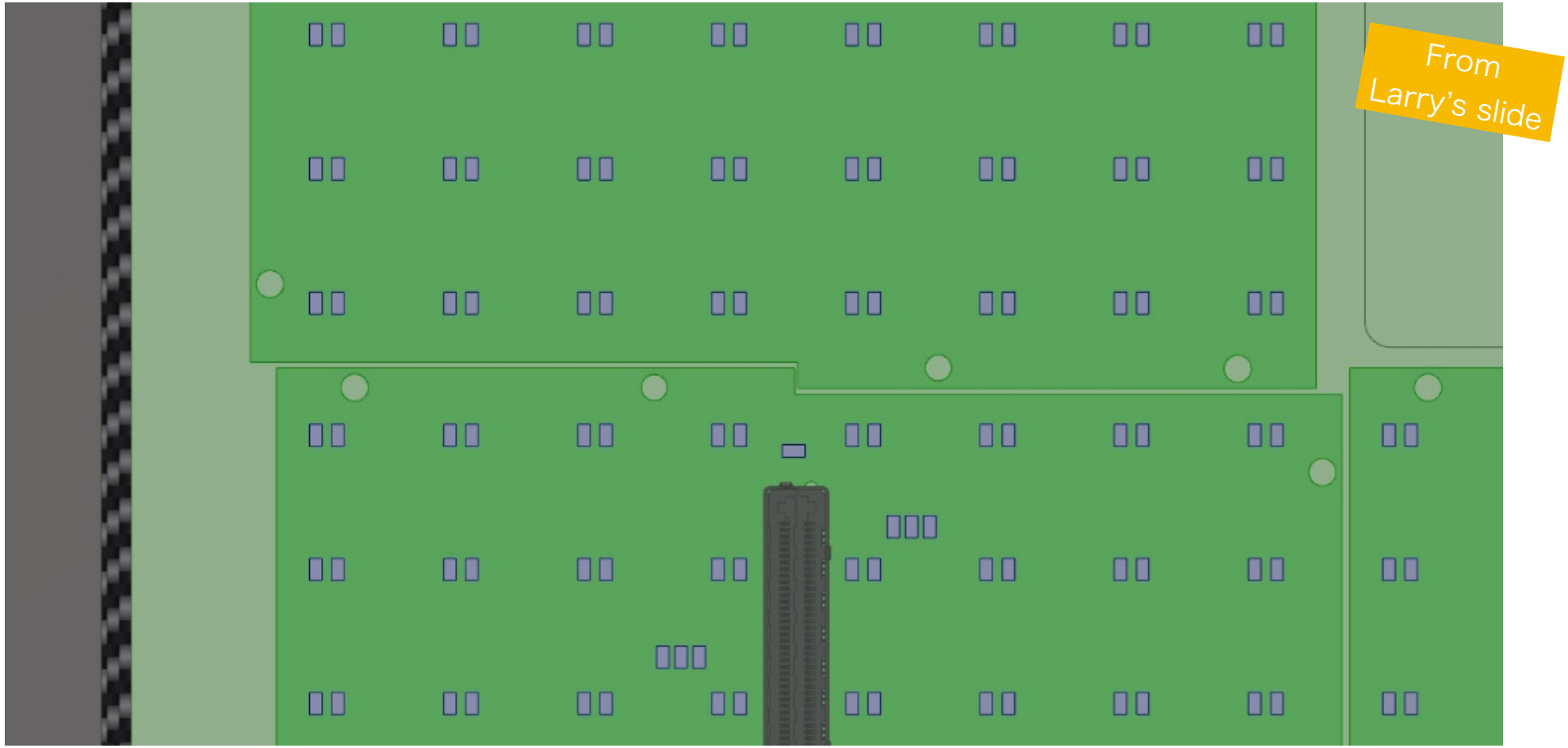
# Summary of MPPC64-PCB design

- Points of mechanical design
  1) Outer dimension (Clearance between boards) ⋯ OK
  2) MPPC pitch & orientation (90 degree rotation states) ⋯ OK
  3) Interference with the LGP module ⋯ OK
  4) Alignment pin & screws ⋯ NOT YET DESIGNED
  5) Others ⋯ Not identified. Any feedback?

- Other points (somehow related to the box design)
  - Cable holding
  - Light tightness

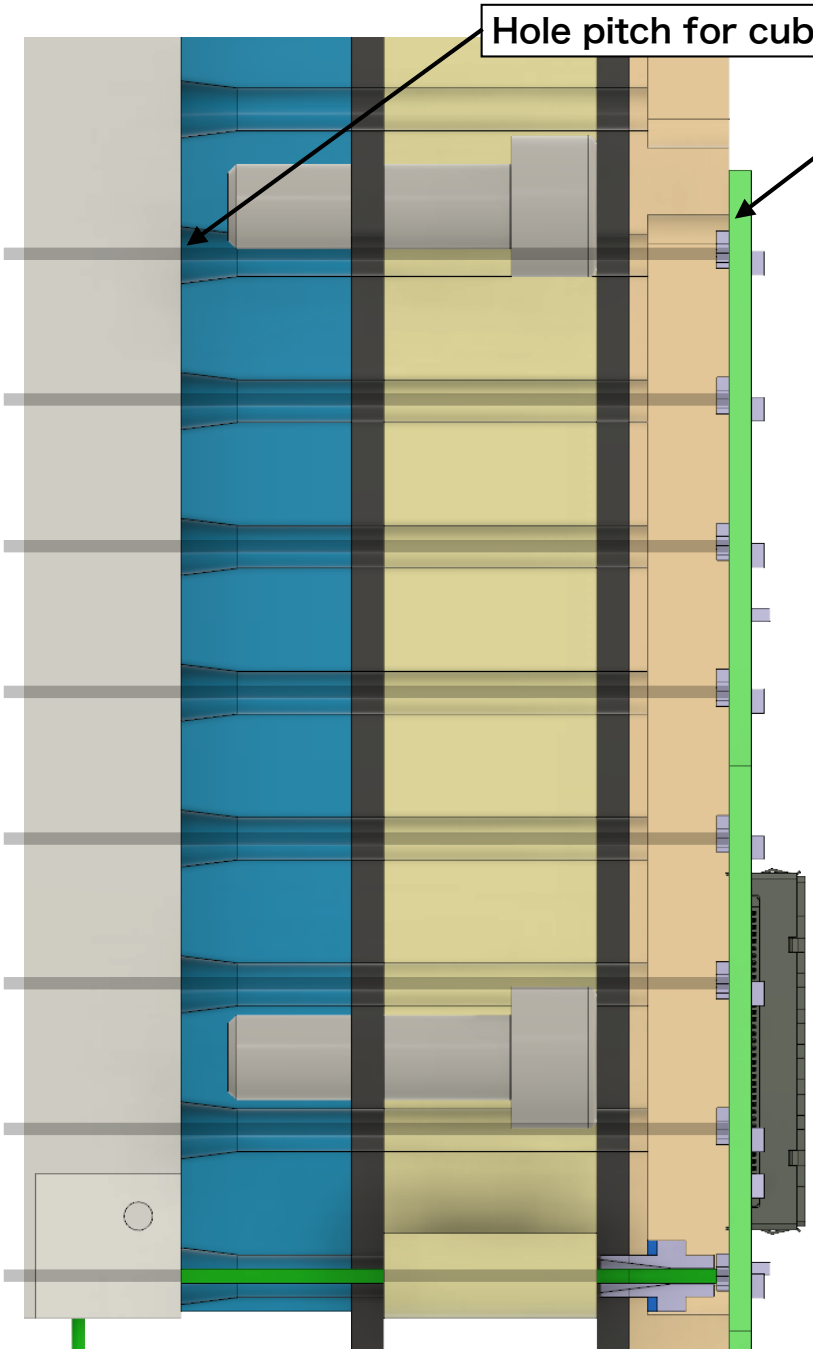
(NOTE: Review of electronic design is ongoing by LSU)

# 1) Outer dimension



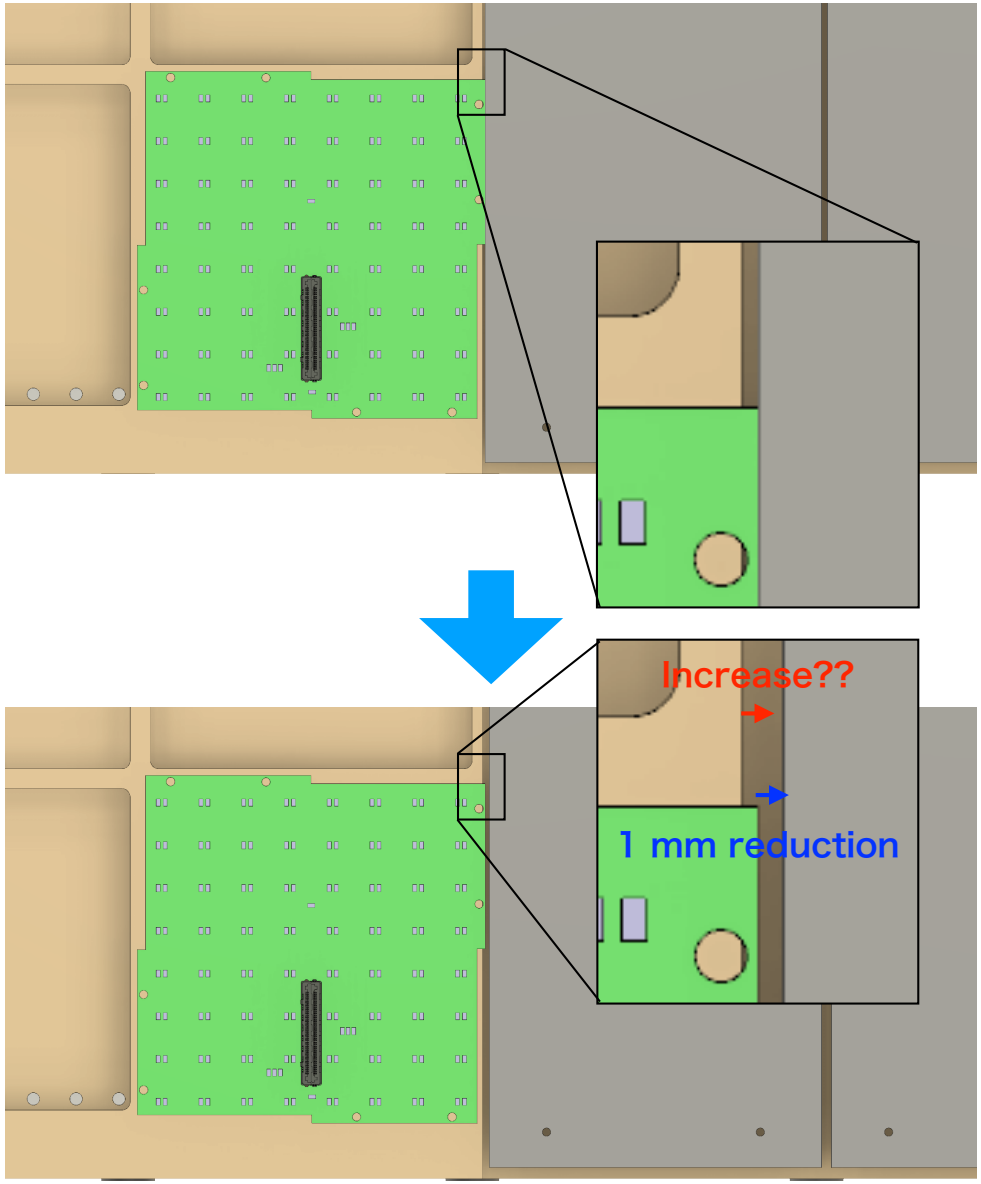

- There is clearance between vertical boards with current design
- We plan to require negative tolerance for  the outer dimension

# 2) MPPC pitch & orientation

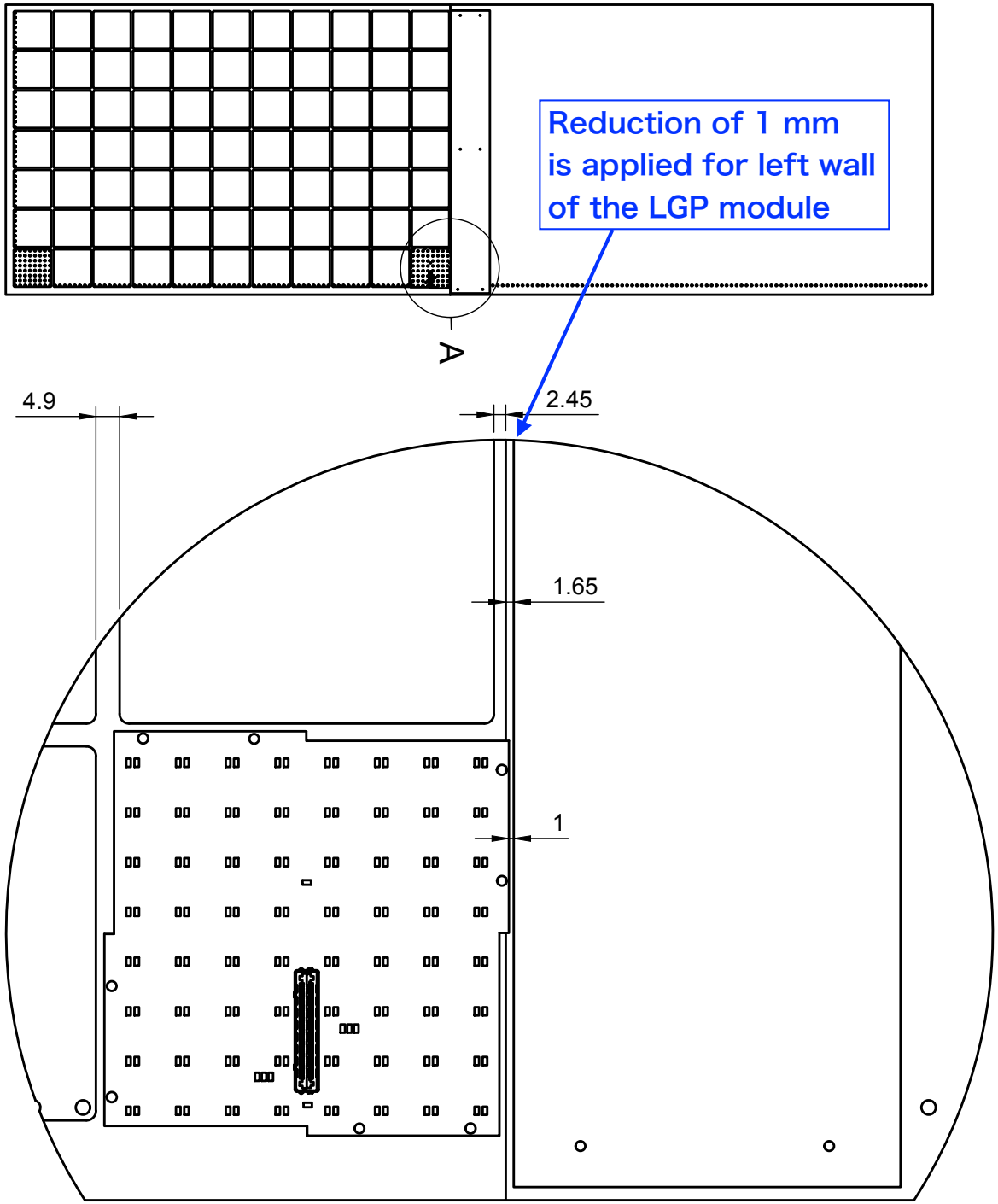



- Last week, we agreed to align box holes to the MPPC centers
  (10.30 mm pitch for the vertical direction)
- Pitch between board is tuned and the misalignments are absorbed at the conical holes
- 90 degree rotation states is kept for the MPPC64-PCB
  (10.30 mm pitch for horizontal direction, too.)

# 3) Interference with the LGP module




- Larry pointed interference between MPPC-PCB and LGP module for the side wall of the box.
- We agreed to reduce the thickness of the container for the wall LGP module from 2 mm to 1 mm
- This is only for 2 modules located at the boundary of right/left plates. No issue (e.g. strength and manufacturing) is expected for the wall module by reducing the thickness with -1 mm.
- It allows us to enlarge **the thickness of the G10 grid wall** to screw MPPC-PCB. I proposed 0.65 mm (next page).
- We can then keep the enough clearance to mount the narrower LGP module.

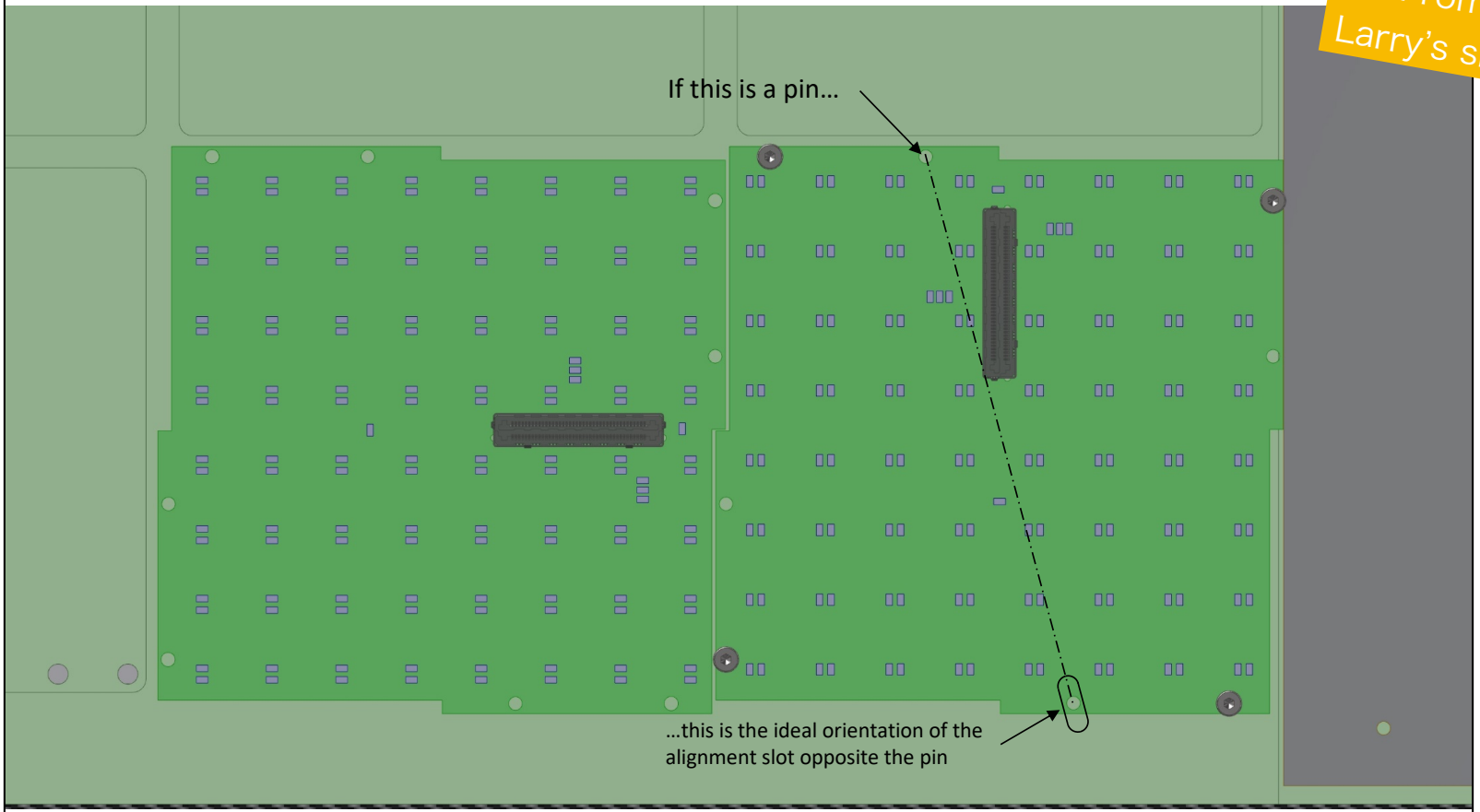



- 2.45+0.65 mm would be a reasonable choice for the G10 grid thickness?
- 1mm clearance is then kept between the G10 wall to the LGP module

# 4) Alignment pin & screws

Still to do…too many holes for alignment pins

From Larry's slide




The four corner holes of the MPPC board are designed for M2 bolts. We do not need to use all of the remaining four holes for alignment pins, only 2.

I need to figure out the pin pattern and propose a slot for the MPPC board that makes sense with tolerances.

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We need to know the final design as soon as possible

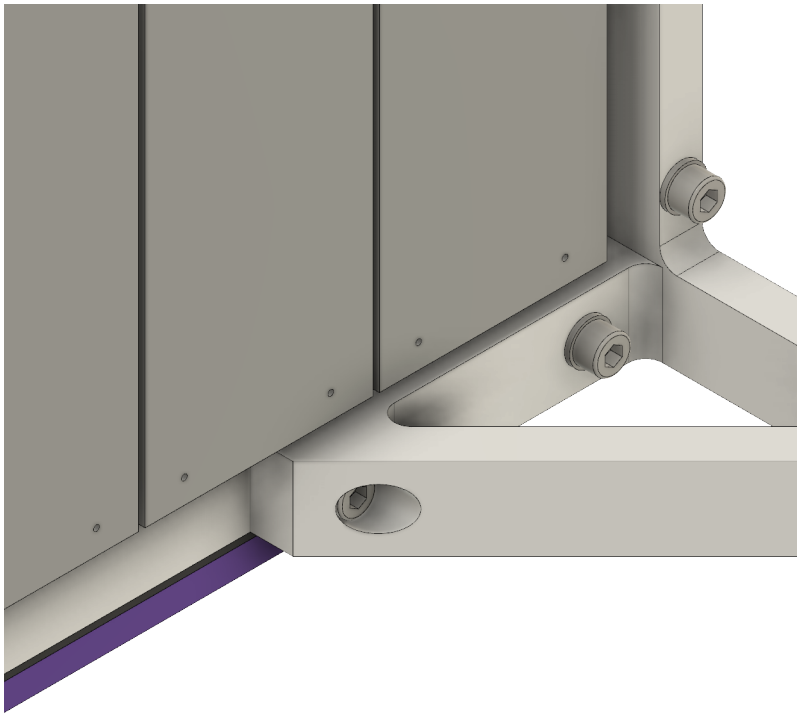
# Summary of LGP module design

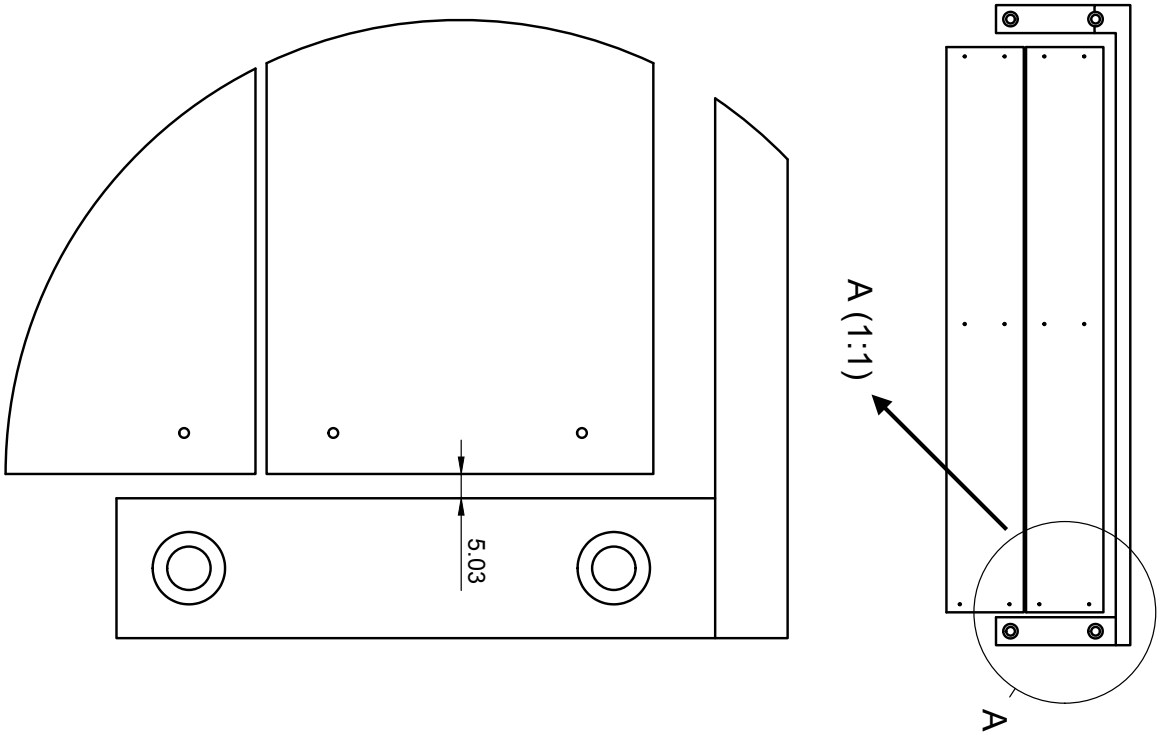
- Points of mechanical design
  1) Outer dimension ⋯ OK
  2) Pitch size for the notches & box holes ⋯ OK
  3) Cabling ⋯ OK
  4) Screw and screw holes ⋯ OK
  5) Others ⋯ Not identified. Any feedback?

- Other points (somehow related to the box design)
  - Cable holding
  - Light tightness

(NOTE: Evaluation of optical specification is ongoing by TMU)

# 1) Outer dimension (Interference b/w modules and bracket)

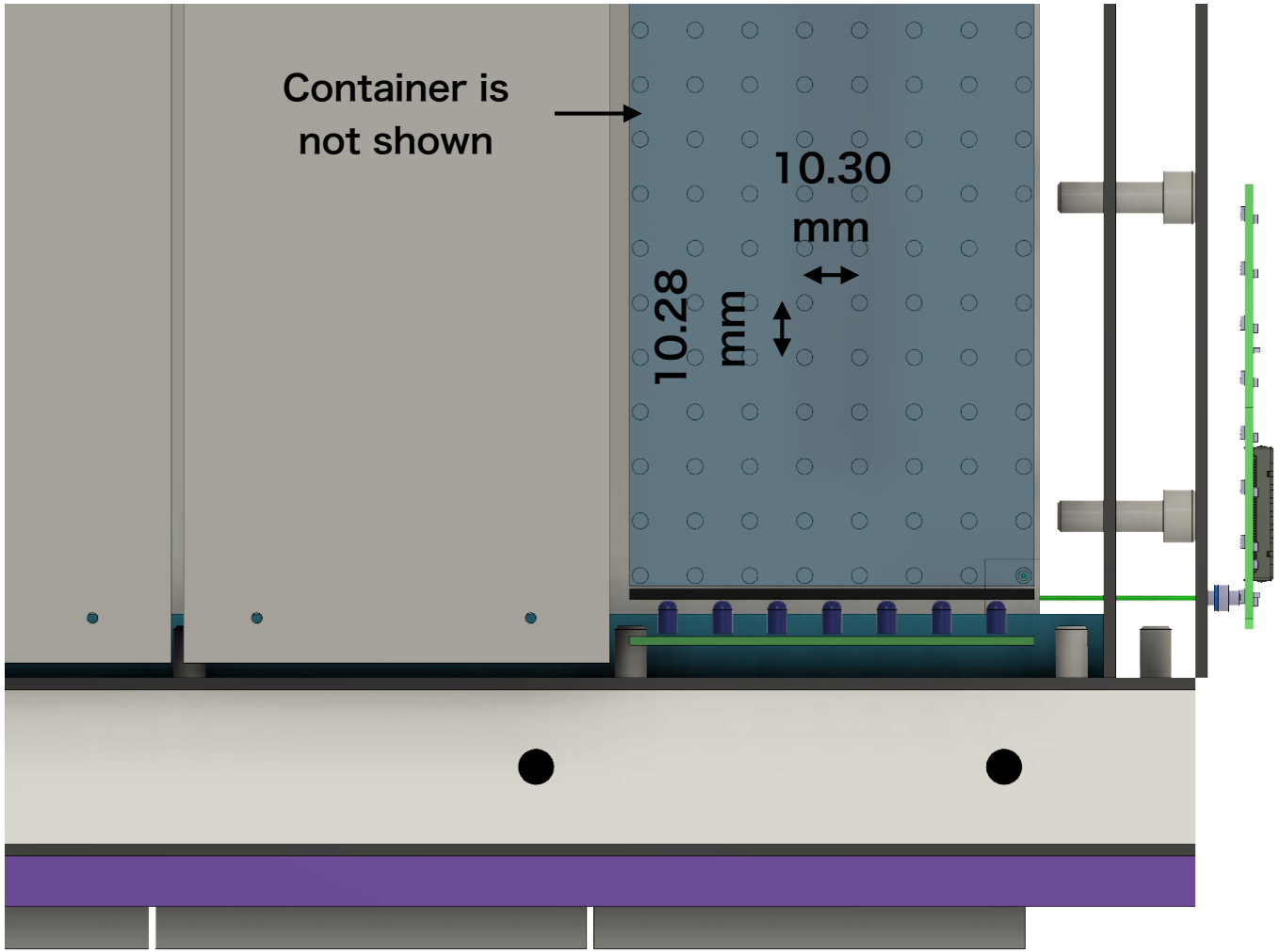





- 2 mm clearance between modules
- No interference with bracket (and other parts for sure)

- Space of ~5 mm at the corner looks safe for routing of cable from LED-PCB in the module. (3 mm is enough at maximum)
  - We would have to attache the cable first before mounting the module but it looks feasible.

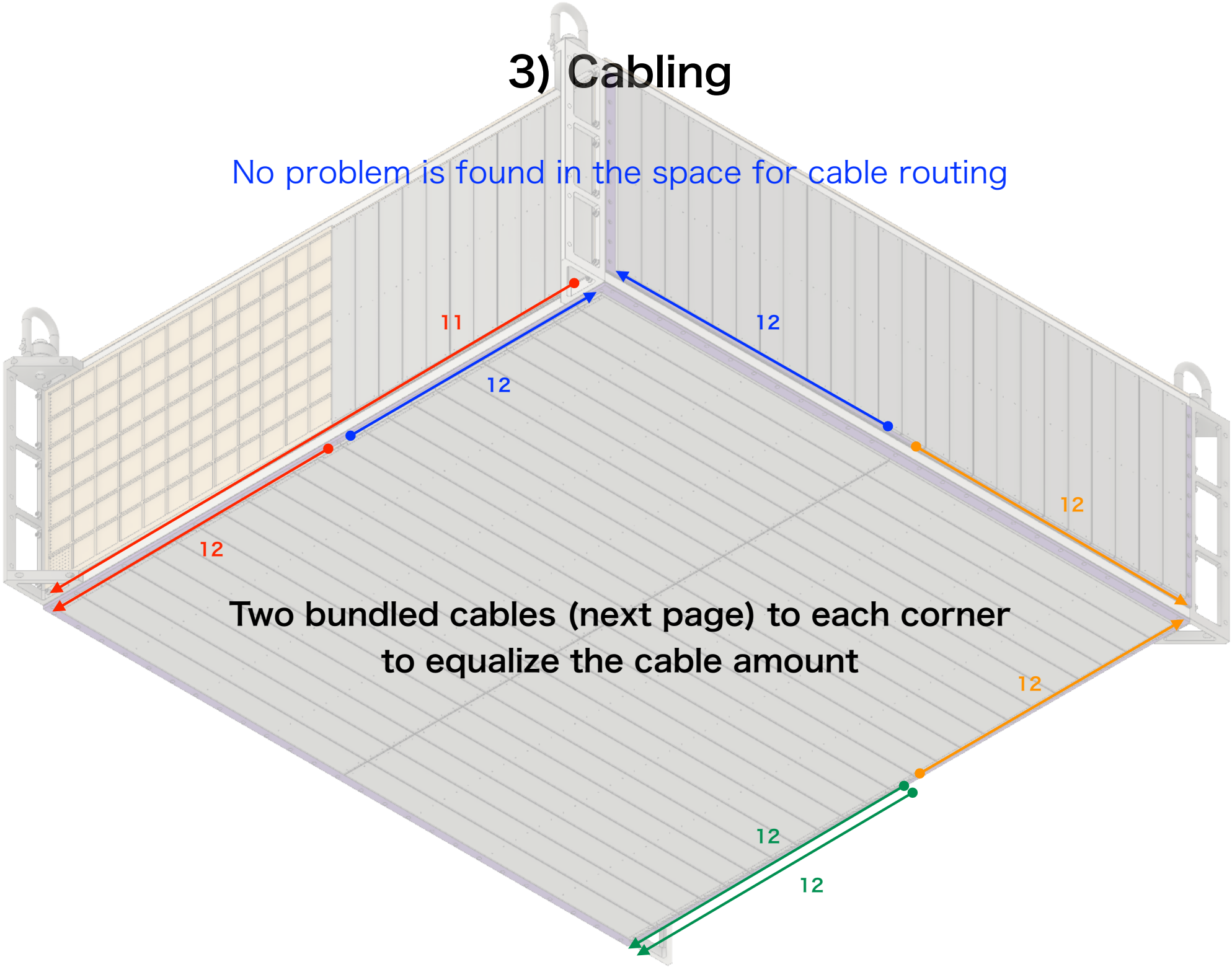
# 2) Pitch size for the notches & box holes




・As we agreed in the meeting on Wednesday, vertical pitch of the box hole will be made with 10.28 mm equal pitch, unlike MPPC-PCB.
Minimal misalignment is expected between the cube and box hole.

# 3) Cabling

No problem is found in the space for cable routing




**Two bundled cables (next page) to each corner to equalize the cable amount**

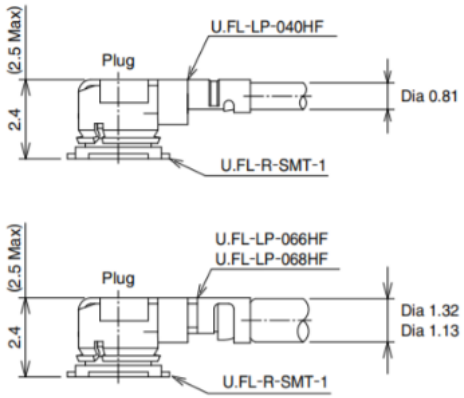
# Choice of connector/cable type

## ●Cable Guide

| Description | Cable Type | Cable Specification | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Inner Conductor* | Dielectric Diameter | Outer Conductor* | Jacket Diameter | Flame Retardant Grade | Nominal attenuation At 3GHz | Nominal attenuation At 6GHz |
| Dia.0.81mm Coaxial Cable | 04 | 7/0.05 SA (AWG#36) | Dia.0.4mm FEP | Single Shield TA | Dia.0.81mm FEP | | 5.4dB/m | 8.0dB/m |
| Dia.1.13mm Coaxial Cable | 068 | 7/0.08 SA (AWG#32) | Dia.0.68mm FEP | Single Shield TA | Dia.1.13mm FEP | | 3.73dB/m | 5.44dB/m |

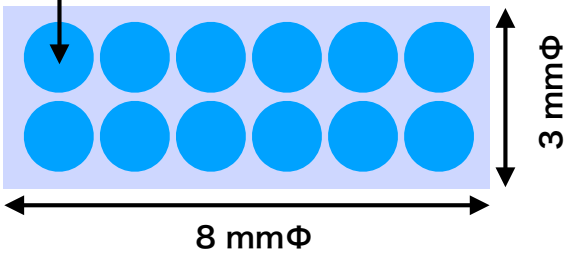
Halogen-free is not available

Halogen-free is available

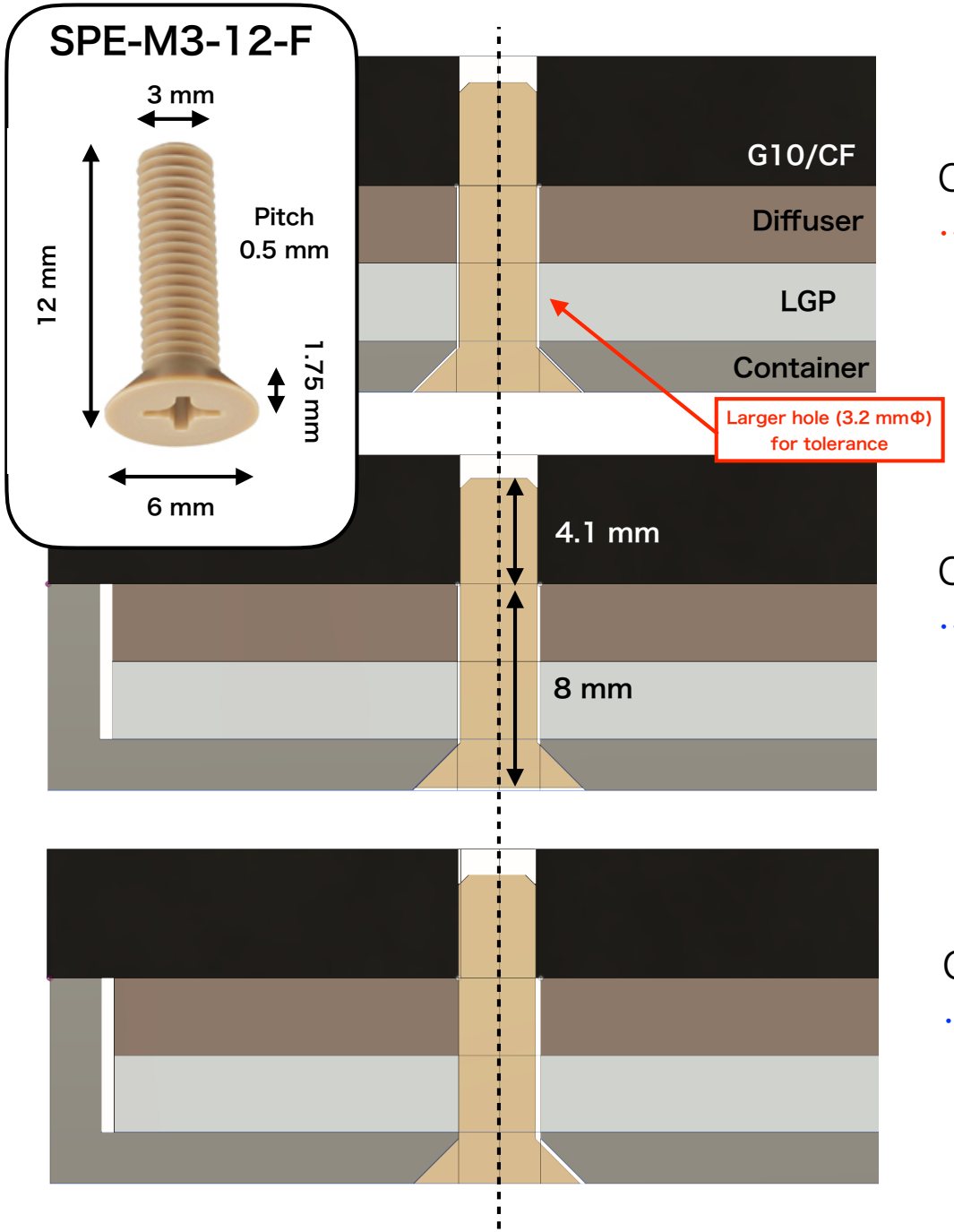

1.13 mm we bought for check

1.13 mmΦ (or 0.81 mmΦ)




We only need a cross-section of “8 mm x 3 mm” for cable routing around the detector

# 4) screws and screw holes




Center, 0.1 space

⋯ Not well fixed if nominal depth

Center

⋯ Fixed by screwing with +0.1 mm depth

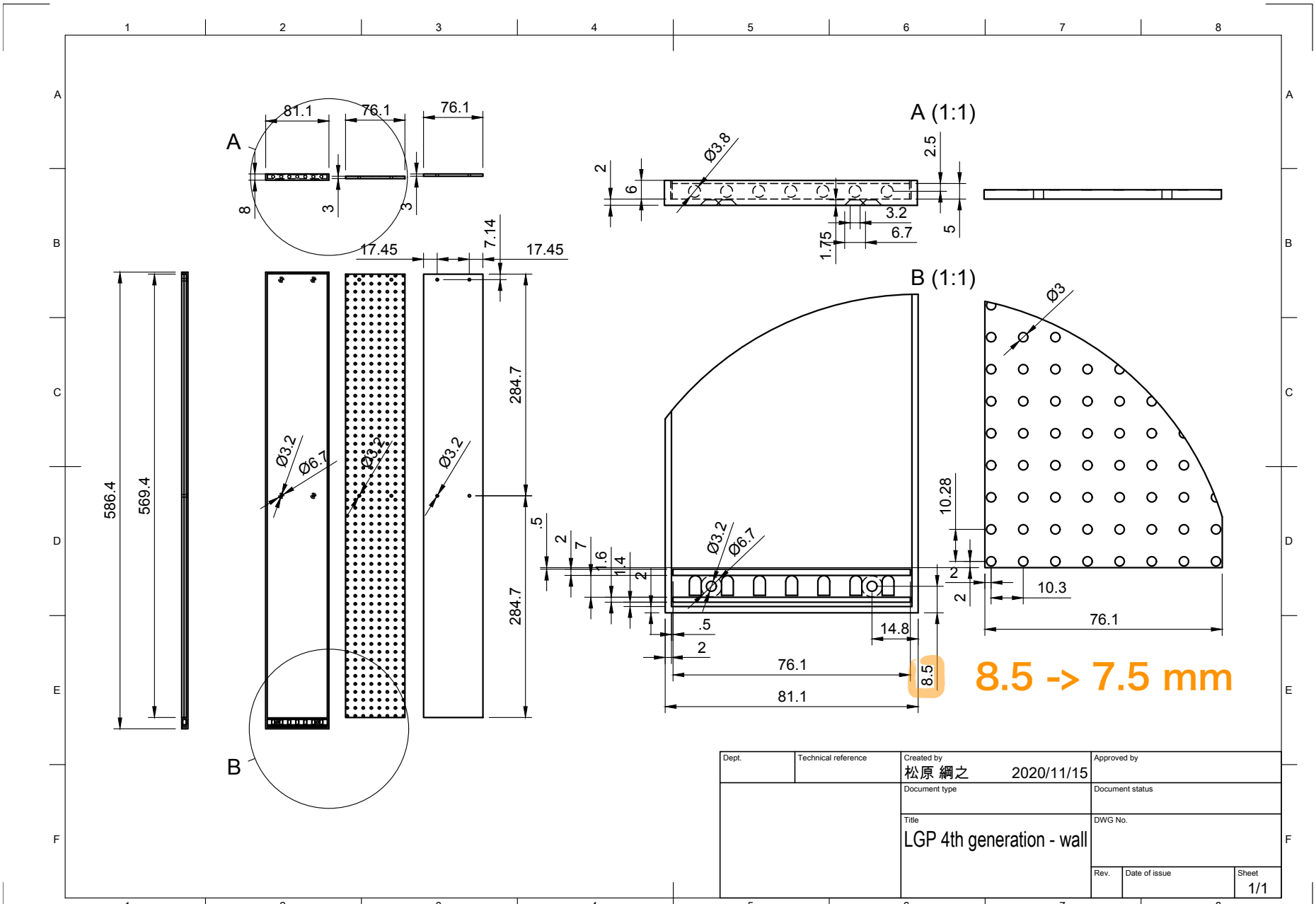
- Current G10 for the calib. system is 4 mm.
- **Additional depth of 0.1 mm at least is needed in the CF layer for screwing.**

Off-center (X = +0.1mm)

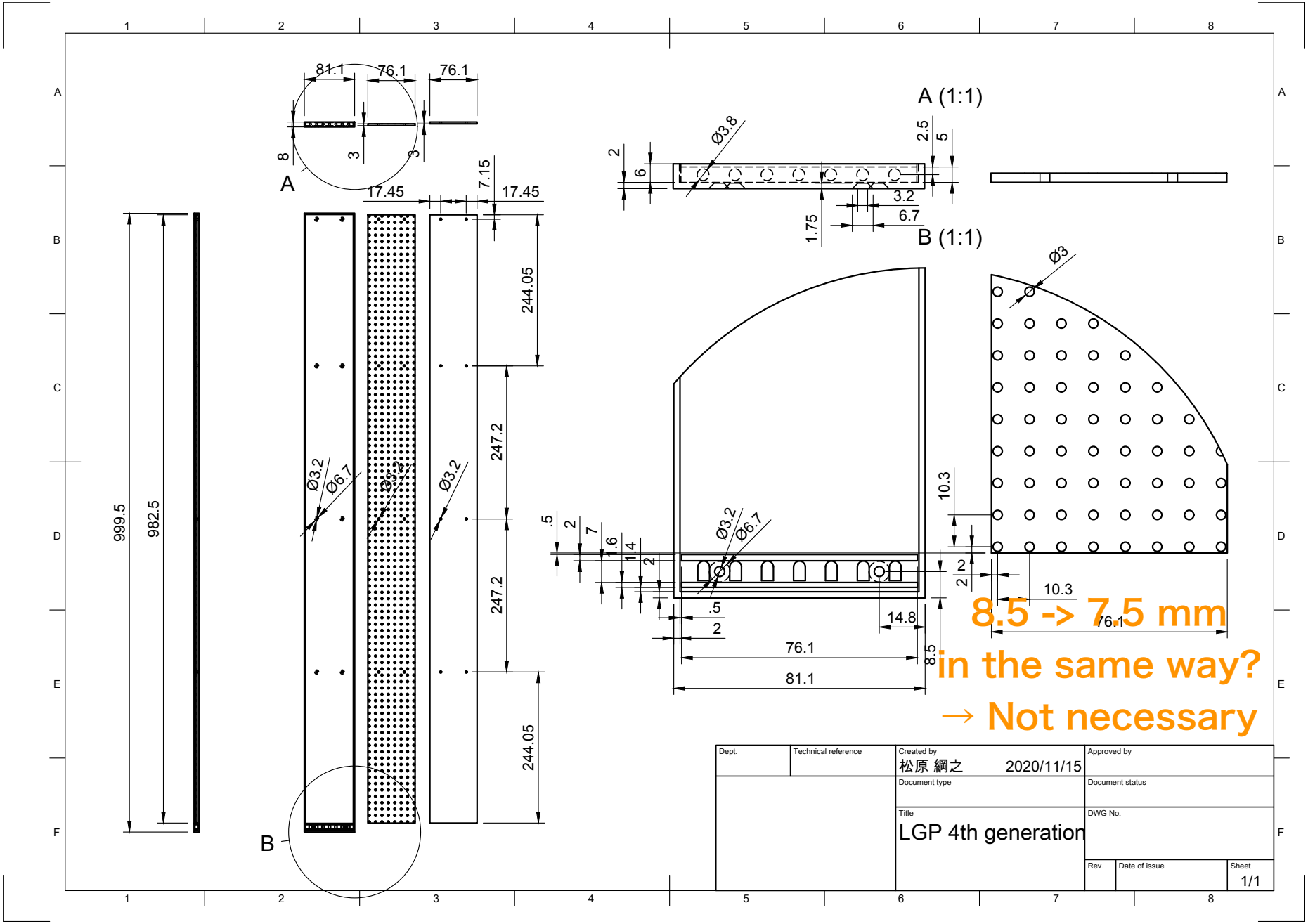
⋯ Fixed by screwing with nominal depth

https://www.nbk1560.com/en/products/specialscrew/nedzicom/chemicalscrew/SPE-F/SPE-M3-F/?SelectedLanguage=en

# Drawing of the wall module



# Drawing of the bottom module



# Conclusion

- Small internal review is expected before the mass production.
- Preliminary investigation for the reviewing is performed.
- Feedbacks are welcome.
- We plan to summarize those information in an official document.

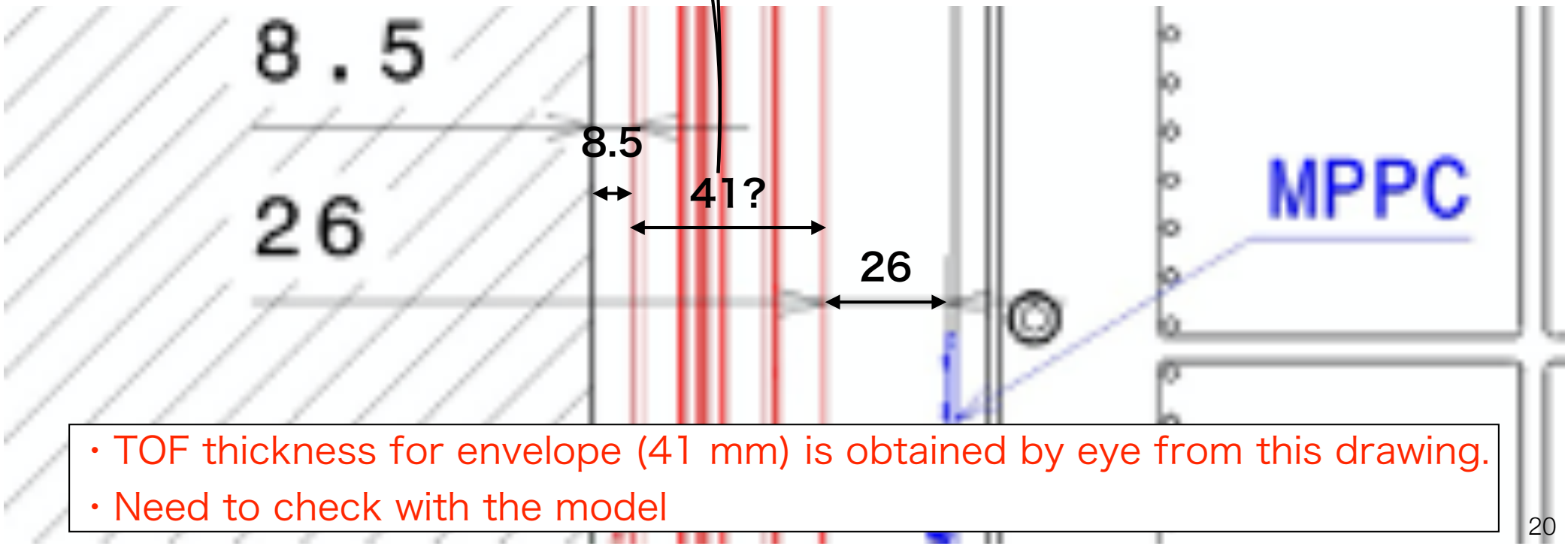
# Backup

# Private check of envelope

# Understandings of envelope along beam axis

| Space along Z axis | | size (mm) | Comment |
|---|---|---|---|
| ECAL-TOF clearance | | 8.5 | From Franck's document in Fig. 10 |
| TOF | | 41.0 | 50.0 from Franck's document in the step 2 |
| TOF-SFGD clearance | | 10.0 | From Franck's document in Fig. 10 |
| SFGD | SFGD cable | 16.0 | From Franck's document in Fig. 10 |
| | SFGD mppc | 1.6 | G10 is not included (G10 is a part of the box) |
| | SFGD box | 1969.4 | Breakdown (See right table) |
| | SFGD calib+cable | 8.0 | G10 is not included (G10 is a part of the box) |
| SFGD-TOF clearance | | 8.0 | From Franck's document in Fig. 12 |
| TOF | | 41.0 | 50.0 from Franck's document in the step 2 |
| TOF-TPC clearance | | 9.5 | From Franck's document in Fig. 12 |
| Summation above | | 2113.0 | |
| Available envelope | | 2113.0 | Uncertainty of the ECAL position |

| Box structure along Z axis | size (mm) | Comment |
|---|---|---|
| Upstream G10 - for mppc | 7.0 | From Larry's model |
| Upstream CF - outer skin | 2.3 | From Larry's model |
| Upstream Divinycel H250 (Al frame) | 15.0 | From Larry's model |
| Upstream CF - inner skin | 2.3 | From Larry's model |
| Upstream foam | 12.0 | From Larry's model |
| Cube | 1895.2 | From Larry's model (=10.3x184 mm) |
| Downstream foam | 12.0 | From Larry's model (=13-1 mm) |
| Downstream CF - inner skin | 2.3 | From Larry's model |
| Downstream Divinycel H250 (Al frame) | 15.0 | From Larry's model |
| Downstream CF - outer skin | 2.3 | From Larry's model |
| Downstream G10 - for calibration | 4.0 | From Larry's model |
| Total | 1969.4 | Thickenss for gluing seems to be neglected |




- TOF thickness for envelope (41 mm) is obtained by eye from this drawing.
- Need to check with the model

# Risk analysis

Uncertainties what Davide and I privately discussed are:

- 1 mm flatness (any detector given the large surface)
- 1-2mm precision in the measurement we did in ND280
- Earthquake deformation (~4mm from ToF and ~3mm from sFGD)
- Other potential issues we may be missing (misaligned detectors, not perfect installation in ND280 after the upgrade, etc.)

Sum of those uncertainties is ~7 mm (except for potential issues)

→ So it can be accommodated by the current TOF-SFGD clearances (10 (8) mm clearance for upstream (downstream)).

→ But if we still have concern in other potential issues for the available envelope as mentioned above, having more clearance is safer.