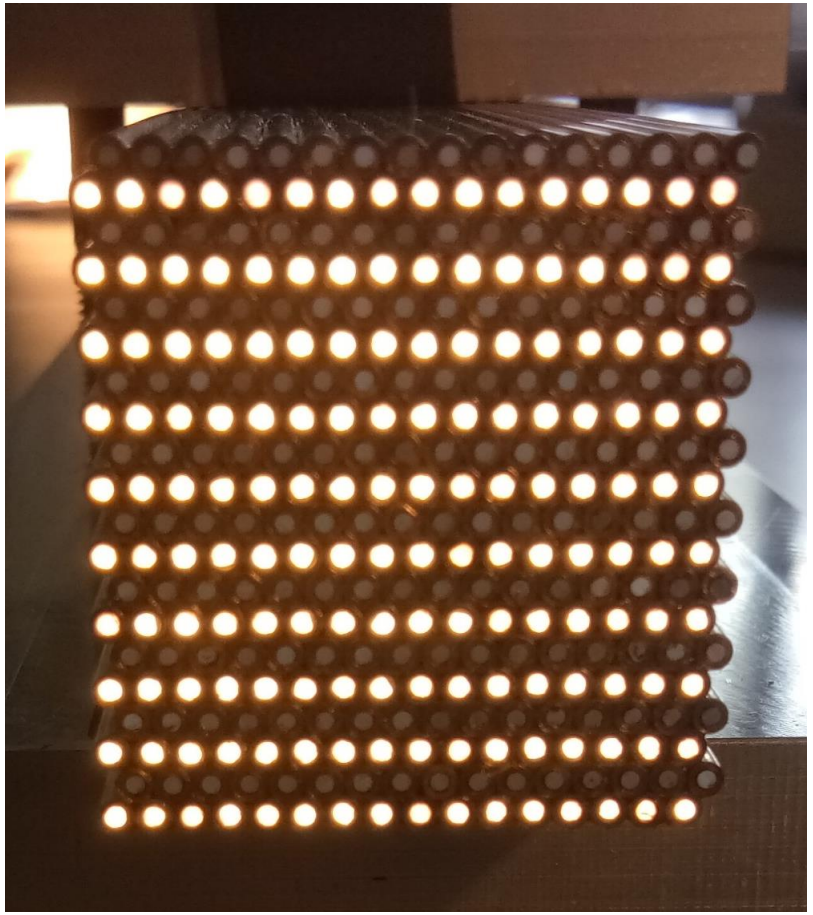
# Status Of Electromagnetic-size Prototype Module Preparation

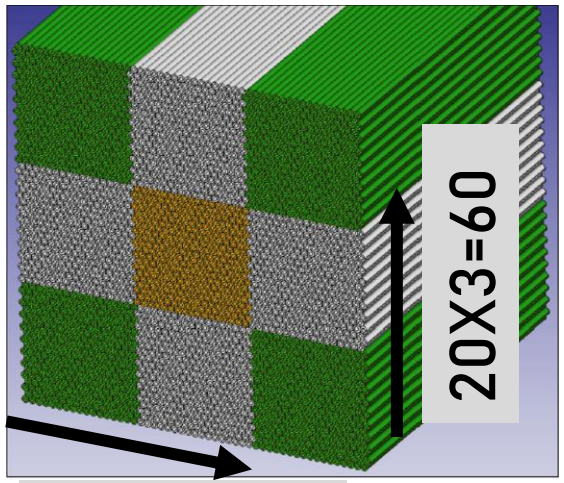
## Dual-readout Calorimetry

Jinky Agarwala
On Behalf of Pavia Group



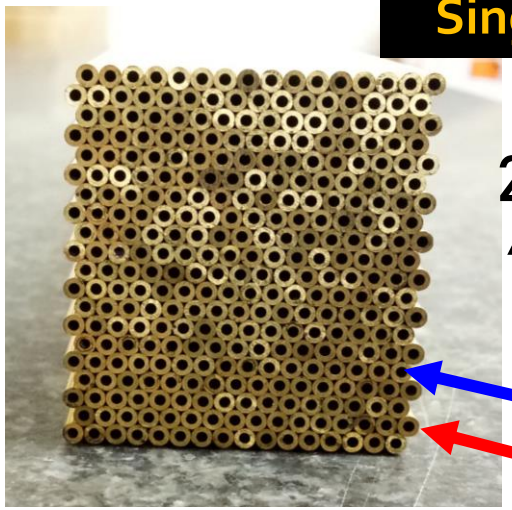
# Contents

# Geometry




- Material: Brass (CuZn37)
- Capillary: 2 mm outer diameter, 1 mm inner diameter
  - Total 9 towers -60 rows X 48 capillary tubes
  - Whole module: ~10 cm x 10 cm x 1 m
  - Central tower 1.2 m long
    - Central tower read by 320 SiPMs
    - Eight surrounding towers read by 16 PMTs (two PMTs per tower)

Single Tower



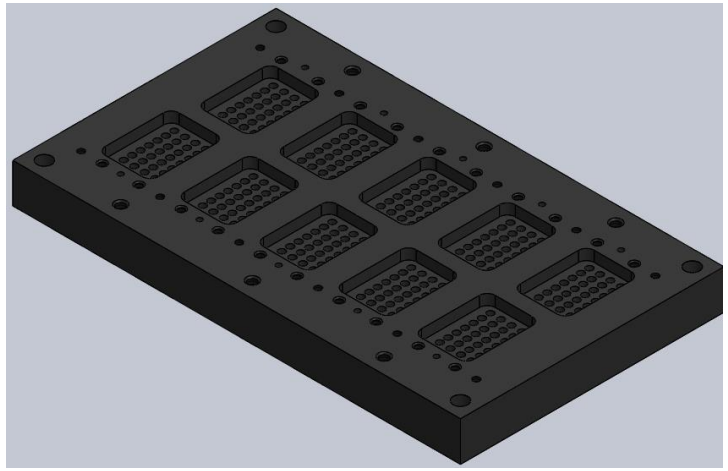

- Single tower: 160 S fibers, 160 C fibers

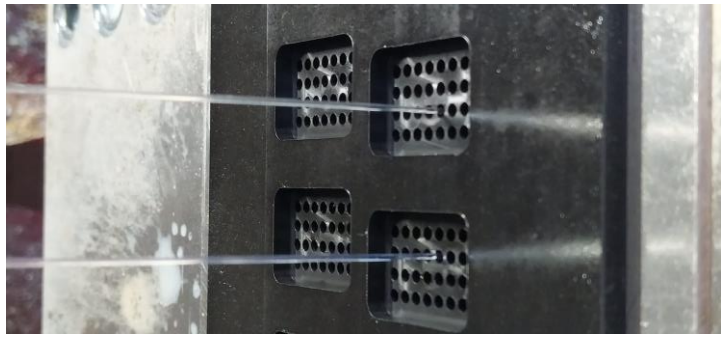
Scintillation channels

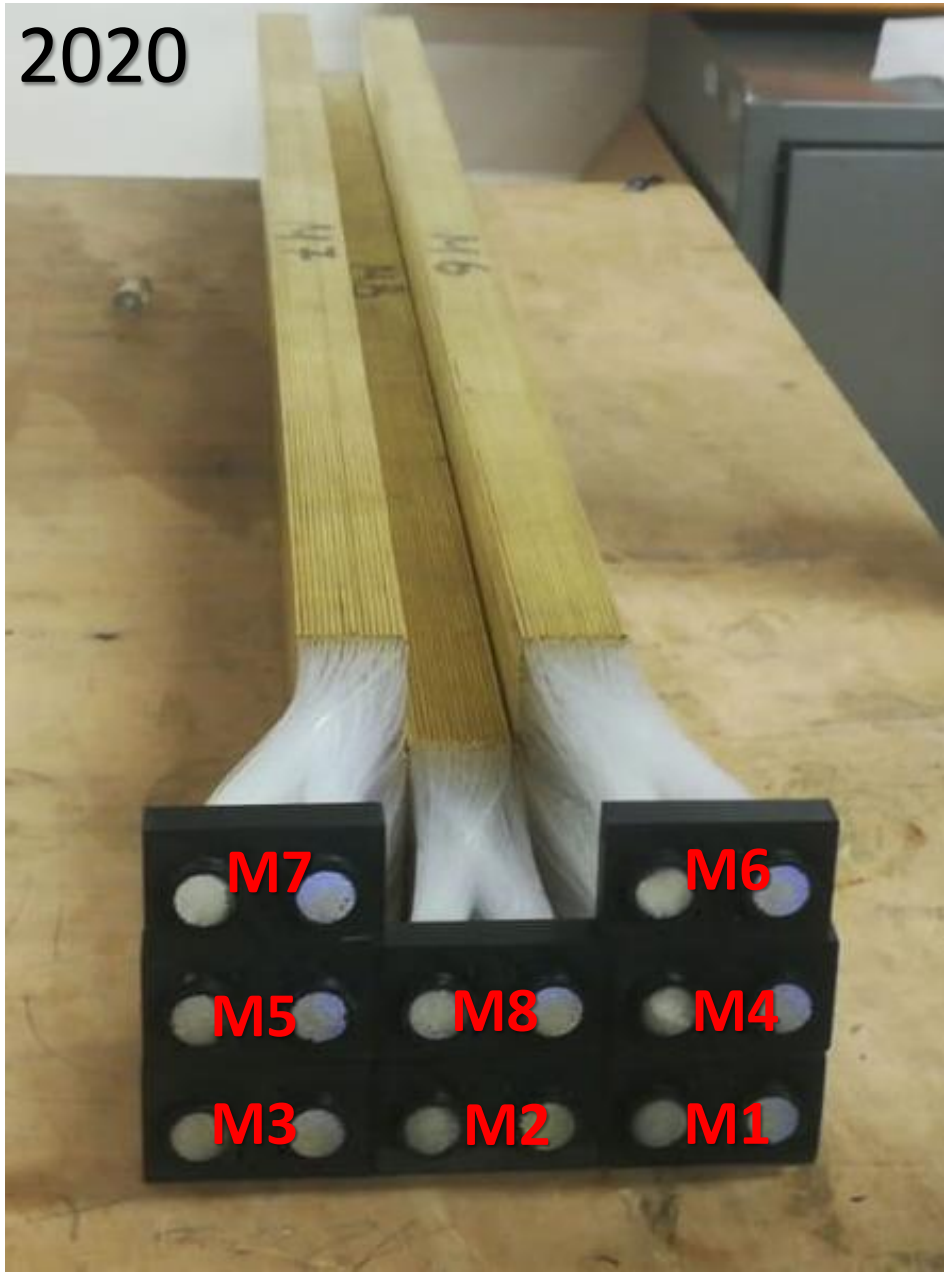
Cherenkov channels

# Status as on CEPC - PlenaryMeet - Dec. 2020

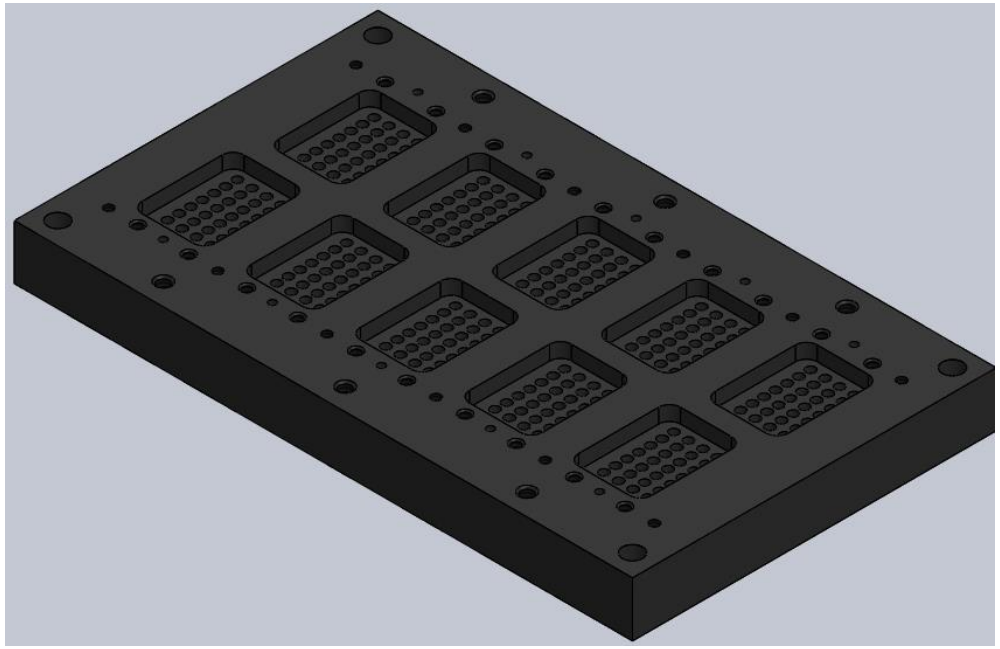
- Fiber insertion, fiber grouping and gluing @ rear ends are done for eight surrounding towers
- Central tower (M0) stand by – has been awaited a tool (plate with 320 holes) to keep all fibers separated for SiPM readouts
  - ✓ The tool has been constructed now







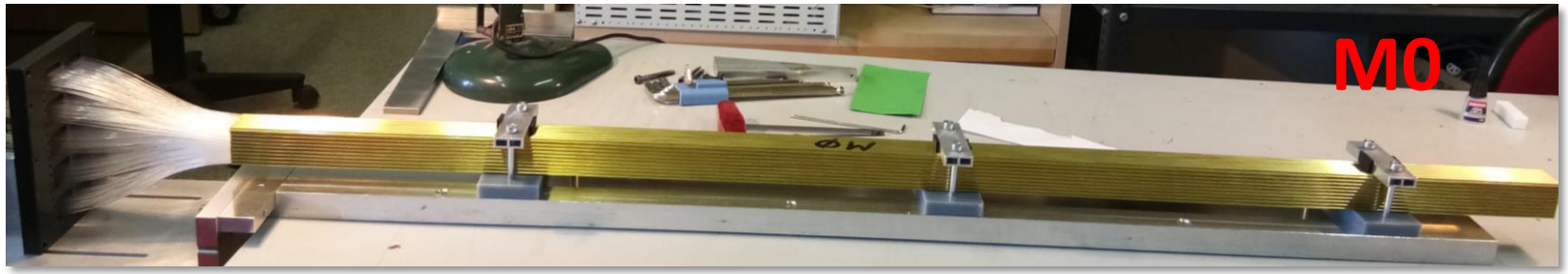
# Why this interface?

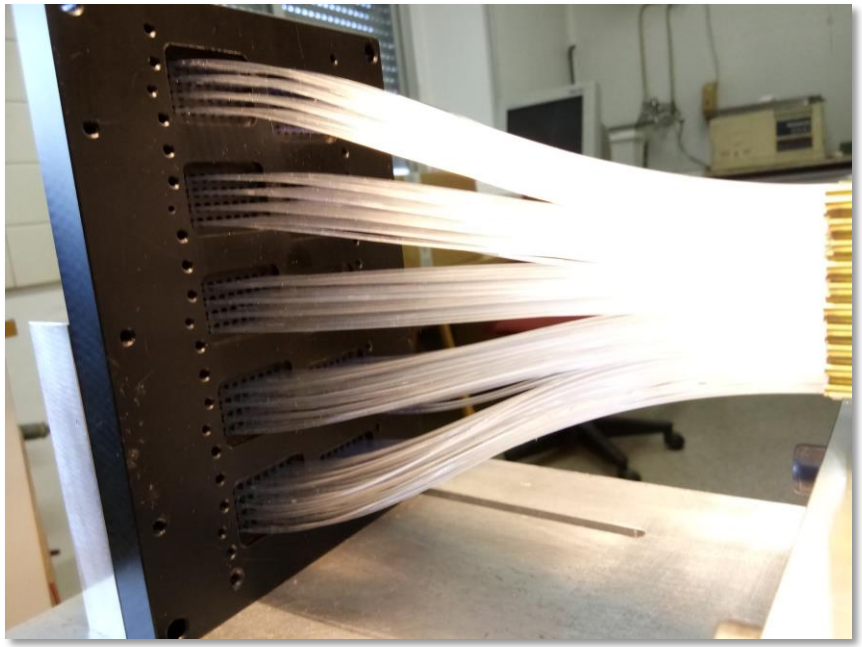


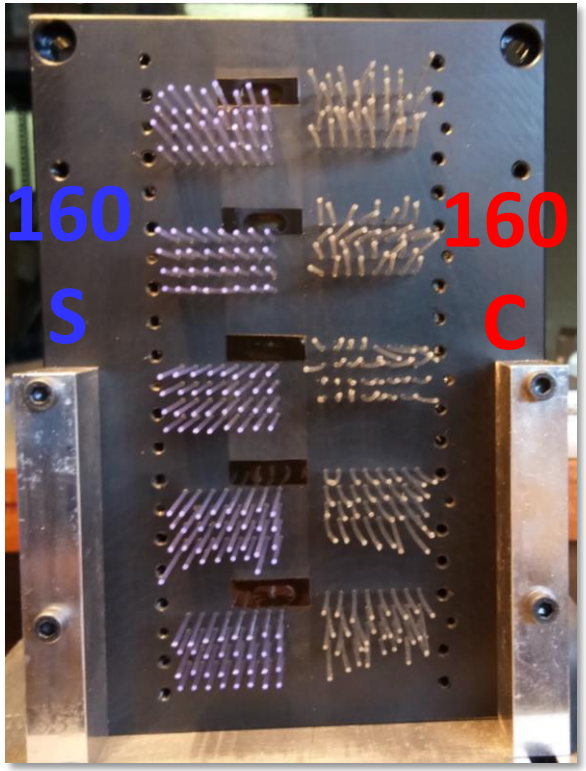
- Temporary solution for Test Beam
- Dimension of SiPMs (15 micron cell) not compatible with tube to tube distance

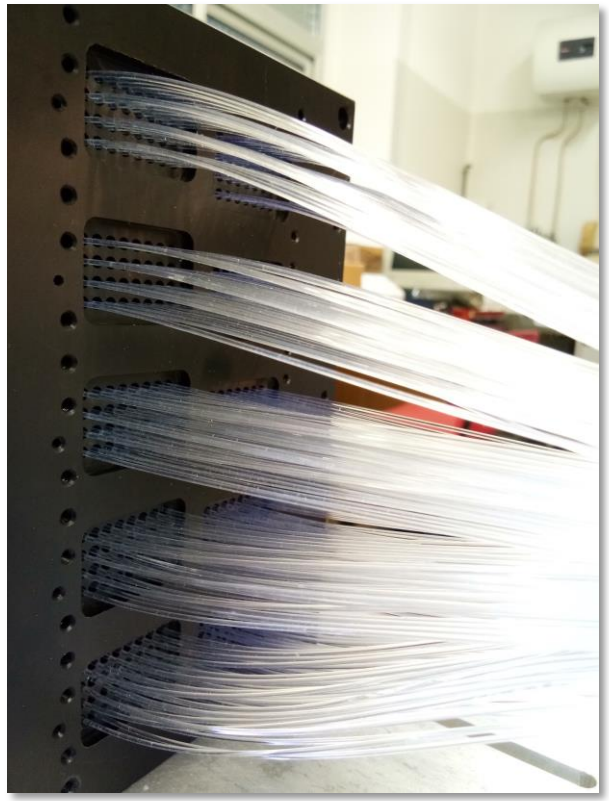
# Central Tower Loaded

- Central tower loaded with fibers

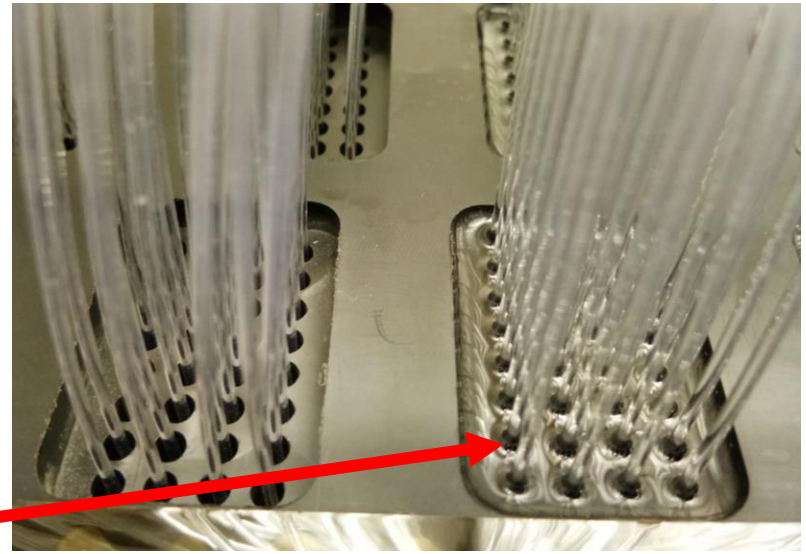




# Gluing

At front side of the interface

- Deeps are filled with glue (BC 600 optical cement)
- 24 hours to set

At back side of the interface

- White frames to be filled with glue
- 24 hours to set

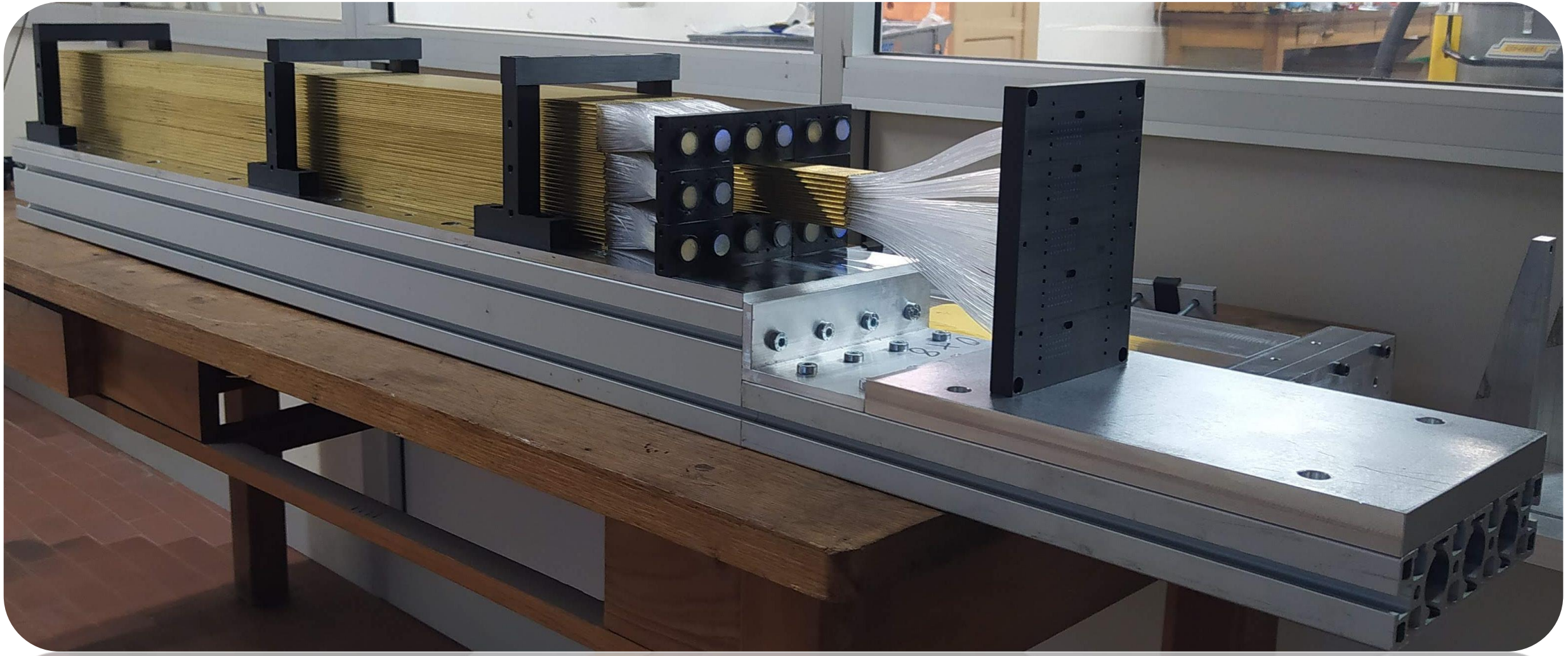

# Machining

- Back side of the interface milled upto the level of surface and polished

Fine polished

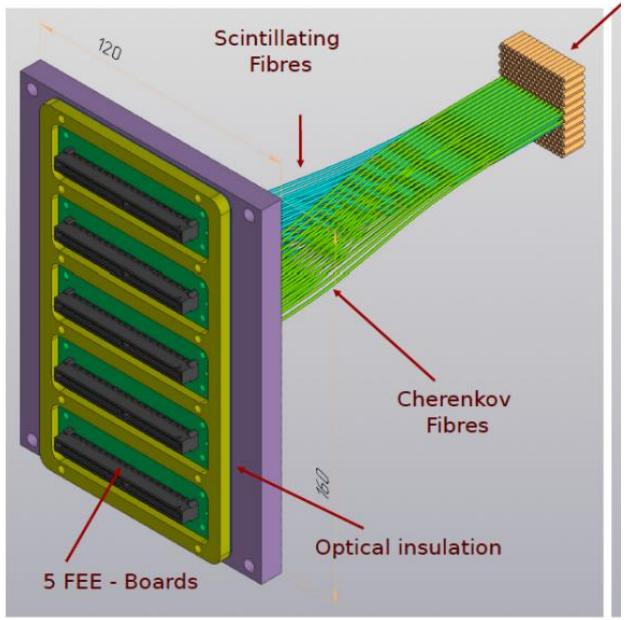
Sample SiPM board attached

# Ready to be coupled with SiPMs and PMTs



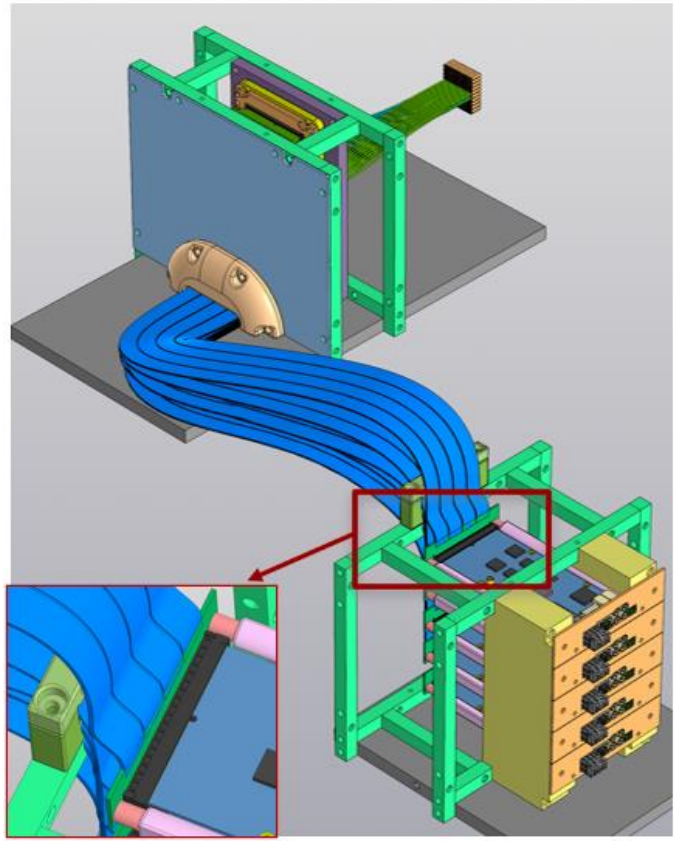
# Updates on Electronics

Calor

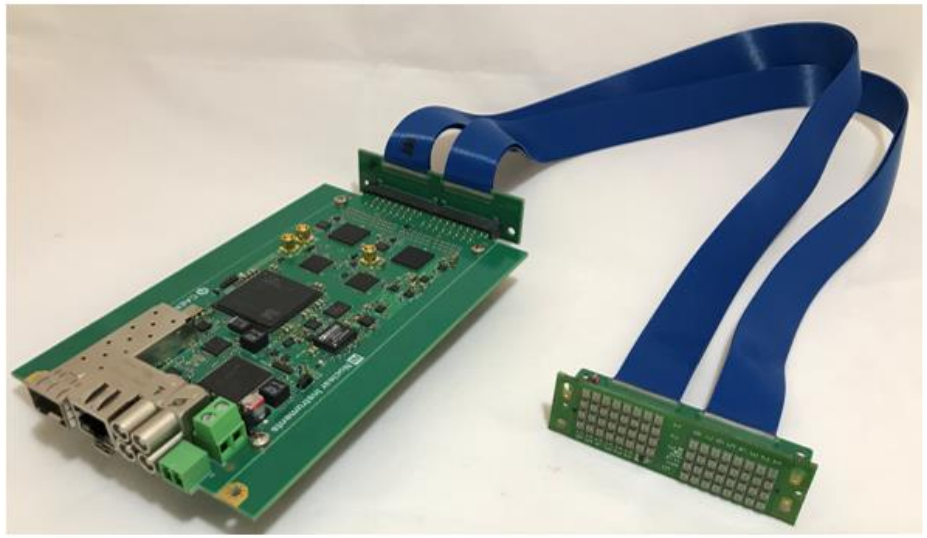



5 boards—> 64 SiPMs (32 S+32 C) to FERS boards

## Taken Care by Univ. of Insubria, Como Group



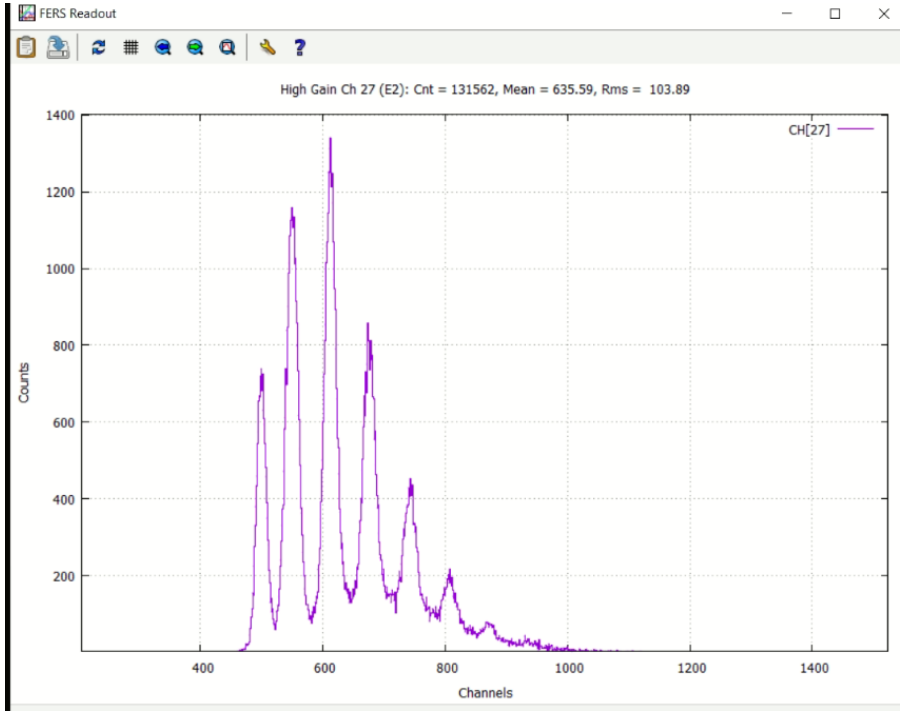
**Readout Boards:**
**5 FERS - A5202**
**1 FERS - A5202 (spare)**

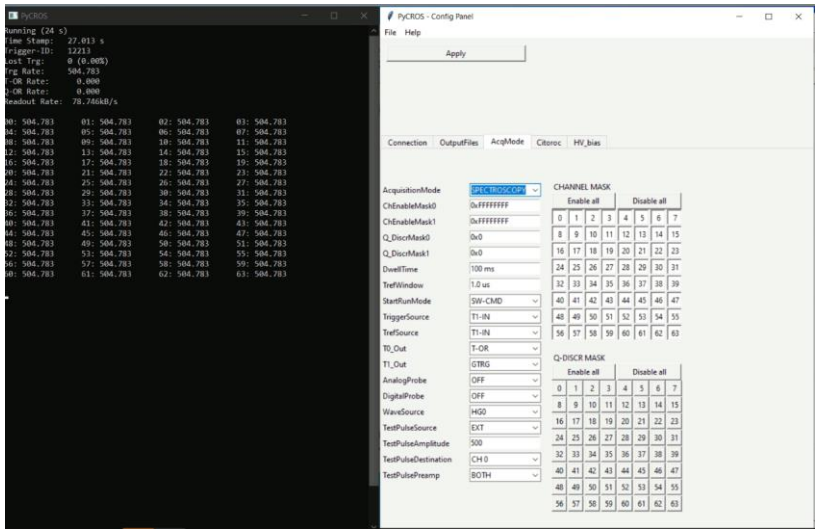


**FEE – Boards**
**5 Boards (320 SiPMs)**

# Updates on Electronics

- 5 FEE Boards
  - All boards have been delivered: qualification is on-going
  - In total we have 318/320 working channels
- Cables from Samtec
  - All cables (5 + spares) have been delivered and qualified: all working
- FERS – A5202
  - All boards have been produced. They are in CAEN for electrical qualification.
  - In Como there is a prototype board to practice and qualify the system (FEE-boards, SiPMs, final cabling)
  - The software development is still on-going: we have a beta-version to operate the system



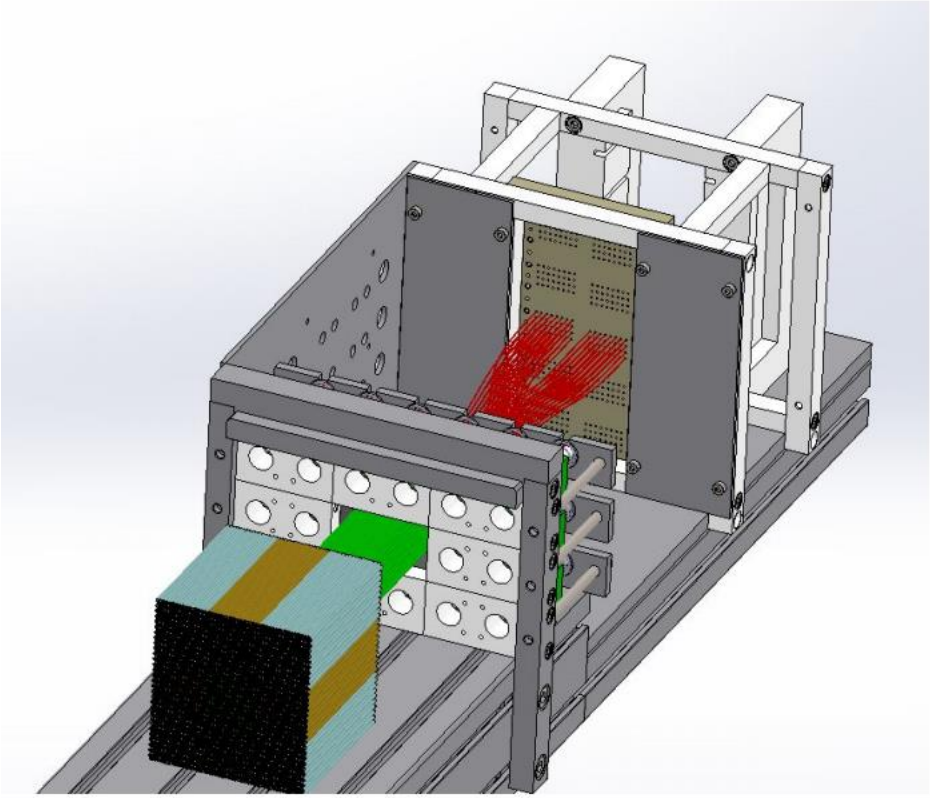
# Conclusions

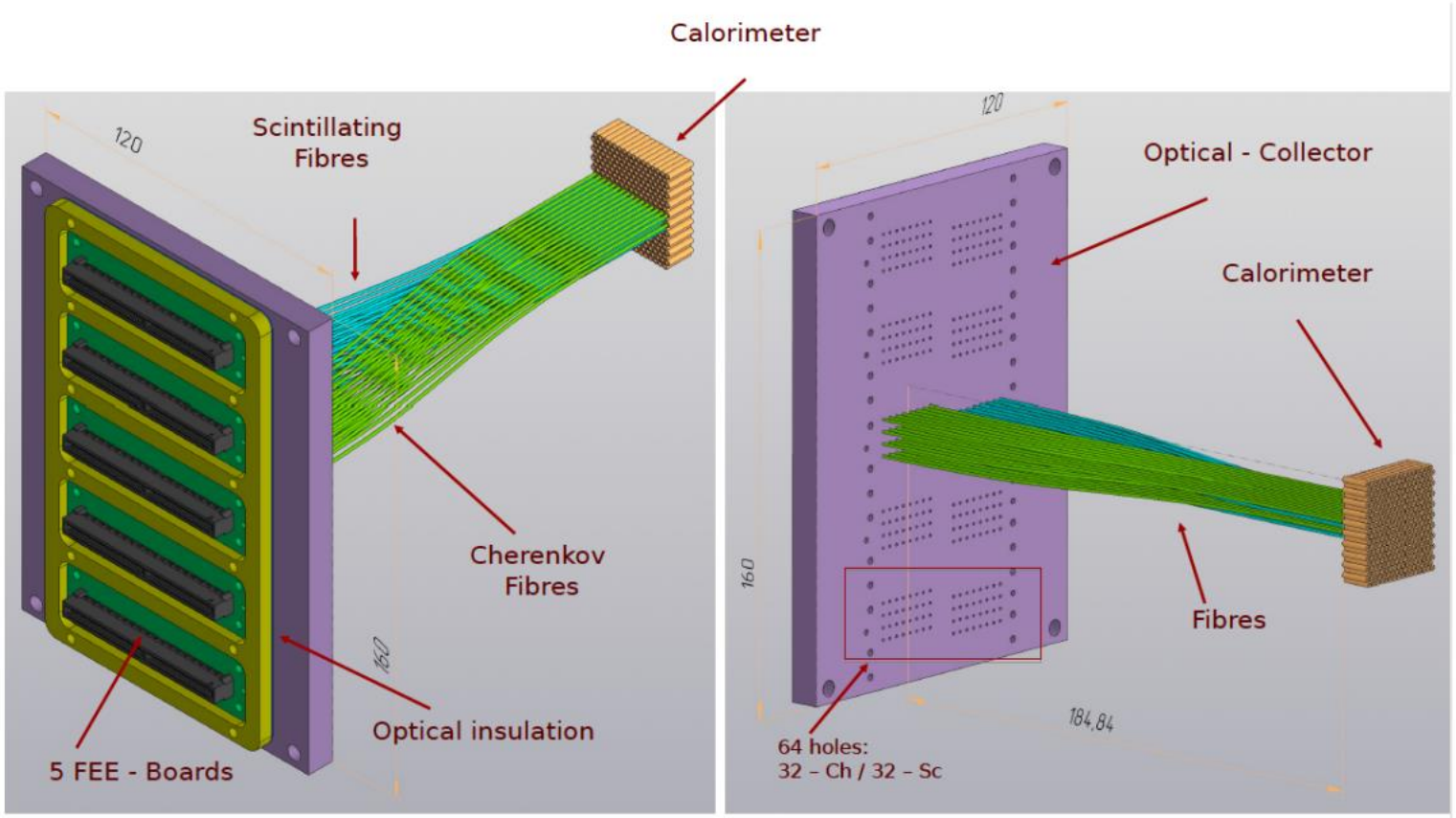
- EM-size module has been constructed and ready to be coupled with readouts
- PMTs tested in Pavia are linear and ready to be used (info about PMTs and test results are put on back up slides)
- Test Beam
  - Moved from Nov. 2020 to mid Feb. 2021. Further postpone until spring due to present Covid situation
  - Another TB @ CERN North Area – request submitted

Thank You!

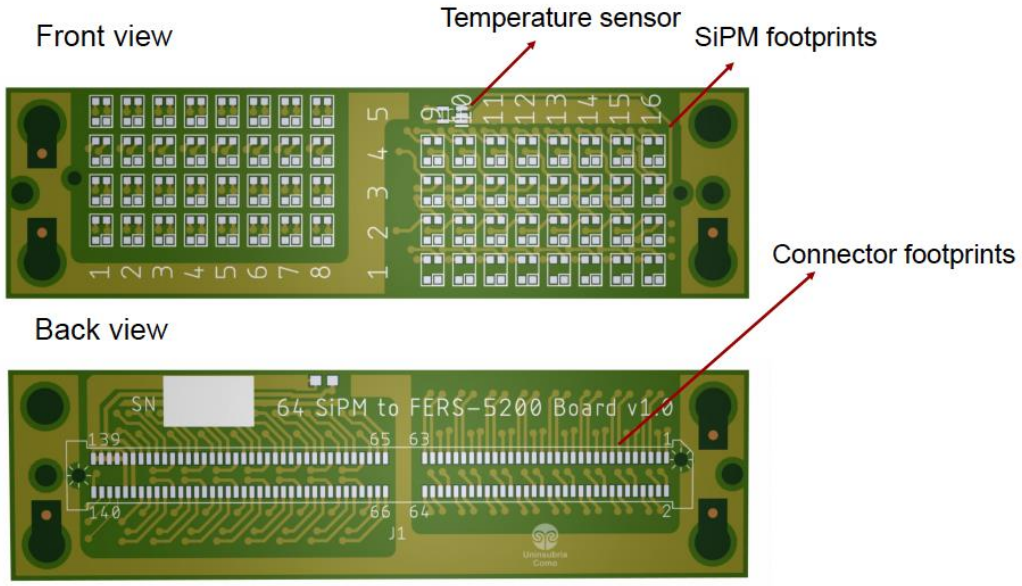
# Back Up

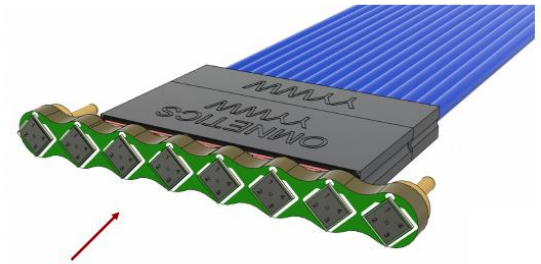
# READOUT




Calorimeter
120
Scintillating
Fibres
Cherenkov
Fibres
160
Optical insulation
5 FEE - Boards
120
Optical - Collector
Calorimeter
160
Fibres
184,84
64 holes:
32 – Ch / 32 – Sc

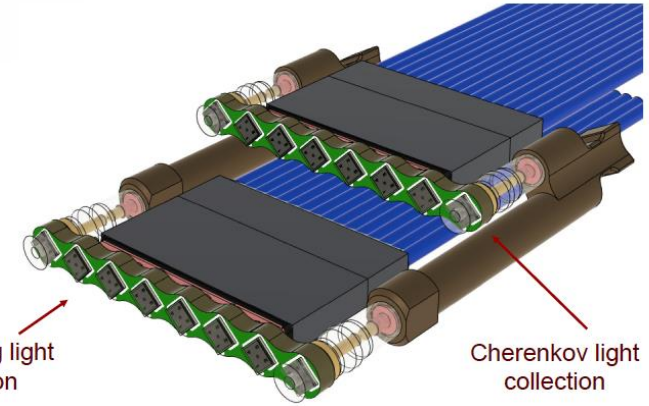
# Test Beam → Real Experiment



FEE-board + SiPMs
Segmentation optimised to exploit grouping

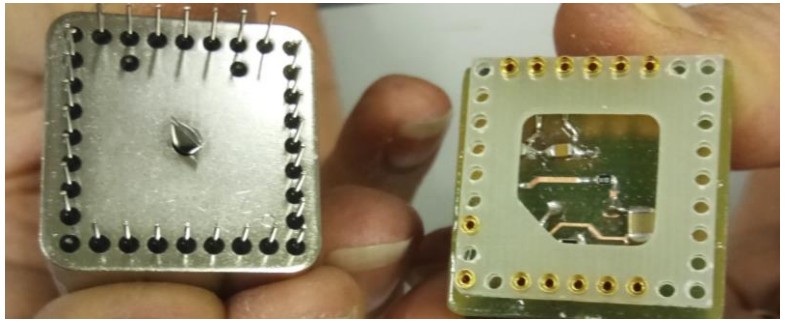
Pair of FEE-boards joint together with clips



# Testing PMTs - setup

| PMT Type | No. of PMTs |
|---|---|
| R8900 | 8 |
| R8900-100 | 8 |

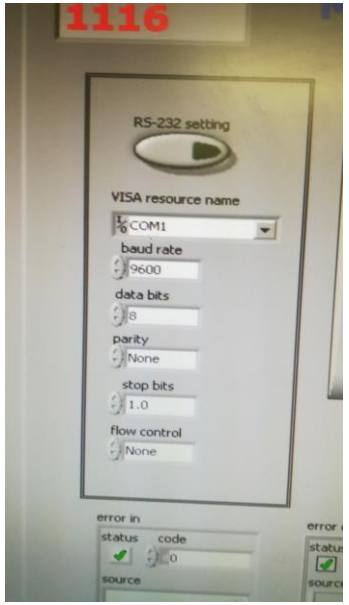

Position Sensitive PMT HAMAMATSU




LASER Source



Attenuator




Labview

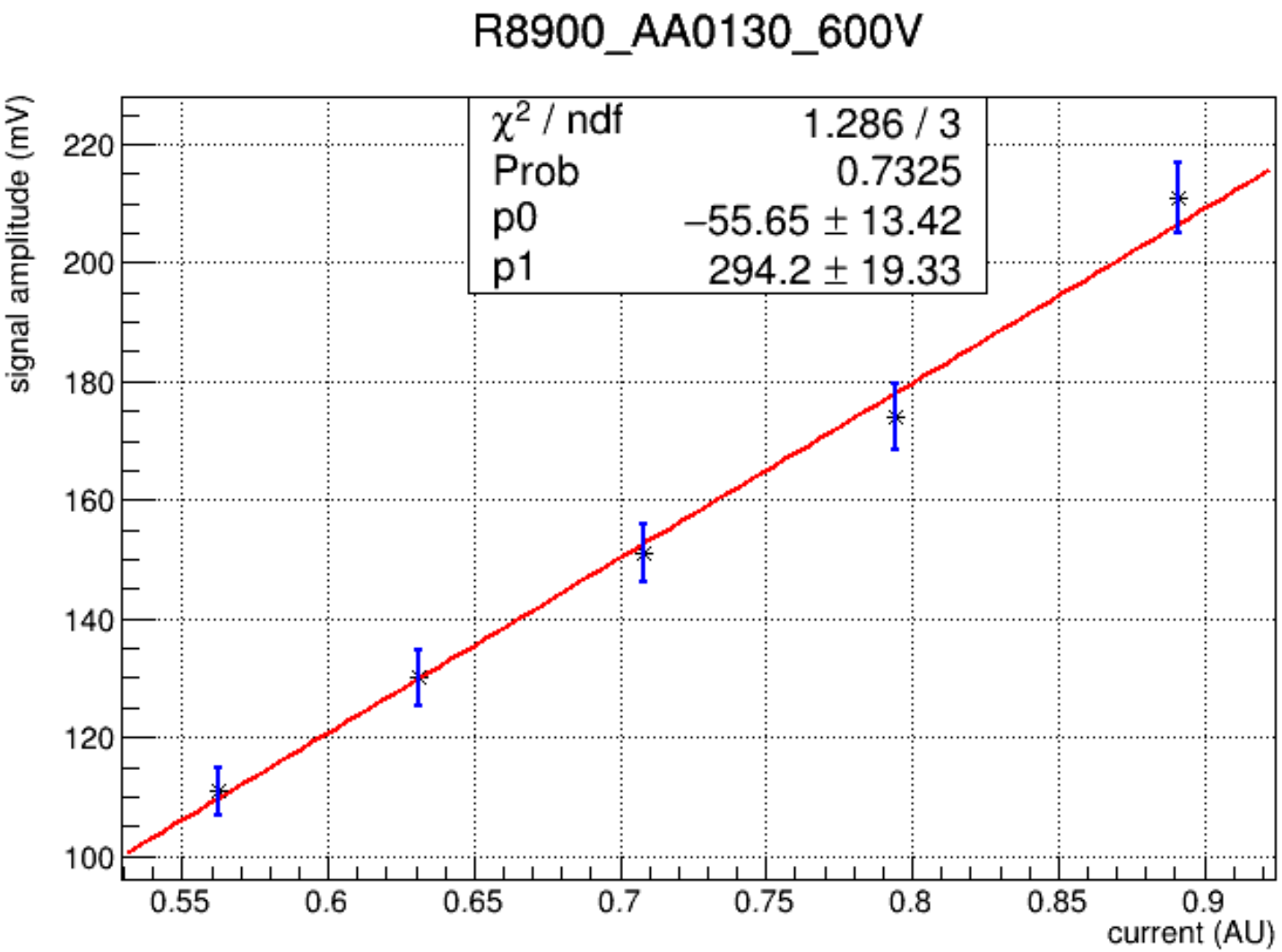
Fiber

PMT

HV

Connection to scope

# Linearity Tests and Results




- No absolute scale for measuring light intensity
- We have the maximum from the set up
- Then we use attenuator

Current,

$I = I_0 \times 10^{(-dB/20)}$

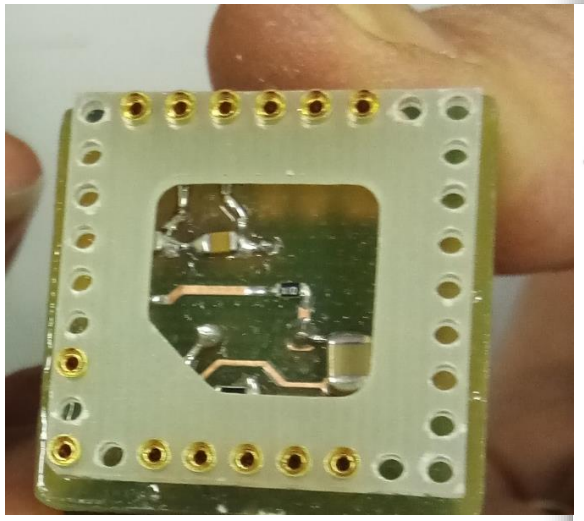
# Linearity Tests and Results

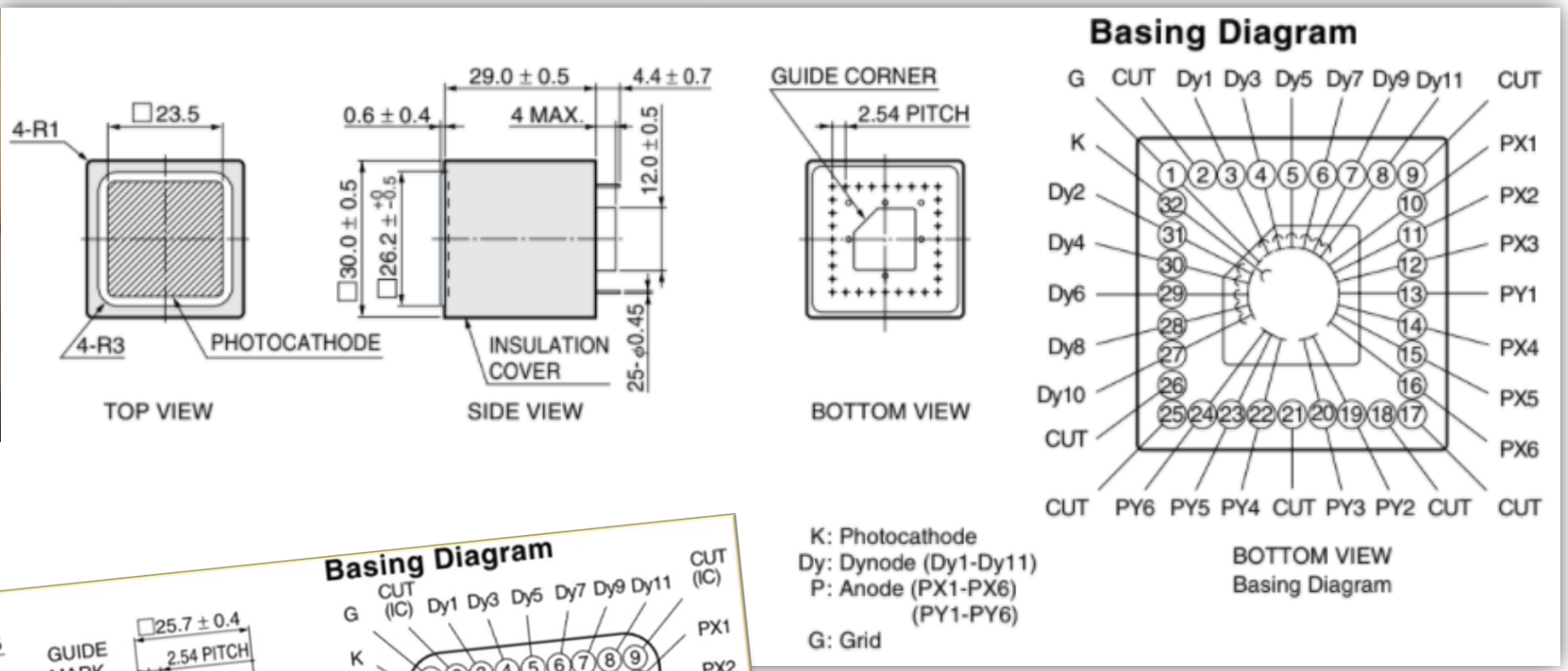
## For HV = -600 V

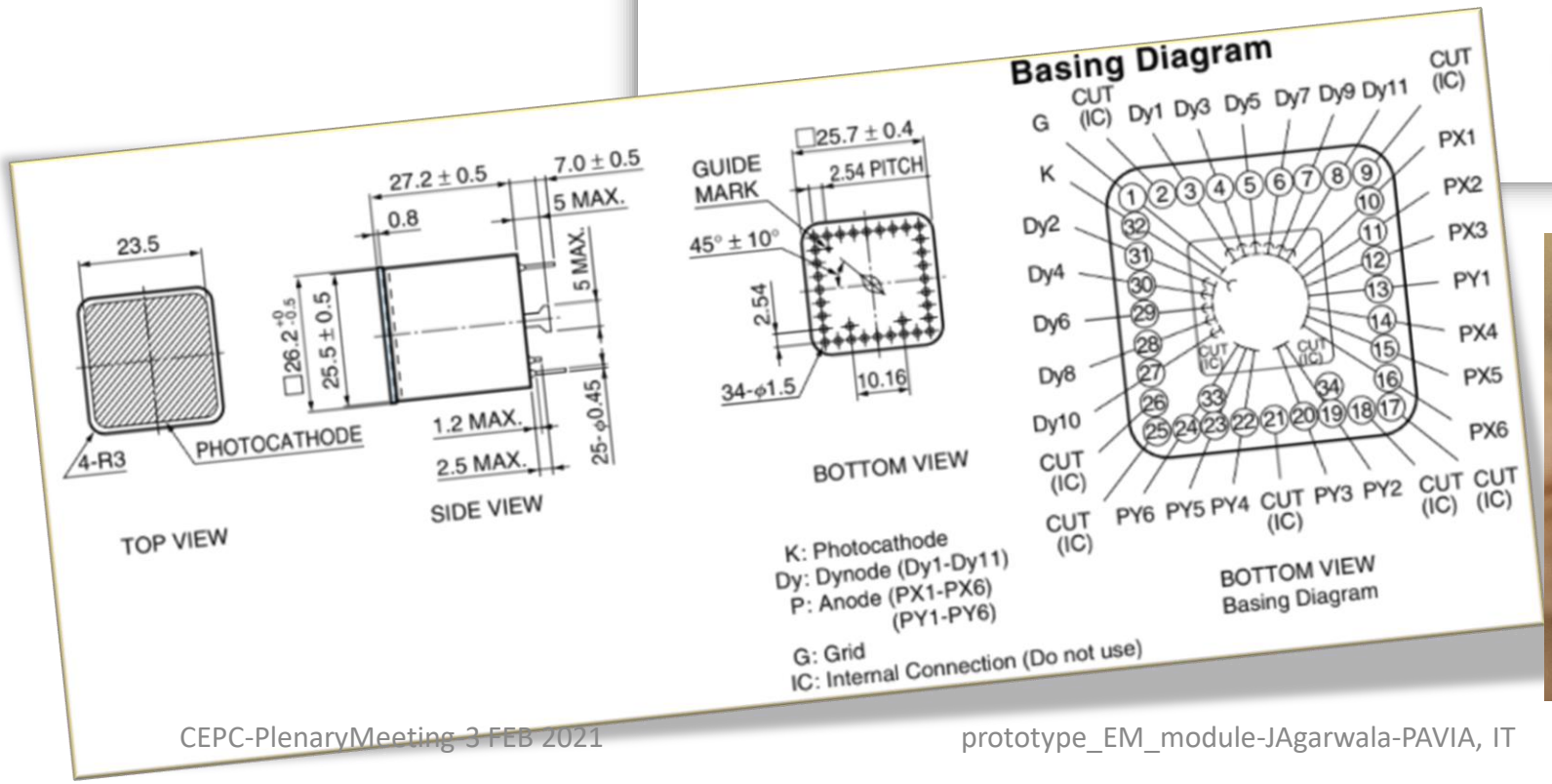
| PMT type | PMT No. | Chi-squared/ndf |
|---|---|---|
| R8900 | AA0130 | 1.286/3 |
| | AA0134 | 3.471/3 |
| | AA0140 | 2.920/3 |
| | AA0156 | 2.679/3 |
| | AA0161 | 2.674/3 |
| | AA0165 | 1.228/3 |
| | AA0166 | 1.041/3 |
| | AA0167 | 1.199/3 |

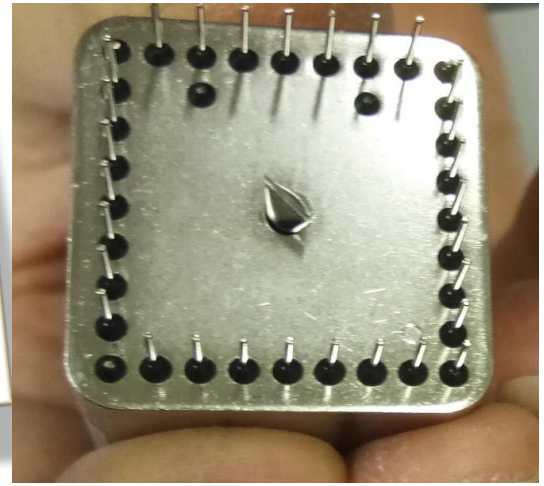
| PMT type | PMT No. | Chi-squared/ndf |
|---|---|---|
| R8900-100 | DA0043 | 4.385/3 |
| | DA0157 | 3.396/3 |
| | DA0162 | 4.907/3 |
| | DA0164 | 5.357/3 |
| | DA0170 | 4.27/3 |
| | DA0171 | 4.867/3 |
| | DA0172 | 3.601/3 |
| | DA0182 | 5.124/3 |

## All chosen PMTs are linear




4-R1
□23.5
29.0 ± 0.5
4.4 ± 0.7
0.6 ± 0.4
4 MAX.
12.0 ± 0.5
□30.0 ± 0.5
□26.2 +0 -0.5
4-R3
PHOTOCATHODE
INSULATION COVER
25-φ0.45
TOP VIEW
SIDE VIEW
GUIDE CORNER
2.54 PITCH
BOTTOM VIEW
Basing Diagram
G CUT Dy1 Dy3 Dy5 Dy7 Dy9 Dy11 CUT
K
Dy2
Dy4
Dy6
Dy8
Dy10
CUT
PX1
PX2
PX3
PY1
PX4
PX5
PX6
1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16 17
18 19 20 21 22 23 24 25
26 27 28 29 30 31 32
CUT PY6 PY5 PY4 CUT PY3 PY2 CUT CUT
K: Photocathode
Dy: Dynode (Dy1-Dy11)
P: Anode (PX1-PX6)
(PY1-PY6)
G: Grid
BOTTOM VIEW
Basing Diagram


23.5
27.2 ± 0.5
7.0 ± 0.5
0.8
5 MAX.
5 MAX.
□26.2 +0 -0.5
25.5 ± 0.5
1.2 MAX.
2.5 MAX.
25-φ0.45
4-R3
PHOTOCATHODE
TOP VIEW
SIDE VIEW
GUIDE MARK
□25.7 ± 0.4
2.54 PITCH
45° ± 10°
2.54
34-φ1.5
10.16
BOTTOM VIEW
Basing Diagram
G CUT (IC) Dy1 Dy3 Dy5 Dy7 Dy9 Dy11 CUT (IC)
K
Dy2
Dy4
Dy6
Dy8
Dy10
CUT (IC)
PX1
PX2
PX3
PY1
PX4
PX5
PX6
1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16 17
18 19 20 21 22 23 24 25
26 27 28 29 30 31 32
33 34
CUT (IC) PY6 PY5 PY4 CUT (IC) PY3 PY2 CUT (IC) CUT (IC)
K: Photocathode
Dy: Dynode (Dy1-Dy11)
P: Anode (PX1-PX6)
(PY1-PY6)
G: Grid
IC: Internal Connection (Do not use)
BOTTOM VIEW
Basing Diagram



# Glue

# BC 600

- ✓ Optical Cement - clear epoxy resin
- ✓ Formulated specially for making optical joints with plastic scintillators
- ✓ Refractive index close to 1.59
- ✓ Is a Two part –
  - Low viscosity adhesive, cured at room temperature
  - Hardener
    - 100 : 28 (by weight) -> 12g : 3.4g (for single tower)

| BC 600<br>Optical Properties<br>Transmittance value of 125 micron thick layer | |
|---|---|
| Wavelength (nm) | Transmission |
| Above 400 | > 98% |
| 340-400 | > 95% |
| 308-340 | > 90% |