# Low Beam Intensity Monitoring at CNAO experimental room

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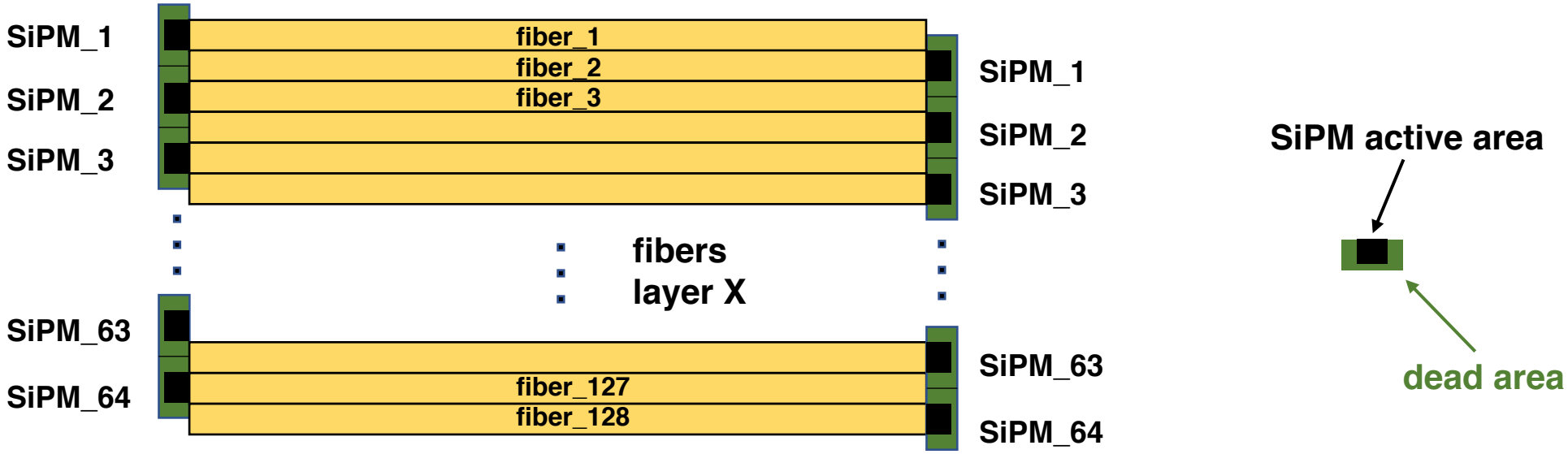
**CNAO experimental room meeting – 02/10/2020**

# Adopted technology

- Two layers (x-y) of plastic scintillating fibers (squared, 1 mm side) readout by SIPMs with 1mm$^2$ active area.
- 128 fibers per layer will be read on the two sides of the plane alternately, for a total of 64 channel per side and an overall number of 256 channels for the whole detector



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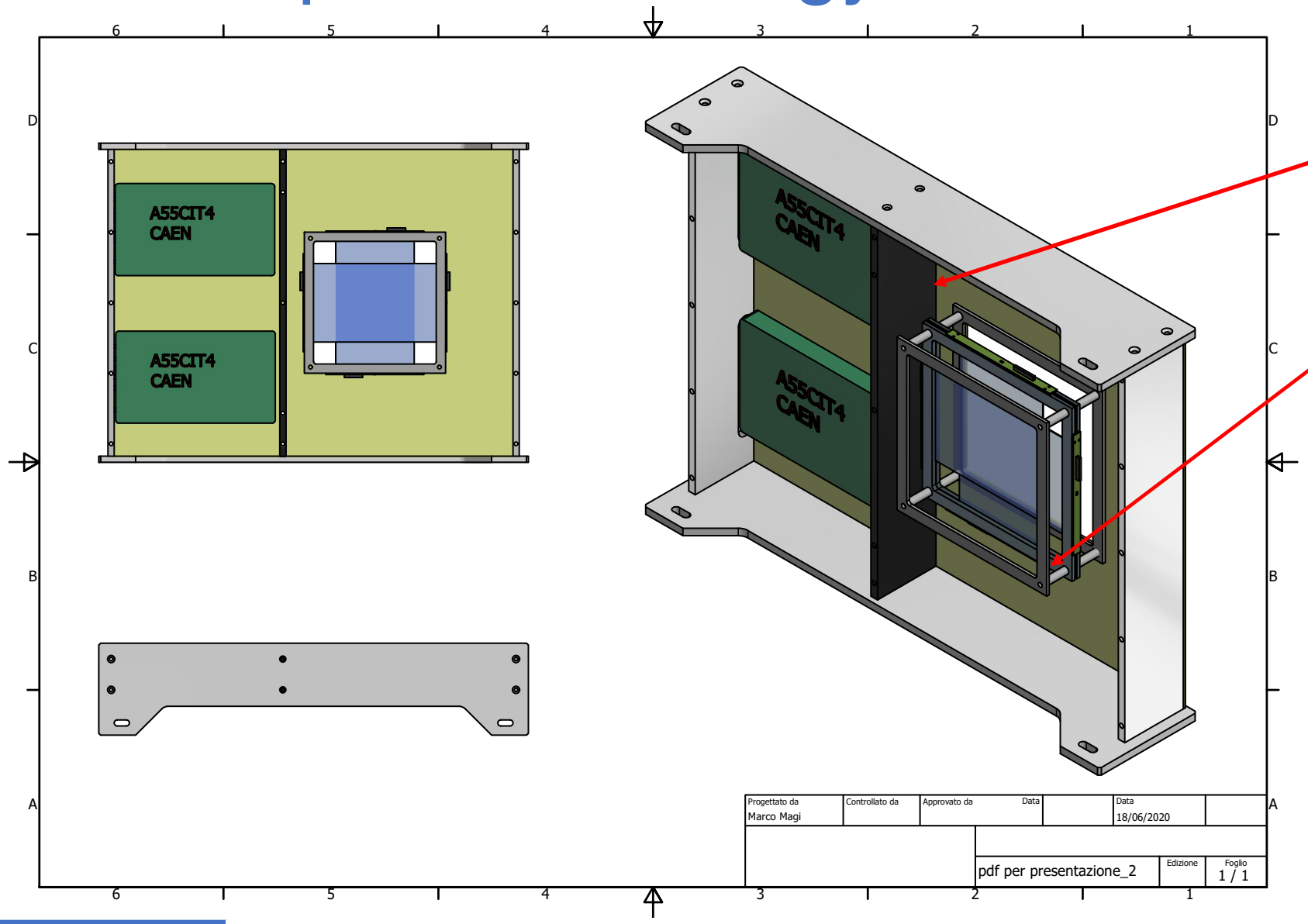
- Aluminum frame centered with respect to the beam isocenter, holding the two layers of fibers and the SIPMs boards.
- Readout system : custom CAEN - A55CIT4 / DT5550W  handling 128 channels. Two of such boards can manage the readout of the whole detector, each board reading a BM view (x-y).

# Adopted technology



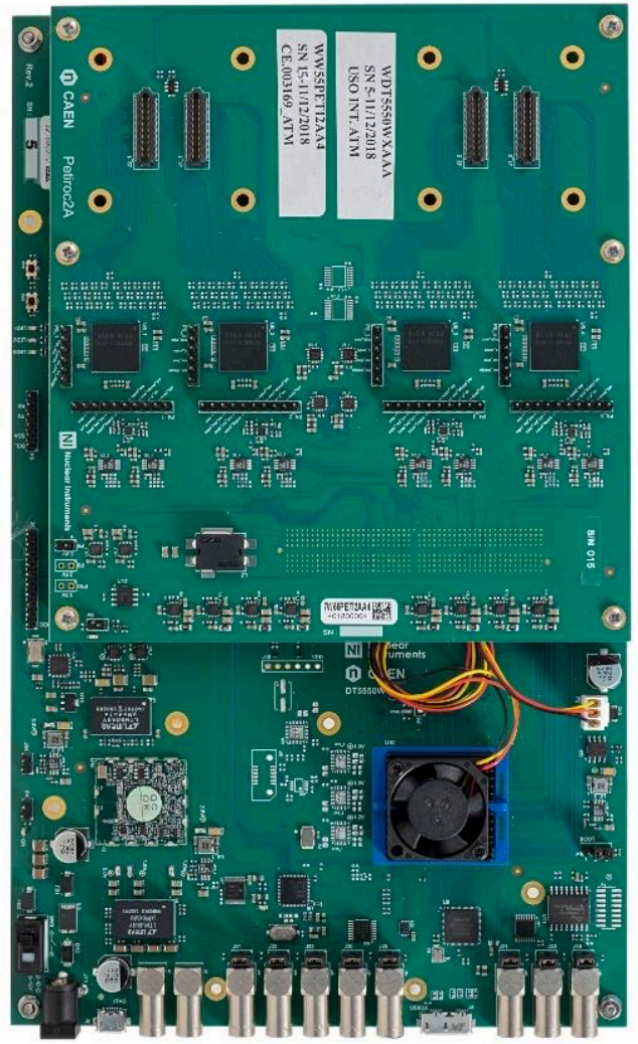

Bulkhead and beam monitor enter and exit windows for light tightness

SiPMs boards have to be custom designed

Cable connecting SiPMs boards to the CAEN boards not shown

# The readout system

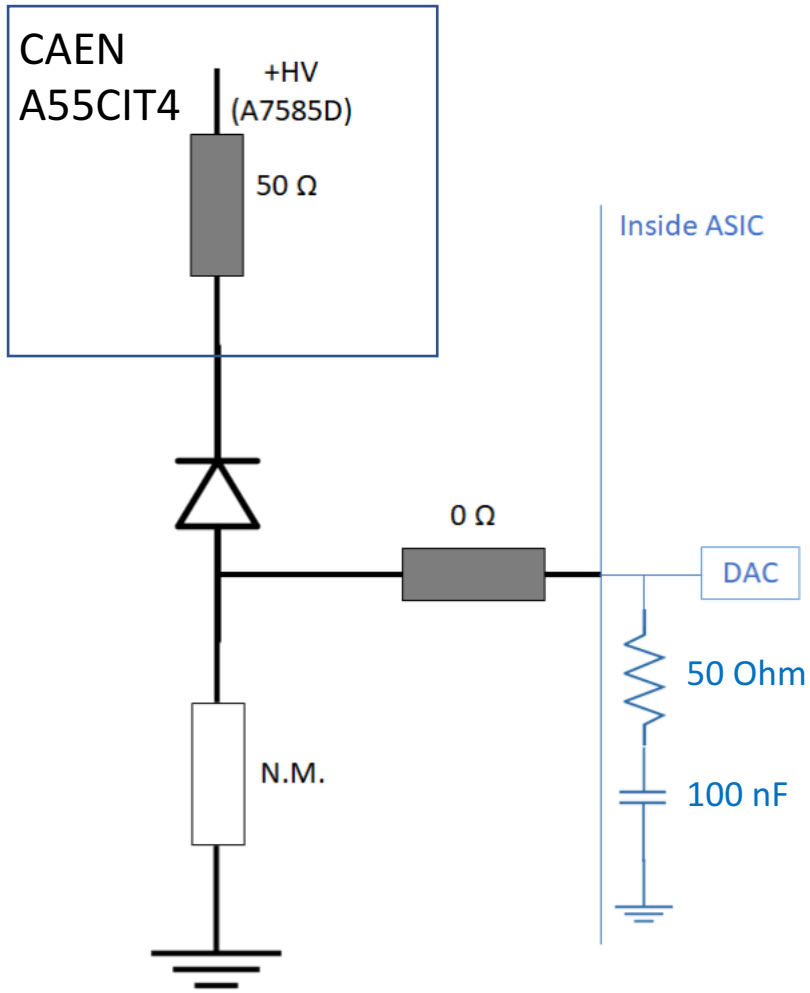
- The readout system is composed of:
  - A55CIT4 that host four CITIROC 1A WeeROC ASICs, managing 32 channels each, and providing a power supply for SiPM
  - DT5550W motherboard hosting a Xilinx XC7K160T (Kintex-7 family) FPGA
- Two readout modes:
  1. Photon counting (providing the ID of the hit channels up to 10 MHz)
  2. Analog Charge Integration: measuring released charge in a dynamic range 0-400 pC up to 100 kHz
- Photon Counting mode tested with Dual Timers and oscilloscope up to 10 MHz



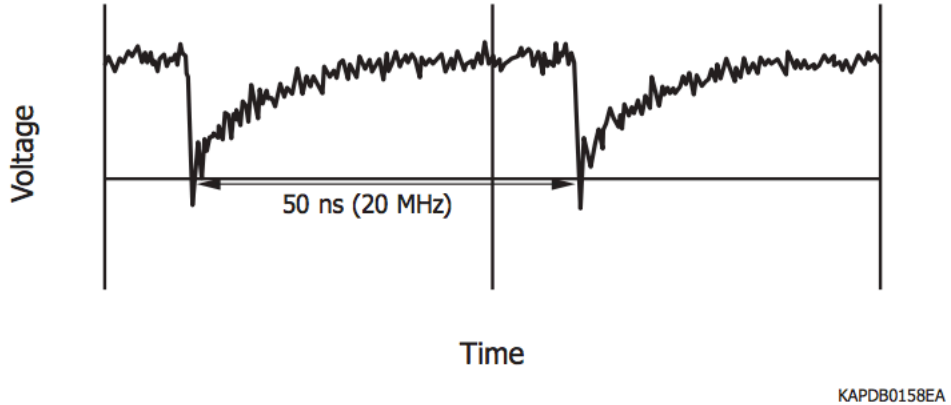
**A55CIT4**

**DT5550W**

# SiPM choice and SiPM boards

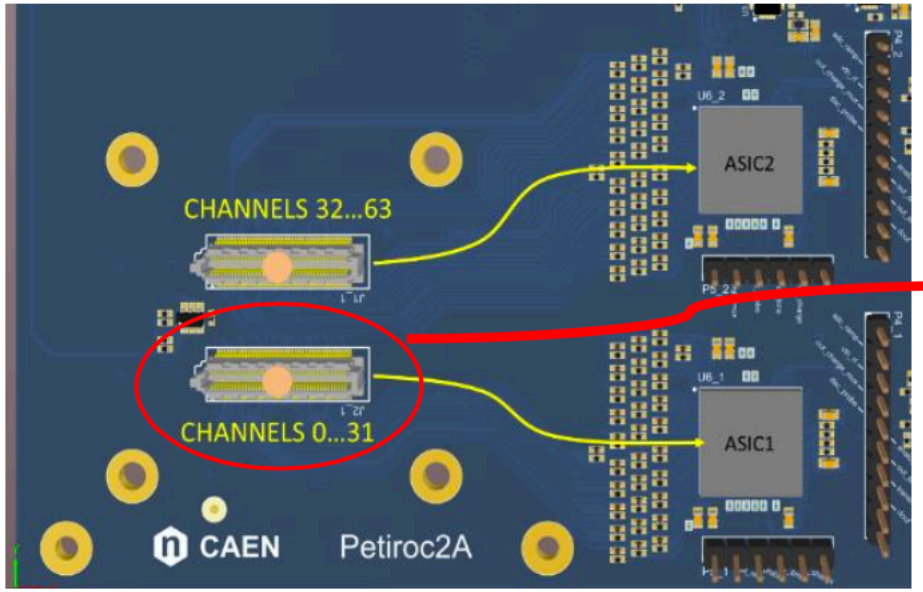



MPPC S12571-050C HAMAMATSU: recovery time
50 ns compatible with 10 MHz

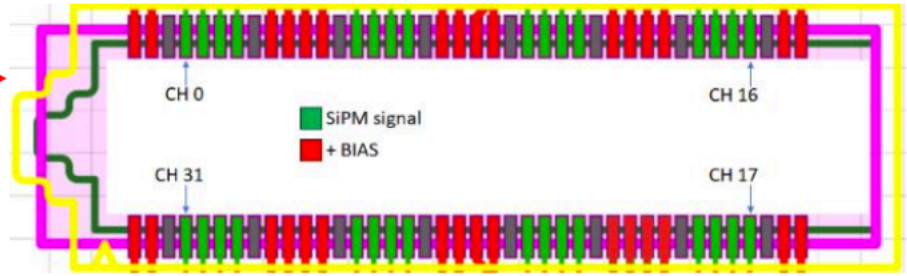



The SiPM bias is provided onboard by the CAEN A7585D Power Supply module, which is extremely low noise (**no additional filters needed – confirmed by CAEN**). The bias lines for SiPMs are grouped eight by eight and connected to the A7585D through a 50 Ω resistance in series.

# SiPM choice and SiPM boards

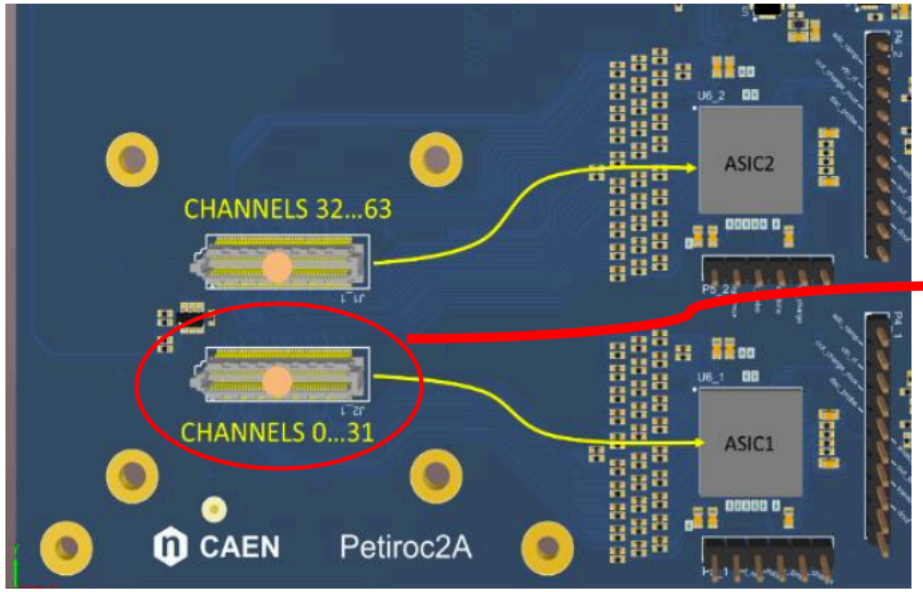


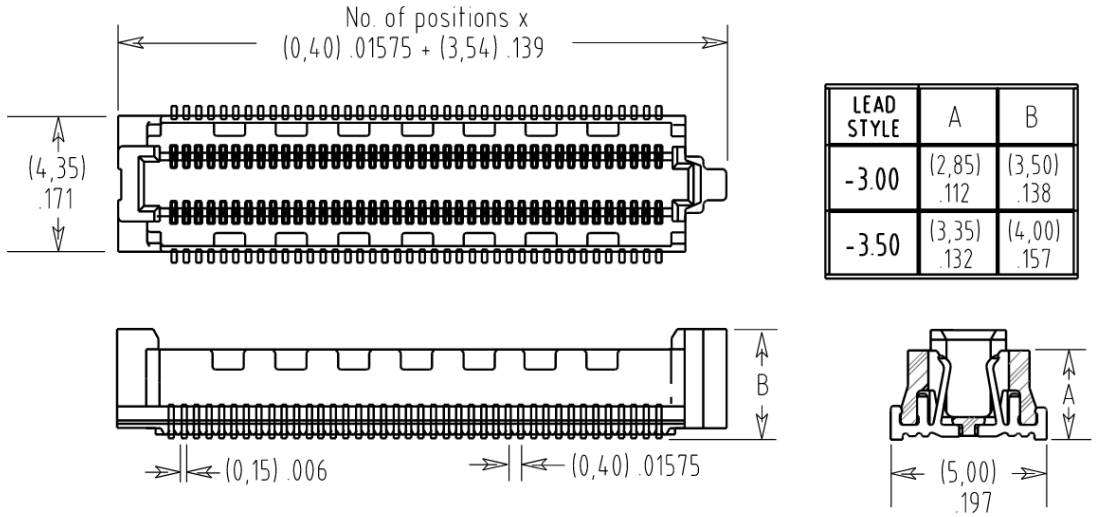

The A55CIT4 board hosts two couples of Samtec SS4-40-3.0-L-D-K-TR connectors which read 32 SiPM channels each.




Start of the work for SiPM board design by the Servizio Elettronica INFN Roma1.
The idea is to design a SiPM board with 64 channels (able to read a side of the BM) and two 32-channel samtec connectors.

# SiPM choice and SiPM boards




| LEAD STYLE | A | B |
|---|---|---|
| -3.00 | (2,85) .112 | (3,50) .138 |
| -3.50 | (3,35) .132 | (4,00) .157 |

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# Materiale che abbiamo

- 1 scheda CAEN A55CIT4 / DT5550W per leggere un piano del monitor
- Le fibre necessarie per un monitor e spare
- I SiPM necessari per un monitor e spare
- le finestre in maylar/kevlar e la paratia laterale per la tenuta di luce

# Materiale da acquistare

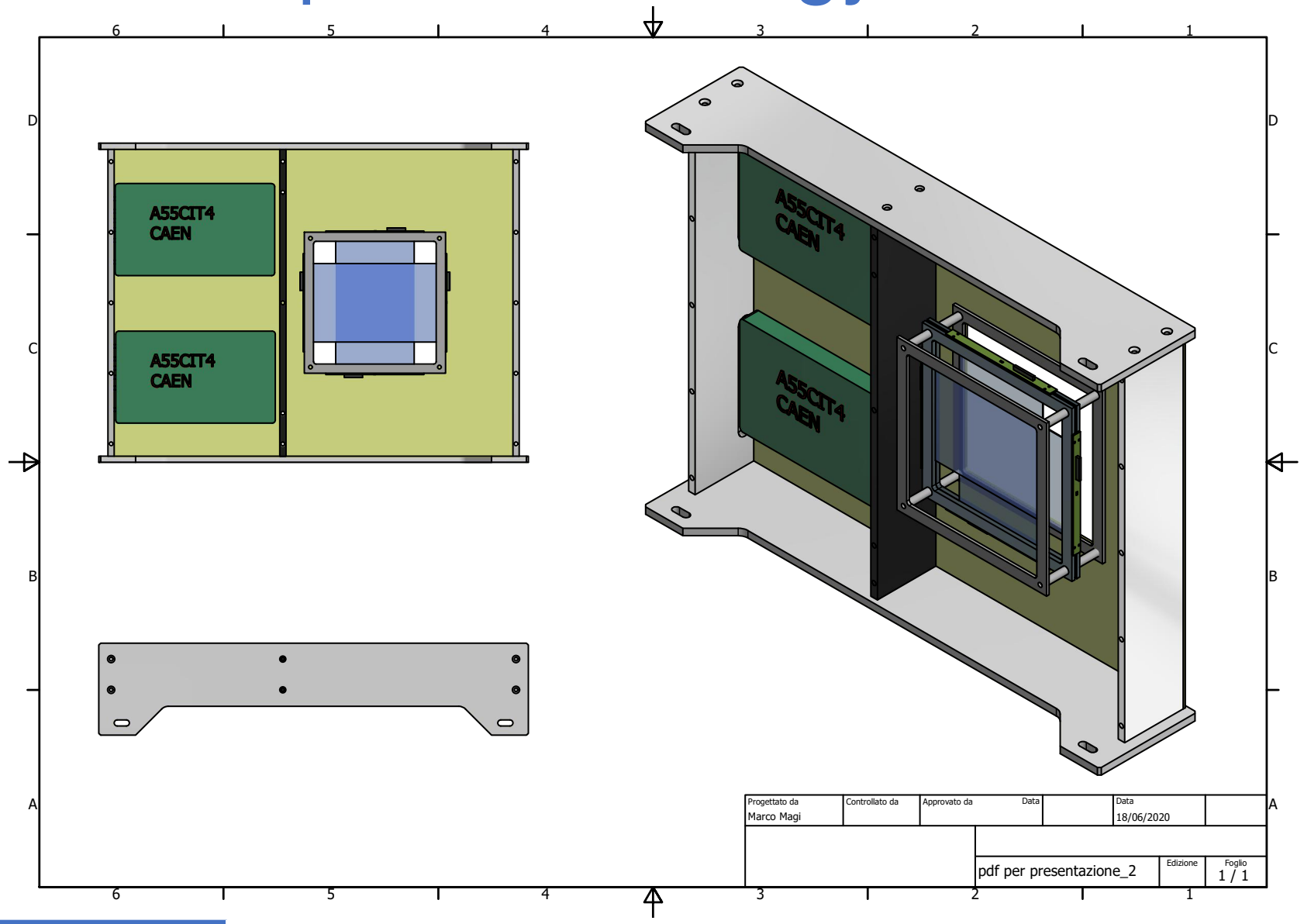
- 2 schede CAEN A55CIT4 / DT5550W (una per leggere l'altro piano del monitor e una spare). (DT550W->2.6k€, A55CIT4->3.5k€)x2 ~ 12k€
- Cavi e connettori SAMTEC e vanno prodotte le boards per i SiPM: 4 boards + 2 spare (questo tutto insieme nel bando di gara per acquisto di materiale e lavorazione, una volta prodotto il disegno tecnico delle boards dal servizio di elettronica INFN Roma1). Stima costo produzione (escluso costo cavi e connettori) ~ 4k€
- Frame in alluminio per supporto meccanico fibre: 2 cornici + 1 spare vanno ricavate da 3 lastre da 25x25x1cm$^3$ in alluminio: stima costi ~500 €. Materiale da acquistare, ma lavorazione completamente effettuata dal servizio di elettronica del Dipartimento di Scienze di Base e Applicate per l'Ingegneria (SBAI) della Sapienza
- un PC portatile con OS Windows per il DAQ: modello Lenovo Thinkbook 15 (641 euro + iva) con accessorio aggiuntivo un SSD da 1 TB (51€)

# SPARE SLIDES

# Goals of the Beam Monitor for low intensities

- **Goal**: Provide a feedback to the Dose Delivery system and to the research teams when working in the CNAO experimental room about the beam properties at low intensity, in terms of:
  1. primary ions counting
  2. beam position
- **Motivations**: when beam rate intensity is < 1 MHz, CNAO standard beam monitors (layers of parallel-plane ionization chambers closed in two BOX equipped with strips and pixels to measure the beam flux and x-y position) are almost 'blind' and so not able (very inefficient) to count the number of the impinging primaries ions
- The goal is to develop a monitor to measure rates up to 10 MHz covering an active area of ~ 13 x 13 $cm^2$ able to provide feedback about the beam position with an experimental resolution on both views (x,y) of ~1mm

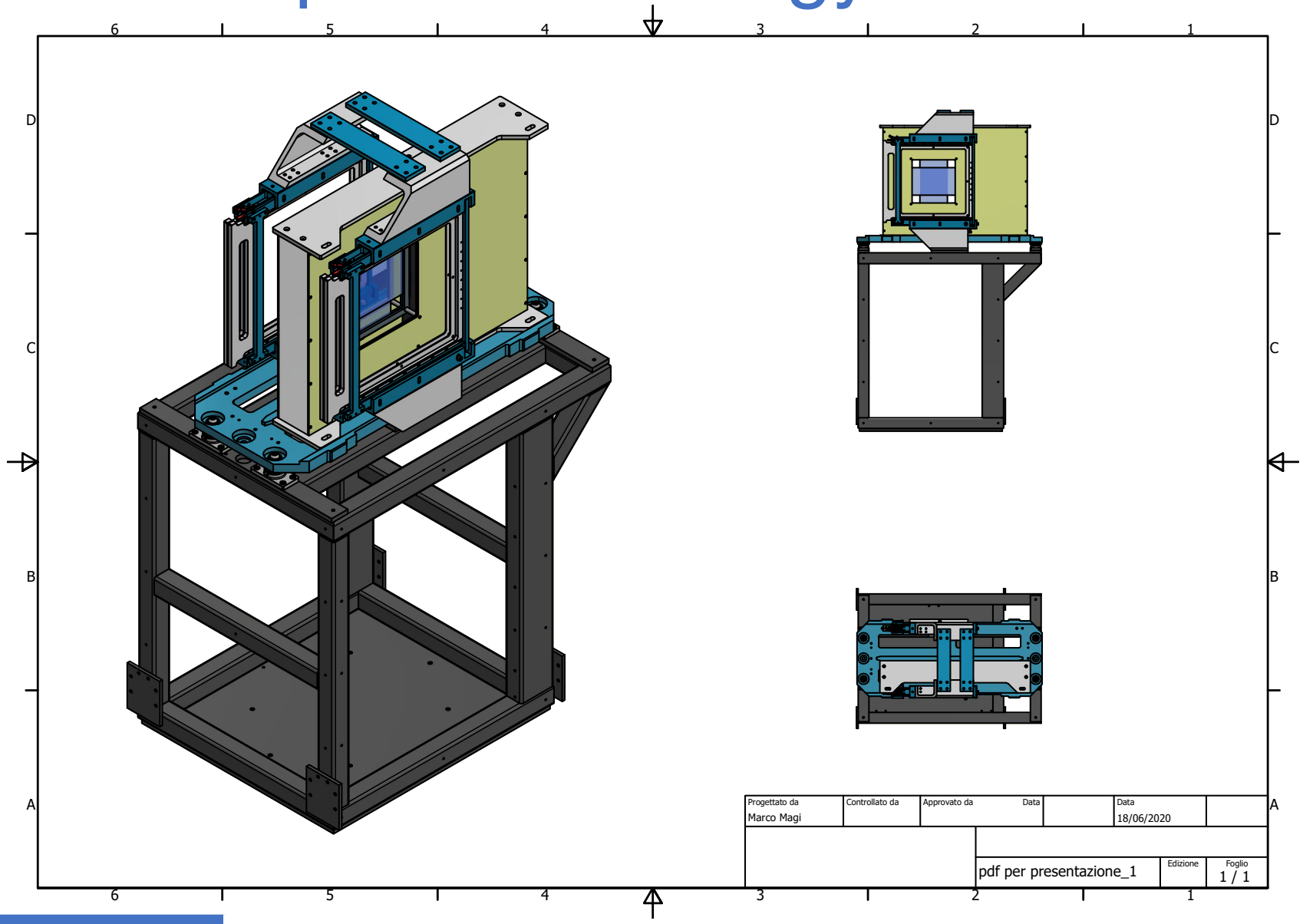
# Adopted technology




**Further requests**:

1. in order to take care of aging effects the aluminum frame with the two layer of scintillators fibers have to be replaceable with new layers
2. The BM has to be removable from the beam axis for groups that don't need it

# Adopted technology




Low intensity beam monitor designed to be positioned in the same frame of the CNAO BOXes

With this design the beam monitor overall frame is in the same position of BOXes with beam impinging on the center of the monitor

# Conclusions

- A detector to be used as monitor in the CNAO experimental room for the case of low beam rate intensity is in the planning stage
- The monitor has to be able to measure rates up to 10 MHz, covering an active area of ~ 13 x 13 $cm^2$ of scintillating fibers read by SiPM, and to provide feedback about the beam position with an experimental resolution on both views (x,y) of ~1mm
- The adopted technology guarantee a low material budget minimizing fragmentation of the beam in the monitor itself (for carbons), and a dynamic range spanning from protons and carbons provided beam energies at CNAO
- The readout system has been tested to reach the expected maximum rate capability of 10 MHz
- Design of the SiPM board has started in INFN Roma1