

# Mass test facilities nel consorzio

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Università  
degli Studi  
di Ferrara



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# Contents

- Test overview;
- SiPM massive test set-up;
- Massive test protocol;
- Massive test timeline;
- Massive test set-up in the consortium;
- Conclusions

# SiPM tests

Today



Choice phase

Quality assurance

Single SiPM

25 FBK (2models)  
25 HPK (4models)

6 SiPM array

250 FBK (2models)  
250 HPK (4models)

Detailed measurements for each sensor:

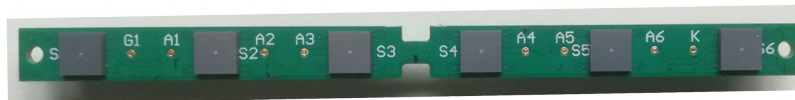
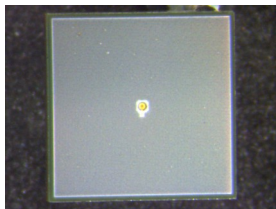
- Vbd (room-LN2 T);
- Rq (room-LN2);
- Thermal cycles;
- Waveform acquisition;
- Ganging.

Downselection

SiPM

Massive tests:

- ProtoDUNE2-SP
- 4000 HPK 75HR
- 4000 FBK TT
- DUNE FD
- 300000 sensors



# SiPM massive tests

- Purposes:
- check SiPM “identity”;
  - failure/mortality rate;
  - quality assurance;

N.B. A large number of SiPM have to be tested

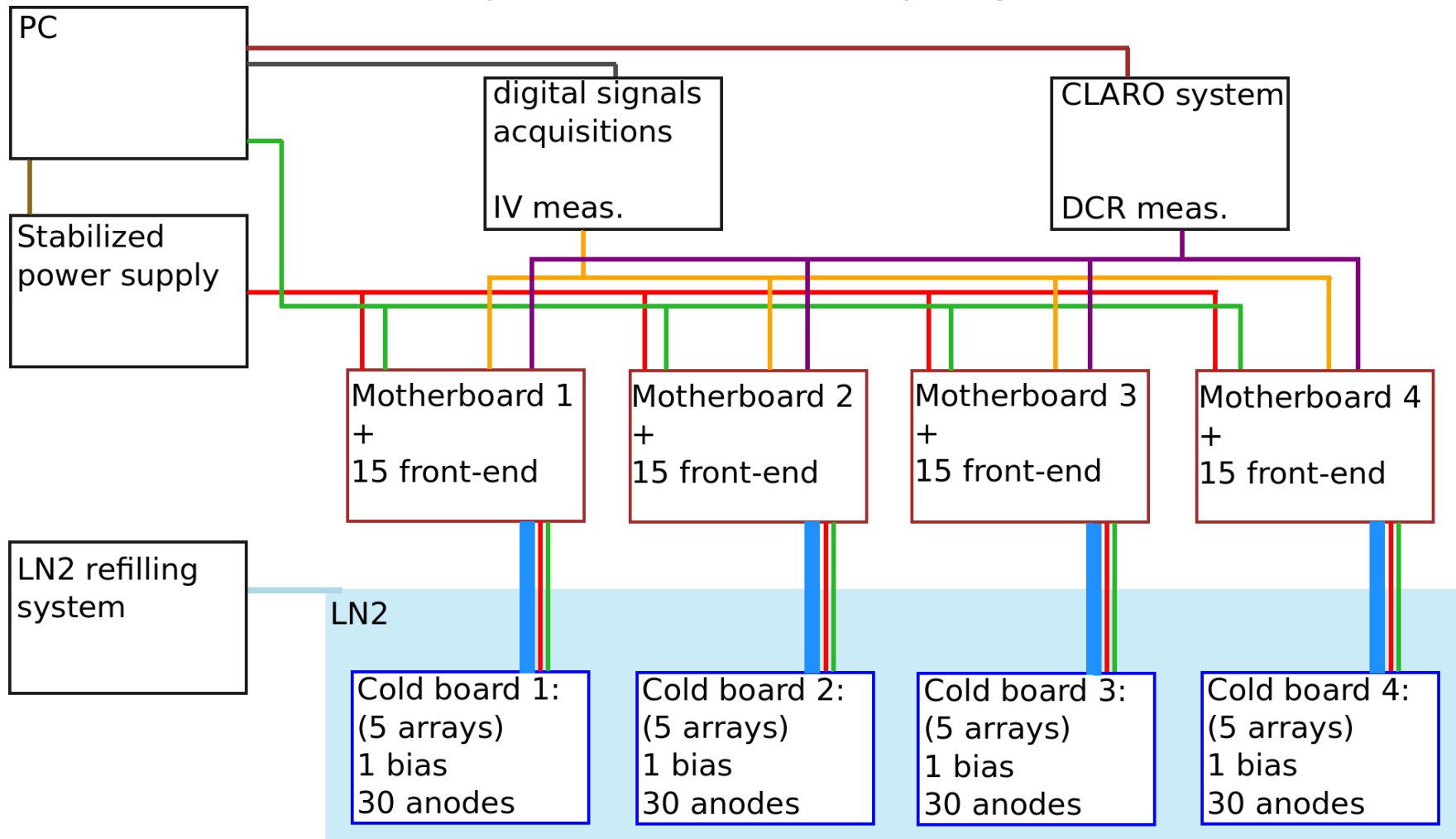
Measurements & parameters:

- IV@room T → (FW)  $R_q^{RT}$  + (REV)  $V_{bd}^{RT}$ ;
- IV@LN2 T → (FW)  $R_q^{LN2T\_pre}$  + (REV)  $V_{bd}^{LN2T\_pre}$ ;
- Thermal cycles;
- IV@LN2 T → (FW)  $R_q^{LN2T\_post}$  + (REV)  $V_{bd}^{LN2T\_post}$ ;
- DCR@LN2 T → **global-DCR** total dark signals, AP, CT + bursts;

Data will be organized in a DATABASE

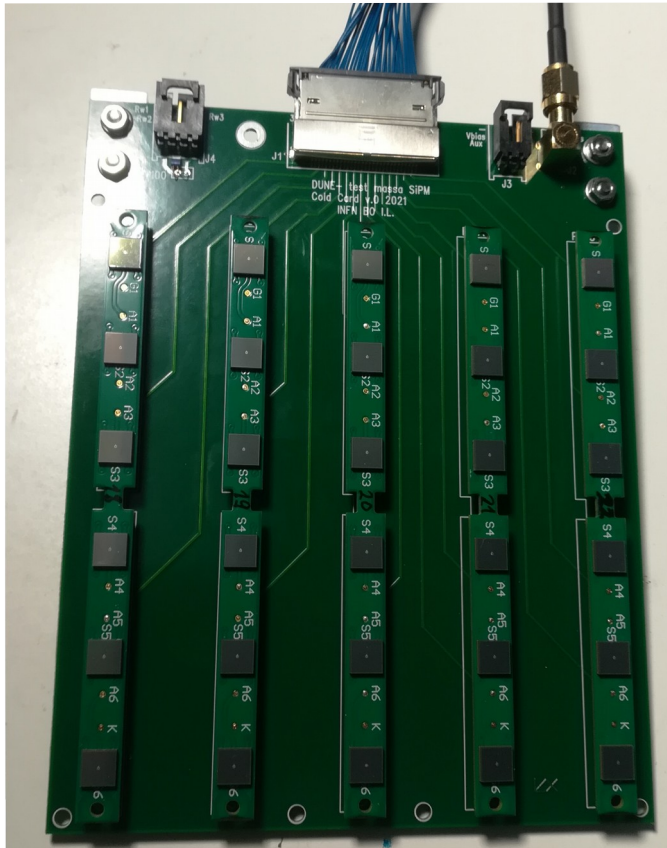
# Mass test system: overview

Features: modularity; automatic; easy replication;

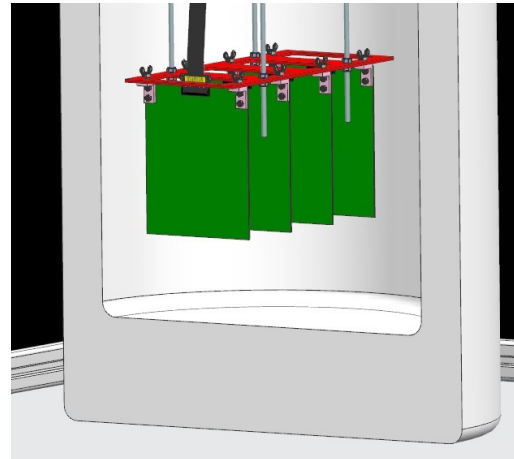


# Set-up: cold parts

- 55 l LN2 dewar;
- 120 SiPM;
- Automatic refilling system.



Cold board prototype #1



## Board @ LN2T:

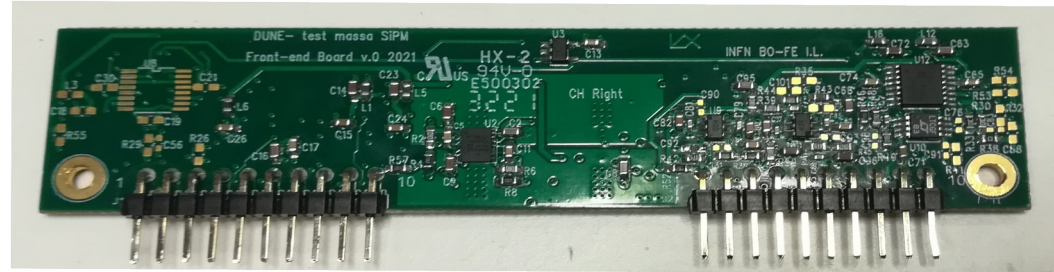
- 5 arrays: 30 SiPMs in total;
  - 30 anode connections;
  - mini-coax cables;
  - 1 common cathode + filter;
  - temperature sensor;
  - 4 boards per system;
- +light shield;  
+mechanical extractor.



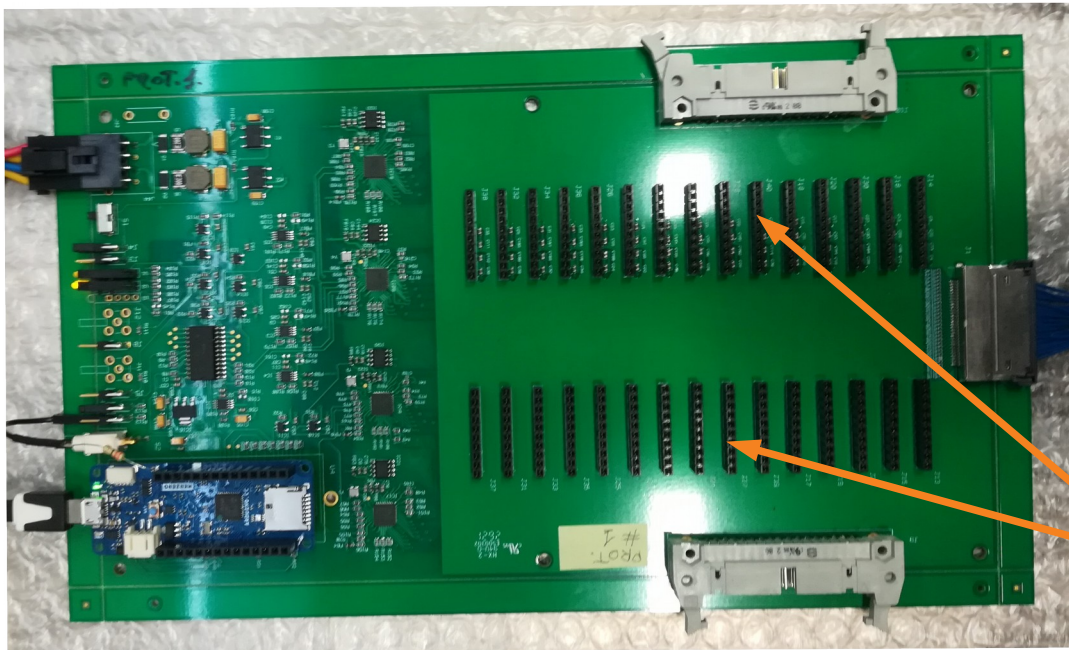
# Set-up: room T boards

## Front-end cards:

- 2 SiPMs per card;
- First amplification stage;
- Programmable gain;
- Split signals (DCR & IV meas);
- High dynamic range [nA-mA];
- 60 cards in total.



*Front-end card prototype #1*



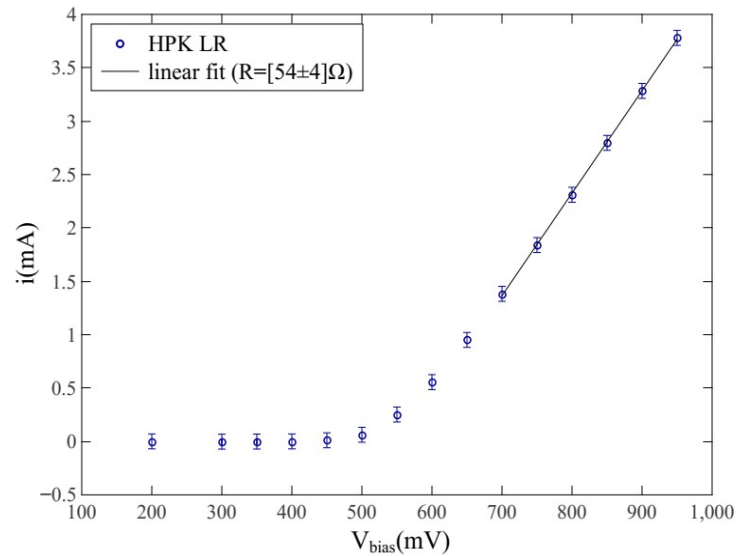
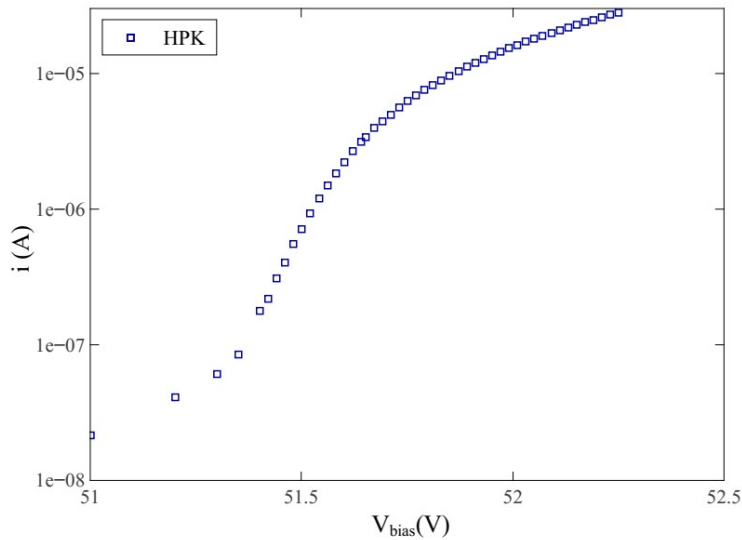
*Motherboard prototype #1*

## Motherboards:

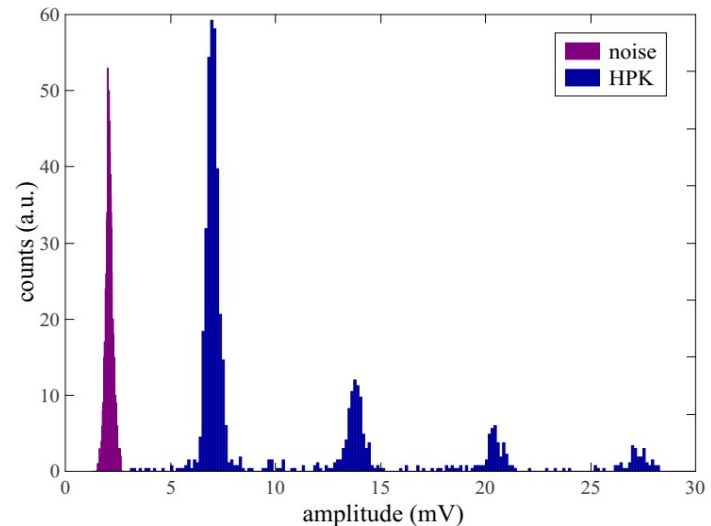
- 30 SiPM per board;
- 4 ADCs;
- Acquisition;
- Supply power;
- 4 motherboard per system.

Slots for front-end cards

# Set-up: measurements examples



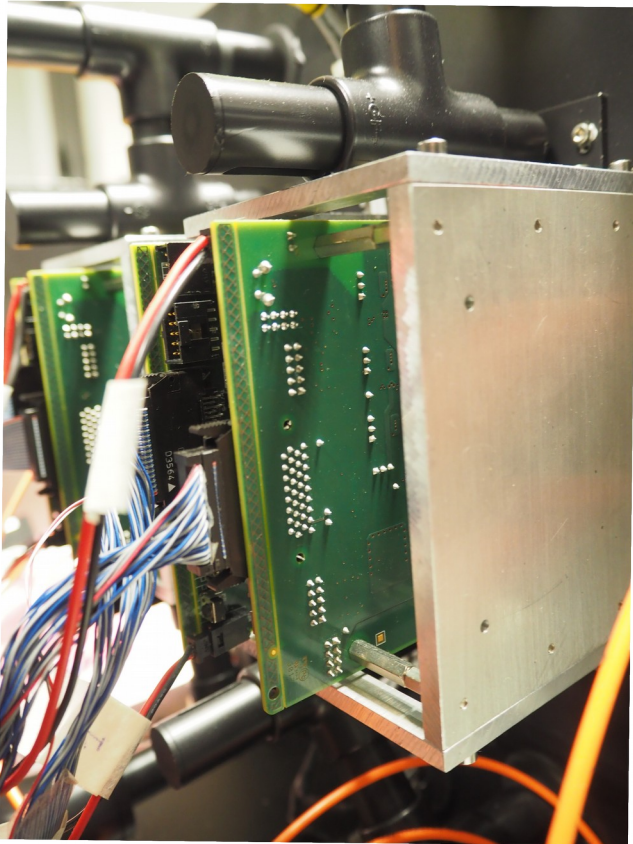
- **IV curves:**  
 $R_q$  and  $V_{\text{bd}}$  estimation from measurements;
- **DCR:**  
Environmental noise VS 1 p.e peak;



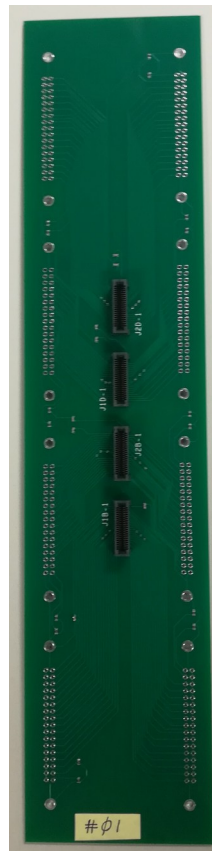


# Set-up: CLARO

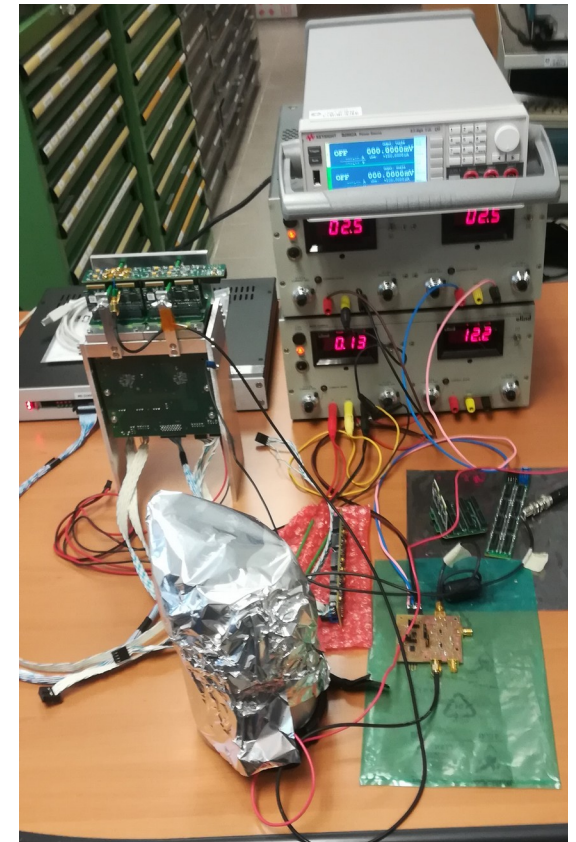
- DCR measurement:
- Motherboard to CLARO adapter;
  - CLARO amplifier/discriminator: **count**;
  - Re-use **LHCb RICH** elementary cell test set-up;



Part of CLARO system



CLARO-Motherboard



Test setup

# Procedure protocol

Ferrara site of the mass-test set-up



- Mounting & board identification: 45min;
- IV curve at room 120 SiPM in parallel: 30min;
- 1<sup>st</sup> diving phase: 30min;
- IV curve at LN2T 120 SiPM in parallel: 30min;
- thermal cycles 3x15min: 45min;
- IV curve at LN2T: 30min;
- global DCR at LN2T: 30min.  
For a sub sample of SiPM DCR before cycles

120 SiPM per day

LN2 refilling system

Cold board holder

LN2 dewar

Translator stage



QR-code for identification

# ProtoDune2-SP tests timeline

Date	Activity
November 2021	Mass test system completion
December 2021	SiPM delivery; Mass test system commissioning
January 2022	SiPM test begin (FBK/HPK)
March 2022	8000 SiPM test completion



# Test systems in the consortium

## Test systems sites:

- Ferrara (1st system, end-2021 ready )
  - Bologna (January 2022 ready)
  - Milano Bicocca (2022);
  - Prague (Cz) (2022);
  - Granada (Es) (2022);
  - .....
- } ProtoDUNE2-SP SiPM test
- } DUNE FD SiPM test

## SiPM delivery:

- HPK: ~7000SiPM/month (considering only Spain splits delivery)
- FBK: ~4000SiPM/month

## Test capability:

- Single system: ~1900 SiPM/month
- 6 systems: 11000 SiPM/month → **Min request: 6 systems!**



# Conclusions

- SiPM quality assurance: **SiPM massive test system**;
- The system:
  - **measure IV-curve** ( $R_q$  and  $V_{bd}$ ) for **all** SiPMs;
  - perform a variable number of **thermal cycles**;
  - **measure the global-DCR** for **all** SiPMs;
- Ferrara & Bologna initial sites + additions (+4 sites) in 2022;
- **1900 SiPM/month per set-up**;
- ProtoDUNE2-SP SiPM tests foreseen to end in march 2022;

# The end

Thanks for your attention!