

# HiDRa: Kick-off Meeting



Romualdo Santoro e Massimo Caccia

Università dell'Insubria and INFN - Milano



# WP2: Light Sensors



## 2.1 Work Package 2: Light Sensors

**WP2 Responsible: Massimo Caccia**

**WP2 Contributors: BO, CT, MI, PV, TIFPA**

**WP2 Activity:** Light sensors qualification. The aim of the work package is the study of two light-sensor technologies capable of equipping the highly granular calorimeter in view of the expected performances. The sensors of interest are the analogue and digital SiPMs. The first option (baseline) is based on a mature technology that would immediately allow to equip and operate the core (~10000 sensors) of the demonstrator, while the second (a proof of concept) is a prospective solution that, in case of success, would allow to reduce the cost of the sensors and the readout complexity with comparable and in some cases better performance (i.e. timing).

## WP2 Description of Work and Role

- T2.1. Definition of a qualification protocol [M1-3][CT,MI,PV,TIFPA]
- T2.2. Test setup preparation to qualify the different sensors [M1-12][CT,MI,TIFPA]
- T2.3. Procurement and qualification of SiPMs produced by different vendors [M4-15][CT,MI]
- ~~T2.4.~~ Definition of dSiPM specification for Run 1 [M4-5][MI,PV,TIFPA]
- ~~T2.5.~~ dSiPM design and fabrication (Run 1)[M6-13][MI,PV,TIFPA]
- ~~T2.6.~~ Definition of dSiPM specification for Run 2 [M13-14][MI,PV,TIFPA]
- ~~T2.7.~~ dSiPM design and fabrication (Run 2) [M15-24][MI,PV,TIFPA]
- ~~T2.8.~~ dSiPM qualification [M14-27][BO,MI,PV,TIFPA]
- T2.9. Procurement and qualification of all the SiPMs needed to equip the central part of the demonstrator [M15-30][CT,MI]
- ~~T2.10.~~ Qualification of the 64 dSiPMs used to equip the small 64-fibre prototype [M25-30][BO,MI,PV,TIFPA]

# WP2: Light Sensors



## WP2 Milestones

- M2.1. Definition of a characterisation protocol for SiPMs of interest [M3]
- M2.2. Selection of the SiPM that will be used to equip the central part of the calorimeter [M15]
- ~~M2.3.~~ Definition of a dSiPM specification for Run1 [M5]
- ~~M2.4.~~ Definition of a dSiPM specification for Run2 [M14]

## WP2 Deliverables

- D2.1. Setup to qualify SiPMs ready [M6]
- ~~D2.2.~~ Setup to qualify dSiPMs ready [M12]
- ~~D2.3.~~ 1st batch of dSiPMs delivered [M14]
- ~~D2.4.~~ 2nd batch of dSiPM delivered [M25]
- D2.5. Qualification of all SiPMs needed to equip the central part demonstrator [M30]
- ~~D2.6.~~ Qualification of the 64 dSiPMs needed to equip the small module prototype [M30]

# WP3: Front-end and DaQ



## 2.1 Work Package 3: Front-end and DAQ development

**WP3 Responsible:** Romualdo Santoro

**WP3 Contributors:** MI, TIFPA, BO, PV, CT

**WP3 Activity:** ASIC qualification and readout board production. This work package will qualify the different ASICs designed for SiPMs available on the market. Candidates of interest for this kind of application are Citiroc 1A (the baseline choice), HDSOC and MUSIC. After a full qualification, the ASIC that best fits all requirements and constraints will be integrated into the flexible readout system (FERS) designed by CAEN. This system will allow the calorimeter to be operated in a beam test. Thanks to the experience gained during the qualification phase, the team will contribute to the definition of the readout specification and system qualification. The 20 boards needed to read out the core of the demonstrator will be delivered to the collaboration for the final test on beam. Part of them (5 boards), equipped with the Citiroc 1A, are already at our disposal and have been removed from the project costs. We think that we will eventually be able to qualify the system performance with a waveform sampler also in a hybrid readout system.

# WP3: Front-end and DaQ



## WP3 Description of Work and Role

- T3.1. Definition of the ASIC qualification protocol [M1-3][BO,MI,PV]
- T3.2. ASIC procurement with the proper evaluation boards [M1-8][BO,MI]
- T3.3. Design and production of a series of passive boards and cables needed to interface the SiPMs to the evaluation boards [M1-8][BO,MI]
  
- T3.4. ASIC qualification and performance comparison in response to the SiPMs of interest [M9-14][BO,CT,MI]
  
- T3.5. Definition of the readout system specifications [M9-14][BO,MI,PV]
  
- T3.6. Design and production of the interface boards and flat cables required to equip the central part of the calorimeter [M13-18][BO,MI]
  
- T3.7. Readout board procurement and qualification [M19-30][BO,CT,MI]
  
- T3.8. Design and production of the interface boards and flat cables required to equip the small prototype with dSiPMs [M25-30][BO,MI]

# WP3: Front-end and DaQ



## WP3 Milestones

- M3.1. Definition of the readout system specifications [M14]
- M3.2. Readout system commissioning [M30]

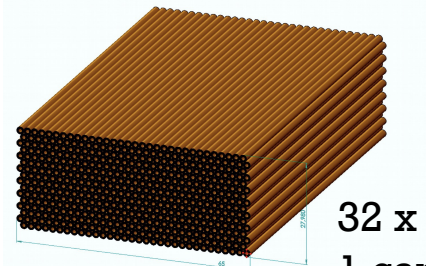
## WP3 Deliverables

- D3.1** ASIC test setup station ready [M8]
- D3.2. Final readout board built [M18]
- D3.3. Interface boards and cables to equip the calorimeter with SiPMs ready [M18]
- D3.4. Interface boards and cable to equip the small prototype with dSiPMs ready [M30]

# The design of a scalable solution: new sensor

## The challenge:

### The Mini-Module

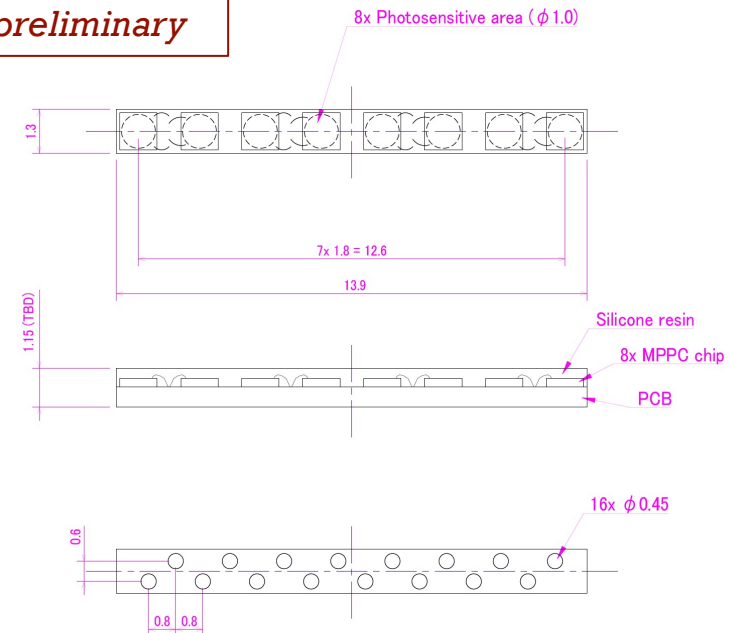


32 x 16 capillaries  
1 capillary:  
2mm OD and 1.1mm ID

- ❑ 1 SiPM per Fiber: compact package
- ❑ SiPM with high Dyn-Range: 10 $\mu$ m pitch
- ❑ No contamination between Cherenkov and scintillating light

## SiPM module from Hamamatsu

*preliminary*

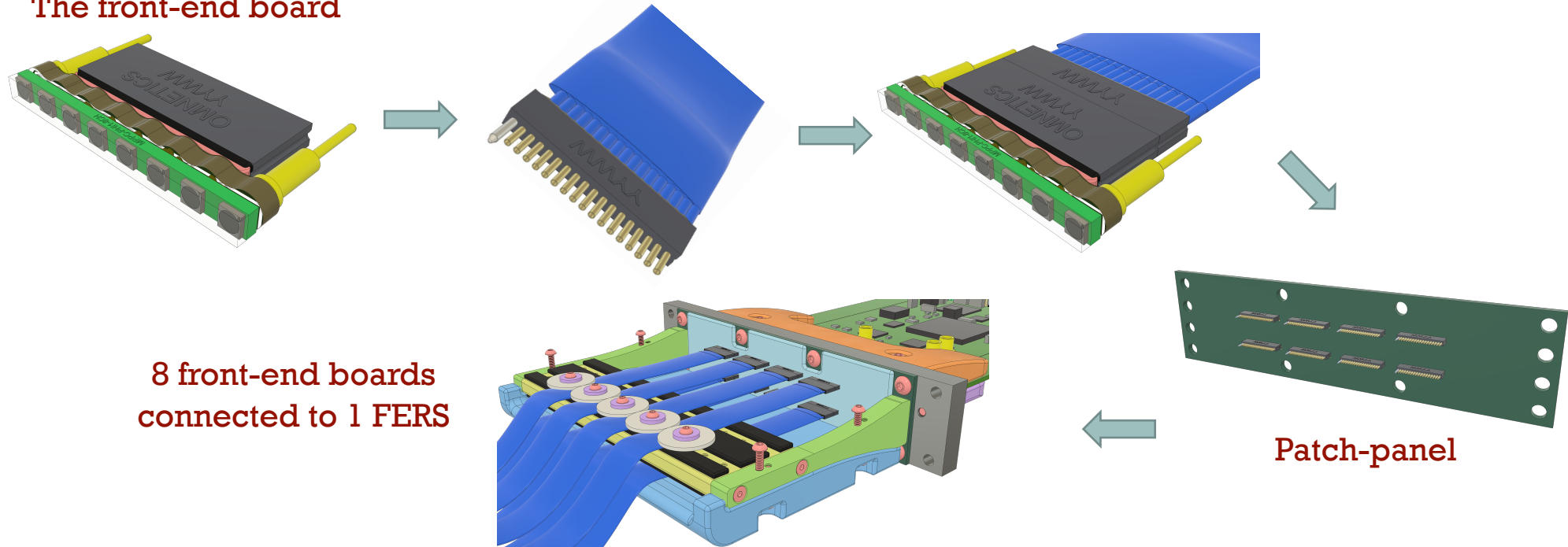


- ❑ Custom designed module with 8 SiPMs (1x1mm<sup>2</sup>)
- ❑ Distance between SiPMs: 2mm (drawings to be modified)
- ❑ Two options: 10 and 15  $\mu$ m pitch



# The front-end board

The front-end board



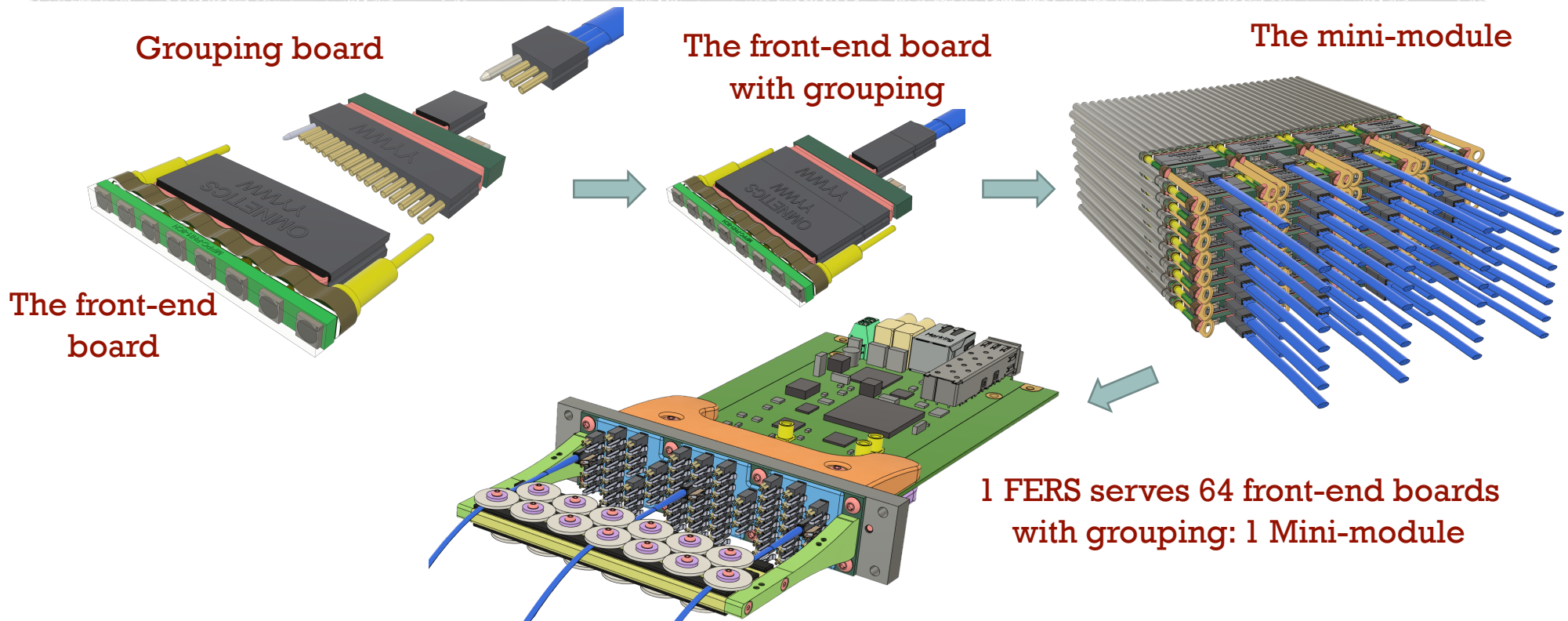
8 front-end boards  
connected to 1 FERS

Patch-panel

## For commissioning:

- ❑ Each SiPM is qualified individually
- ❑ 1 FERS allows to operate up to 64 SiPMs at the same time

# Mini-module: the baseline solution



## Baseline solution

- ❑ Each bar of SiPMs will be operated at the same voltage
- ❑ The signals from 8 SiPMs is summed up in the grouping board

# Sezione Milano



R. Santoro	MI	0,50	2	5	8,5	1
M. Caccia	MI	0,30	1	5,9	2	1
RUTD-a	MI	0,20		2	2	2,6
AdR (50% on project funds)	MI	0,67		11	11	

MI	2	D-SiPM: Design	40			cons
	2	D-SiPM: Test		20		cons
	2	A-SiPM: Procurement	30.3	45		cons
	2	SiPM: Test station	10			inv
	3	Adapter boards, grouping and cabling	8	8	4	cons
	2,3	Human resources (AdR)		19	19	AdR
	2,3	meetings, conference	1	1	1	travel
	2,3	test beam			2	travel
			<b>Total Milano</b>	<b>89.3</b>	<b>93</b>	<b>26</b>

# Assegnazioni Milano



Sigla Loc.	Capitolo	Riunione	Note Alla Richiesta	Rich.	Rich. SJ	Assegn.	Assegn. SJ	Assegn. Dot.	Commento Alla Assegnazione	
MI	MISS	Assegnazioni	Meeting, conferenze	1.0	0.0	0.0				
		<b>Totale MISS</b>			<b>1.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	
	CON	Assegnazioni	Run di produzione dei Digital SiPM	40.0	0.0	0.0			la commissione ritiene di non finanziare la parte di sviluppo sul dSiPM	
		Assegnazioni	Acquisto dei SiPM	30.5	0.0	0.0	25.0		subjudice alla presentazione delle offerte	
		Assegnazioni	Adapter boards, grouping and cabling	8.0	0.0	5.0				
		<b>Totale CON</b>			<b>78.5</b>	<b>0.0</b>	<b>5.0</b>	<b>25.0</b>	<b>0.0</b>	
	INV	Assegnazioni	Equipaggiamento per la stazione di test necessaria alla qualifica e calibrazione delle front-end board con i SiPM	10.0	0.0	0.0			Test Station finanziata in altre sezioni	
		<b>Totale INV</b>			<b>10.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	
	<b>Totale MI</b>				<b>89.5</b>	<b>0.0</b>	<b>5.0</b>	<b>25.0</b>	<b>0.0</b>	