

AIDAinnoVA

WP8: Calorimeters and Particle Identification Detectors

INFN coordinator: R. Ferrari

WP8 structure

Task 8.1: Coordination and Communication

Task 8.2: Towards next generation highly granular calorimeters

- 8.2.1 - Integration aspects of highly granular calorimeters
- 8.2.2 - Future Liquid Noble Gas Calorimeters

Task 8.3: Innovative calorimeters with optical readout

- 8.3.1 - Crystal detectors
- 8.3.2 - Large area scintillator detectors

Task 8.4: Innovative solid-state light sensors and highly granular dual-readout fibre-sampling calorimetry

- 8.4.1 - Innovative SiPMs and future applications in PID detectors
- 8.4.2 - Development of highly granular dual-readout fibre-sampling calorimeters

AIDAinnova task 8.3.1

Crystal Detectors

(CERN, FZU, VU, INFN-PG, INFN-LNF, INFN-TO)
(institutes referenced in EU proposal)

INFN coordinator: M. Moulson

Fast, radiation-hard crystals – R&D Program

- Development of next-generation crystals, with $\sigma_t < 30$ ps, for high rate and high radiation environments
- Innovative test suites for high-rate crystal performance measurements, both in lab and with test beams; crystal classification
- Development of large-scale cost-effective production techniques, in collaboration with the industrial partners

			Percentuale (FTE)				
			2021	2022	2023	2024	Totale
PM da progetto							11
Costo PM da progetto (1 PM = 5 kE)							55
INFN in-kind (PM)			8.6	7.2	8.6	8.6	33.0
Nome	Progetto sinergico	Sede					
Laura Bandiera	STORM	FE	0.1	0.1	0.1	0.1	5
Matthew Moulson	NA62-KLEVER	LNF	0.1	0.1	0.1	0.1	5
Ivano Sarra	RD_MUCOL	LNF					
Guglielmo De Nardo	Belle II	NA					
Mario Merola	Belle II	NA					
Marco Mirra	NA62-KLEVER	NA			0.1	0.1	2.5
Lorenzo Sestini	RD_MUCOL	PD	0.1	0.1	0.1	0.1	5
Claudia Cecchi	Belle II	PG					
Elisa Manoni	Belle II	PG	0.2	0.2	0.2	0.2	9.5
Mauro Raggi	PADME, NA62	RM1					
Cristina Biino		TO					
Nadia Pastrone	RD_MUCOL	TO	0.1	0.1	0.1	0.1	5
Dario Soldi	CMS-FASE2, NA62-KLEVER	TO	0.1				1

INFN Personnel (matching funds): 33 PM (EU funded: 11 PM)

INFN activities and group responsibilities

Frascati Ferrara Roma Torino	Development of ultrafast, ultra compact, Čerenkov detectors for forward calorimetry at fixed target <ul style="list-style-type: none">• PbF₂ crystals, longitudinal segmentation (multi-layer), compact SiPM readout• Applications: KLEVER, PADME, muon collider
Perugia Napoli	Development of a fast, radiation-hard calorimeters for e ⁺ e ⁻ colliders <ul style="list-style-type: none">• Pure CsI crystals with APD and SiPM readout• Applications: Belle-II & BES-III upgrades, tau-charm factories
GlassToPower	Development of ultra fast and robust scintillators based on semiconductor nanostructures (perovskites, chalcogenides) <ul style="list-style-type: none">• Nanoparticles cast with polymer or glass matrices• Can be used to add e.g. fast tagging layers to calorimeters• Applications as fast and robust WLS materials
Padova	Technologies for Run 5 upgrade of LHCb calorimeter <ul style="list-style-type: none">• Polysiloxane scintillators and GAGG crystals

Schedule

M1-M24	Investigation of different materials	CERN, MIB, FZU, Vilnius, Minsk
M6-M48	Characterisation of optical, timing properties, radiation damage	CERN, MIB, FZU, Vilnius, Minsk, PG
M6-M36	Simulation	Minsk, ICCUB, CERN, PG, LNF
M18-M48	Production techniques	GlassToPower , Crytur
M18-M42	Prototype construction	PG, LNF , CERN, Minsk, ICCUB
M30-M48	Beam tests	PG, LNF , CERN, Minsk, ICCUB

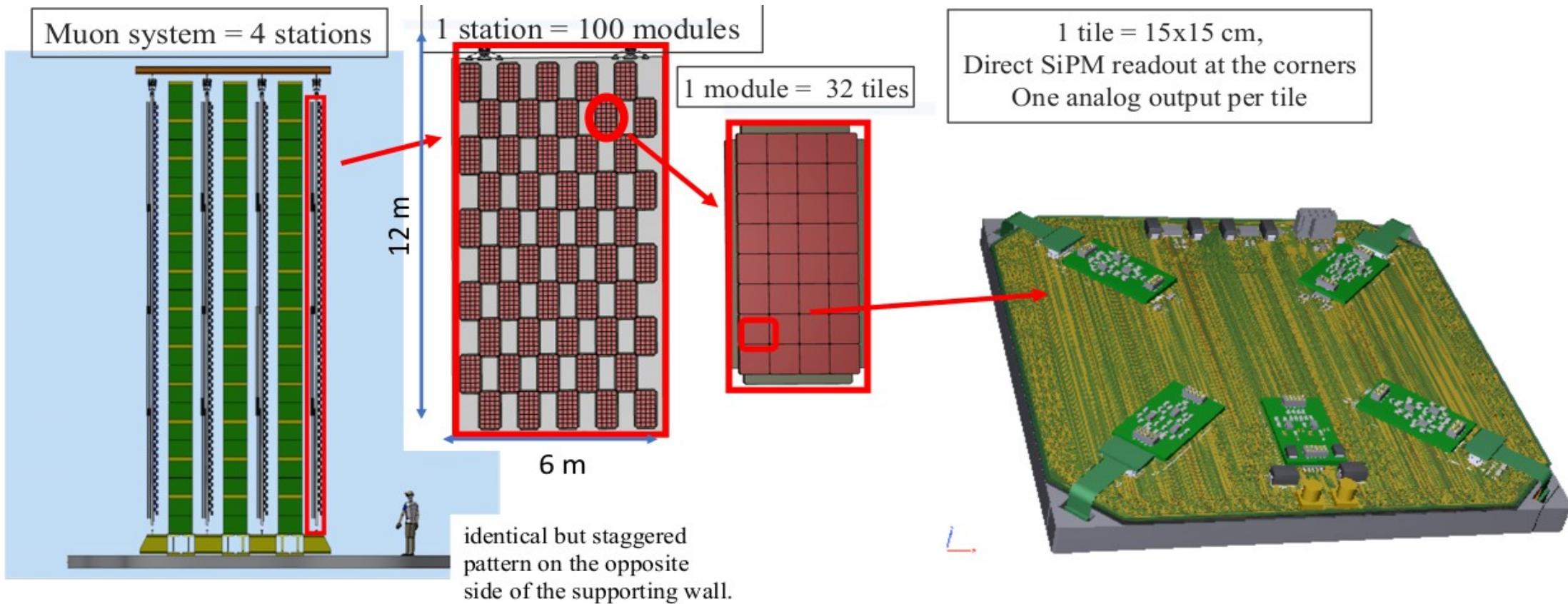
AIDAinnova task 8.3.2

Large area scintillator detectors

(MPP-MPG, DESY, INFN-BO, INFN-LNF, JGU)

INFN coordinator: A. Montanari

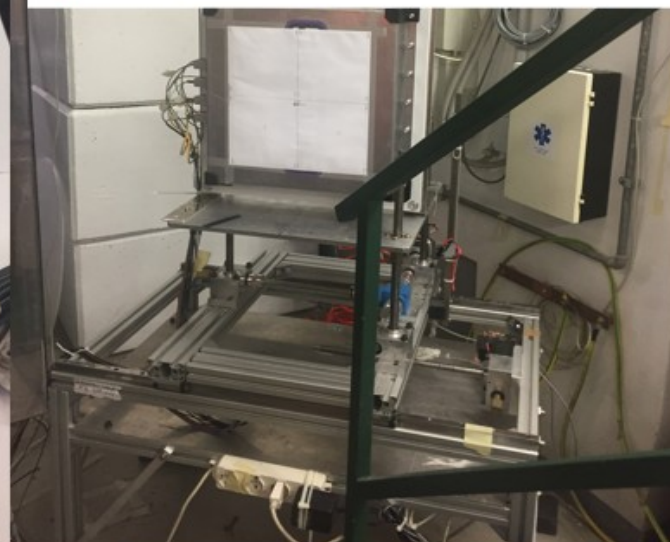
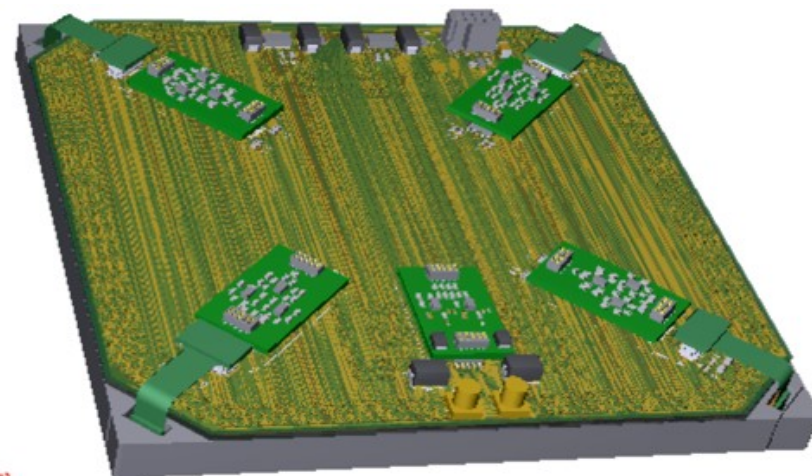
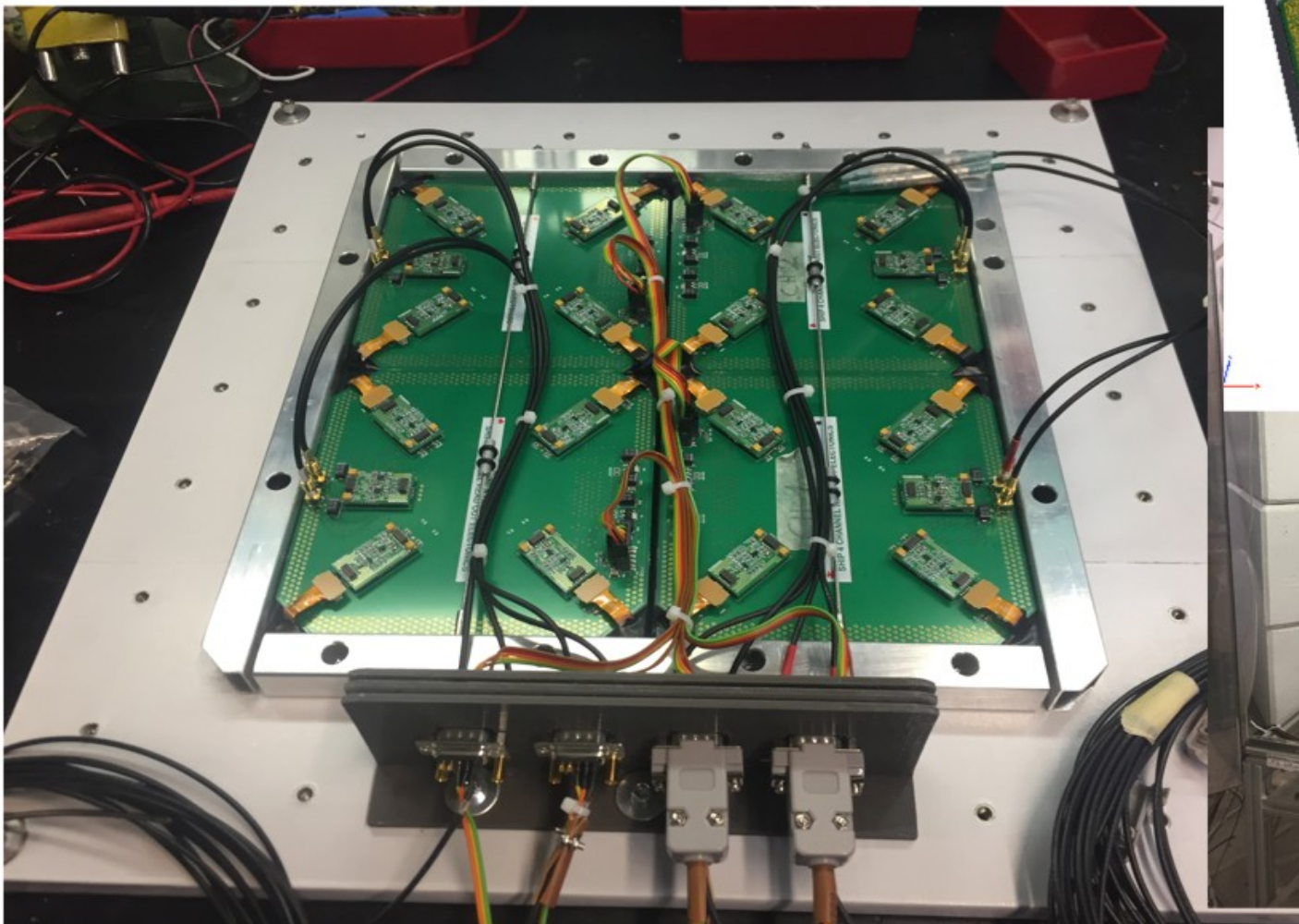
Large area scintillator detectors



GOAL:

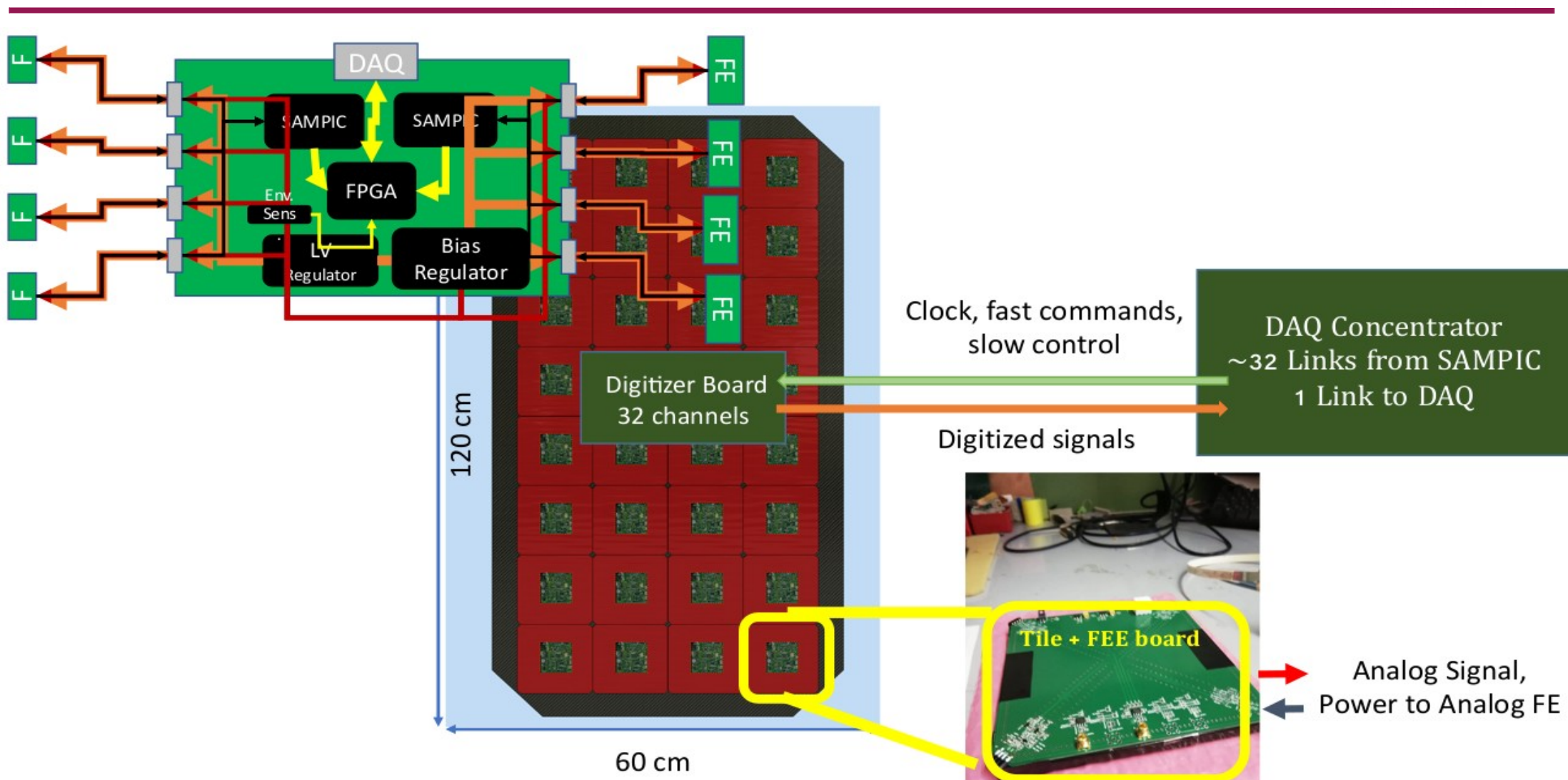
modular system for large area, low cost, with exceptional timing performance

R&D done in SHiP



about **200 ps** reached on single tile

Plan



Develop complete standalone module-0 with 32 tiles

Personnel and funding

- Units:
 - INFN Bologna (A. Montanari, N. Tosi)
 - INFN LNF (G. Lanfranchi)
- Original requests: 120 k€
- Approved request: 20 k€ (Bo)
 - almost 1Y “research grant” (should be ~ 25 k€)
 - not enough for module-0, just for R&D
 - need additional funding
- Matching funds:
 - A. Montanari 0.5 PM/Y, N. Tosi 0.5 PM/Y
 - G. Lanfranchi 1 PM/Y

AIDAInnova task 8.4.1

Innovative SiPMs and future applications in PID detectors

(JSI, INFN-PD, INFN-TO, CERN, FBK, UiB, FZU)

INFN coordinator: E. Torassa

Project in EOI #54

Silicon photomultipliers for particle identification devices of Čerenkov detectors

INFN Padova Ezio Torassa (**)	INFN Torino Roberto Mussa	Jožef Stefan Institute Rok Pestotnik (*)	Nagoya University Kenji Inami	FBK Alberto Gola
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EU contribution 162 k€ Matching funds 324 k€ Full costs 486 k€



SiPM developments: 62 k€ (1 run, 10 wafers)
4Y Fellowship: 100 k€

(*) Task 8.4.1 Coordinator

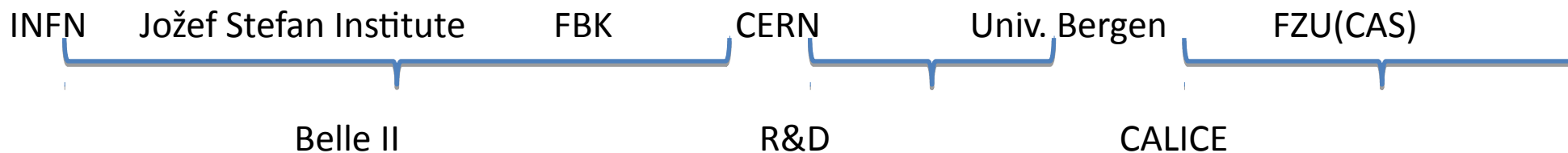
(**) Task 8.4.1 INFN Coordinator and INFN-Padova AIDAinnova coordinator

Deliverables:

- 1) characterisation of samples from different producers (M12)
- 2) review production process, change design, produce and test new samples (M36)
- 3) select and test multi-channel detector module for aerogel RICH and time-of-propagation counter (M48)

Approved Task 8.4.1 (beneficiary EU institutions)

Innovative SiPMs and future applications in PID detectors



EU contribution with overhead 137.5 k€

EU contribution without overhead 110 k€



{ INFN: 20 k€
 JSI: 40 k€
 FBK: 50 k€ (10 wafers -> 5 wafers)

Critical issues:

20 k€ about 3 k€ under minimum gross cost of 1Y fellowship in Italy

50 k€ can cover production cost for minimal chip development (1 run, 5 wafers)

without considering packaging and personpower at FBK.

INFN personnel costs (assuming 0.1 FTE = 1.2 PM and unit cost = 5 k€ / PM)

Name	2021	2022	2023	2024	TOT PM	TOT cost
Ezio Torassa	0.1		0.1	0.1	3.6	
Massimo Benettoni	0.1				1.2	
Flavio dal Corso	0.1	0.1			2.4	
Roberto Mussa			0.1		1.2	
Umberto Tamponi		0.1			1.2	
					TOT 9.6	TOT 48 k€

AIDAInnova task 8.4.2

Development of highly granular dual-readout fibre-sampling calorimeters

(INFN-PV, INFN-MI, INFN-PI, INFN-BO, UoS, ~~RBI~~, CAEN)
+ INFN-CT + INFN-RM1

INFN coordinator: G. Gaudio

Development of highly-granular dual-readout fibre-sampling calorimeters

(INFN-PV, INFN-MI, INFN-PI, INFN-BO, University of Sussex, ~~RBI~~, CAEN) + INFN-CT + INFN -RM1

- The production and mechanical assembly of the detector elements, the readout of $O(10^8)$ channels with an optimised scalable system, and the possibility to discriminate photon and electron showers from hadrons by time measurements will be investigated.
- The readout system will be developed in collaboration with CAEN in order to equip several 10×10 cm², 2 m long, prototypes to be qualified with test beams.

Deliverable:

D8.4 : Construction and qualification with beam of 10×10 cm², 2 m long, prototypes [46]

A large-scale prototype of a dual readout calorimeter that allows for extrapolation to a full system will be constructed and operated. Its performance will be documented in a report (task 8.4)

Budget

Full costs budget per Task

Beneficiary short name	Person-months	Monthly personnel cost	Personnel costs	Travel	Equipment and consumables	Other direct costs	Sub-contracting	Material direct costs	Total direct costs	EC requested funding (without overheads)	EC requested funding (including overheads)
Task 8.1 Management											
INFN	4,0	5.000,0	20.000,00	4.000,00				4.000,00	24.000,00	4.000,00	5.000,00
Task 8.4.2 Dual readout calorimetry for future particle physics experiments											
INFN	20,0	5.000,00	100.000,00	10.000,00	10.000,00			20.000,00	120.000,00	40.000,00	50.000,00
Total	24,0		120.000,00	14.000,00	10.000,00	0,00	0,00	24.000,00	144.000,00	44.000,00	55.000,00

Total funds INFN: 120 k€

40 k€ from EU: 2Y post-doc position (possibly 4 if co-funded by INFN/University)

80 k€ co-funded by INFN: manpower (see next slide) + travel and equipment (20 k€)

Other partners in the task:

Univ. of Sussex (120 k€)

CAEN (60 k€ : 30 k€ from EU + 30 k€ co-funded by the company)
[development of RO boards]

Personnel and matching funds

tecnico: 3 keu/PM								
ric/tecn: 4-6-7 keu/PM					2021	2022	2023	2024
Roberto Ferrari	RD_FCC	PV			0.1	0.1	0.1	0.1
Gabriella Gaudio	RD_FCC	PV			0.1	0.1	0.1	0.1
Giacomo Polesello	RD_FCC	PV			0.1	0.1	0.1	0.1
Claudio Scagliotti		PV			0.1	0.1	0.1	0.1
Franco Bedeschi	RD_FCC	Pisa			0	0	0.1	0.1

	WP8 [PM]				
tecnico: 3 keu/PM					
ric/tecn: 4-6-7 keu/PM	T8.1	T8.3.1	T8.3.2	T8.4.1	T8.4.2
Sedi					
Responsabile	R.Ferrari	M. Moulson	A. Montanari	E.Torassa	G. Gaudio
PM TOT PROGETTO	4	11	12	12	20
COSTO personale (*) [keu]	20	55	60	60	100
	2.5	33.0	8.0	9.6	20.0