DUNE-SAND

Requests (no travel funding) to CSN1

Luca Stanco



- Tracker
- GRAIN

MAGNET – KLOE 0.6T superconductive coil + Fe Yoke

ECAL - KLOE Lead Scintillating Fibers calorimeter (Barrel ~85 t + EndCaps ~40 t)

TRACKER (STT) – 5 ton Straw-Tube tracker with "solid-H" target CH_2 and C interleaved foils (Drift Chamber, DCH, similar)

GRAIN – 1 ton liquid Argon target with VUV imaging system (fully optical read-out)

SAND, a multipurpose detector with a high-performant ECAL, light-targeted tracker, LAr target, <u>all of them in a</u> <u>magnetic field</u>







SAND status in a nutshell

> Activity in Frascati going on quite smoothly:

continuing preparation for tools and test operations;

dismounting of calorimeter modules, done for the Barrel ones, ready for the Endcap ! Active involvement of Fermilab engineering group for re-installation planning and preparation Just underwent to the DUNE PDR, on July 22nd and 23rd.

LAr-GRAIN detector: key issue on ASIC read-out under vibrant studies (defined roadmap towards design and production of 1024 channels ASIC),

first cold test in Genova of coded masks and lenses prototypes almost ready to start; major advances in cryogenics and preparation of a full-scale test facility in INFN Legnaro Lab

- Tracker: advanced prototyping activities at CERN, Pisa and Bologna (plus other sites, installing and testing machines for straws production). Discussion in progress on tracker selection (STT vs DCH).
- DAQ, Trigger, Timing and Slow Controls: significant progress on integration with DUNE-DAQ and on timing.
- > Calibrations: newly formed group; already developed a plan for calibrating ECAL and GRAIN
- > **TDR writeup**: writeup progressing; about 240 pages written, for now
- > **Physics**: part of the task force for re-evaluation and re-enforcement of the SAND detector
- > All schedules: already rather detailed



2

The latest 12 months: very reach of satisfactions !



ECAL

- Barrel modules extraction
- Tooling for Endcaps
- Modules in good conditions
- DUNE PDR just over
- Test stand at LNF ready (*)
- FEE defined path (*)
- HV/LV defined path (*)

(*) it corresponds to requests for 2025







Highlights

Magnet

- Power supply defined path (*)
- Interaction with FNAL people started
- Discussion and documentation on the way on
- Extraction defined (*)
- Magnet test at LNF in 2025 (*)
- Shipping under first evaluation (**)

(*) it corresponds to requests for 2025 (**) it corresponds to requests for 2024/25



Extraction/Insertion Tool





Highlights

Tracker

- First STT prototype on test beam
- New STT prototype under way (*)
- Infrastructure for STT production/assembling
- Option B (DCH) under prototyping (*)
- We should make a choice next year
- We have to start to define tooling (*)











5

Highlights

GRAIN

- Lens and Mask under robust R&D
- Internal vessel defined
- ARTIC station at Genova fully activated (*)
- Test station at Legnaro in good progress (*)
- ASIC run and packaging defined path (*)

(*) it corresponds to requests for 2025

Vacuum tank for Inner Vessel test at INFN-Legnaro almost ready for tender

INFN-Torino started the design of a new ASIC 1024 channels. Expected dynamics of photon arrival on SiPMs is used to choose optimized frontend

architecture

Camera with 256 channels ready to be tested in ARTIC facility, Genova (LAr cryostat)





SAND timeline – construction and delivery - I





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SAND timeline – construction and delivery - II





DEEP UNDERGROUND NEUTRINO EXPERIMENT

SAND timeline – construction and delivery - III





SCHEDULE: KLOE-to-SAND (ECAL+Magnet+Yoke)

	2019	2020	2021	2022	2	2023	2024	ļ.	2025	2026	2027	2028	2029	2030	2031		2032	
Task Name 👻	H1 H2	H1 H2	H1 H2	H1	H2	H1 F	H2 H1	H2	H1 H2	. H1 H2	H1 H2	2 H1 H2	H1 H	2 H1 H2	H1	H2	H1	ŀ
▲ KLOE2SAND																		
✓ Drift Chamber Extraction																		
DC Tooling Draw and Construction																		
Drift Chamber Extraction					Ĩ													
ECAL extraction					Г													
ECAL Barrel Tooling Preparation																		
ECAL Barrel Extraction								h										
ECAL Module Revamping							Ĭ											
ECAL Module Test																		
Selection and test of readout electronics																		
Procurement of HV System																		
Procurement of readout electronics									Ť.									
ECAL EndCaps Tooling Preparation							_											
ECAL EndCaps Dismounting																		
Packaging											Ь							
ECAL modules post-delivery QA/QC																		
COIL Extraction						I												
Coil PS and Cryo interface procurement									h									
Coil PS Installation									Т.									
Coil Test									Ť.	h								
Disassembly of service turret																		
Design and construction of extraction tooli																		
Coil Extraction																		
▲ Yoke Dismounting																		
Yoke Dismounting																		
▲ Shipping												ר						
Shipping Preparation																		
Shipping											Ť.	ľ						



SCHEDULE: Tracker (STT)





SCHEDULE-I: GRAIN

	2019		2020	2021	202	2	2023	2024	ł.	2025	5	2026		2027	20	28	202	9	2030	203	1	2032	2
Task Name 👻	H1 I	12	H1 H2	H1 H2	H1	H2	H1 H2	H1	H2	H1	H2	H1	H2	H1	H2 H1	L H2	H1	H2	H1 H2	2 H1	H2	H1	H2
⊿ GRAIN																							
Lar design, assembly, integration until 2023												LAr c	lesign	, asse	embly, in	tegrati	ion[6	30 k€]	;Grain Cı	ryostat	2022	[1]	
▲ Internal Vessel																							
Design Internal Vessel																							
Simulation Internal Vessel									h														
Design of Camera frame fixing points									h														
Design of Camera frame									ľ	h													
Production of Camera frame																							
Tender for Internal Vessel and order									Ě	Intern	al Ve	ssel[1	80 k€]										
Internal Vessel delivery										•	25/0	4											
⊿ Vacuum Tank																							
Vacuum Tank design										1													
Tender for Vacuum Tank and order									т	h													
Delivvery Vacuum Tank										• 07	7/02												
Design of support and sliding system									K	Slidin	g syst	tem[20) k€]										
Design of anti-swing system									K														
Design Cradle for Vacuum Tank									K	J													
Tender and order of Cradle										Vacu	um T	ank[5	0 k€]										
Delivery of Cradle										T.													
▲ External Vessel								Г															
Test outgassing sample 150x150x6									h														
Test permeazione campioni flangiati									Ľ	L													
External Vessel design																							
External Vessel simulation											Ì												
External Vessel tender and order												Ĭ-	Exterr	nal V	essel[500	0 k€]							
External Vessel delivery													•	01/1	.2								



SCHEDULE-II: GRAIN

	203	9	2020	20)21	202	2	2023	5	2024		2025		2026	202	7	2028	8	2029)	2030		2031		2032	
Task Name 👻	H1	H2	H1 H	2 H	1 H2	H1	H2	H1	H2	H1	H2	H1	H2	H1 F	2 H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
Proximity Cryogenic System									I																	
Proximity Cryogenic system P&D									1																	
Control system design									1	h																
Order and delivery of components of Cont										Ť		-														
Assembling of Control System												հ														
Control software												Ť														
Definition of requirements of each compor											հ															
Technical document for tender											Ĭ															
Market Survey											Ĭ															
Tender procedure and order 1st batch of p											L	Proxim	nity (ryogen	ic syste	m - ba	atch 1	[500	k€]							
Delivery Recirculator Pumps													Н													
Delivery Valves Box													Н													
Delivery Pump Box													+													
2nd batch of parts of system												Prox	imit	y Cryog	enic sys	tem -	batch	n 2[50)0 k€]							
Delivery Recondenser													Ī													
Delivery Purifiers													Ī													
Delivery Flowmeters																										
Integration of components with Control Sy:																										
Final full functional tests														Ť												
Manual for commissioning and operation c														Ĭ												
▷ LNL Facility										Г																
▷ Test in ARTIC									I																	
Thermo-Electrical test									I																	
GRAIN Cold Interface Board (GCIB)																										
▷ ASIC									I																	
GRAIN Camera Board (GCB)													Г													
GRAIN Warm Interface Board (GWIB)																										
Detector test																I			I							
Installation and commissioning																		1								



SCHEDULE-III: GRAIN

	2019	2020	2021	2022	2023	2024	4	2025	202	6	2027	7	2028		2029		2030	203	1	2032	2
Task Name 👻	H1 H2	H1 H2	H1 H2	H1 H2	2 H1 H2	H1	H2	H1 H2	H1	H2	H1	H2	H1 H	12	H1 F	12	H1 H2	H1	H2	H1	H2
✓ LNL Facility																					
Dismounting Old obsolete apparatus																					
New connection lines definition																					
New lines orders and delivery							b h														
New lines installation							Ĭ.														
Floor inspection by expert						h															
Possible floor adaptation								$\left\{ \right. \right\}$													
Support framework																					
Seismic qualification of support framework							H.														
Ground connection								ř – – –													
Oxygen monitors procurement and installa																					
Heavy loads limits inspection							ł		Ш												
Electrical risk inspection									H												
Safety valves Inspection									H												
Connection trays for cables							ŀ]													
Contingencies to fix possible non-complian							Ľ														
Argon and Nitrogen procurement									H												
Facility Commissioning																					
Facility commissioned									×.	22/04	1										
▲ Test in ARTIC							_														
Finalize ALCOR DAQ																					
Assemble lenses							K														
Assemble masks							K														
Alcor camera calibration						Í	1														
Test with artificial light sources																					
Installation and commissioning of CRT							h														
Test with cosmics in Argon							ſ														
Imaging system demonstrated									03/10	0											



MONEY





Caveats for "money" profile reshuffling

- Delay of the DUNE experiment
- Delay of the DOE-INFN MoU signature
- Delay in the identification of the Fermilab sites and definition of the installation procedure



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N Core Co	st Spending Profile									
	he	2021	2022	2023	2024	2025	2026	2027	Total	
ND										
MAGNET	Yoke				200				200	
	Yoke disassemply, packaging, storage at LNF				300		-	200	300	
	Foke Integration/Installation			100	540			200	200	
	Transport to ENAL (includes EMC)			100	540	1300			1300	
FMC	EMC test, disassembly, renovation	340	149	300	565	- 750			2104	
GRAIN	LAr design, assembly, integration	010	40	315	680	1040		→	3055	
	Spares, small components and transport to FNAL						200		200	
STT	Design and Prototype			65	150				215	
	Contribution to the construction of STT					1700	→ 1700	→ 1700	→5100	
TRIGGER	Trigger design, realization					200	_		200	
		340	189	780	2235	4990	2880	1900	year 2	028
		340	189	780	1116.	5 2444 2620	4573.) 4393	5 2700 .5	17	00
		340	529	1309	2425	5.5 486	9.5 94 4	13 12143	3. 138	843



SAND INFN sites involvements

with hardware & consumable requests 2025 in ()

- ECAL: Bologna, Ferrara (3 k€), Lecce (20 k€), LNS, LNF (80 k€), Pisa (5 k€), Roma1 (614 k€+553 k€ s.j.+10.5 k€)
- Magnet: LNF (635 k€+120 k€+170 k€ s.j.)
- Tracker: Bologna (35 k€), Pisa (5 k€+200 k€ s.j.)
- GRAIN: Bologna (54 k€+35 k€), Genova (120 k€ s.j.+19 k€), Lecce (34 k€+10 k€), Padova, Torino (268 k€ s.j.)

• ECAL: 732.5 k€ + 553 k€ s.j.

- Magnet: 755 k€ + 170 k€ s.j.
- Tracker: 40 k€ + 200 k€ s.j.
- GRAIN: 152 k€ + 388 k€ s.j.

2990.5 k€



18

DEEP UNDERGROUND NEUTRINO EXPERIMENT

INF



Additional SAND requests for 2024/25

- 90 k€ for Magnet PS (190 -> 280)
- 50 k€ for Magnet software
- 40 k€ for Shipping Engineering study



SAND: conclusions

- The SAND detector is a key element of the ND-complex (and DUNE) (formally based also on the MoU just signed off)
- Our plan is compatible with the first day of ND-hall allowance to start installation (Sept. 2028), (thanks also to FNAL interplay)
- Disassembly of KLOE in Italy is actively and wonderfully going on (some delays not relevant for the schedule)
- Robust R&D program underway for the Tracker and GRAIN (PDR/TDR will be a disentangling milestone)
- The physics potentials are huge, for oscillation physics and beyond (undergoing Task Force mission)

