SAND – 2025/2026

accomplished
in progress
working on

KLOE_2_SAND LNF-ROMA1-LNS-PI-FE-BO

- Removal of all the cables and the FEE+HV racks
- Extraction of the Drift Chamber

CALORIMETER

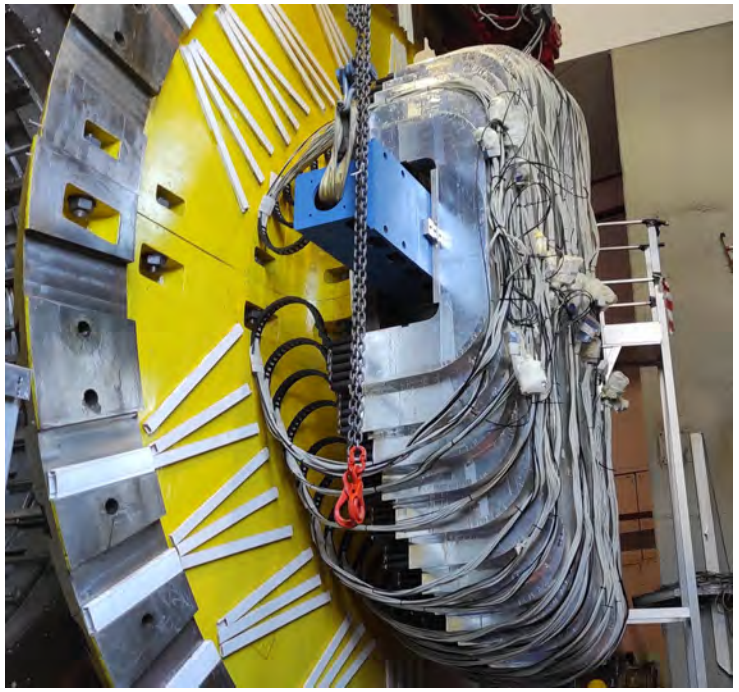
- Laser Tracker survey
- Extraction of Barrel (24 modules)
- Dismounting of 4 End-Caps
- Modules consolidation
- Operational test

MAGNET AND YOKE

- Purchase of new Power Supply
- Installation of new Power Supply
- Cooling and operational test
- Extraction of the Cryostat
- Dismounting of the Iron Yoke
- Packaging and Shipping

Preparation of dismounting ECAL End-caps

Testing the insertion of the blue bar



In parallel, we work with the SAND-US group to define the procedure, the documentation as well as the deliverables of INFN and FNAL

Two notable documents have been produced so far:

- Fitness-for-Service Assessment of the KLOE Pressure Equipment
- SAND-US scope

More work underway to produce all the documentation for the engineering review of all the tools used to disassemble KLOE which will be used for the reassembly of SAND

Dismounting Module 1

Sollevatore modulo 1

Rotatore e rastrelliera modulo 1

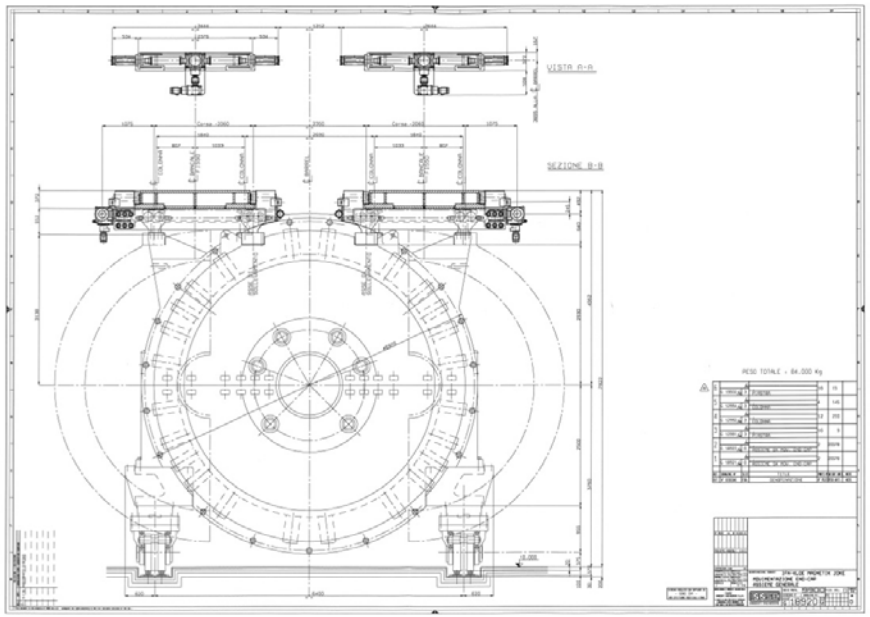
Iron Yoke Disassembly

BALDON
SOCIETÀ PER AZIONI

Budgetary offer from Baldon (the same firm which assembled KLOE). More detailed offer requested to start negotiations.

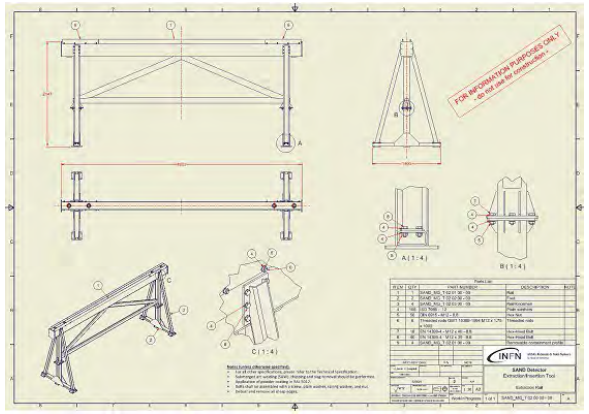
34 parts of ~20t weight each, total weight 800t

Drawings of parts fully available

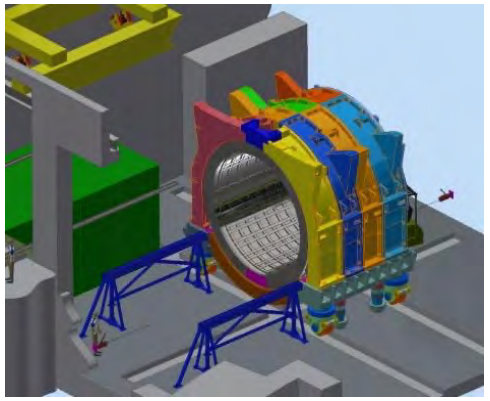


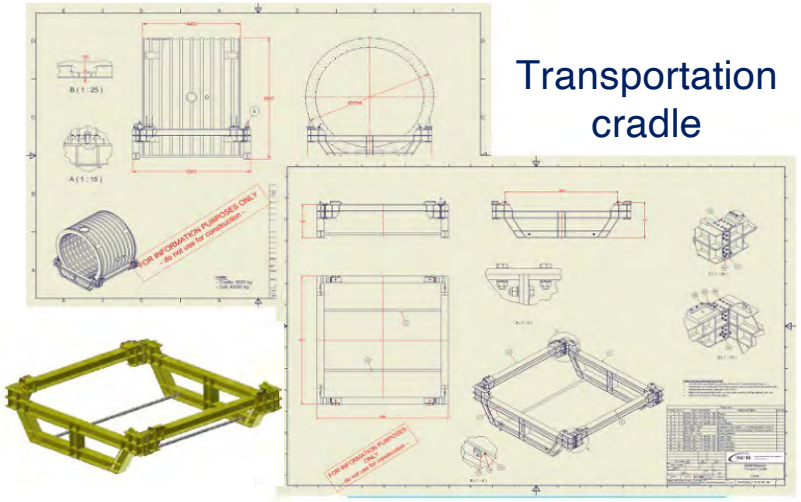
INFN DUNE

Magnet Cryostat Extraction



Extraction rails





Transportation cradle

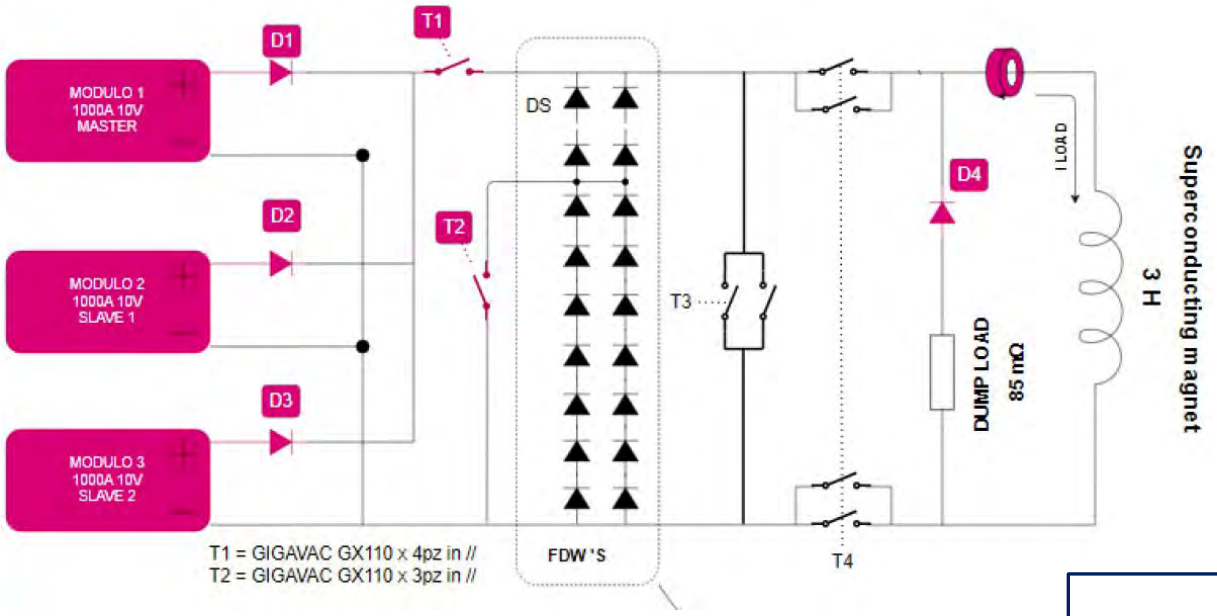
- Executive drawings ready
- Ready to start construction
- Agreement with local company for cryo-turret removal

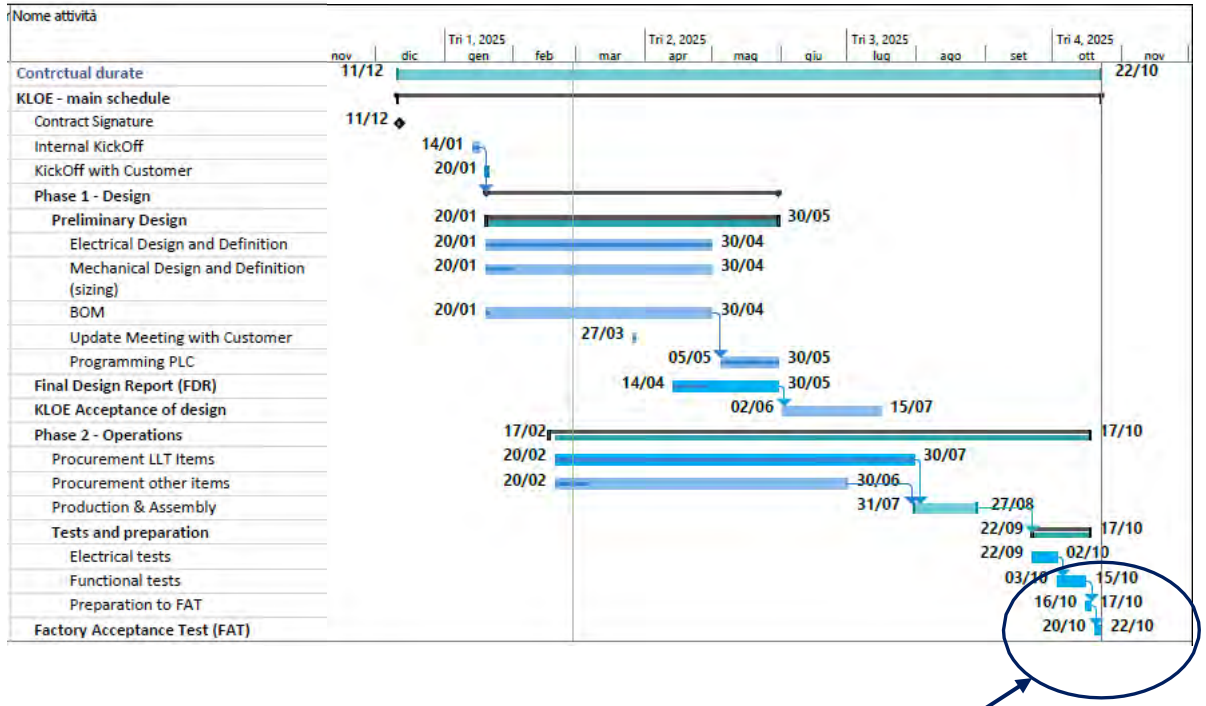
- Load test of deck in 1 or 2 weeks
- Working on deck extension
- **Tests on existing deck done: validated**

New Magnet Power Supply

Pink: new parts
3 power units 10V/3000A
other 24 components

Black: revamped parts
18 freewheling diodes
T3-T4 contactors





FAT date
20 October 2025

Control System
to be migrated from LabVIEW
to most recent SW release

ECAL Barrel Refurbishment

Main Consolidation items:

- Gluing of delaminated parts
- Wrap with new tape

Operational Test:

- Space and Time resolution with cosmic muons

Peel strength and unwrapping force tests at different angles with a load 1.4 more dense than ECAL

First choice:
Aluminum+Fiberglass
3M tape

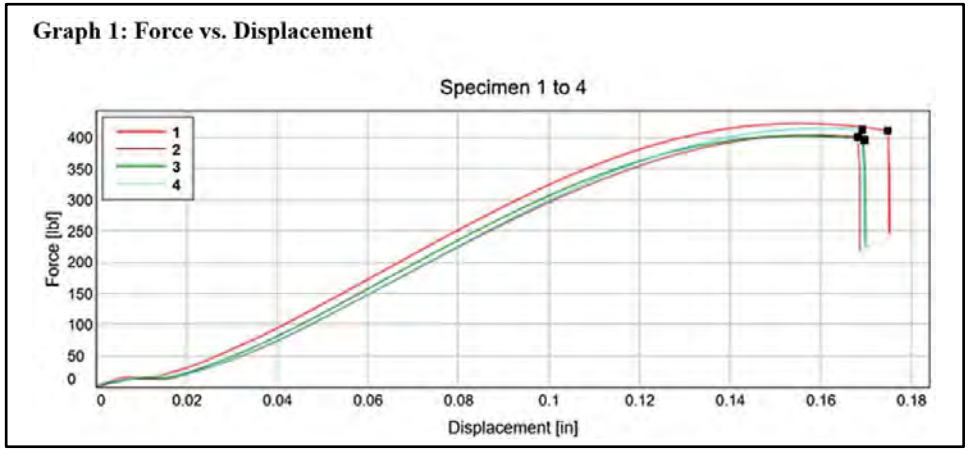
<u>unsuccessful</u>

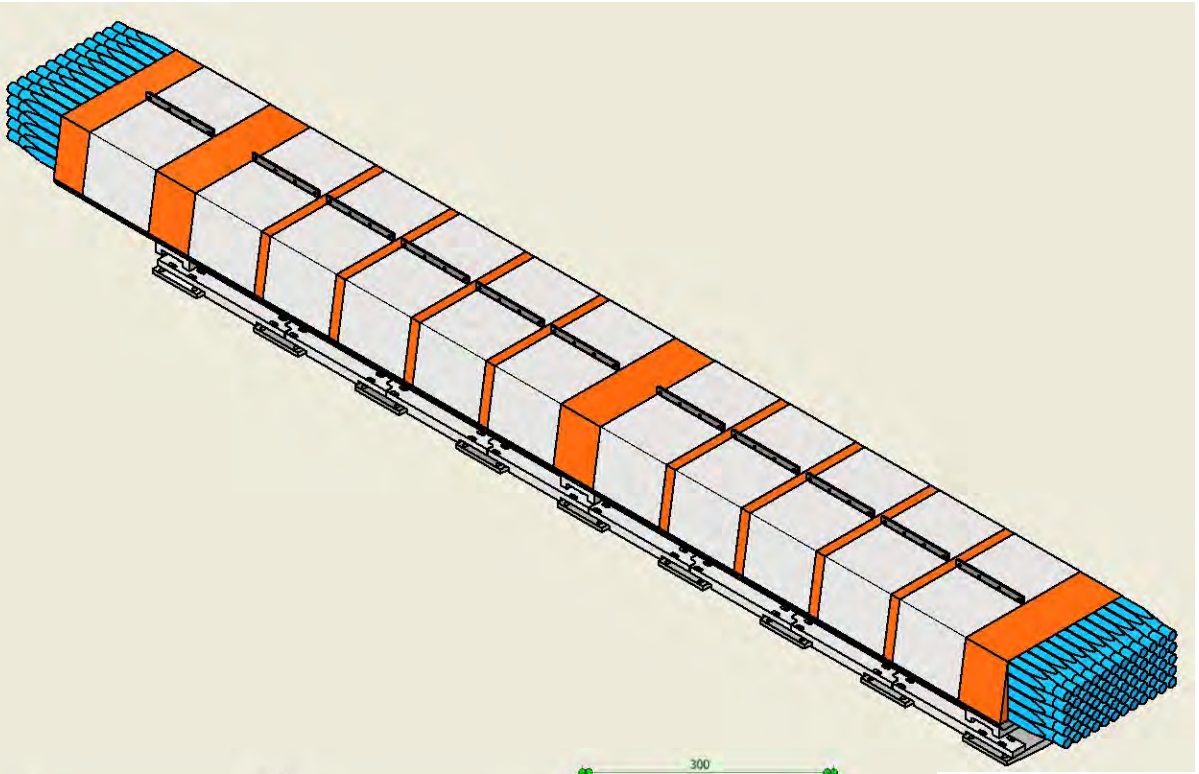
New acrylic-adhesive tapes (not silicon) will be tested

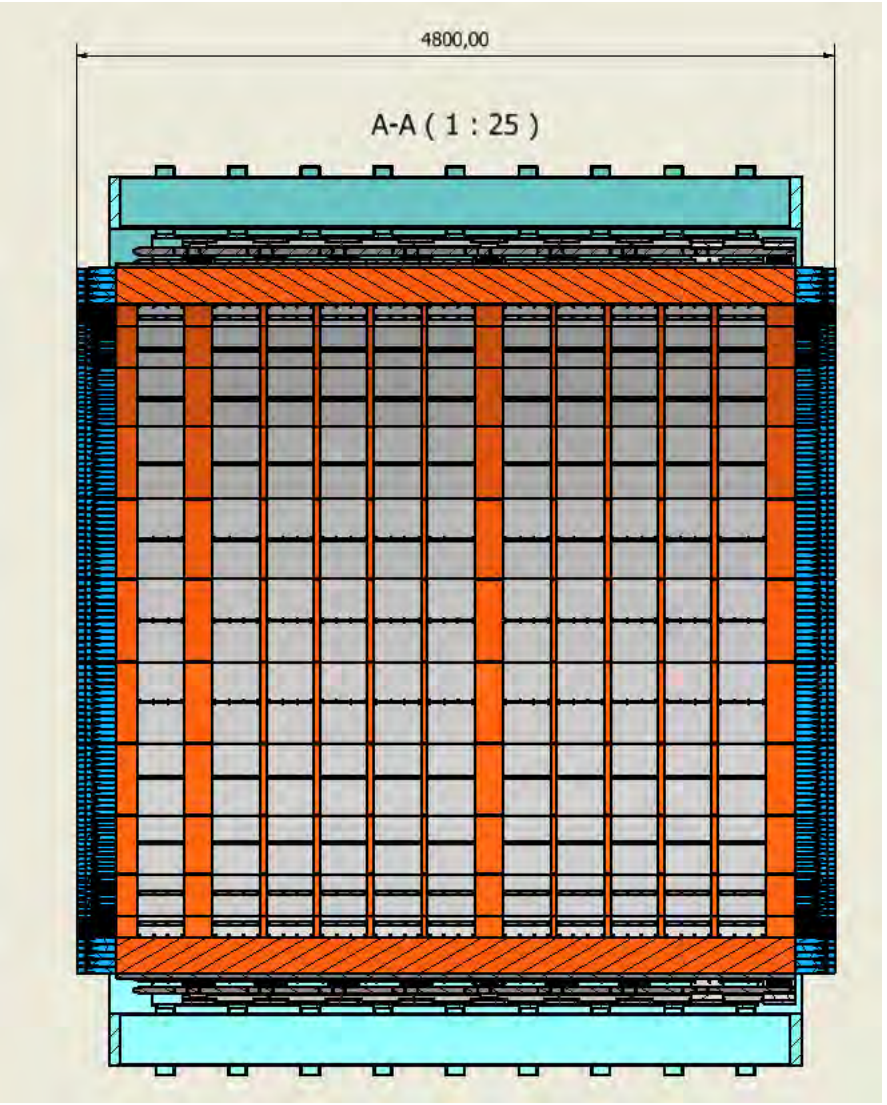
ECAL Barrel Refurbishment

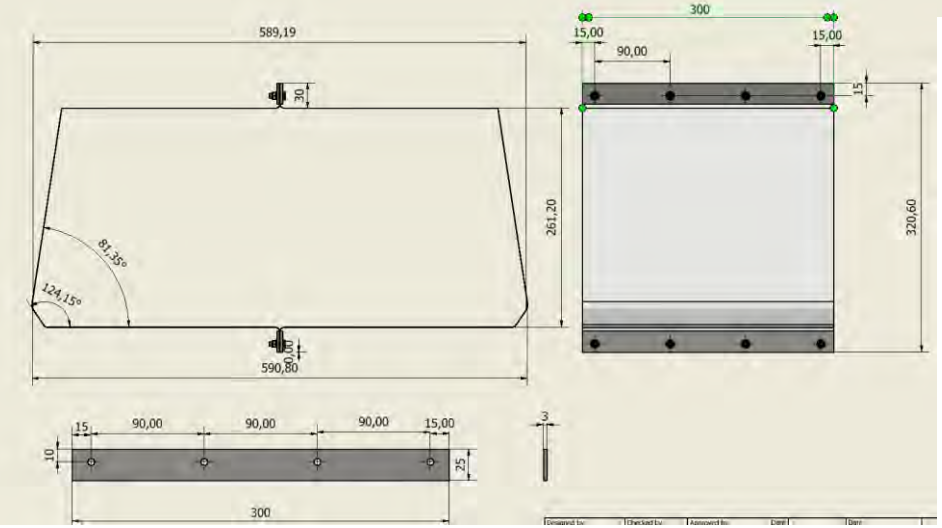
Test at Pisa of glue
EA 9483 Loctite Henkel
on ECAL samples
according to
Single lap shear test
ISO 4587-2003

Other solutions under test



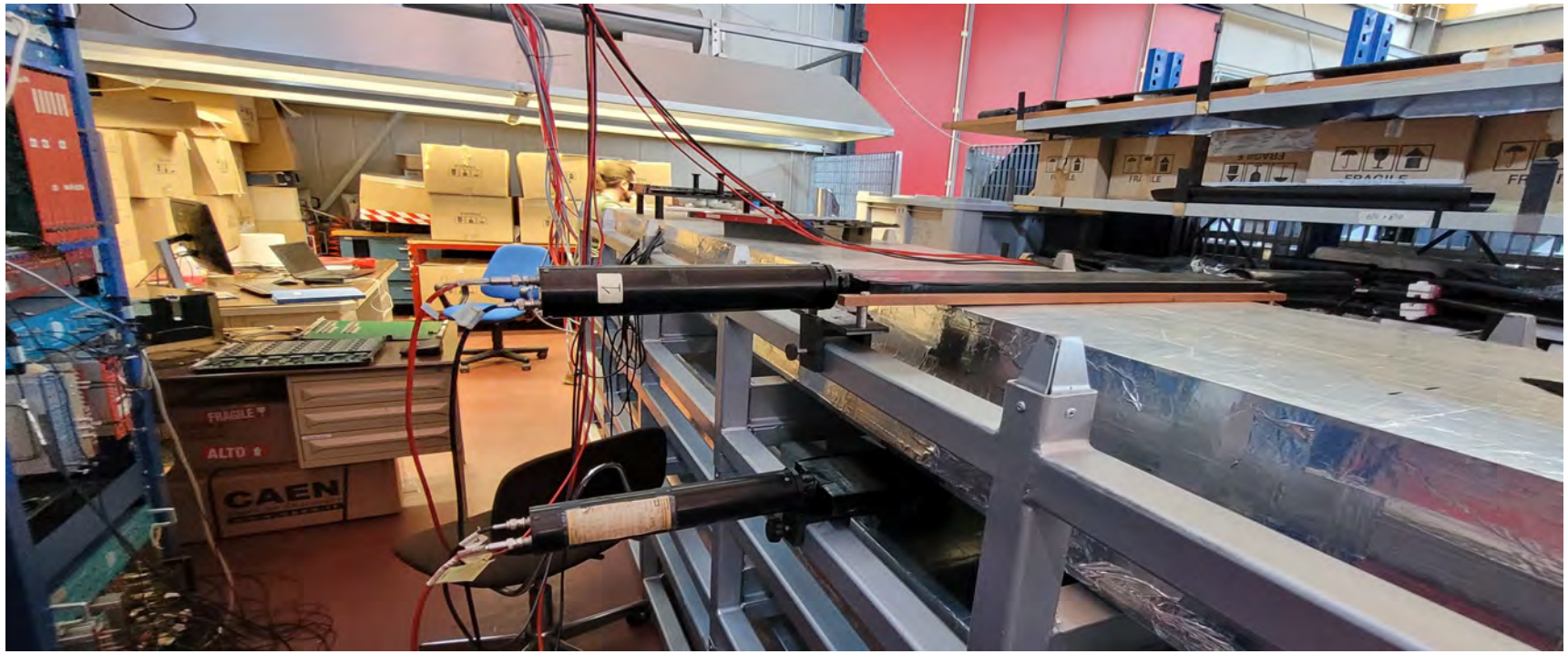


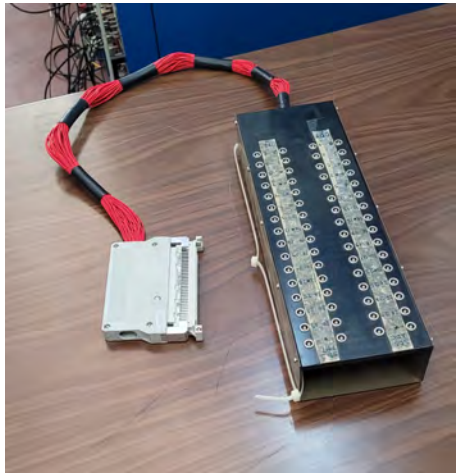


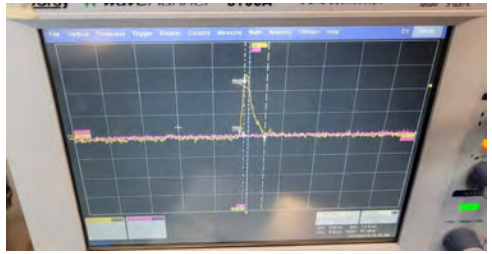


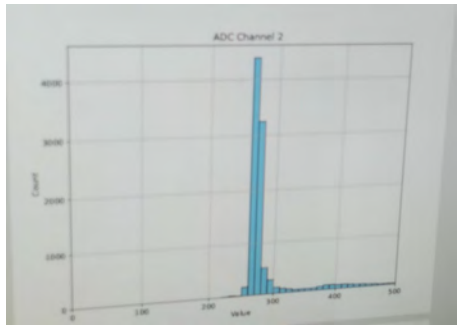
Adopted solution: use .3 mm stainless steel shaped sheets glued to the modules Tests being performed in Pisa

ECAL test at LNF – turning on the system









ECAL: procurement of HV and LV power supply

HV

LV

~~Offer CAEN updated July 2024~~

~~n° 102 board A7030P (48 ch.) = 527k euro~~

~~n° 7 Sistem SY4527B = 41k euro~~

~~n° 7 Power supply booster A4533 = 12k euro~~

~~TOTAL: **580k euro** (IVA escl.)~~

~~spare: 10 5 A7030P + 2 1 SY4527B + 2 1 A4533 = **67k 34k euro** (IVA escl.)~~

~~warranty ext. 3 years: = **53k euro** (IVA escl.)~~

n° 10+2 spare board A25251 8 full floating channels 8V/12A = **31k euro** (IVA escl.)

Mapping of present HV cables 5x12ch on 48 ch. modularity not trivial (to be studied also for LV)
=> under study to minimize cost (custom connectors or patch panel)

Choice of FEE for SAND/ECAL

Four possible solutions investigated with CAEN

COST

Digitizer VX2730

Fsampl ~ 500 MS/s => **~ 3.5 Meuro**

COST

Digitizer VX2745B

Fsampl ~ 125 MS/s
+ shaper 64 ch. => **~ 1.6 Meuro**

PERFORMANCE

DT5203+A5256

PicoTDC + discr. double threshold with ToT => **~ 790 keuro**

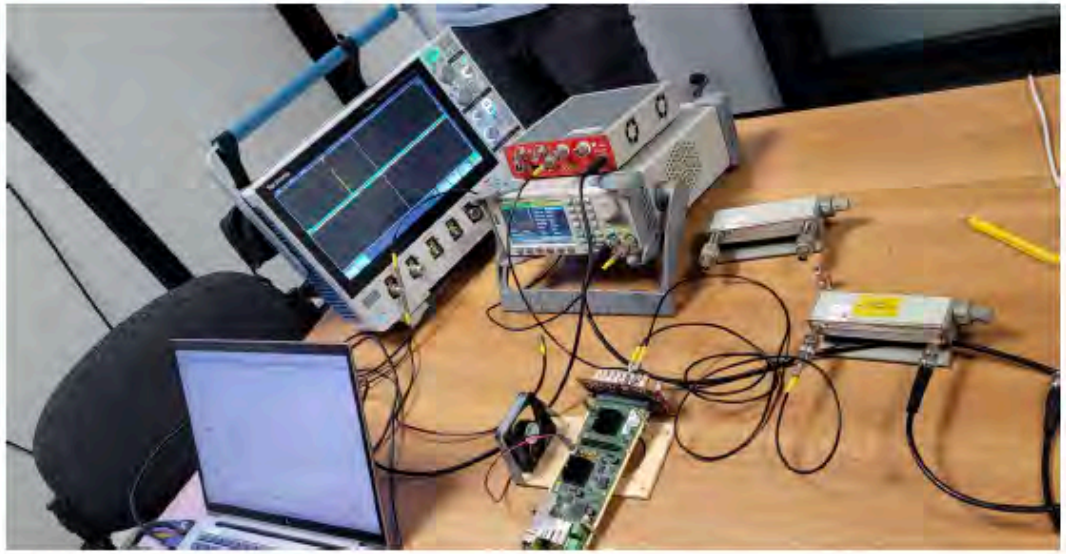
PERFORMANCE

A5204 RADIOROC with picoTDC

PicoTDC + discr. single threshold with ToT (for all signals)
+ peak sensing ADC with slow shaper – dead time 20µs
and good resolution (for rarer signals of large amplitude);
feasibility study in progress => **~ 520 keuro**

Choice of FEE for ECAL – prototypes (QTDC)

test @ CAEN 7-9 July 2025



Preferred choice
~1100 K€

V9290 - 32ch Multievent Charge & Time Pulse Processor **QTDC**

- dynamic range 60dB
- can accept large signals (~3 V amplitude)
- ADC + TDC branches for all signals
- very good time (T_0 and ToT) and charge resolutions

Preliminary Shipping Plan

- Started the detailed plan for the italian route: Frascati- ~~Civitavecchia~~ **Anzio (under study/test)**
- USA route should be from St.Lawrence river mouth to Romeoville (IL), 23 mi from Fermilab
- Detailed USA plan will follow as a further step

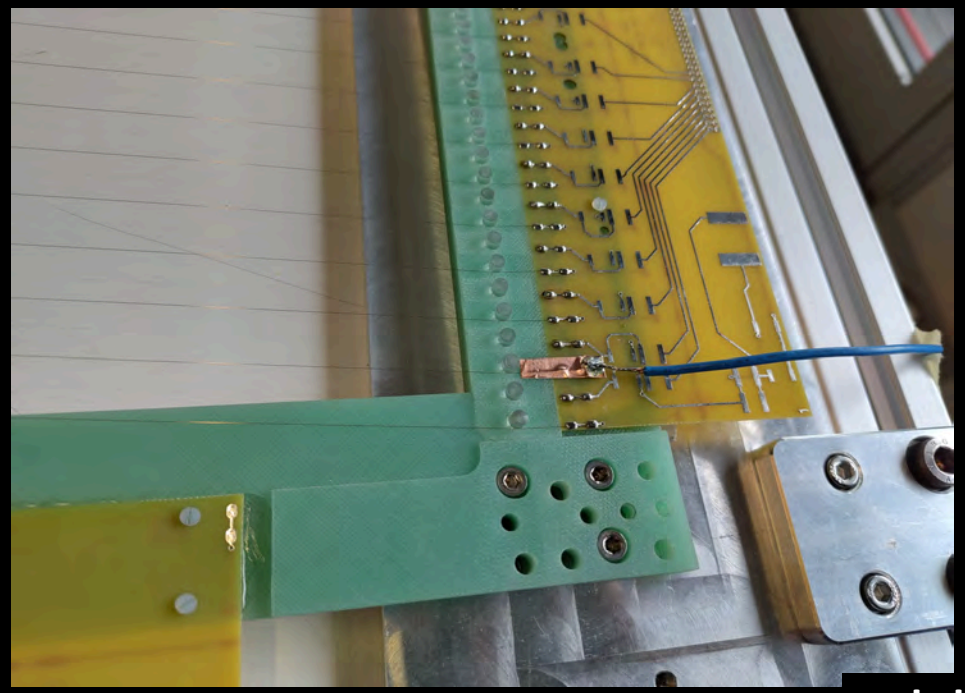
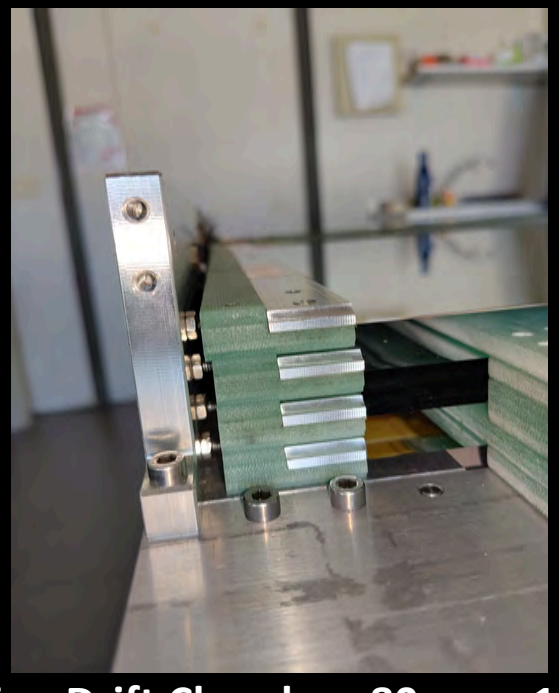
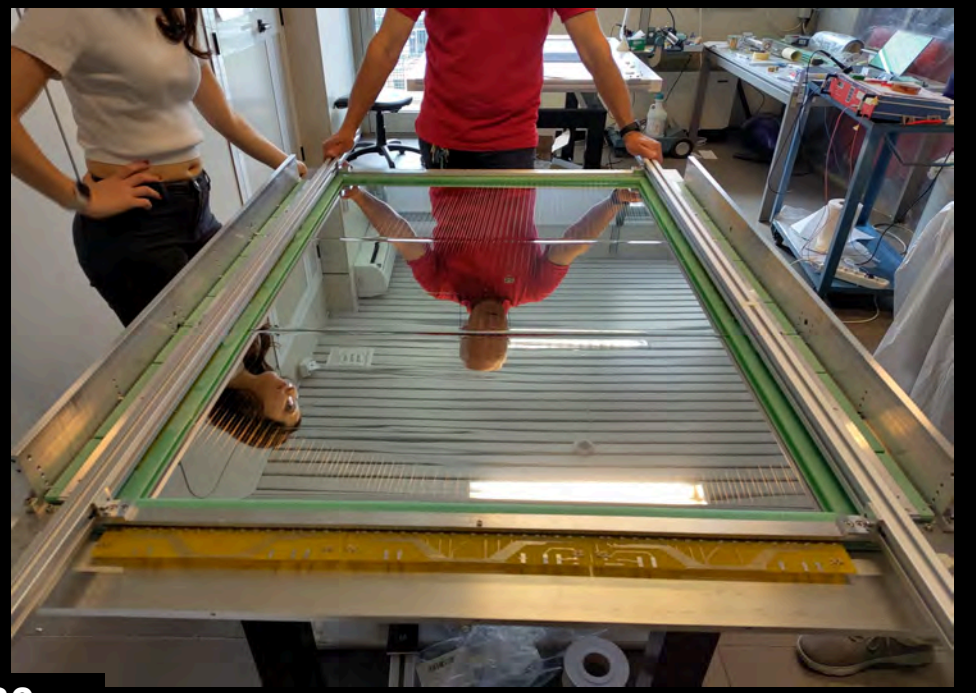
	STUDIO TRASPORTO LOGISTICO RELATIVO AL TRASPORTO DI MAGNETI "POLOIDAL FIELD" (PF) DA PORTO DI CIVITAVECCHIA AL CENTRO ENEA DI FRASCATI (ROMA)	DTT ID: PFC-TEC-61305	Page: 0/73
DTT		External ID: CIG Z4085D049A	Rev. 1.0

Access: ☐contractual ☐ open ☐ restricted		
STUDIO TRASPORTO LOGISTICO RELATIVO AL TRASPORTO DI MAGNETI "POLOIDAL FIELD" (PF) DA PORTO DI CIVITAVECCHIA AL CENTRO ENEA DI FRASCATI (ROMA)		
Project Details	DTT S.c.a r.l. *This document is issued for the execution of the DTT project*	
	DTT ID Number	PFC-TEC-61305
	External ID Number	
	DMS ID Number	DTT2022_05704

SAND/TRACKER (BO/FE/PV/PI)

2025

- Progettazione e costruzione prototipo Drift Chamber 80 cm x 120 cm
- Valutazione performance prototipo su fascio (IN CORSO)
  - Collaborazione con DRD1 e gruppo BES/Ferrara
  - Front End: ASIC TIGER, amplificatore custom per lettura singolo canale
- Confronto performance con l'alternativa basata su straw-tube

prototipo Drift Chamber 80 cm x 120 cm

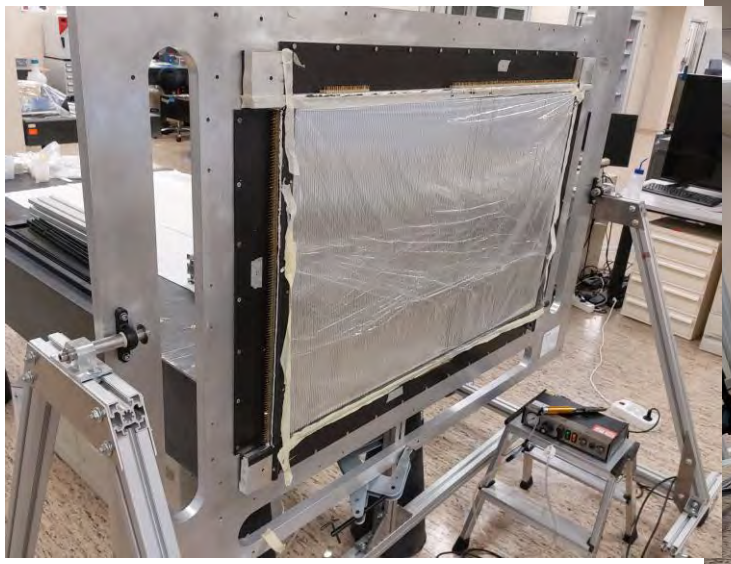


SAND/TRACKER 2025

PISA

- A straw prototype (1200x800 mm) has been built in Pisa . The prototype will be tested at CERN in July or at the beginning of August. A full-scale prototype will be assembled partially In Dubna and in India. The design of the full-scale prototype has been made by the Pisa Group.
- Contacts are underway with the Bologna group to verify the feasibility of an alternative based on drift chambers
- The study of the calorimeter refurbishing is in progress. A stand has been made to test various solutions. Wrapping with tape. Gluing Stainless steel sheet 0.3 mm thick.

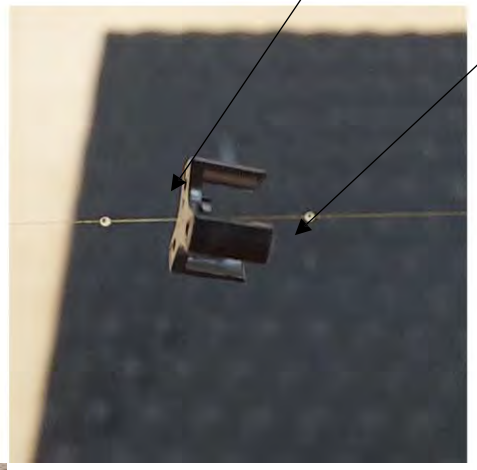
Some pictures of the construction of the prototype in Pisa .

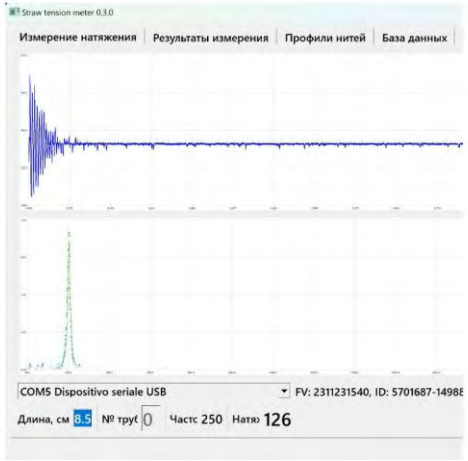


Inner spacer

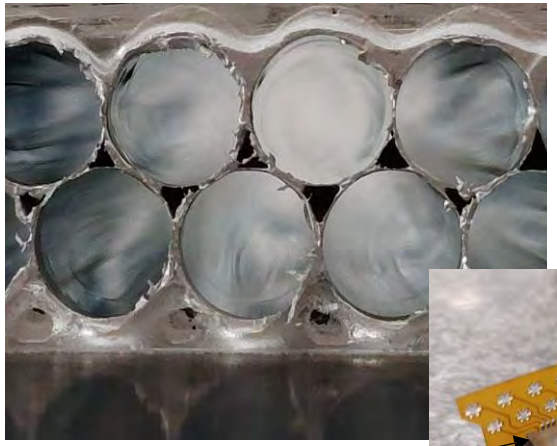
Tungsten wire 20 micron

Wiring (2/3): spacer and calibration





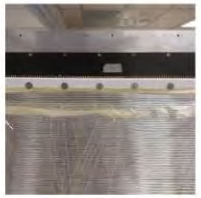
Wire tension measurements



(a) *Sealing the holes*

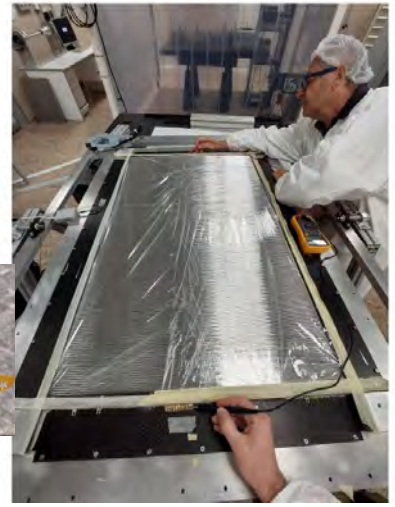
(b) *Adding an o-ring like seal*

(c) *Teflon mold*



(d) *Teflon mold*

Wire resistance measurements



Cable

Cables and electronics

SAND/TRACKER 2026

BO/FE/PI/PV

- Tracker design
- Front-end electronics development
- Design and construction of a full-scale Drift Chamber prototype
- Automated system design (wiring, soldering, etc.)
- Beam testing

PAVIA

- Collaborazioni con Bologna per la realizzazione prototipo camera a fili SAND (elettronica).

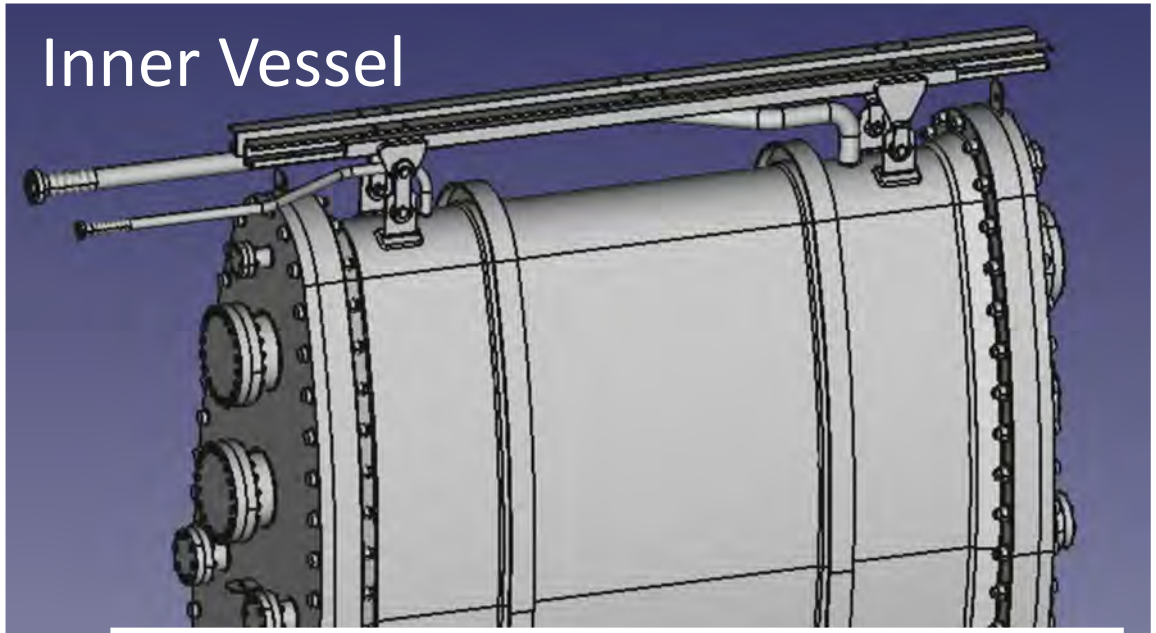
PISA

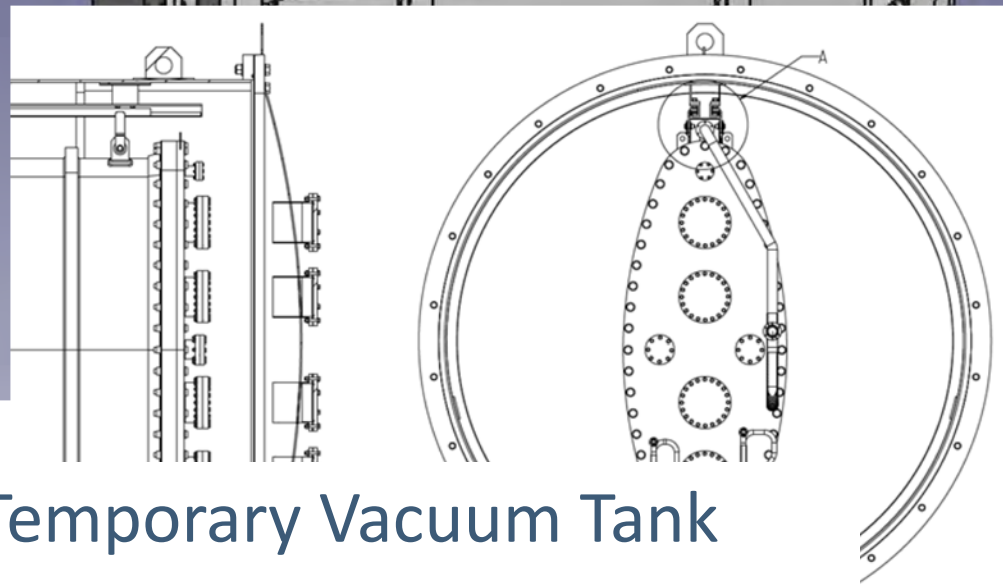
- Participation in the mechanical and the electronic design of the tracker.

SAND/GRAIN 2025 (BO, GE, LE, LNL, PD, TO)

- GRAIN Inner Vessel tendering (Ongoing)
- Prototypes of the electrical interconnections for the Inner Vessel (Ongoing)
- Proximity Cryogenics P&ID (New Design)
- Mockup Production for Thermoelectric Testing to be performed at LNL in 2026
- ARTIC: Recirculation System Completion and Installation
- Prototypes Construction
- Design of the ASIC and of the GRAIN readout
- Building and testing of detector prototypes at ARTIC

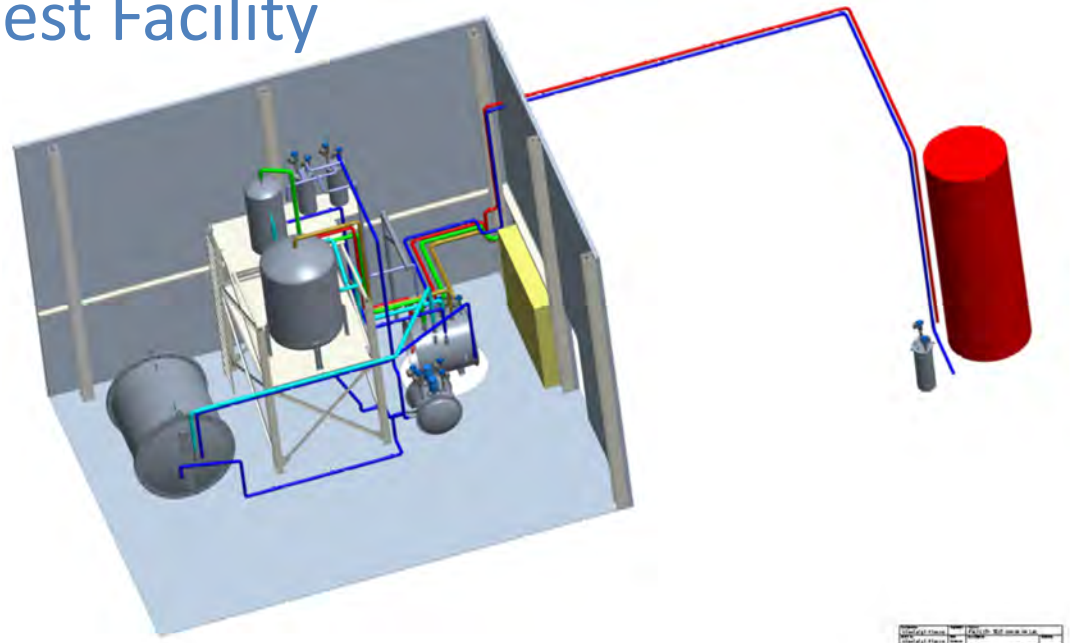
Inner Vessel

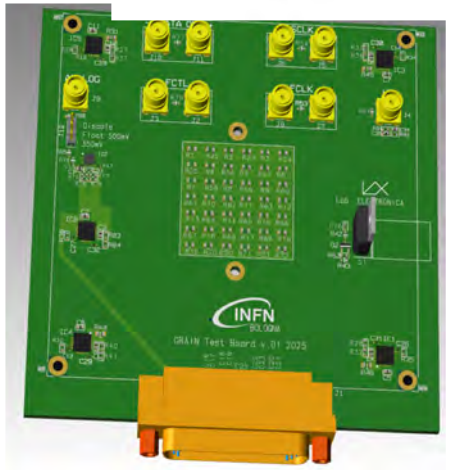




Temporary Vacuum Tank

LNL Test Facility





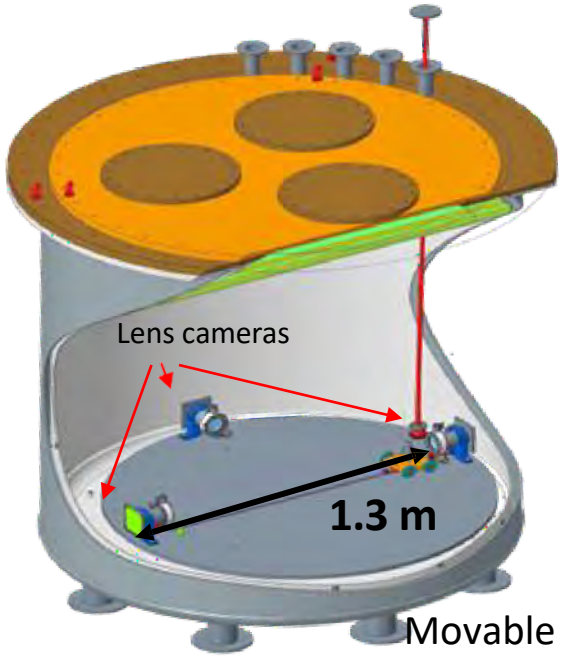
Mockup Camera Board

Feedthrough

Test con i sensori ottici basati su lenti e maschere

Per l'ottimizzazione del sensore sono necessari i test in ARTIC a Genova con l'elettronica ALCOR (16x16):

- Test con sorgente di luce artificiale INIZIATI
- Test con i cosmici (MUON TAGGER costruito dal gruppo di Lecce)



Movable system of the light source along a rail

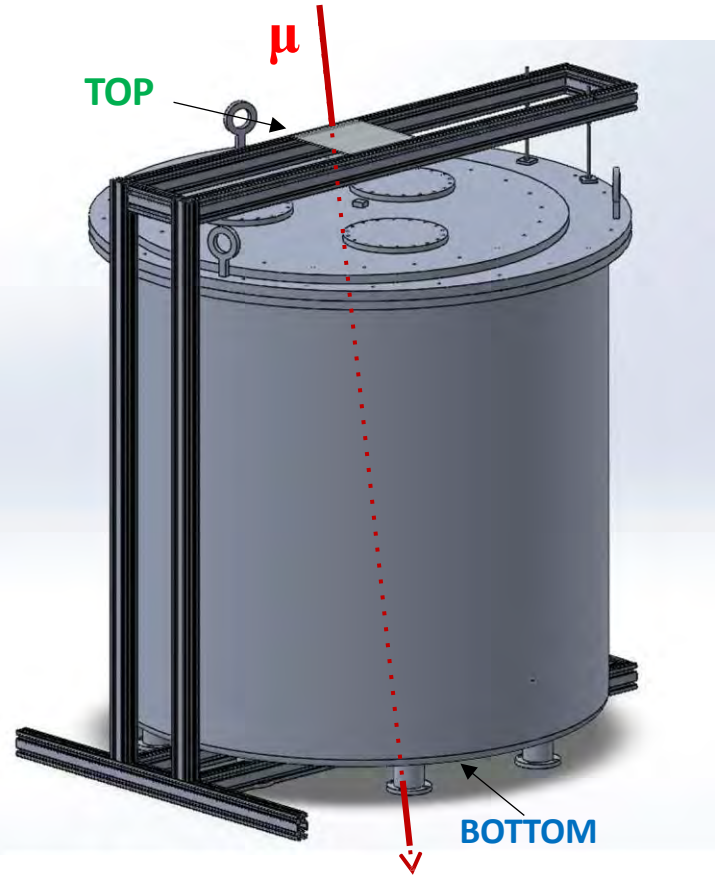
Hardware activities in 2024 / 2025

✓ **Realization of Cosmic Ray Tagger (CRT) for ARTIC @ GE**

… to provide a trigger and tracking device of cosmic muons for the image reconstruction setup of tracks in LAr

CRT Designed, assembled and tested in Lecce in 2024

✓ **Commissioning at end of July '24 at INFN-Genova**



CRT GOALS:

.Trigger for the LAr acquisition (fourfold coincidence)

.Two-view tracking to help the LAr event reconstruction

SAND/GRAIN Lecce

ARTIC cryostat was previously lifted to allow the placement of the CRT bottom arm

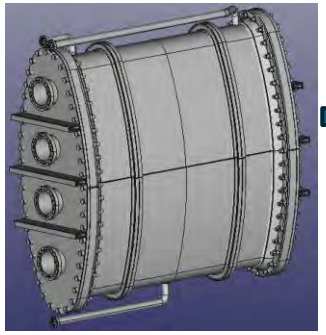
CRT commissioning

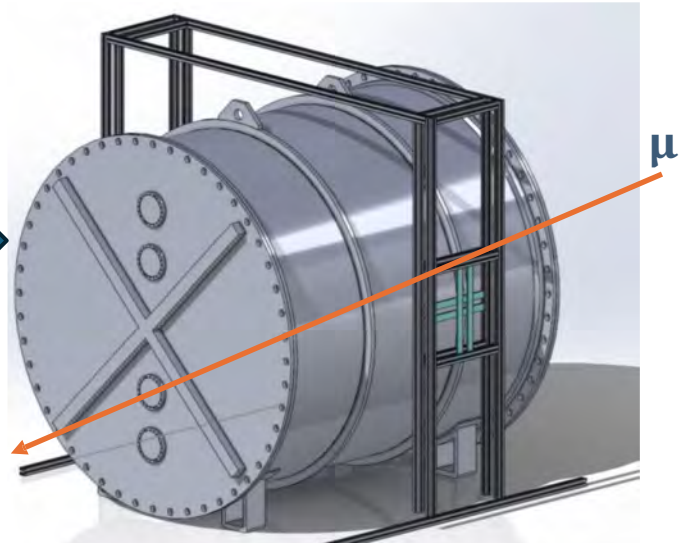
- Installed on ARTIC @ Genova in July
- Preliminary stand-alone test: OK
- Ready for ARTIC operations on next months

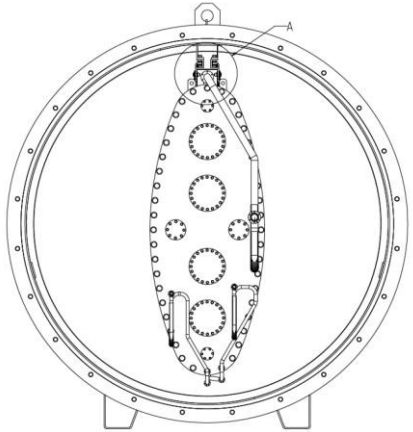
CRT for GRAIN full-size prototype @ LNL

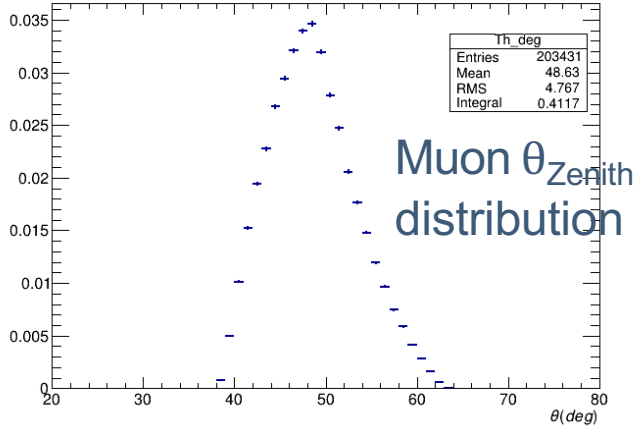
✓ Simulation and start of design of the new Cosmic Ray Tagger for LNL

GRAIN 1:1









Muon θ_{Zenith} distribution

Monte Carlo simulation with

- TOP & BOTTOM size: 68cm x 68cm
- (T-B) Horizontal Distance: 180 cm
- (T-B) Vertical-Distance: 160 cm

Cosmic muons on vertical surface A (one side):
Rate ≈ 44 μ /m²/s * A → **Rate(TOP) ~20 μ /s**

From the simulation:

- Geometry acceptance of (T+B): 0.02
- **Expected Muon Rate: ~ 0.4 Hz** (~1400 μ/h)

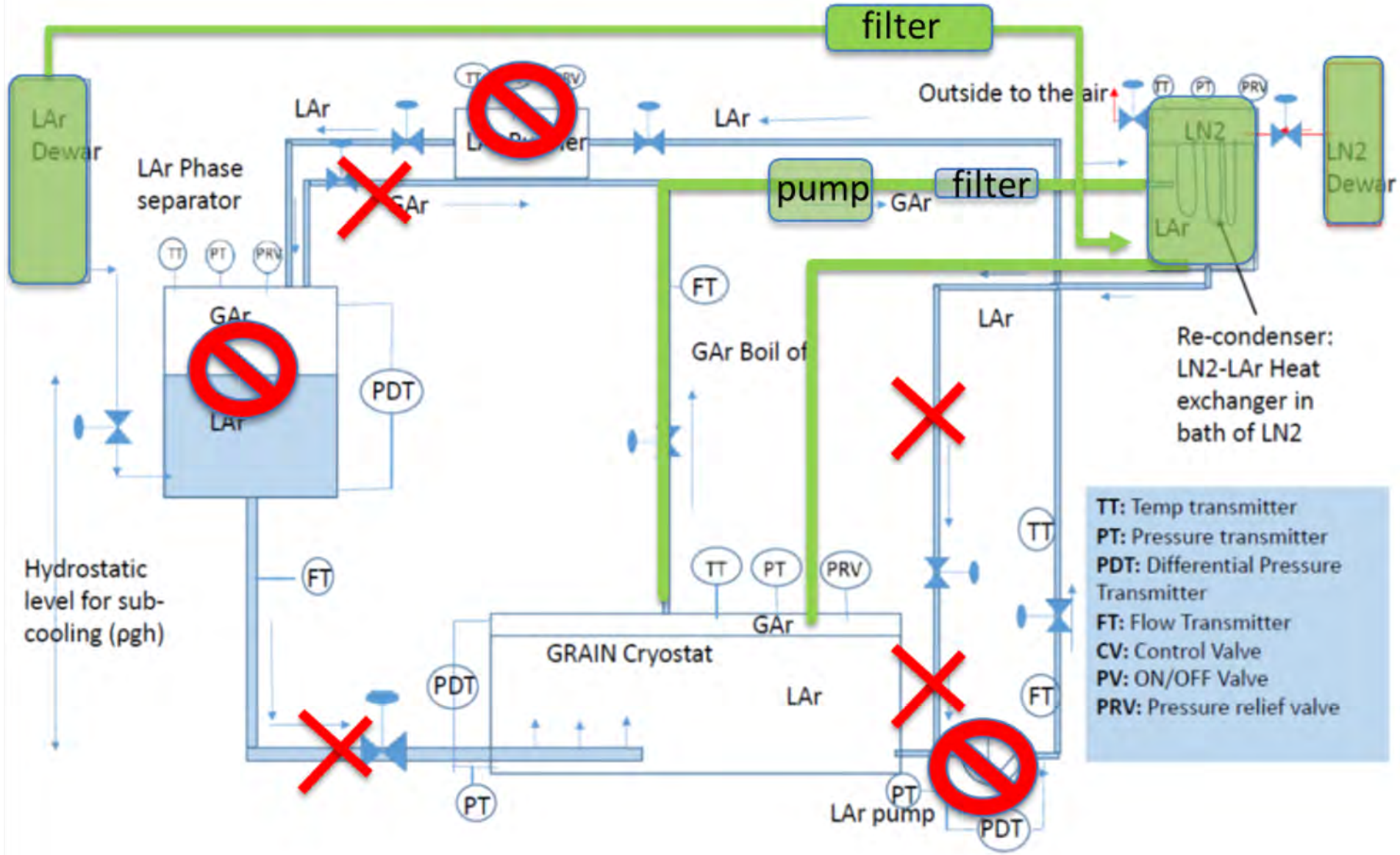
→ **~10^3 tracks /h** (for inefficiency, track reco, ..)

SAND/GRAIN 2026

BOLOGNA

- Gara per componenti criogenia di prossimità con design semplificato
- Sviluppo scheda di front end
- Sviluppo flange e cavi per la connessione Front End – Back End
- Prosecuzione delle attività connesse alla facility LNL e alla criogenia (Test Mockup)
- Disegno e costruzione del «camera frame» per Vessel Interno
- Prosecuzione studi di fattibilità di Vessel Esterno in composito
- Test in ARTIC

BSI – prosegue l'attività di sviluppo sensori backside illuminated (attività finanziata da CSN5, IBIS_NEXT)


filter
LAr Dewar
LAr
LAr Phase separator
LAr
Outside to the air
TT
PT
PRV
LN2
LN2 Dewar
pump
GAr
filter
LAr
GAr
FT
GAr Boil of
LAr
Re-condenser: LN2-LAr Heat exchanger in bath of LN2
PDT
LAr
Hydrostatic level for sub-cooling (ρgh)
FT
TT
PT
PRV
GAr
GRAIN Cryostat
LAr
PDT
FT
PT
LAr pump
PDT
TT: Temp transmitter
PT: Pressure transmitter
PDT: Differential Pressure Transmitter
FT: Flow Transmitter
CV: Control Valve
PV: ON/OFF Valve
PRV: Pressure relief valve

Simulazione e Analisi di SAND (BO,FE,GE,LE, RM1)2025/2026

- Studio prestazioni GRAIN
- Studio, ottimizzazione e confronto di opzioni alternative del tracciatore
- Sviluppo Kalman Filter per la ricostruzione di tracce
- Sviluppo di un software per la ricostruzione completa degli eventi in SAND
- Analisi di fisica con il rivelatore SAND (in corso: idrogeno solido, beam monitor, Heavvy Neutral Lepton, NSI)
- Sviluppo di un framework di ricostruzione e porting
- Studio calibrazioni

DAQ per SAND (BO, GE)

- Schede di timing acquistate e distribuite a SAND.
- Studio di integrazione di DUNE DAQ, DUNE timing system e prototipi

MILESTONES

PDS

- Completamento della produzione delle signal routing boards (seconda tranche) [31/12/2026]
- Completamento dei test di massa dei SiPM di FD1-HD presso le facility CACTUS [31/12/2026]
- Completamento dei test di massa della cold electronics di FD1-HD presso i LNS [31/12/2026]
- Deposizione del pTP per il 30% delle glass windows di FD2-VD [31/12/2026]

SAND

SAND/MAGNET Completamento del test a freddo del magnete (31 luglio 2026)

SAND/ECAL. : Revamping e test del 50% dei moduli del barrel. - 31 ottobre 2026

A commento dell'ultima milestone: l'analoga MS del 2025 verrà soddisfatta al 50% (quindi 25% dei moduli) perché si è reso necessario un revamping più profondo (incamiciamento in acciaio invece di tape), che necessita di appositi tools preparatori. Pensiamo quindi di arrivare al 50% dei moduli per la fine del prossimo anno.

MILESTONES

SAND/GRAIN

- Costruzione e test Inner Vessel 31 ottobre 2026
- Sottomissione del primo run dell'ASIC di GRAIN (DENEB) alla fonderia OTTOBRE 2026
- Validazione del funzionamento delle lenti con readout a 256 canali e inizio ingegnerizzazione del sistema in GRAIN DICEMBRE 2026

SAND/TRACKER

- Progetto meccanico delle due soluzioni (STT/ Drift) e della struttura di supporto per il montaggio nel calorimetro: Dicembre 2026
- Definizione dell'elettronica di FE Dicembre 2026