
ATTIVITA' E PREVENTIVI GRUPPO SND@LHC NAPOLI

Antonia Di Crescenzo
per il gruppo SND@LHC di Napoli

- 9 Luglio 2024 -

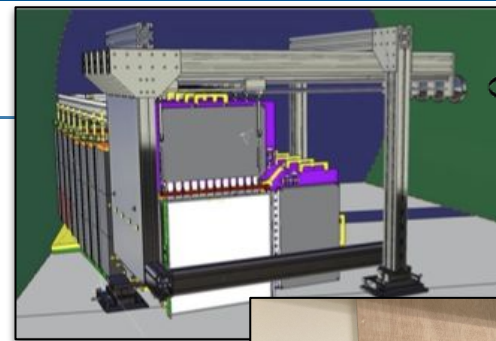


OUTLINE

- Responsabilità e ruolo del gruppo in SND@LHC
- Attività **2024**
 - Assemblaggio e sostituzione wall, sviluppo emulsioni
 - Installazione nuovi microscopi (Napoli e CERN)
 - Scanning e analisi delle emulsioni nucleari
 - Ottimizzazione processamento dati e ricostruzione
 - Progettazione meccanica e realizzazione modifiche per upgrade Veto
- Attività **2025**
 - Assemblaggio e sostituzione wall, sviluppo emulsioni
 - Scanning e analisi delle emulsioni nucleari
 - Ricerca di interazioni di neutrino in emulsione
- Riepilogo richieste

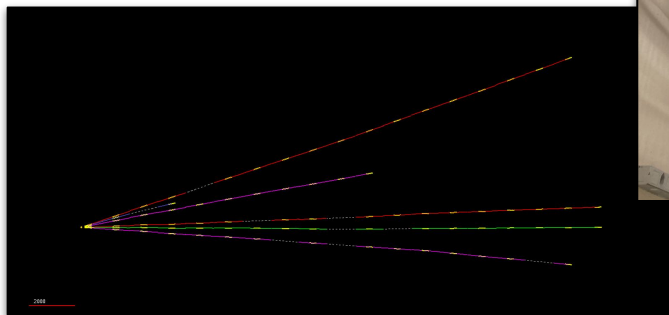
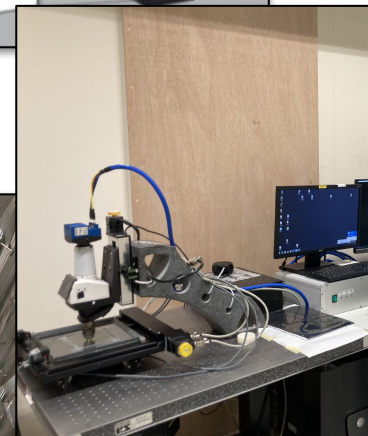
NA GROUP RESPONSIBILITIES

- Spokesperson (G. De Lellis)
- Physics coordinator (A.Di Crescenzo)
- Convener microscopy and emulsion scanning (A. Alexandrov)
- Convener software for emulsion data reconstruction (V.Tioukov)
- Convener emulsion target system (S.Buontempo, A. Di Crescenzo)



HIGHLIGHTS OF PAST YEARS ACTIVITIES (2021-2023)

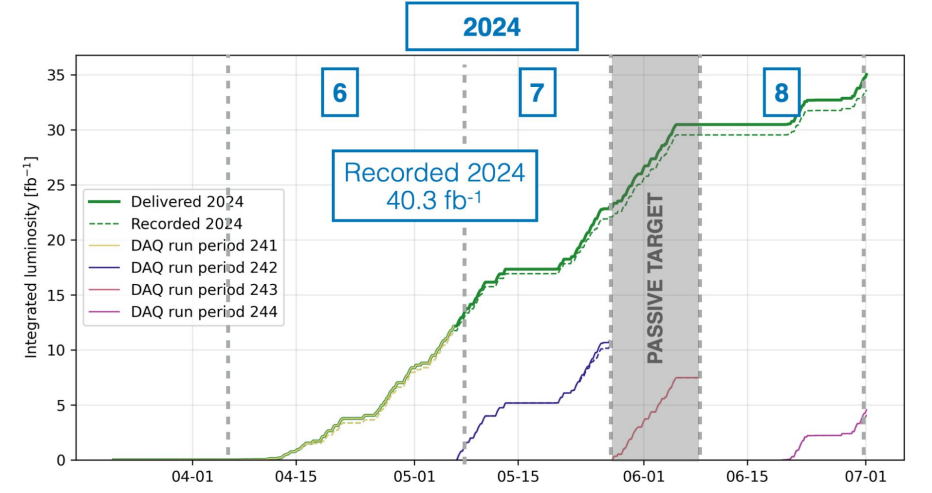
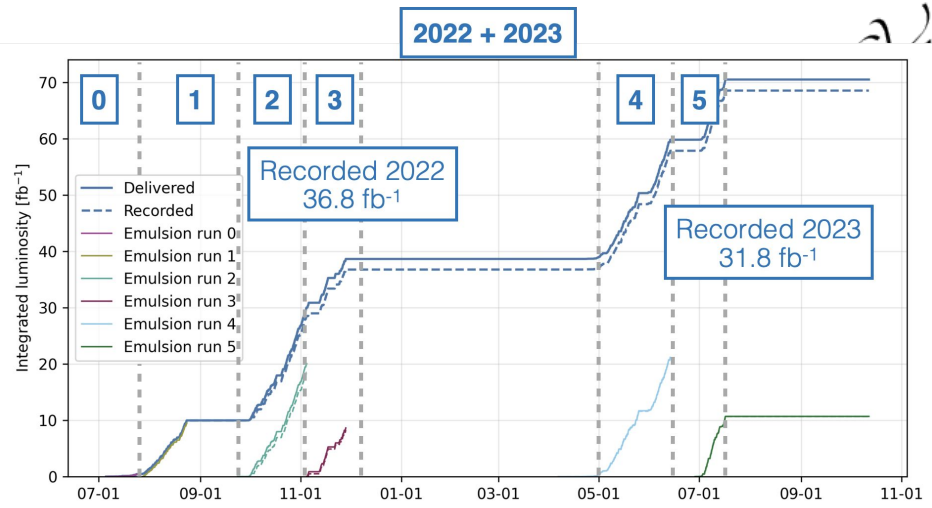
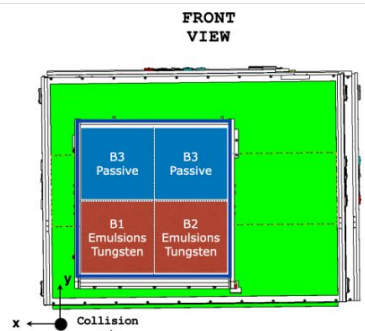
- Design and construction of target mechanical structure
- Installation and operation of emulsion facility at CERN
- Emulsion target assembly and replacement
- Emulsion film development
- Installation and operation of emulsion scanning stations
- Development of new tools for emulsion data analysis



ATTIVITA' 2024

DATA TAKING

- **68.6 fb⁻¹** integrated in **2022** and **2023**
 - Five emulsion target replacements
 - Upper limit for each target: 20 fb⁻¹ to keep muon density <5x10⁴ tracks/cm²
- New strategy in **2024** due to unexpected (factor 2) increase in the muon flux
 - Instrumentation of half target to maximise signal/noise ratio
 - Upper limit for the exposure: 12 fb⁻¹
 - One full target + two half targets exposed
 - **40.3 fb⁻¹** integrated up to now
 - Six additional half-targets to be exposed



EMULSION TARGET #6

- Full target: five Emulsion/Tungsten walls
- Total mass: **797 kg**
- Number of emulsion films: **1140** (100% Nagoya)
- Target assembly: March 16th-19th
- Target installation: **March 20th**
- Target extraction: **May 6th**

Integrated luminosity: 12.1 fb⁻¹



Emulsion target transportation



Emulsion target replacement team



Emulsion target installation

EMULSION TARGET #7 and #8

- Semi-target: five half walls (50% equipped with emulsions, 50% passive)
- Total mass: **398 kg**
- Number of emulsion films: **570** (100% Nagoya)

EMULSION TARGET #7

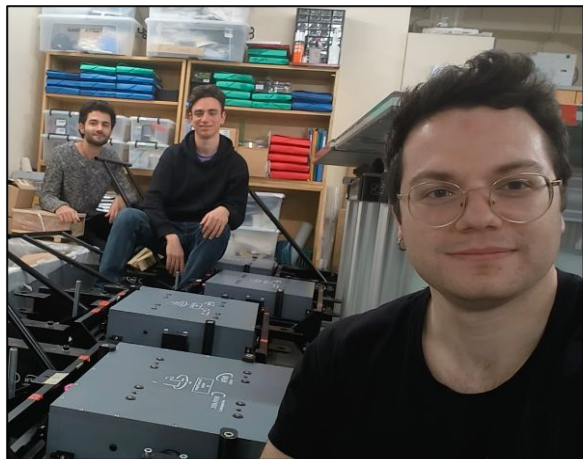
- Target assembly: May 20th-22nd
- Target installation: **May 27th**
- Target extraction: **June 13th**

Integrated luminosity: 7.5 fb⁻¹

EMULSION TARGET #8

- Target assembly: June 10th-13th
- Target installation: **June 13th**
- Target extraction: **July 8th**

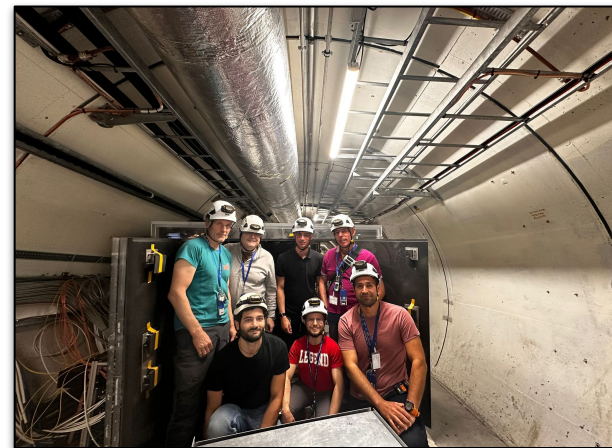
Integrated luminosity: 9.8 fb⁻¹



Emulsion target assembly



Emulsion target installation



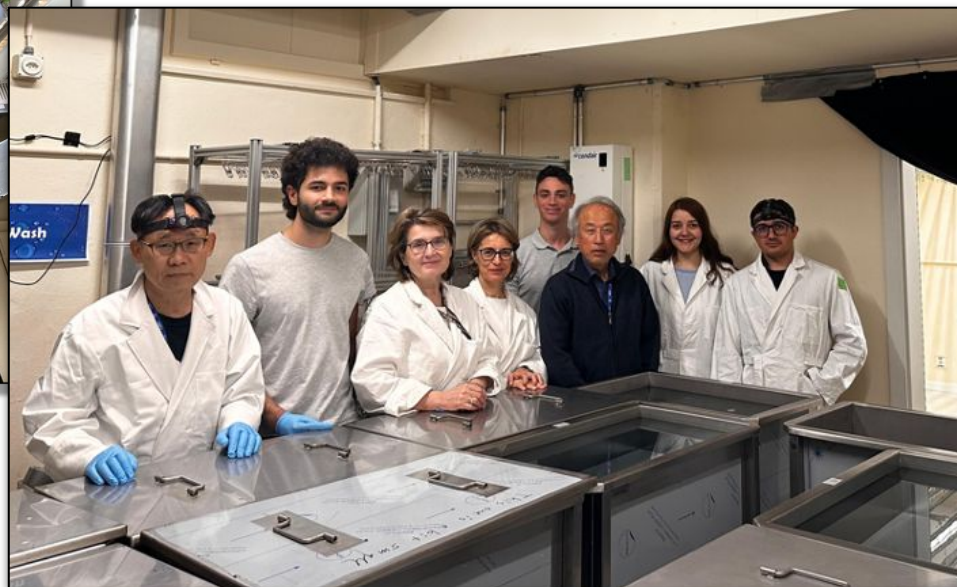
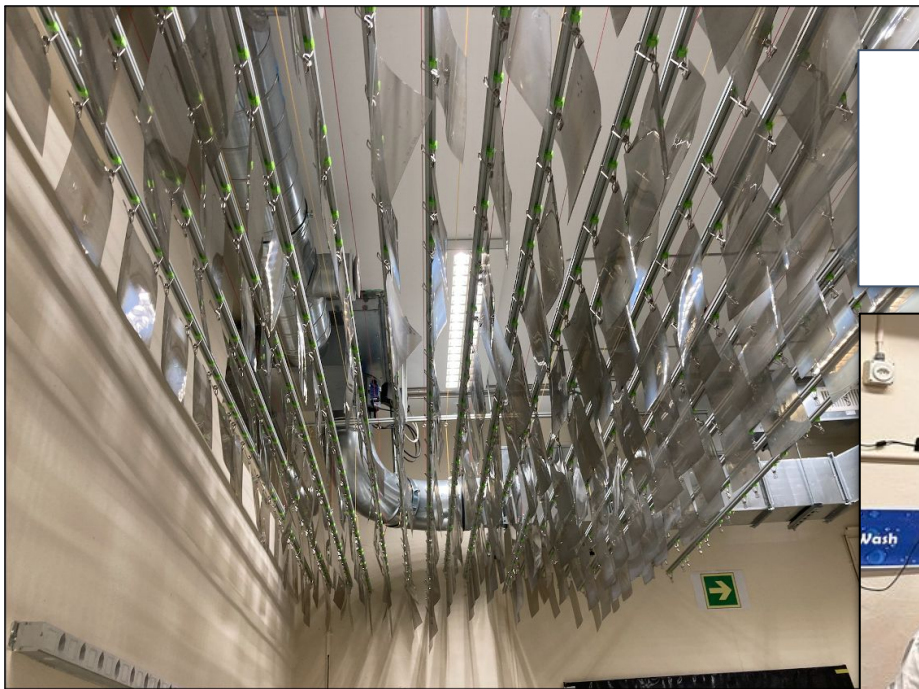
Emulsion target replacement team

EMULSION FACILITY

A. Lauria, M.C. Montesi



- **40 walls** assembled (15 in 2024)
- **8000 emulsion** films developed (3000 in 2024)
- **300 m²** emulsion films developed (110 m² in 2024)



MICROSCOPY

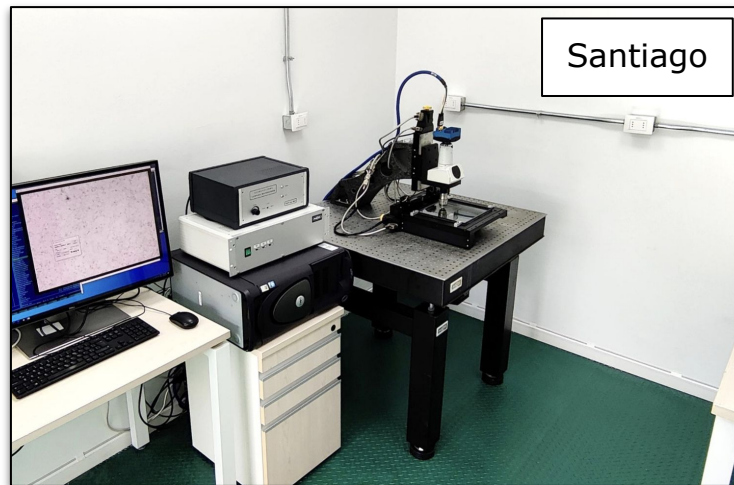
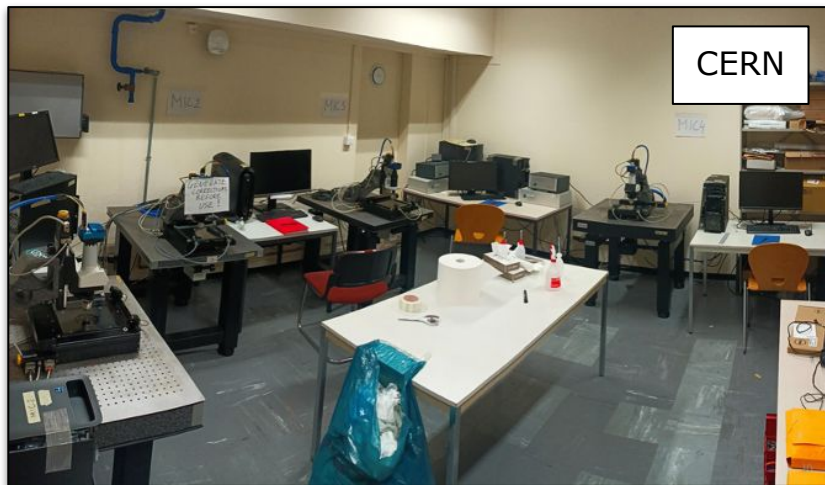
A. Alexandrov

Scanning stations in the Collaboration

- 1) **Bologna:** 2 systems taking data
- 2) **CERN:** 4 systems taking data (+3)
- 3) **Napoli:** 3 systems taking data (+1)
- 4) **Santiago:** 1 system ready to take data (+1)

Relevant improvements in **2024:**

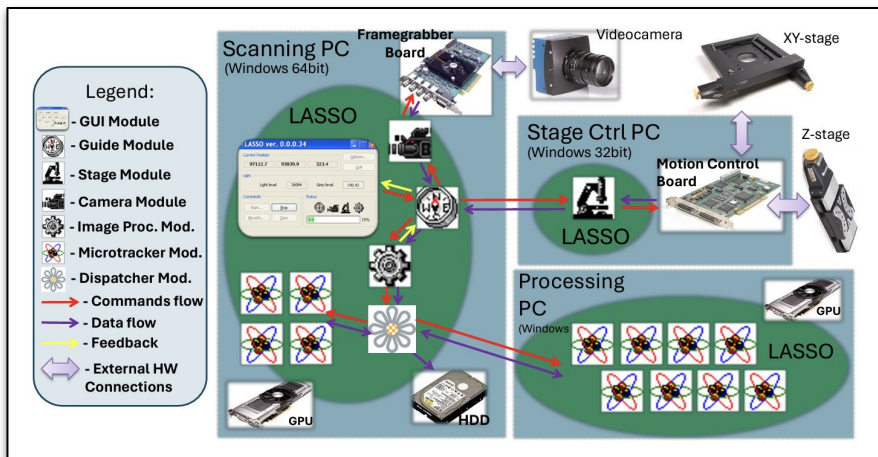
- Installation of three additional scanning systems at CERN
- Installation of scanning system in Santiago de Chile



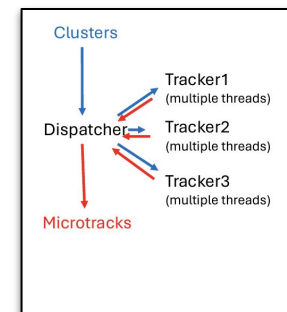
EMULSION SCANNING

A. Alexandrov

- Development and installation of **distributed dispatcher** for the emulsion data processing
- Boost in the scanning rate:
 - **factor two increase**: from 1 to 2 films/day/system
 - scanning time independent from the integrated luminosity
 - scanning of high luminosity (signal enriched) targets started
- Requirements: one dedicated workstation (*DELL Precision 7875 Tower*) and two GPUs (*MSI Ge Force RTX 4070*) per each pair of scanning systems, switch with 48 1-Gb + 8 10-Gb sockets, 10 Gb fiber line



- Dispatcher splits incoming cluster flux and redirects views into different Trackers for processing
- A Tracker uses multiple threads and GPUs to reconstruct microtracks
- The resultant microtrack flux is sent back to Dispatcher
- Dispatcher aggregates microtracks view-by-view in the original order (and sends the microtracks flux further or saves it to the hard disk)

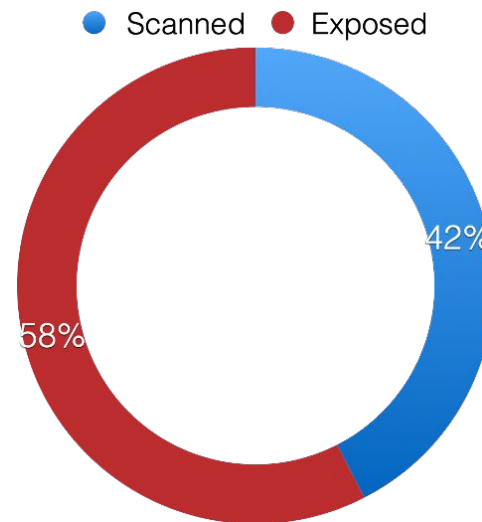




SCANNING STATUS - 2022 DATA

		EMU	LAB	SCAN	RECO	ANALYSIS
RUN1 (9.5 fb ⁻¹)	W1	S	Lebedev	✗		
	W2	N	Napoli	✓	✓	🔄
	W3	S	Napoli	✗		
	W4	N	CERN	✓	✓	🔄
	W5	S	Bologna	✓	🔄	
RUN2 (20.0 fb ⁻¹)	W1	N	Bologna	✗		
	W2	N	CERN	🔄 90%		
	W3	N	Napoli	🔄 36%		
	W4	N	CERN	🔄 4%		
	W5	N	Napoli	✗		
RUN3 (8.6 fb ⁻¹)	W1	N	CERN	🔄 16%		
	W2	N	Bologna	🔄 16%		
	W3	N	Napoli	🔄 25%	🔄	
	W4	N	Napoli	🔄 60%	🔄	
	W5	S	CERN	🔄 50%	🔄	

S = Slavich N = Nagoya ✗ Not started 🔄 In progress ✓ Completed

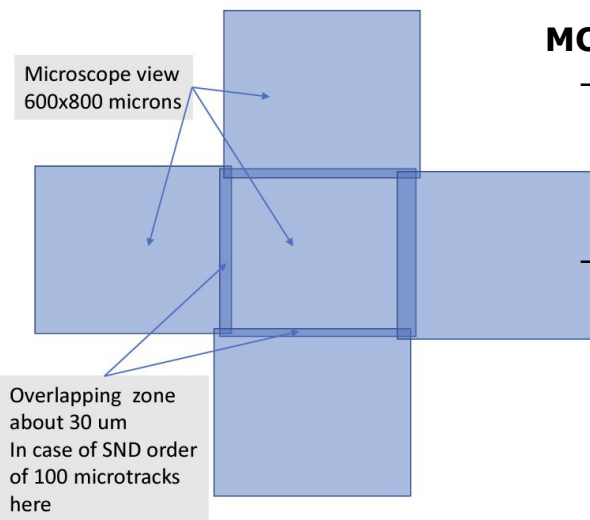


45% of exposed films scanned
15 fb⁻¹
 (+6 fb⁻¹ in the last two months)

EMULSION DATA RECONSTRUCTION

- Relevant improvements in the data reconstruction:
 - optical distortions corrected by applying distortion matrix
 - frame-to-frame vibrations corrected online using cluster shadows
 - limiting factors: mechanical deterioration, encoder problems, thermic excursions, stage vibrations
 - Innovative method allowed to improve the position resolution by one order of magnitude

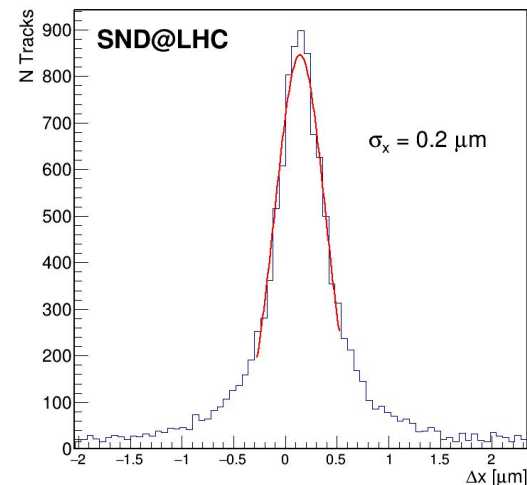
V. Tioukov



MOSAIC ASSEMBLY

- Use microtracks found twice in the overlapping regions to align views to each other in each emulsion layer
- Require about 3×10^5 separate alignments per each SND@LHC plate scanning

POSITION RESOLUTION $0.2 \mu\text{m}$



EM SHOWER SEARCH

V. Tioukov, F. Alicante

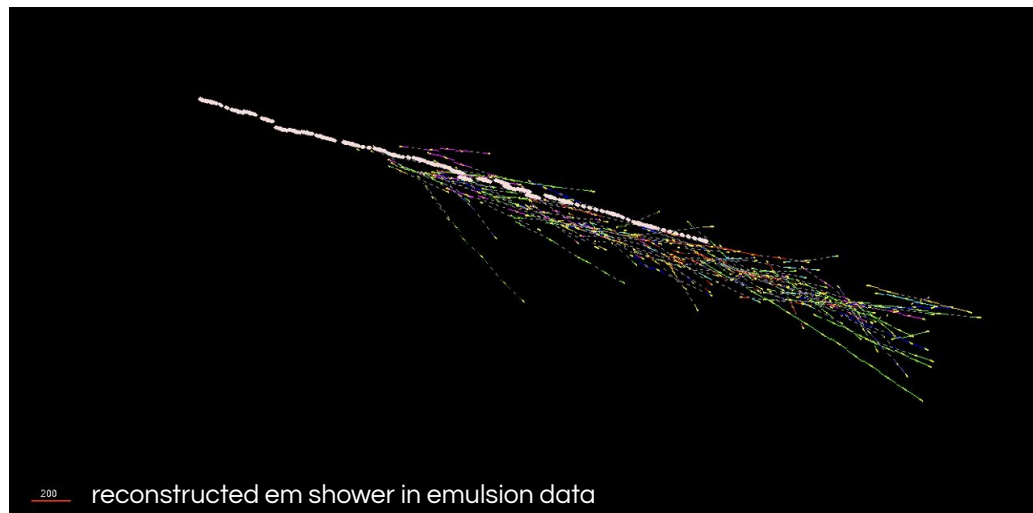
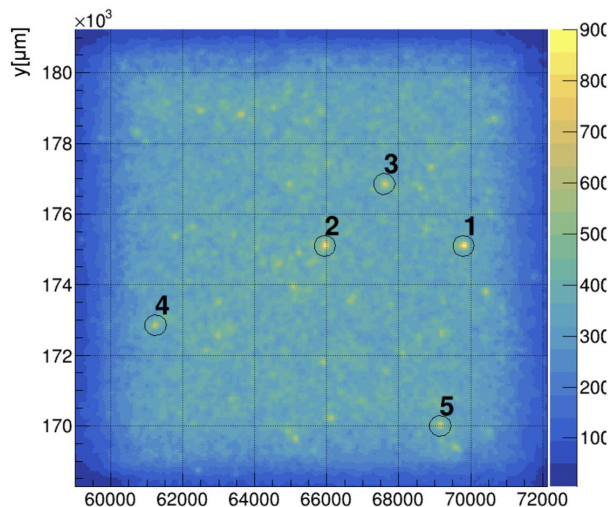


Strategy

- Identify regions of high track density in the emulsions
- Consistent with the expectation of electromagnetic shower development
- Search for neutral vertices associated to identified showers

Status

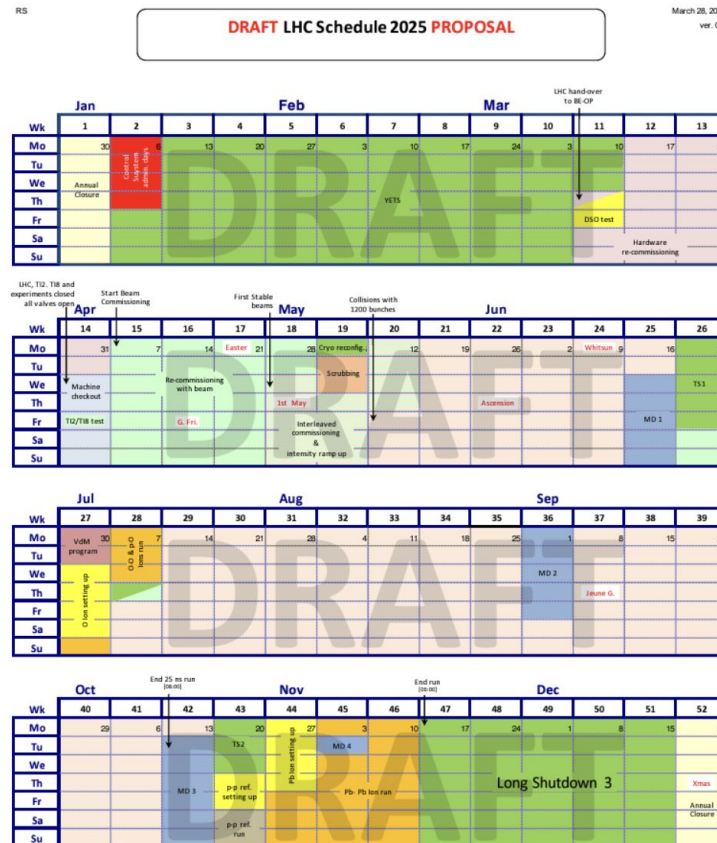
- Electromagnetic shower patterns identified
- Rejection of passing muons ongoing
- Vertex association ongoing



ATTIVITA' 2025

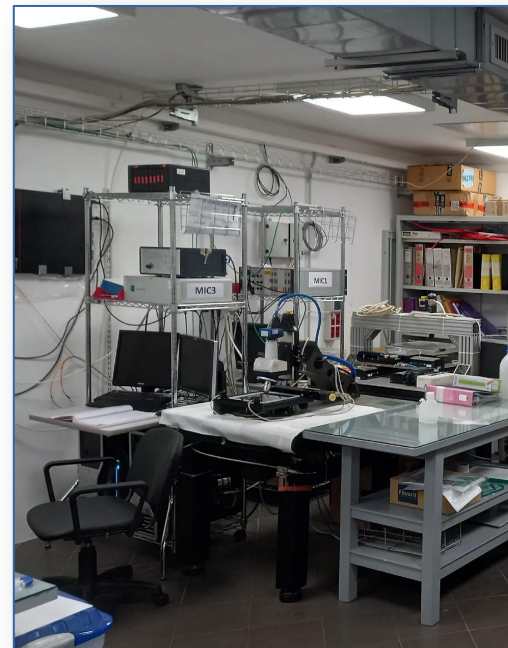
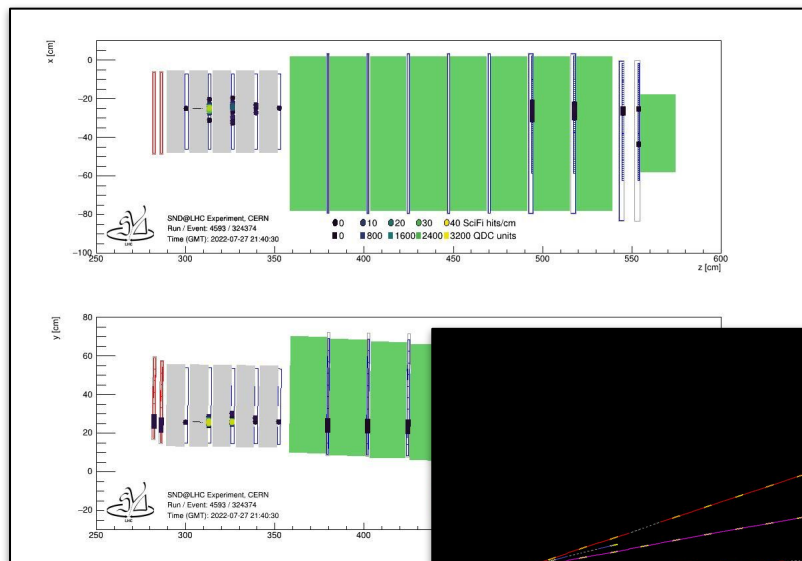
TARGET INSTALLATION AND DEVELOPMENT

- About 90 fb^{-1} (123 days pp run) expected in 2025
- From 4 to 5 full targets depending on the muon flux
- Target assembly and replacement
- Emulsion development



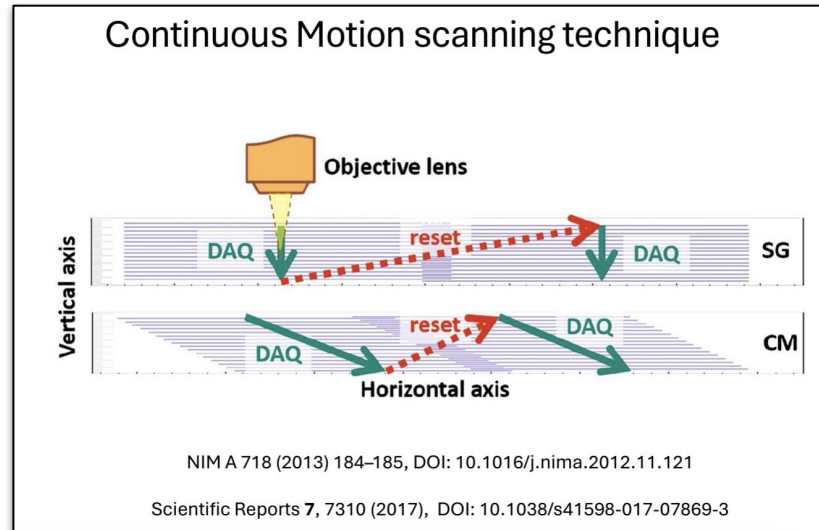
EMULSION DATA ANALYSIS

- Emulsion scanning with optical microscopes
- High-resolution track and vertex reconstruction
- Development of analysis tools for background rejection
- Neutrino interaction search
- Global event reconstruction



EMULSION SCANNING

- Improvement in the scanning rate aiming at **3-4 films/day/mic**
- Use **Continuous Motion** (CM) technique with SND@LHC films
- Development of new scanning and reconstruction software for film scan in CM mode



NAPOLI SCANNING LABORATORY

Hardware upgrade consists in:

- Nikon Objective (20X)
- Camera and framegrabber
- DELL Workstation for the data processing

All other components inherited from European Scanning System (ESS) used for OPERA since 2004

Intensive usage of microscopes in the last year caused several damages to:

- XY stages
- Z axis
- old computers hosting the graphic card
- illumination system
- power supplies

New components urgently needed, spares from OPERA are running out

**motorized Z-axis
REQUIRED**

11 k€

**new XY stage funded
by INFN in 2024**





PEOPLE

Ricercatori: 32 **(+1)**

Tecnici: 1

Totale FTE: 23.15 **(+6.35)**

Totale PhD equivalent: 25 **(-)**

COGNOME	NOME	FTE
Acampora	Giovanni	0,7
Albanese	Raffaele	0,7
Alexandrov	Andrey	0,8
Alicante	Fabio	1
Arpaia	Pasquale	0,6
Bangaru	Nayana	1
Buontempo	Salvatore	0,1
Canale	Vincenzo	0,25
Centanni	Daniele	1
Davino	Daniele	0,7
de Asmundis	Riccardo	0,3
De Benedetto	Egidio	0,6
De Lellis	Giovanni	1
de Magistris	Massimiliano	0,7
Di Crescenzo	Antonia	1
Fresa	Raffaele	0,7
Krzempek	Lukasz	1
Lantwin	Oliver	1
Lauria	Adele	0,6
Loschiavo	Vincenzo Paolo	0,7
Miano	Andrea	0,7
Montesi	Maria Cristina	0,5
Prota	Andrea	0,7
Quercia	Antonio	0,7
Sadykov	Zhakypbek	1
Scalera	Valentino	0,7
Sekhniaidze	Givi	0,2
Tioukov	Valeri	0,8
Vilela	Cristovao	1
Visone	Ciro	0,7
Vitiello	Autilia	0,7
Yazici	Ceren	1
Totale		23,15



RICHIESTE 2025 NAPOLI

1 mu = 4k€

MISSIONI: **247 k€**

- Metabolismo ITA (1 k€/FTE)+ EU(1 mu/FTE): **23 k€ + 92 k€**
- Spokesperson: **4 mu**
- Physics coordination: **4 mu**
- Sostituzione bersaglio: **2.5 mu** (2 su/cambio x (4 cambi+1 estrazione))
- Assemblaggio wall: **3 mu** (3 su/cambio x 4 cambi)
- Sviluppi emulsioni: **5 mu** (5 su/cambio x 4 cambi)
- Test beam rivelatore a silicio: **2 mu**
- Doctoral student: **50 k€**

CONSUMO: **111 k€**

- Metabolismo (1.5 k€/FTE): **34.5 k€**
- Materiale handling emulsioni: **2.5 k €**
- Apparato di scansione: **4 k€**
- Prototipo e dimostratore rivelatore a silicio per test beam (20 stazioni) **70 k€**

APPARATI: **11 k€**

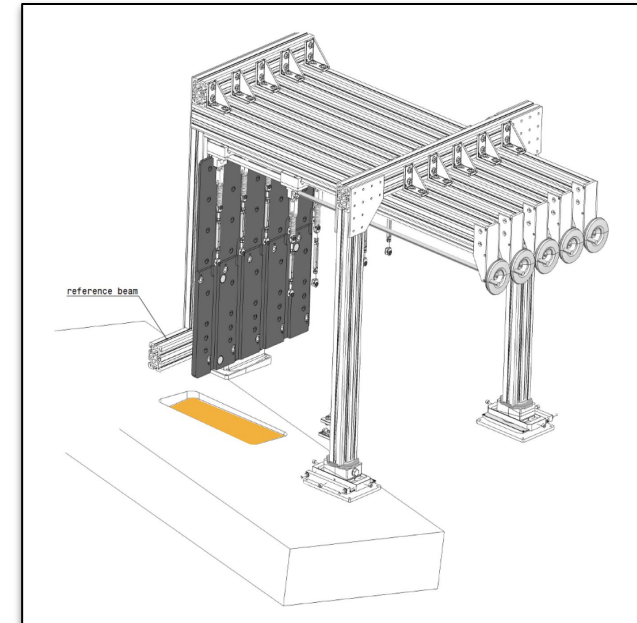
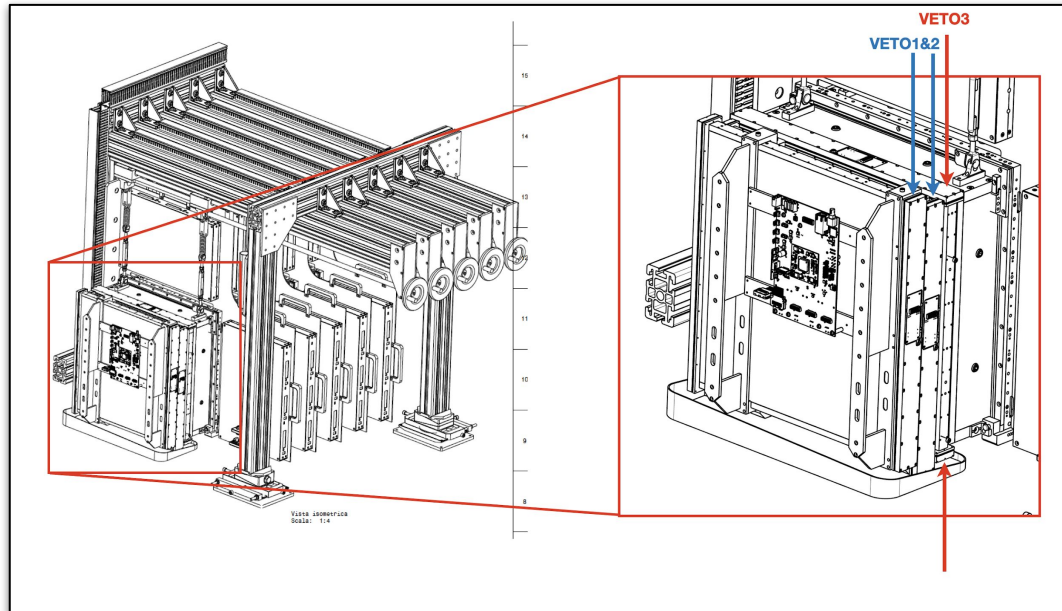
- Asse Z motorizzato: **11 k€**

BACKUP

UPGRADE OF THE VETO SYSTEM

G. Passeggio

- Design of the mechanical support for the third Veto plane
- Upgrade of the target system mechanics
- Definition of requirements for excavation in the tunnel floor



EMULSION PROCUREMENT IN 2024

Nagoya emulsions

- Shipment #1: **46 m²** (delivered on February 26th)
- Shipment #2: **45 m²** (delivered on April 23rd)
- Shipment #3: **45 m²** (delivered on May 31st)
- Shipment #4: **45 m²** (delivered on July 1st)

- Shipment #5: expected by August 3rd



Emulsion shipment #1



Emulsion shipment #3

Emulsion shipment #2

PEOPLE 2024

Ricercatori: 31 **(+1)**

Tecnici: 1

Totale FTE: 16.8 **(+3)**

Totale PhD equivalent: 25 **(+1)**

Officina meccanica: 3 m.u.

Progettazione meccanica: 1.5
m.u.

COGNOME	NOME	FTE
Acampora	Giovanni	0,4
Albanese	Raffaele	0,5
Alexandrov	Andrey	0,3
Alicante	Fabio	1
Arpaia	Pasquale	0,4
Asada	Takahashi	0,3
Buontermppo	Salvatore	0,1
Canale	Vincenzo	0,3
Centanni	Daniele	1
Davino	Daniele	0,5
de Asmundis	Riccardo	0,2
De Lellis	Giovanni	0,4
de Magistris	Massimiliano	0,5
Di Crescenzo	Antonia	0,5
Fiorillo	Antimo	0,5
Fresa	Raffaele	0,5
Ilieva	Simona	1
Krzempek	Lukasz	1
Lantwin	Oliver	1
Lauria	Adele	0,2
Loschiavo	Vincenzo Paolo	0,5
Miano	Andrea	0,5
Montesi	Maria Cristina	0,2
Prota	Andrea	0,6
Quercia	Antonio	0,5
Sadykov	Zhakypbek	0,7
Scalera	Valentino	0,8
Sekhniaidze	Givi	0,2
Tioukov	Valeri	0,3
Vilela	Critovao	1
Visone	Ciro	0,5
Vitiello	Autilia	0,4

RICHIESTE 2024 NAPOLI

MISSIONI: **210 k€**

- Metabolismo ITA (1 k€/FTE)+ EU(1 mu/FTE): **16.8 k€ + 67.2 k€**
- Spokesperson: **4.0 mu**
- Physics coordination: **4.0 mu**
- Sostituzione bersaglio: **2.5 mu** (2 su/cambio x (4 cambi+1 estrazione))
- Assemblaggio wall: **3 mu** (3 su/cambio x 4 cambi)
- Sviluppi emulsioni: **3 mu** (3 su/cambio x 4 cambi)
- **2 mu** (3 su/cambio x 4 cambi) (**EX BARI**)
- Modifiche meccanica per upgrade Veto: **0.5 mu**
- Doctoral student: **50 k€**

CONSUMO: **31.5 k€**

- Metabolismo (1.5 k€/FTE): **25 k€**
- Materiale handling emulsioni: **2.5 k €** (**EX BARI**)
- Apparato di scansione: **4 k€**

APPARATI: **12 k€**

- Stage XY: **12 k€**