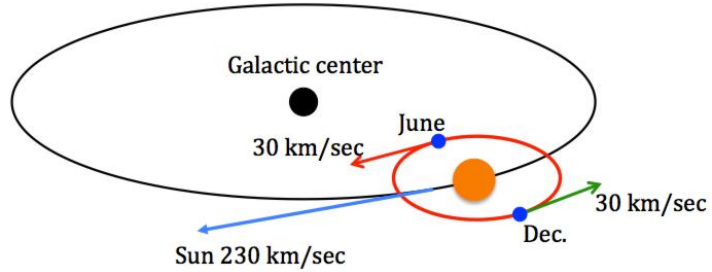
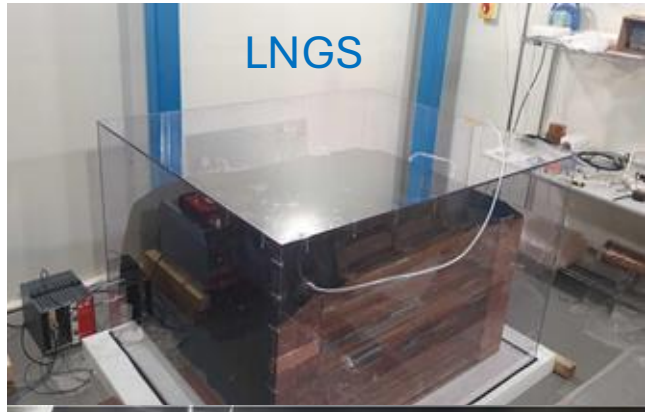
Esperimento: SABRE

Responsabile Locale: Davide D'Angelo



Scopo e Status dell'esperimento

- Verifica del risultato di DAMA (modulazione annuale del rate interpretabile come interazione di materia oscura ?) con un nuovo array di cristalli ultra-puri di NaI(Tl) a LNGS e in Australia. Range energetico: [1-6] keV
- Fase CSN2: R&D 2015-2021; Validazione: 2022-2024; Costruzione: 2025-2027
- Sfida sperimentale: ottenere un background rate ~ 0.5 cpd/kg/keV, i.e. < DAMA
- Strategia: crescita dei cristalli dopo Zone Refining (ZR) presso Mellen (USA).
- **Primo cristallo full size dopo ZR (NaI-42) ready. Will ship to LNGS next week.**
- Nel 2026 cambio di supplier per la polvere di NaI da Merk (Astrograde) a Cosine collaboration.
- Obiettivo: array di 9 cristalli, da 5 kg ciascuno in schermatura passive.



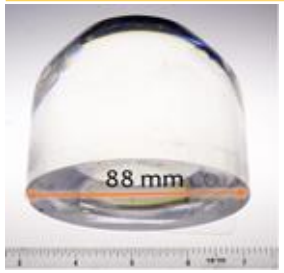
Radiopure NaI(Tl) crystals

- Background ~1 cpd/kg/keV → at the level of DAMA/LIBRA Phase 1
- Used for Proof-of-Principle phase
- Best crystal after DAMA, until now

grown from chunks, enabling zone refining

Boston, MA (USA) of powder from COSINE-200: 0.39 mBq/kg ^{210}Pb, best crystal so far!

2015



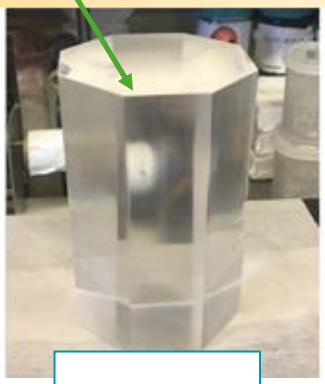
First high purity growth

2018

NaI-31

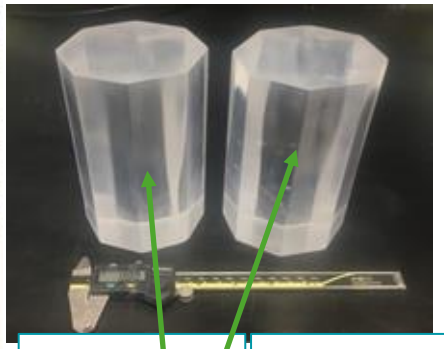
First full size

2019



NaI-33

2022



NaI-35

NaI-37

Reproducibility of clean growth within factor 2

2023

NaI-41

2025

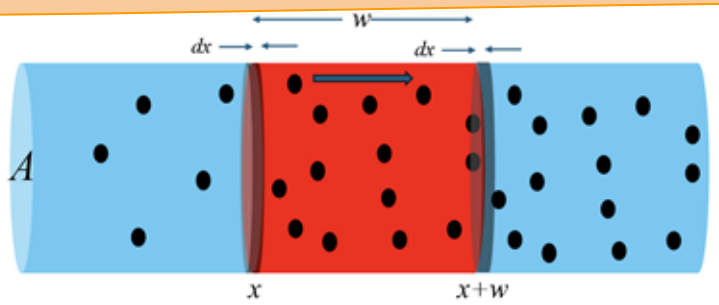
NaI-47

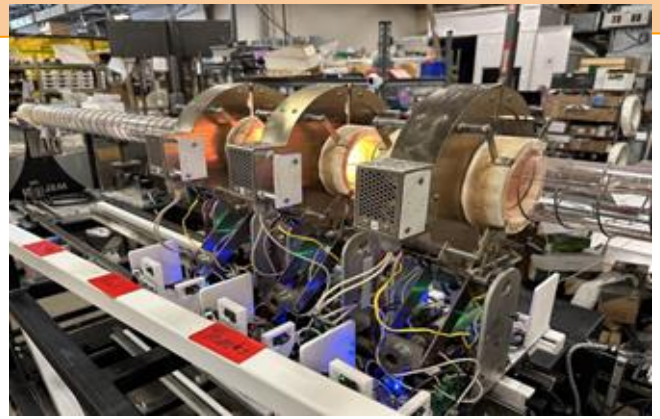
2026

NaI-42

- first crystal from Zone Refined material
- First of the physics array

Zone Refining

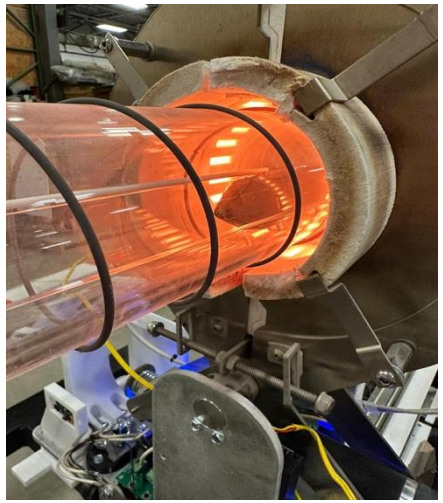




MELLEN

Concord, NH (USA)

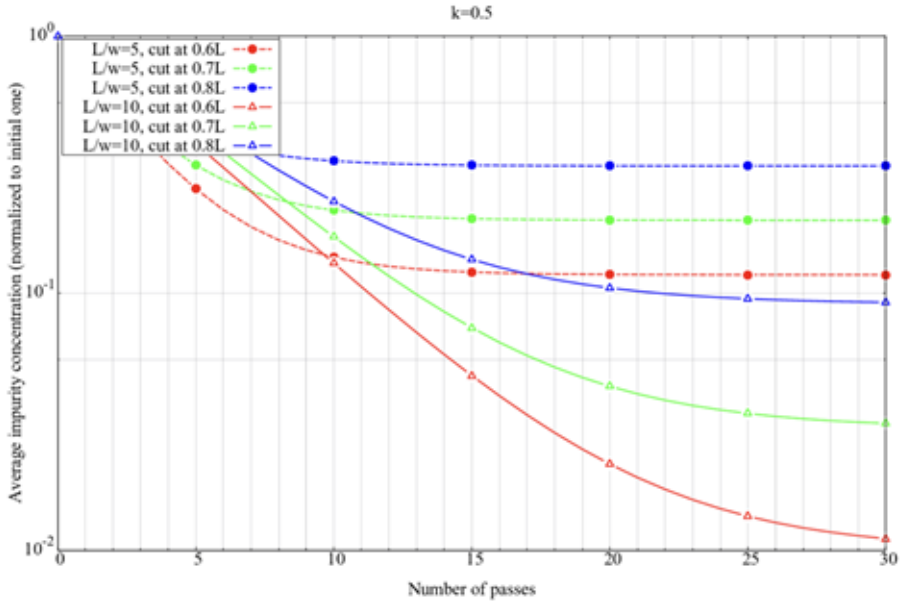
- Most impurities prefer the liquid phase
- A moving molten zone “pushes” the impurities to one end, later discarded
- Unique machine with the three annular furnaces
- Multiple passes at tunable speed
- 3 x 4-kg runs needed for 1 ingot, i.e. 6 weeks / crystal
- Finalized anti sticking procedure with SiCl4 gas



ZR RUN	Mass [kg]	^{39}K in powder [ppb]	^{39}K after ZR [ppb]
ZR-011	2	6.8	1.6
ZR-012	1.9	8	1.9
ZR-013	2	8	1.9
ZR-014	3	6.8	1.6
ZR-015	3.8	17.7	2.5

ICP-MS @ Seastar

Developed a mathematical model to describe the ZR purification process: **arXiv:2601.15998**, submitted to JINST



Milano crew and activities

Nome	Afferenza	FTE
Davide D'Angelo	Unimi, PA	0.4
Valerio Toso	Unimi, AdR	0.3
Fabrizio Armani	Unimi (PRIN), Adr	1.0
Totale		**1.7**

Richieste economiche per il 2027 (to be defined)

Missioni: ~ 10 k
Consumo: ~ 5 k

Servizi: nessuna richiesta

Activities:

- Supporto ai run a LNGS
- Sviluppo sw di ricostruzione e analisi dati
- Responsabilità del DAQ
- Coordinamento ditte RMD e Mellen per Zone Refining e crescita cristalli
- Management

Remembering Frank Calaprice

The Frank Paul Calaprice Memorial

took place on Friday 29 May 2026

at Princeton University

The SABRE collaboration remembers the invaluable contributions of Professor Frank Calaprice, who played a fundamental role in shaping the SABRE experiment.