

# SABRE @ LNGS

10th Astroparticle Physics Scienc Fair

GSSI Feb 6th, 2024

Aldo Ianni

INFN - LNGS

# SABRE

## Sodium-iodide with Active Background RejEction

---

- The **scientific motivation** for SABRE is to verify the longstanding modulation effect shown by DAMA/LIBRA,
  - ✓ determination of modulation amplitude and phase with a better background than that of DAMA/LIBRA
  - ✓ this modulation finds possible justification in models of dark matter regardless of its interaction with the detector
- Findings
  - ✓ Observed annual modulation is of order 0.01 cpd/kg/keV (1 dru) in ROI [1,6]keV
  - ✓ Background in ROI is of order of 1 dru

# Strategy in SABRE

---

- High signal-to-background ratio by **ultra-high purity NaI(Tl) crystals**
  - ✓ aim to 0.1-0.3 dnu in ROI
- **North-South «twin» experiments** at LNGS(Italy) and SUPL(Australia)
  - ✓ Rule out seasonal effects
- **Proof-of-Principle (PoP) at LNGS --- DONE!**
  - ✓ Exploit active background rejection with a liquid scintillator
  - ✓ Test crystals radio-purity

# NaI(Tl) crystal production for SABRE

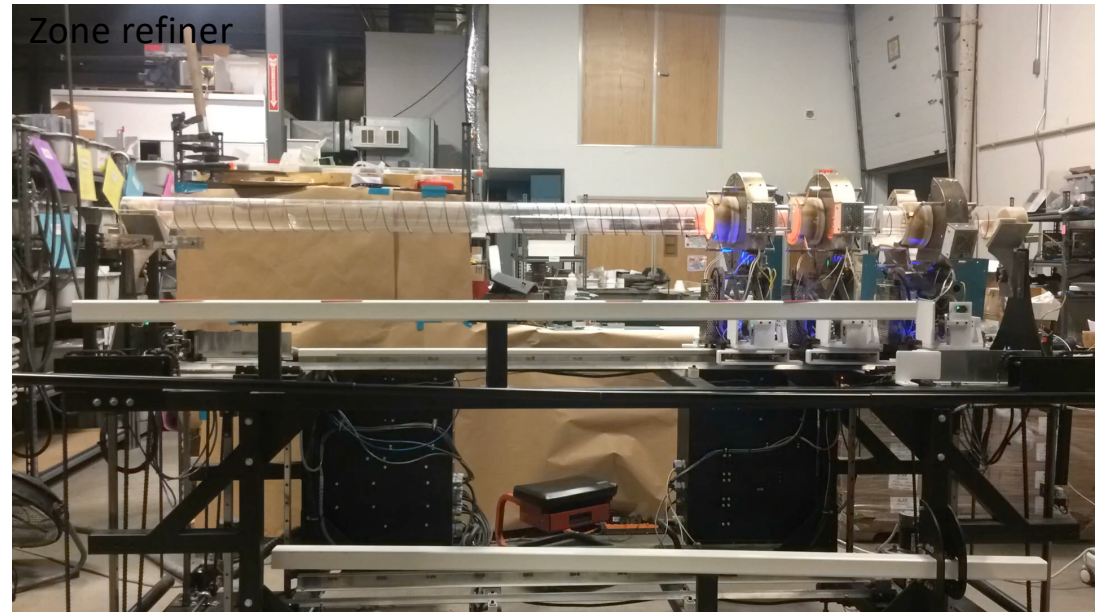
---

- Crystals are grown from Astro Grade (developed in the framework of SABRE)
  - ✓ a few ppt in U, Th and a few ppb in K and Rb
- The Bridgman method has been selected to mitigate the risk of contamination during growth
  - ✓ molten material is sealed inside a cleaned crucible
- Crystal growth is performed by the industrial partner Radiation Monitoring Devices (RMD)
  - ✓ some quality controls are performed prior to underground counting
- Zone refining purification of the powder is performed before growth in collaboration with the industrial partner MELLEN

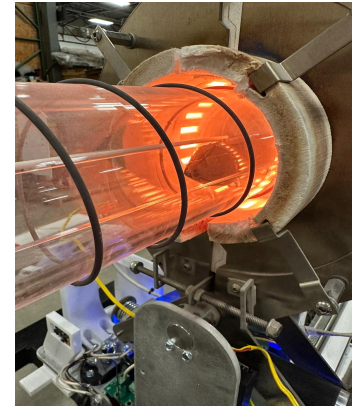
# Zone refining of NaI powder

- Four runs with 900 gr of Astro Grade NaI powder have been performed at MELLEN, NH, USA
- Number of passes: 26 or 50
- Speed: 3.8cm/h and 5.08cm/h
- Samples were taken along the length of the solid ingot and shipped for ICP-MS measurements

Sample	39K [ppb]	65Cu [ppb]	85Rb [ppb]	133Cs [ppb]	138Ba [ppb]	208Pb [ppb]
	LSC	LSC	LSC	LSC	LSC	LSC
powder	14.4	17	<0.8	36.7	<0.6	2
Zone 1	<4	<5	<0.8	<0.3	<0.5	<1
Zone 2	<4	<5	<0.8	<0.3	0.8**	<1
Zone 3	6.7	<5	<0.8	0.4	0.8**	<1
Zone 4	40	<5	<0.8	0.4	3.8	<1
Zone 5	540	234	1.3	447	10	<1



Ampoule

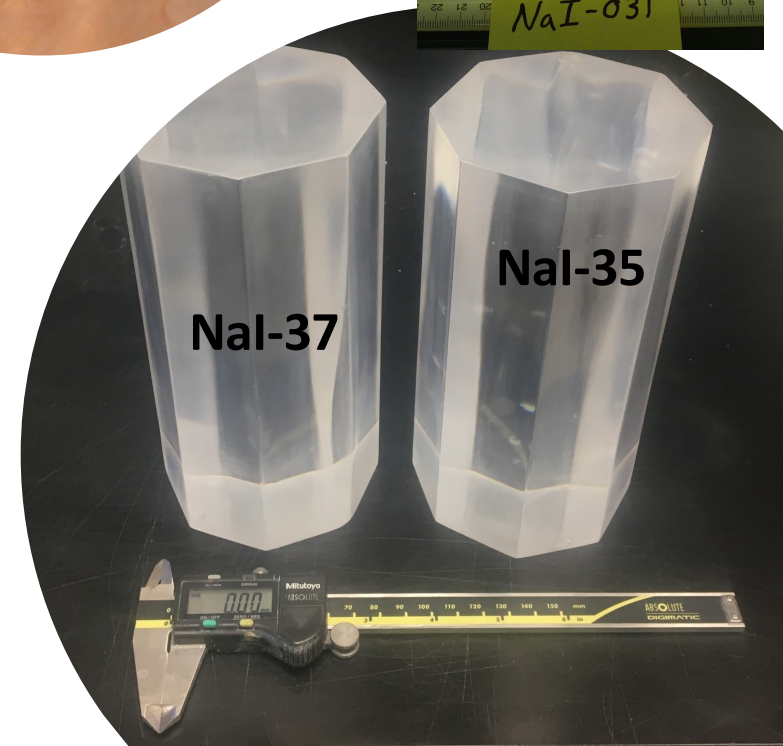
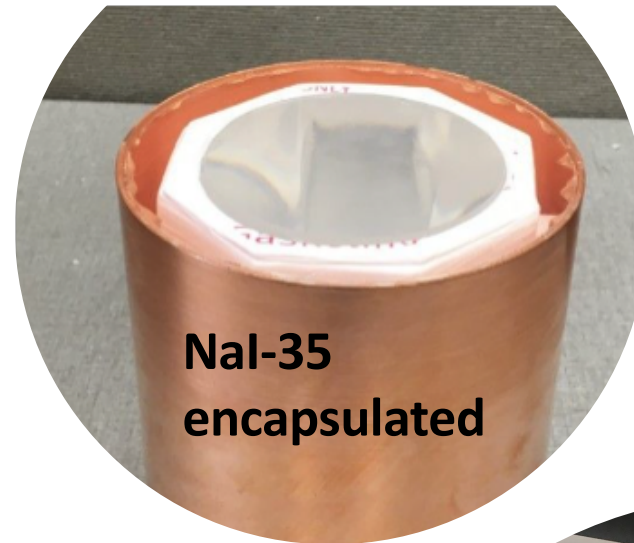


Broken ingot after ZR



# Grown crystals underground at LNGS

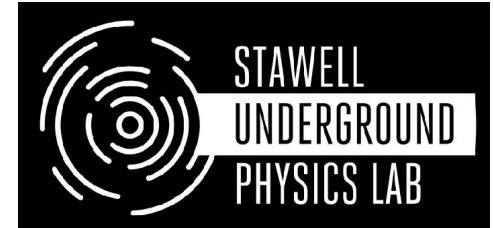
- **NaI-31** at LNGS since April 2019
- **NaI-33** since August 2019, assembled in Princeton
- **NaI-35** since May 2022, assembled at RMD
- **NaI-37** since March 2022, naked and encapsulated at LNGS
- **NaI-41** since December 2023, assembled at RMD and grown from chunks





# SUPL

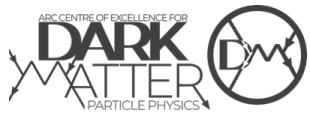
- Located in the **active** Stawell Gold Mine, 240 km west of Melbourne, Victoria, Australia
- First underground lab in the southern hemisphere



<https://www.supl.org.au>



Strong support of the local community





# Future activities

- Complete and characterize a 5 kg crystal after zone refining
  - ✓ June 2024: crystal expected at LNGS
- Submit TDR for full scale experiment at LNGS
  - Baseline: ~50 kg
  - June 2024
- Start crystal production and characterization
  - Summer 2024

Thank you for your attention

For further questions write to: [aldo.ianni@lngs.infn.it](mailto:aldo.ianni@lngs.infn.it)