

SABRE Detector performance and characterisation

Zuzana Slavkovská

CDM Annual Meeting, 23 Nov 2022





Importance of SABRE South

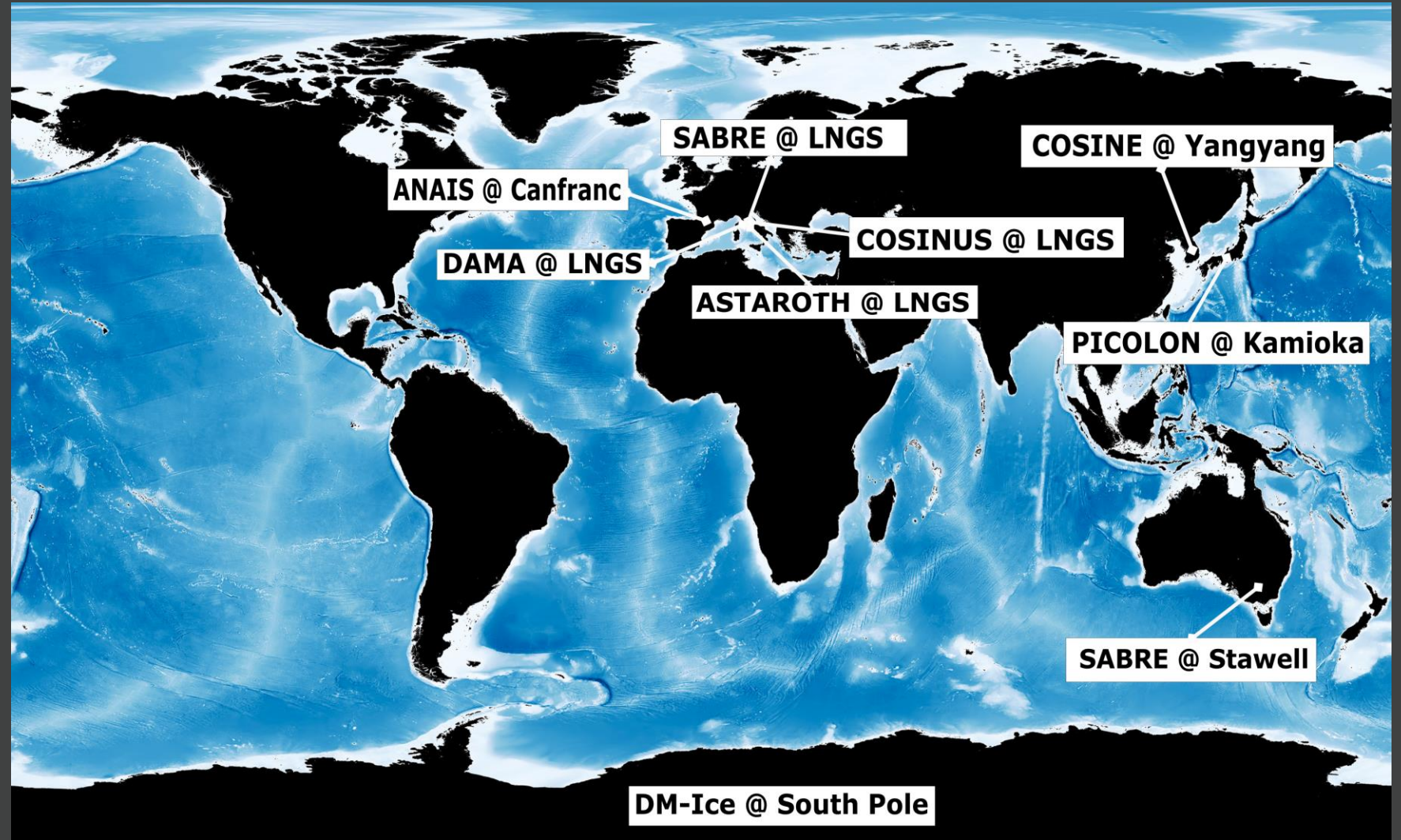
DIGGING FOR DARK MATTER



A tiny Australian mining town might hold the key to solving one of the universe's biggest mysteries – and to a local economic boom. What do scientists hope to find in a cave 1km underground?



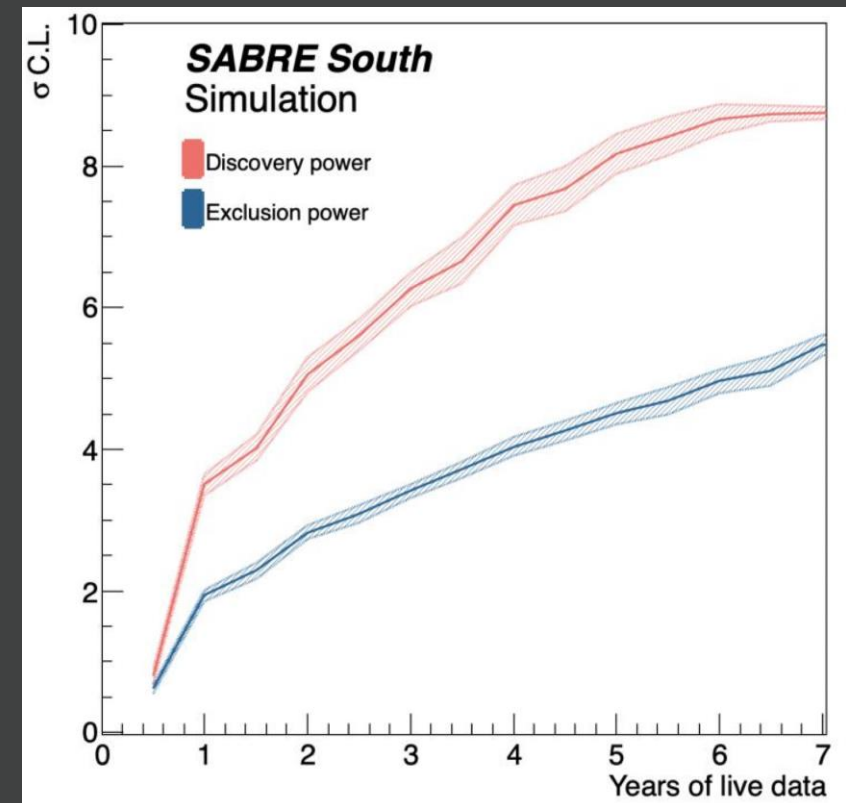
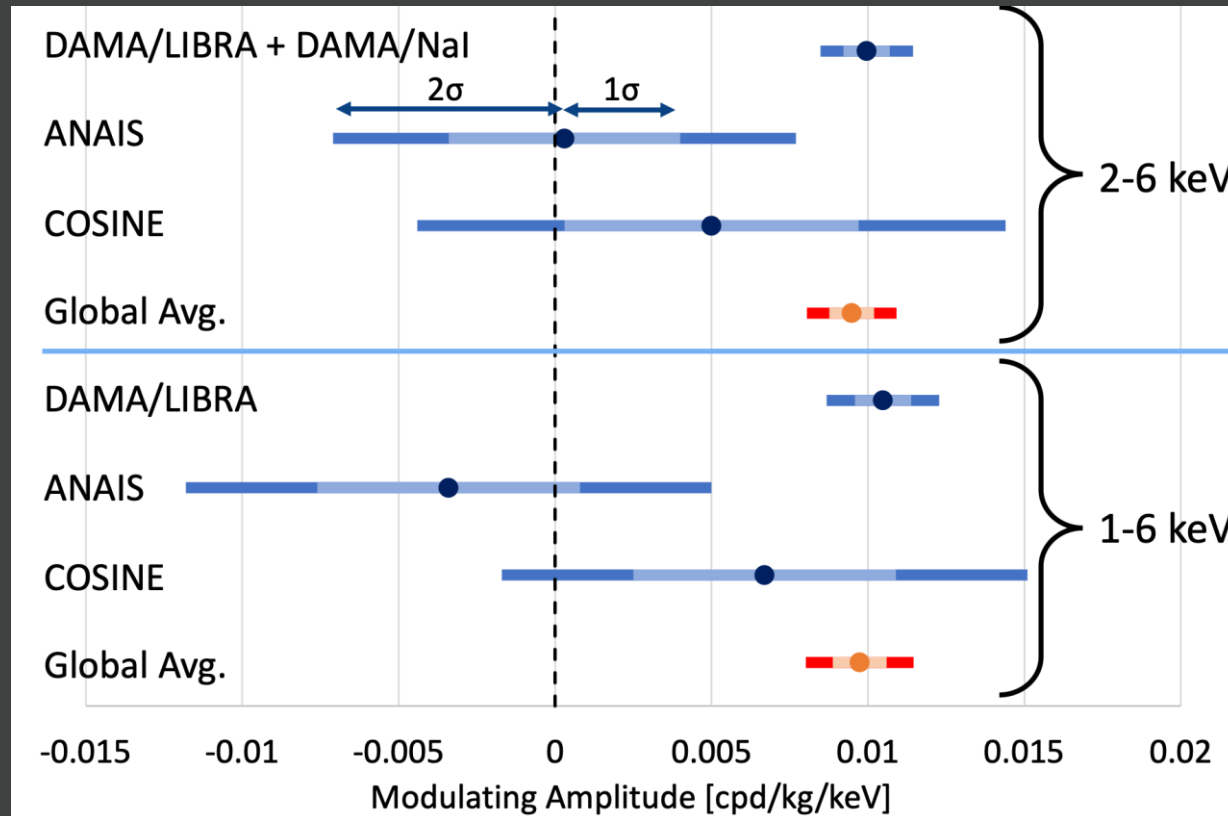
SABRE in the world



Test of annual modulation with NaI

ANAIS, COSINE and SABRE

At present time, DAMA has the smallest uncertainty and best sensitivity



SABRE South

Muon System

9.6 m² x 5 cm EJ200 scintillators

Liquid Scintillator Veto System

10 T Linear Alkyl Benzene + PPO & Bis-MSB

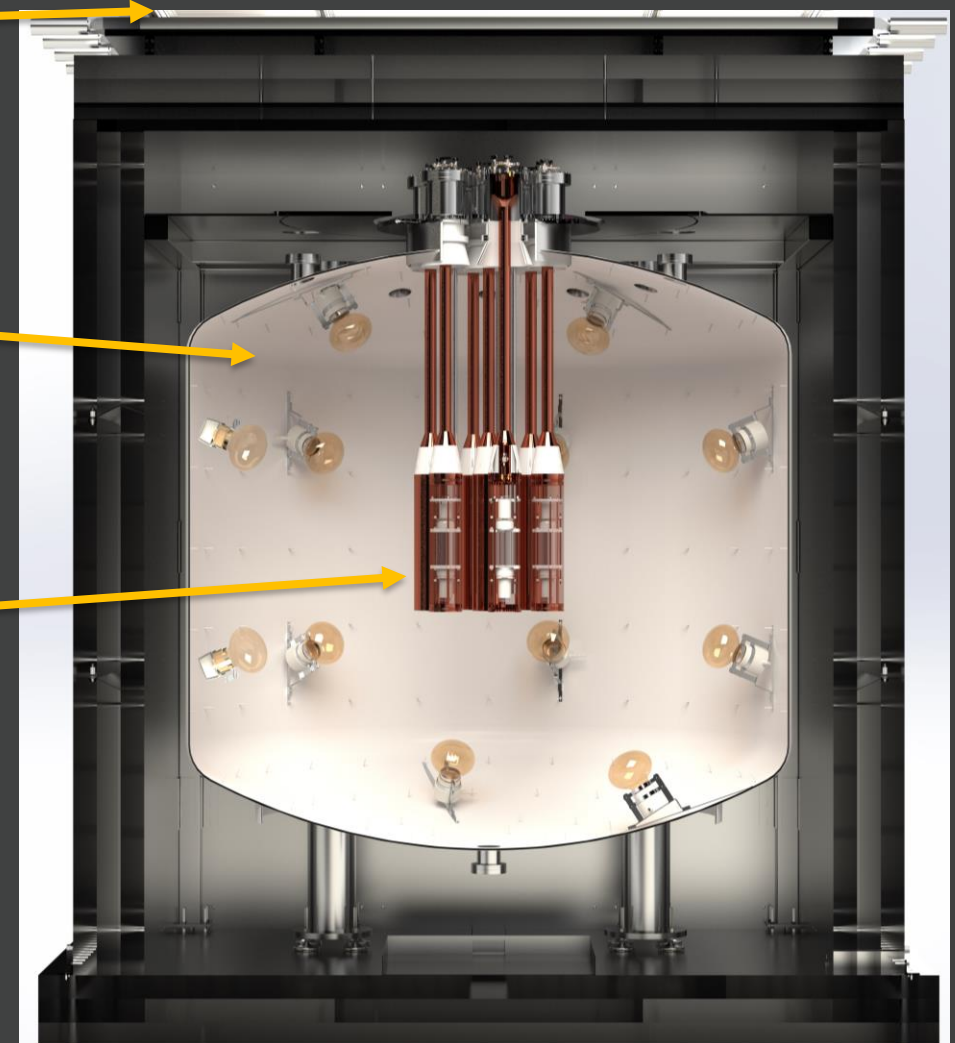
Stainless steel, non-thoriated welds, reflective lumirror layer

18 oil-proof base R5912 PMTs

DM Target Detector

7 NaI(Tl) Crystals

14 R11065 low radioactivity PMTs



SABRE South

DM Target Detector

NaI(Tl) Crystals

14 R11065 low radioactivity PMTs

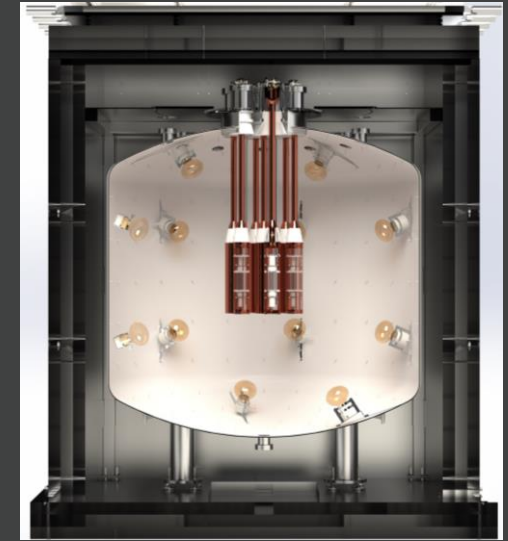
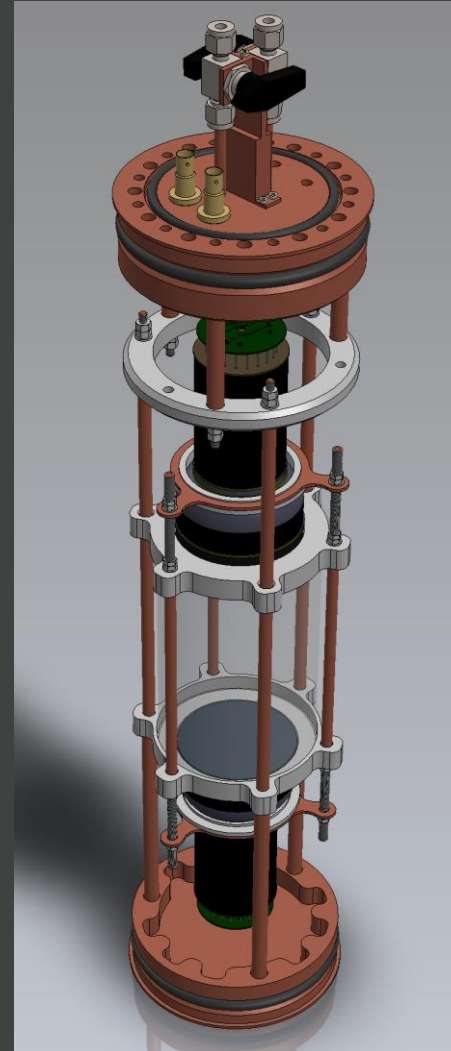
Currently under discussion

- 7 x 7 kg NaI crystals (total mass of ~50 kg)

or

- 7 x 4.5 kg NaI crystals with zone refining (~35 kg)

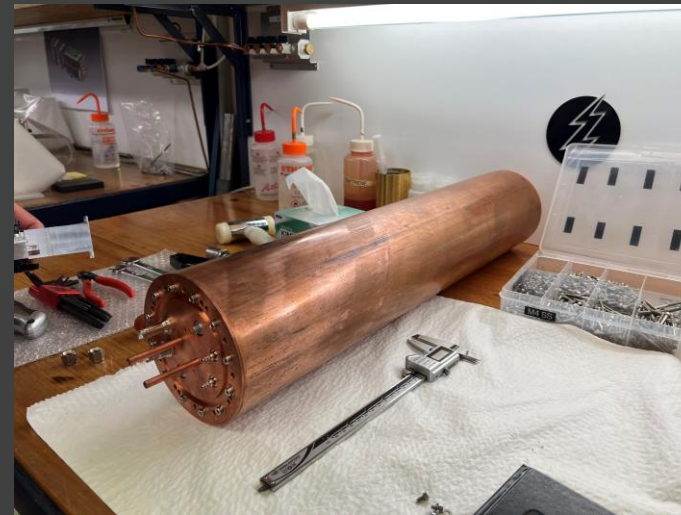
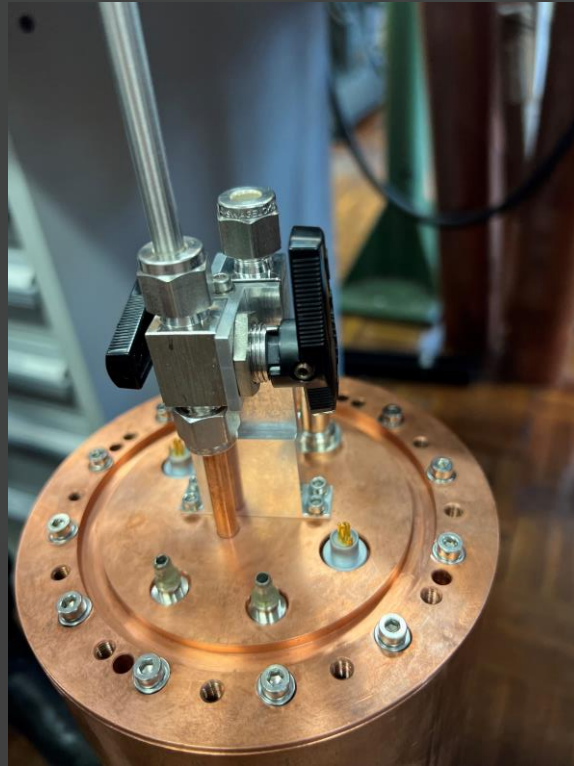
Purification method: narrow region of a crystal melted, **the molten zone moved along the crystal**, impurities concentrate at the end of the crystal and can be removed.



Enclosure leak testing at ANU

Testing in October 2022

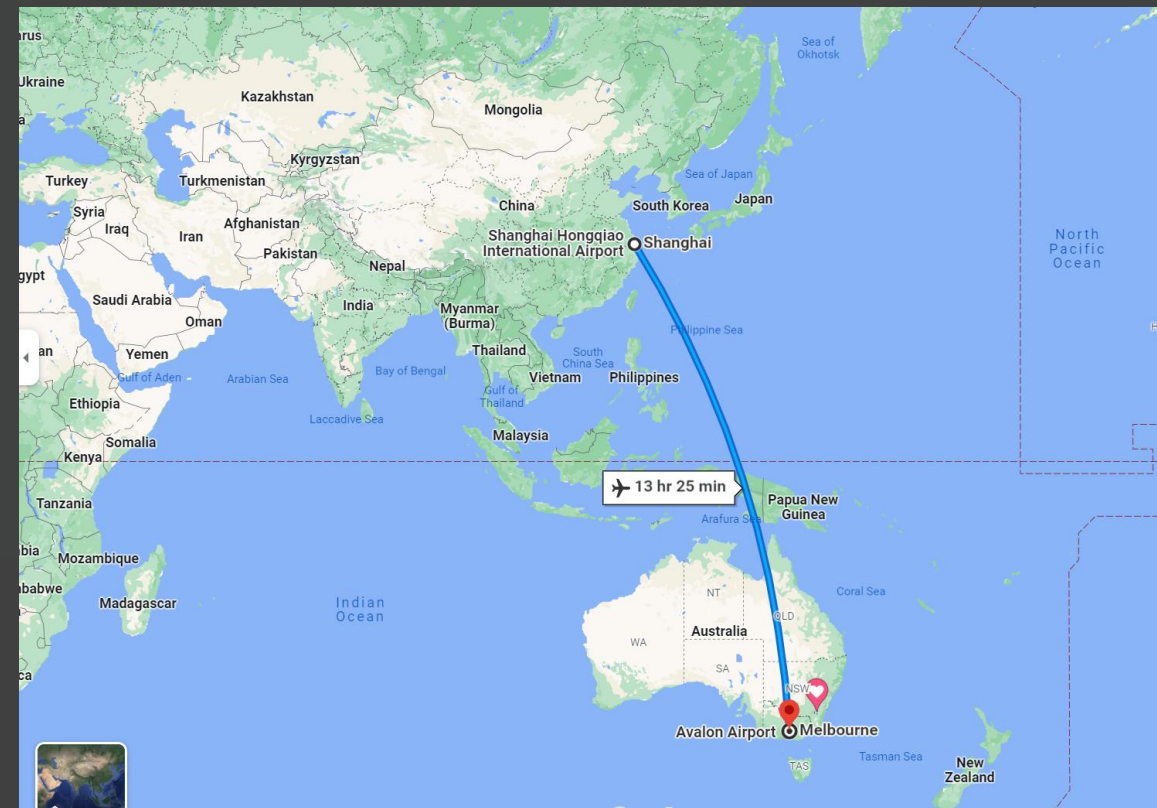
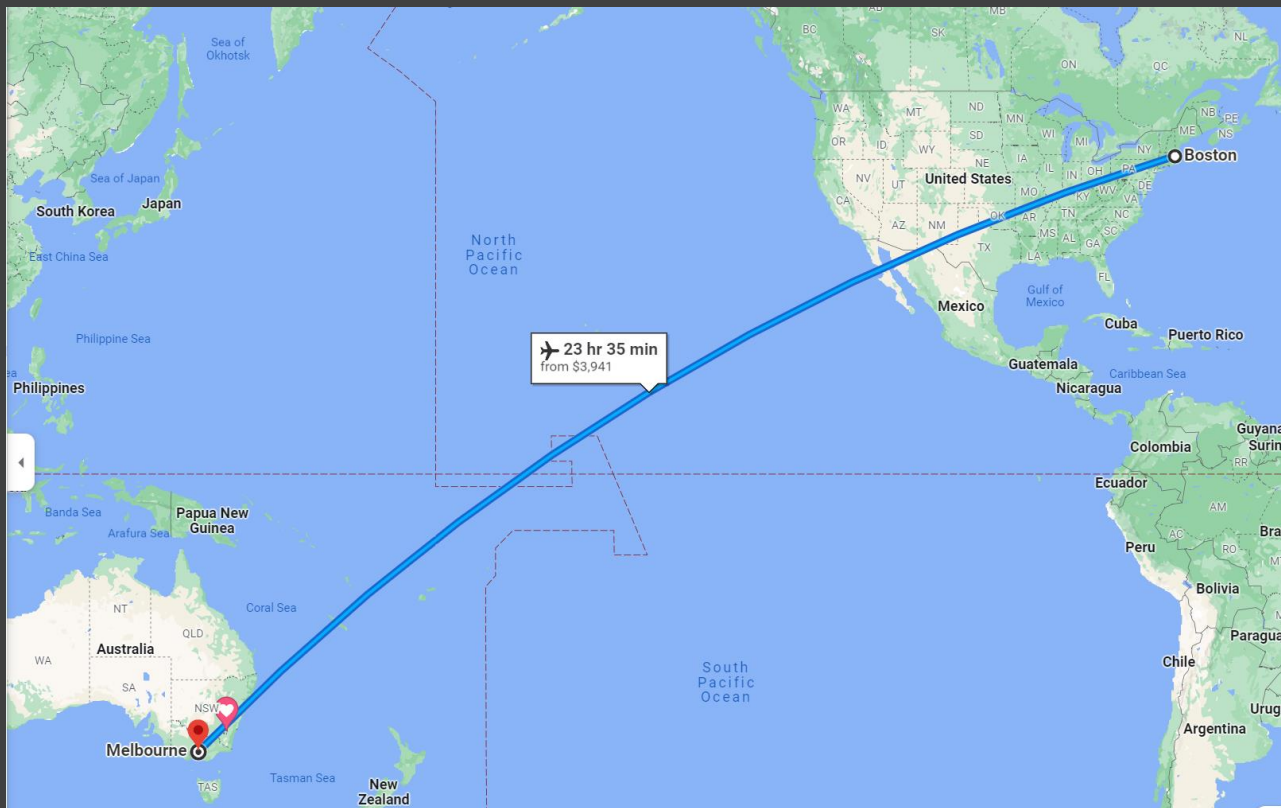
Tiziano Baroncelli (Uni Melb), Lindsey Bignell, Thomas Tunningley, Zuzana Slavkovska (ANU)



Potential crystal providers

RMD (**R**adiation **M**onitoring **D**evelopments, Boston, MA, US)

SICCAS (**S**hanghai **I**nstitute of **C**eramics, **C**hinese **A**cademy of **S**ciences)



Boston to Stawell

Shanghai to Stawell

Crystal powder

Astrograde-quality powder - 100 kg in Melbourne

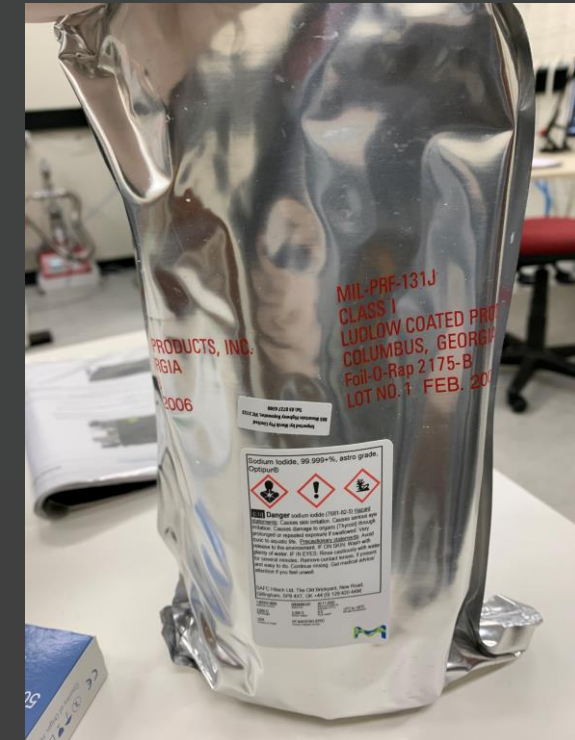
SICCAS also uses Kunshan powder for crystal growth development

Certificate of Analysis

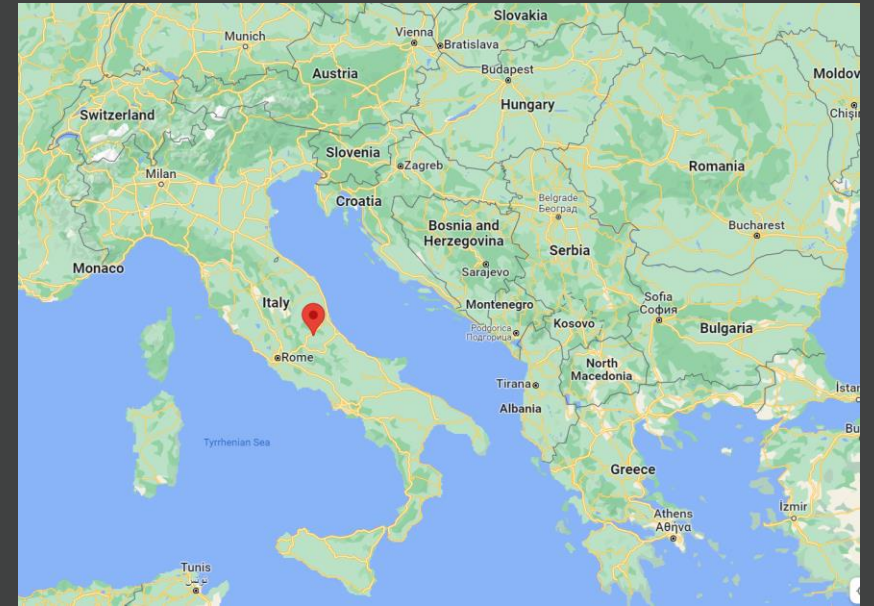
Product: Sodium Iodide, 99.999+%, astro grade, Optipur®
Material No.: 1.89333.9999
Production Date: 03/09/2020
Expiration Date: 03/09/2022
Lot No.: 0000089188
CoA Issue Date: 11/29/2018

| Test Parameter | Unit | Specification | Result |
|-------------------------|------|---------------|-----------|
| Appearance (Color) | | White | White |
| Appearance (Form) | | Powder | Powder |
| Water (by Karl Fischer) | ppm | ≤ 300 | 224 |
| ICP Major Analysis | | Confirmed | Confirmed |
| Purity | | Confirmed | Confirmed |
| Trace Metal Analysis | ppm | ≤ 10,0 | 0,8 |
| Aluminum (Al) | ppm | | 0,3 |
| Potassium (K) | ppb | ≤ 100,0 | 3,0 |
| Lithium (Li) | ppm | | 0,5 |

Remarks:
ICP Major Analysis: Confirms Sodium Component
Purity: >=99.999% Based on Trace Metals Analysis



NaI-035 Performance Measurements



LNGS (Laboratori Nazionali del Gran Sasso), Assergi, Abruzzo, Italy
funded by the **INFN** (Istituto Nazionale di Fisica Nucleare)

NaI-035 Performance Measurements

May 2022

SABRE South team:

Bill Melbourne (Uni Melbourne)

Ferdos Dastgiri (ANU)

Zuzana Slavkovska (ANU)

LNGS SABRE North team:

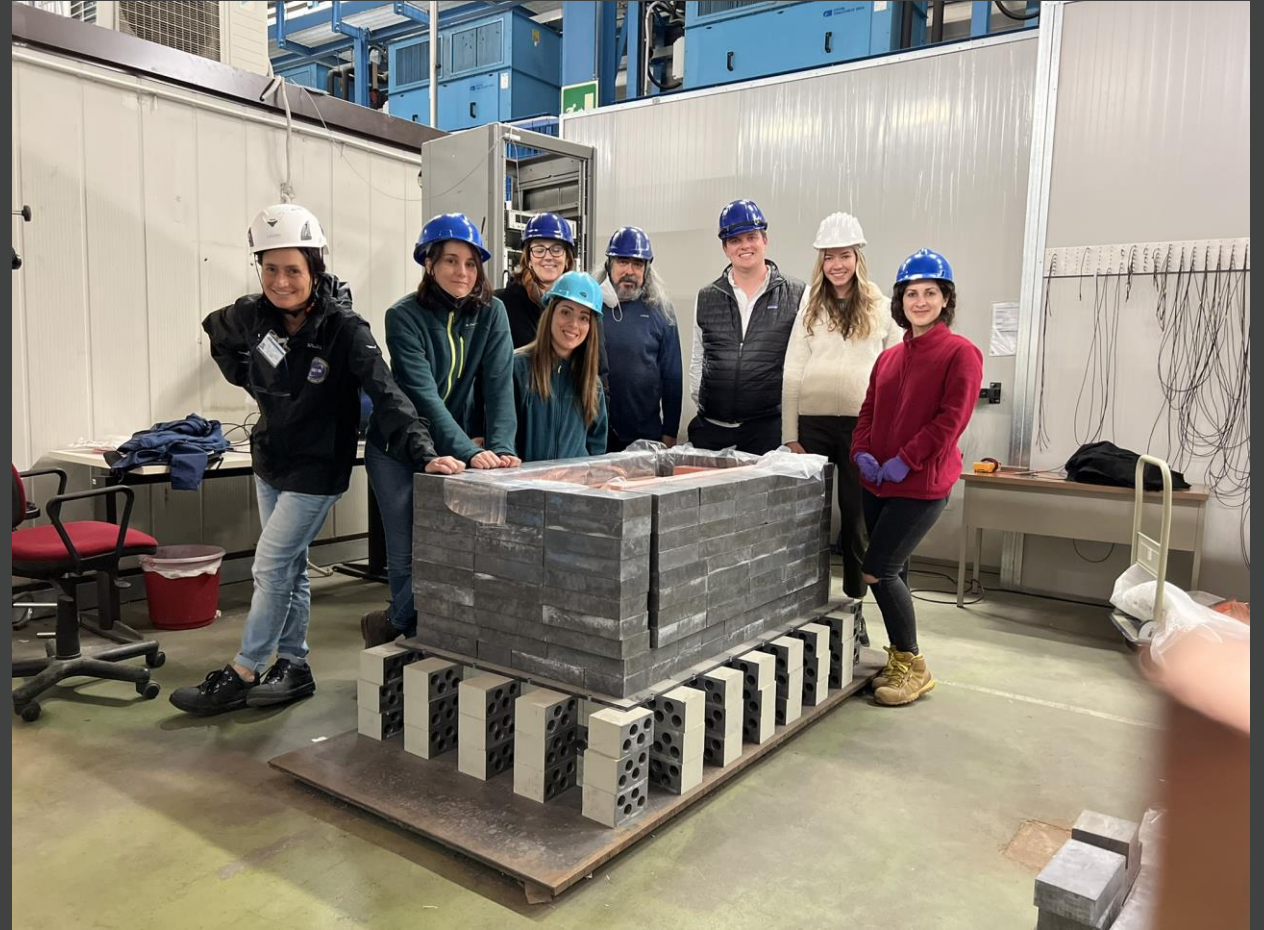
Chiara Vignoli

Giuseppe Dicarlo

Ambra Mariani

Claudia Tomei

Giulia D'Imperio



NaI-035 Performance Measurements

NaI-035 produced by **RMD** (Radiation Monitoring Devices, Boston, MA, US)

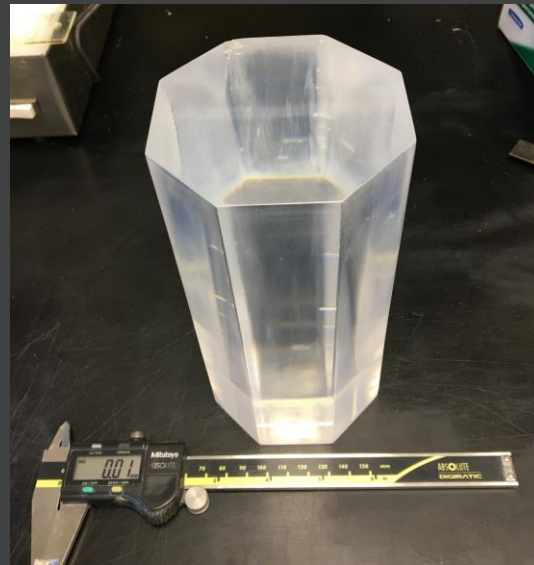
octagonal crystal

3.7 kg heavy

181 mm long

89 mm wide

in copper enclosure
with quartz windows



NaI-035 Performance Measurements

Performed measurements:

- **PMT noise run studies**
- **Series of energy calibration source runs**
(Am-241 source on different positions) to study spatial effects from the crystal growth
- Several **gamma-ray source measurements**
- **Alpha rate measurements (ongoing)**

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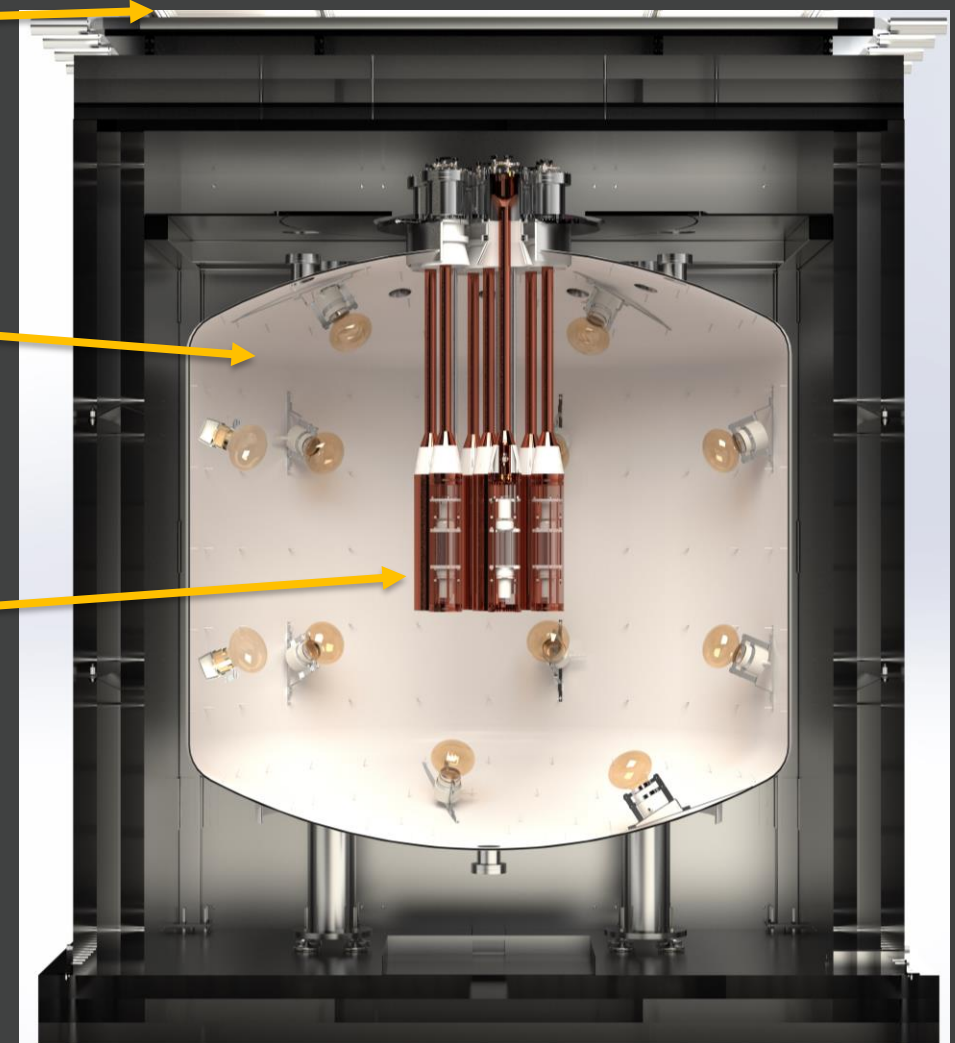
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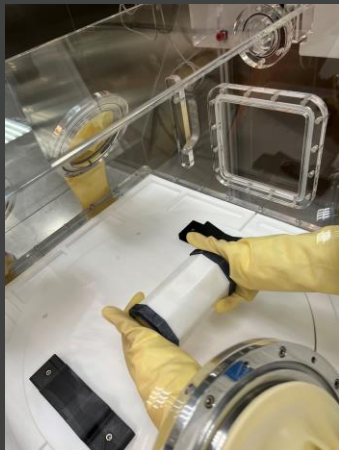
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Glove box



Glove box at LNGS

Glove box built by Palazzi SRL, Italy
CIS tested at Uni Melbourne

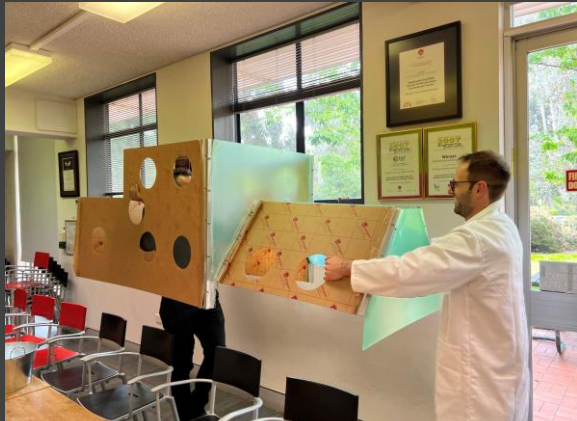
Glove box mock-up

Testing in October 2022

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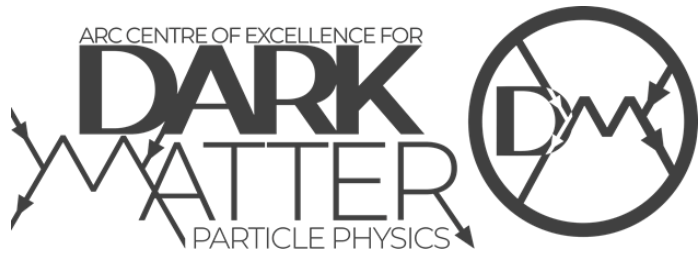
Mock-up assembly



Mock-up glove box testing



Procedure testing inside the glove box



INTERNATIONAL PARTNER ORGANISATIONS:



The University of Sheffield.

