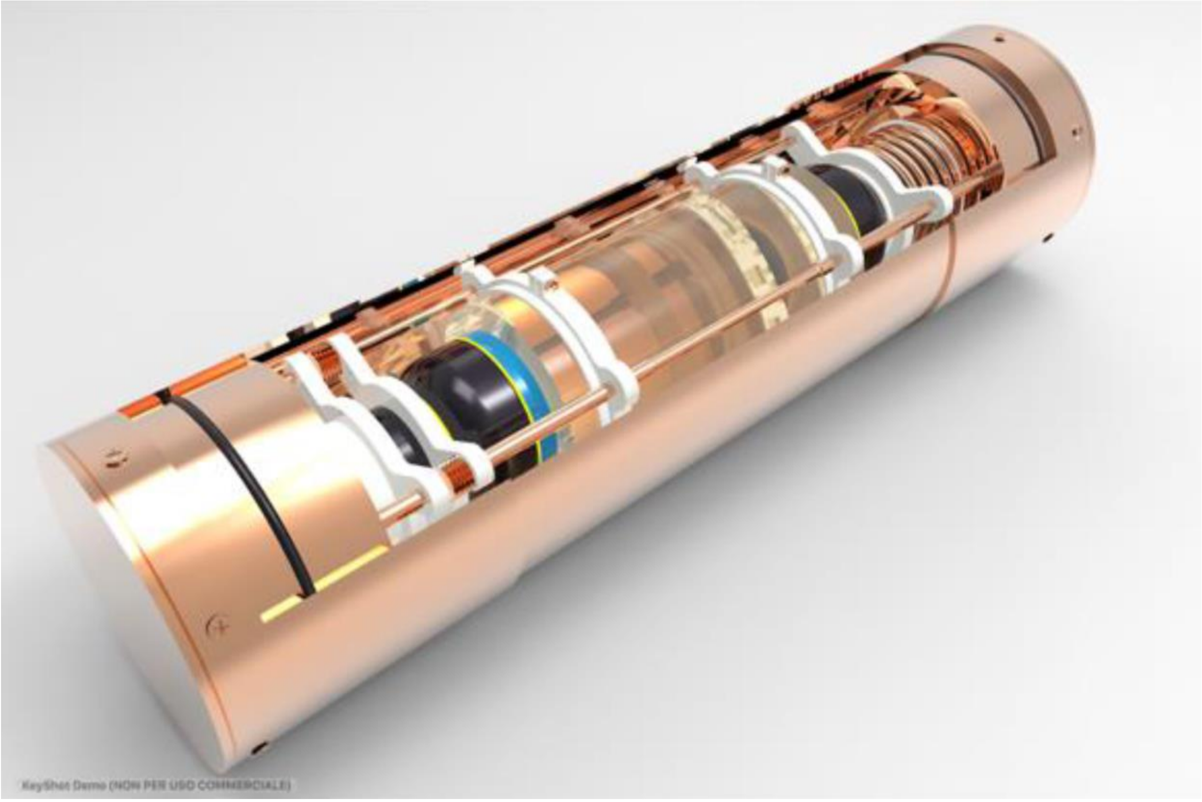
Enclosure

Mock-up overview, new design and future activities



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SABRE General Meeting, LNGS, October 4th, 2017

The mock-up (overview)

We prepared a mock-up enclosure in alluminium in order to test the design and assembly procedure (eventually into a glove box).

A new version of the top flange has been done (in brass at LNGS) in order test a different feedthroughs placement. This version is also more compact than the first one.

The current version of the bottom flange is identical to the old top flange but without holes. The final version will have the same size of the new top flange.

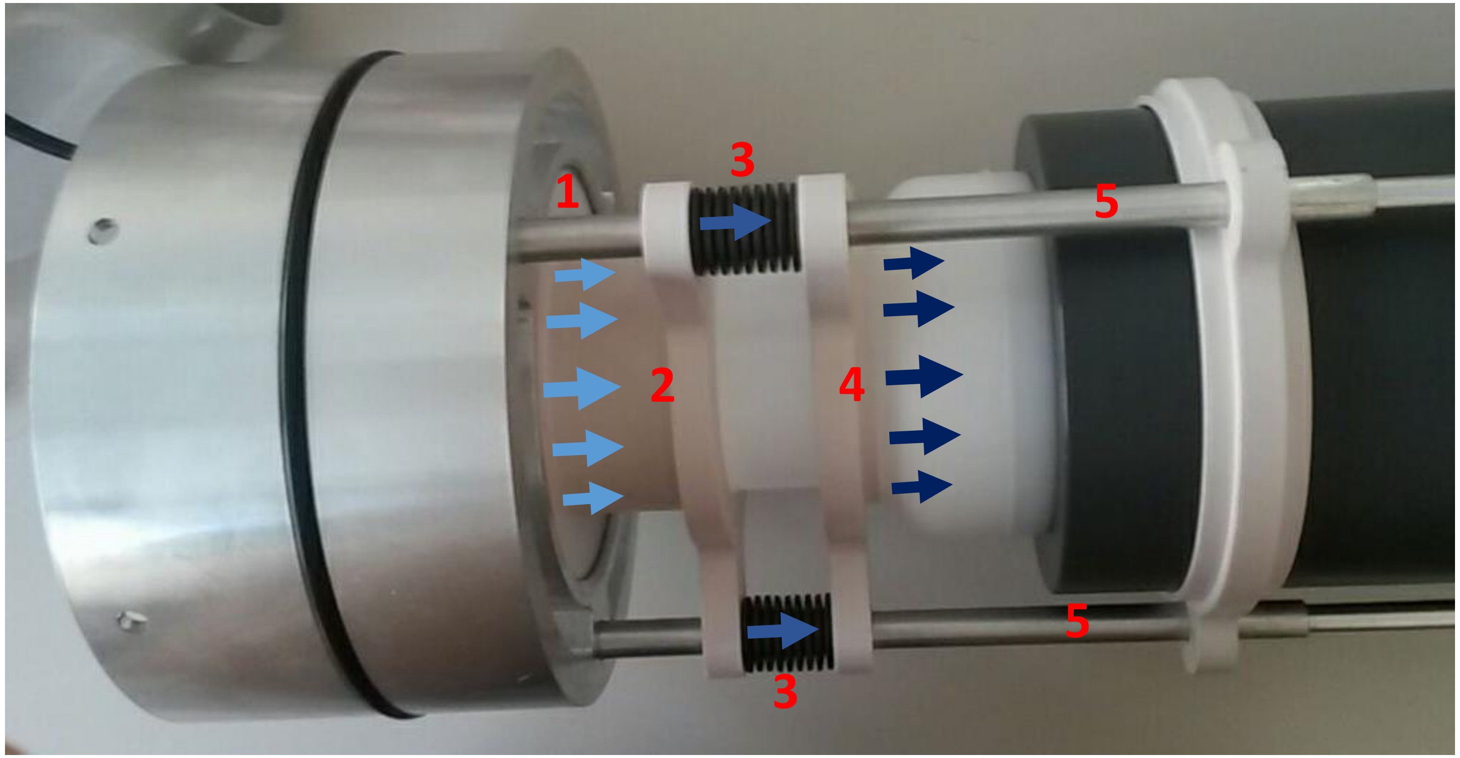
After some assembly tests with the mock-up, **we asked the company to start the production of the final version**.

It will be ready in mid October.

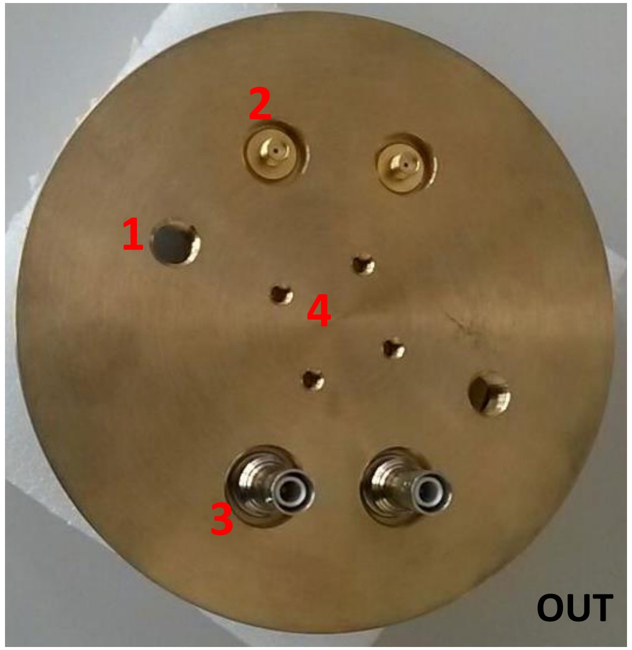
NOTE: in the final version of the enclosure, all the metal elements will be made of OFHC copper (from the CUORE experiment) and all the plastic elements will be made of PTFE. The only exception will be the spring systems: copper for the cup-springs or stailess steel for the standard springs. The shell will be soldered with the TIG (without support) technique in order to prevent contaminations.

The mock-up (PMT holders)

The pressure between the crystal and the PMT (on both sides) can be adjusted by screwing a PTFE threaded cylinder (1) which acts on the PMT throug two PTFE rings (2 and 4) that can slide along the support columns (5). Such rings are connected by three systems of springs (3).



New Top flange



The top flange will have:

1. 2x Nitroger flow holes
   https://www.swagelok.com/en/search?Ntt=ss-200-1-2-or&language=en
2. 2x Signal feedthroughs (SMA/SMA)*
   https://www.pasternack.com/sma-female-sma-female-straight-adapter-pe9184-p.aspx
3. 2x High voltage feedthroughs (SHV/soldering pin)*
   https://www.pasternack.com/shv-jack-standard-solder-cup-terminal-connector-pe4500-p.aspx
4. 4x dead holes to fix the support bar

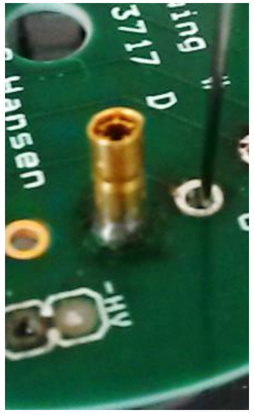
* Will be provided by Princeton University

Mechanics

- The final crystal size must be known before to produce some components of the enclosure. In particular the PTFE crystal support rings depend on the crystal diameter and the PTFE rings used to push the PMTs depend on the crystal height.
- The room behind the PMTs should be enough to place the cables so no modification to the end-caps (e.g. asymmetrical end-caps) are needed except for the shift of the O-ring housings (already implemented). If more room will be needed in the top end-cap, the crystal could be shifted downwards by ~1 cm wrt the supporting rings.
- The PTFE supports for the PMTs have been modified in order to accommodate the real PMTs.
- Copper cup-springs are better than standard stainless steel springs in terms of radiopurity. Nevertheless we must test the feasibility of the assembly procedure into the glove box. The cup-springs could be pre-assembled or marked with acid. Both the solutions (cup and standard springs) will be maintained up to now.
- Solutions for the optical coupling and the crystal reflective wrapping are still missing. They affect the installation procedure.

Readout

- **Signal**
  - **Cables**: **RG 178**, PTFE insulation, very flexible even if it has a shield (radiopurity data: see next slides).
  - **Feedthroughs**: SMA connectors on both sides of the flange (a right angle connector could be used in the inner side, see the last point of this slide).
- **HV**
  - **Cables**: **RG 179 without shielding**, PTFE insulation (radiopurity data: see next slides).
  - **Feedthroughs**: SHV connector (outer side) soldering pin (inner side).
- The cables will be soldered to the PMT dividers before to be moved into the glove box. A *pin-holder* (see figure) will be soldered to the inner side of each SHV connector. Such pin-holders will be used to connect the HV cables to the feedthroughs just before closing the enclosure top flange.
- A specific operation to close the top end-cap must be defined in order to limit the mechanical stress between the cables and their connections. For example a rotation of the flange, during the closing procedure, could be used to route the cables as a spiral. These details coud affect the orientation of the weldings (both on the dividers and the feedthrough pins).



Installation

- The installation procedure has not been fully defined yet
- The orientation of the setup, during the installation, could be horizontal in order to avoid to push the PMT against the crystal before to install the PMT support structure.
- In case of horizontal installation a cradle to support the crystal has been provided.
- The main installation steps could be:
  1. The crystal (and the reflective wrapping) is fixed to the holders and the three columns.
  2. The bottom PMT is inserted with its support structure, avoiding the PMT to touch the crystal.
  3. The optical grease is placed on the crystal; at this point the PMT can be pushed against the crystal and fixed with the end-cap.
  4. The cables from the divider of the bottom PMT must be routed to the opposite side of the enclosure.
  5. Points 2. and 3. are repeated for the top PMT.
  6. The shell is inserted as well as the bottom flange.
  7. All the cables are connected to the top flange, which is then screwed to the shell.

Glove box

- The enclosure, as well as the shell, is ~65 cm long; this implies that **the glove box must be longer than 130 cm** in one direction in order to be able to slide the apparatus inside the shell.
- Critical points:
    - What is the maximum umidity that we can tollerate inside the g.b.?
    - How long we expect the crystal will be kept inside the g.b.?
    - The g.b. will be overpressured: what pressure? What nitrogen flux?
    - Is the nitrogen purity a critical parameter?
- A dedicated GB is ready at Princeton University!

Shipping

Given the characteristics of the enclosure, the shipping from PU to LNGS, is not particularly critical.

How the enclosure will be delivered? **By ship or by plane**?

- From the mechanical point of view the two solutions are **almost equivalent**.

In **vacuum or nitrogen**? What pressure?

- The enclosure will be tested at ~10^{-5} mbar, but the transportation in **nitrogen is more safe** from the radiopurity point of view: a small nitrogen overpressure prevents contaminations.

What is the maximum **pressure difference** that it can sustain?

- From the simulations **$\Delta p = \pm 500$ mbar** is well sustainable.

Can the shipping damage the enclosure or its content? **How the vibrations could damage it**?

- In general the **enclosure main structure tolerates the stress** induced by the shipping. The critical part is just the optical grease displacement in case of movement of the PMTs. Such movements can be prevented by loading enough the spring systems that push the PMTs against the crystal. *For instance the mass of the PMT (which is the moving component) is about 0.5 kg, if they are pushed with a force of 10 N, they can sustain up to 2 g of acceleration without changing their position wtr the crystal…*

After the shipping… we need a glove box also at LNGS to restore shipping damages, if any

Glove box at LNGS

We found a glove box (from GERDA collaboration) that almost satisfies our requirements.

We have to check the minimum amount of H_2O that can be reached in this GB.