Tests in Hall B

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Hall B temporary site

We have a temporary experimental site in Hall B.

Currently all the test setups are there, including the veto tank and the DAQ electronics.

Hall B tests

Some preliminary tests have been performed:

- Veto tank:
  - Dry characterization of veto PMTs
  - LED run
  - Crystal run
- Crystal setup
  - High-QE PMTs tested
- Shielding
  - Alpha particles rejection

In some of these activities we used the SABRE DAQ and we found, and fixed, some bugs.

Veto PMTs

The SABRE veto tank is currently equipped with the 10 PMTs, internally covered with lumirror and filled with air.

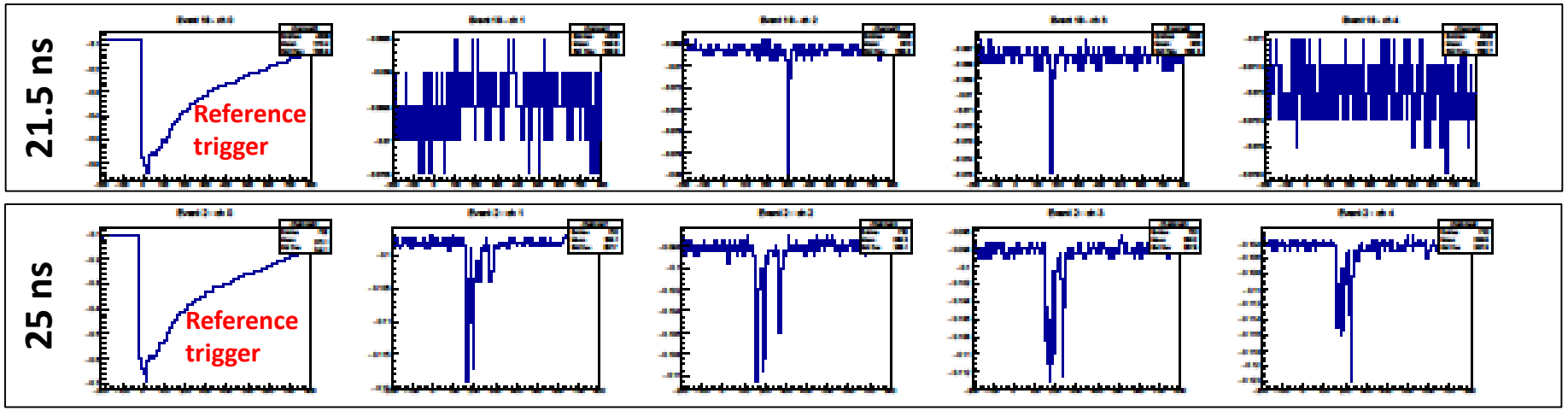
- We did a light leakage test of the tank: two main holes were found. Now all the PMTs show a dark rate between ~2 kHz and ~ 3 kHz.
- Preliminary equalization, in terms of gain, of all veto PMTs:

PMT	HV (V)	single PE (mV)	Area (pVs)	Gain (e6)	P/V
0	1570	9,7	69,6	8,6	1,6
1	1540	10,9	65,8	8,1	1,9
2	1660	11,0	58,2	7,2	1,5
3	1570	10,7	59,0	7,3	2,3
4	1530	11,1	71,7	8,8	1,6
5	1600	10,9	69,4	8,6	1,4
6	1600	10,1	59,4	7,3	1,9
7	1570	11,1	60,1	7,4	1,6
8	1470	11,2	70,1	8,7	1,6
9	1590	12,3	76,0	9,4	1,3

Veto: LED run

We suspended a LED in the center of the tank in order to regularly generate a small amounts of photons.
The LED was powered by a pulser, the pulse duration was used to tune the amount of photons-per-pulse produced.
A reference signal, provided by the pulser, was used as trigger for the DAQ.

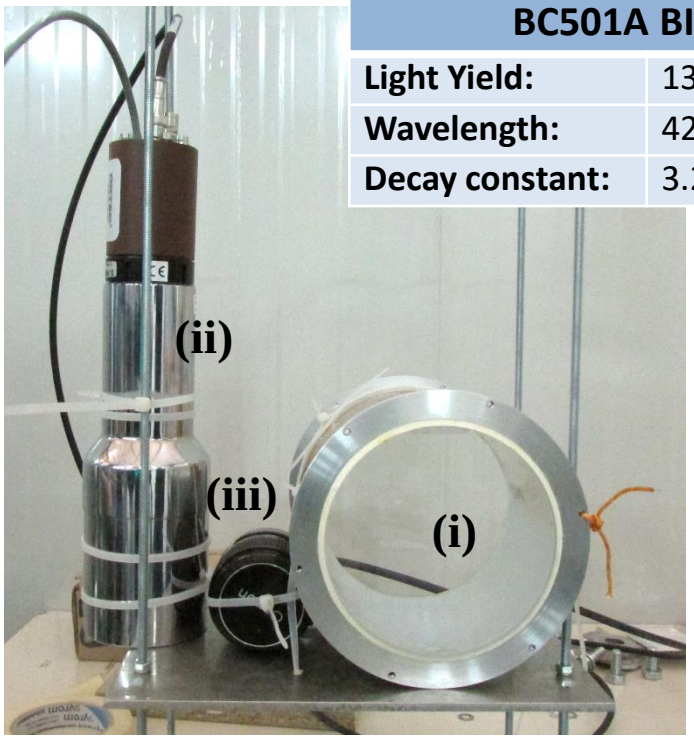
Examples of signals obtained with pulses of 21.5 ns (0-1 photons/PMT) and 25 ns (~10 photons/PMT).



These measurements could be compared with the simulation obtained by LITRANI (LIght TRansmission in ANIsotropic media) simulations.

Veto: LS Cell

We inserted into the tank a structure holding a cell (i) filled with a liquid scintillator (BC501A) a portable stand-alone NaI crystal wrapped with its own PMT (ii) and a commercial photographic lens including Thorium (iii).



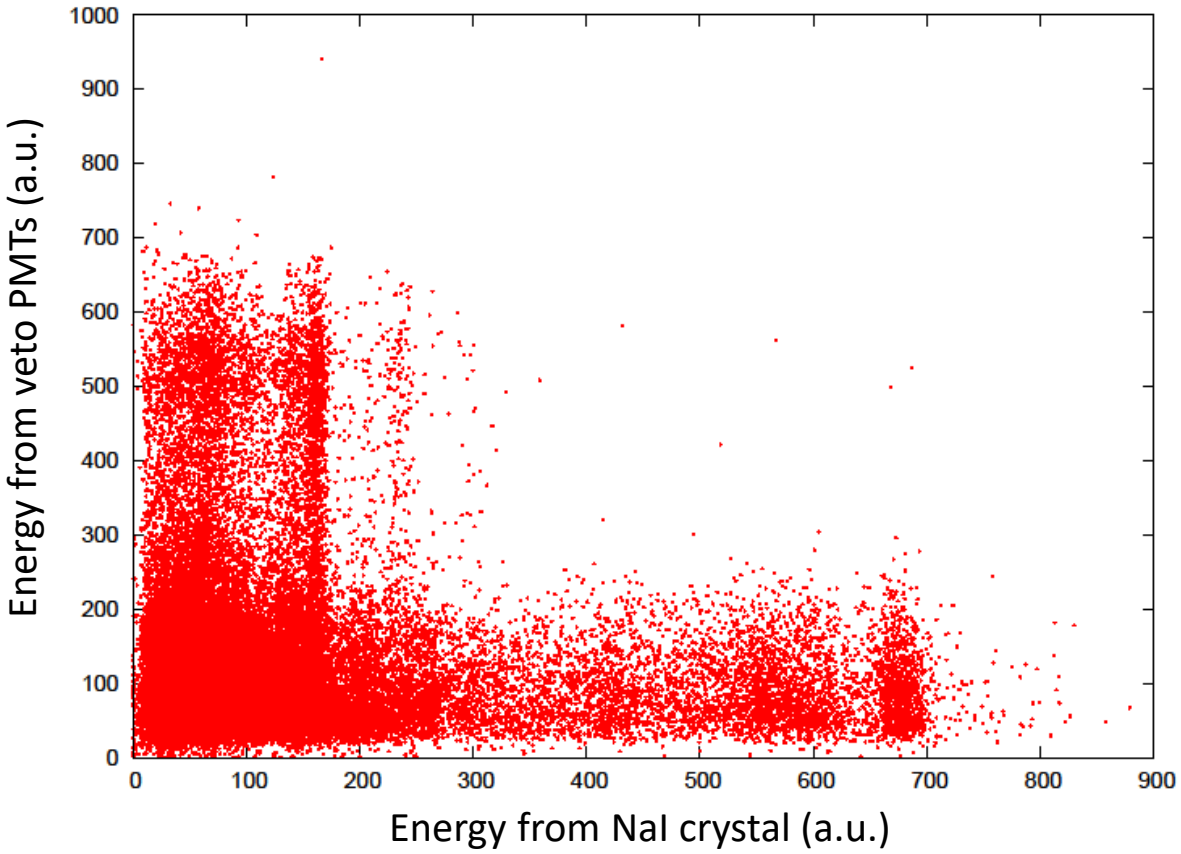
BC501A BICRON	
Light Yield:	13’500 p/MeV
Wavelength:	425 nm
Decay constant:	3.2, 32 and 270 ns

The purpose of this setup is to reproduce the SABRE PoP conditions in order to evaluate our capability to detect coincidences.

Veto: LS Cell

The global trigger is fired when both the crystal PMT and some* of the veto PMTs detect light.

*the minimum number of PMT required to detect light is defined *majority*, in general the trigger rate decreases as the majority increases, but it becomes constant for majority values greater than 4.



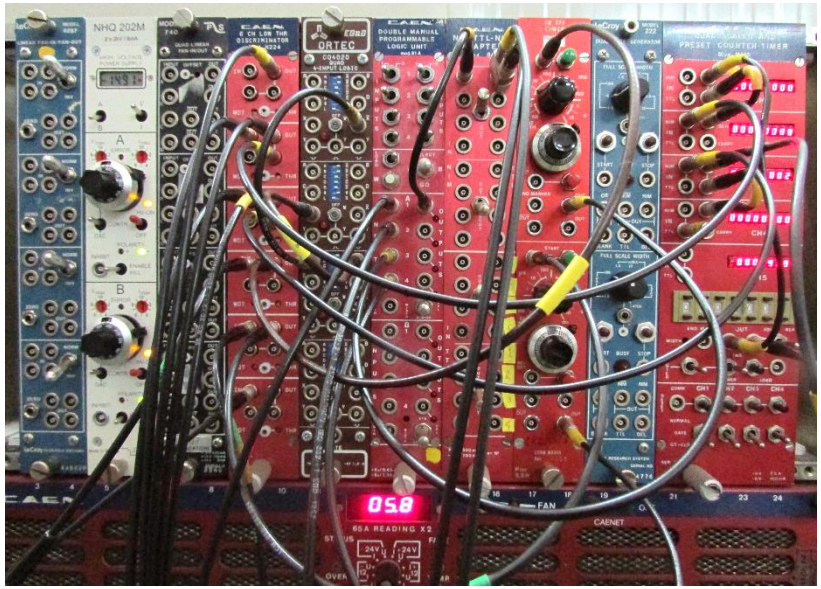
Unfortunately the energy resolution obtained with the LS Cell is very poor (low light yield), so a coincidence specific analysis cannot be done.

Crystal setup

A dedicated test setup has been prepared by placing a NaI (commercial) crystal, coupled with two 3’’ PMTs, inside a copper+lead shielding.

The trigger signal is produced with NIM modules requiring that both the PMTs present a signal between -4 mV (low threshold) and -40 mV (high threshold) within a time window of 200 ns. The purpose of the high threshold is to reject high energy pulses (above few tens of keV).

The two signals are then acquired by a “National Instruments”, 10 bit, 1.25 GS/s, PXI digitizer.

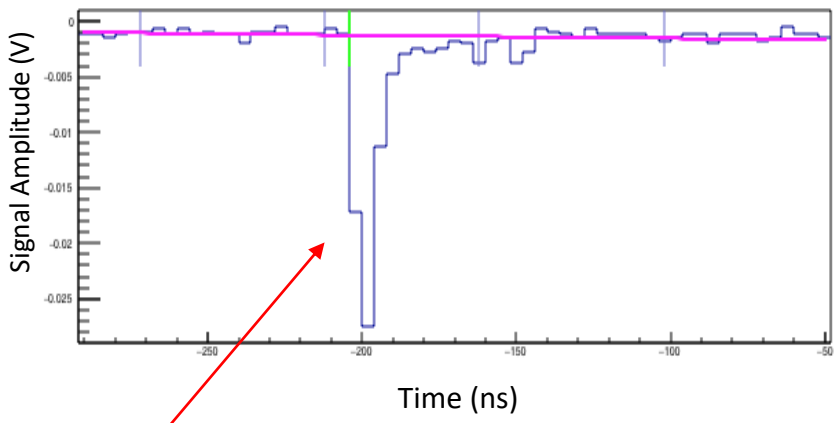


Crystal setup

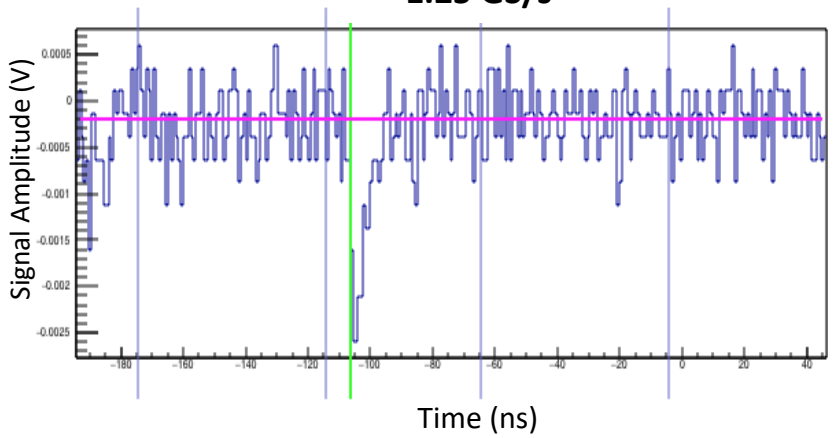
The National Instruments DAQ permitted to acquire the waveforms at different sampling frequencies (up to 1.25 GHz).

Thanks to this setup we will be able to test the PSD parameters (like X_1 and X_2 used by the DAMA experiment) for different values of sampling frequency.

250 MS/s



1.25 GS/s



The rising edge of a small pulse (1 photon) is just two samples long!

Shielding

A setup for low radioactivity measurements has been prepared.

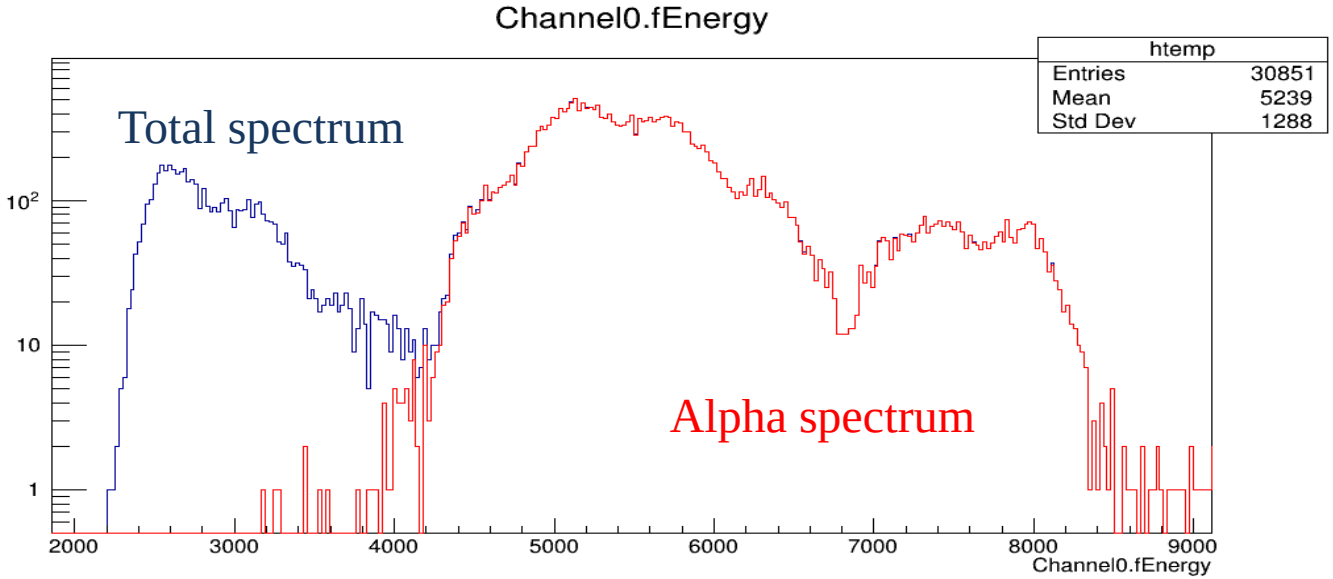
Radon box

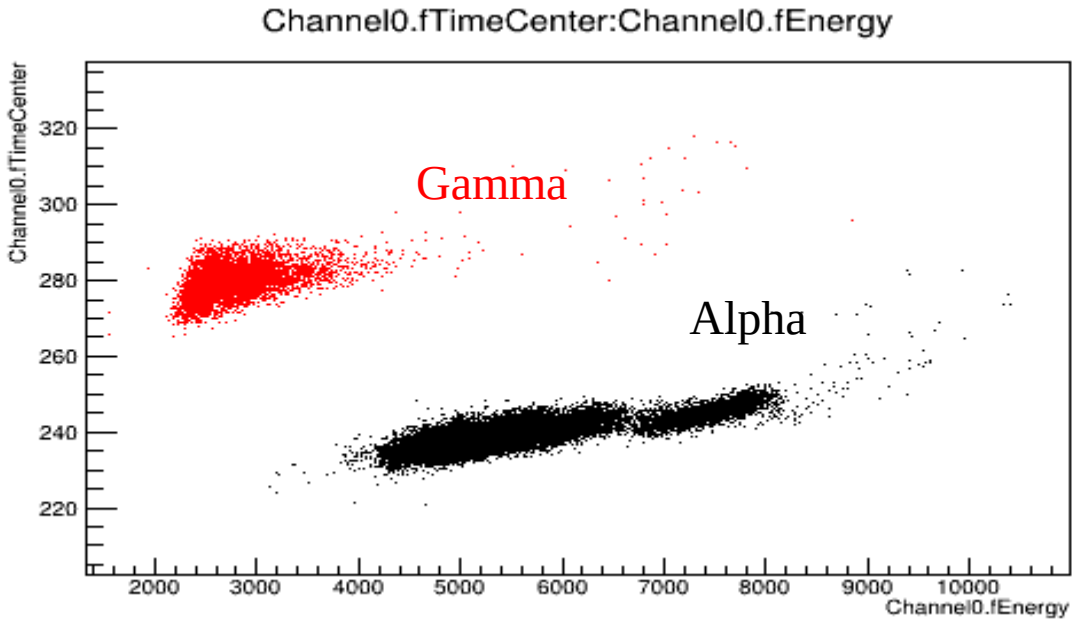
Lead + copper

Cables feedthrough

Alphas rejection

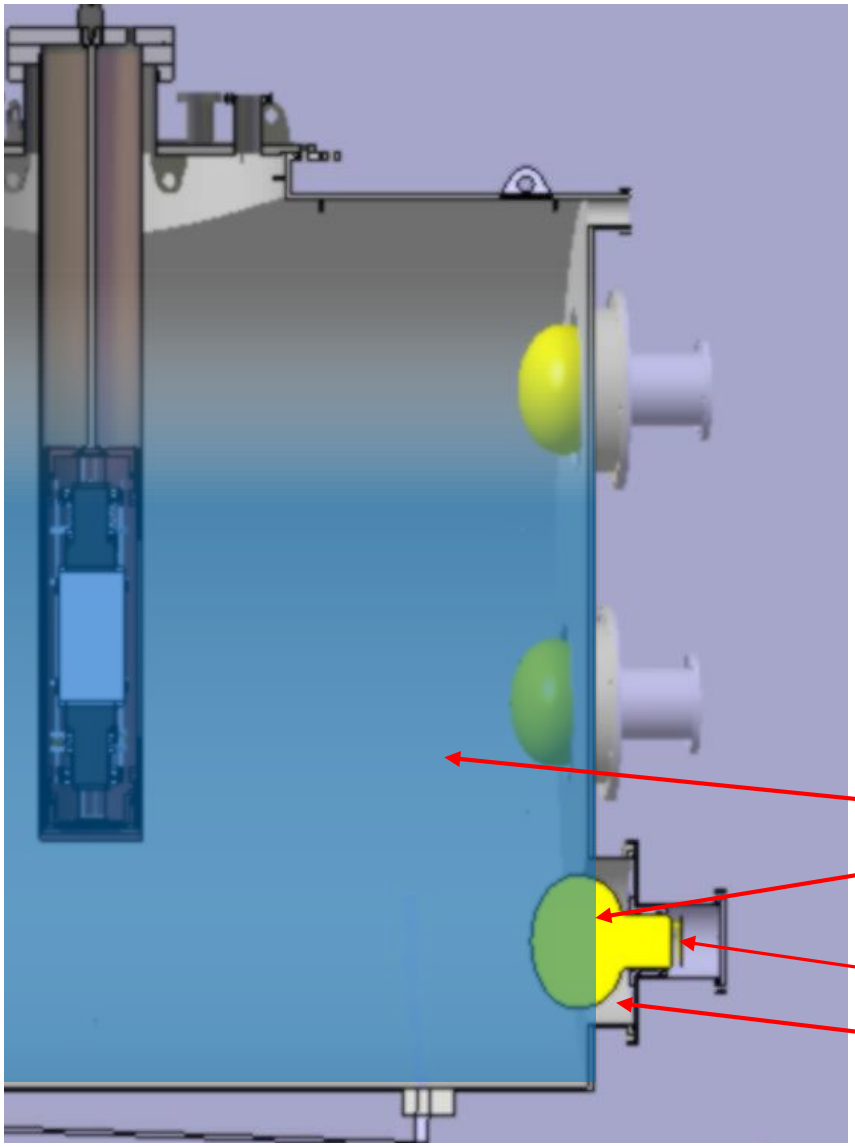
Alpha particles can be identified by the time-charge distribution of the pulse.





Data obtained with a commercial NaI crystal, under the Hall B shielding.

Water run



What is next?

Currently we are focused on more urgent activities (safety systems, enclosure, LS handling, shielding, ecc…), but..

Before to fill the veto tank with LS we could perform the **water run**:
Given the design of the veto tank, the LS could reach the PMT electronics and exit from the tank. **The filling procedure could be simulated with water before the final cleaning of the tank.**