

# *The CNGS neutrino beam and the Borexino events in 2006*

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## *Content:*

- Borexino description
- Borexino during the CNGS runs:
  - in August 2006
  - in October 2006
    - the detector status
    - the expected number of muon events
    - the detected CNGS muon events
- Conclusions

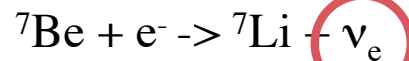
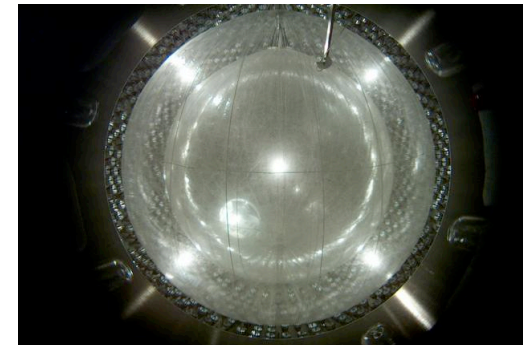
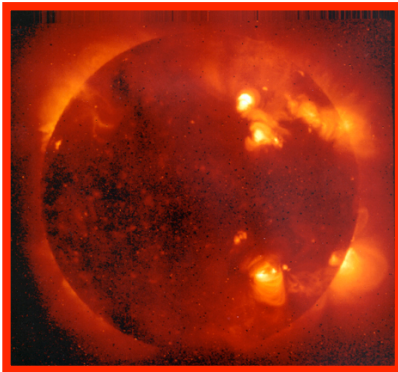
## *The Borexino Collaboration:*

*~70 physicists from 14 institutions:*

<i>Italy :</i>	Milano, Genova, Laboratori del Gran Sasso dell'INFN, Perugia e Ferrara (Università e Sezioni INFN)
<i>France:</i>	APC/ College de France
<i>Germany:</i>	Max-Planck-Institut fuer Kernphysik Heidelberg, Technische Universitaet München
<i>Poland:</i>	Jagellonian University, Krakow
<i>Russia:</i>	J.I.N.R. Dubna Kurchatov Institute - Moscow
<i>USA:</i>	Princeton University (Phys. and Chemical Eng. Dept.) Virginia Polytechnical Institute

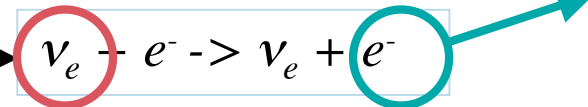
## The Borexino physics:

*To measure, for the first time in real-time,  
the solar  ${}^7\text{Be}$   $\nu_e$  flux  
day/night, seasonal, periodic variations  
comparison with the theoretical predictions (model LMA-MSW)*



0.861 MeV (90%)

0.383 MeV (10%)

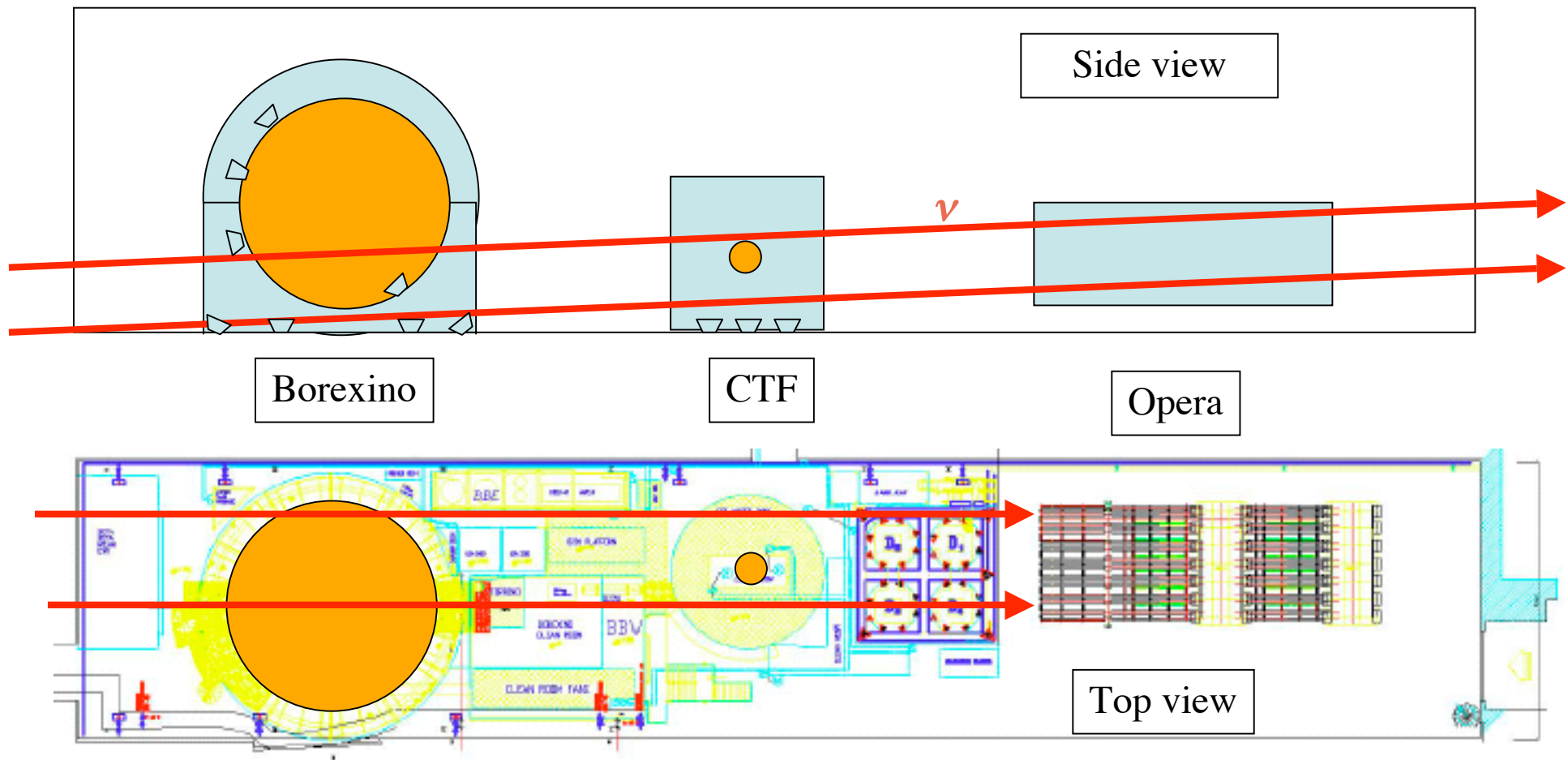


$E_{e\text{max}} = 0.664 \text{ MeV}$

7% of the solar  $\nu$  flux

**note: the  ${}^8\text{B}$   $\nu$  are only  $10^{-4}$  of the total solar  $\nu$  flux !!**

Hall C side and top view :



# The Borexino detector

**The Detector** = 300 t (100 fid) of liquid scintillator : PC+PPO (1.5 g/l)

Suspended inside a nylon sphere  $\varnothing=8.5\text{m}$

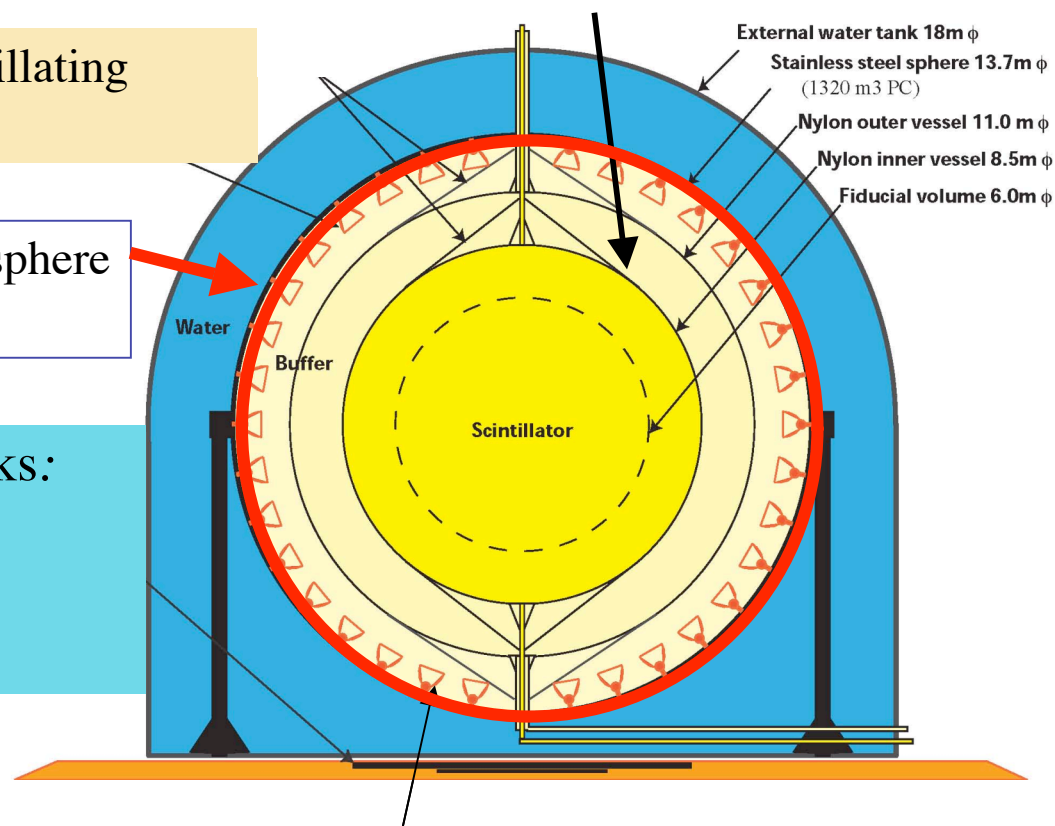
$$\nu_e + e^- \rightarrow \nu_e + e^-$$

The recoiling  $e^-$  signal is seen by 2200 *PMTs*

**The buffer zone** = 1040 t of non scintillating liquid: PC + DMP

All inside a SS sphere  $\varnothing=13.7\text{m}$

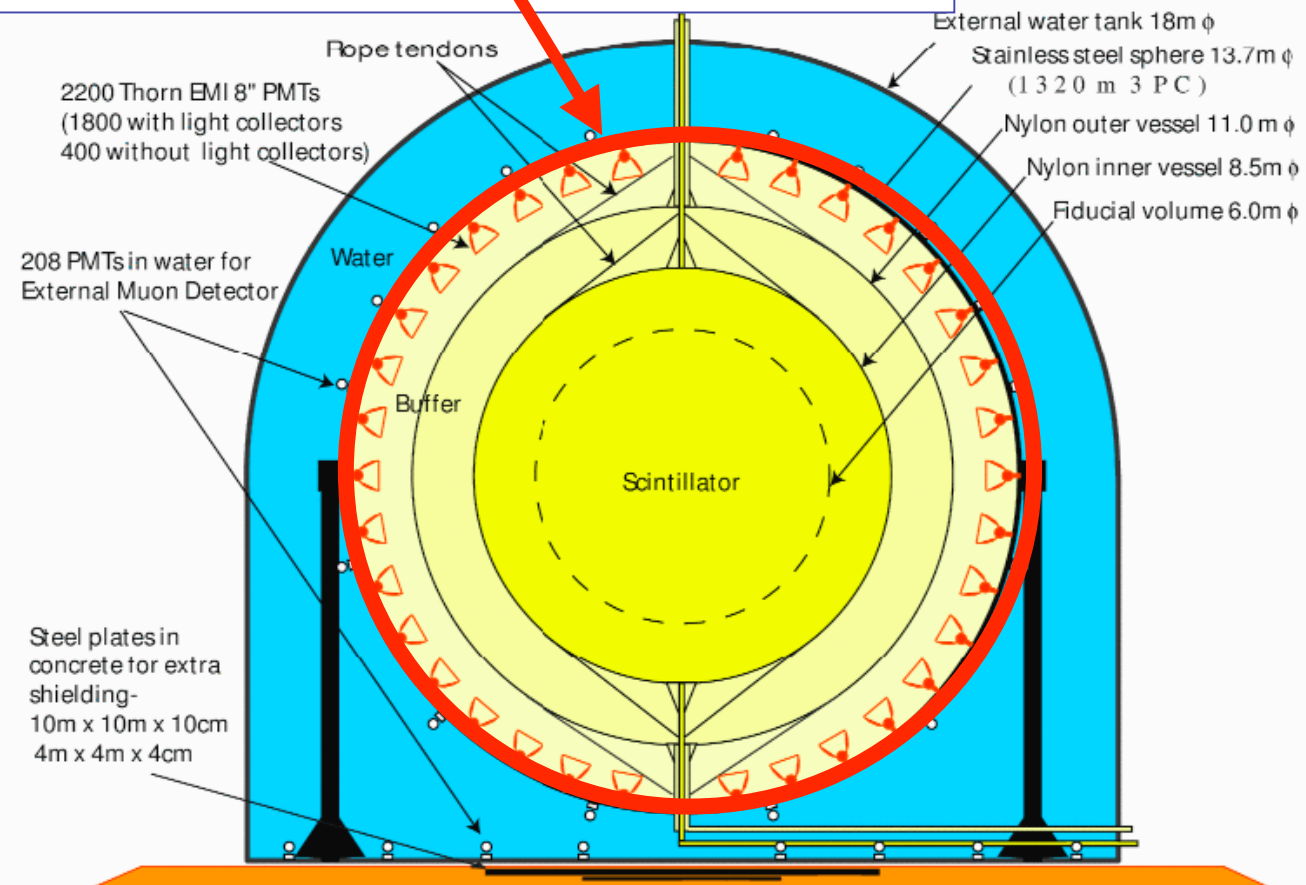
**The shielding** of the  $\gamma$  from the rocks:  
2m of ultrapure water  
In a SS Water Tank  
 $\varnothing= 18\text{m}$





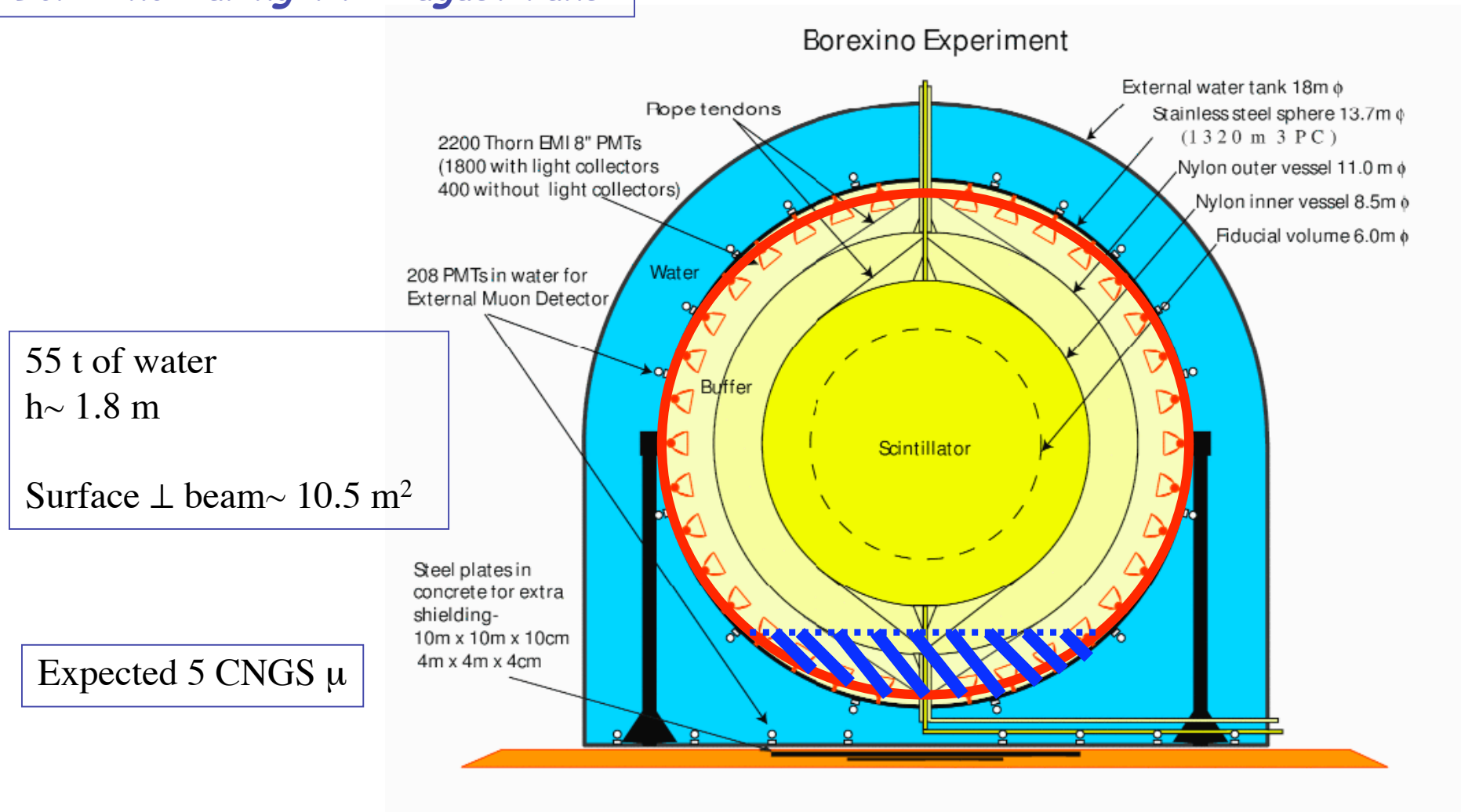
In august 2006 we started filling the SSS with ultrapure water

==>> and this filling always had the priority on anything else !!!





## Borexino during the August runs:

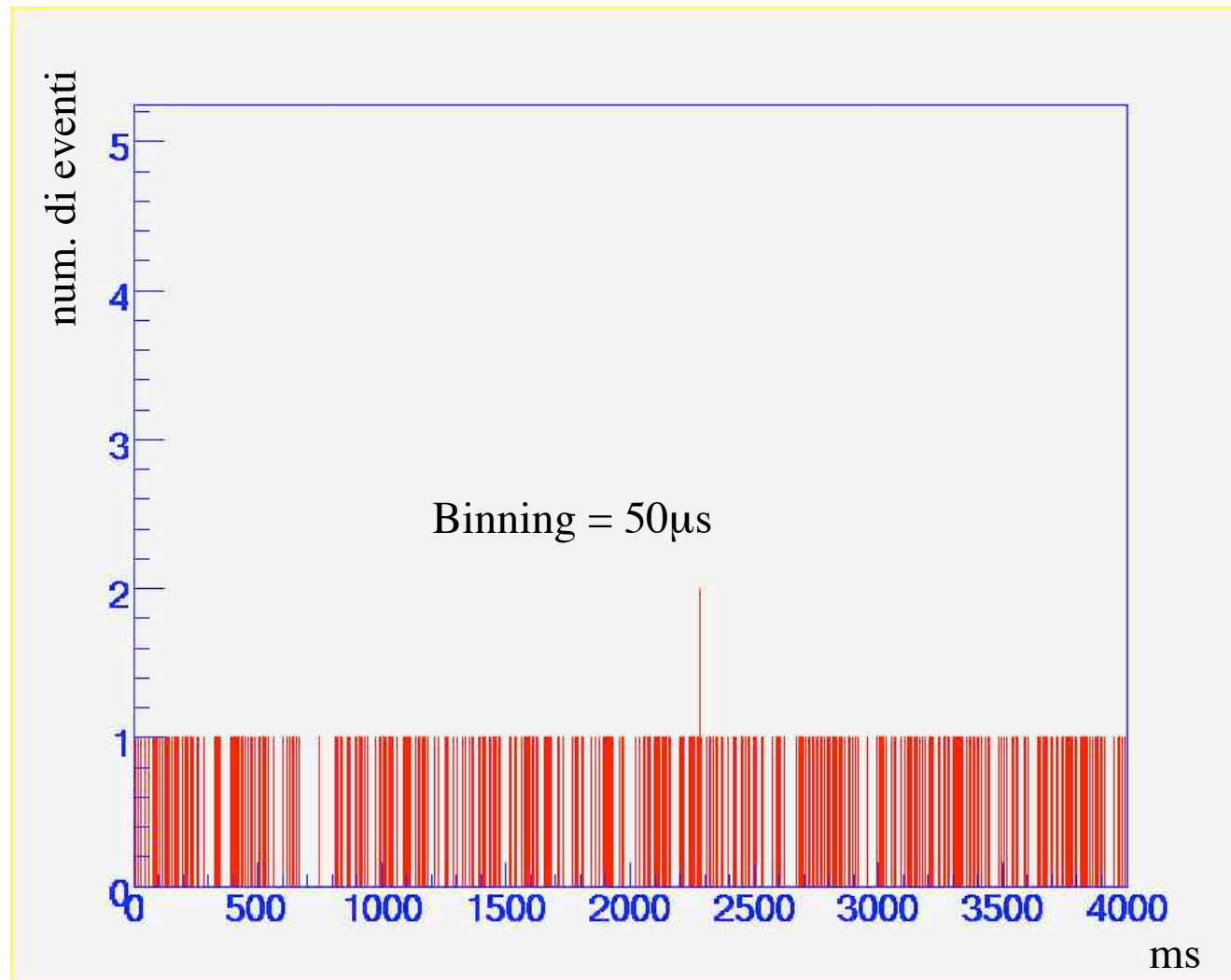


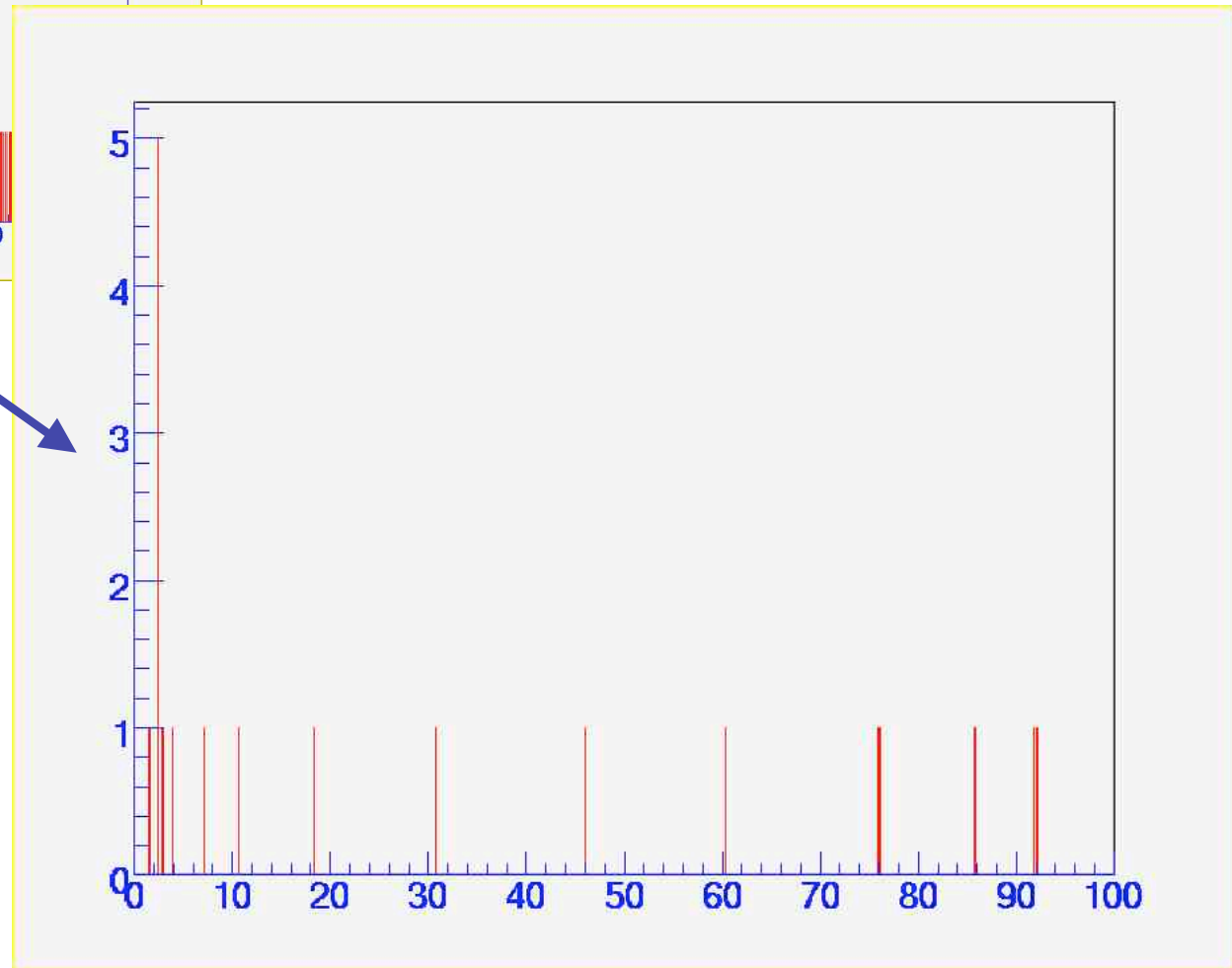
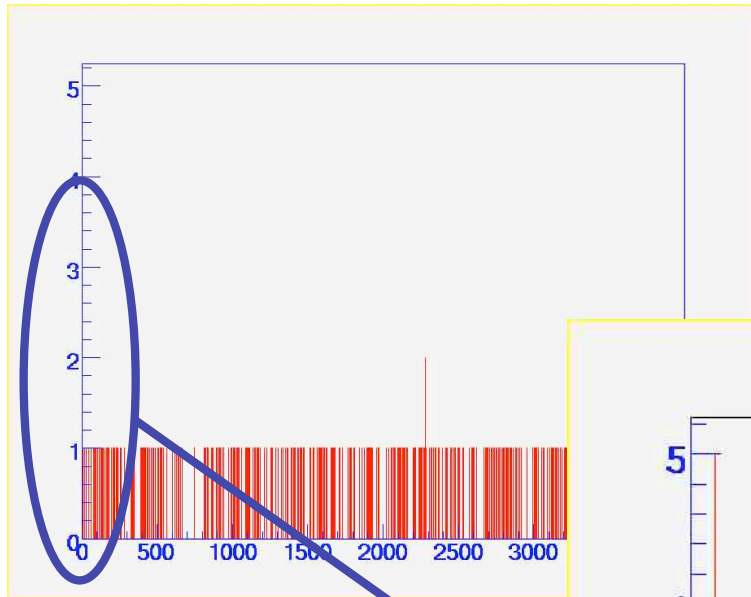


During the august 2006 CNGS runs:

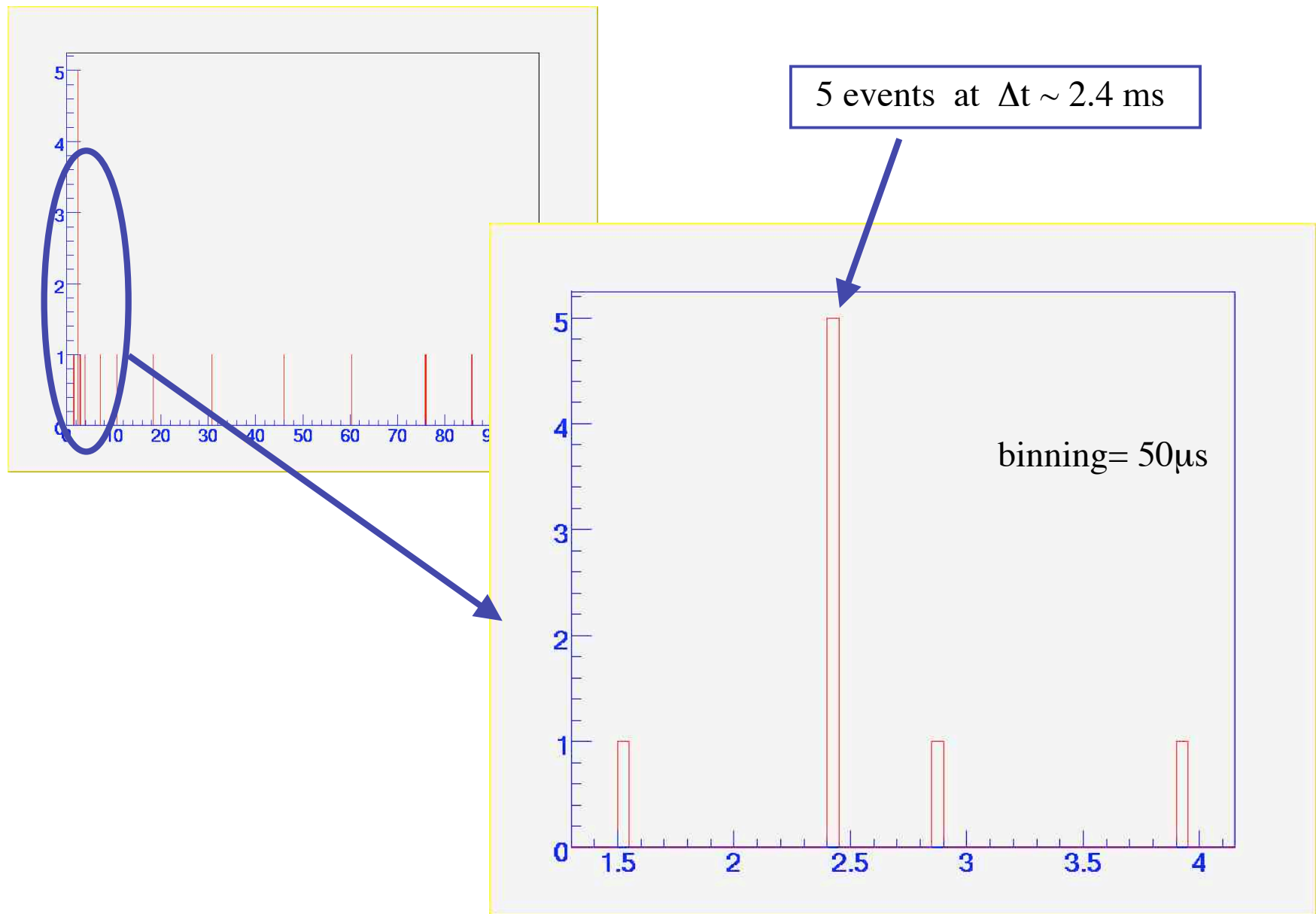
- ~ 30 h of data taking
- no event reconstruction was possible
- we plotted the time difference between the event time and the BX-GPS time

August 2006 time difference between the BX trigger time and the preceeding GPS signal

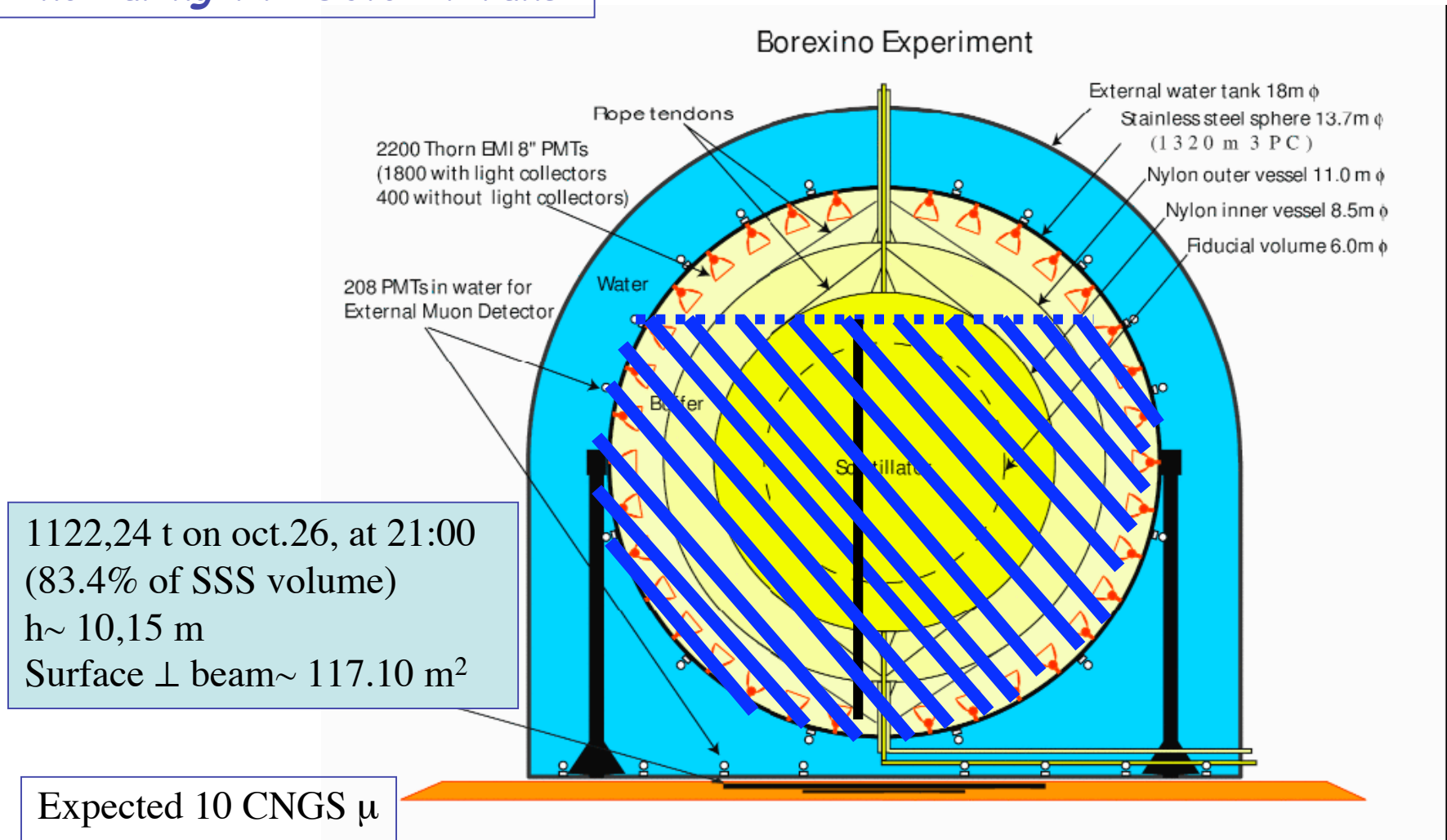




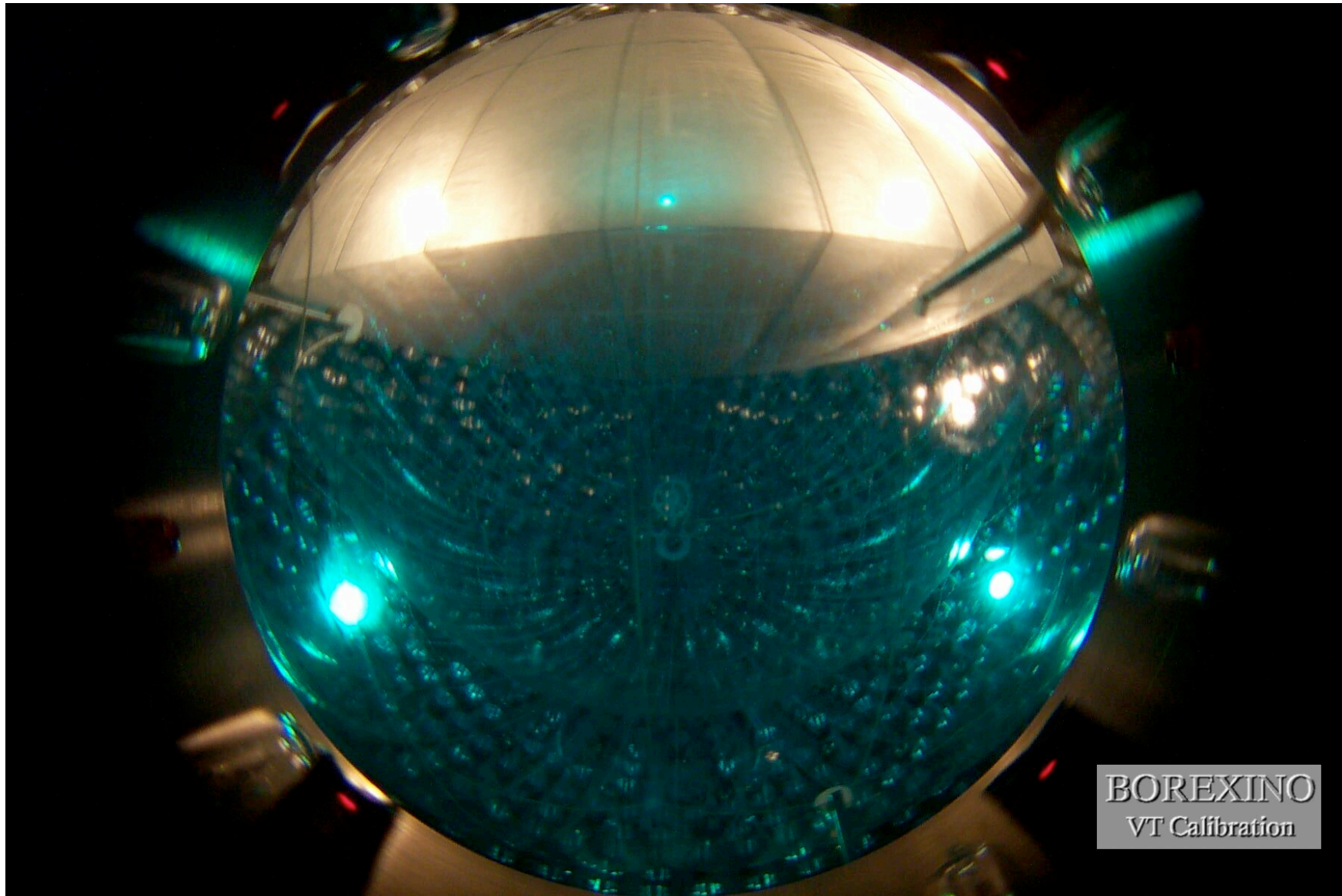
Laura Perasso



## Borexino during the October runs:

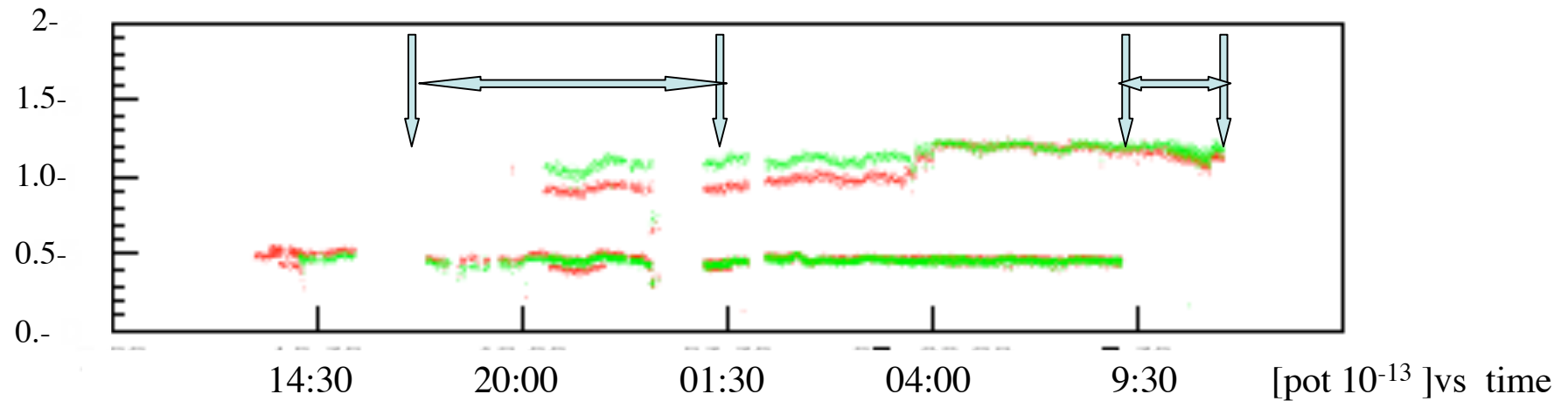


The inside of the Borexino SSS as on October 27<sup>th</sup>, at 7AM



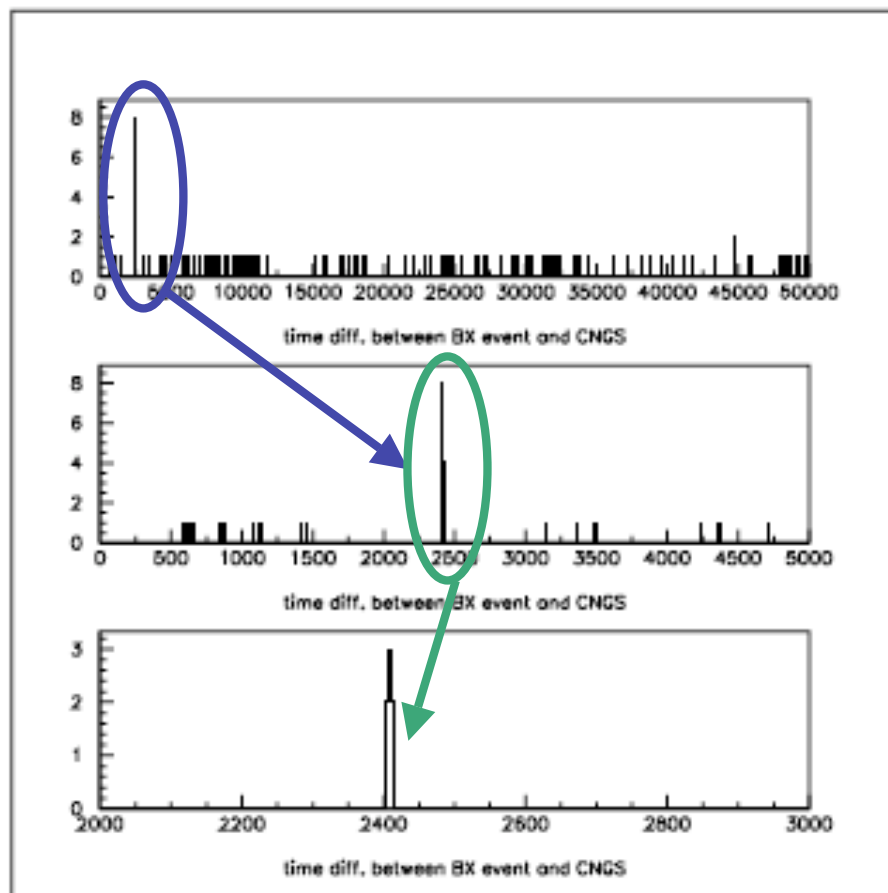
BOREXINO  
VT Calibration

In October 2006 we had two running periods,  
compatible with the SSS water filling,  
for a total of  $\sim 10$  h, equivalent to  $\sim 1.8 \cdot 10^{16}$  pot





October 2006 time difference between the BX trigger time and the preceding GPS signal



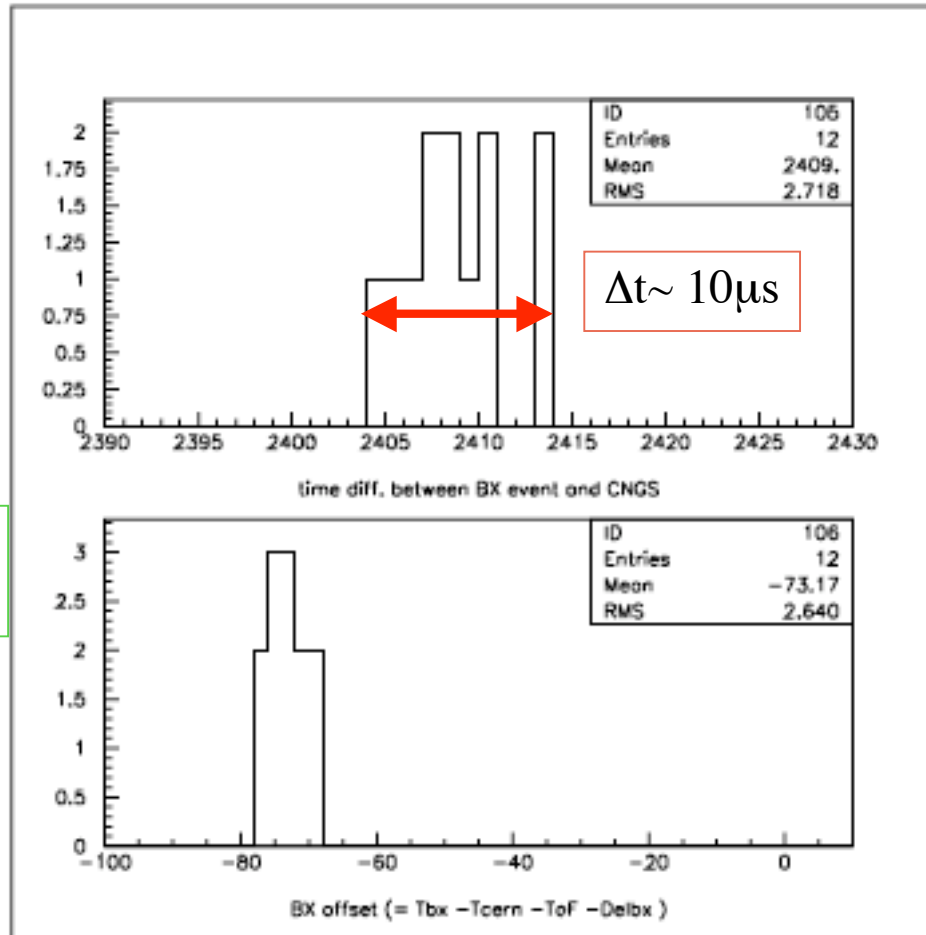
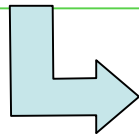
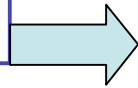
12 events at  $\Delta t \sim 2.4$  ms

October 2006 time difference between the BX trigger time and the preceding GPS signal

12 events at  $\Delta t \sim 2.4$  ms  
with the expected  $\Delta t$

Expected CNGS events: 10

Bx offset (under study) =  
 $\text{BXGP} - \text{CernUTC} - \text{ToF} - \text{LNGSdelay}$



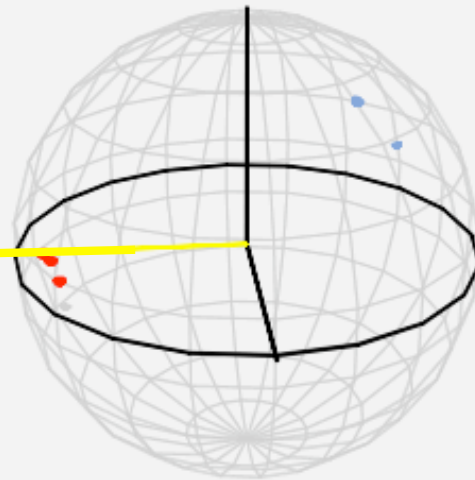
*No analysis, so far (Monte Carlo is in progress) :  
just eye scanning*

*One event:*

Borexino view Run=2919 Event=11059 Weight=1 Time in (-5500, -5482) ns

Z axis

X axis toward CERN



Pmt colors:

< 0.01pe

< 1.1pe

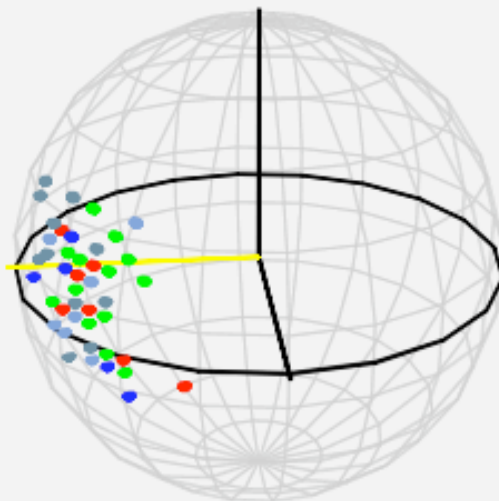
< 2.2pe

< 3.2pe

< 5.2pe

< 50pe

Borexino view Run=2919 Event=11059 Weight=1 Time in (-5480, -5463) ns



Pmt colors:

< 0.01pe

< 1.1pe

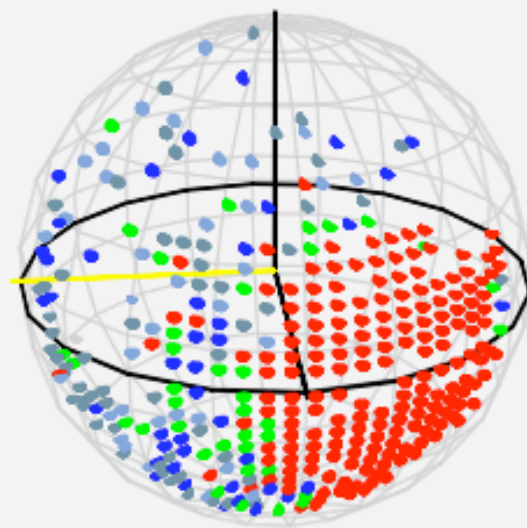
< 2.2pe

< 3.2pe

< 5.2pe

< 50pe

Borexino view Run=2919 Event=11059 Weight=1 Time in (-5463, -5445) ns



Pmt colors:

< 0.01pe

< 1.1pe

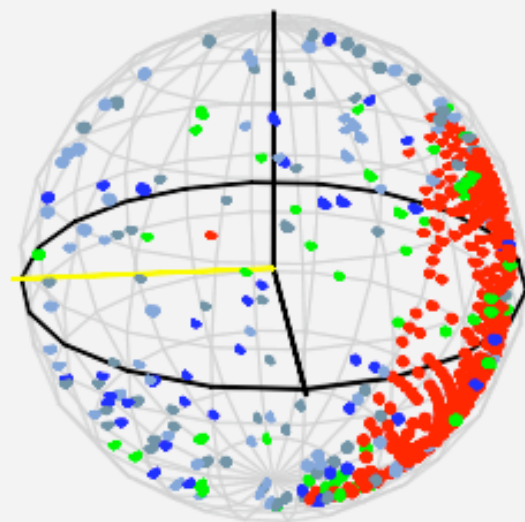
< 2.2pe

< 3.2pe

< 5.2pe

< 50pe

Borexino view Run=2919 Event=11059 Weight=1 Time in (-5445, -5427) ns



Pmt colors:

< 0.01pe

< 1.1pe

< 2.2pe

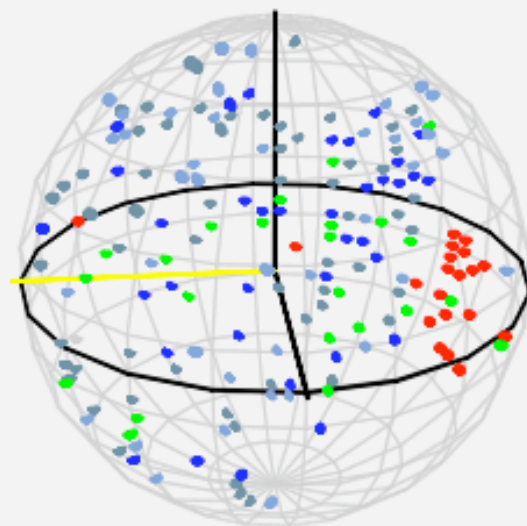
< 3.2pe

< 5.2pe

< 50pe



Borexino view Run=2919 Event=11059 Weight=1 Time in (-5426, -5408) ns



Pmt colors:

< 0.01pe

< 1.1pe

< 2.2pe

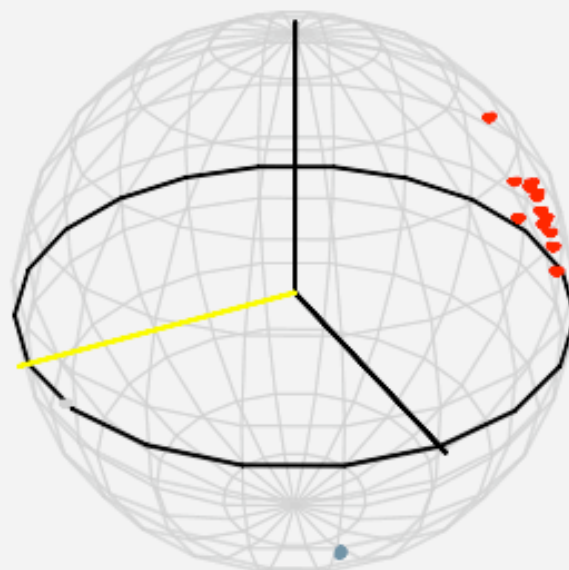
< 3.2pe

< 5.2pe

< 50pe

*... onother event:*

Borexino view Run=2919 Event=12208 Weight=1 Time in (-5521, -5490) ns



**Pmt colors:**

< 0.01pe

< 1.1pe

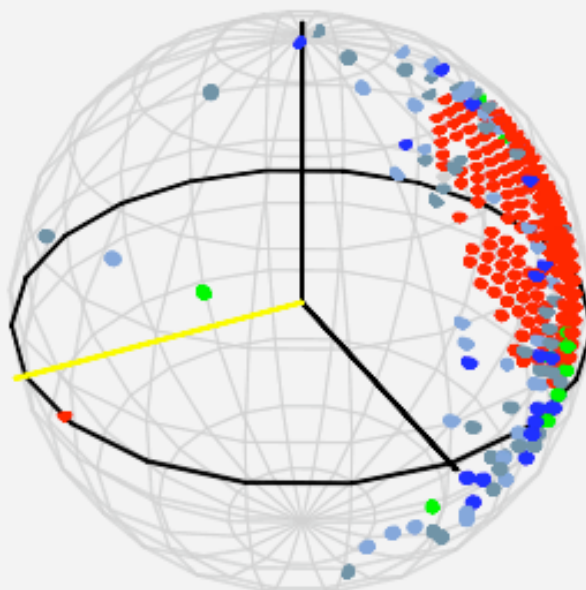
< 2.2pe

< 3.2pe

< 5.2pe

< 50pe

Borexino view Run=2919 Event=12208 Weight=1 Time in (-5506, -5475) ns



**Pmt colors:**

< 0.01pe

< 1.1pe

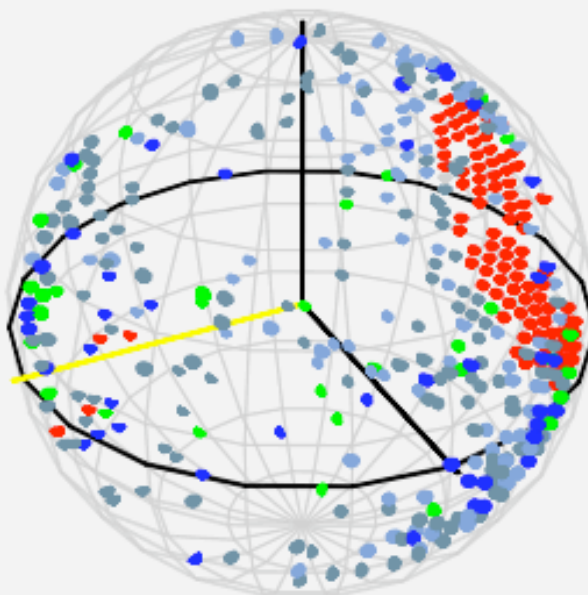
< 2.2pe

< 3.2pe

< 5.2pe

< 50pe

Borexino view Run=2919 Event=12208 Weight=1 Time in (-5485, -5455) ns



**Pmt colors:**

< 0.01pe

< 1.1pe

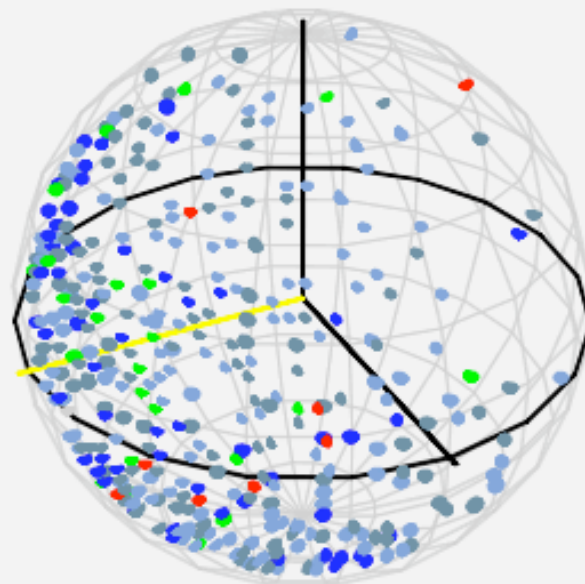
< 2.2pe

< 3.2pe

< 5.2pe

< 50pe

Borexino view Run=2919 Event=12208 Weight=1 Time in (-5455, -5424) ns



**Pmt colors:**

< 0.01pe

< 1.1pe

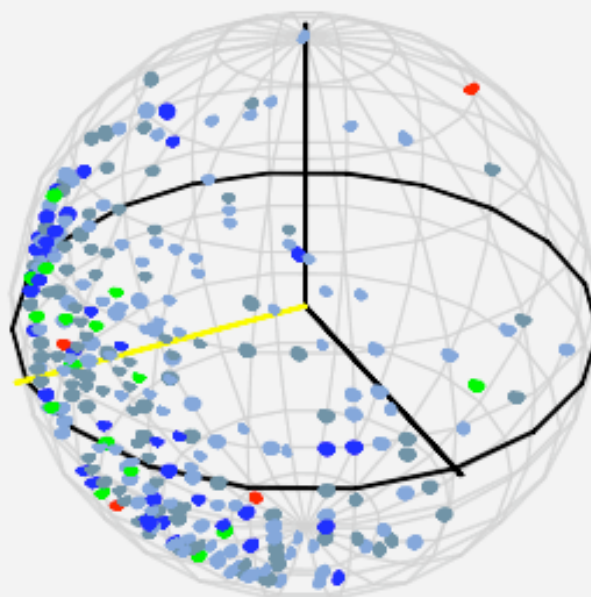
< 2.2pe

< 3.2pe

< 5.2pe

< 50pe

Borexino view Run=2919 Event=12208 Weight=1 Time in (-5434, -5404) ns



**Pmt colors:**

< 0.01pe

< 1.1pe

< 2.2pe

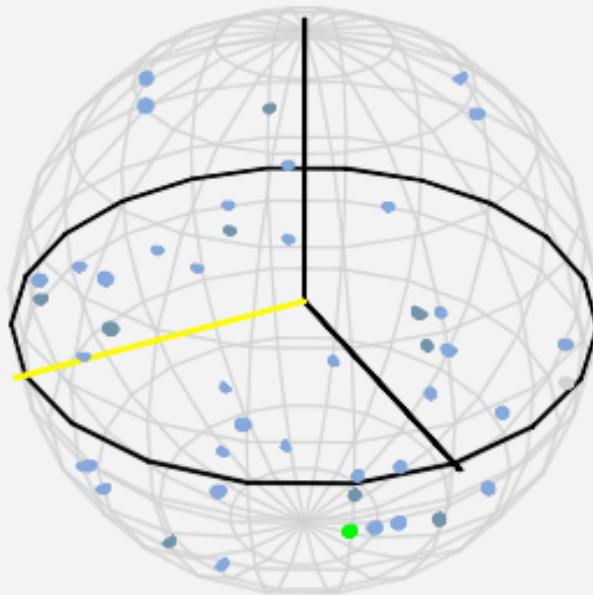
< 3.2pe

< 5.2pe

< 50pe



Borexino view Run=2919 Event=12208 Weight=1 Time in (-5409, -5378) ns



**Pmt colors:**

< 0.01pe

< 1.1pe

< 2.2pe

< 3.2pe

< 5.2pe

< 50pe

## *Conclusions:*

- Borexino, ~ full of water (i.e. acting as a Cherenkov detector) has detected the expected number of events ( one, as expected, together with Opera!)
- The CNGS beam has been very useful to:
  - test all the BX DAQ machinery in a “beam” environment
  - provide some well tagged muons to test the BX muon simulations
- Monte Carlo simulations for Cherenkov in water filled SSS are in progress

.... and we are waiting for the may beam when Borexino will be closer to its final configuration