--Hyper K--
Calibration Source Deployment and Location System

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On behalf of
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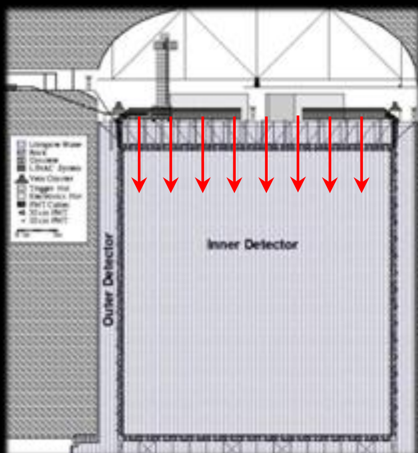
Towards HK

Basic Requirements

- Robustness and automation
  - The system must be personnel-independent due to the Hyper-K size and geometry
  - Use of the CCDs will give real time position information
- Interchangeability of sources
  - Correlated with the above statement
- Weight and cost constraints
  - Top deck can handle only certain kg/m^2

Current Deployment Systems

Super-K

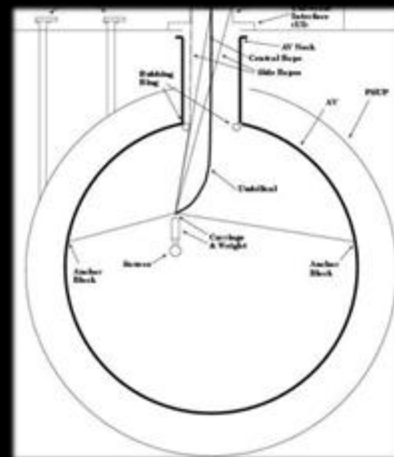


Semi-automatic

1D calibration
System (manual)

Volume Calibrated:
~ 50k m^3

SNO

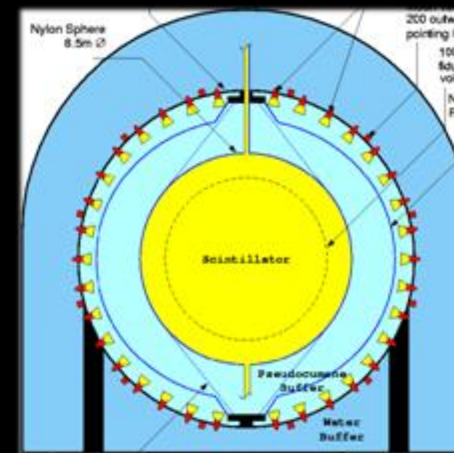


Semi-automatic

2D calibration
System (manual)

Volume Calibrated:
~ 1k m^3

Borexino

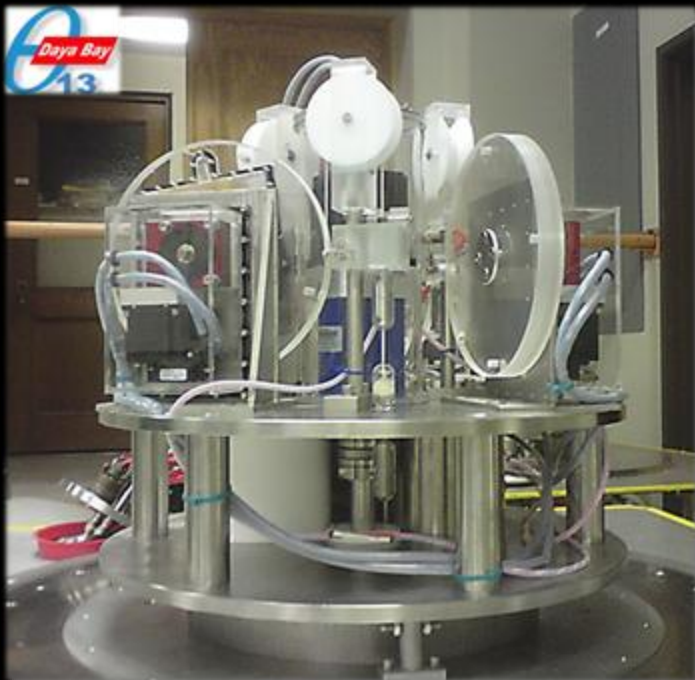


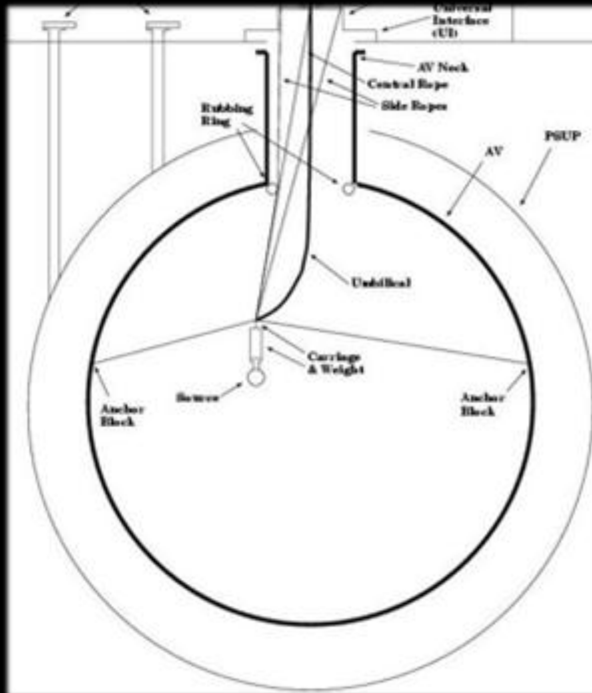
Fully manual

3D calibration
System (manual)

Volume Calibrated:
~ 0.3k m^3

Proposed Deployment Systems I

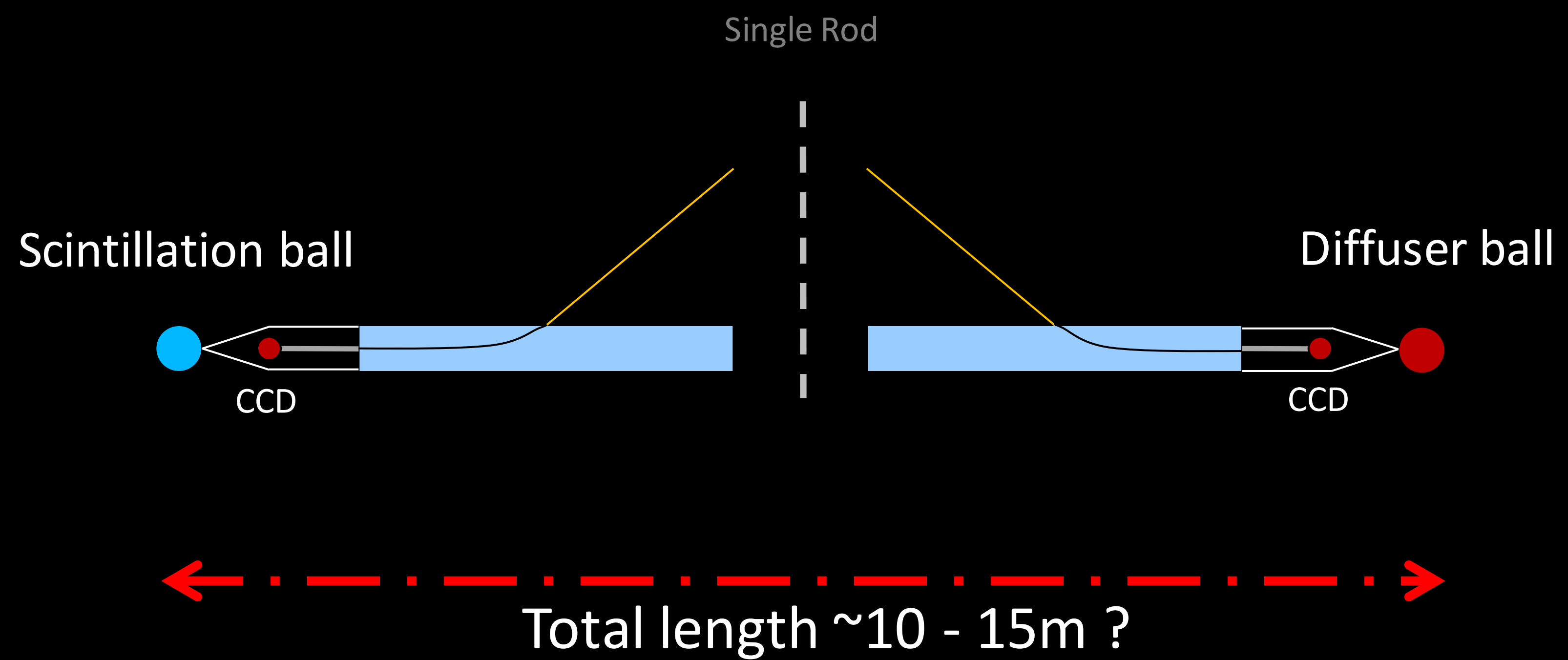




The two systems already implemented and tested in SNO and D-Bay

Use a hybrid for automation (D-Bay) and off-axis capability (SNO)

Proposed Deployment Systems II

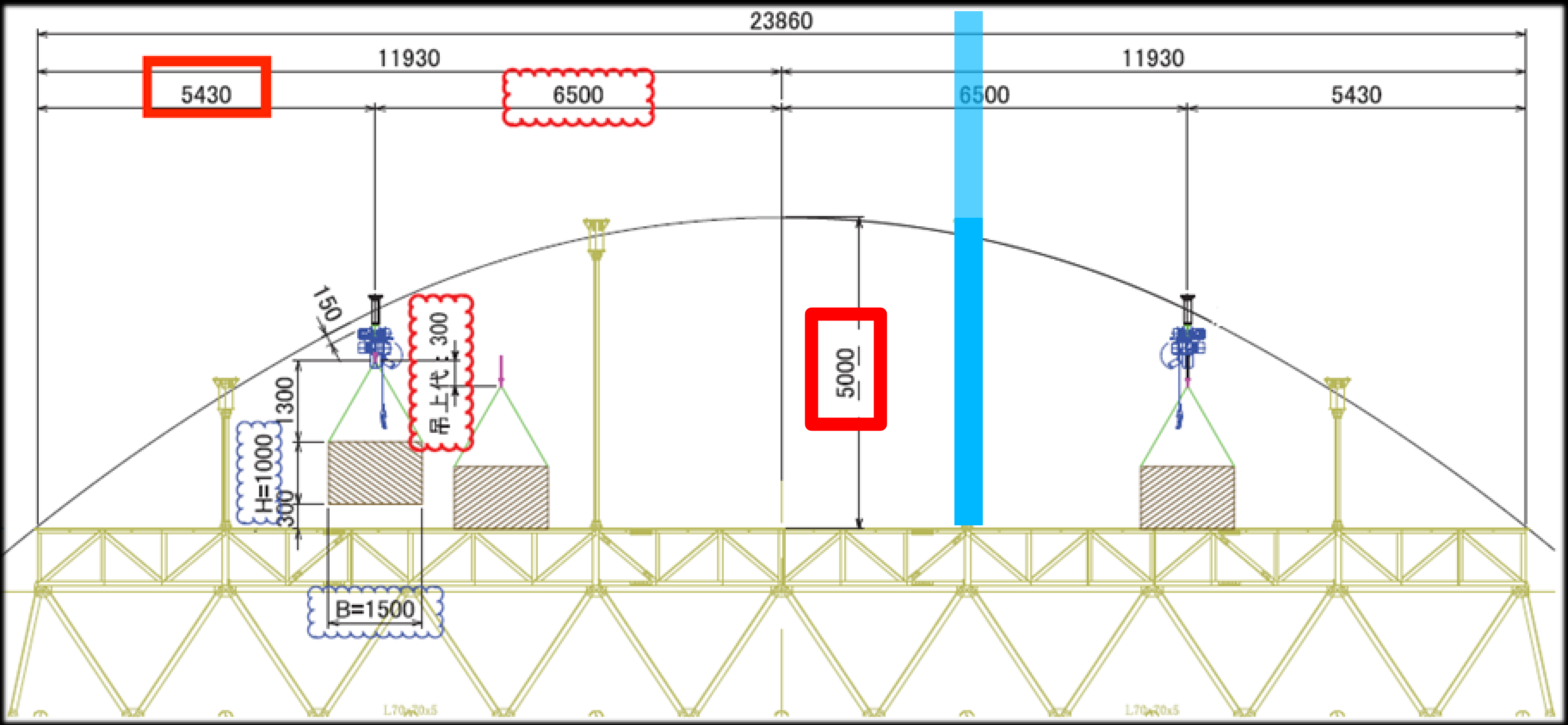


Similar to KamLAND: a solution with one rod, all sources mounted

Problem: where to store such a long rod ?

Proposed Deployment Systems II

Calibration rods stored in vertical holes drilled into the ceiling



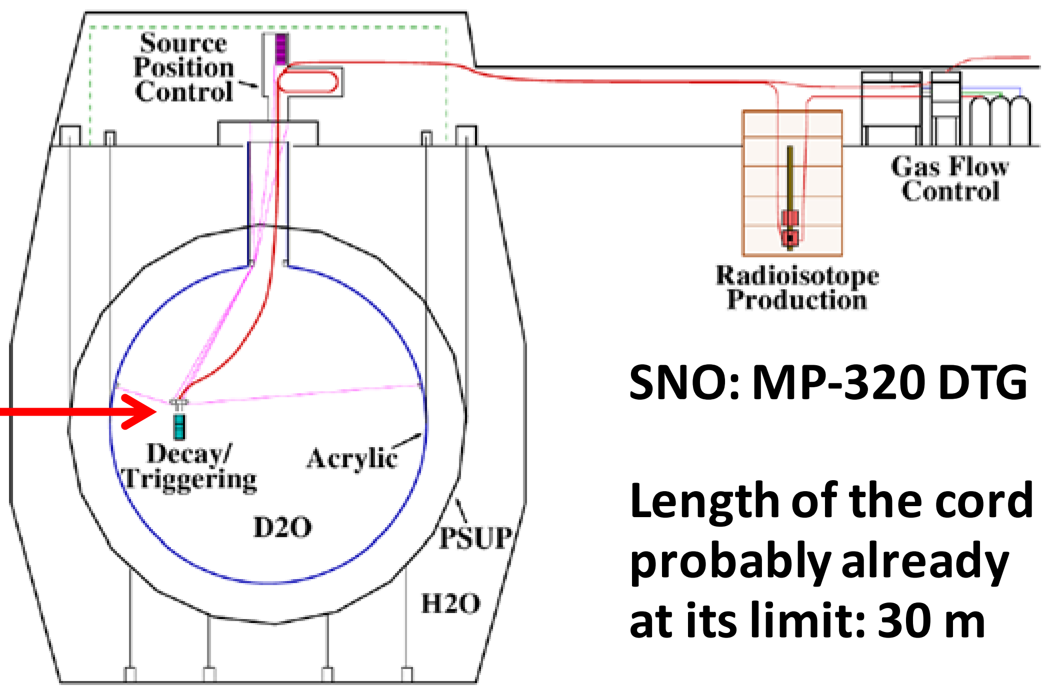
Low-Energy Calibration

- LINAC
  - Difficult option (availability, cost of 10 units)
- ^{16}N from DTG (Deuterium-Tritium n-Generator)
  - Requires a crane for the source (gun) relocation/insertion
- Cf-Ni source
  - Easy to maneuver but cannot switch it OFF
- ^{16}N from DTG in a gaseous form (CO_2)
  - Source delivered to its location via teflon tubing

Low-Energy Calibration

- ^{16}N from DTG in a gaseous form (CO_2)

Decay Chamber



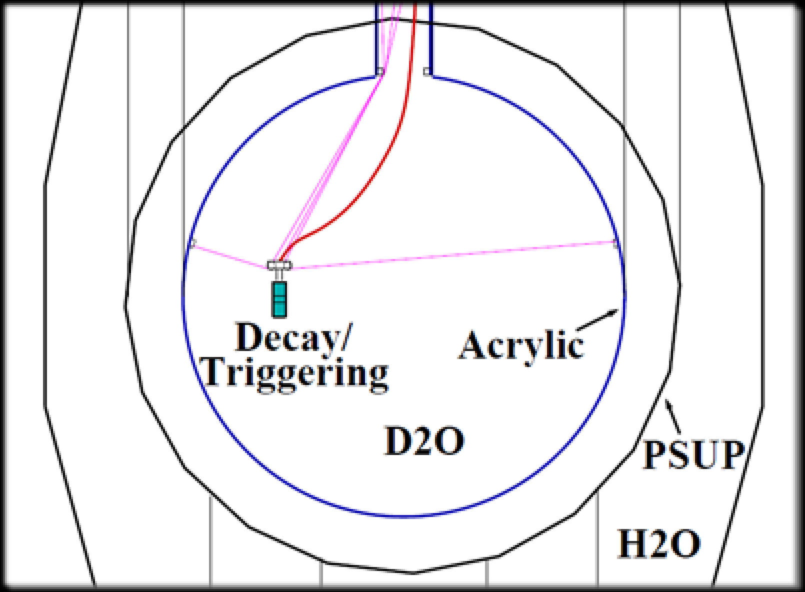
SNO: MP-320 DTG

Length of the cord probably already at its limit: 30 m

arXiv:nucl-ex/0109011

Low-Energy Calibration I

- ^{16}N from DTG in a gaseous form (CO_2)



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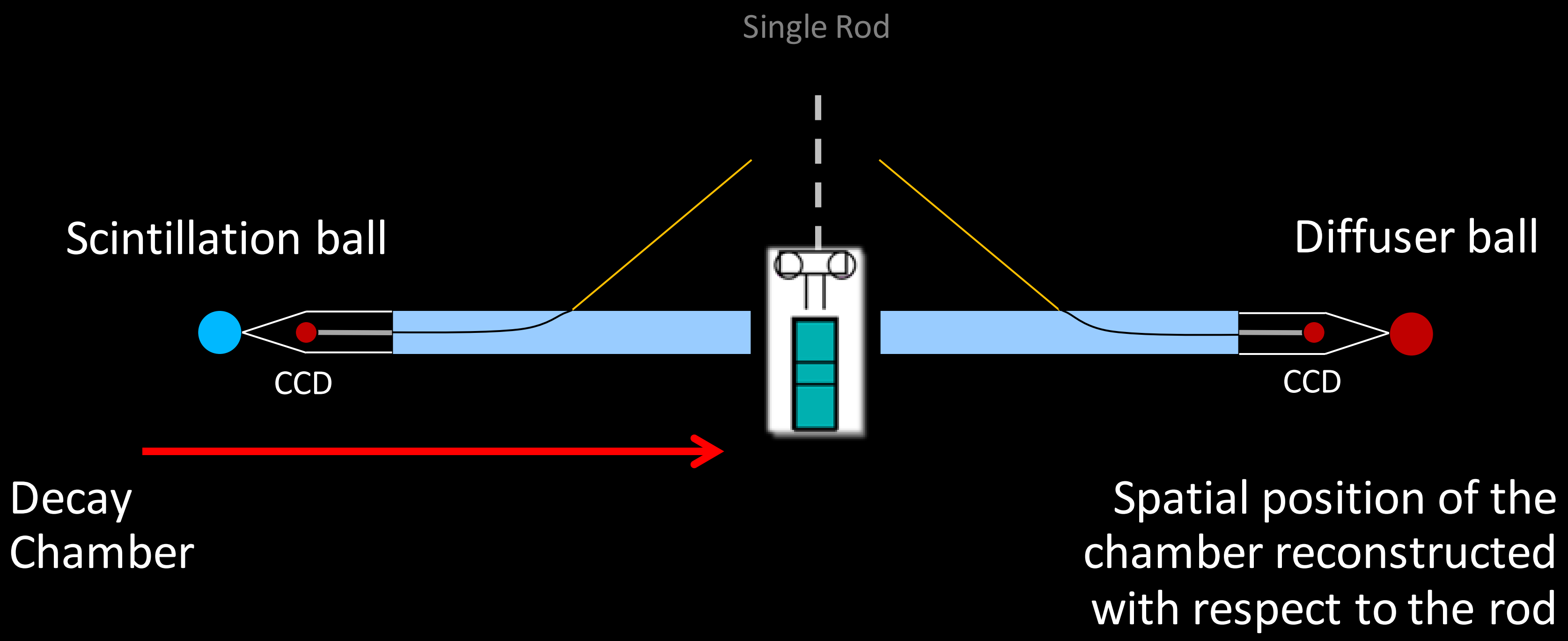
Low-Energy Calibration II

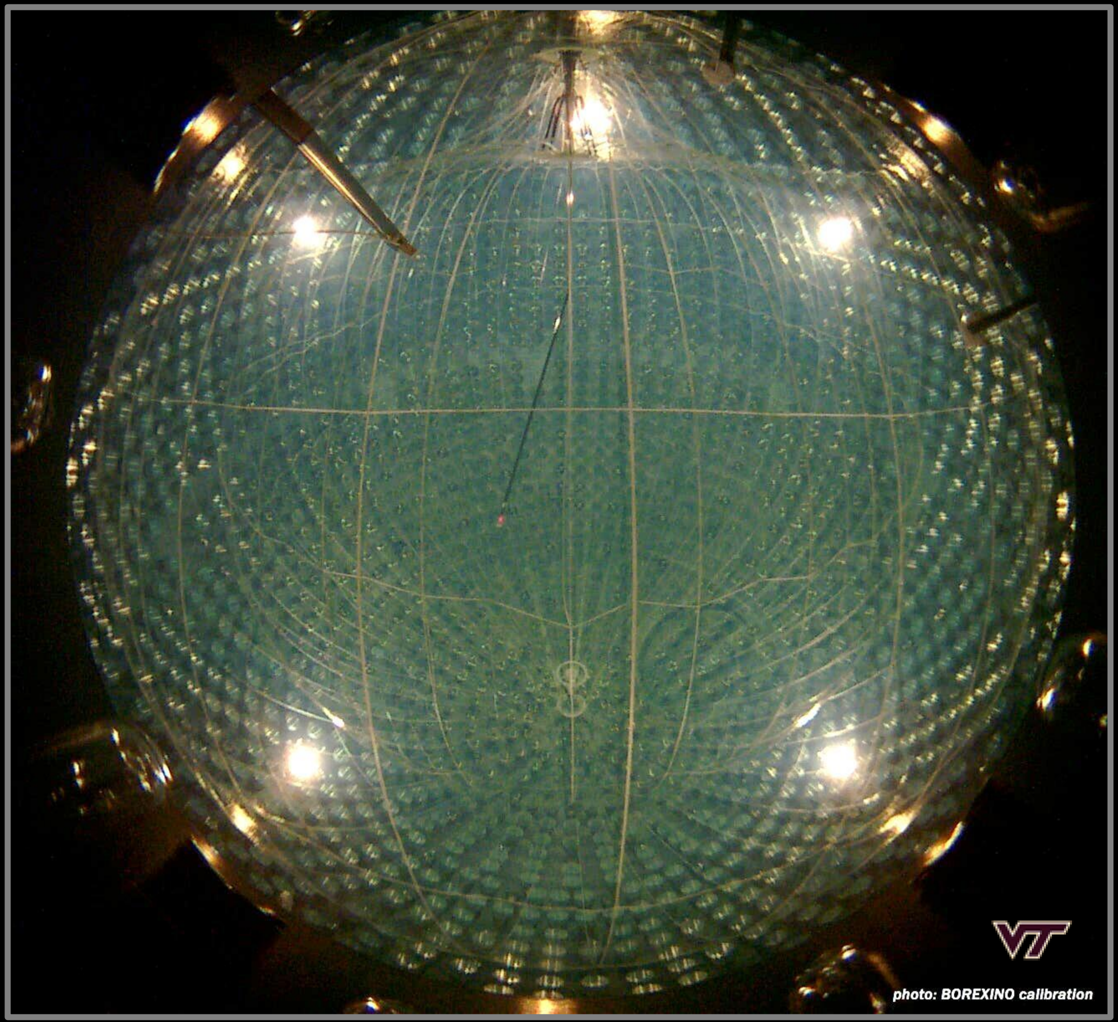
- ^{16}N from DTG in a gaseous form (CO_2)



Need to
Finalize the deployment system design and begin construction of a prototype

Source Location System

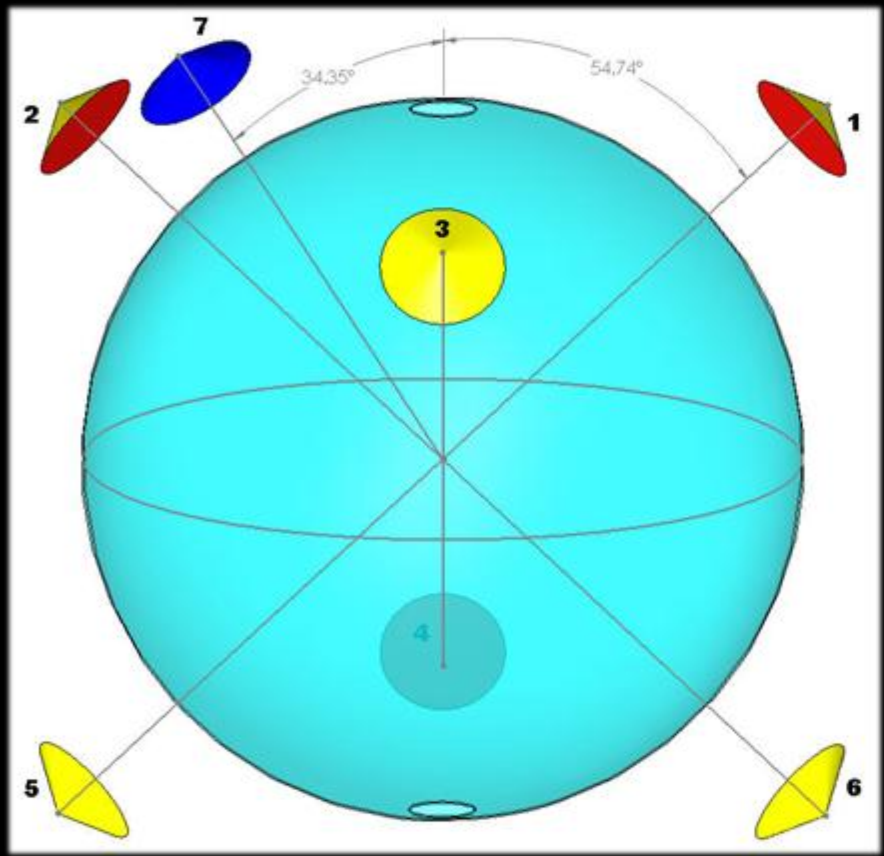
Borexino



Source Location System

Borexino

CCD-Cameras Locations:

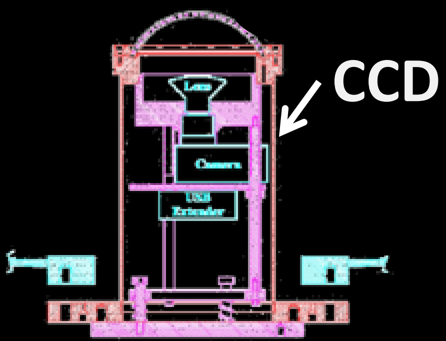


Kodak CCD:

- affordable
- easy to control remotely

CCD Dome:

- waterproof
- built-in 400W halogen lights



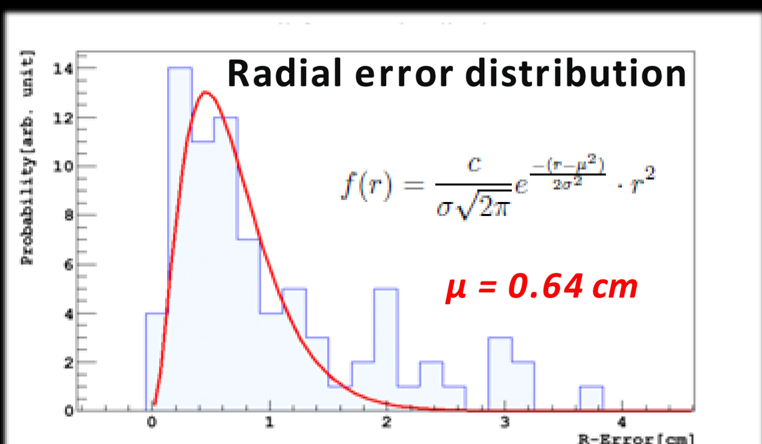
Source Location System

Borexino

We used the rods in on-axis position to verify the CCD reconstruction

Rods' position in vertical direction known to within 2 mm

Plot Δ(rod-CCD) vs z-axis (vertical)



The design goal for CCD precision for the source position was 2 cm

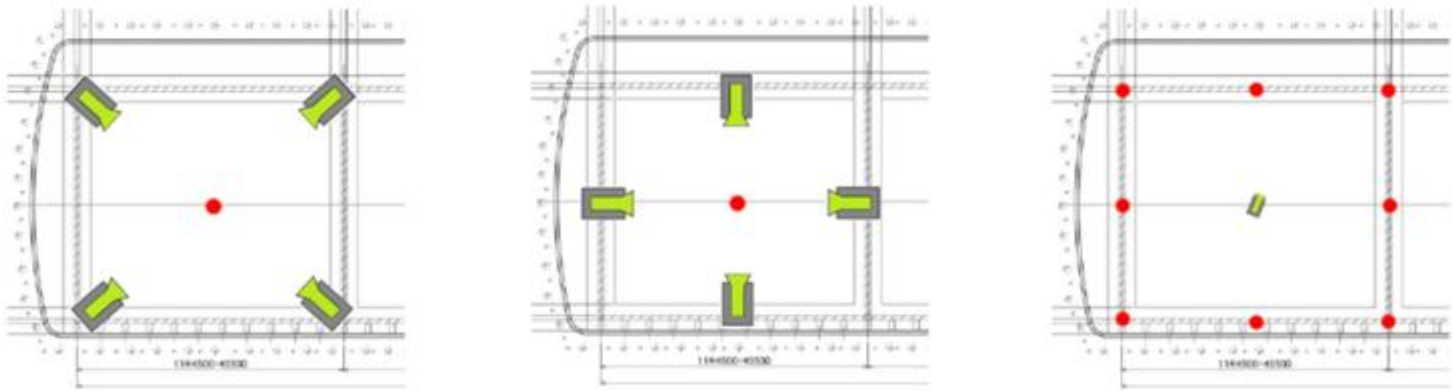
With the mechanical ruler (rods) we determined it to be 0.6 cm

Resulted in < 1% uncertainty on FV

Source Location System

Hyper-K

- Location of the CCD-Cameras
  - a) b) Cameras mounted on the Hyper-K tank
  - c) Only one camera mounted at the source-location

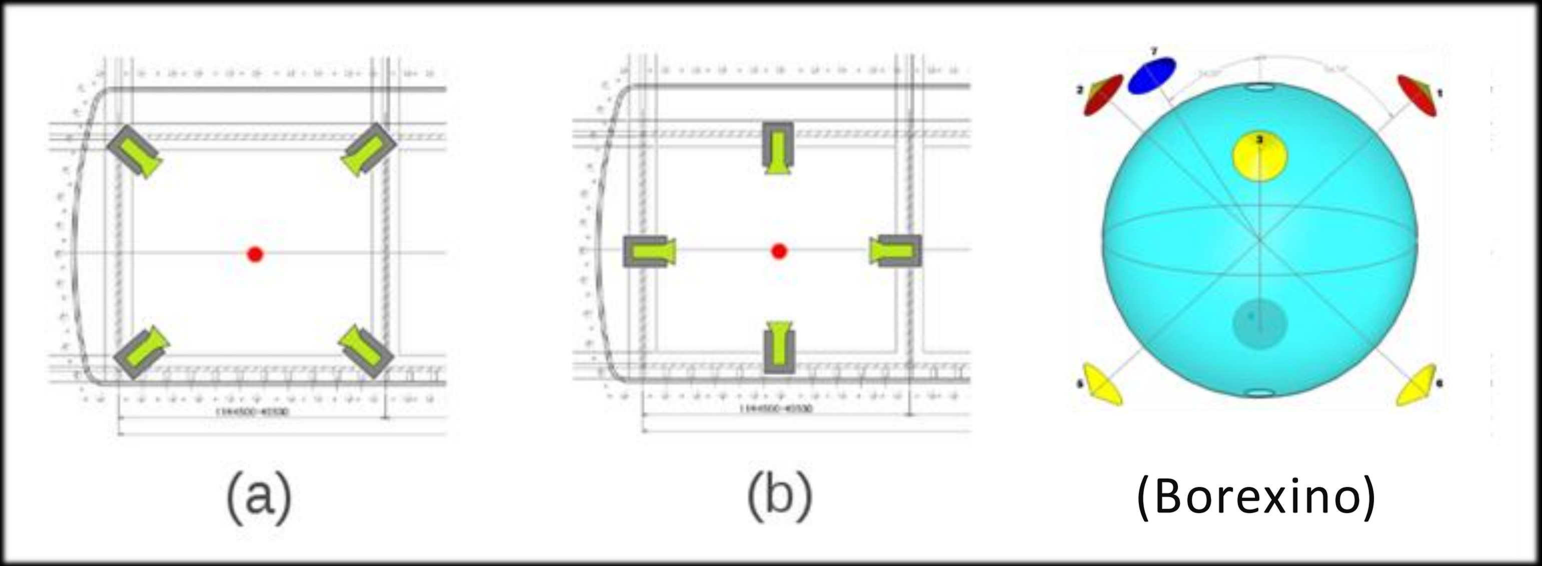


(a) (b) (c)

Source Location System

Hyper-K

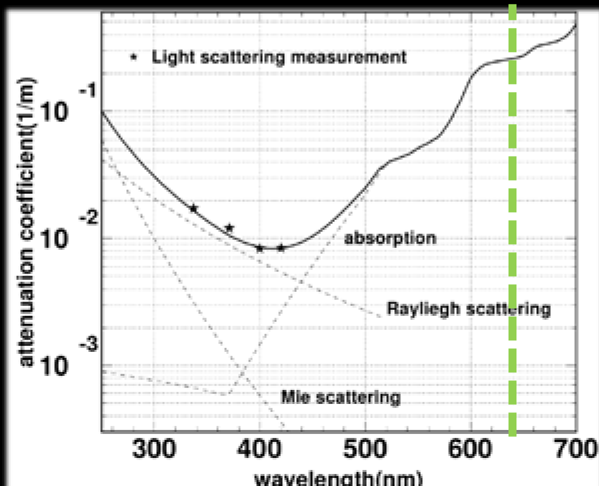
- Configuration of the CCD-Cameras (a, b)
  - 2 cameras sufficient, more needed due to limited lifespan
  - Cameras facing each other for self-calibration purpose

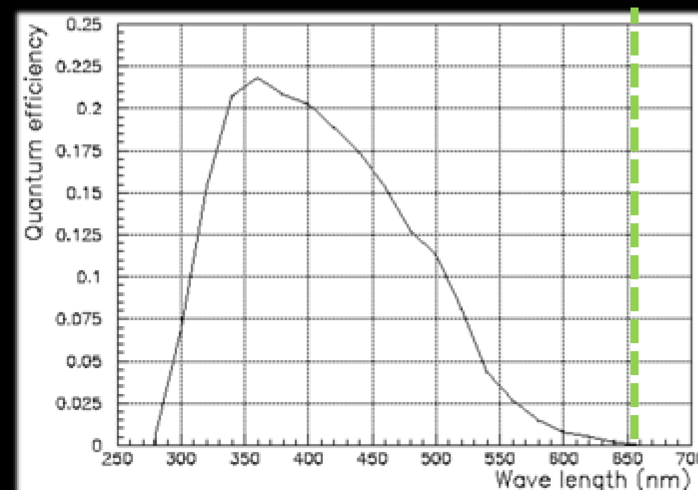


Source Location System

Hyper-K

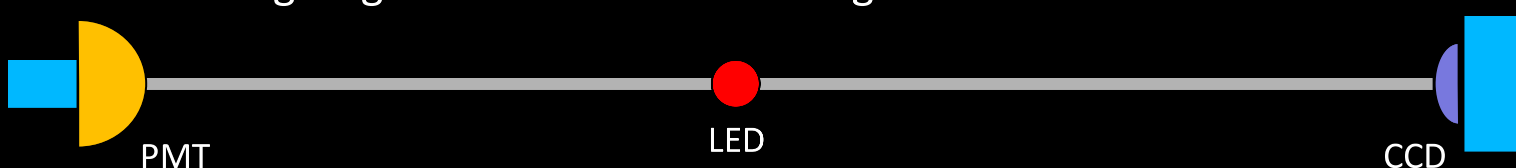
- Test of the CCD System in Water





660nm used in BX Should give enough Light for the CCD

Anything > 700nm Would require High-Watt LEDs



Conclusions

- Calibration deployment system
  - Finalize the design
    - Configuration I (SNO+DB) or II (KamLAND)
  - Justify low-energy calibration
    - Cf-Ni, DTG or DTG+CO_2
  - Begin prototype construction and tests
- Source location system
  - CCD and LED tested in PC (Borexino)
  - Complete CCD test in water (or SNO+)

Thank You