Status of the Double Chooz Detectors

Ilja Bekman [1], Emmanuel Chauveau [2], Guillaume Pronost [3], Ben Rybolt [4] on behalf of the Double Chooz collaboration

[1]III. Physikalisches Institut, RWTH Aachen University

[2]Research Center for Neutrino Science, Tohoku University, Sendai

[3]SUBATECH, CNRS/IN2P3, Université de Nantes, Ecole des Mines de Nantes

[4]Department of Physics and Astronomy, University of Tennessee

INTRODUCTION

Double Chooz experiment aims to measure precisely the neutrino mixing angle θ_{13} by looking for disappearance of reactor antineutrinos $\bar{\nu}_e$ with two identical detectors.

The far detector, running since April 2011, participed in the discovery of the non-vanishing θ_{13} and in the first precise measurement based on prediction of neutrino flux.

The construction of the near detector, started in April 2014, is currenlty being finalised. First candidates of "near neutrinos" will be detected in September 2014.

With both detectors running, the final precision of Double Chooz experiment on $\sin^2(2\theta_{13})$ is expected to be ≈ 0.01 [1].

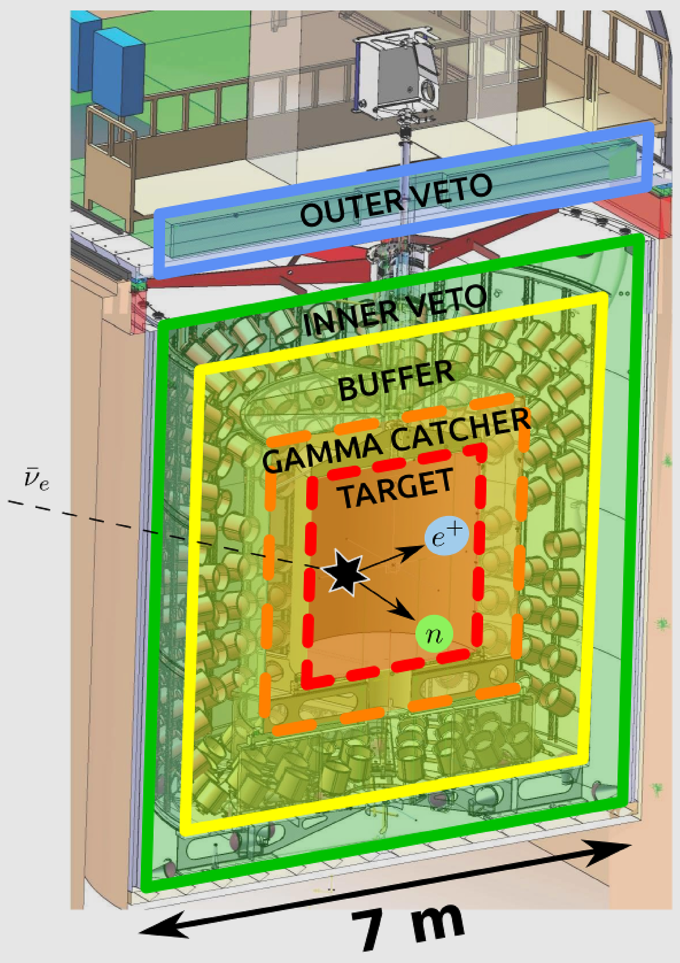
DETECTION PRINCIPLE

$$\bar{\nu}_e + p^+ \longrightarrow e^+ + n$$

prompt signal: scintillation + e⁺ annihilation
E ~ E(ν_e) - 0,8 MeV

delayed signal: gamma ray(s) from neutron capture
n-Gd E ~ 8,0 MeV ΔT ~ 30 µs
or n-H E ~ 2,2 MeV ΔT ~ 200 µs

DETECTOR LAYOUT



Neutrino target (10 m³)
liquid scintillator PXE + Gd

Gamma catcher (22 m³)
liquid scintillator PXE (no Gd)

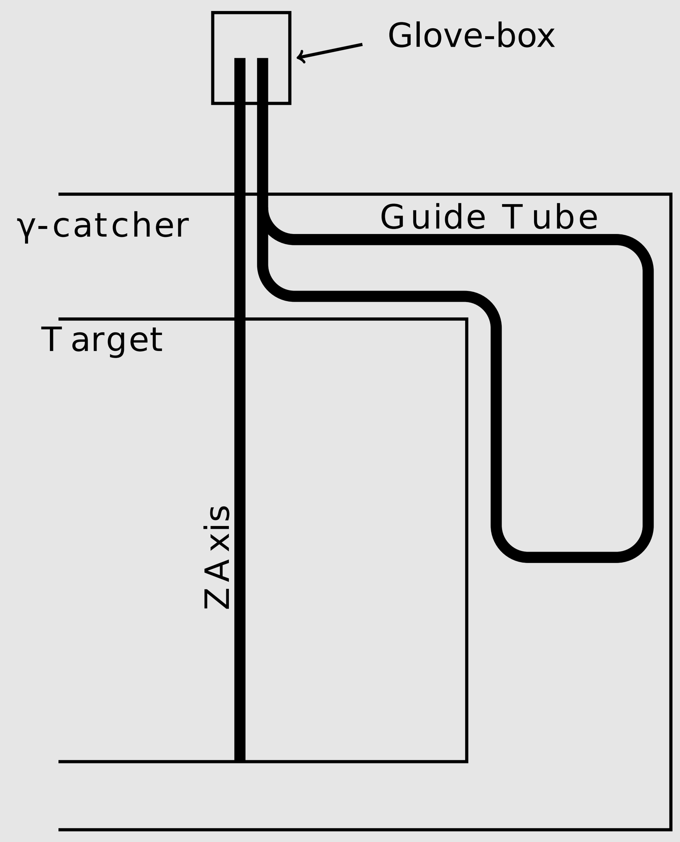
Buffer volume (110 m³)
transparent mineral oil
with 390 x 10" PMTs assembly

Inner Veto (90 m³)
liquid scintillator (LAB)
with 78 x PMTs 8"

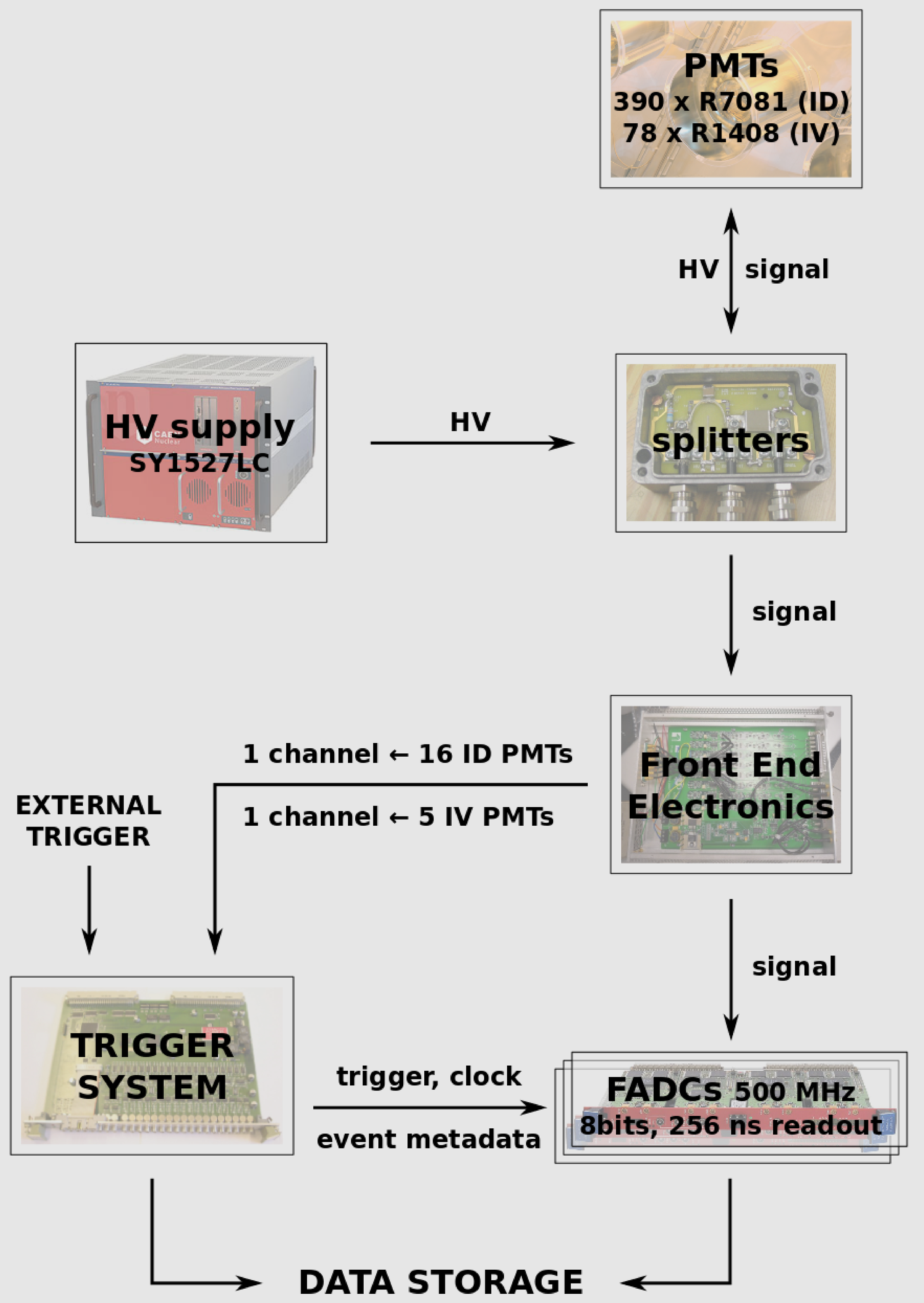
Outer Veto (6.4 x 12.8 m²)
plastic scintillator strips

CALIBRATION DEVICES

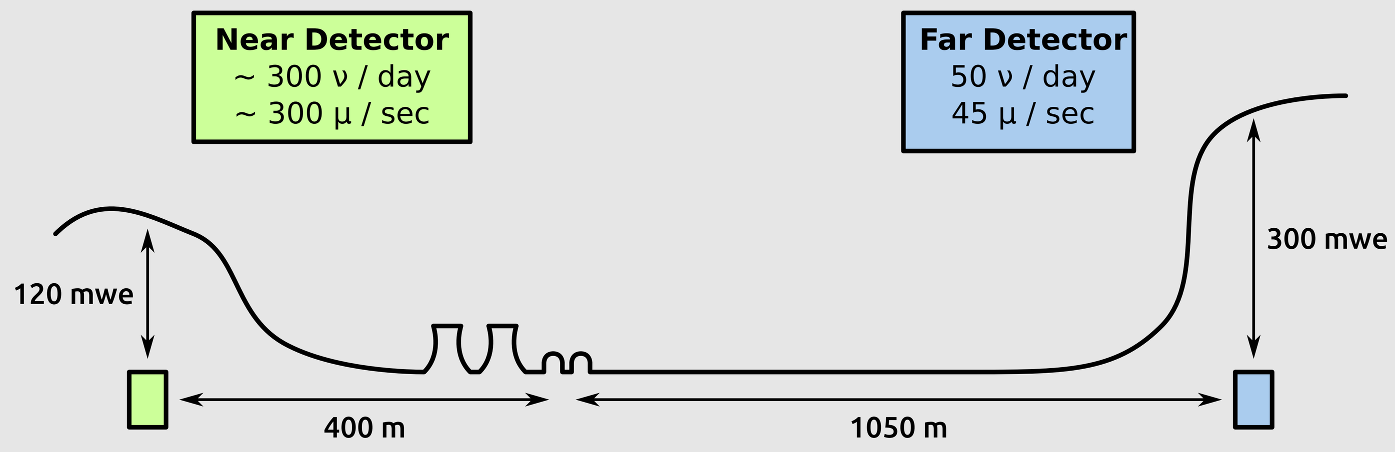
- A fish-line system on the **Z-axis** of the neutrino target, to deploy various calibration sources: ^{60}Co, ^{68}Ge, ^{137}Cs and ^{252}Cf.
- **The guide tube**, a thin calibration tube running along the walls of target and gamma catcher acrylic vessel for absolute calibration of gamma catcher areas.
- **Light injection devices** for each PMT setup (ID and IV) to measure their gain + timing with different wavelengths and light intensities, and to monitor stability.
- **An articulated arm**, planned to be deployed into both detectors to enhance the calibration of the target in currenlty inaccessible regions.

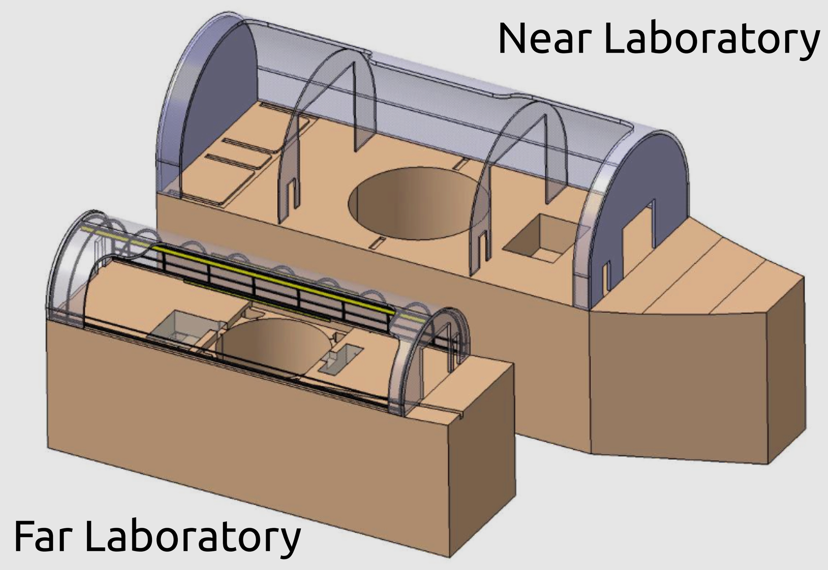


ELECTRONICS AND DATA ACQUISITION

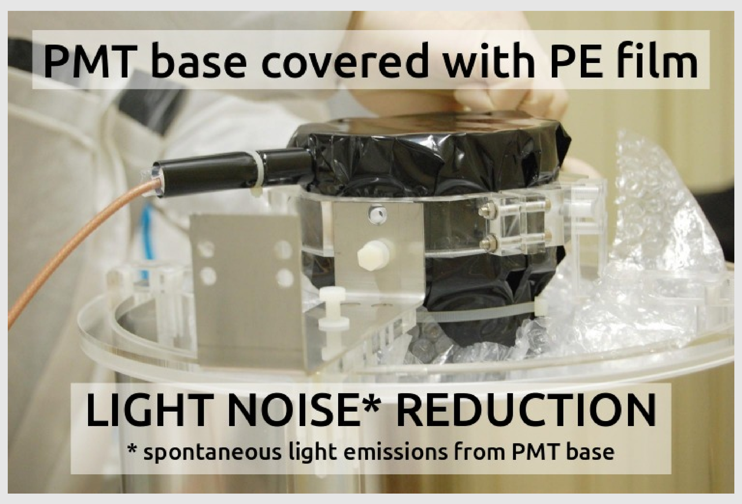


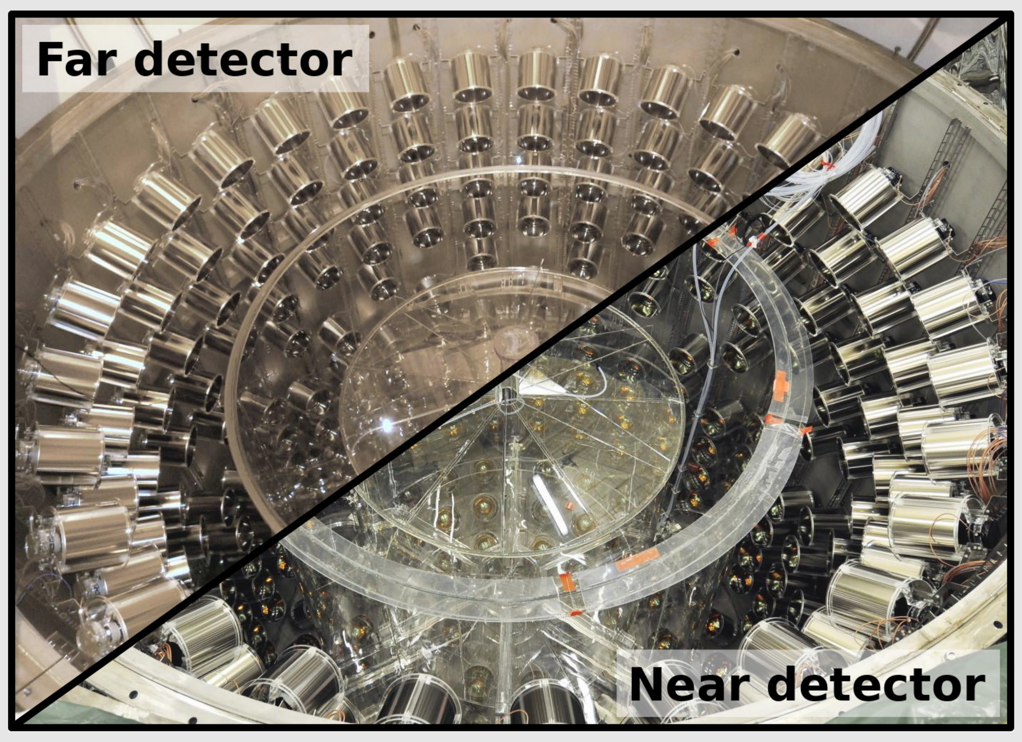
NEAR DETECTOR VS FAR DETECTOR





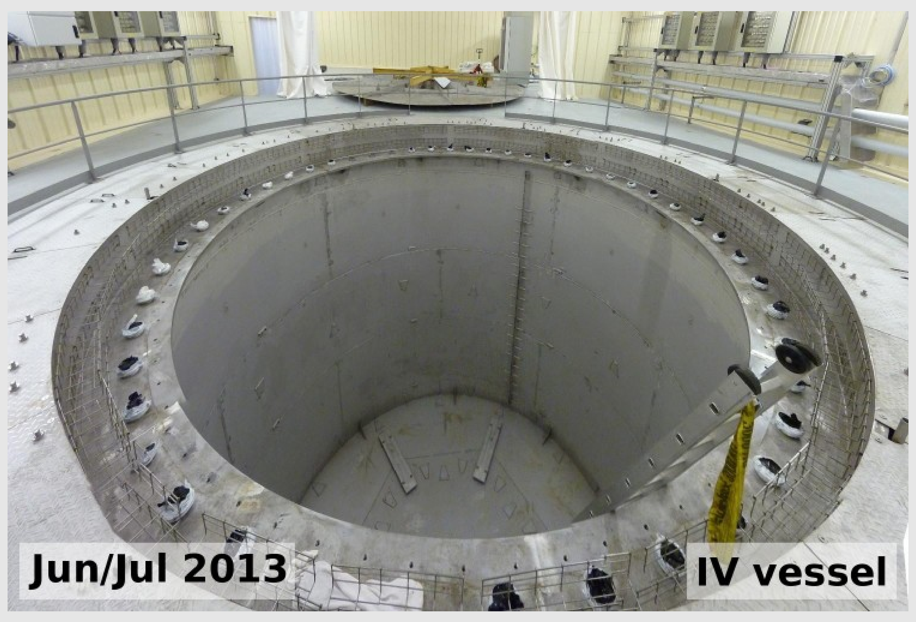
large laboratory with **ISO 5 class** air system
3 separated rooms to parallelise integration steps

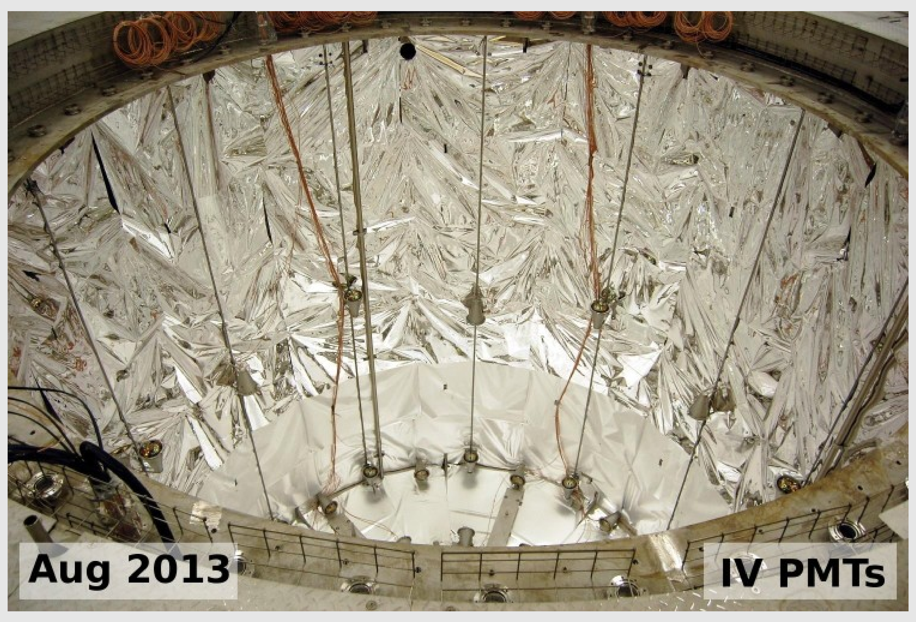


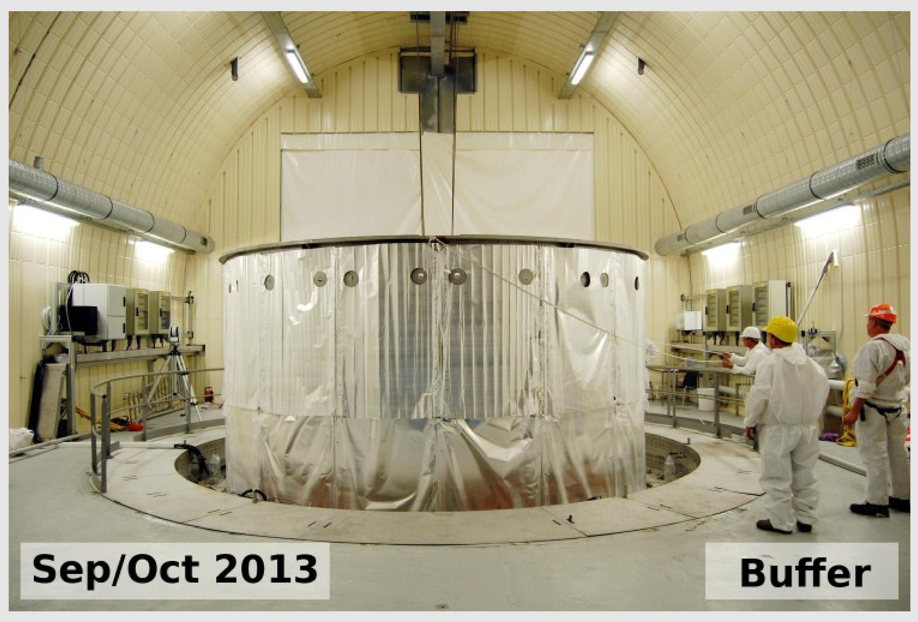


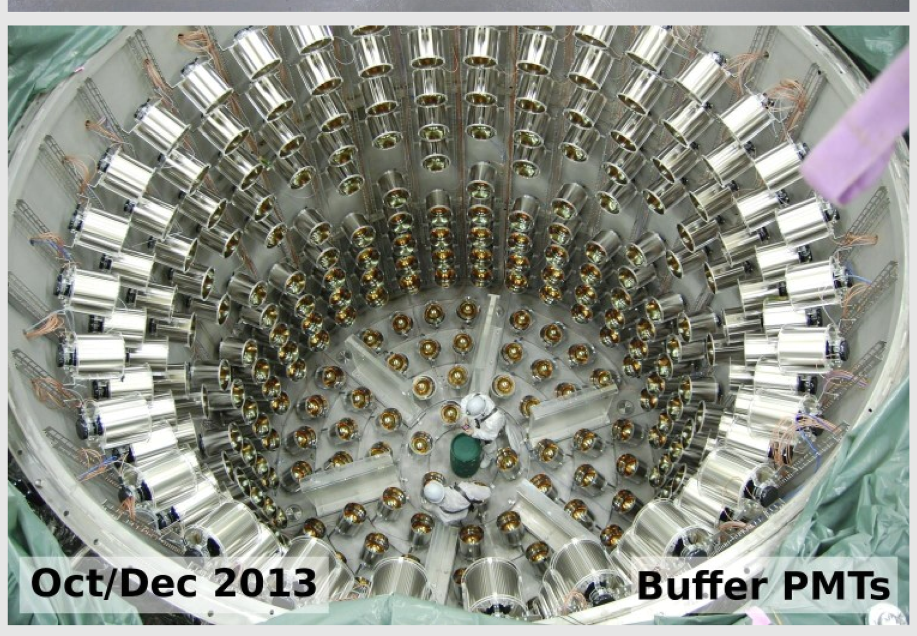
IDENTICAL SENSITIVE DETECTOR

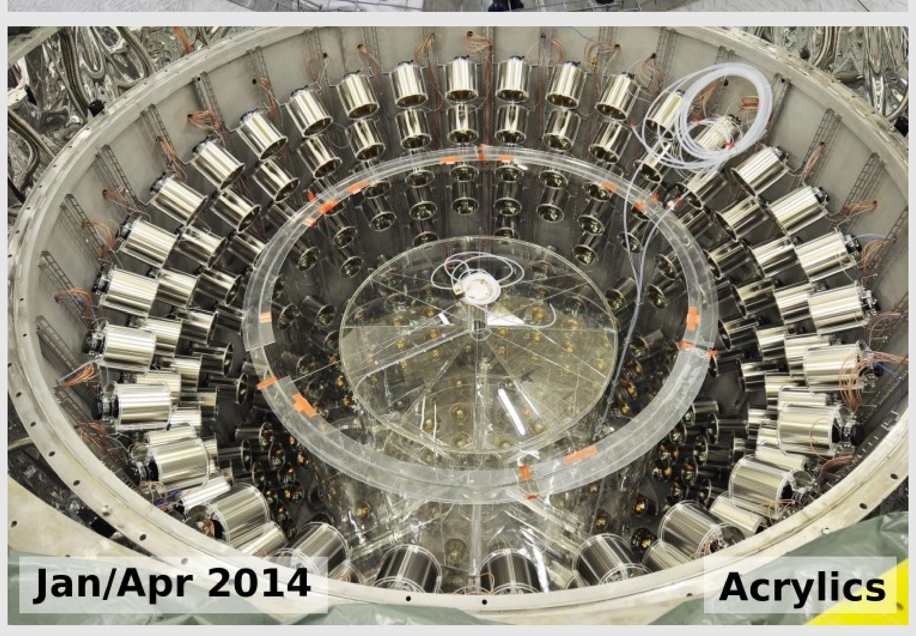
NEAR DETECTOR INTEGRATION

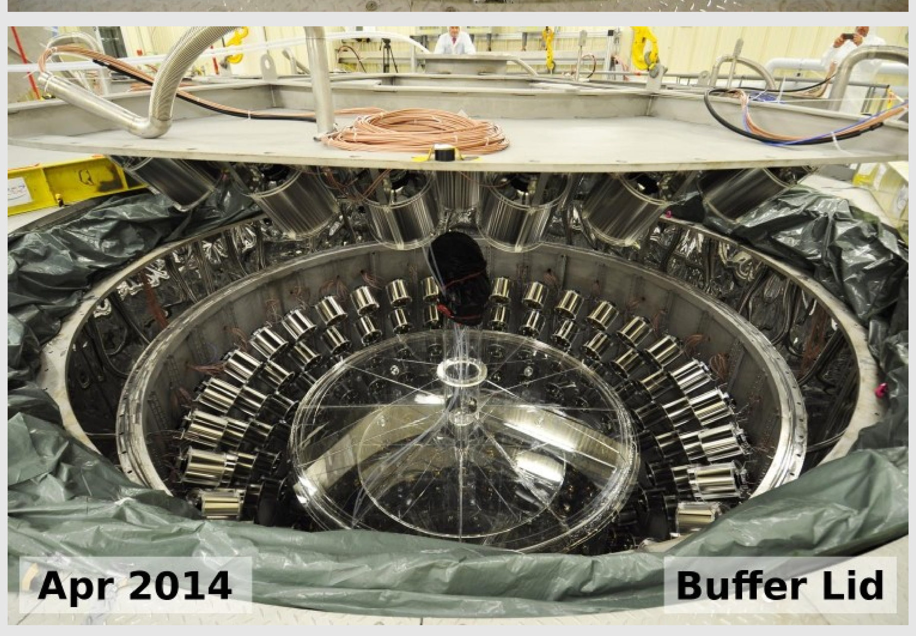


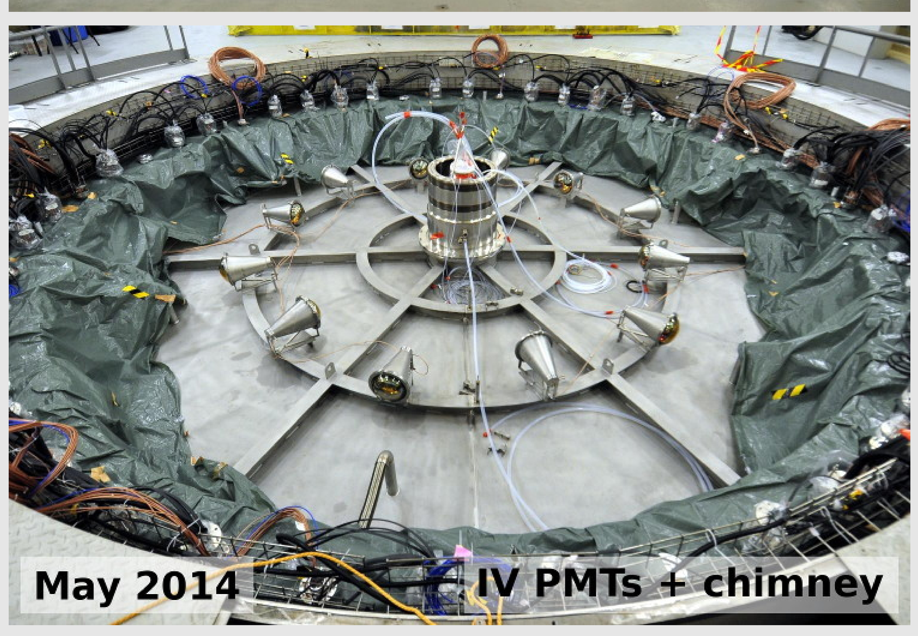












DETECTOR UPGRADE

- Far detector previously running with **14 PMTs** switched OFF due to their strong light noise emission, now fully rejected by improved offline method [2] → all PMTs **back ON** (optimal detection uniformity).
- FEE upgrade: **increase of the gain** by a factor 2 → expect more linear response at the single-PE charge level.
- **Upgraded DAQ capability** (chained DMA transfer, multithreading, ...) to withstand higher event rates, now up to ≈ **600 triggers/s**.
- New trigger firmware to allow some degree of **basic event classification** based on energy threshold flagging.
- Improved DAQ to perform fast event reconstruction (baseline, charge, times, etc.) allowing for future **dynamic data storage reduction** (no waveform).
- Several other improvement in Online, DAQ and Trigger system for enhanced performance for ND+FD combined.

MORE DEDICATED POSTERS ABOUT DOUBLE CHOOZ @ NEUTRINO 2014

1. New results and future capabilities of the Double Chooz reactor antineutrino experiment
2. Reactor antineutrino detection in Double Chooz: New techniques for background
3. Determination of the detection systematics in the Double Chooz experiment
4. The Visible Energy of Double Chooz
5. Neutrino directionality measurement with Double Chooz
6. Observation of ortho-positronium formation in Double Chooz