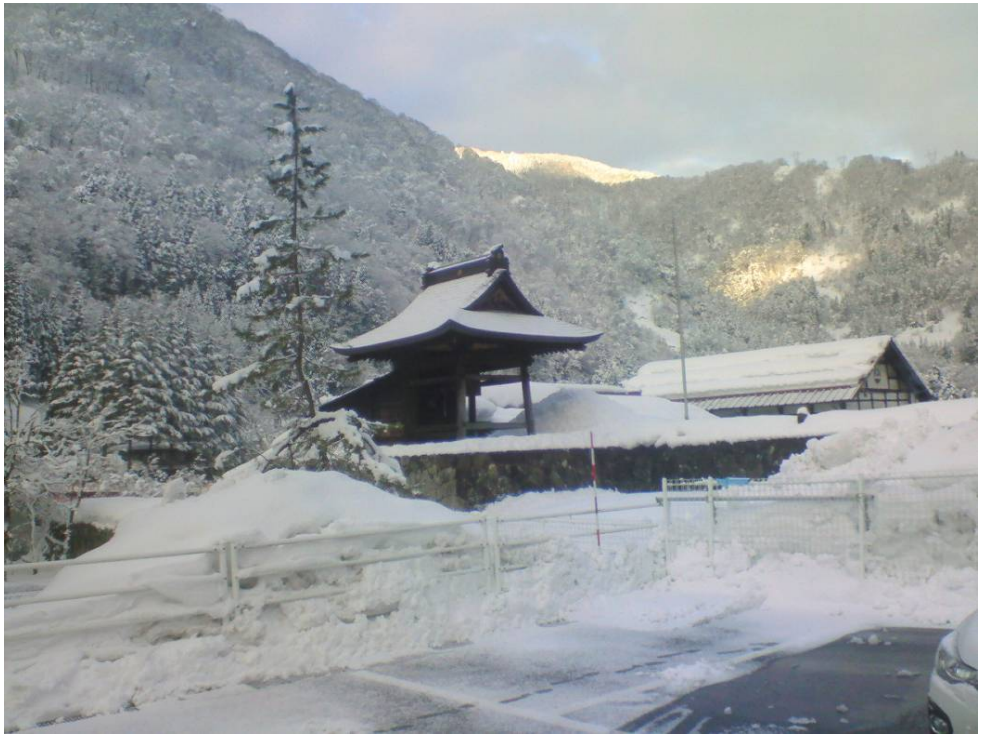
Gadolinium Studies in Mozumi
(i.e., the last two years in ten minutes)



Mark Vagins

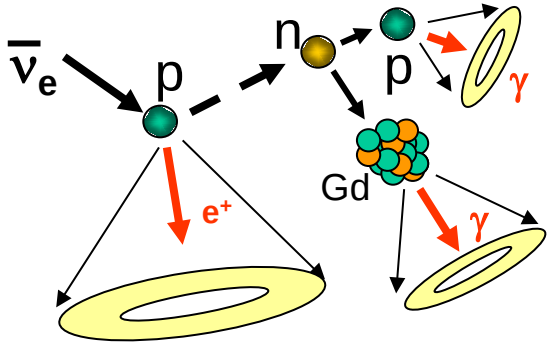
Kavli IPMU, University of Tokyo

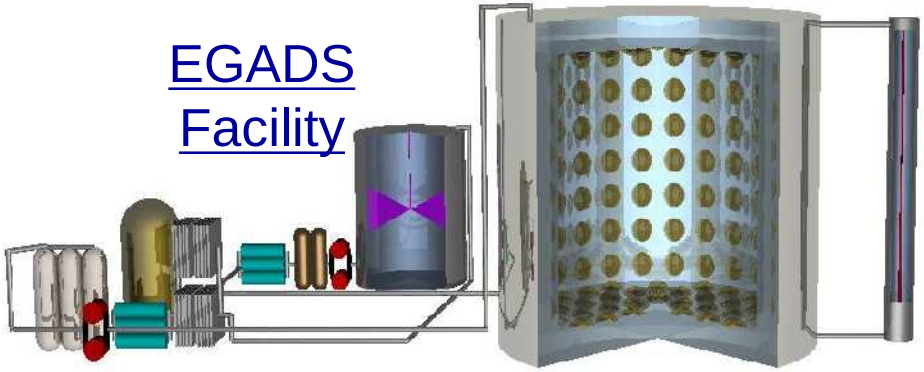
6th Open Meeting for the Hyper-Kamiokande Project

Kashiwa January 30, 2015

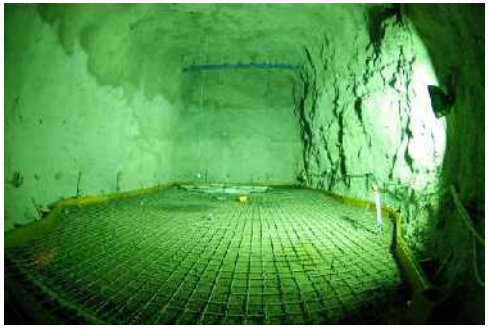
EGADS – Evaluating Gadolinium's Action on Detector Systems

Adding water soluble gadolinium to Hyper-K would greatly enhance its ability to detect antineutrinos. EGADS is a dedicated gadolinium demonstrator project which includes a working 200 ton scale model of Super-K.

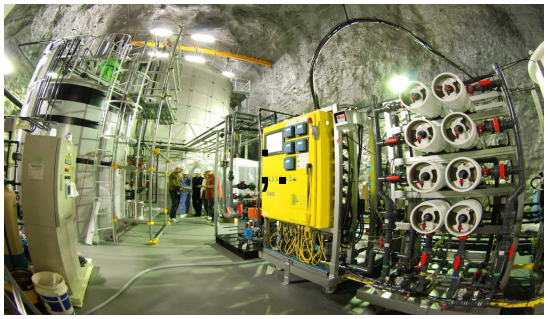




Beacom and Vagins, *Phys. Rev. Lett.*, 93:171101, 2004

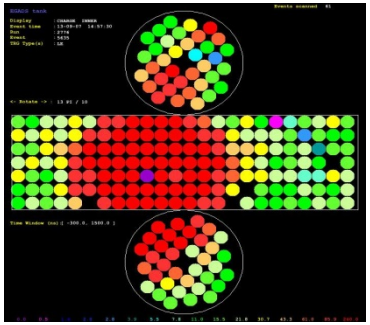


12/2009



11/2011

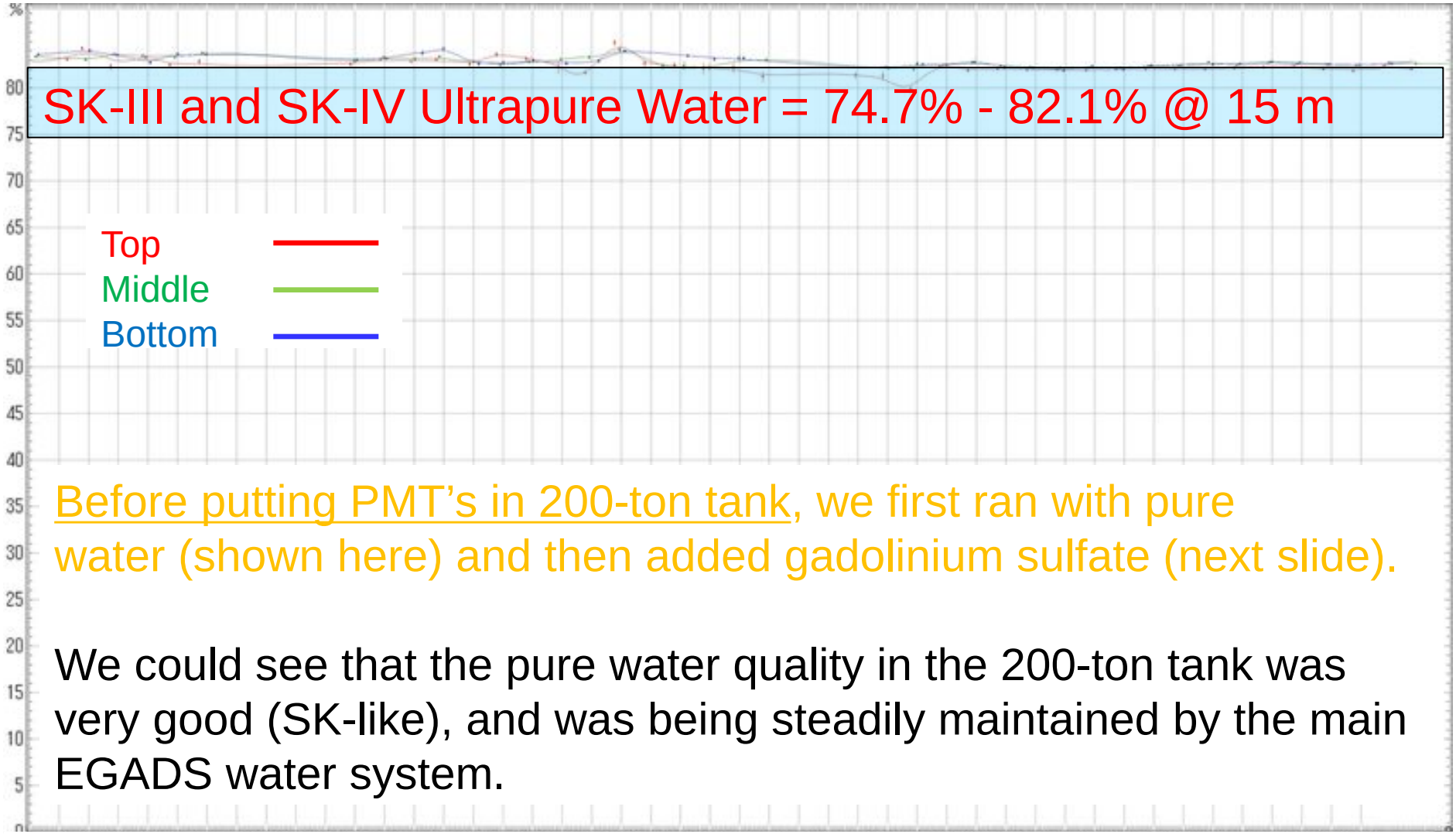
8/2013



9/2013

By April 2015, EGADS will have shown conclusively whether or not gadolinium loading of Super-K/Hyper-K will be safe and effective.
If so, this is the likely future of *all* light water Cherenkov detectors.

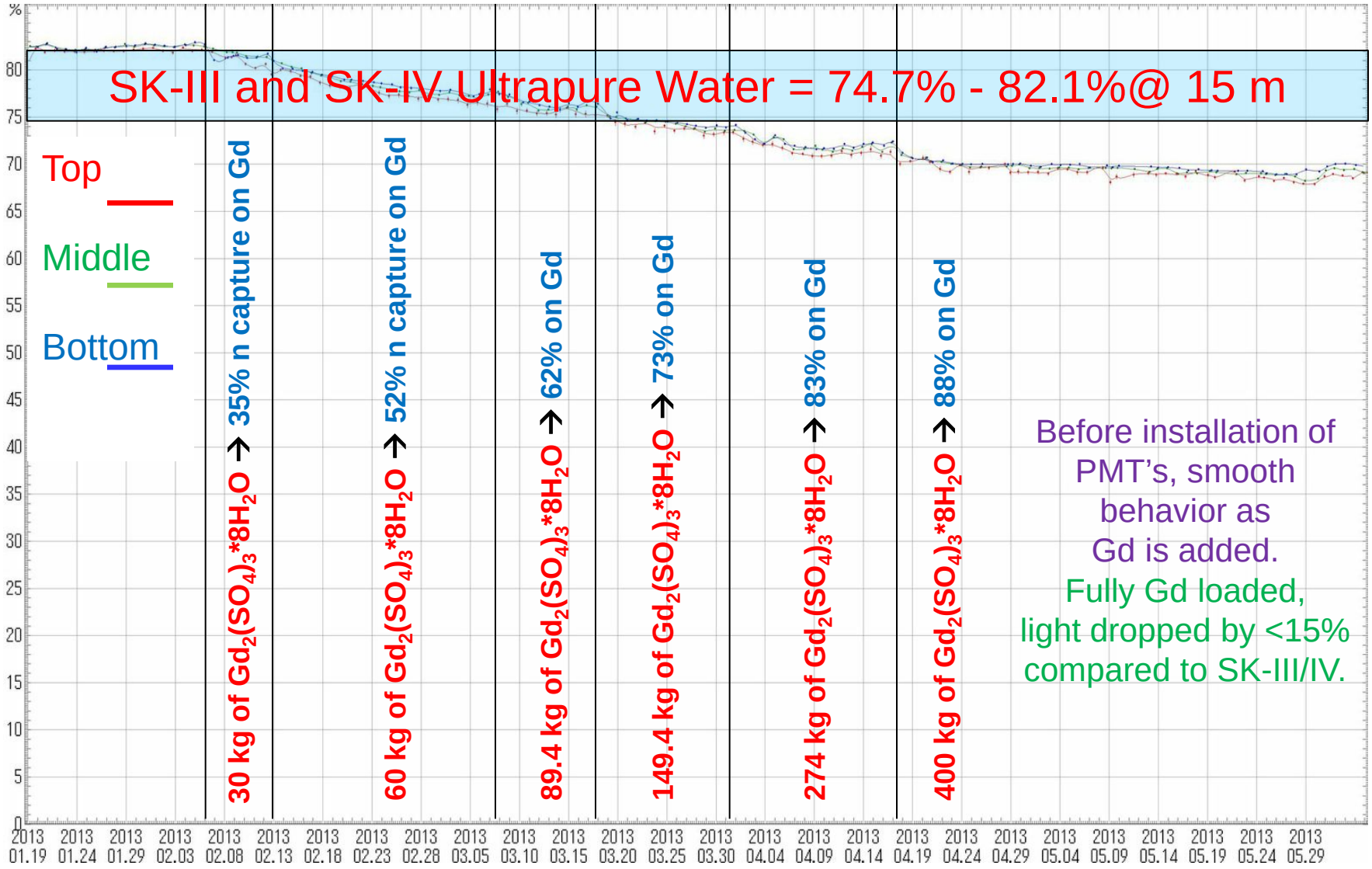
Light @ 15 meters in the 200-ton tank (pure water, no PMT's)



Before putting PMT's in 200-ton tank, we first ran with pure water (shown here) and then added gadolinium sulfate (next slide).

We could see that the pure water quality in the 200-ton tank was very good (SK-like), and was being steadily maintained by the main EGADS water system.

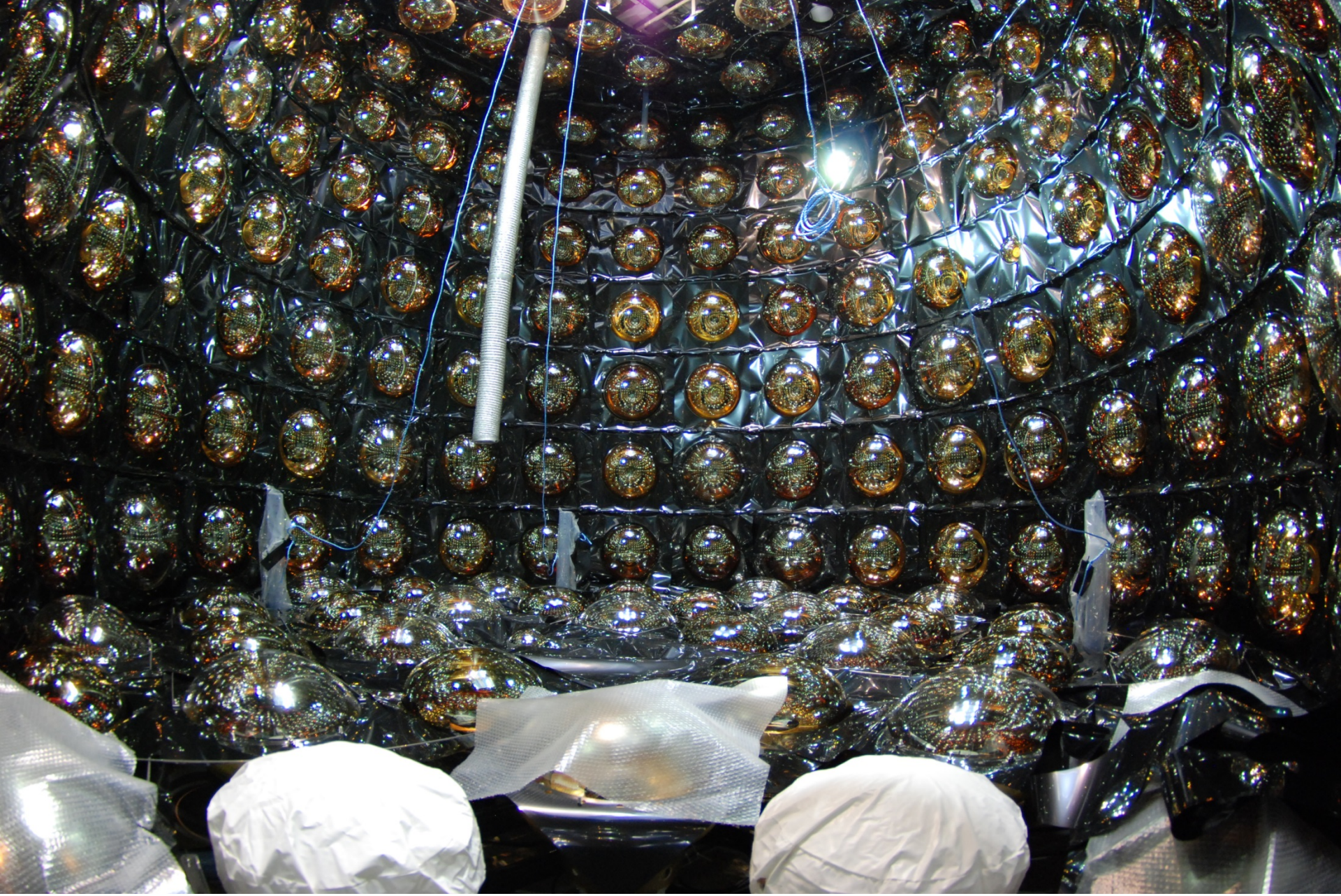
Light @ 15 meters in the 200-ton tank (Gd water, no PMT's)



Jan. 19, 2013

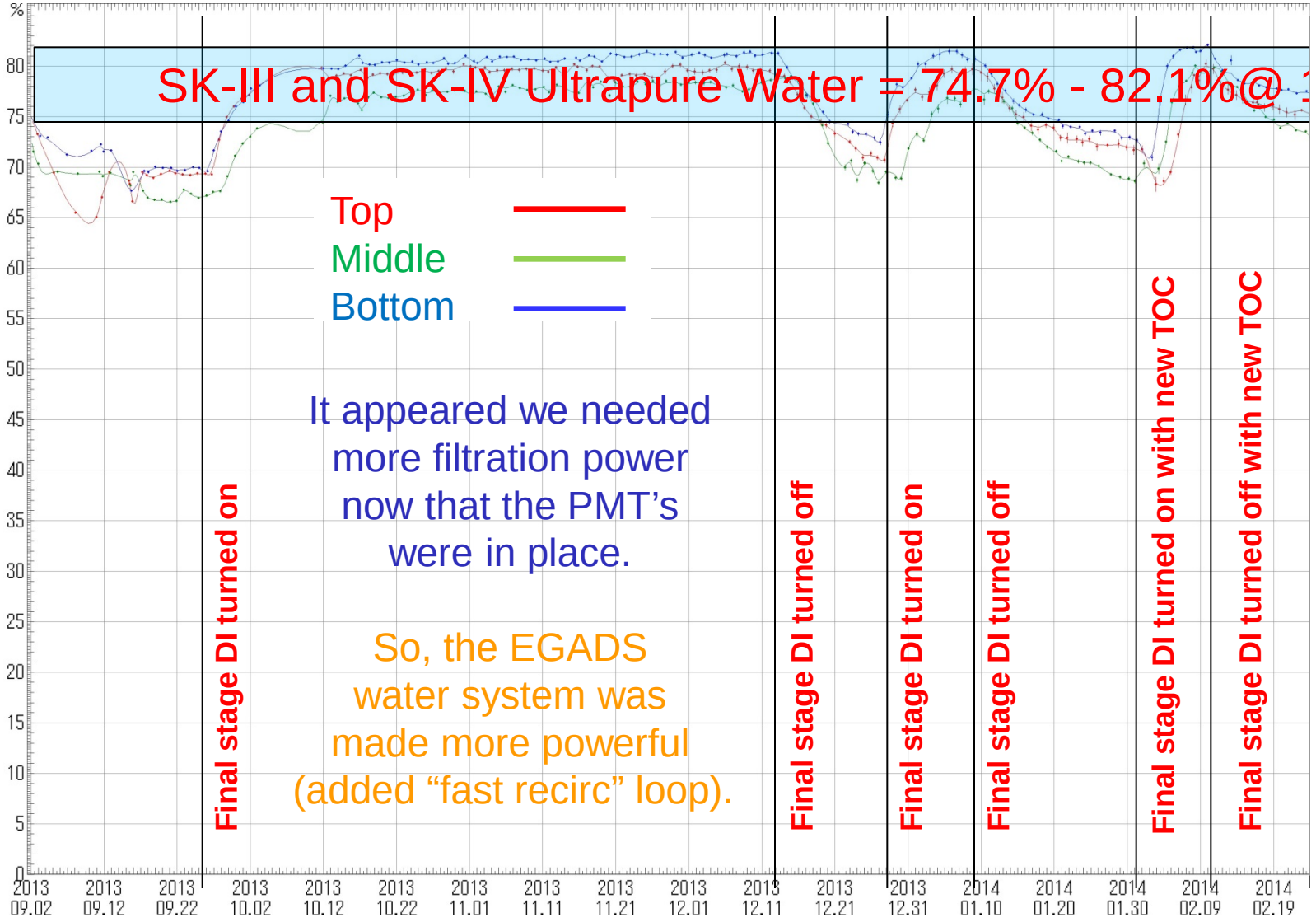
March 29, 2013

June 3, 2013



Inside of EGADS tank; August 8, 2013.

Light @ 15 meters in the 200-ton tank (pure water, with PMT's)

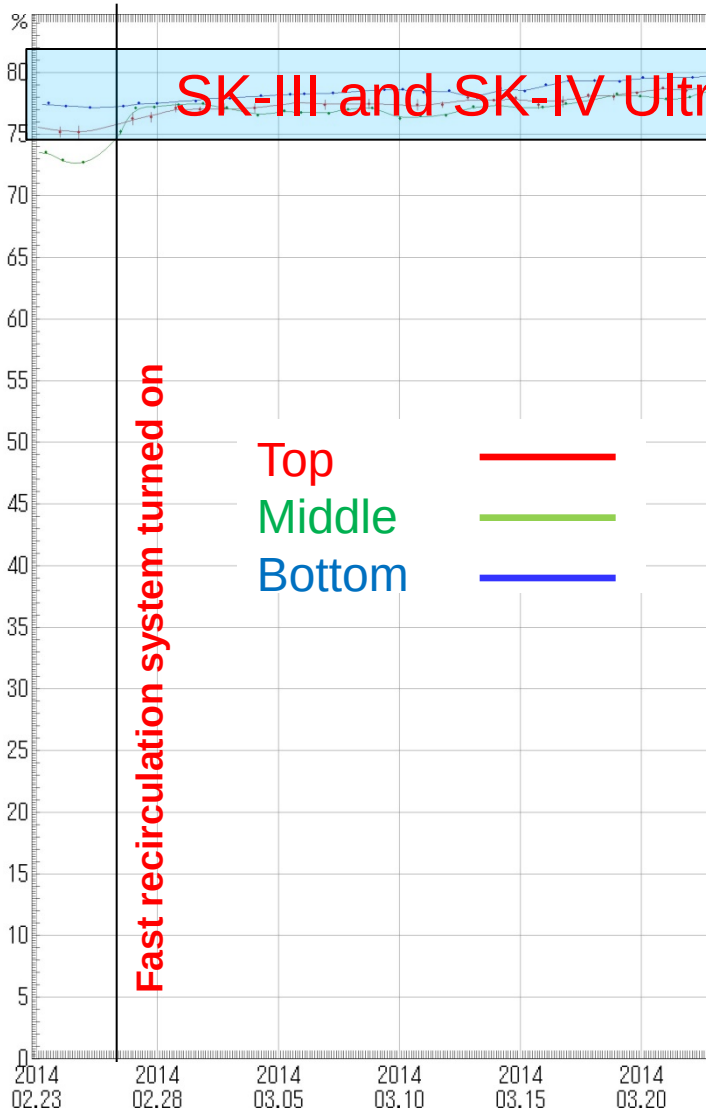


Sept. 2, 2013

Dec. 11, 2013

March 23, 2014

Light @ 15 meters in the 200-ton tank (Gd water, with PMT's)



Very different from what we saw in the bare tank.

Shortly before the previous HK Open Meeting we looked inside…

Feb. 23, 2014

March 26, 2014

April 10, 2014

May, 2014

A trusted Japanese vendor had assured us this structural wire was 304 stainless steel based on the manufacturing company's claims, but it most certainly <u>is not.</u>

This wire also has a core made of Nylon 6: <u>not designed for water.</u>

The road to recovery

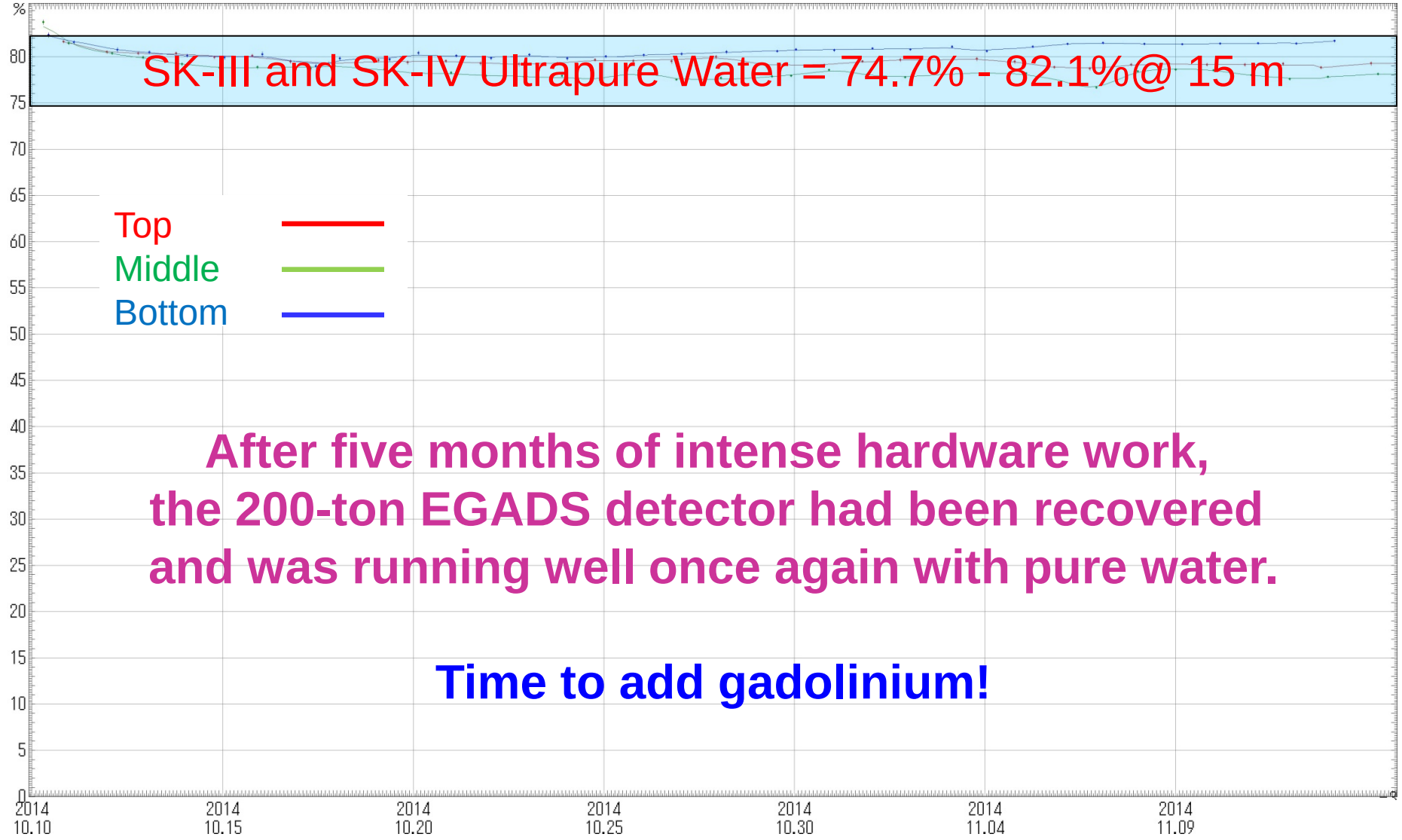
Having discovered the source of 2014's water quality issues, we then spent the next five months cleaning up the EGADS detector.

The road to recovery

Clean up the tank?

Mission:Possible!

Light @ 15 meters in the 200-ton tank (pure water, with PMT's)



After five months of intense hardware work, the 200-ton EGADS detector had been recovered and was running well once again with pure water.

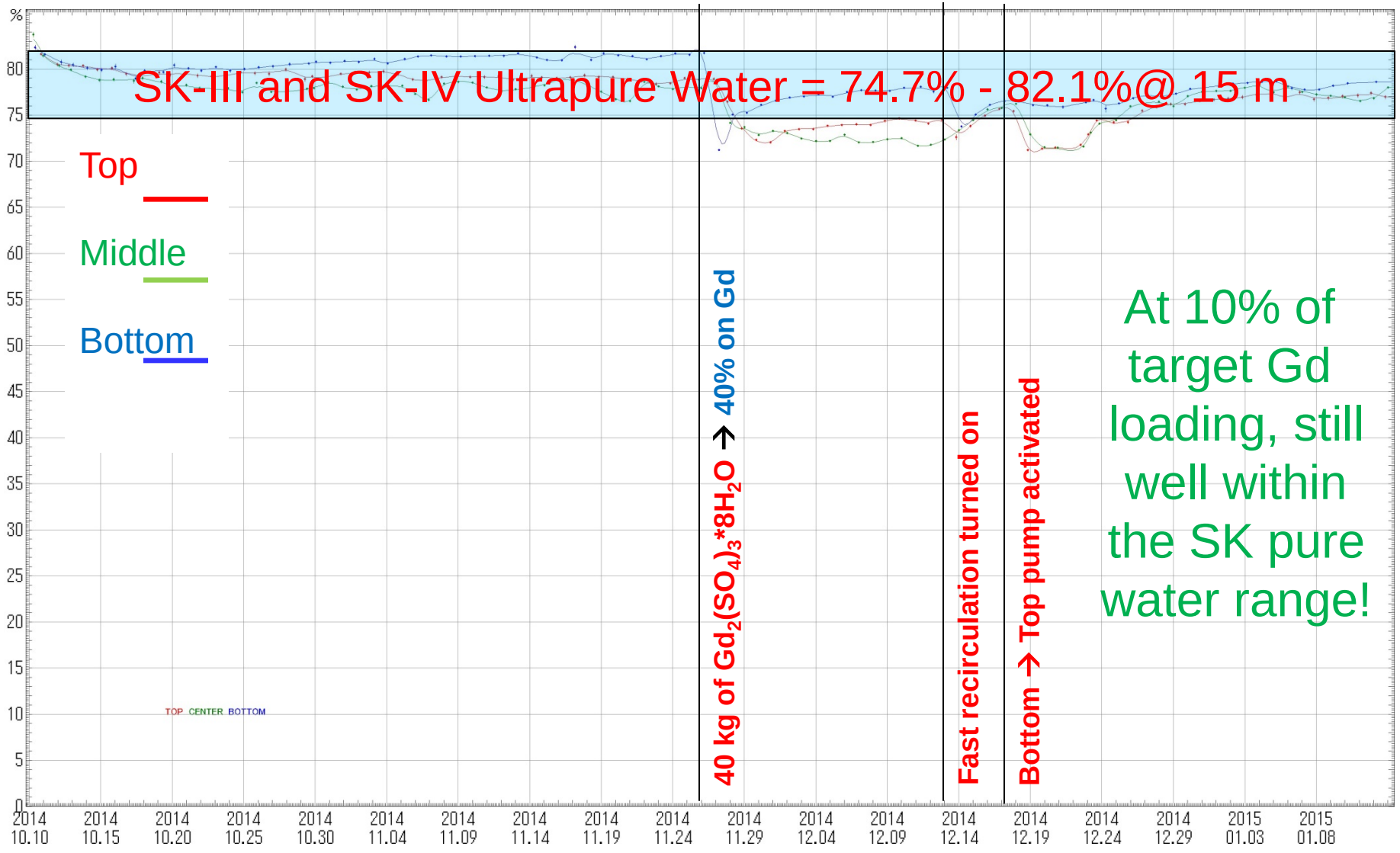
Time to add gadolinium!

Oct. 10, 2014

Oct. 30, 2014

Nov. 14, 2014

Light @ 15 meters in the 200-ton tank (Gd water with PMT's)

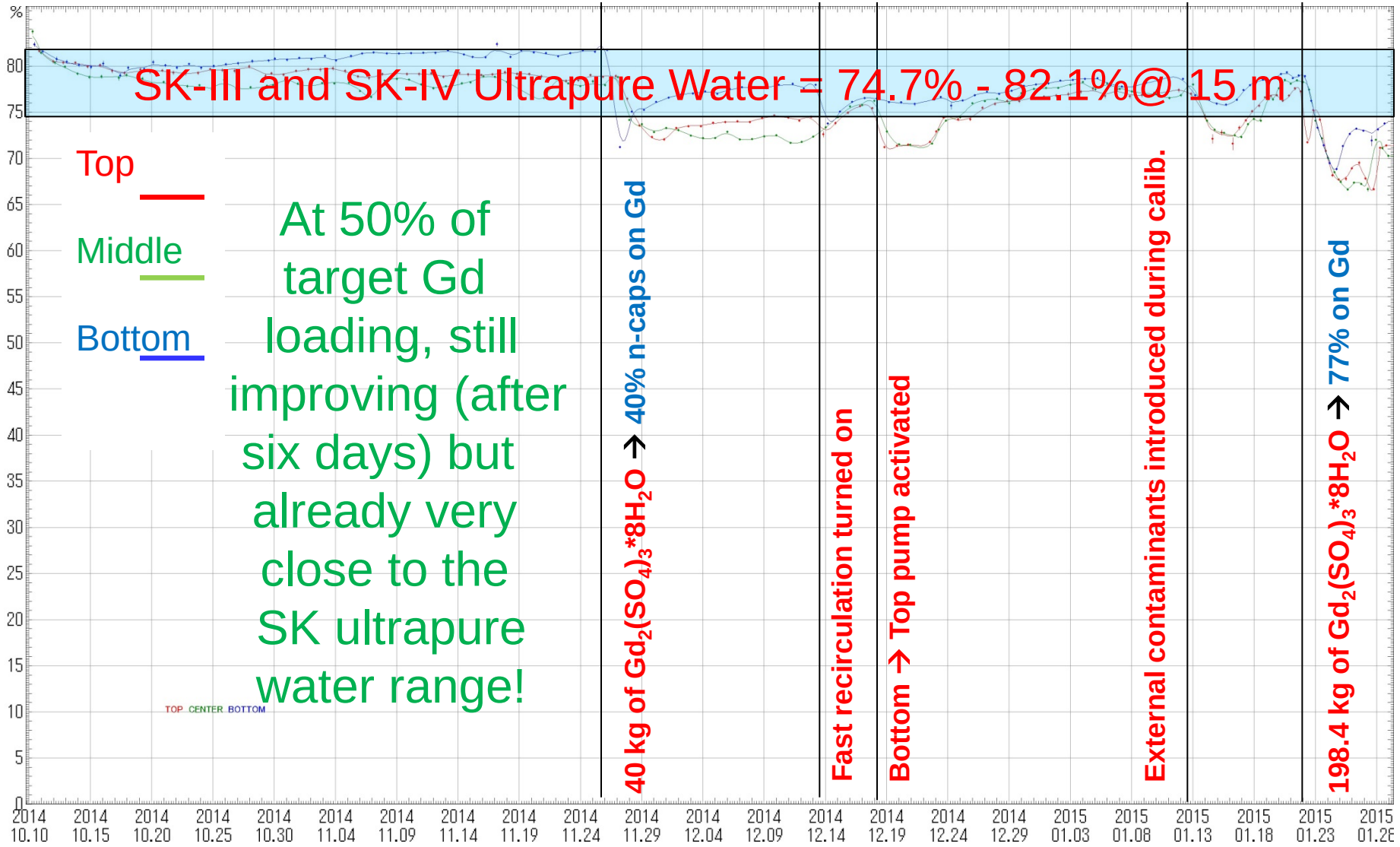


Oct. 10, 2014

Nov. 26, 2014

Jan. 12, 2015

Light @ 15 meters in the 200-ton tank (Gd water with PMT's)



Oct. 10, 2014 **Dec. 4, 2014** **Jan. 29, 2015**

→ **After removing the troublesome wire and carefully cleaning the EGADS detector last year, the pure water now stays clear due to the EGADS water system.**

→ **As of today, the Gd-loading has been successfully brought to 0.1% in EGADS while achieving SK-like transparency.**
(0.2% is the ultimate goal, but at 0.1%
>75% of the neutrons are captured on gadolinium)

→ We will add the rest of the Gd in February! ←