What's the problem in SRN detection?
- Low rate as 1.3-6.7 events/year/22.5kton (18-30MeV) expected.
- High Background due to solar neutrino & atmospheric neutrino
- Need large target mass & background removability
- Expected in Gd-loaded SK
- 10-45 SRN events in 10 years data taking (10-30 MeV)

Why Gadolinium?
- Large cross section (~49,000 barns; 0.3 barns on free proton of Gd for neutron capture)
- 3-4 γ-rays will be produced with total energy of 8MeV.

Detection principle for SRN by adding gadolinium
- Background can be efficiently removed by coincident detection of the prompt positron's Cherenkov light and the delayed neutron capture gammas.
- SRN search window can be extended to 10-30 MeV.

What will happen if we load Gadolinium into Super-K?

EGADS Detector

Photos of EGADS Lab in Kamioka mine and PMT mounting inside the detector
- 200 ton Water Cherenkov detector (EGADS) was built in 2011 to test Gd effects.
- Gd full-loading (0.2%) has been achieved on Apr 21th 2015.
- Circulation system for Gd(3)SO4 is running with excellent performance.
- ~75% of Cherenkov light remains after 15 m in Gd-loaded EGADS detector, similar to SK.
- Calibration work has been carried out in both water & Gd phase.

Achievement & Future Plan
- Based on the success of EGADS, SK-Gd project was formally approved by the SK Collaboration in June of 2015, with the precise timeline yet to be determined.
- 0.2% gadolinium sulfate has been successfully loaded into EGADS tank.
- Basic calibration work has been finished.
- Neutron capture efficiency of gadolinium has been estimated.
- Make supernova alert for EGADS detector. It will be a backup when Super-K is down for Gd loading work in the future.
- All these three steps above are to make realistic test for SK-Gd and better monitoring for supernova.

Neutron Detection in EGADS

Expected νe spectrum by different models

Detection principle for SRN by adding gadolinium

Event reconstruction energy

Neutron capture time
(time difference between prompt and delayed signals)

Data & MC

Neutron capture efficiency by gadolinium

Eff capture 84.36 ± 1.79% 84.51 ± 0.33%

Neutron capture by gadolinium

Using Am/Be as a neutron source.

Analyze Gd capture gammas by comparison with Monte Carlo simulation (geant4.9.6p02 based).

DAQ upgrade plan

GPS signals are sent to EGADS, SK, KAGRA and XMASS for event timing correction.

Upgrade EAGDS DAQ to be prepared for GPS.

For quick start, EGADS is using ATM modules which were left in Super-K III.

To install QTC-based Electronics with Ethernet modules into EGADS, which has lower noise and allows higher rate.

Make a supernova alert for EGADS detector. It will be a backup when Super-K is down for Gd loading work in the future.

All these three steps above are to make realistic test for SK-Gd and better monitoring for supernova.

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