Beam related gamma background at the JSNS²

2020. Feb. 26
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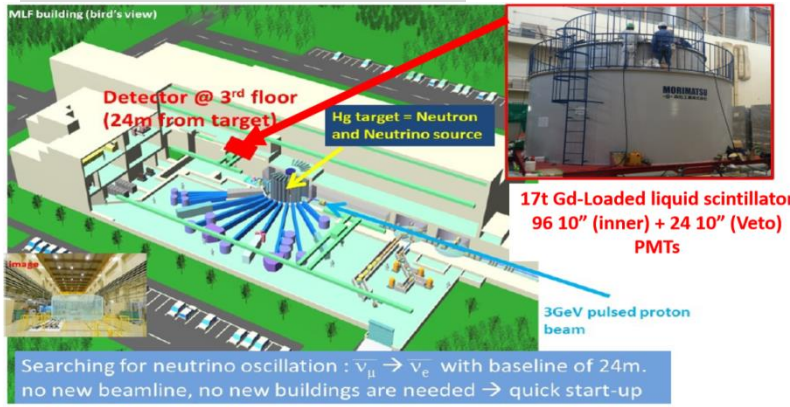
The JSNS² Experiment



- Purpose of JSNS² : search for sterile neutrinos with Δm^2 near $1eV^2$
- A 3 GeV J-PARC proton beam collision with mercury target
- MuDAR, muon decay at rest : $\mu^+ \rightarrow e^+ + \bar{\nu}_\mu + \nu_e$
- Searching for $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$
- IBD,Inverse Beta Decay : $\bar{\nu}_e + p \rightarrow e^+ + n$
- JSNS² Target : fiducial volume of 17 tons, GdLS, 24 m baseline

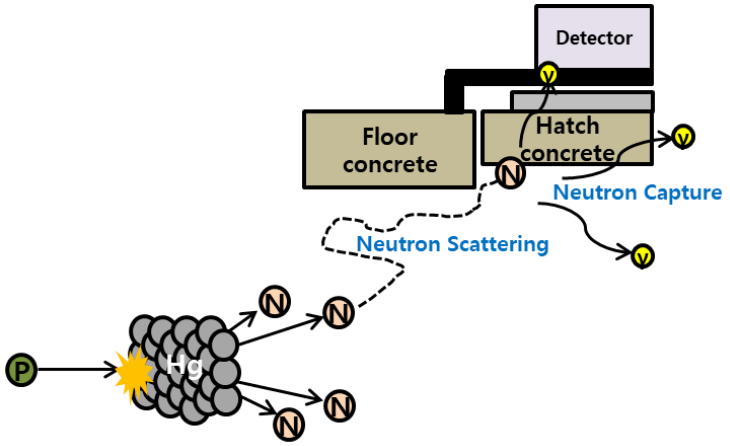
Configuration & Motivation

- Generation Process :
J-PARC proton beam collision with Hg target → Neutron generation → Neutron capture by concrete below detector → Emitting gammas

- Energy of beam-related gammas : ~ 8MeV,
  * Delayed energy region of IBD, **7~12 MeV**

Beam-related gammas may increase accidental background. JSNS² has installed lead blocks and iron as a primary shielding for beam-related gammas. Shielding configuration is optimized using Monte-Carlo simulation

Generating process of Beam-related gamma



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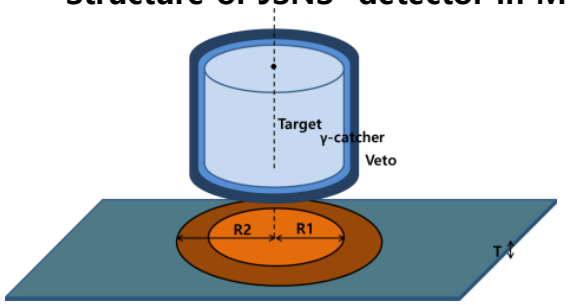
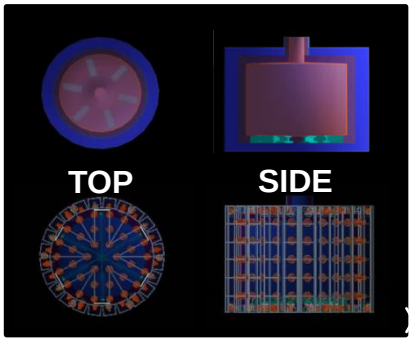
Lead and Iron shielding

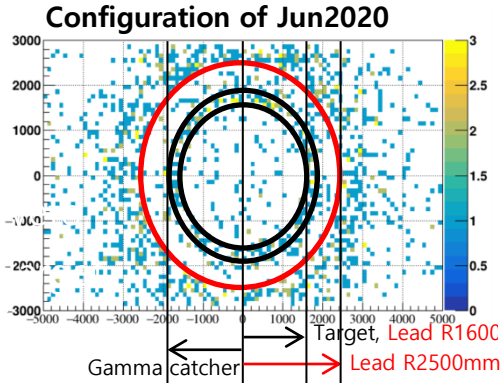
Structure of JSNS² detector in MC

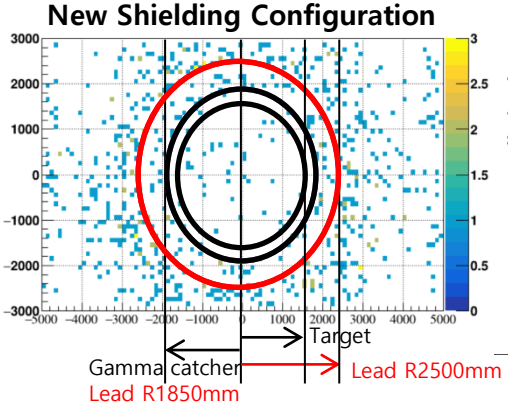


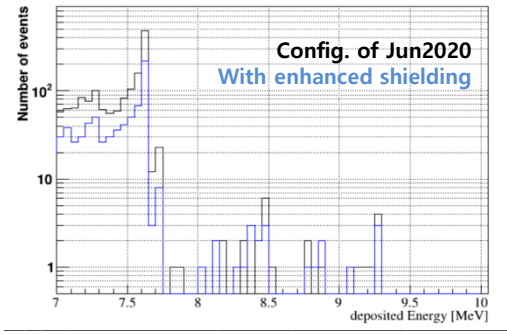
- JSNS² detector in MC : 3-layered cylinder for target, gamma catcher, veto
- Shielding : Iron plate 6 m X 9 m X thickness
  Lower layer of lead 2.5 m radius(R2) X 5cm
  Upper layer of lead (R1) X 5cm

Shielding effects are estimated through deposited energy for each shielding configuration within the constraint of JSNS² facility.









For the enhanced shielding,

- increase the upper radius of lead, R1 upto gamma catcher area from target
- iron 22mm thicker

It will reduce the beam related gamma background by **52%** in sterile delayed region of JSNS². This setup is applied for data taking in 2021.

Summary

- **Proper shielding configuration is studied with Monte-Carlo simulation**
- **Reducing beam induced gamma by 52%**
- **Enhanced lead and iron shielding is set up**
- **Now we are taking data from Jan 12th with beam.**
- **The data is being analyzed. You will see the results soon.**

JSNS²
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