XXXII International Conference on Neutrino Physics and Astrophysics

CICENNS experiment: A 300kg CsI(Na) detector for CEvNS measurement

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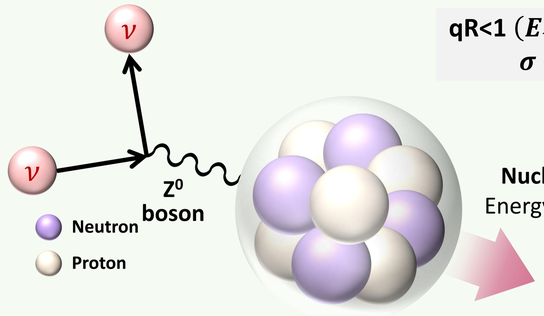
Coherent Elastic Neutrino-Nucleus Scattering (CEνNS)

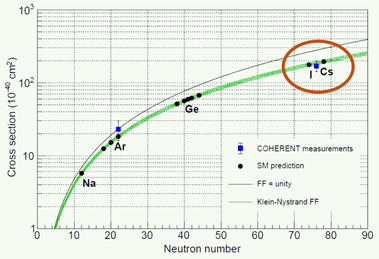


qR<1 $(E_\nu \sim 50\mathrm{MeV})$

$\sigma \propto N^2$

Enhanced neutrino cross-section at low energy by ~1000 times.

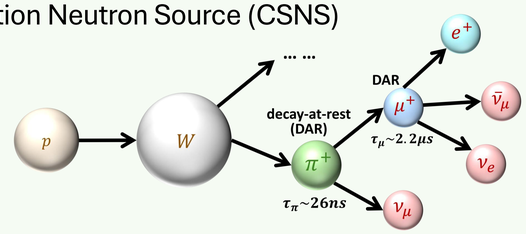
Advantages of CsI(Na) for CEνNS detection

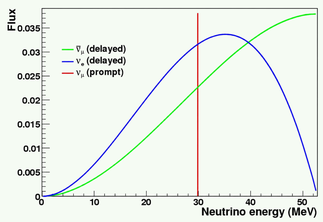


- Substantial event rate
- High light yield (~45 photons/$\mathrm{KeV_{ee}}$)
- Low internal radioactivity and fast scintillation decay
- Lower afterglow than CsI(Tl), favorable for pulsed-beam operation

Neutrino source:

China Spallation Neutron Source (CSNS)



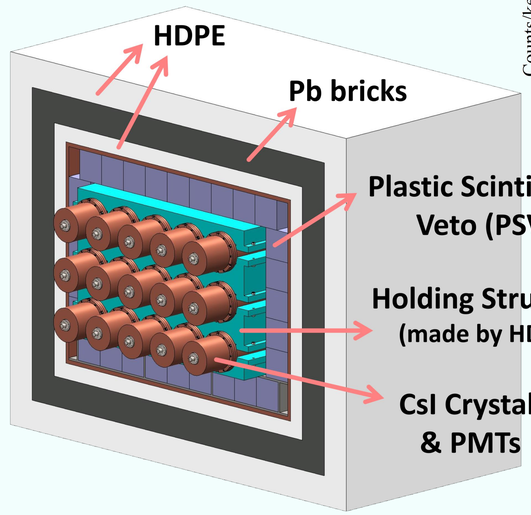


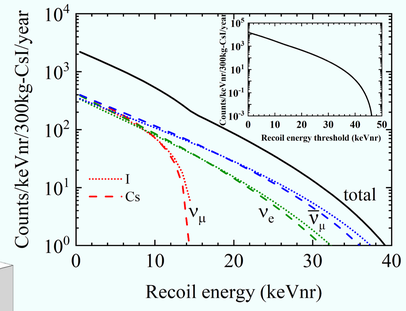
- **π/μ decay-at-rest neutrino source**
- **Detector location:** ~8.2m above the target (7.2 m steel, 1 m concrete)
- **Neutrino flux at 10.5 m:** $6.71 \times 10^6/cm^2/s/flavor$
- **Pulsed beam:** 25 Hz, (beam-related background refection)
- **Beam power:** 160 kW → 500kW

Pulsed DAR neutrinos at CSNS allow timing-based background rejection for CEvNS detection.

CICENNS: 300 kg CsI(Na) Detector for CEνNS

- **Target:** 15 CsI(Na) Crystal, 20kg each, 300kg in total
- **Readout:** dual-ended PMTs
- **Active veto:** plastic scintillator veto (PSV)
- **Passive shielding:** Pb / Fe / HDPE





Two PMTs on both sides of crystal to reduce dark noise background events.

Light yield: $10.5 \sim 14.9$ p. e./$\mathrm{keV_{ee}}$

Large target mass & dual-ended readout allow a high-statistics CEvNS measurement at CSNS.

Background estimation

Source	Mitigation / evaluation
Beam-related neutron	active veto by PSV / on-site neutron measurement
PMT dark noise	dual PMT coincidence / reduction by 3 orders
Internal radioactivity of CsI(Na)	powder purification / ICPMS & HPGe measurement
Environmental γ / neutron	Pb, Fe, HDPE shielding
Cosmic-induced events	PSV / negligible

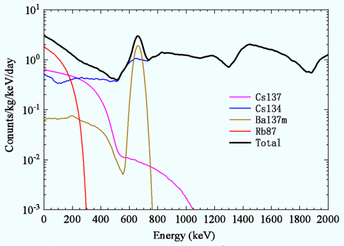


Fig. Background spectrum of CsI crystal.

Internal radioactivity background of CsI(Na)

by ICPMS & HPGe measurements

Isotopes	238U (ppt)	232Th (ppt)	87Rb (ppb)	137Cs (mBq/kg)	134Cs (mBq/kg)
CICENNS	63±25	14±5	0.77±0.04	2.27±2.22	23.1±3.0
COHERENT	<1000	<1000	~20	28±3	26±2

Improvement: CICENNS vs COHERENT

Feature	CICENNS	COHERENT
Target mass	300 kg	14.6 kg
Signal events	~7000 per year	306±20 in total
Threshold	2~3 keVnr	7 keVnr
Rb87 radioactivity	0.77 ppb	~20ppb
Neutron veto	PSV & crystal array	No veto & single crystal

Physics Potentials

Primary goal
- Precision CEvNS cross-section measurement

Standard Model / nuclear physics
- Neutron distribution / neutron radius
- Weak mixing angle at low momentum transfer

BSM searches
- Non-standard neutrino interactions (NSI)
- Light mediators / dark sector candidates
- Sterile neutrino oscillation

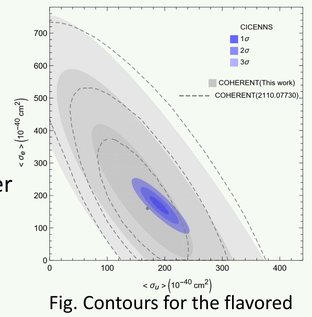


Fig. Contours for the flavored CEvNS cross section.

Current status and commissioning plan

- **Full detector:** 15 CsI(Na) and 32 PSV
- **Optimization of shielding design** under progress based on background measurement at CSNS.
- **Full detector assembly** in August 2026
- **Check of detector performance** with cosmic-ray test.
- **CSNS deployment:** after the CSNS beam upgrade to 200 kW (expected in Oct. 2026) the full detector will be commissioned at CSNS.
- **Physics run:** after full-system commissioning.

Reference

[1] COHERENT Collaboration, Phys.Rev.Lett. 129 (2022) 8, 081801

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