

Physics Opportunities of Large Liquid Scintillator Detectors

Mainz Townhall
13 October 2026

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What are we trying to learn?

First Townhall – Irvine (June 2026)

PHYSICS



CAPABILITIES

- Is there a compelling **science case** for a large liquid scintillator detector?
→ Neutrinoless double beta decay
- Is this a single-purpose detector?
→ No, a broad physics program is highly desirable.
- Compared to JUNO, what **detector capabilities** are required?
→ depth? design? timing?

Second Townhall – Mainz (Oct 2026)

CAPABILITIES



TECHNOLOGIES

What are the **enabling technologies** to achieve these **detector capabilities**?

- Liquid scintillator + Isotope Loading
- Light sensors + Electronics
- Calibration + Reconstruction + Analysis Techniques
- Influence of Detector Site

ONE DETECTOR. ALL THE CAPABILITIES.

The next-generation large liquid scintillator observatory



JUNO-LIKE LIGHT YIELD

~20,000 photons/MeV
ultra-high light collection
for precision measurements



BOREXINO-LEVEL CLEANLINESS

ultra-pure scintillator,
material radiopurity,
radon control



SNO-CLASS DEPTH

~6000 m.w.e. overburden
for minimal cosmic
ray background



SUPER-K SCALE

multi-kiloton fiducial mass
for broad physics
discovery potential

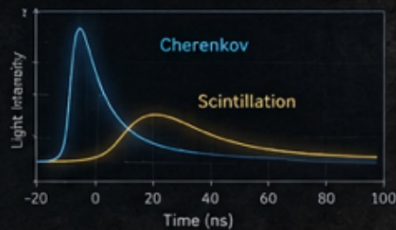


KAMLAND-ZEN XENON LOADING

flexible isotope loading
for $0\nu\beta\beta$ and other
rare event searches

UNPRECEDENTED CHERENKOV/SCINTILLATION SEPARATION

advanced photosensors and waveform
digitization enable statistical separation
of Cherenkov and scintillation light



TOPOLOGICAL RECONSTRUCTION

3D event imaging for particle identification,
background rejection, and new physics
sensitivity



BROAD PHYSICS PROGRAM

- Neutrino oscillations
- Supernova neutrinos
- Solar neutrinos
- Diffuse supernova background
- Proton decay
- Geo-neutrinos
- $0\nu\beta\beta$ decay and rare events



BUILT FOR DISCOVERY

- Modular, scalable design
- State-of-the-art DAQ and calibration
- Flexible for upgrades and
future technologies
- Global collaboration
- Long-term vision



SCIENCE DEMANDS IT. TECHNOLOGY MAKES IT POSSIBLE. TOGETHER, WE CAN BUILD IT.



SIZE
Super-K



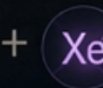
LIGHT YIELD
JUNO



CLEANLINESS
Borexino



DEPTH
SNO



ISOTOPE LOADING
KamLAND-Zen



CHER/SCINT
SEPARATION
Unprecedented



TOPOLOGICAL
RECONSTRUCTION
3D Imaging



POLITICAL &
COMMUNITY SUPPORT
Essential

A NEW WINDOW ON THE UNIVERSE. A LEGACY FOR THE FUTURE.

from Irvine (Gabriel's slides)

Format of this Townhall

Day 1+2

- Overview of double-beta landscape
- Series of sessions *discussing* different technological aspects
- General structure of the sessions
 - Short intro talk by the chair
 - 10-min teasers on technological developments
 - Discussion time (30-45 min)
 - Wrap-up by the chair
- Feature talks on JUNO/KamLAND-ZEN

Day 3

- Poster session
- Detector design challenge
 - what could a future detector look like?

→ Speakers please upload their slides before the session [here](#).

→ Lunch tomorrow here at HIM

→ Social dinner on Wednesday evening at the *Baron*.

Scientific program:
Gabriel, session chairs

Local organizers:
Alfons, Stefan, Michi
→ Heike, Kira

Welcome (back :-) to Mainz!



FroST 2016 happened 10 years (minus 10 days) ago!