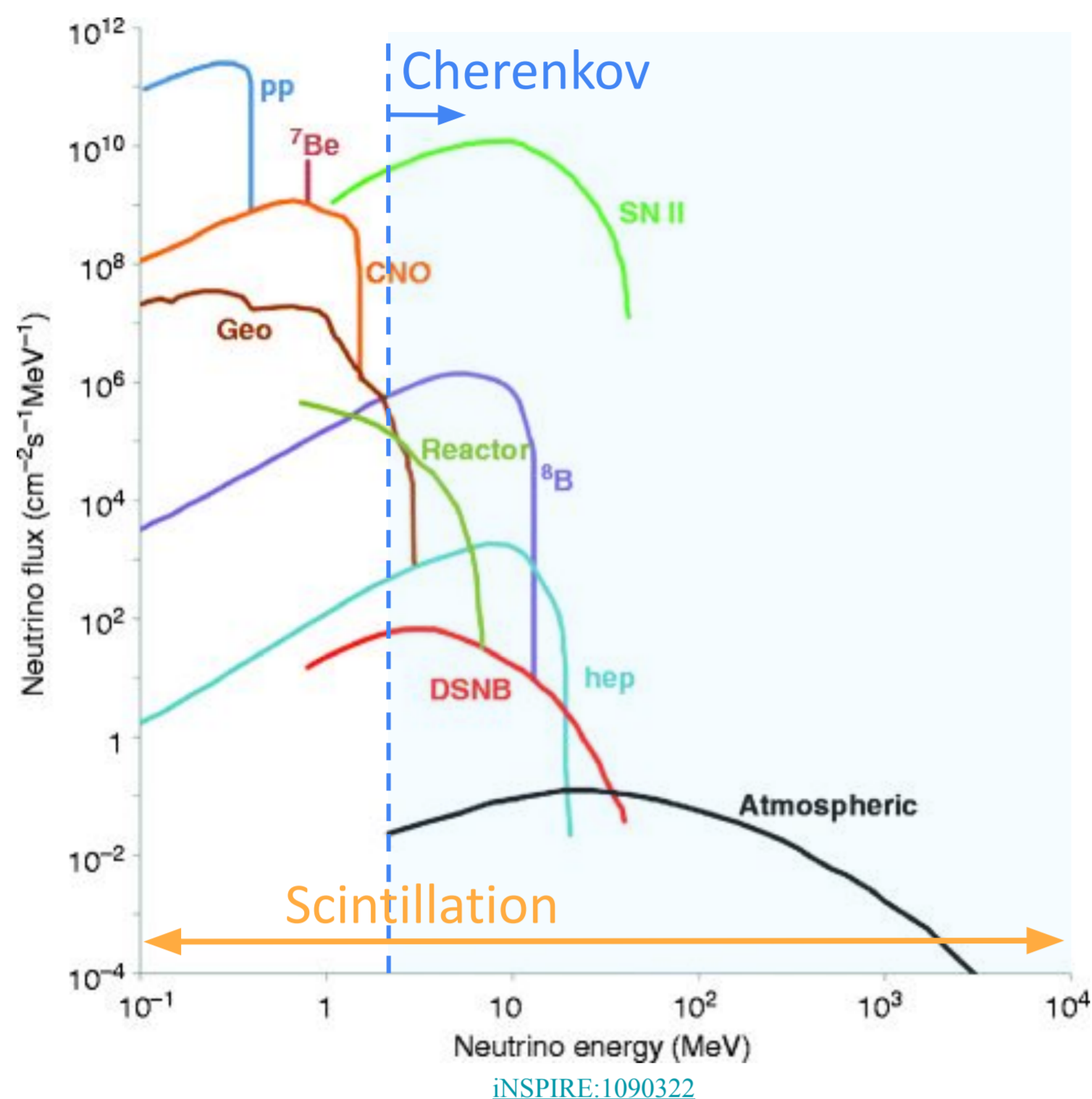


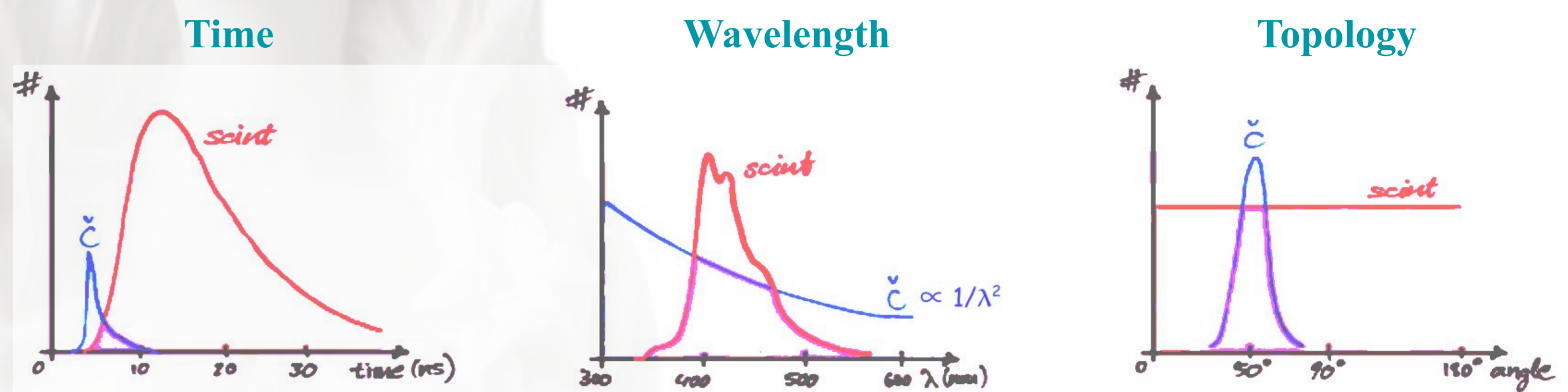
THEIA is a proposed large-scale neutrino detector designed to use both Cherenkov and scintillation signals to enable a rich program of fundamental physics, including both low- and high-energy neutrino physics, as well as the potential to search for neutrinoless double-beta decay with a sensitivity reaching the normal ordering regime.



### Cherenkov and scintillation

- Cherenkov photons discriminate events based on directionality/topology.
- Scintillation is abundant, providing good resolution & low  $E$  thresholds.

The two types of photons can be distinguished by:

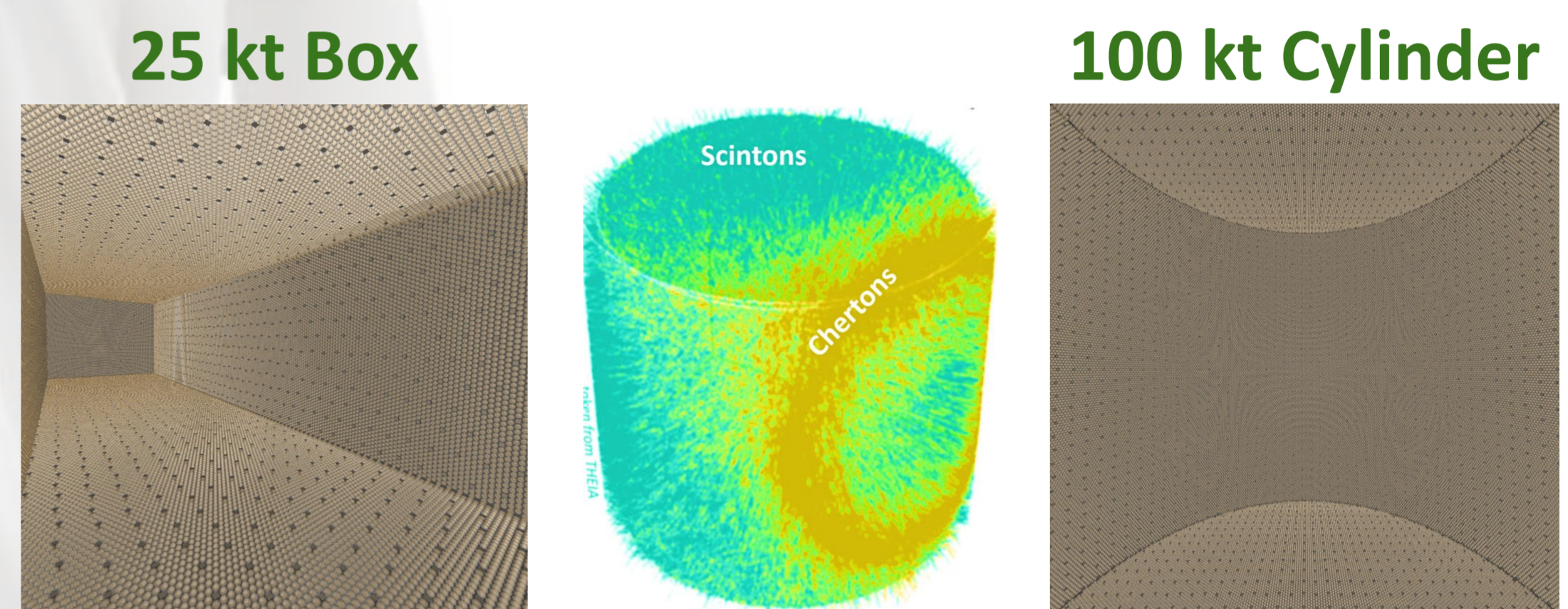


### THEIA program

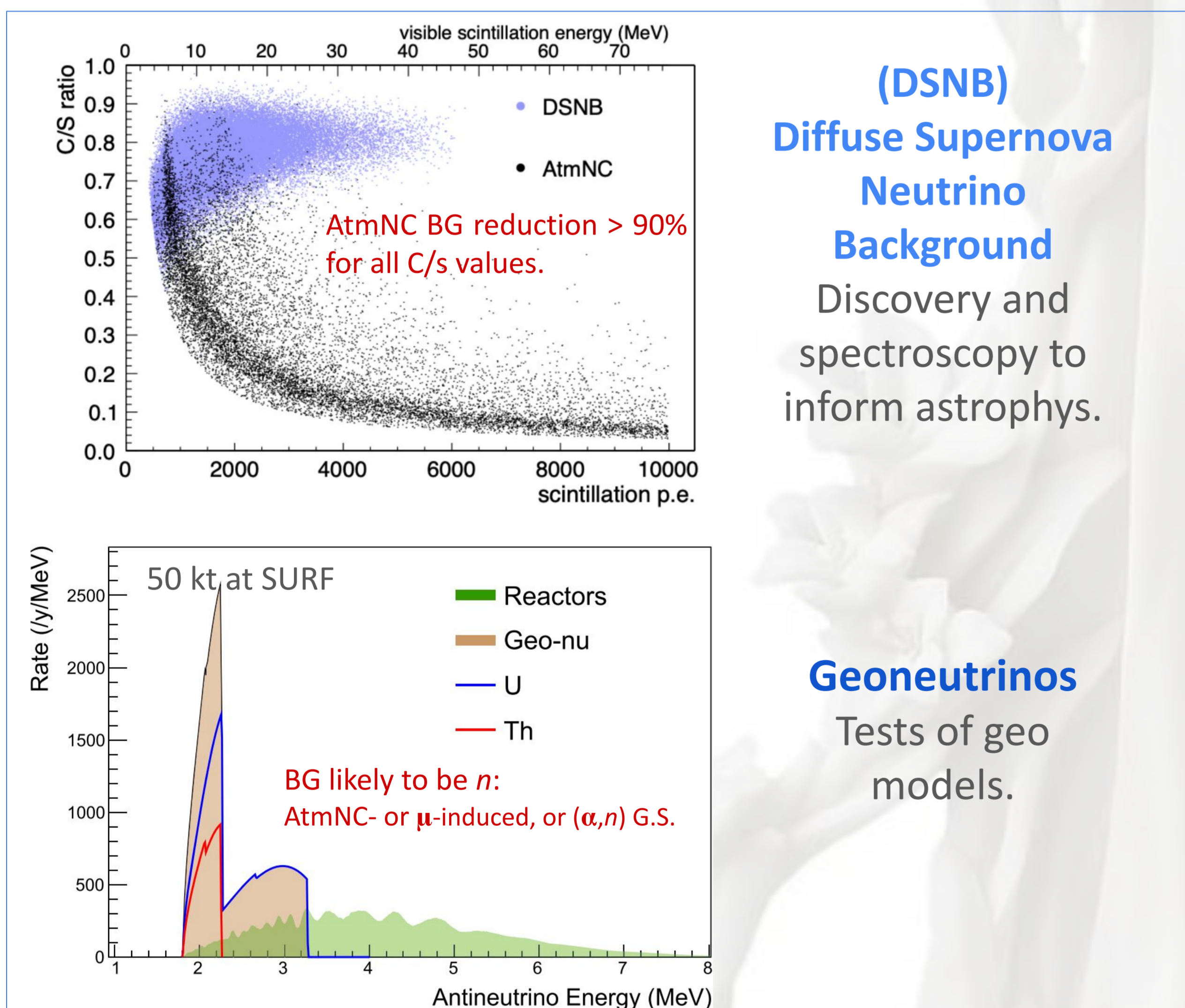
Primary Physics Goal	Reach	Exposure / assumptions
Long-baseline oscillations	$> 5\sigma$ for 30% of $\delta_{CP}$ values	524 kt-MW-yr
Supernova burst	$< 1(2)^\circ$ pointing accuracy 20,000 (5,000) events	100(25)-kt detector, 10 kpc
DSNB	$5\sigma$ discovery	125 kton-yr
CNO neutrino flux	$< 5$ (10)%	300 (62.5) kton-yr
Reactor neutrino detection	2000 events	100 kton-yr
Geo neutrino detection	2650 events	100 kton-yr
NLDBD	$T_{1/2} > 1.1 \times 10^{28}$ yr	211 ton-yr $^{130}\text{Te}$
Nucleon decay $p \rightarrow \bar{\nu}K^+$	$T > 3.80 \times 10^{34}$ yr (90% CL)	800 kton-yr

### THEIA detector

THEIA's baseline design consists of 25 kt or 100 kt of a novel scintillator, such as water-based liquid scintillator (WbLS), along with fast, spectrally-sensitive photon detectors.



Simple  $C/s$  ratio offers powerful discrimination: heavy particles ( $\alpha, p, n$ ) produce no Cherenkov at low  $E$ .

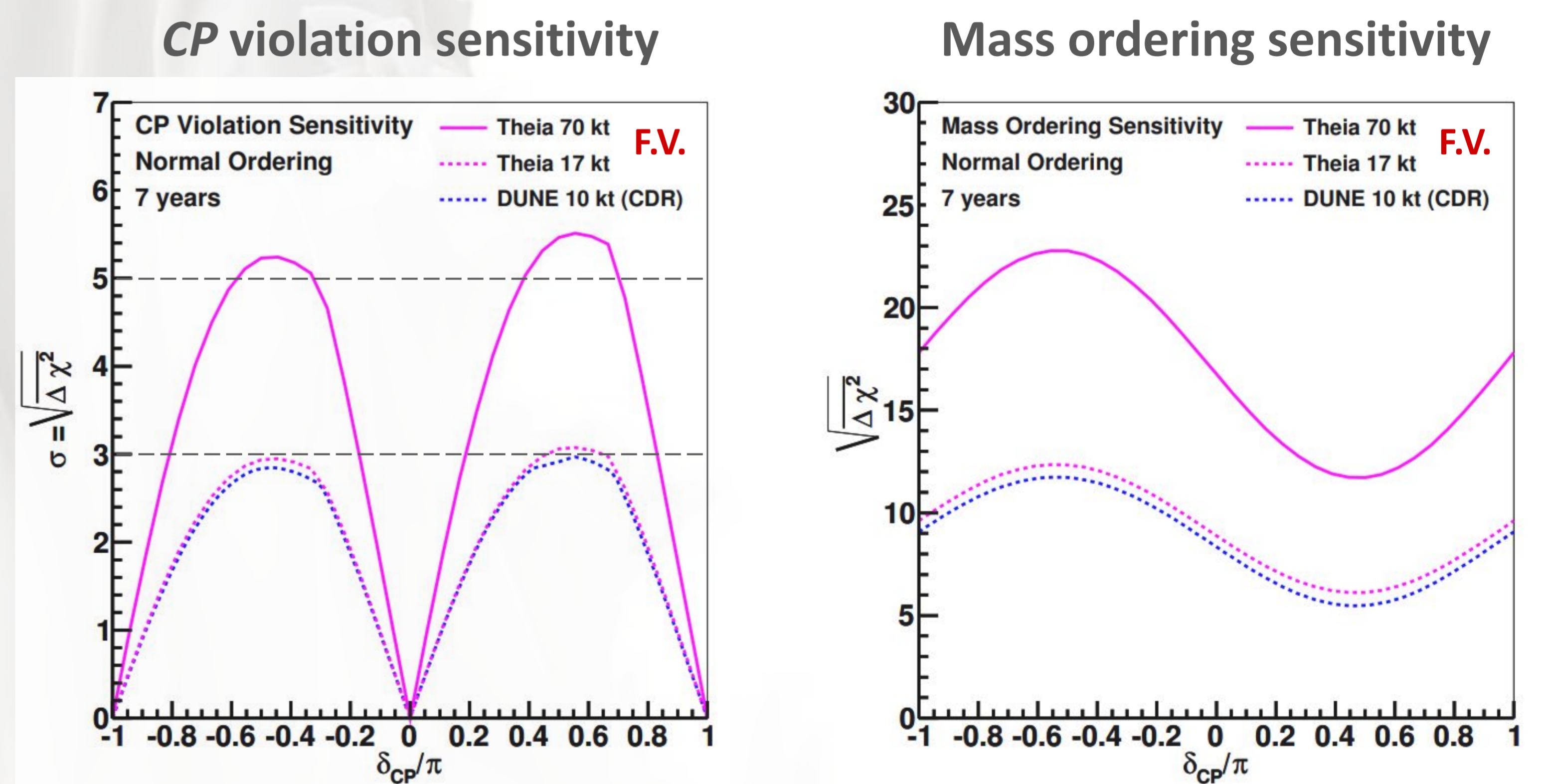


**(DSNB) Diffuse Supernova Neutrino Background**  
Discovery and spectroscopy to inform astrophys.

**Geoneutrinos**  
Tests of geo models.

### Long-baseline oscillations

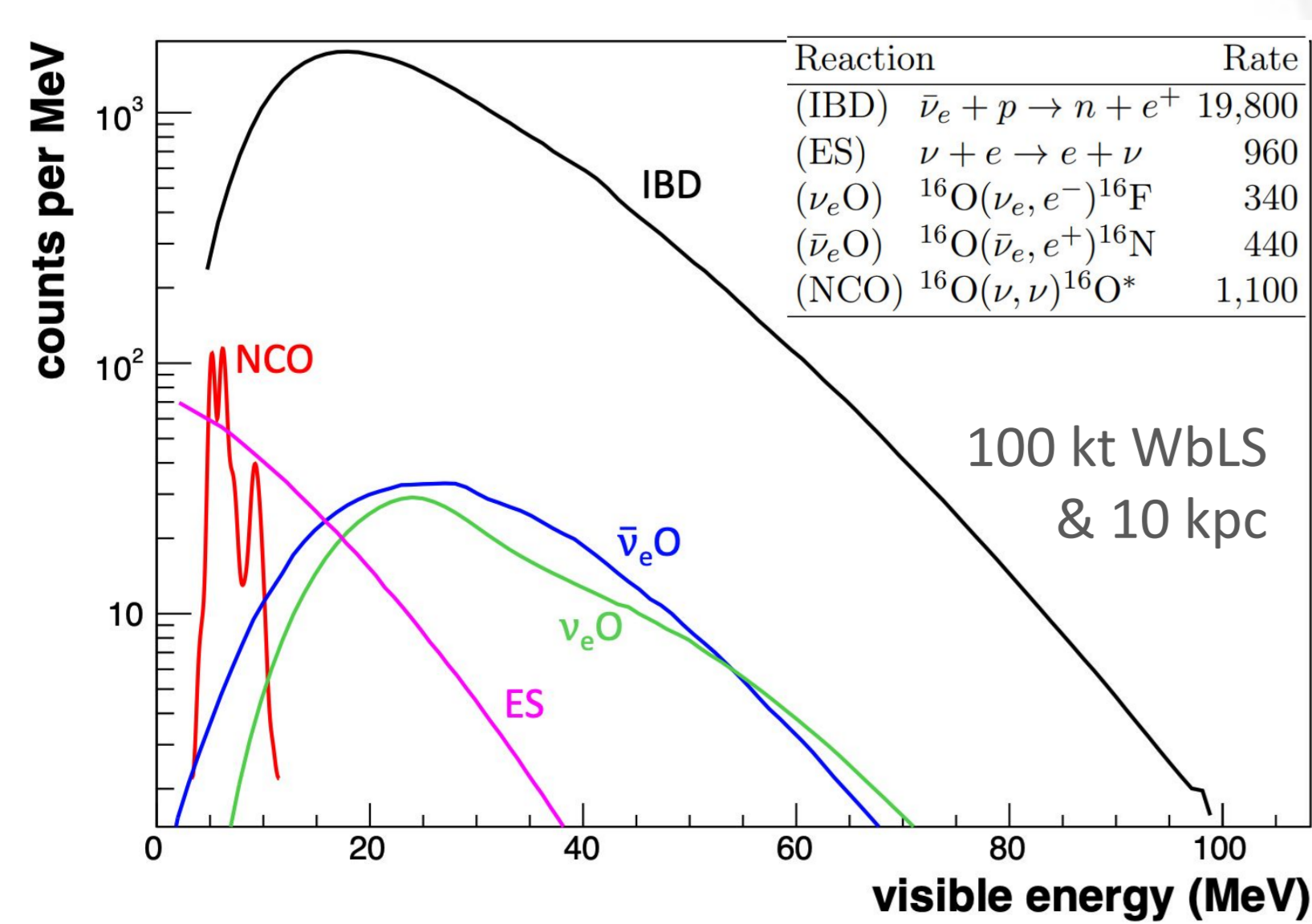
At SURF, THEIA would measure GeV neutrinos and antineutrinos from the LBNF neutrino beam. Advanced Cherenkov ring imaging techniques lead to improved particle ID and ring counting, greatly improving BG rejection.



Cherenkov directionality offers powerful discrimination for directional sources or backgrounds.

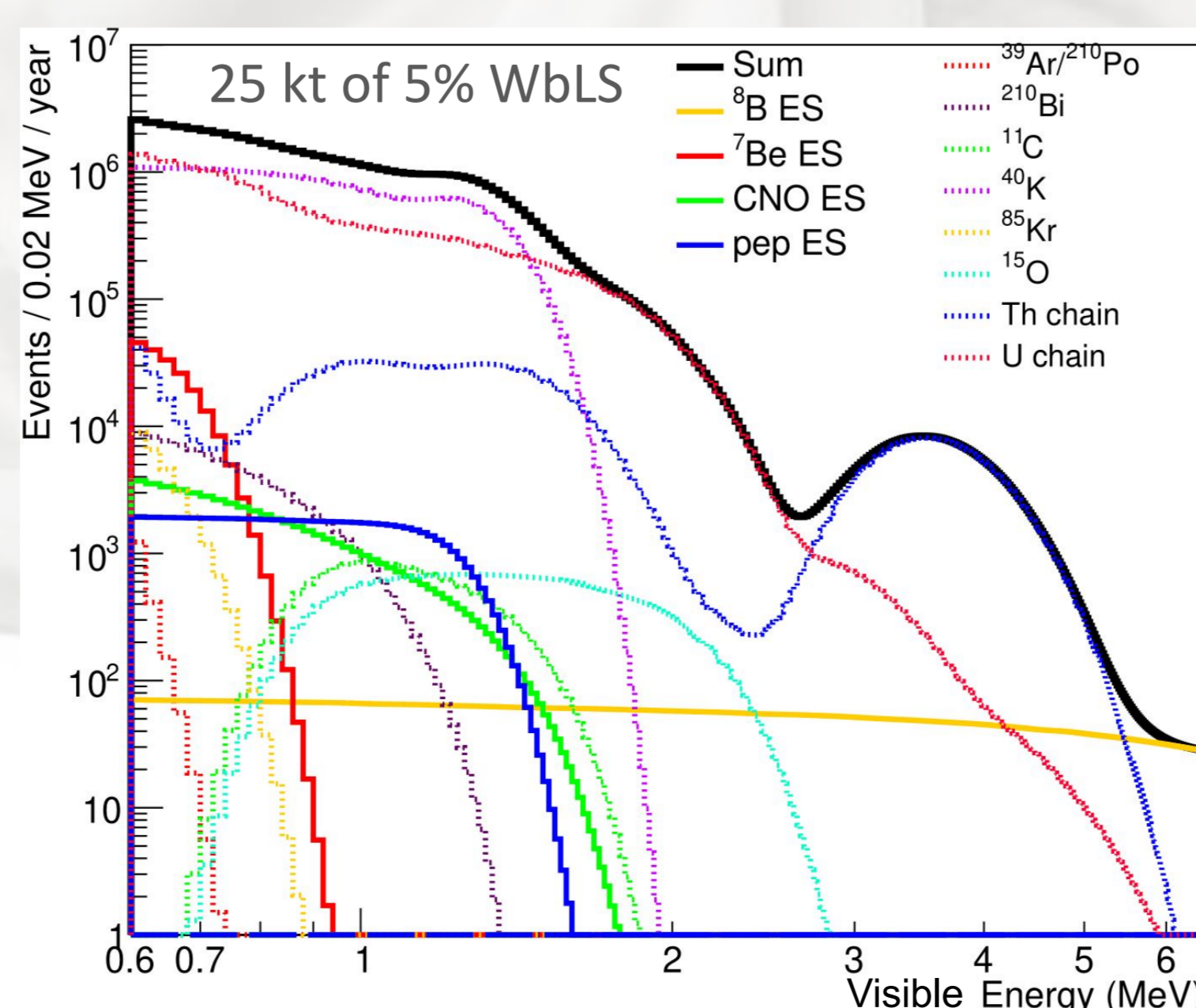
### Supernova burst

Flavor-resolution & spectral analyses ( $E$  &  $t$ ).  
Pre-SN:  $3\sigma$  detection at 3 kpc.



### Solar neutrinos

Test solar models & search for new physics.



### (NLDBD) Neutrinoless double-beta decay

THEIA 100 kt for 10 years

