Los Alamos National Lab's Contribution to the LOX Mission

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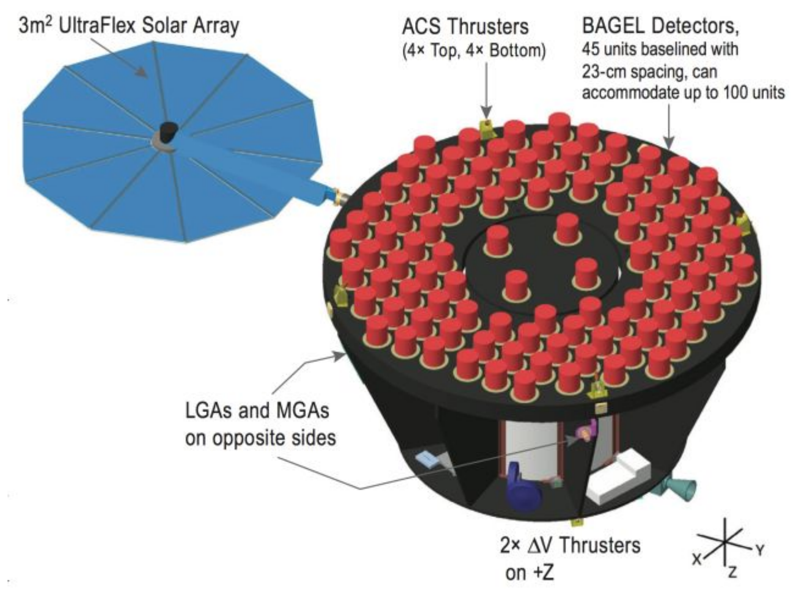
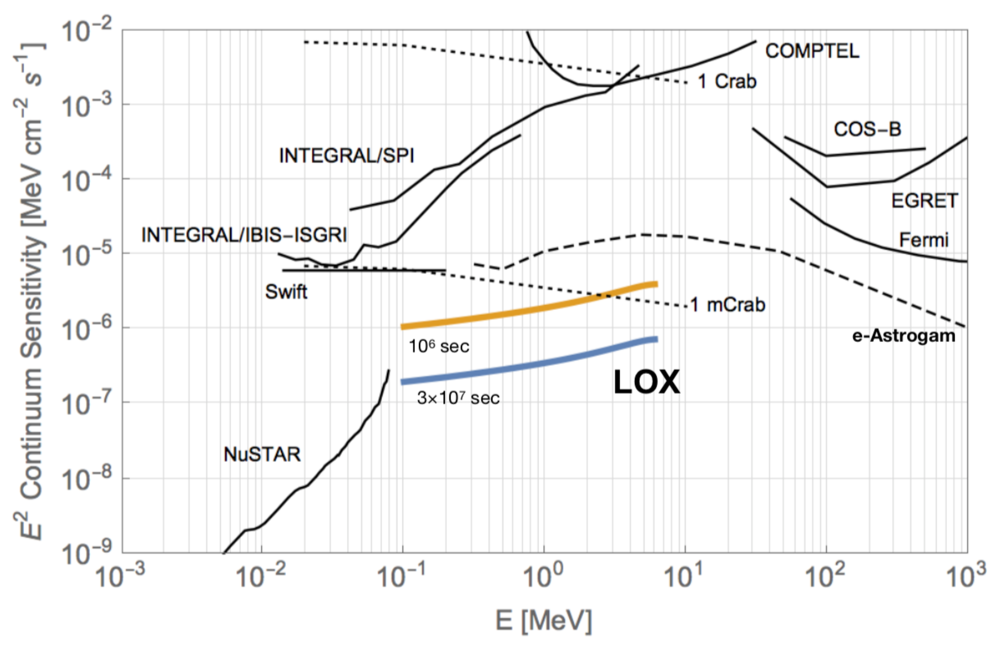
The Lunar Occultation eXplorer (LOX)

- will use the Moon as a platform to probe the cosmos at **MeV** energies
- well-suited for **all-sky monitoring** and **time-domain astronomy** pertinent to supernova investigations

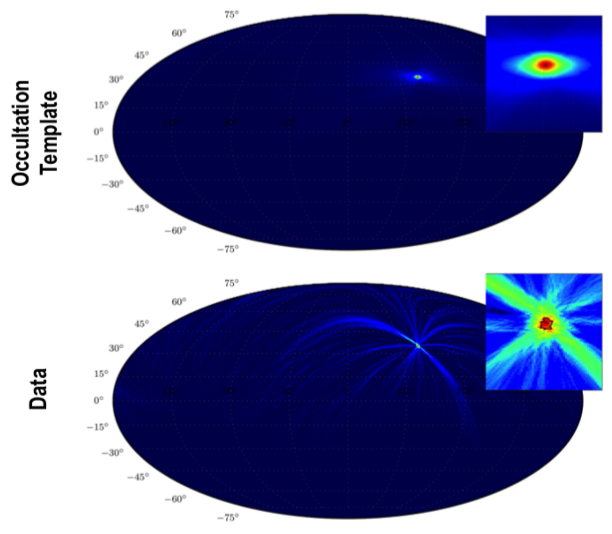


- Big Array for Gamma-ray Energy Logging (BAGEL) = large-area non-imaging spectrometer
- 0.1-10 MeV
- 10% uncertainty

- UVOIR SNeIa light curves can be used as standardizable candles with ~15% accuracy — 1% accuracy is needed to determine the nature of dark energy
- An **100-fold improvement in sensitivity** will revolutionize nuclear astrophysics and enable population studies of SNeIa



Lunar Occultation Technique (LOT)



- The Moon serves as a natural occulting disk to generate required modulation via repeated eclipses of sources
- The Moon is favorable due to lack of atmosphere, magnetosphere, benign background, and well-established lunar albedo

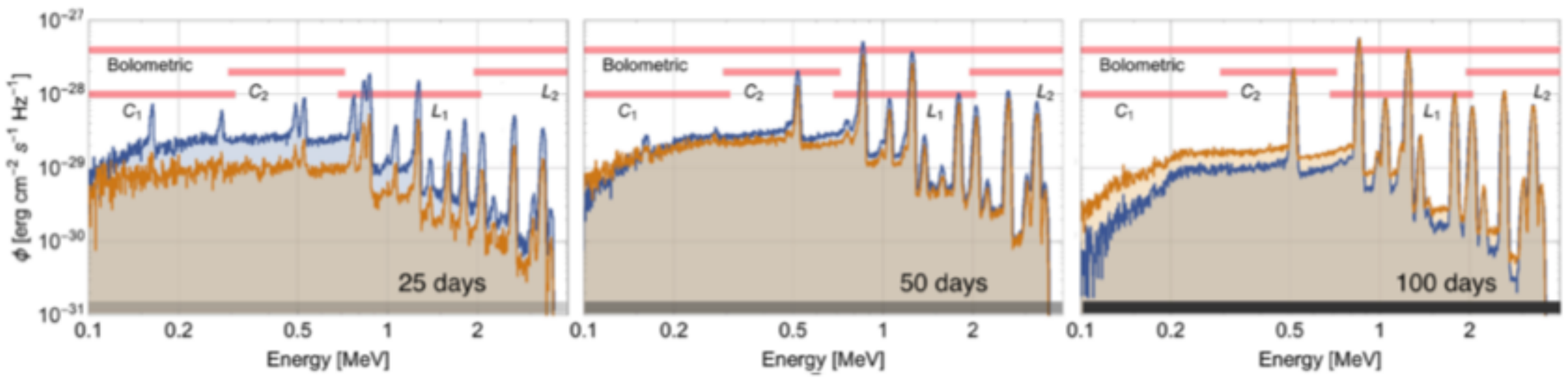
Future work

- modify existing modeling and analysis tools in C++ for spectral analysis, time variability, and cross-correlation with observations at different energies
- modify LOX background model to account for MeV galactic diffuse emission
- create predictive sky maps extrapolating from pre-existing source catalogs
- derive the expected MeV sensitivity from simulated sky maps

Type IA Supernovae

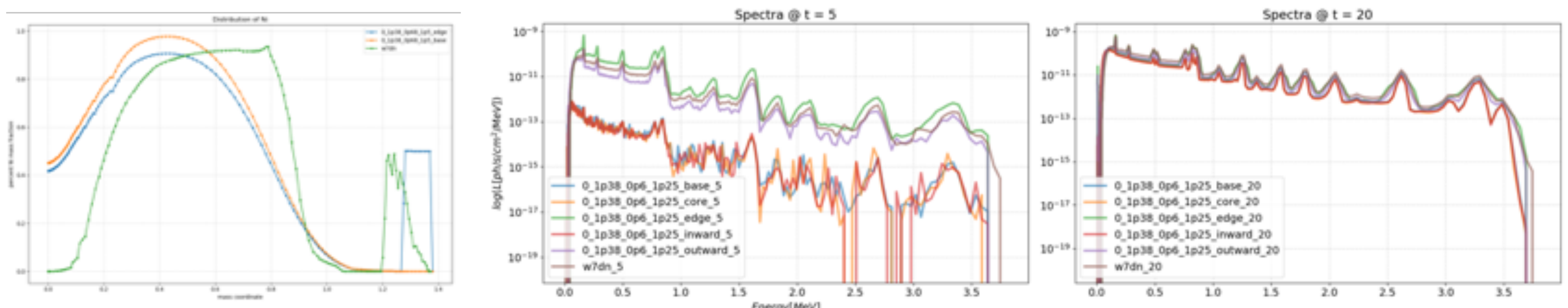
- Standard model picture of SNeIa is difficult to produce from UVOIR-based trends
- Information loss from nuclear radiation reprocessing is inevitable
- γ-rays are a **direct consequence of nuclear physics** governing the structure and dynamics of SN

Astro2010 Decadal Survey Findings	Top-Level Science Goals	Top-Level Science Objectives
What are the progenitors of SNeIa and how do they explode? (SSE2) **Why is the Universe accelerating?** (CFP2) **How do stars form?** (PSF1) **What controls the mass–energy–chemical cycles within galaxies?** (GAN2) "Areas of Unusual Discovery Potential": **Time-Domain Astronomy & Surveys**	**Characterize the Spectral Evolution of Type-Ia Supernovae**	Parameterization of Type-Ia Gamma-Ray Light Curves
	Quantify the Diversity of Type-Ia Supernovae	Population Studies of Type-Ia Supernovae Spectral Evolution, Including Identification of Subclasses
	Probe the Thermonuclear Physics & Standardization of Type-Ia Supernovae	Perform Census of Type-Ia Supernovae Progenitor Subclasses
		Perform Census of Type-Ia Supernovae Environments
		Connection to Type-Ia Supernovae UVOIR Diagnostics

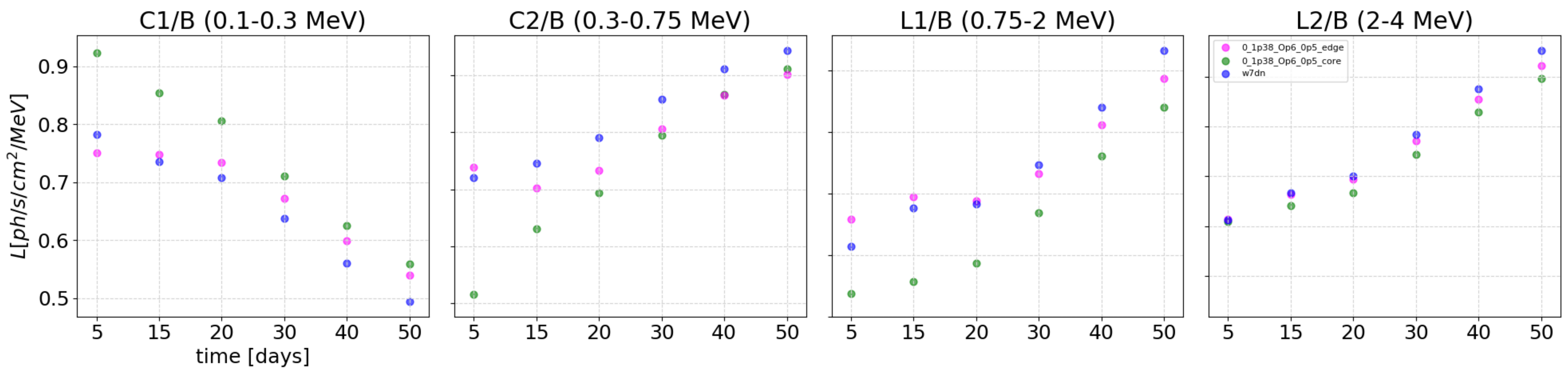


- Spectral evolution encodes information about progenitor systems
- Gamma-ray energy bands contain information about elemental origin and transport processes relevant for SNeIa studies — meaning high-spectral resolution is not critical

Preliminary data cube analysis



- Spectral and time-dependent information spanning a range of parameters from Ni distribution, total mass, total kinetic energy, and Ni mass
- **Goal:** find correlations in the theoretical data that will map to observational signatures (i.e. the width-luminosity relation, the Phillips relation) across γ-ray energy bands that will be useful to future missions such as LOX



- Example: the ratio of the integrated luminosity in the energy band C2 at early times could help distinguish models with differing Ni distributions

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