

Bayesian UQ for contamination mapping and spectral analysis

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Free-moving contamination mapping

Systems: Free-moving (UAV, hand-carried, vehicle-borne) spectrometer arrays

Data: Time-series list-mode gamma-ray data, 3D pose, 3D scene

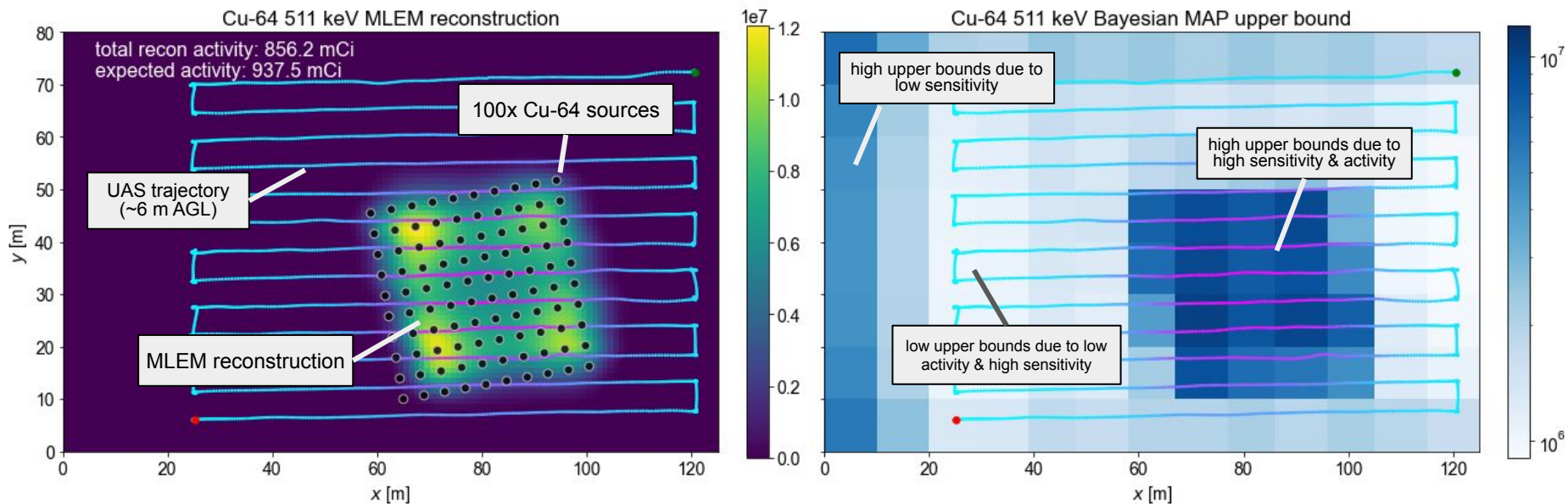
Objective: Reconstruct the distribution of gamma-ray emitters in the 3D environment

- MLEM and MAP iterative reconstructions
- Priors imposed on expected spatial correlations
- [UQ via Bayesian MAP perturbations](#)
 - **Want near real-time UQ, validated with full MCMC**

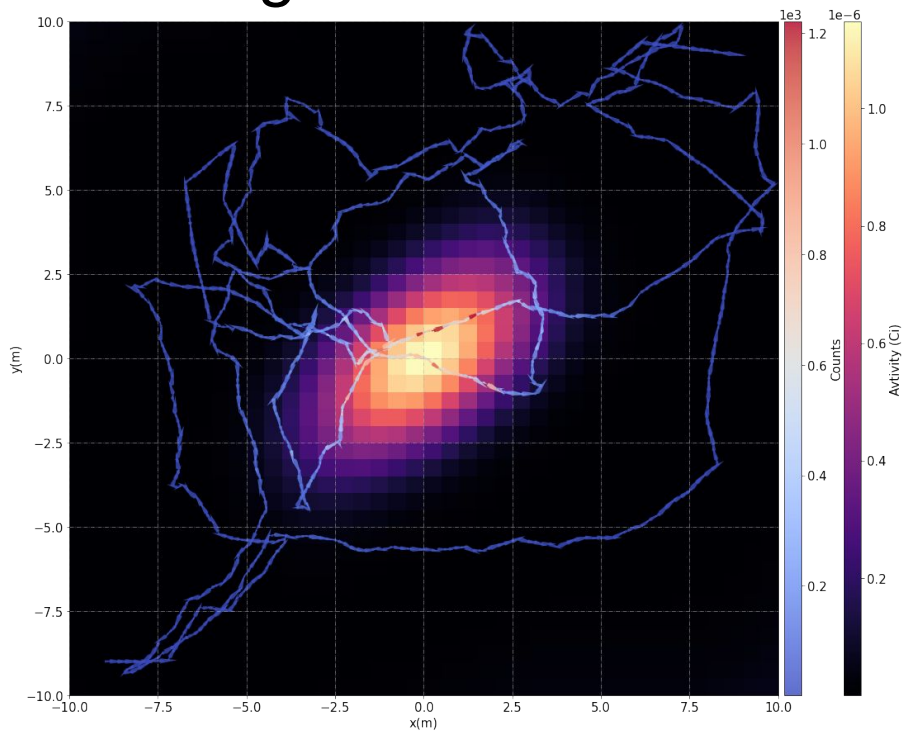
Example: UAV-borne system mapping a contamination environment

Experimental, ground-truthed data of UAV/contamination scenario

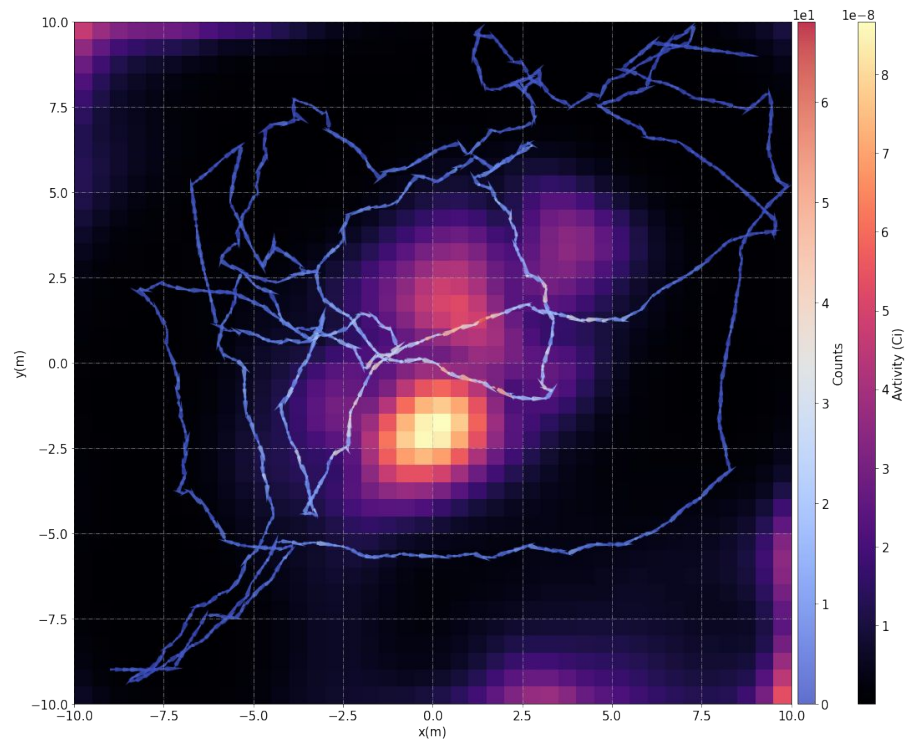
- Multiple source configurations and UAV flight patterns
- Exploring reconstruction and UQ performance



Also exploring pCN MCMC in toy problems w/ GP-regularization

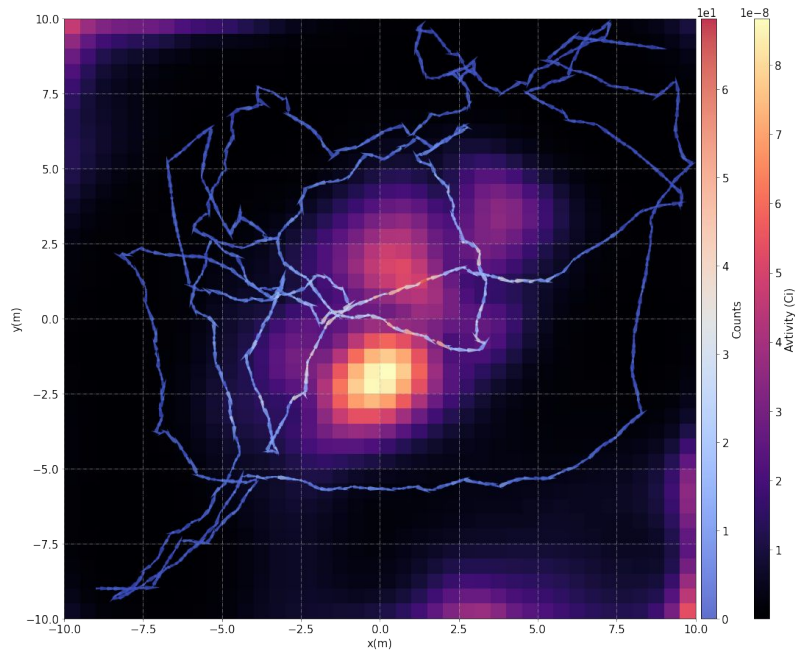


True image

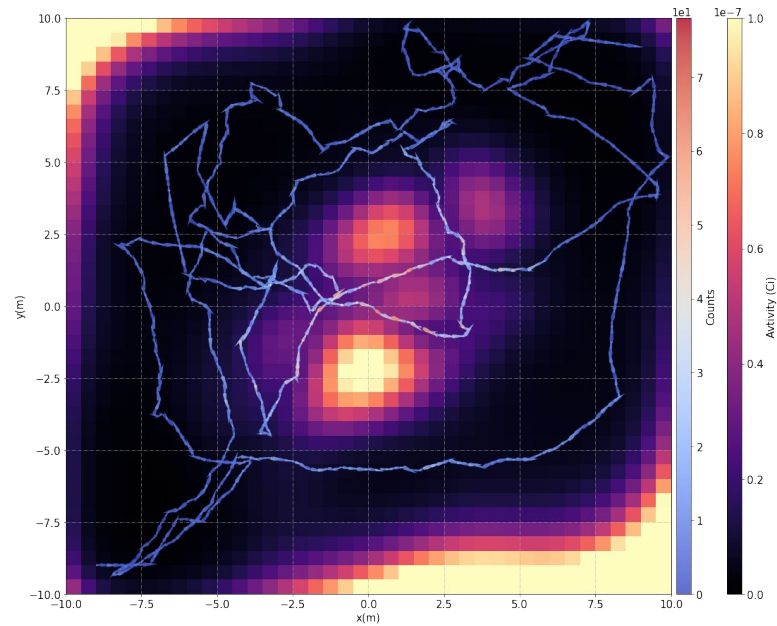


pCN MCMC 90% Bayesian credible interval
map (10^5 samples ~ 10 min)

... and the application of Laplace's approximation to the UQ task



pCN MCMC 90% Bayesian credible interval map
(~10 min)



Laplace's approximation 90% Bayesian credible interval (~0.5 sec)

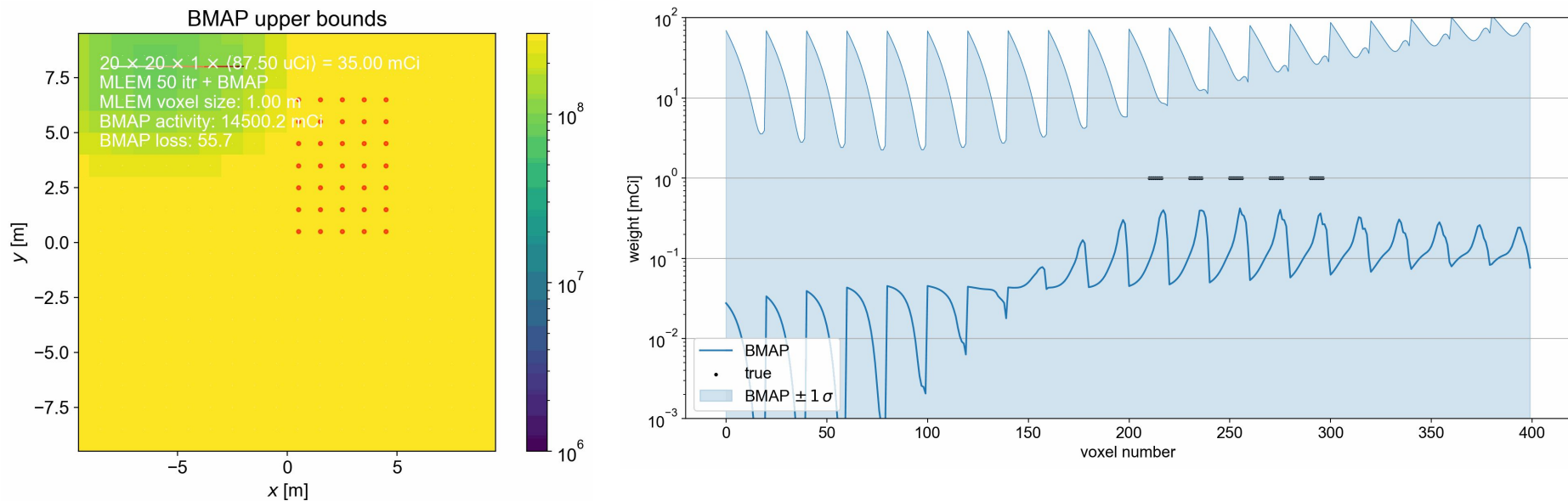
Additional interest in spectral decomposition and UQ

Interest in low-statistics spectral deconvolution in spectrometers and accurate UQ

- Given knowledge of detector response, transform measured spectra into energy dependent gamma-ray flux
- Potentially attribute flux to surfaces in the local scene
- Creates opportunities for data fusion, multi-agent navigation policies, etc...
- UQ is crucial for principled fusion of data from multiple measurements and disparate detector types

Backup

Bayesian MAP uncertainty quantification with synthetic data



BMAP upper bounds tighten around the MLEM estimate as the flight progresses

With enough sensitivity, BMAP lower bounds begin to appear