

DAMSA Experiment @ Fermilab PIP-II and Beyond

P5 Town Hall

June 27, 2023

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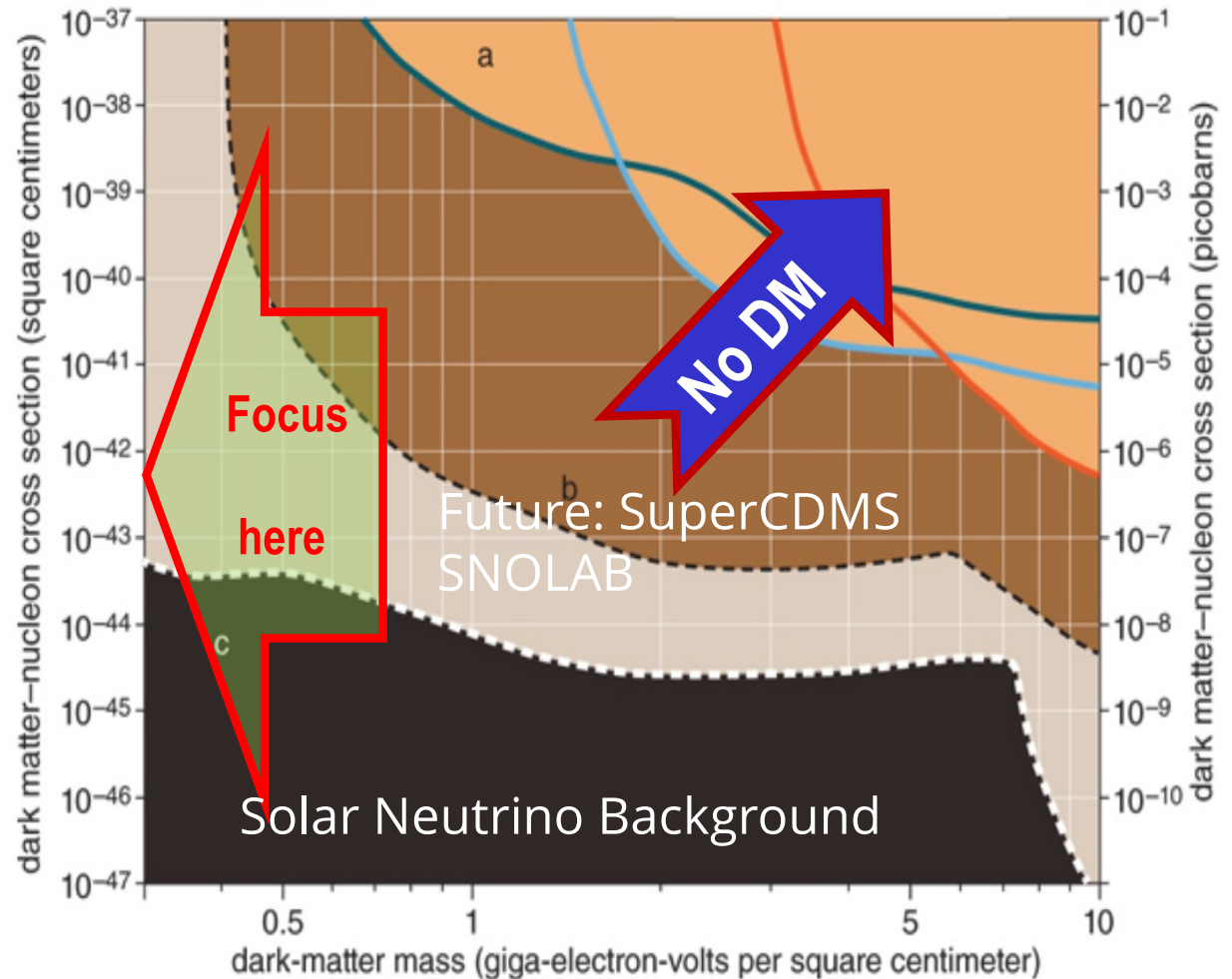
For the DAMSA Collaboration

What is DAMSA?

- Dark sector particle (DSP) search and discovery experiment at low E, high intensity proton beam facility
- Stands for **D**ump produced **A**boriginal **M**atter **S**earch at an **A**ccelerator (DAMSA)
 - 담사 (潭思) = 깊은생각 – Ruminating or Reflection
 - [Jang et al., PRD 107, L031901 \(2023\)](#)
- Aims to discover DSP's in the low mass regime at an accelerator → ideally E_{beam} below the pion threshold
 - Originally developed for 600MeV proton beams at a nuclear rare isotope facility
- The 800MeV PIP-II and the ACE beams fit the bill
 - The goal is to build the experiment by 2029 in time for PIP-II

Physics Motivation For DSP

- Direct searches have challenges in kinematic reach, leaving low mass range un-explored
- Strategy:
 - Search for rare particles in unexplored kinematic regime
 - Make and discover DSPs in an accelerator
 - Establish human infra on DM production



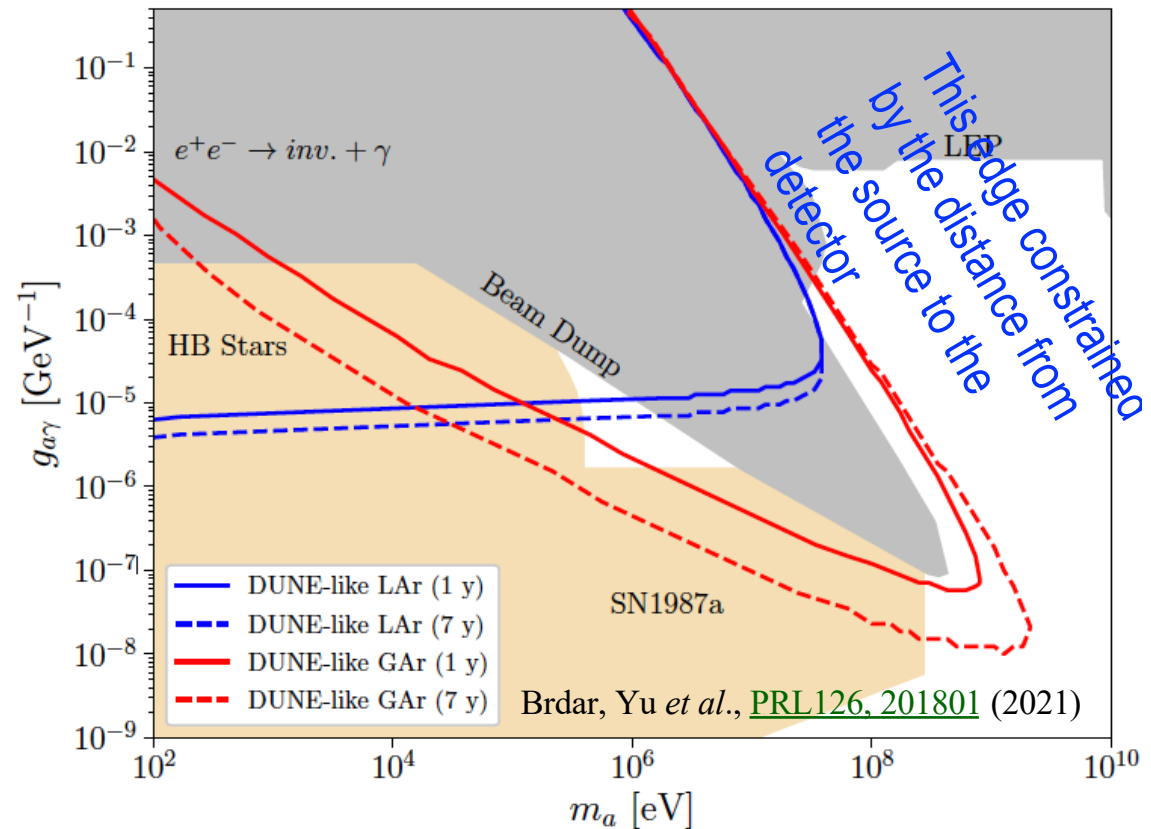
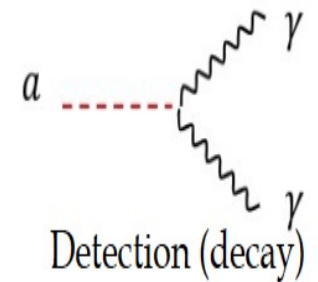
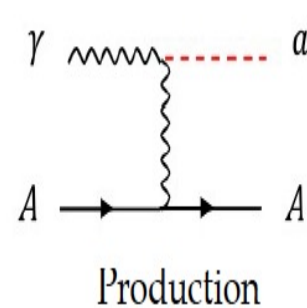
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See Gordon K's talk

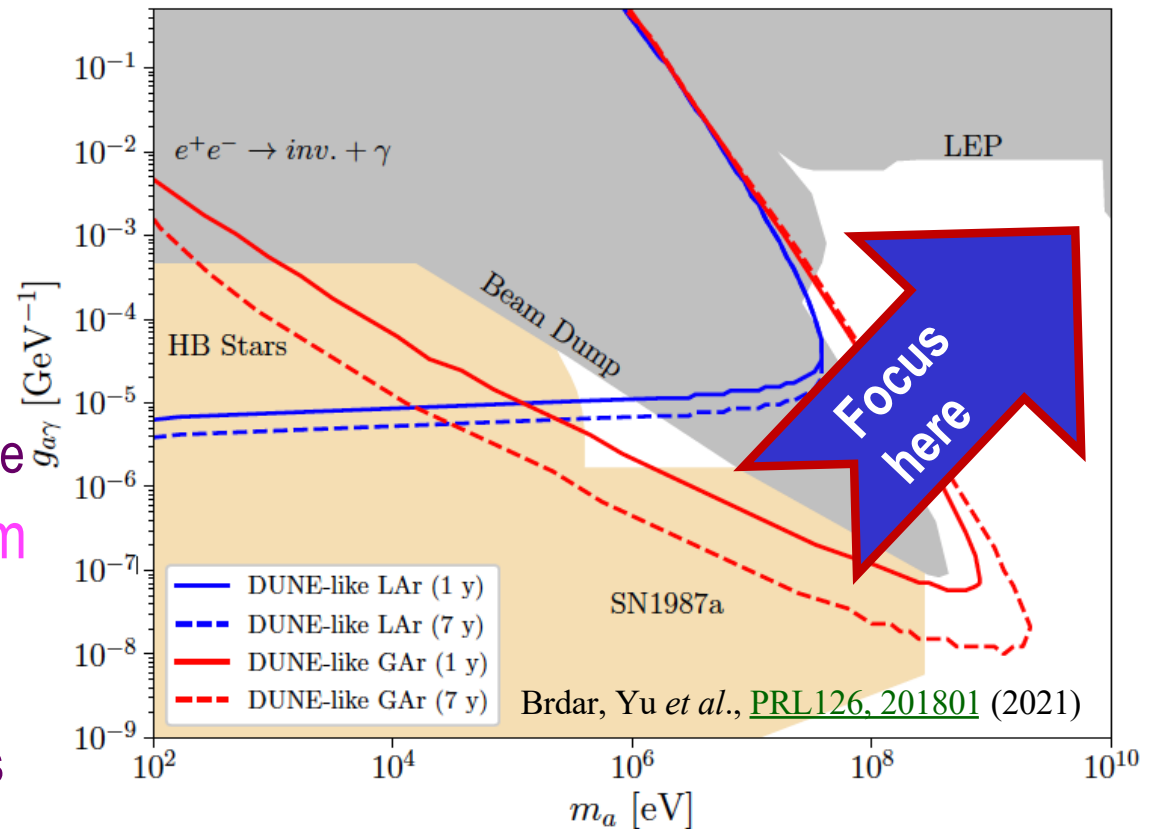
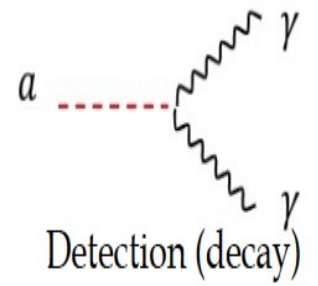
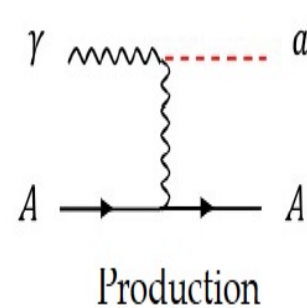
DAMSA Physics Strategy

- Focus on Axion-like particles (ALP) in their **two-photon** final state via the Primakoff process as the use case



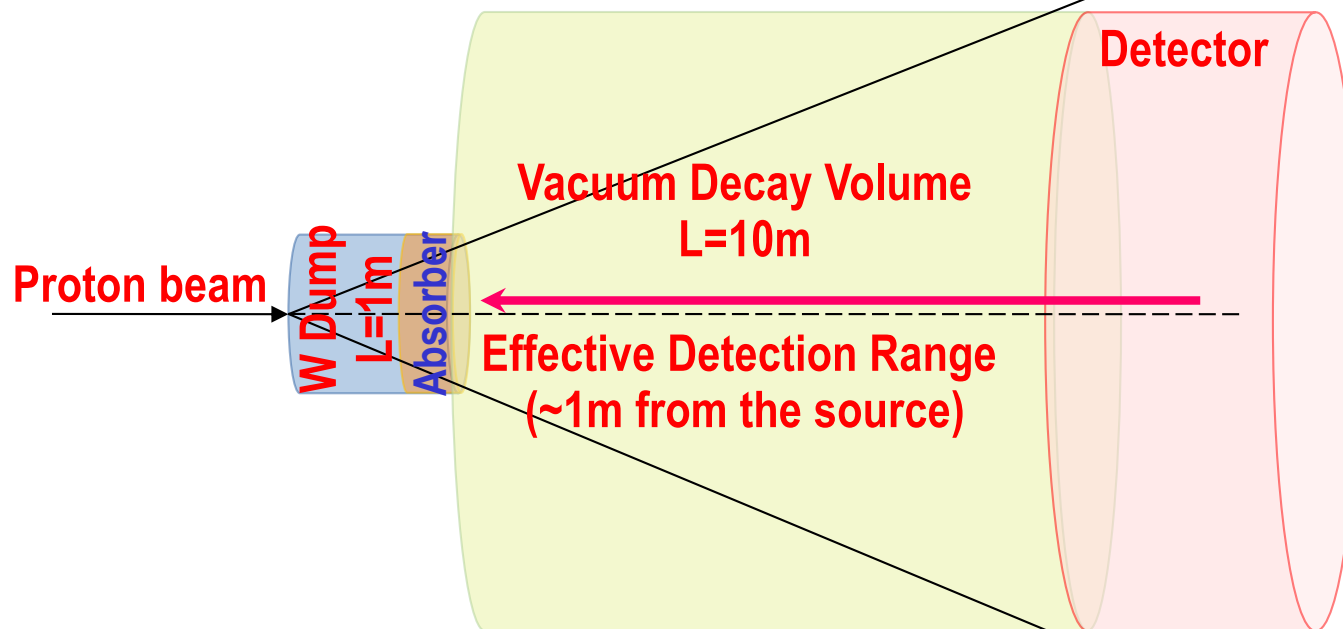
DAMSA Physics Strategy

- Focus on Axion-like particles (ALP) in their **two-photon** final state via the Primakoff process as the use case
- Produce as many photons as possible in the dump
- Capture as many ALPs as possible in as wide a mass range as possible
 - Minimize the distance from the source to the detector
 - Utilize a vacuum chamber to further expand detector coverage
- Minimize the backgrounds from neutral particles
 - Neutron spallation
 - ν QE, RES, and NC interactions

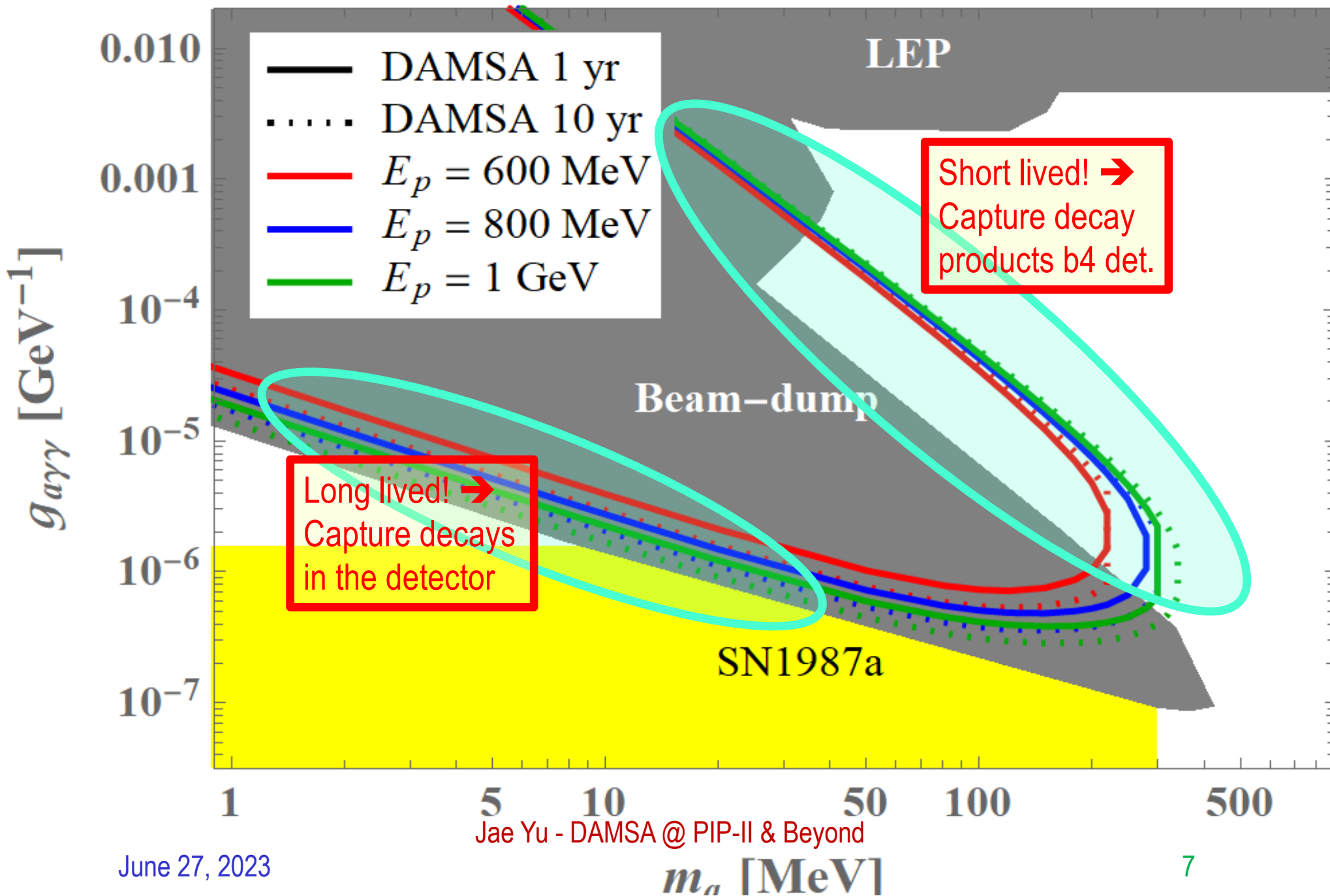


DAMSA Exp. Concept

- Inject and absorb as many low-E protons and produce as large number of γ in the dump as possible
- Allow higher mass ALP's to decay in the vacuum w/ as small number of neutrons escaping the dump as possible
- Place the detector as close to the dump as possible on axis to expand the mass reach to higher mass region



DAMSA Sensitivity Reach



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Summary

- DAMSA is a DSP search and discovery experiment that leverages high intensity, low energy proton beams
- DAMSA aims to be ready to take data in 2029 as PIP-II LINAC construction completes
- Detailed GEANT based studies completed for detector parameter requirements → Design optimization ongoing
- Collaboration building in progress (8 US, 6SK at present)
- DAMSA presents an excellent opportunity for transforming Fermilab's PIP-II and beyond to a world-class DSP facility