



FIPs in the ALPs: Roundtable

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Phenomenology of ALPs, searches for MeV-GeV FIPs at fixed-targets

Public tool called **ALPINIST**¹ (ALPs in numerous interactions simulated and **tabulated**):



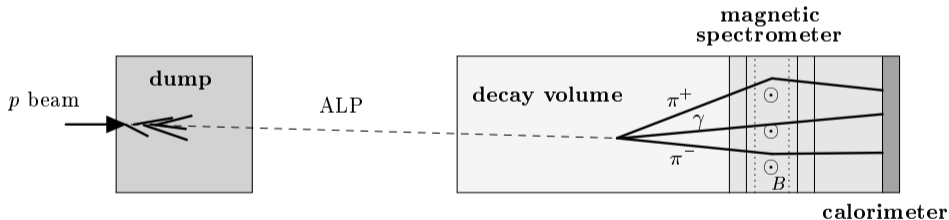
- ‘universal framework for study of MeV-GeV FIPs’
- allows the *reinterpretation* of searches for ALPs (and other FIPs) with MeV-GeV m_X and ms-ps τ_X in terms of custom ALP-SM coupling at UV;
- the tool incorporates the calculation of σ_{prod} for the dominant production channels and BR_{decay} for the decay channels at these masses;

- besides ALPs, ALPINIST also allows interpretation of the searches in terms of Dark Scalars (possibly also Dark Photons) and in the near future also HNLs;
- in principle any source can be used as input data for the reinterpretation module of ALPINIST (data/simulation for fixed-targets, accelerator searches, SNe, ..)

¹JJ, B. Döbrich, F. Ertas, F. Kahlhoefer, and T. Spadaro, *JHEP* 07 (2022) 094 [2201.05170]

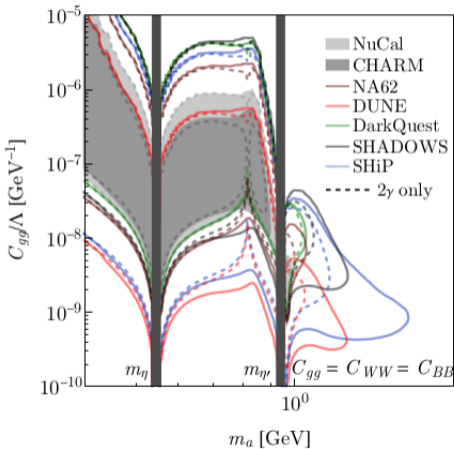
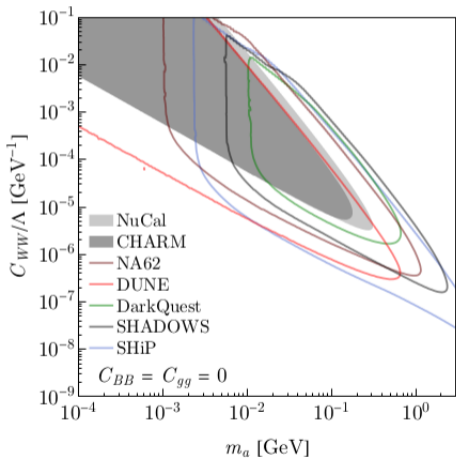
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- Since current (proton) fixed-target experiments are served with $\mathcal{O}(10)$ - $\mathcal{O}(100)$ GeV beams they are ideal for production of FIPs of before-mentioned m_X and τ_X :
 - besides the *reinterpretation* module, the tool is also equipped with a simplified fixed-target MC incorporating the exp. geometries and basic FIP analysis selection criteria for given decay modes;



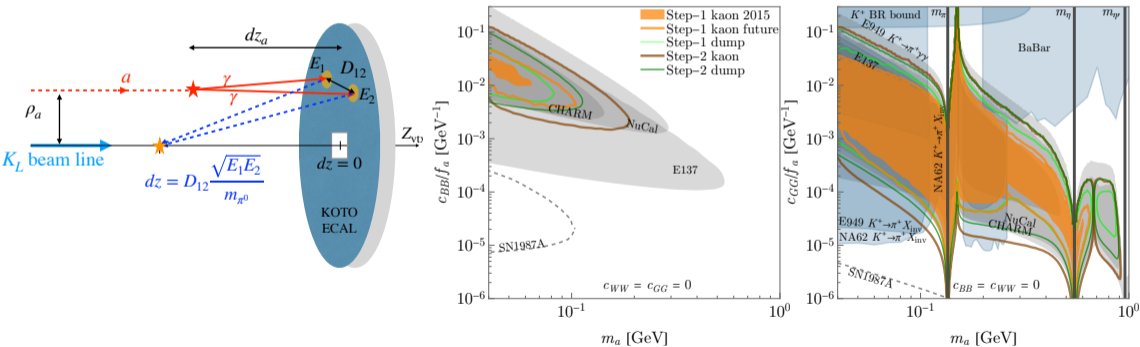
- the tool also includes an FIP generator based on Pythia, which allows FIP production in the target in secondary meson decays, direct ALP production via Primakoff process and via ALP mixing with the neutral pseudoscalar mesons, etc.

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Using ALPINIST MC to reinterpret the $K_L \rightarrow \pi^0 \nu \bar{\nu}$ search at KOTO experiment (JPARC) as a search for ALP $a \rightarrow 2\gamma$ ²



²Y. Afik, B. Döbrich, JJ, Y. Soreq, and K. Tobioka [2303.01521]

NA62 experiment



- Fixed-target at CERN SPS, ECN3 cavern;
- main purpose: kaon physics ($K^+ \rightarrow \pi^+ \nu \bar{\nu}$);
- can be operated in beam-dump mode - target ~ 90 (230) m from the decay volume (calorimeter);
- plan to collect 10^{18} POT during this run (currently we have $\sim 1.4 \times 10^{17}$ to analyze);
- sensitivity in new regions of mass-coupling parameter space for all types of FIPs:
Dark Photon analyses finalized, I'm working on gluon-/quark-coupled ALPs (hadronic decays)

Other topics:

- Spinor-helicity formalism (notably search for soft theorems in EFTs)
- Development of TDAQ control system for NA62

Backup slides

Dark Photon at NA62

Exclusion from $A' \rightarrow \mu\mu$ and ee

