LLPs @ Future Colliders

Cristiano Alpigiani, Ben Brau, Ben Carlson, Giuliano Gustavino, Henry Lubatti, John Stupak, Gordon Watts

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Overview

Neutral LLPs at Future Colliders

We plan to perform a **comprehensive comparison** of the sensitivity of proposed future colliders/detectors to **electrically-neutral LLPs**, including consideration of so-called "external" detectors (e.g. MATHUSLA). We propose to **initially focus on Higgs-portal** hidden sector scenarios, and consider additional scenarios (gauge-portal, heavy neutral leptons, RPV SUSY, etc.) person-owner permitting. We plan to study a **variety of production modes and lifetimes**, ranging from effectively prompt to effectively invisible, using **ID-, calorimeter-, MS-, and MET-based signatures**. In order to understand how future detectors can maximize sensitivity to these unconventional signatures, we also plan to investigate the **impact of various detector functionalities**, such as precision timing and tracking at L1.

Higgs portal smoking gun:
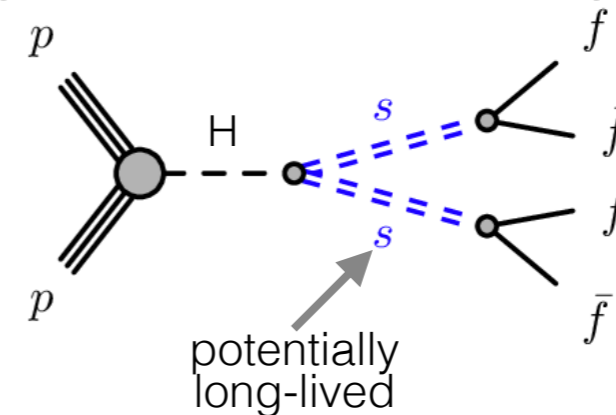
Flavors of displaced jets:

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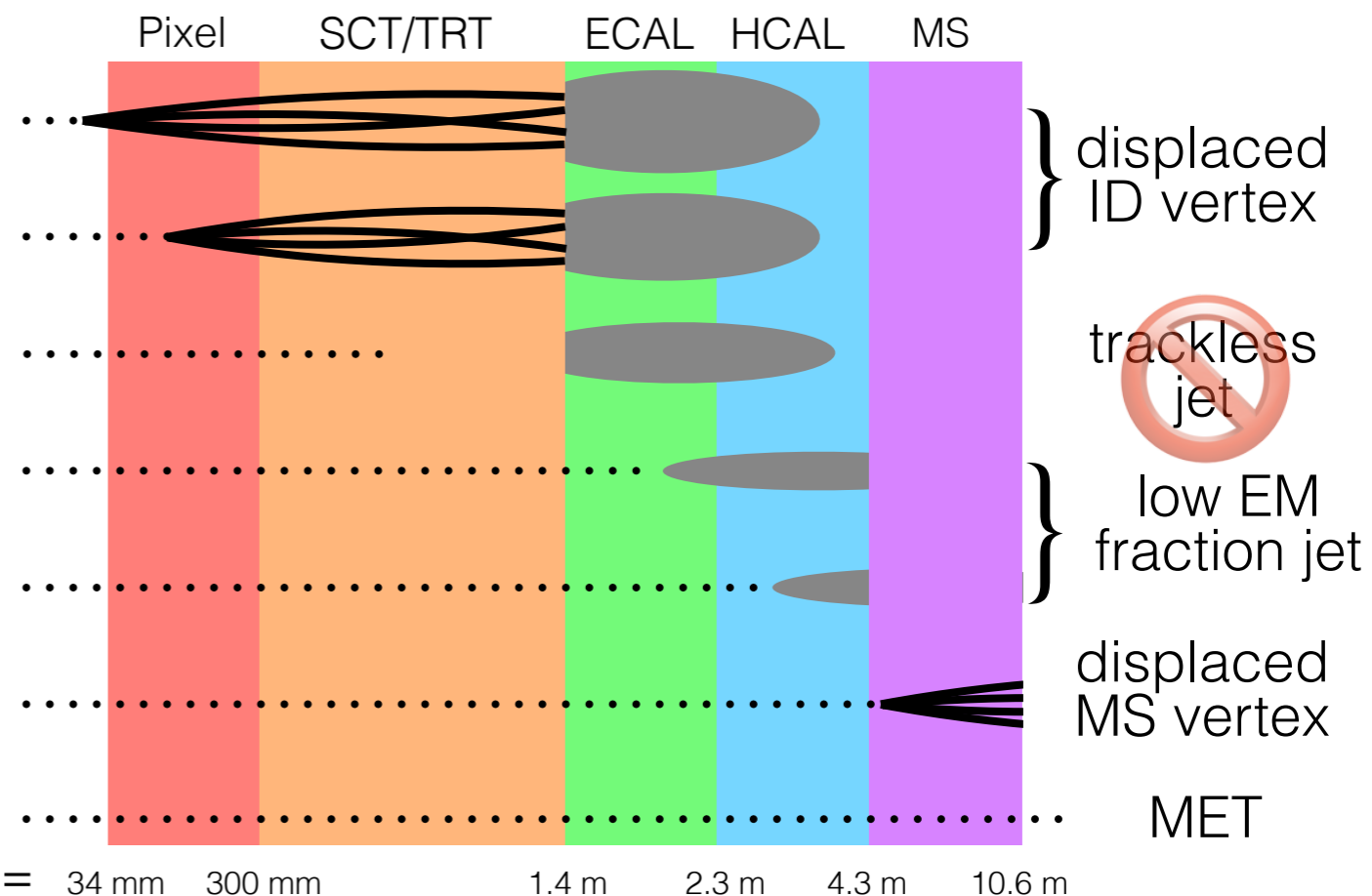
Higgs Portal Searches

- B-tagging: 2005.12236, 1806.07355 (LL interpretation)

- ID DV: CMS-PAS-EXO-19-021, 1705.07332 (LHCb), 1911.12575 (ATLAS: ID+MS)

- Low EM fraction jets: 1902.03094

- MS DV: 1811.07370

- MET

  - H→inv: ATLAS-CONF-2020-008 (VBF: 139/fb), 1904.05105 (combo: run1+36/fb)

  - Mono-X: 1712.02345

- Indirect (couplings): 1606.02266

lifetimes from prompt to invisible currently probed

[1806.07355]   [1902.03094,1811.07370]

132 fb^{-1} (13 TeV)

[CMS-PAS-EXO-19-021]

[ATLAS-CONF-2020-008]
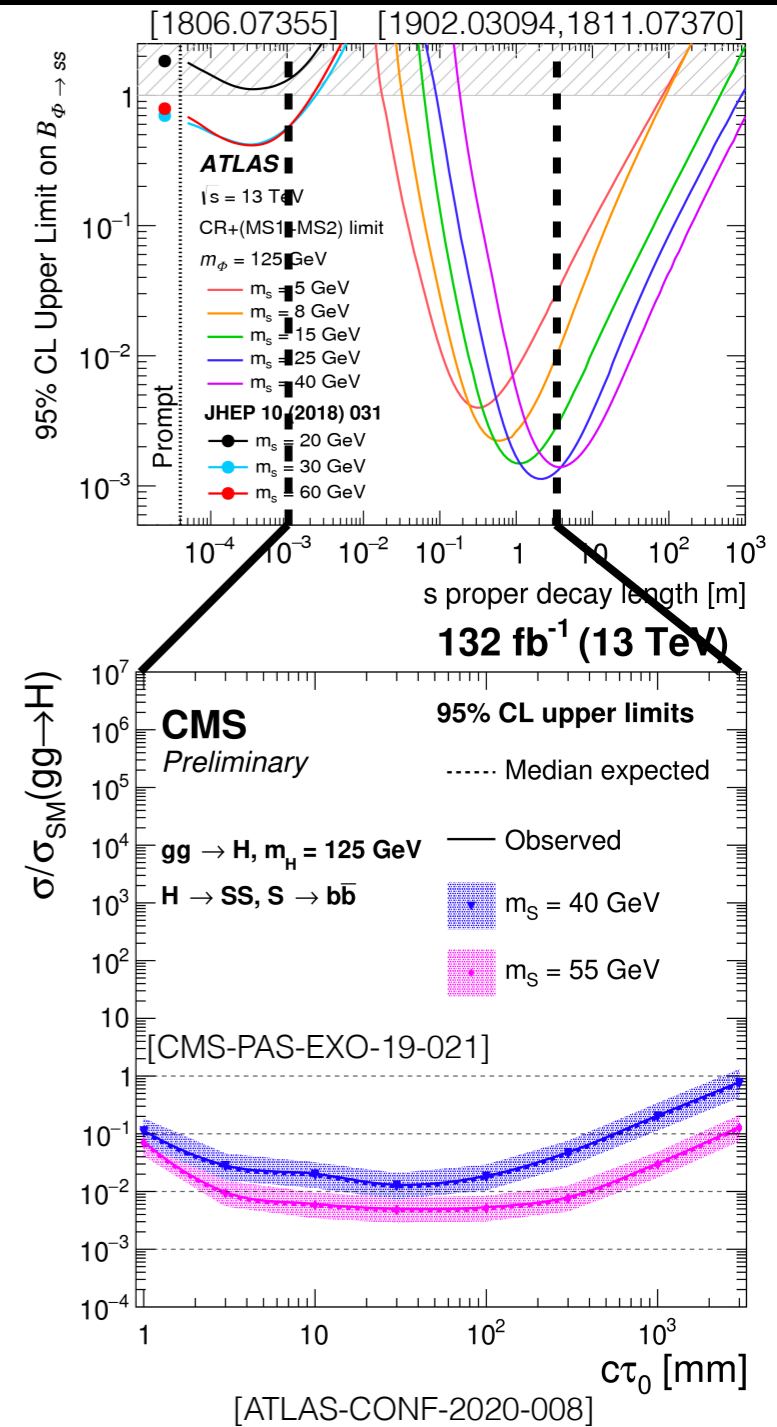
limits on BR(H→inv):

	Observed	Expected
	0.132	0.132

John Stupak - University of Oklahoma
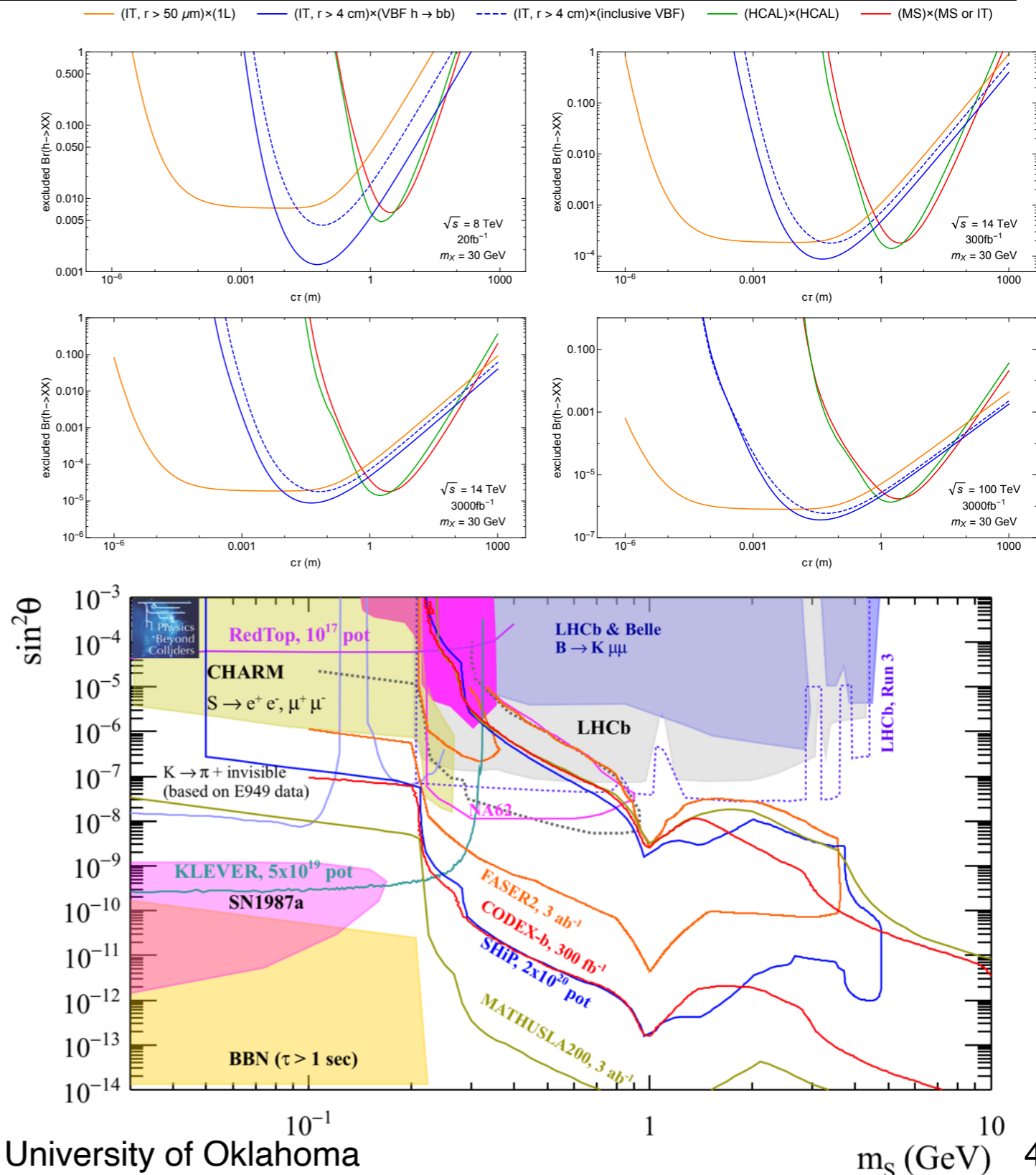
Higgs Portal Projections

- Landscape is incomplete and (at least) somewhat out of date

  - Curtin, Verhaaren: 1506.06141

  - PBC: 1901.09966

Open Questions

- What is the expected coverage of future "main" detectors?

  - Can sub-leading production modes provide sensitivity?

  - How does collider energy and PU affect discovery potential?

  - Does clean environment at lepton colliders allow access to new regimes, or is the lack of statistics a killer?

- Of the many proposed "external" detectors, which provide unique sensitivity? What is the minimal set needed to maximally cover parameter space? (see slides from David et. al. for details)

- Post HL-LHC, are there gaps in sensitivity to LLPs? Can they be filled?

- How can we design future experiments to maximize sensitivity to long-lived particles?

  - Where should we concentrate our limited efforts?

    - Hardware/HL triggers, new subdetectors (timing, etc), improved subdetectors (better pointing res), offline algorithms (machine learning)?

Collaboration

- We are **very** open to new collaborators and/or joining forces with others

- Don't hesitate to get in touch!