Muon Collider Targets

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IMCC is preparing list of target parameters for the many systems that compose the muon collider facility.
Converging on integrated tentative design, to start iterations

By this effort, we know today way more details on the muon collider than its energy and luminosity.
In particular, beam properties/BIB levels and composition that impact experiment and detector design.

Physics targets are needed to evaluate performances of the whole chain, identify pitfalls and required improvements

We also need key studies in order to consolidate the physics case.
Define the targets harmonising these different needs.

BSM Searches

Plain heavy BSM resonance searches are needed:

Concrete **BSM** scenarios and **models** feature many particles, and many signatures. Detailed study will enable:

- Comparative assessment of different Direct strategies and their complementarity, as well as Direct vs Indirect
- Study muon collider discovery **and characterisation** perspectives
- BSM characterisation is toy version of high-energy measurements
- Sound comparison with FCC: not signature- but model-based

Comprehensive and **realistic** signature survey, fertile ground for studies like:

- Boosted hadronic objects, studied for FCC-hh as well, but our problem is not QCD
- EW radiation, e.g., neutrino jet
- 10TeV MuC detector specification requirement

A reasonable starting point is the HVT scenario:

- All possible SM final states, from μμ and from VBF
- Multiple BSM interpretations
- Ongoing pheno studies, **link**
- Experimental work needed

Long-Lived Particles

Called “unconventional” signatures at LHC, but MuC design will instead take them into account from Day 1

Direct interplay with detector/technology, trigger and analysis.

Benchmarks under definiton:

A survey from Zhen Liu: **link**

- Disappearing tracks in good shape
- Displaced decay vertices
- Anomalous showers
- Highly ionising particles
- Delayed decays

Benchmarks

- Non-colored LLP
  - (Higgsino, GMSB)
  - (decay via Higgs and Z, getting reach from both leptonic and hadronic decays)
  - (mass v.s. ctau)
- Colored LLP
  - (gluino, mini-split SUSY)
  - LSP mass 100 GeV (non-compressed)
  - 100 GeV mass gap (compressed)
  - (mass v.s. ctau)
- Higgs portal
  - (Higgs to LLPs, neutral naturalness)
  - (LLP mass 50 GeV, 10 GeV, 1 GeV)
  - (Br v.s. ctau)
- Disappearing Track
  - ✓ Higgsino reach
  - ✓ Wino reach
- Light Dark Sector:
  - HNL
  - ALP
  - Dark Photons
  - Dark showers

- Yellow: MuC excellence (to be demonstrated)
- White: MuC pontential

19

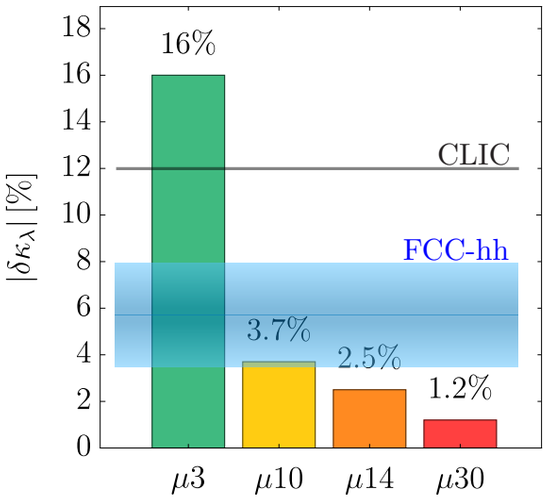
Precision Physics

Is the MuC (also) a Precision Machine?

We have shown it has the **statistical potential** for that.
And, **low physics backgrounds**.
But:

- Will per-mille class measurements for Higgs physics be possible?
- And per-mille level predictions?

Could sound ambitious at this stage to embark in fully realistic study, but assessment of possible showstoppers is needed



	HL-LHC	HL-LHC +10 TeV	HL-LHC +10 TeV + ee
κ_W	1.7	0.1	0.1
κ_Z	1.5	0.4	0.1
κ_g	2.3	0.7	0.6
κ_γ	1.9	0.8	0.8
$\kappa_{Z\gamma}$	10	7.2	7.1
κ_c	-	2.3	1.1
κ_b	3.6	0.4	0.4
κ_μ	4.6	3.4	3.2
κ_τ	1.9	0.6	0.4
κ_t^*	3.3	3.1	3.1

* No input used for μ collider

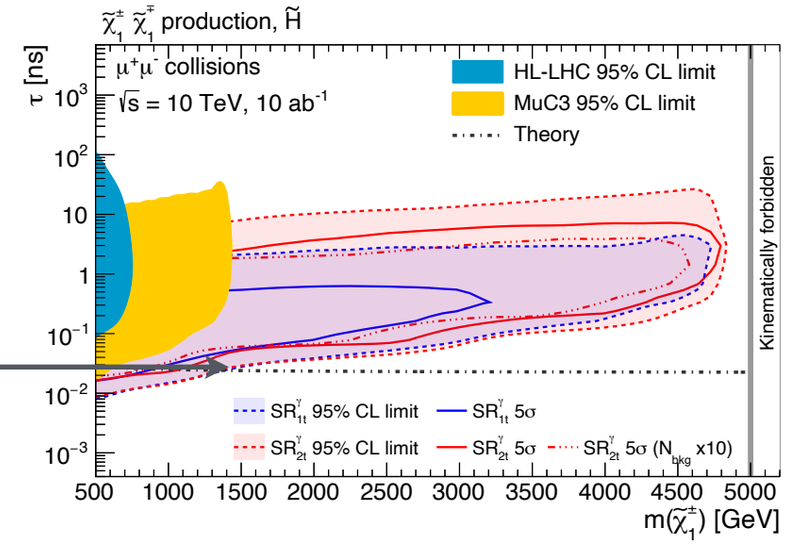
WIMP Dark Matter

Unanimously recognised as important target

Higgsino and Wino as specific benchmark models for all colliders.

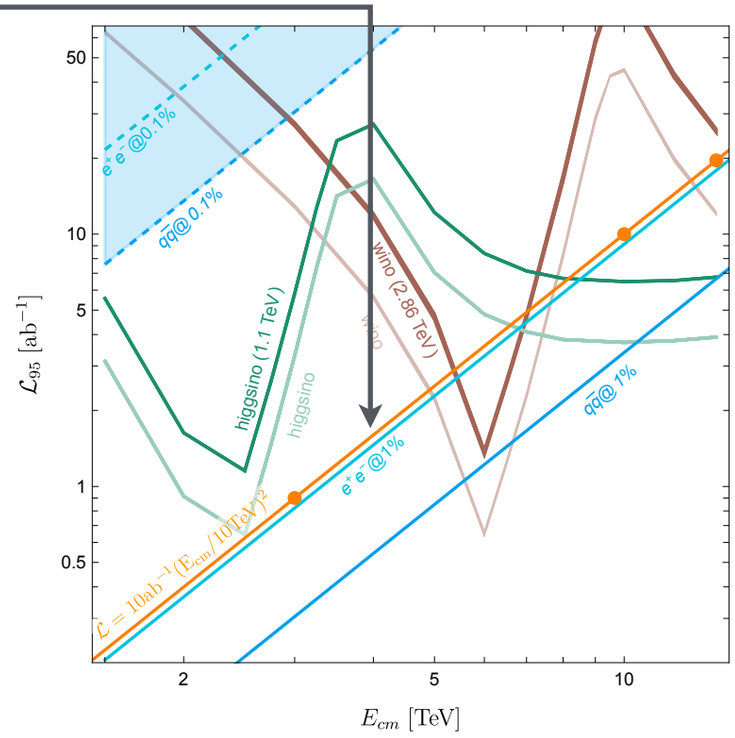
We have great perspectives, but:

- Higgsino from disappearing tracks **lives dangerously**
- Mono-X "direct" searches are in fact **precision measurements** of the X kinematics. **1% systematics affect reach strongly**
- So-called "indirect" probes from loops are less demanding. on uncertainties, but still…



Need feasibility assessment:

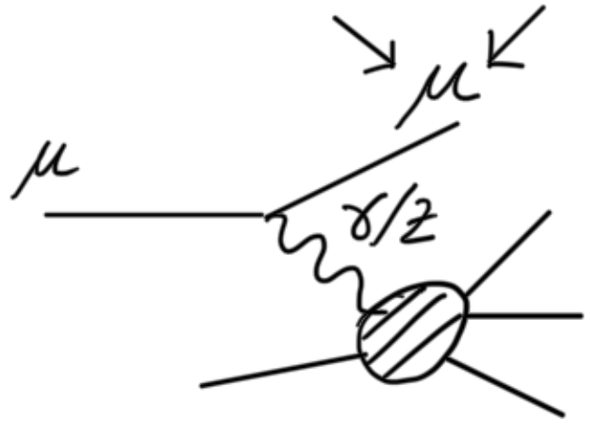
- Experimental error
- Theoretical predictions



Forward Muon Detector

One specific sub-system for Effective Vectors tagging and reconstruction, through fwd μ

- Unique of the MuC
- Further boost VBS/VBF MuC potential



Possible benchmarks:[**link**]

- Higgs couplings: Kw vz Kz, CP violating couplings
- Higgs to invisible
- Higgs portal models
- Pheno work done or in progress. Experimental work needed

Delphes Card

Evolving Delphes card with detector performances

- Best way to communicate our findings
- Easy for newcomers to make semi-realistic sensitivity projections
- Should integrate **state-of-the-art** and **aspirational** performances
- Let the community at large evaluate performances and identify key improvements