Can future colliders be the light to see dark matter?

Deborah Pinna
(University of Wisconsin, LPC)

P5 Town Hall Meeting, *Short remarks*

BNL, 12-14 April

Why and where to look for Dark matter?

DM evidence

- *Many empirical evidences of DM from astrophysical observations*
  - interacts gravitationally, long lived and neutral
  - *no information about its nature*
  - ✱ *most studied class of theories: DM is a weakly interacting massive particle*

DM production

- *DM could be produced at colliders (rare process)*
  - no direct trace in the detector, but could create a p_T imbalance (***MET***)
  - need *visible particle X* for DM particle to recoils against (*mono-X searches*)

investigate specific interactions/final states

DM signature

- *Very rich phenomenology studied at LHC*
  - simplified models
  - DM Higgs portal
  - 2HDM, …
  - ✱ *not only mono-X …*
    - dijet
    - resonances

WHAT IF DM HIDES AT HIGHER ENERGIES?

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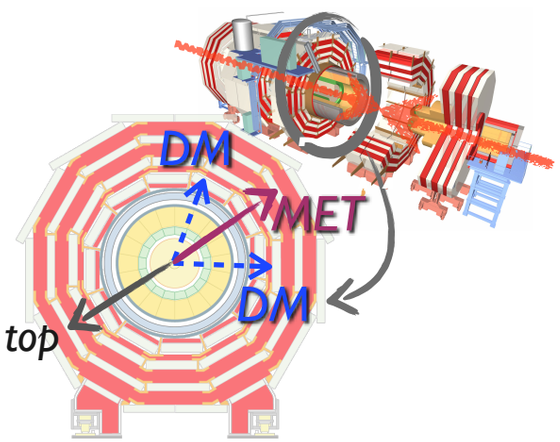

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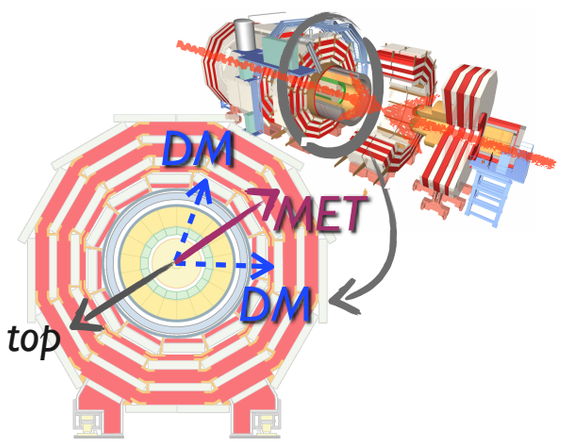

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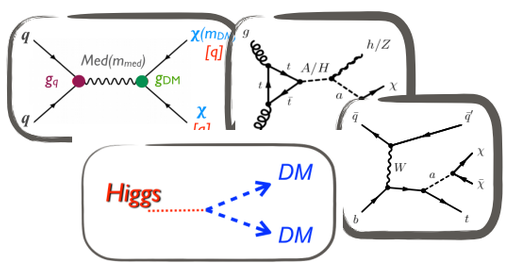

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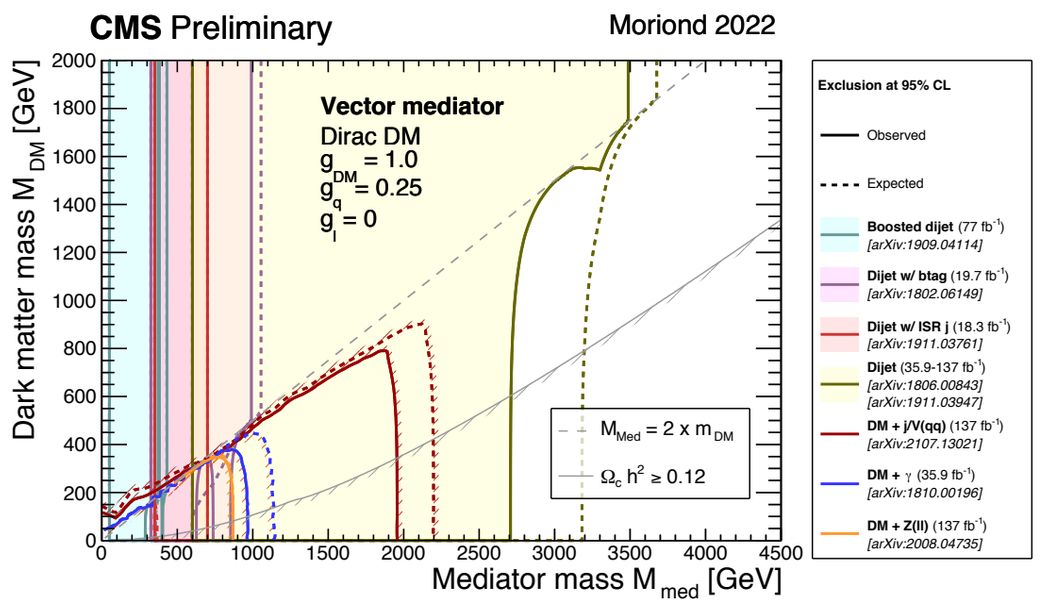

WHAT IF DM HIDES AT HIGHER ENERGIES?

Leaving no stone unturned …

- *DM could be the lightest member of an EW multiplet* arXiv:2009.11287, arXiv:1805.00015
  - *near mass degeneracy* extremely challenging
  - *very high mass scale*, DM mass ~1-23 TeV
  - *Higher dark matter/mediator mass parameter space will remain unexplored after HL-LHC*
  - challenging to probe in direct detection experiments due to loop-suppressed cross-sections

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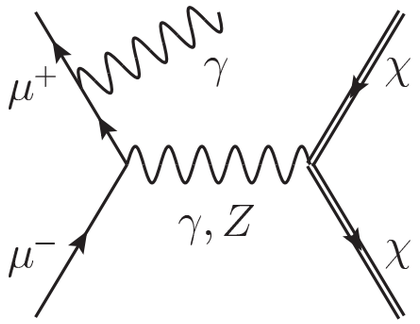
- FUTURE COLLIDERS ARE THE ANSWER!

  - MUON COLLIDER: arXiv:2205.10404v1, arXiv:2206.03456, arXiv:2009.11287

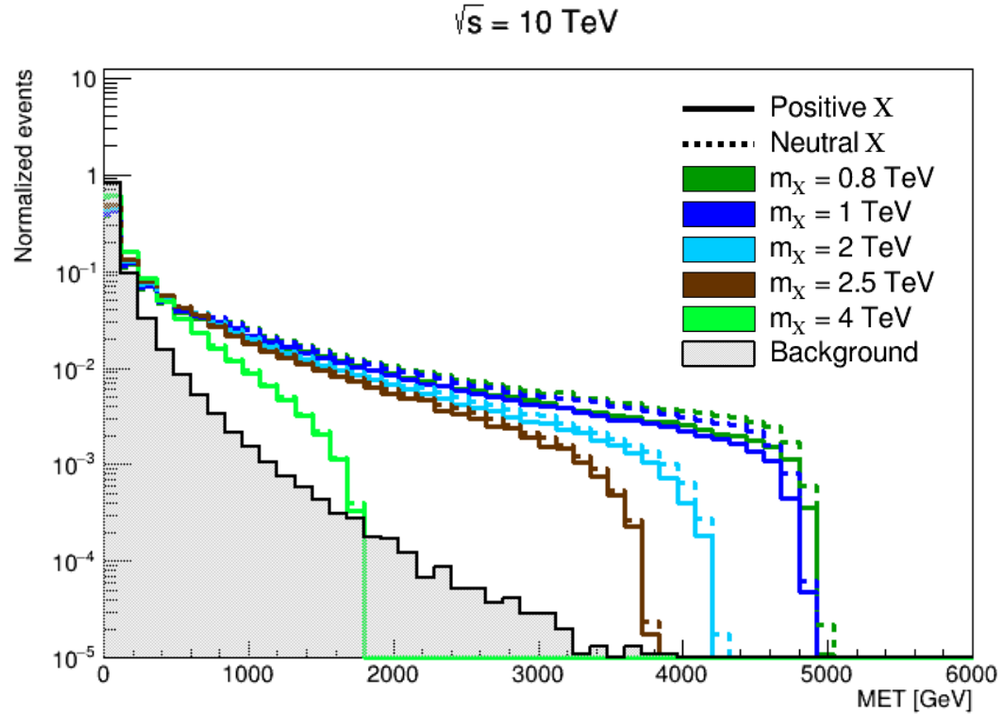
    - could explore well beyond current energies, *(complementary mass ranges wrt to ee colliders)*
    - fixed $\sqrt{s}$, full event reconstruction
    - *direct search* through mono-X for eg mono-photon
    - *indirect searches* model-independent probe of new EW states through precision measurements

MUON COLLIDER: mono-photon signature



  - HADRON COLLIDER: arXiv:1810.10993v2

    - potential higher $\sqrt{s}$, variable collision energy due to pdfs
    - *direct search* through mono-X or disappearing tracks
    - *indirect searches* model-independent probe of new EW states through precision measurements



COMPLEMENTARITY WILL BE ESSENTIAL FOR DARK MATTER DISCOVERY

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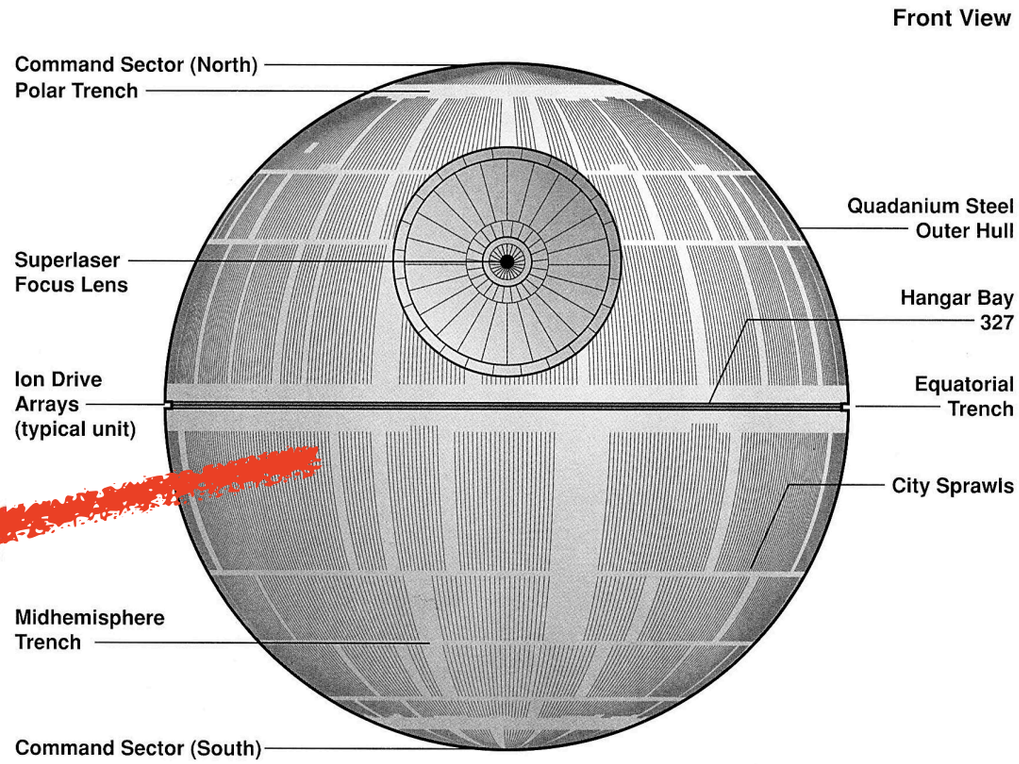

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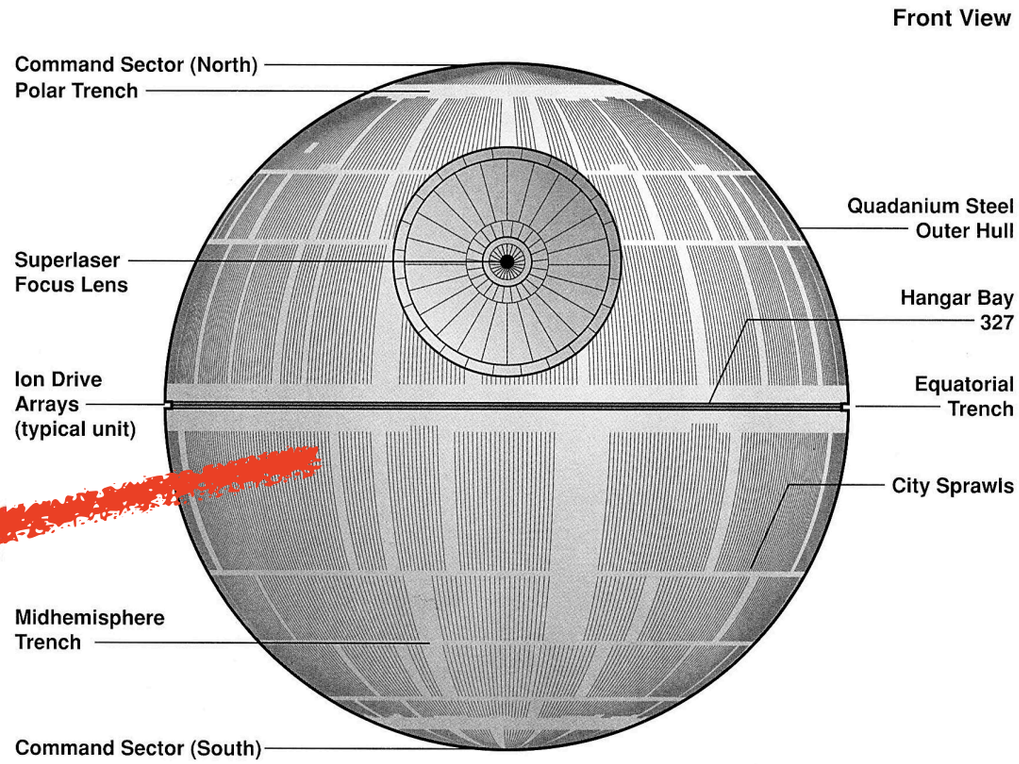

Thank you!