DM@LHC discussion points

Based on material provided by the session conveners
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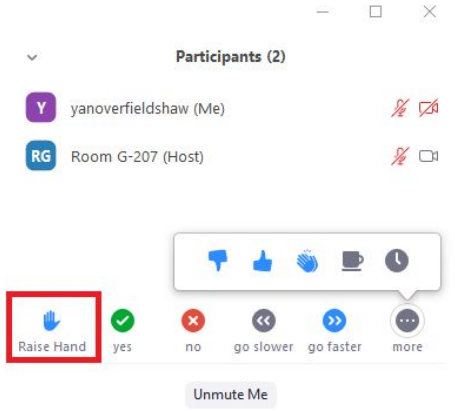
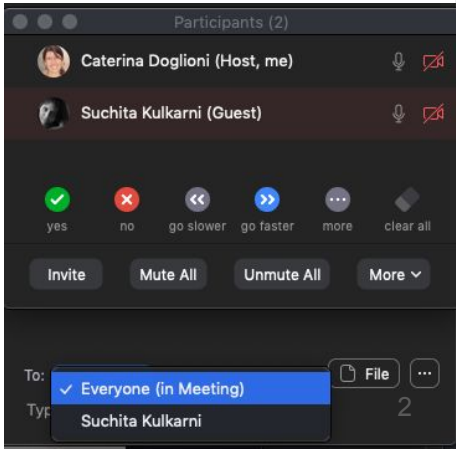
Final discussion session on DM@LHC

- We have about 40’ for this closing discussion, much more time would be needed...
  - Kudos to everyone involved (organizers, conveners, speakers) for organizing such a lively conference!
- Raise your Zoom-hand if you’d like to make a comment, or write in the chat window
  - We will try to give everyone the chance to speak, even if this means we may cover less material
    - There is always Mattermost!
  - If you have a pressing comment referring to the ongoing discussion, ping one of the session conveners with a DM in the chat window





In this discussion session

- Playing the long game @ Run-3 and Run-4: ideas
- Building new avenues: Higgs and DM, sub-GeV DM, non-standard signatures
- New experimental techniques
- Near-collider experiments, developments in astrophysics
- DM@LHC-relevant discussions: groups and initiatives
- Machine learning
- Development of tools and community resources

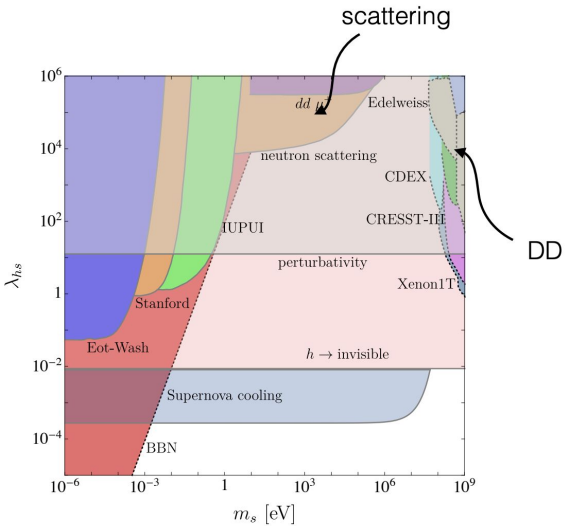
Playing the long game @ Run-3 and Run-4: ideas

- Outlook for mono/di-X searches: slow but steady advancements
  - Target for “how low in couplings should we go”: motivate with complementarity
  - Trigger & systematics are the way to accelerate luminosity gains, require hard work
- Precision measurements
  - Learn more about the fundamental constituents of ordinary matter && constrain/discover dark matter
  - Precision backgrounds necessary for mono-/di-X searches
- Supersymmetry
  - SUSY with photons still relatively less explored
- Global fits
  - Likelihoods allow for SR combinations and robust conclusions about parameter space

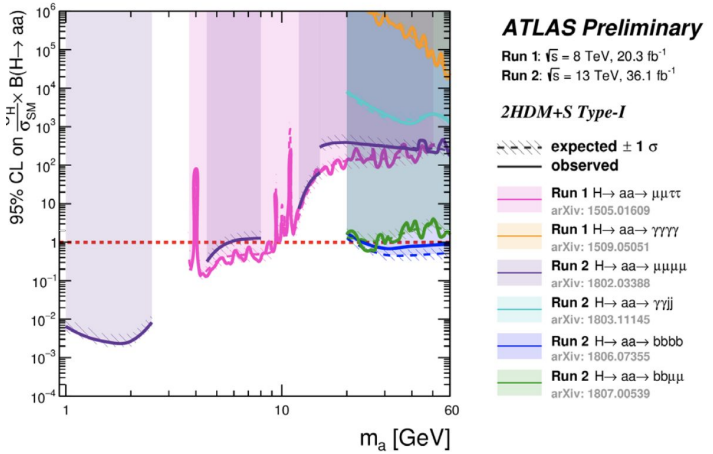
Question: How to motivate experimentalists and theorists to continue walking on the well trodden grounds, in the hope that a HL-LHC hint will make a case for future colliders?

Building new avenues: Higgs and DM

- DM and Higgs
- DM and LLP
- DM and flavour
- Light dark matter
- Strongly interacting dark sectors
- DM with non-standard early Universe



[MB, Foldenauer, Reimitz, Plehn 2005.13551]

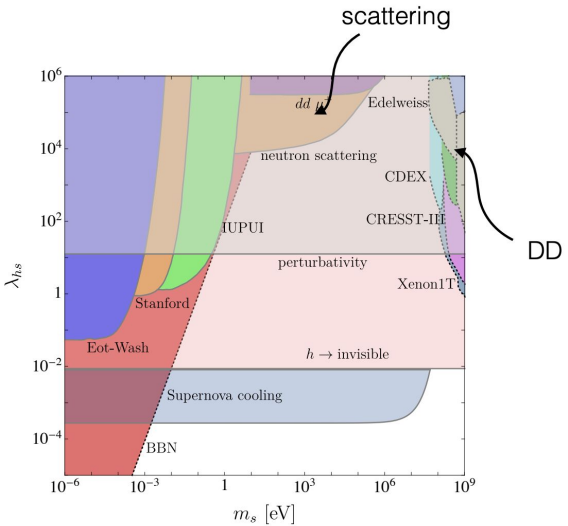


Interplay?

Question: what can we learn about Higgs/new scalars and DM at the HL-LHC and at flavour experiments? (Also thinking of di-Higgs probes)

Building new avenues: sub-GeV DM

- DM and Higgs
- DM and LLP
- DM and flavour
- Light dark matter
- Strongly interacting dark sectors
- DM with non-standard early Universe



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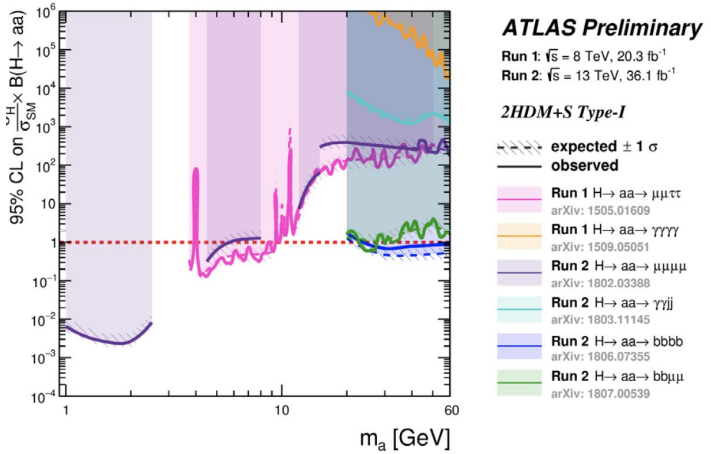
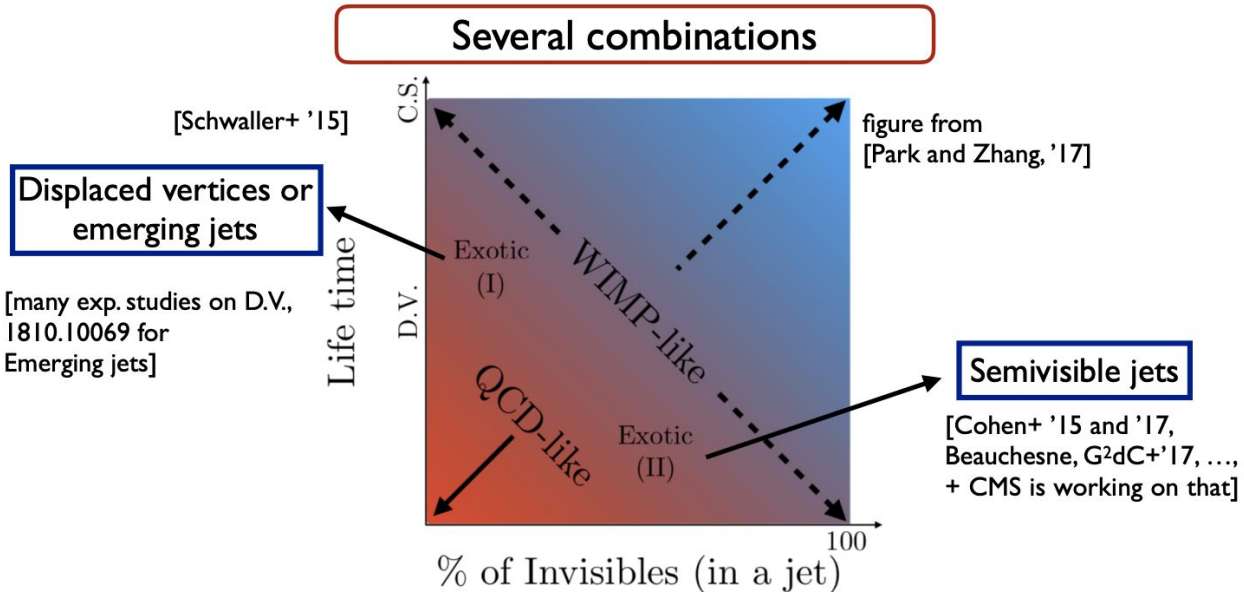


Interplay?

Question: How to identify common broad experimental signatures to design model independent searches but also identify smoking gun signatures?

Building new avenues: strongly interacting DM

- DM and Higgs
- DM and LLP
- DM and flavour
- Light dark matter
- Strongly interacting dark sectors
- DM with non-standard early Universe



Question: Where to start for a theory prioritization of dark sector signatures with dark matter candidates, if at all possible?

New experimental techniques

- Development of new triggers and analysis techniques
  - Can open up much more of the parameter space
  - Broader use of non-standard data taking techniques (e.g. Turbo/scouting/TLA, parking...)
- More of the spotlight is on non-standard signatures
  - Careful not to restrict to “ordinary physics objects” only, also in terms of analysis formats

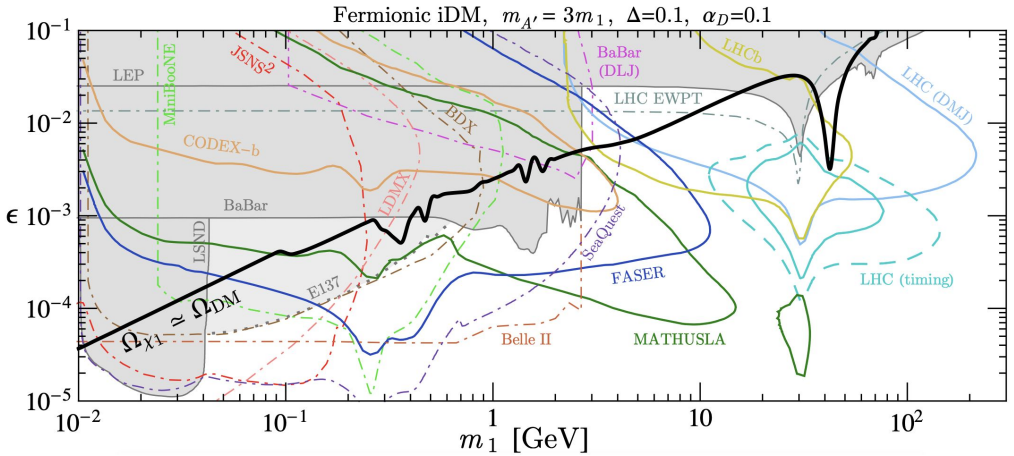
Question: What assumptions do we currently make in our trigger/reconstruction/analysis formats etc that bias our views towards SM processes?

Question: Are we making HL-LHC / future collider experiment choices that lock us out of being sensitivity for certain models?

Near-collider experiments, developments in astrophysics

- Intensity frontier searches
  - Complementarity in light DM
- Lifetime frontier experiments
- Astrophysics connections
  - Gravitational waves, upcoming large scale surveys, astrophysical probes of light dark matter

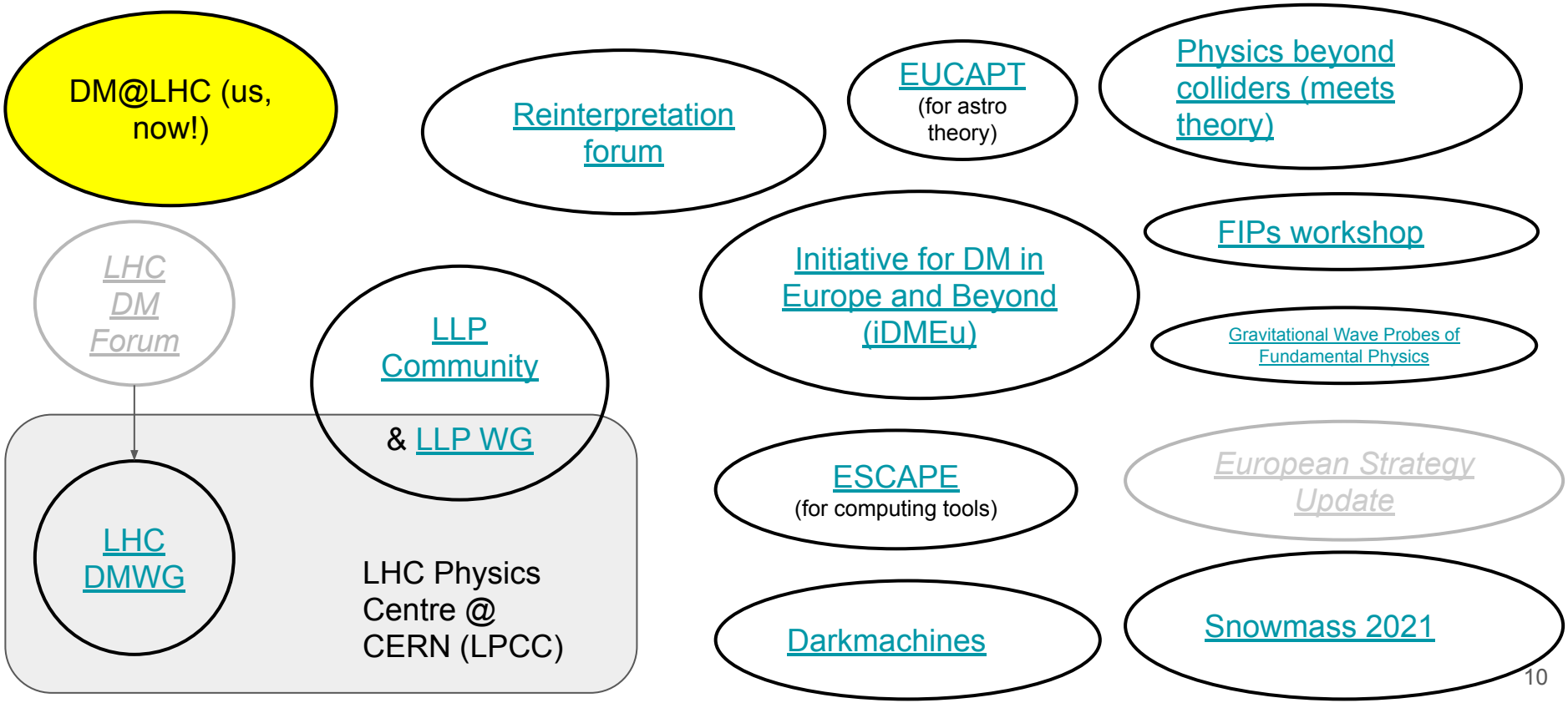
[Berlin, FK 1810.01879]



Question: Complementarity and wealth of new experiments encourages to explore other/less simplified models and understand interplay of different probes → how to best discuss? See next slide...

Where DM@LHC-relevant discussions take place

A slide of links (did we miss anything? We'll add it to the slides!)



Machine learning

- Relevant for both pheno and experiments
  - Changing our needs in terms of computing resources
- Speeding up traditional calculations but also gaining new insights
  - E.g. Density estimators, anomaly detection, likelihood free inference
- Valuable resource: DarkMachines community
  - brings together ideas and expertise using the forum

Question: In general machine learning specific model features for pheno is model dependent, how far are we going to take ML approach?

Community resources (and recognition thereof)

- Reinterpretation tools
  - Multiple tools available for susy studies
  - New tools for light gauge bosons, extended gauge sectors
  - Growing need for an up-to-date collection of reinterpretable LLP analyses
- Open access codes/model databases
  - Discussion about search & measurement sustainability and reinterpretability ongoing (Reinterpretation Forum)
  - Machine learning studies can/should make their codes public
  - Need for model catalogue (a la Feynrules), currently multiple repositories available
- iDMEu, ESCAPE
  - Plans to create meta-repositories and reproducible analysis pipelines for DM searches

Important point: Acknowledgement for tools/code developers and maintainers necessary, because it enables searches → integral part of studying dark matter!