Wrap-up topics for lunch discussion

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Prelude: models motivating the detector studies

- **Theory input needed:** which are the most important signals to consider in 30 years from now?

- **Experimental input needed:** post-discovery at DD sees something, what can we do at the FCC?

- What we did with ATLAS/CMS DM Forum (http://arxiv.org/abs/1507.00966) & preceding workshops (http://arxiv.org/abs/1506.03116, etc)

  - Systematic exploration of models leading to minimal basis of (simplified) models

  - Distinct kinematics —> distinct detector needs, can be guidance for detector studies

Examples from yesterday's theory talks

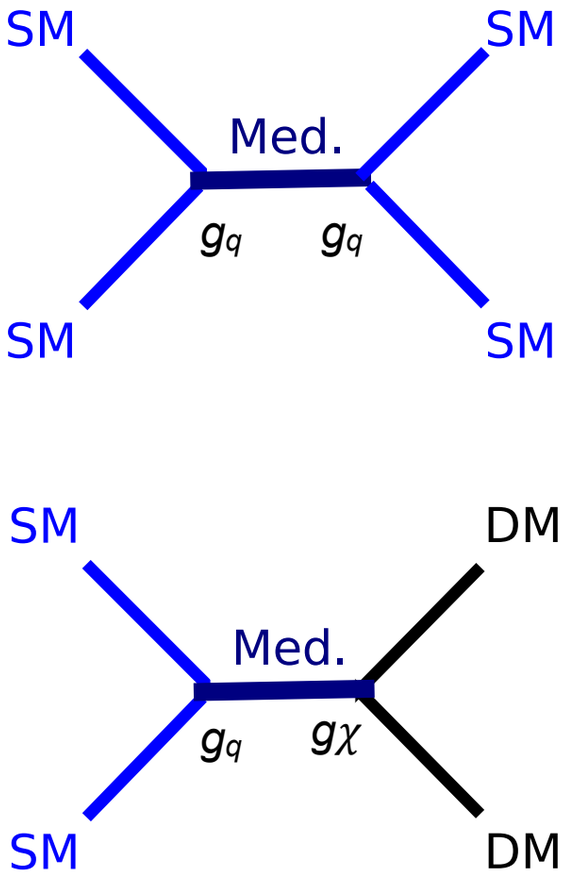
- A first attempt at classification:
- *Singlet dark matter*
  - Look for (new) physics associated to DM particles
  - Interesting phenomenology -> general search for new physics (heavy mediators benefit from CoM increase)
  - Role of VBF
  - Cascade decays
- *Bino/Wino/Higgsino DM, compressed*
  - Look for signatures with (no)MET/soft leptons and photons
- *Dark sector*
  - Specialized tracking studies

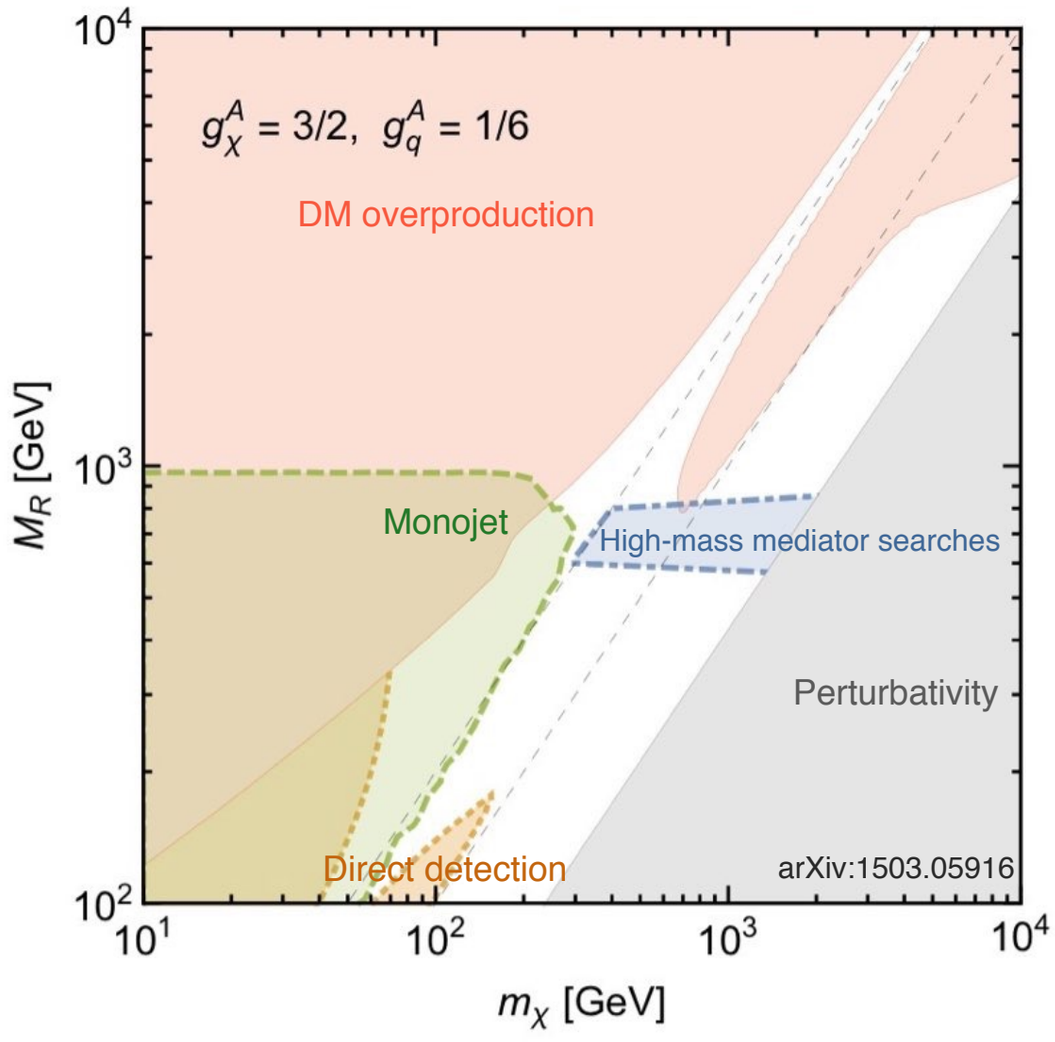
What can we achieve with this discussion?

- Brainstorming is important, but so is focus
- Come up with a list of questions leading to **concrete studies** connecting **Dark Matter** to **detector characteristics**
- Ideally: model motivating studies
- If a task list is there, more likely to be picked up (student projects…)
- Input to document edited by Pedro and Phil
- Input to overall FCC Detectors effort

Example: complementary Mono-X / mediator searches

- **triggering challenges** already at the LHC





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Example 1: MET in mono-X searches

1) Collect a series of detector and different pile-up conditions in the form of Delphes cards

- Start with baseline configuration for FCC-hh detectors (see here)

2) Use background $Z \rightarrow \nu\nu$ + jets events and general signals from the Forum

3) Look at tails of MET spectrum, with and without Particle flow approach

4) Vary calorimeter and tracker parameters

- Granularity and Energy Resolution
- Tracker acceptance (|eta|< 4, 6)

Version 1.0 (2014-02-11)	LHC	HL-LHC	FHC-hh
c.m. Energy [TeV]	14		100
Circumference *C* [km]	26.7		100 (83)
Dipole field [T]	8.33		16 (20)
Arc filling factor	0.79		0.79
Straight sections	8		12
Average straight section length [m]	528		1400
Number of IPs	4		2 + 2
Injection energy [TeV]	0.45		3.3
Peak luminosity [10^{34} $cm^{-2}s^{-1}$]	1.0	5.0	5.0
Peak no. of inelastic events / crossing at - 25 ns spacing - 5 ns spacing	27	135 (lev.)	171 34
Total / inelastic cross section [mbarn]	111 / 85		153 / 108
RMS IP spot size [mm] - 25 ns - 5 ns	16.7	7.1 (min)	6.8 3

Example 1: MET in mono-X searches

5) Add further detector effects not implemented in official delphes, Eg:
   - tracking efficiency dependence on the distance from jet axis as in http://arxiv.org/abs/1503.03347
   - angular resolution
   - longitudinal calorimeter segmentation

6) Get significance ~ S/sqrt(B) above a given MET cut, as a function of the layout parameters, for several pile-up conditions and suppression algorithms (e.g. PUPPI)

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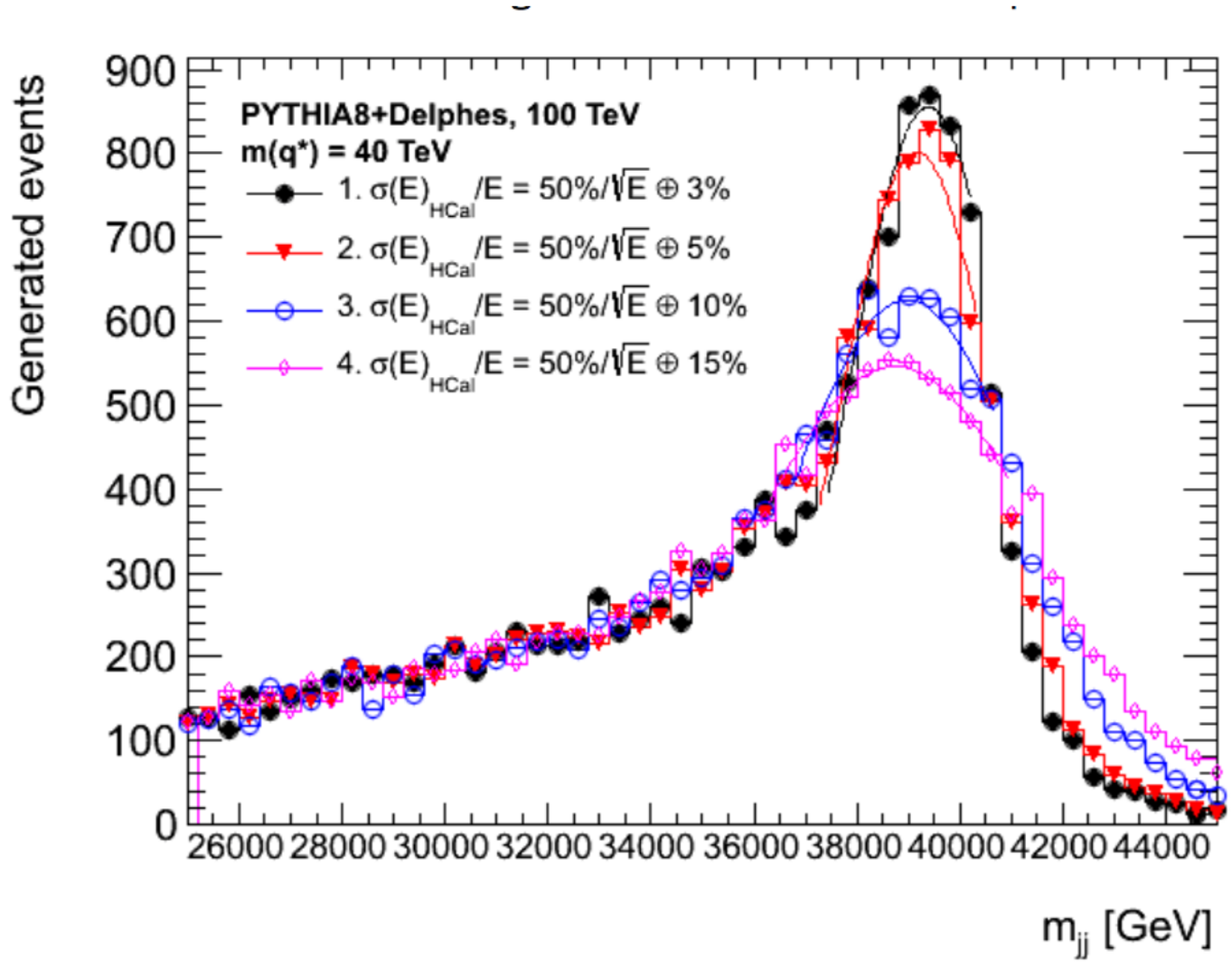
Example 2:

Jet reconstruction for DM mediator searches

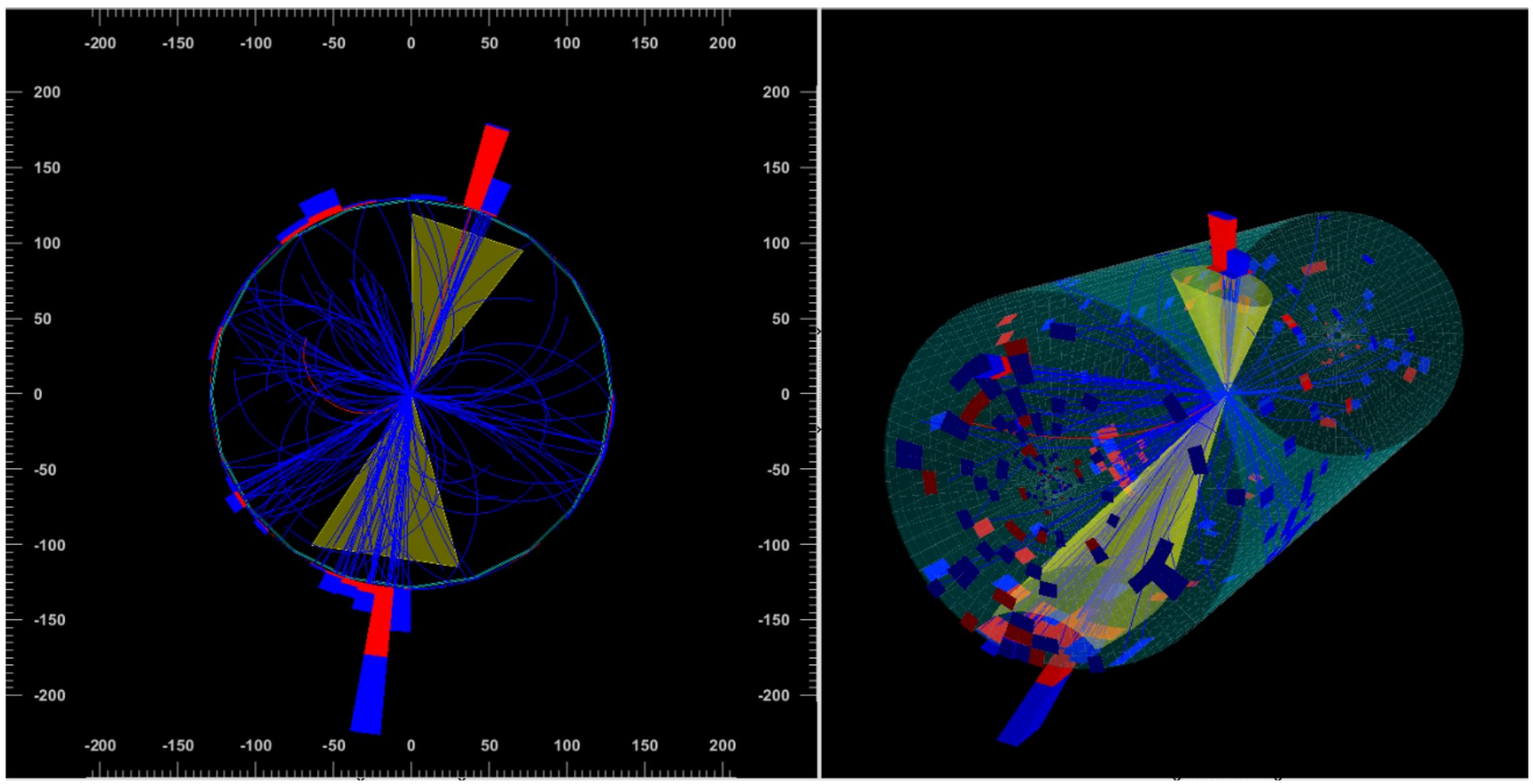
1) Consider narrow mediators decaying to dijets (small couplings, sensitive with 1/ab)
2) Sensitvity depends on mass resolution (=peak sharpness), which in turn depends on
   - Jet algorithm (see jetography paper: http://arxiv.org/abs/0810.1304)
   - Calorimeter resolution
     - Calorimeter depth (leakage)



B. Auerbach, S. Chekanov, A. V. Kotwal, M. Low, J. Proudfoot

Example 3:

scalar mediator to boosted ttbar



1) Boosted objects needed (everything from the ttbar system merges)
    1) Ultimate calorimeter granularity needed
    2) Try substructure techniques on the market in Delphes: are they enough?