Search for Dark Matter at the LHC

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LPNHE Biennale 2016

Oct 4, 2016

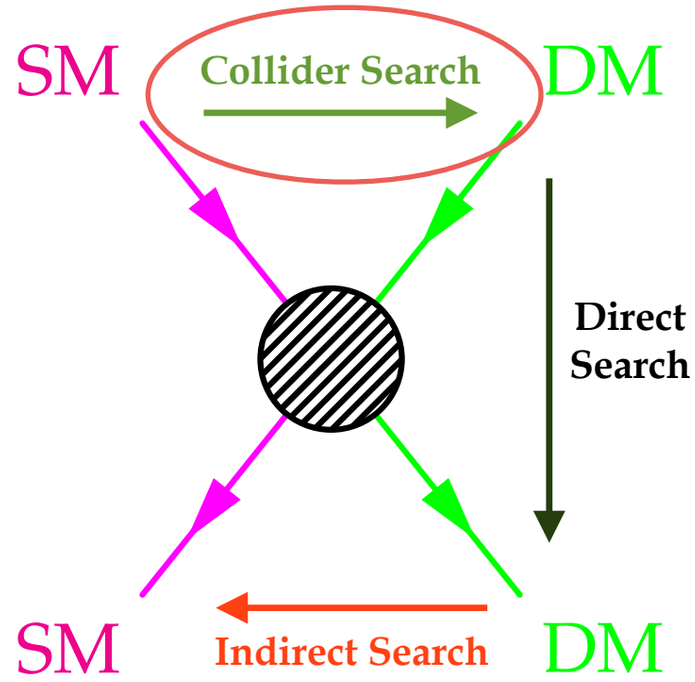
Introduction

- I come from Wuxi, Jiangsu, China

- I did my PhD on experimental particle physics at Northeastern University in Boston (CMS experiment)
  - 1.5 year (Boston) + 0.5 year (Chicago) + 3 years (Geneva)
  - I came to LPNHE from April as a postdoc and joined the ATLAS experiment

What I am working on

- I am mainly working on the DM searches at the LHC
  - The existence of DM has been over 40 years, and it is a major component of the universe (measurement of the rotational velocity of spiral galaxies, gravitational lensing, etc.)

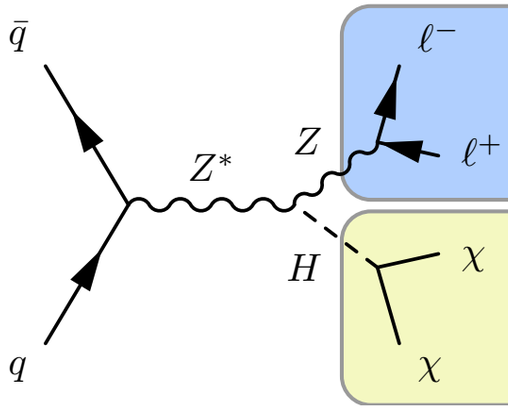


  - However, **no evidence** yet for **non-gravitational** interactions between DM and SM particles, **we even don't know <u>what is DM</u>!**

Higgs-portal DM

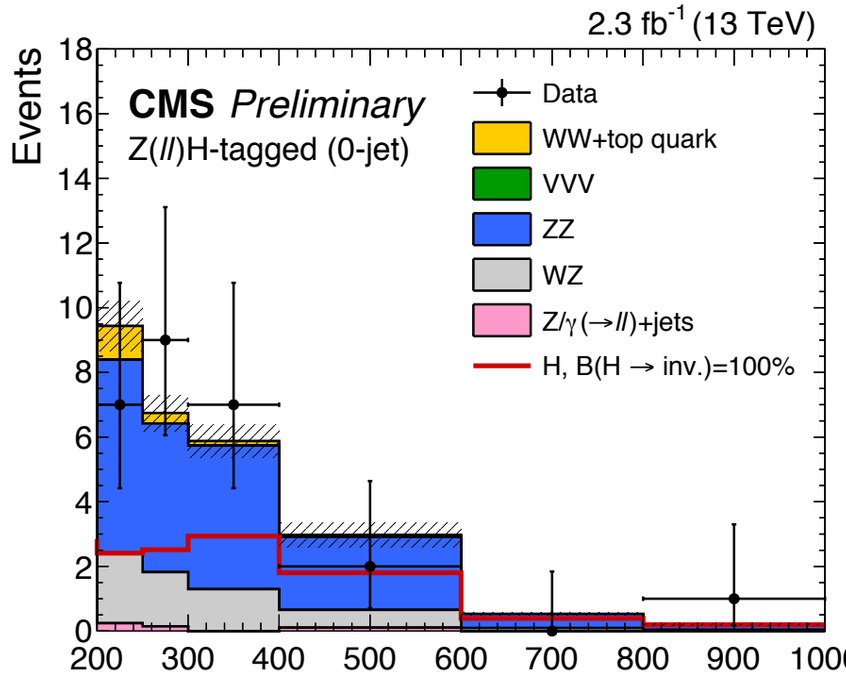
- LHC Run1 results yielded the discovery of a Higgs boson, but still exists uncertainty in BR for visible decays

- Many models with invisible heavy-mass particles can couple to Higgs, but SM Higgs has BR(h->ZZ->vvvv) ~ 0.1%, a sizable BR will be a strong sign of BSM



a pair of high p_T, isolated leptons with opposite charge compatible with a Z boson

large missing transverse momentum together with limited jet activity



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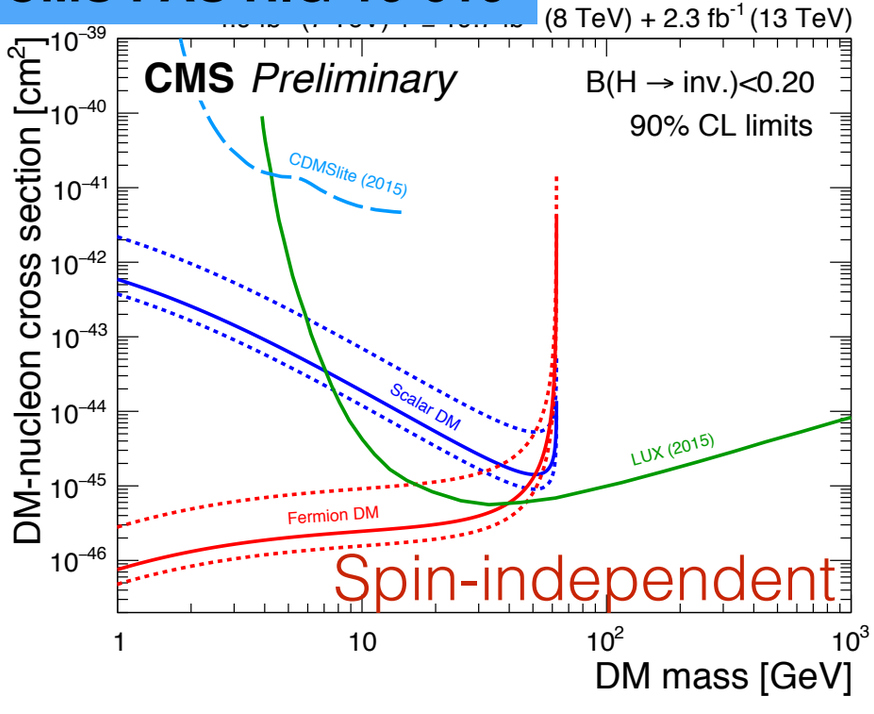
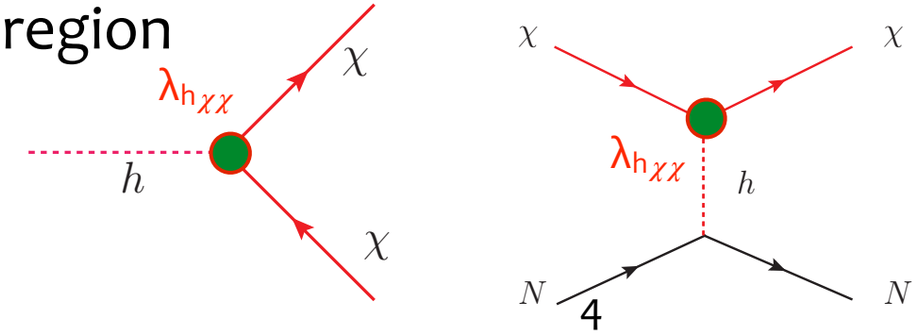
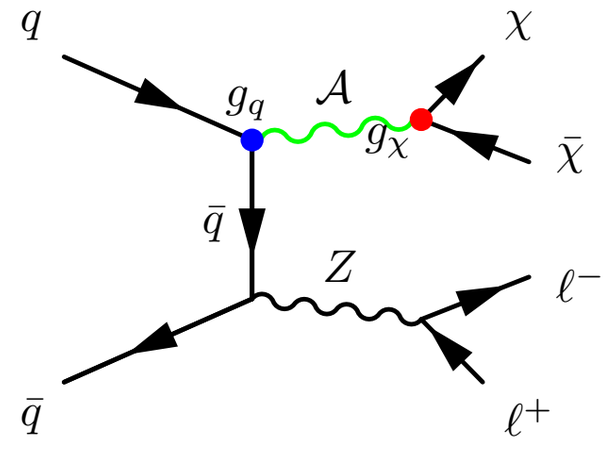


- With assumption of a scalar/Fermion DM, invisible Higgs provides strongest limit on SI DM-Nucleon Cross Section at low mass region

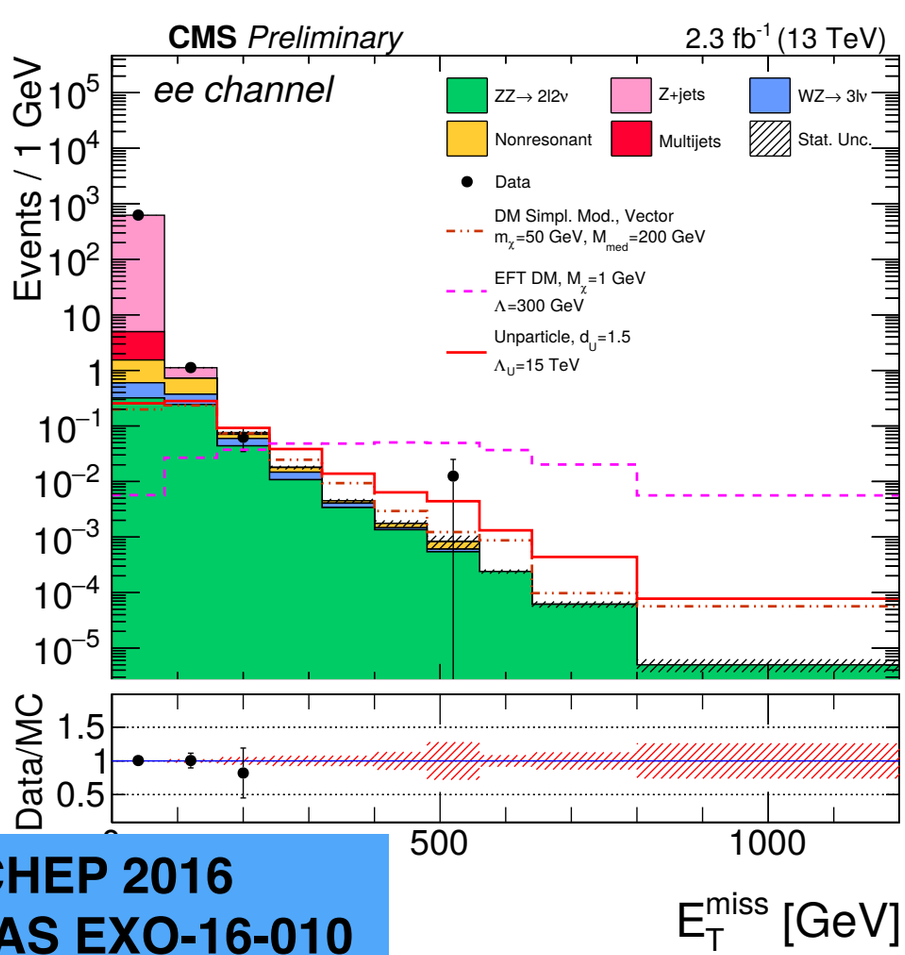


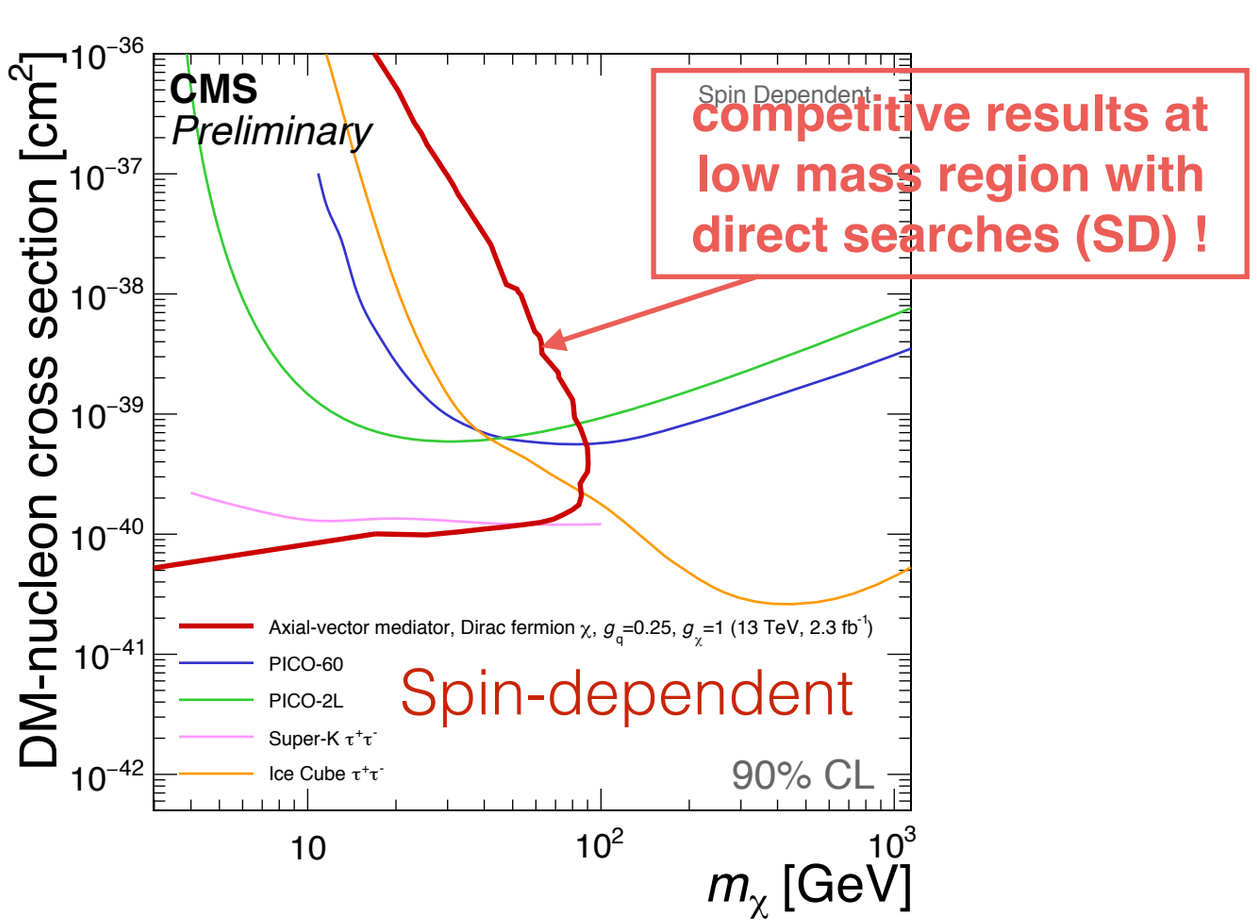
DM + Z boson (l^+l^-)

- Searching for DM events with
  - 2 high-pT leptons compatible with a Z boson
  - and large MET, limited hadronic activity



- Simplified model: a vector mediator Z' with vector/axial-vector coupling to DM and quarks
- No big excess is observed, limit is reinterpreted into DM-nucleon XS





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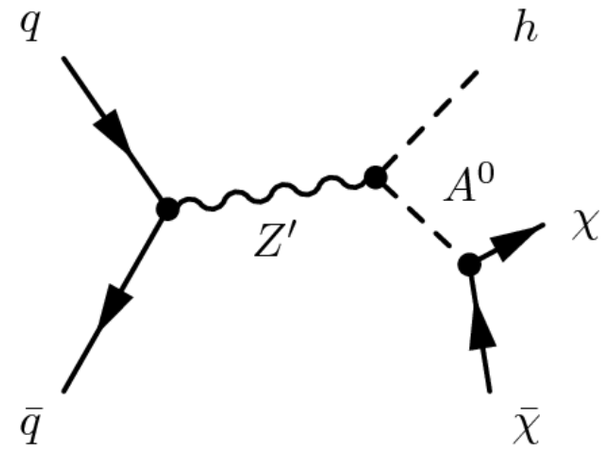
LPNHE, with B.Laforge, A.L.Solis

DM + Higgs ($\gamma\gamma$)

- Signature: two well-identified photons + large E_T^{miss}
  - pretty clean channel, four different event categories:

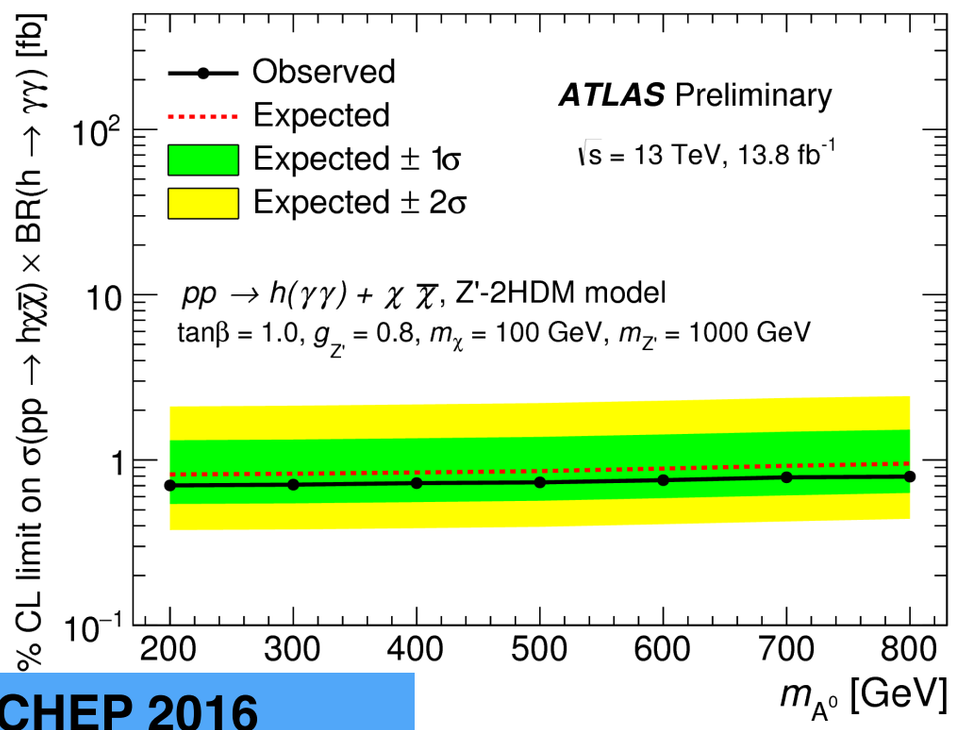
most sensitive

Category	$S_{E_T^{miss}}$ [$\sqrt{\text{GeV}}$]	$p_T^{\gamma\gamma}$ [GeV]
High $S_{E_T^{miss}}$, high $p_T^{\gamma\gamma}$	> 7	> 90
High $S_{E_T^{miss}}$, low $p_T^{\gamma\gamma}$	> 7	≤ 90
Intermediate $S_{E_T^{miss}}$	> 4 and ≤ 7	> 25
Rest	-	> 15



$$S_{E_T^{miss}} = E_T^{miss}/\sqrt{\sum E_T}.$$

  - data-driven non-resonant background: $\gamma\gamma$(main), γ+jet, jj, by fitting diphoton mass



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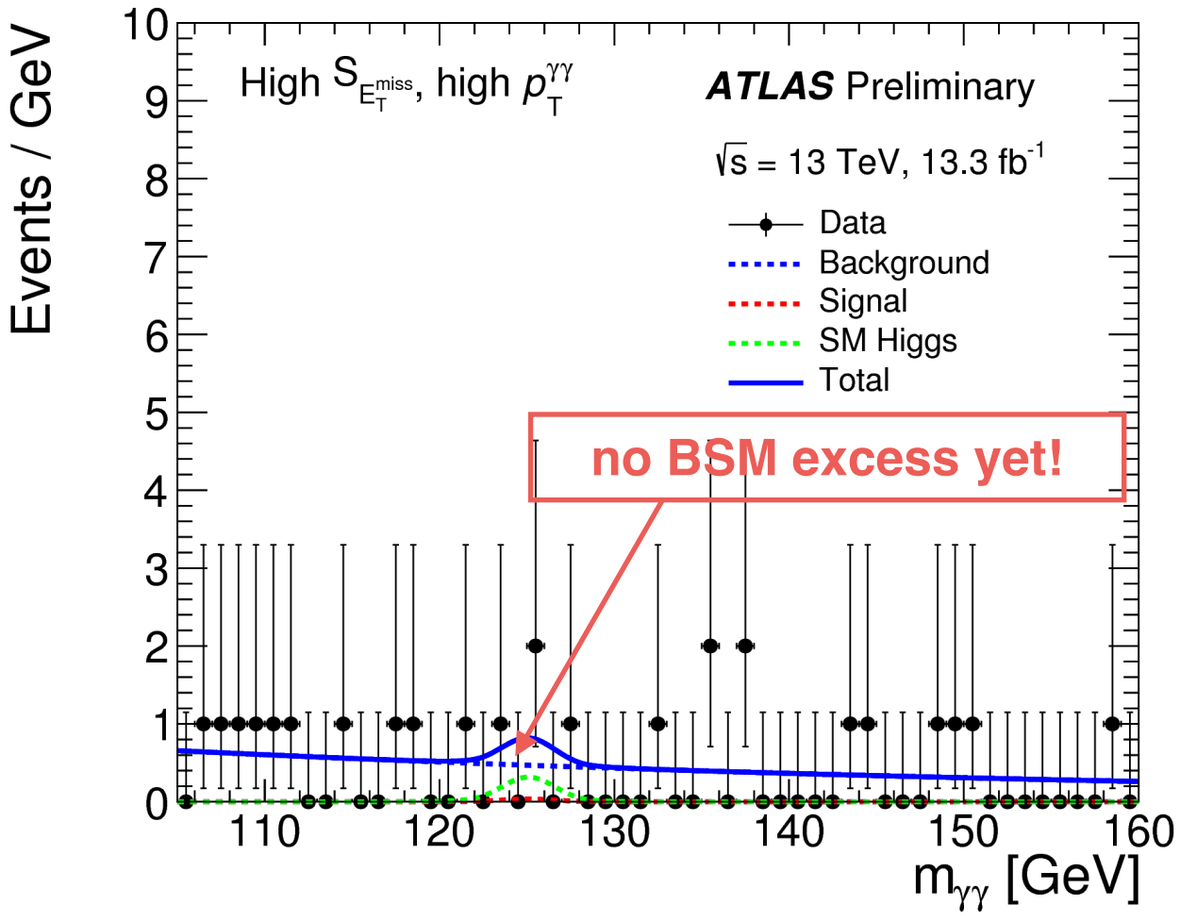
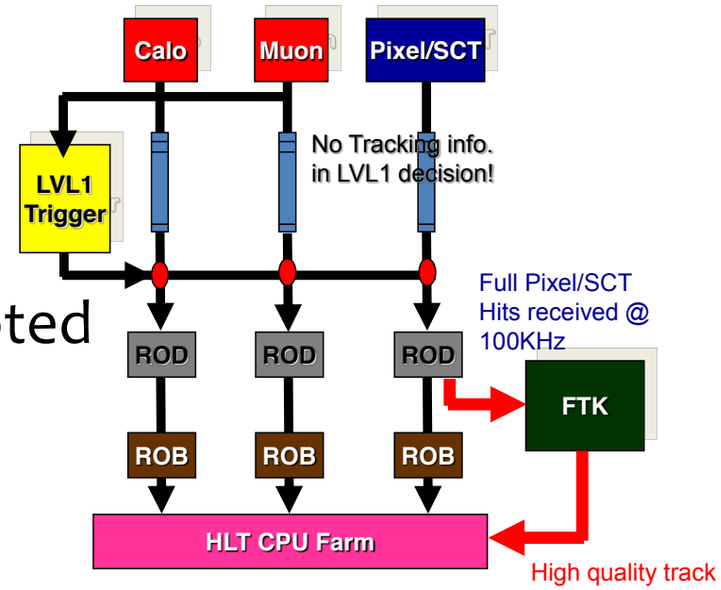
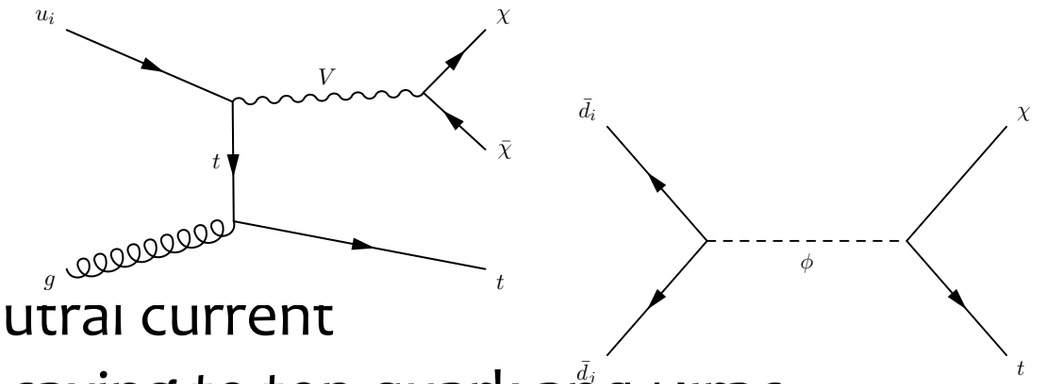


Outlook @ LPNHE

- MET Trigger in ATLAS:
  - ATLAS MET L1/high-level trigger rate monitoring
  - MET trigger upgrade using FastTracKer (FTK) tracks
    - FTK reconstruct **all tracks** (pT > 1 GeV) for all LVL1 accepted events, and provide **track information** to HLT before trigger decision
    - Improve MET resolution



- I am working on DM searches in the channel of
  - mono-Higgs (with B.Laforge, A.L.Solis)
  - mono-top (with P.Francavilla)
    - Vector mediator: contains flavor-changing neutral current
    - Scalar mediator: a colored, changed scalar decaying to top quark and Dirac fermion DM
  - ATLAS_DM@LPNHE (with S.Cecco, D.Portillo), potential combination of mono-H(bb) and -H($\gamma\gamma$)
  - also, I am working with theorists to valid/update several DM benchmark models that will be used during Run2 for both ATLAS & CMS experiments [DM Forum report]



DM searches at the LHC just started, so let's stay tuned with our 13TeV results!