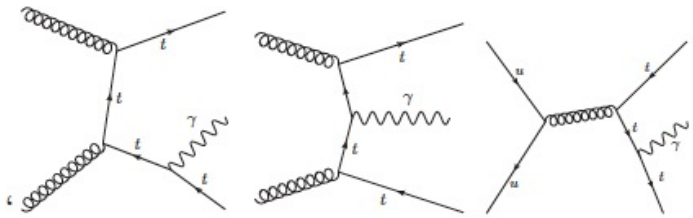
ttbar + Photon / Z – Andrey Loginov, Yale

- MadGraph cross sections (LO)
  - Statistics for the processes is the issue, so need more events
  - Expect smaller systematics for higher pt photons
    - 20 GeV photon pt cut for the ttbar + photon cross section in the table below

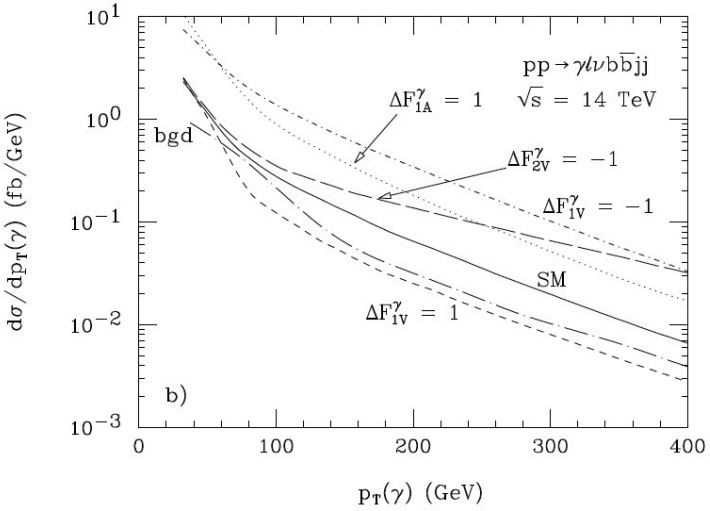
$\sqrt{s}$, TeV	7	8	13	14	33
$\sigma(t\bar{t}\gamma)$, pb	0.2753	0.3627	0.9248	1.054	8.394
$\sigma(t\bar{t}Z)$, pb	0.09705	0.1393	0.5423	0.6571	4.489
$\sigma(t\bar{t})$, pb	93.35	134.7	464.5	554.1	3531

ttbar + Photon

- Sensitive to top charge and to **top-photon couplings**
- With current 2011 / 2012 data
  - Measure ttbar + photon cross section with **5+ sigma** significance (separately in 7 TeV and in 8 TeV data)
- **7** -> **14** TeV: LO cross section increases by a factor of **5 (MadGraph,** photon p_T > **20** GeV**)**
  - Basic idea is to **identify photons coming from top** (with delta R and invariant / transverse mass cuts), and then **look at photon pt distribution to study couplings**
  - **300 fb^{-1}**: few thousands events expected => couplings measurement, **Phys.Rev. D71 (2005) 054013**
    - In both lepton + jets and dilepton channels
  - **3000 fb^{-1}**: differential measurements (for instance, couplings as a function of photon p_T)



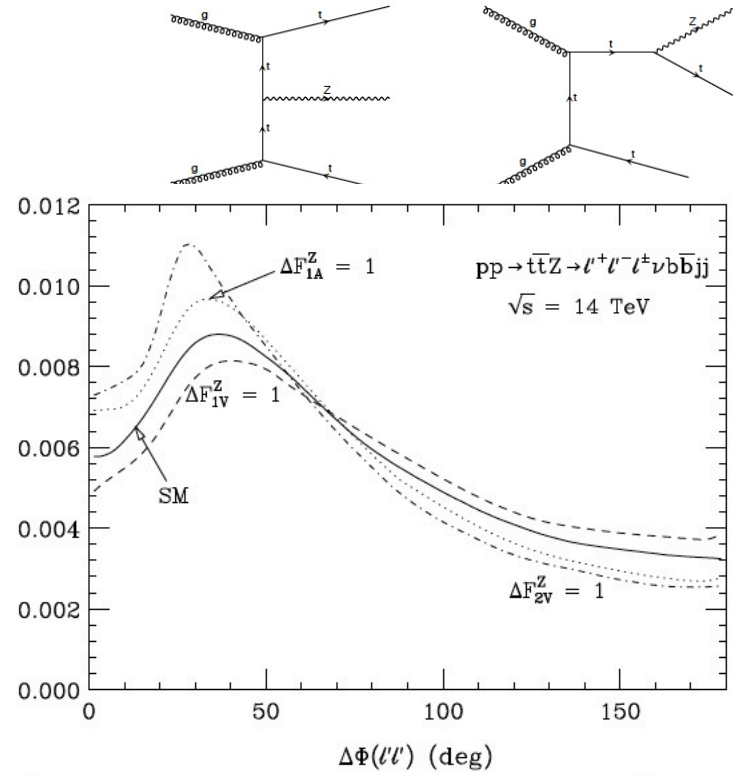
Phys.Rev. D71 (2005) 054013



coupling	300 fb^{-1}	3000 fb^{-1}
ΔF^{γ}_{1V}	$^{+0.079}_{-0.045}$	$^{+0.037}_{-0.019}$
ΔF^{γ}_{1A}	$^{+0.051}_{-0.077}$	$^{+0.018}_{-0.024}$
ΔF^{γ}_{2V}	$^{+0.19}_{-0.20}$	$^{+0.12}_{-0.12}$
ΔF^{γ}_{2A}	$^{+0.19}_{-0.21}$	$^{+0.11}_{-0.14}$

ttbar + V

- ttbar + Z production is directly sensitive to **ttZ couplings**
- So far only measured the cross section
  - **CMS: arXiv:1303.3239 (submitted to the PRL)**
  - **Dominated by stat. uncertainty**
- **7** -> **8** TeV: ttZ LO xsec increases by **~1.4** (**MadGraph**) => still **limited by statistics**
- **7** -> **14** TeV: LO xsec increases by **~10**(**MadGraph**)
  - **300 fb^{-1}**: ttZ axial (vector) couplings can be determined with an uncertainty **45-85%** (**15-20%**), **Phys.Rev. D71 (2005) 054013**
  - **3000 fb^{-1}**: a factor of **3** better
  - Basic idea is **look at Z pt distribution and delta phi (leptons) to study couplings**

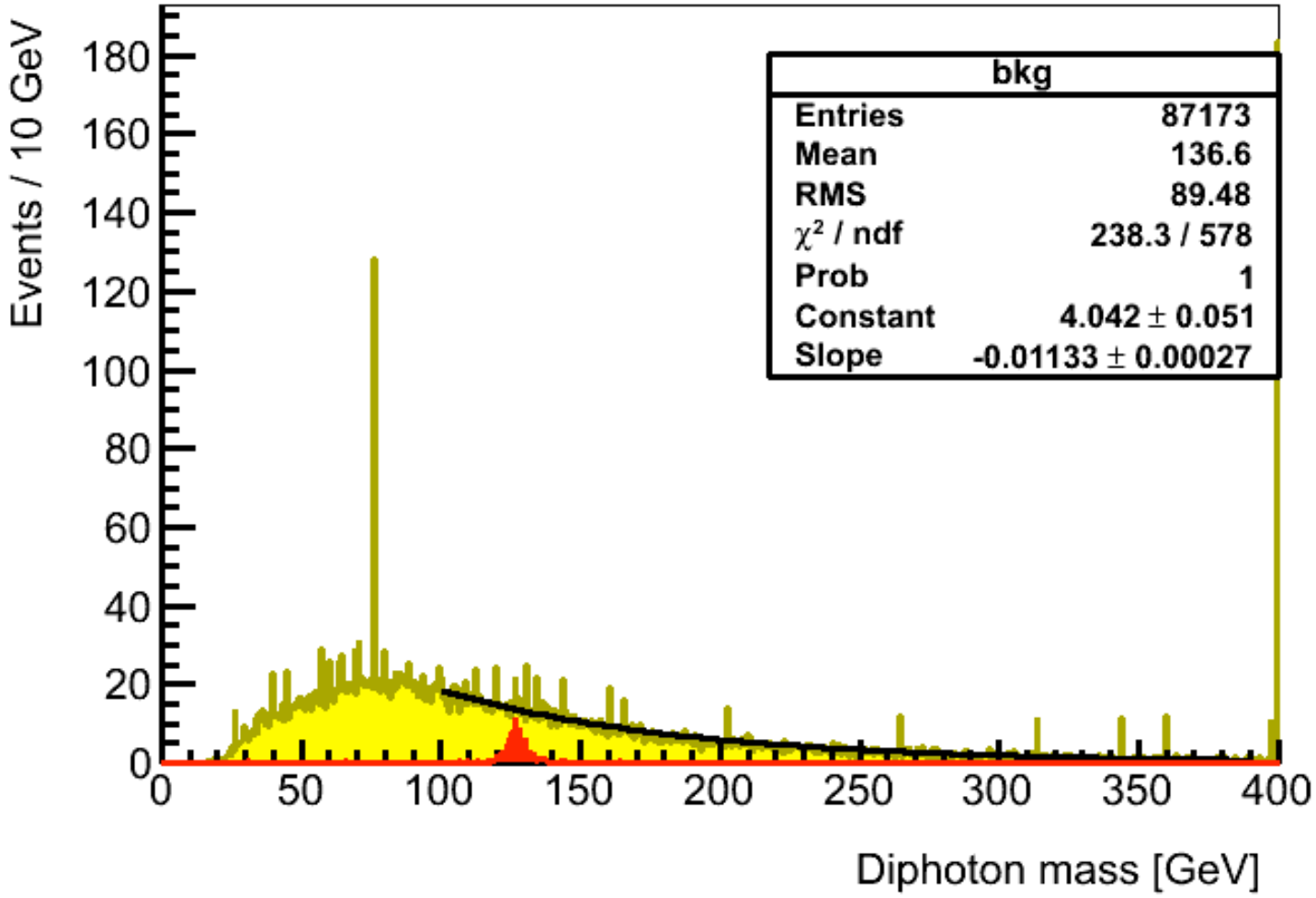


coupling	300 fb^{-1}	3000 fb^{-1}
ΔF^Z_{1V}	$^{+0.87}_{-0.46}$	$^{+0.62}_{-0.22}$
ΔF^Z_{1A}	$^{+0.15}_{-0.20}$	$^{+0.056}_{-0.074}$
ΔF^Z_{2V}	$^{+0.52}_{-0.52}$	$^{+0.30}_{-0.29}$
ΔF^Z_{2A}	$^{+0.54}_{-0.53}$	$^{+0.30}_{-0.31}$

ttH Higgs decay channels – Jahred Adelman, Yale

- H(bb) is nominally the way to go but it's an extremely challenging measurement requiring the profiling of order(100) nuisance
- parameters and understanding very complex environments with multivariate techniques
- Hard to know if we can trust such a "measurement" for Snowmass, though some folks in the Higgs group are working on it
- Have extrapolations from current measurements from ATLAS and CMS that we can and will make in the white paper
- H(WW) has many final states (SS leptons, taus, 3 leptons, 4 leptons), many of which are being explored, but in the Higgs group
- H(tautau) has a paper that shows excellent prospects at 14 TeV LHC with only 100 fb-1. We can and will quote this paper. Maybe the best channel?
- Not too much in the way of work for LCs, muon colliders or 33 TeV machines
- H(mumu) is underway. Hopefully results for Snowmass. Signal samples being prepared, student is ready for them
- H(di-photon) next

ttH with H→γγ


Events / 10 GeV
180
160
140
120
100
80
60
40
20
0
0
50
100
150
200
250
300
350
400
Diphoton mass [GeV]
bkg
Entries 87173
Mean 136.6
RMS 89.48
χ² / ndf 238.3 / 578
Prob 1
Constant 4.042 ± 0.051
Slope -0.01133 ± 0.00027

ttH – Jahred Adelman

- Studying H→γγ
- Preliminary findings: Possible for 3000 fb^{-1}
- Numbers (within large uncertainties) are the same order of magnitude as ATLAS ES studies

- Outlook:
- To-do: Write up all channels, do best to extrapolate from
- current results for bb
- We (top couplings folks) are working on a joint document

Lepton colliders (from Kaustubh's talk)

- allows study of pure EW top production (no QCD background)
- Beam polarization is major asset: it allows disentangling of top coupling to photon and Z and collecting samples enriched in left/right-handed helicities
- As a result of above, electroweak couplings can be determined at a percent level, allowing probe of new physics as well
- ttH: 11 (4)% (with H bb) at 500 (1000) GeV, with 1000/fb

Other top coupling activities

- Wtb couplings in single top production
  - Single top t-channel cross section → |Vtb|
  - Anomalous Wtb couplings

- See talk by Matt