FCC-ee Workshop
CERN, June 19-21 2014

Overview of FCC-hh Physics Workshop (May 26-28 2014)

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CERN, PH-TH

** on behalf of the other FCC-hh co-conveners, Austin Ball and Fabiola Gianotti*

Due to limited time, will review explicitly only phenomenology talks.
For further info and details, see the indico agenda

FCC-hh physics activities documented on:

- o http://indico.cern.ch/categoryDisplay.py?categId=5258
- o https://twiki.cern.ch/twiki/bin/view/LHCPhysics/FutureHadroncollider

Mailing list exists (see e.g. header of any of the mtgs in the Indico category above) => register to be kept uptodate

So far:

- 7 preparatory mtgs of the pp WG
- Task force on "Software platform for FCC studies (hh/ee/eh)"
- "BSM opportunities at 100 TeV" Workshop:
  - http://indico.cern.ch/event/284800/
- "100 TeV Physics" Workshop, May 26-28:
  - http://indico.cern.ch/event/304759/
- Several mtgs of the Heavy Ion subgroup

PLAN: prepare a report documenting the physics opportunities at 100 TeV, on the time scale of end-2015, ideally in cooperation with efforts in other regions

Main directions of ongoing studies

- Document properties of pp interactions at 100 TeV:
  - global event features: total cross sections, multiplicities, spectra (relevant for discussion of radiation levels, pileup modeling, as well as to stimulate interesting QCD studies in totally new dynamical regimes)
  - SM cross sections: including TH systematics, availability/reliability of MC modeling tools, etc
- Extend studies of discovery potential of phenomena from 14 TeV to 100 TeV
- Explore new directions and opportunities, specific to physics at E ≫ 14 TeV (*see in particular the "BSM Workshop" in February)*
  - identify new observables
  - identify possible "no-lose" BSM scenarios (e.g. for electroweak baryogenesis, weak-scale DM, ...)
  - define analysis and/or detector scenarios beyond LHC landscape

Wshop agenda

FCC project reports:
Status of FCC project (Michael Benedikt
Status of FCC-hh accelerator studies (Daniel Schulte
Status of FCC-eh physics studies (Max Klein
Status of FCC-ee physics studies (Jonathan R. Ellis

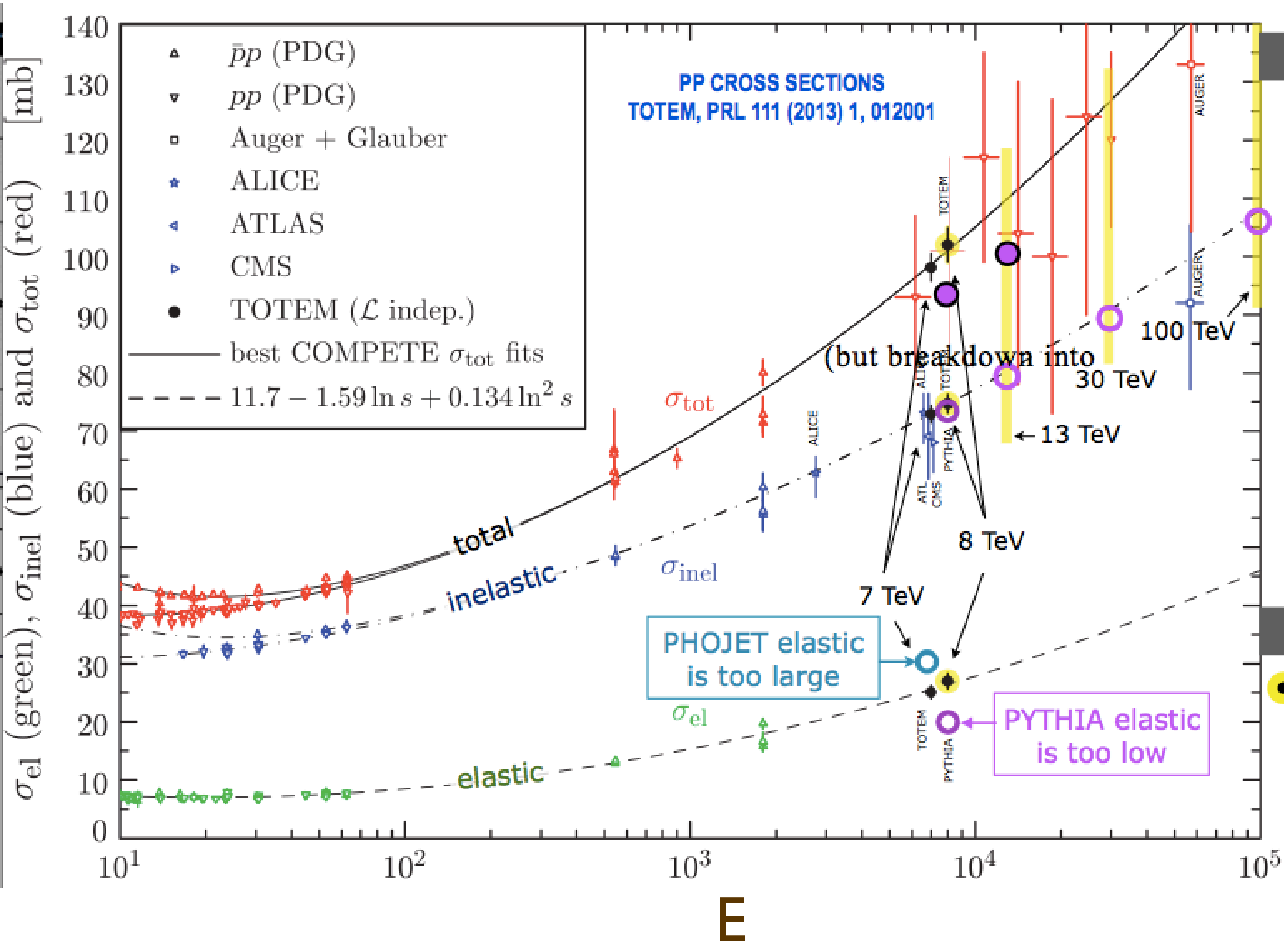
Global event properties, boosted objects, etc
Event structure and small-x issues at 100 TeV (Peter Skands
Report from the "Pileup mitigation" workshop (Gavin Salam
Tagging hyper-boosted gauge bosons (Maurizio Pierini
Tagging hyper-boosted top quarks (Michele Selvaggi

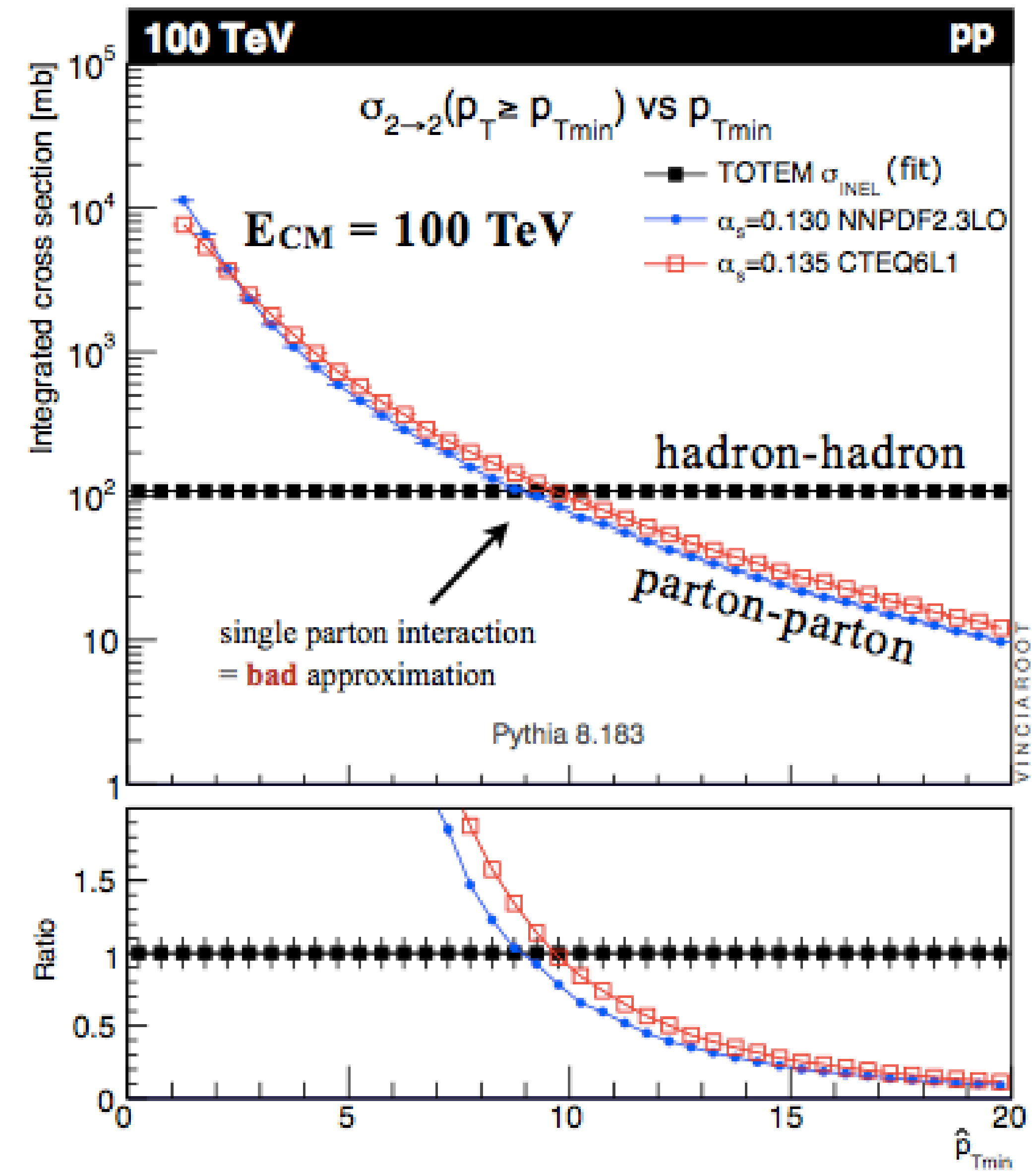
Studies with SM probes (precision physics, search for indirect BSM phenomena)
Physics potential of flavour physics in pp with L~ab-1 (Luca Silvestrini
Rare W decays (Thomas Edward Melia
Electroweak corrections in the Sudakov limit at the LHC and at future pp colliders (Mauro Chiesa
Gauge boson production at high energy (Jesper Roy Christiansen
Precision top physics at 100 TeV (Juan Antonio Aguilar Saavedra
ttW production, a probe of the charge asymmetry in ttbar production (Ioannis Tsinikos
Physics with initial state top quarks (Benjamin Fuks

Detector and DAQ ideas, software framework for simulation studies
Radiation studies status and plans (Werner Riegler (CERN))
Progress on EM calorimeter requirements and technologies (Marcello Mannelli
First considerations about hadronic calorimetry (Clement Helsens
DAQ architectures for flavour physics at L>10^34 (Giovanni Punzi
Status of magnet studies (Herman Ten Kate
Magnetic field calculations with TOSCA (Slava Klyukhin
Status of the software framework for FCC studies (Benedikt Hegner
Progress report on DD4HEP+G4 based simulation (Clement Helsens

Higgs physics and EWSB, BSM
Rare Higgs, top and vector boson production processes at 100 TeV (Paolo Torrielli
ttH/ttZ as a precision probe of the top Yukawa coupling (Michelangelo Mangano
Testing Higgs compositeness through double Higgs production (Roberto Contino
Higgs pair production in gluon fusion at 100 TeV (Minho Son
Pair production of vector bosons, heavy fermions and scalars in ttbar fusion (Da Liu
pMSSM explorations at 100 TeV (Marco Battaglia
Production of vector resonances at 14 and 100 TeV (Riccardo Torre

Global aspects of 100 TeV pp collisions



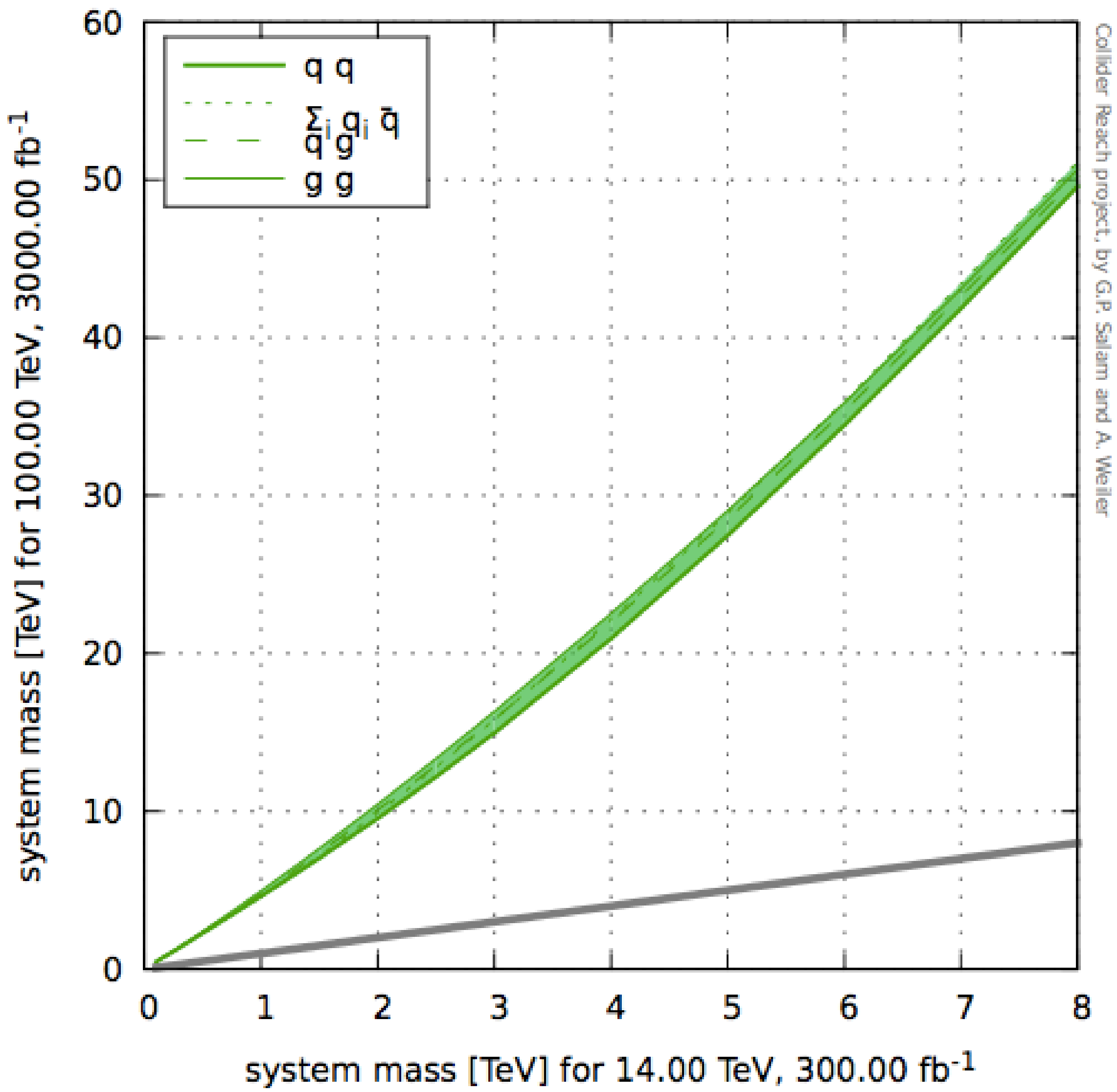


P.Skands

Projecting the discovery reach

http://cern.ch/collider-reach, Salam, & Weiler

14 TeV$_{300\ fb^{-1}}$ → 100 TeV$_{3\ ab^{-1}}$



The PDF choice was CT10nlo.LHgrid

Original mass	gg	qg	allqq	qqbar
100.	469.	465.	462.	457.
125.	585.	579.	575.	568.
150.	702.	693.	687.	679.
200.	937.	923.	912.	902.
300.	1414.	1386.	1365.	1350.
500.	2394.	2332.	2279.	2261.
700.	3401.	3300.	3206.	3194.
1000.	4956.	4793.	4619.	4640.
1250.	6287.	6072.	5818.	5892.
1500.	7647.	7382.	7038.	7187.
2000.	10444.	10090.	9552.	9905.
2500.	13337.	12908.	12185.	12781.
3000.	16319.	15833.	14954.	15795.
4000.	22531.	21986.	20933.	22162.
5000.	29050.	28508.	27467.	28894.
6000.	35863.	35366.	34451.	35960.
7000.	43079.	42620.	41854.	43411.
8000.	50671.	50230.	49590.	51132.

Rule of thumb: at fixed Luminosity, discovery reach scales like 2/3 E_{beam}
=> x 5 from 14 to 100 TeV

Without a guarantee that any particular new phenomenon will manifest itself, the exploration of the discovery potential must be accompanied by a more focused understanding of what are the qualitative changes made possible by the access to the 100 TeV region. Address obvious questions such as:

- if we haven't seen something by 14 TeV, why should it show up by 100 TeV?
- what are the origins and the motivations of mass scales in the range beyond the LHC, but within the reach of 100 TeV?
- what are the new rare processes that become interesting to explore with the increased statistics possible at 100 TeV?
- are there BSM scenarios for which one can formulate "sort of" no-lose theorems at 100 TeV ?
- For phenomena that could already be probed at the LHC, which new observables and states that may open up for exploration at 100 TeV?
- How do these interplay with other probes that could be available 30 years from now (e.g. from the cosmos, from an e+e– collider, etc)?
- ...

Higgs physics

NLO rates **R(E)** = σ(E TeV)/σ(14 TeV)

	σ(14 TeV)	R(33)	R(40)	R(60)	R(80)	R(100)
ggH	50.4 pb	3.5	4.6	7.8	11.2	14.7
VBF	4.40 pb	3.8	5.2	9.3	13.6	18.6
WH	1.63 pb	2.9	3.6	5.7	7.7	9.7
ZH	0.90 pb	3.3	4.2	6.8	9.6	12.5
ttH	0.62 pb	7.3	11	24	41	61
HH	33.8 fb	6.1	8.8	18	29	42

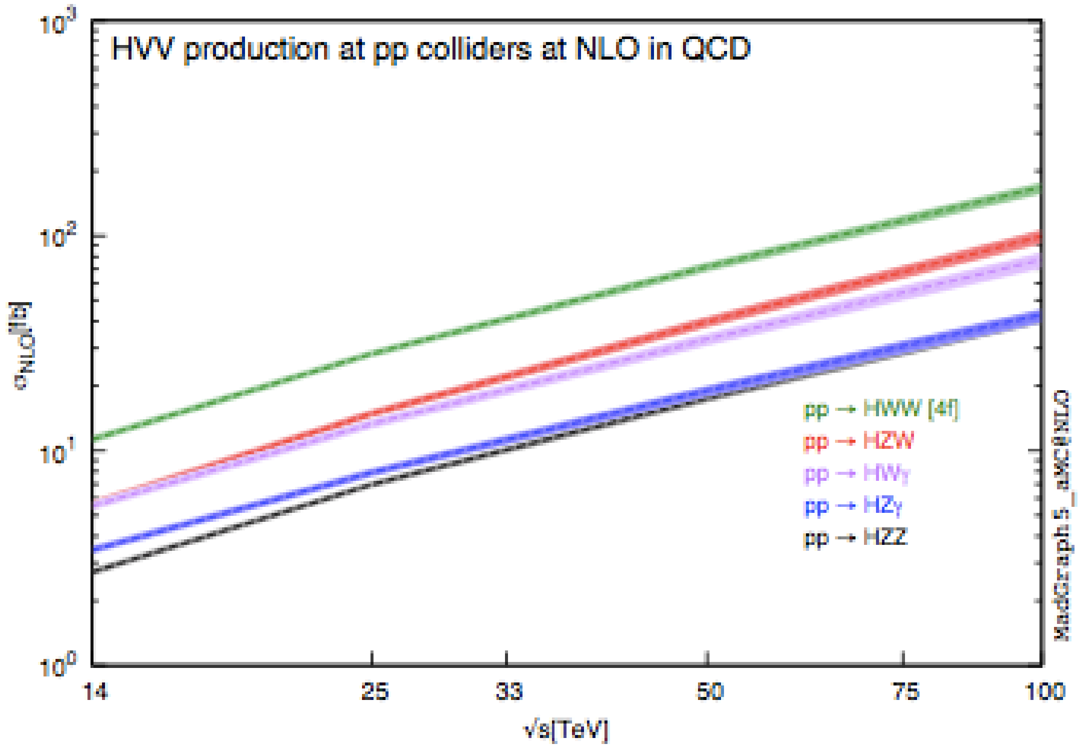
In several cases, the gains in terms of "useful" rate are much bigger.
E.g. when we are interested in the large-invariant mass behaviour of the final states:
$\sigma(ttH, p_T^{top} > 500\ \mathrm{GeV}) \Rightarrow R(100) = 250$

Task: explore new opportunities for measurements, to reduce systematics with independent/complementary kinematics, backgrounds, etc.etc.

Examples: how much can we reduce jet veto systematics by "measuring" jet rates/vetoes in "clean" channels like $H \to ZZ^* / \gamma\gamma$?

Rare H production modes

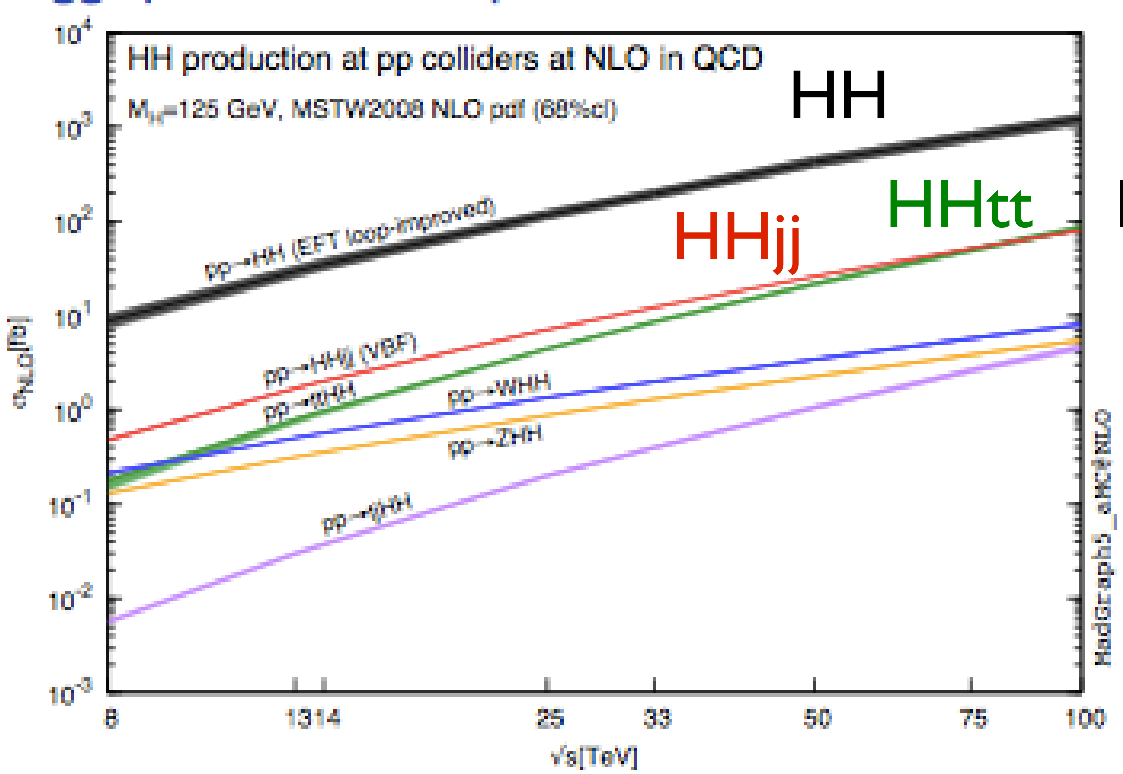
Higgs-diboson associated production



100 fb

Channel	$\frac{\sigma_{100}}{\sigma_{14}}$	$\frac{\sigma_{100}}{\sigma_{8}}$
HWW	20	35
HZW	20	45
$HW\gamma$	15	35
$HZ\gamma$	10	30
HZZ	15	40

Higgs-pair associated production



1000 fb

100 fb

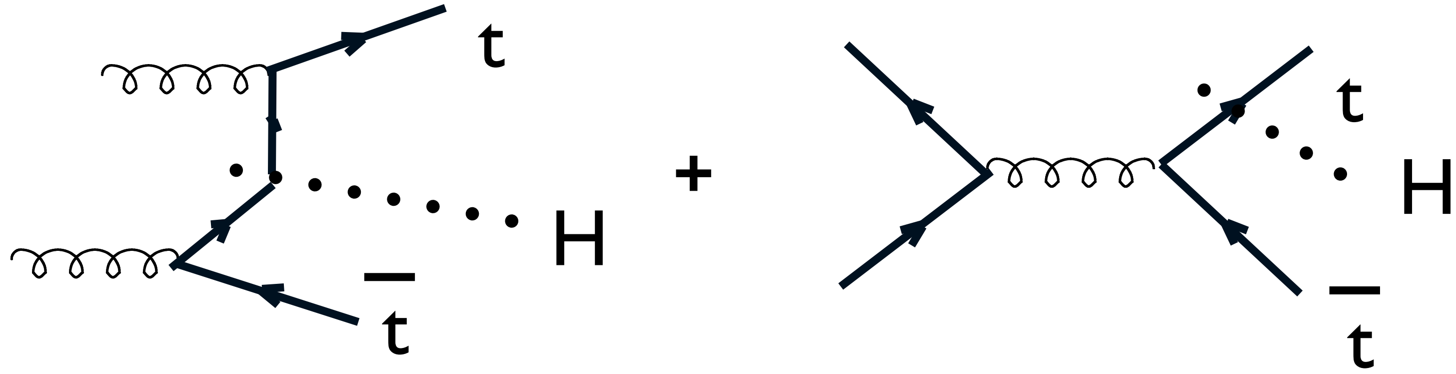
Channel	$\frac{\sigma_{100}}{\sigma_{14}}$	$\frac{\sigma_{100}}{\sigma_{8}}$
HH	35	150
$HHjj$ VBF	45	180
$HHt\bar{t}$	100	600
HHW	15	40
HHZ	15	40
$HHtj$	130	800

Which opportunities for new measurements and probes of Higgs properties are made possible by these new channels ?

P.Torrielli, MadGraph5-aMC@NLO

ttH/ttZ as a precision probe of the top Yukawa coupling

MLM, Frederix



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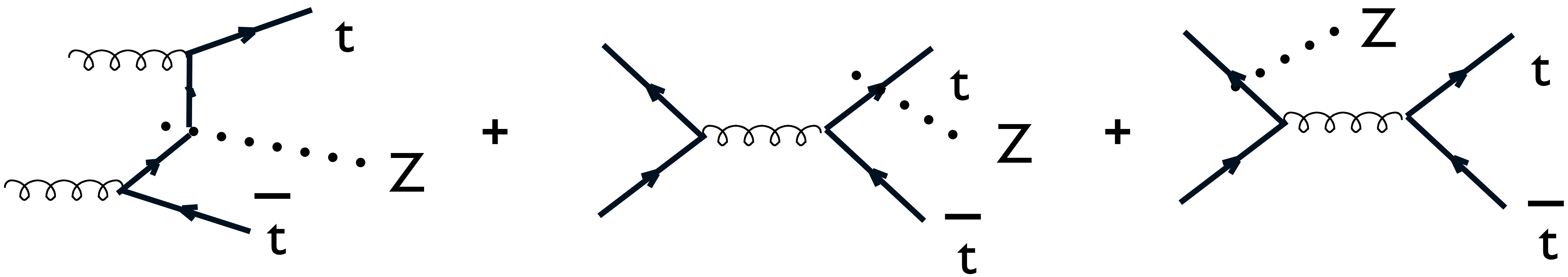


To the extent that the qqbar → tt Z/H contributions are subdominant:

- Identical production dynamics:

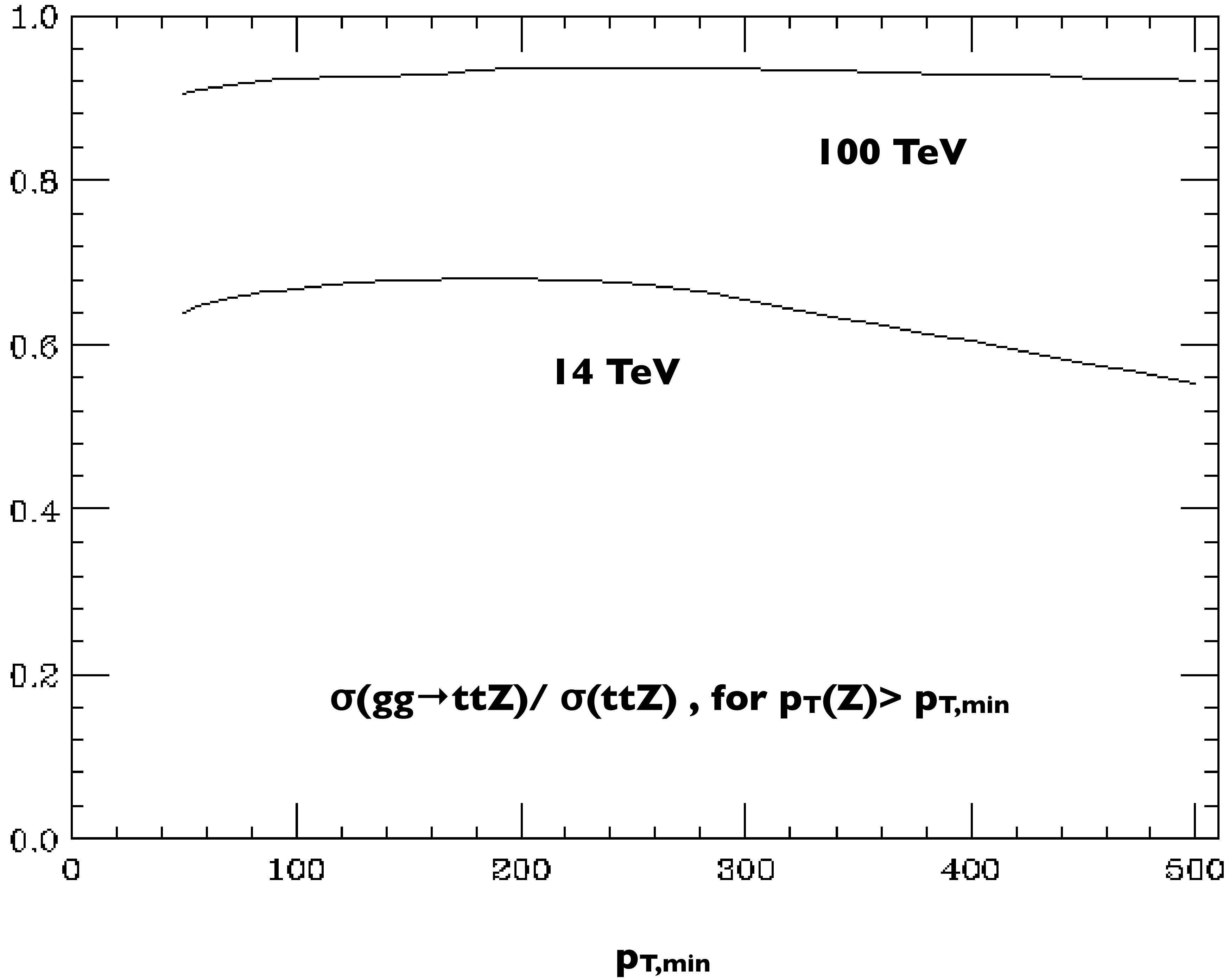
o correlated QCD corrections, correlated scale dependence
o correlated α_S systematics

- $m_Z \sim m_H \Rightarrow$ almost identical kinematic boundaries:

o correlated PDF systematics
o correlated m_{top} systematics

For a given y_{top}, we expect σ(ttH)/σ(ttZ) to be predicted with great precision

gg fraction in pp→ttZ, vs ptmin(Z)



NB: At lower p_T values, gg fraction is slightly larger for ttZ than for ttH, since $m_Z < m_H$

NLO scale dependence:

Scan μ_R and μ_F independently, at $\mu_{R,F}$ = [0.5, 1, 2] μ_0 , with $\mu_0 = m_H+2m_t$

	δσ(ttH)	δσ(ttZ)	**σ(ttH)/σ(ttZ)**	**δ[σ(ttH)/σ(ttZ)]**
14 TeV	± 9.8%	± 12.3%	**0.608**	**±2.6%**
100 TeV	± 9.6%	± 10.8%	**0.589**	**±1.2%**

NB Uncertainty bands for x symmetrized around $(x_{min}+x_{max})/2$

PDF dependence (CTEQ6.6. only)

	δσ(ttH)	δσ(ttZ)	**δ[σ(ttH)/σ(ttZ)]**
14 TeV	± 4.8%	± 5.3%	**±0.75%**
100 TeV	± 2.7%	± 2.3%	**±0.48%**

Conclusion: potential for a %-level precision in the determination of y_{top}

Exploration of EW interactions at high energy via Multi-gauge boson production

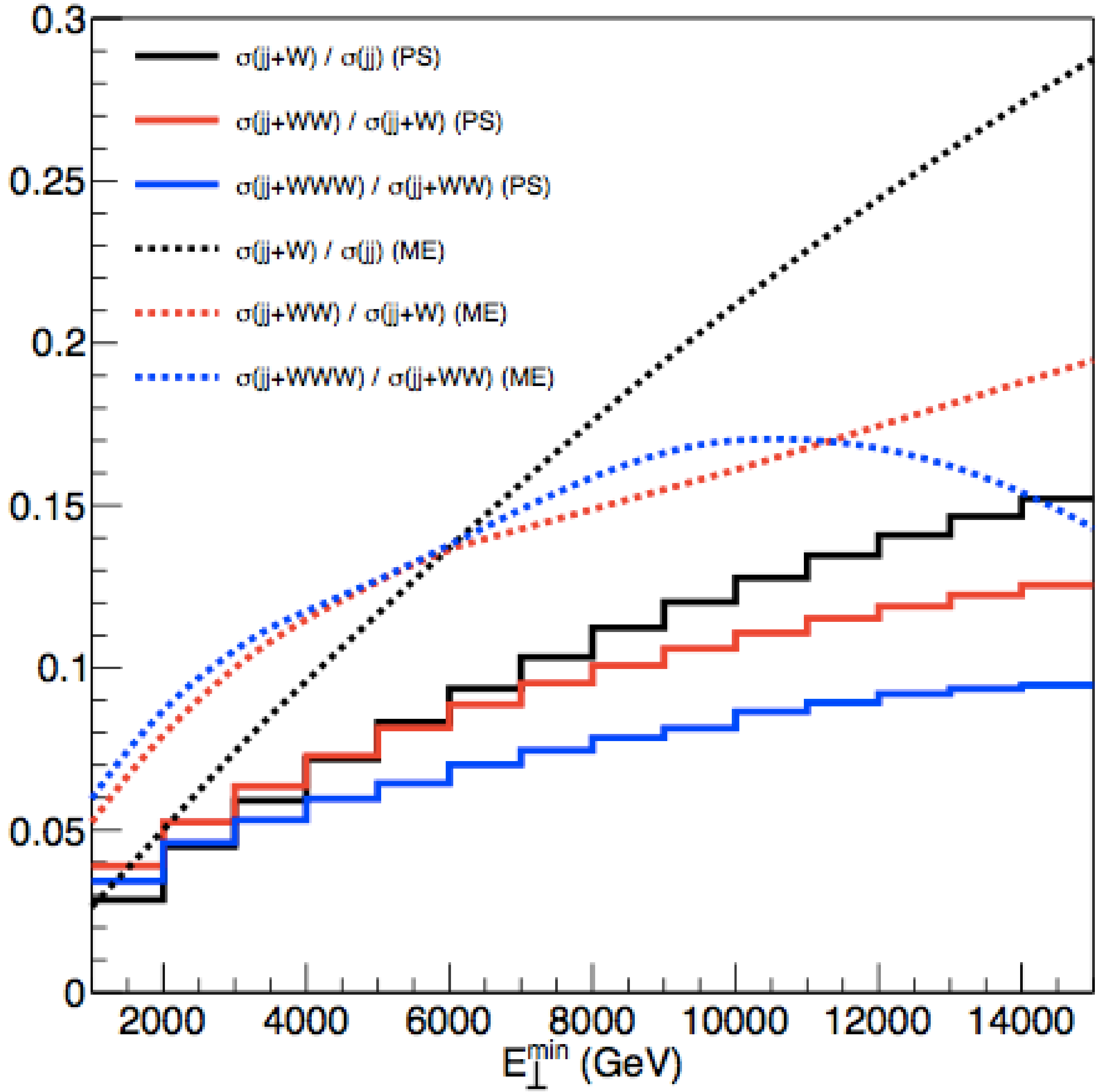
At 100 TeV:

WW	**σ=770 pb**	(no BR included)
WWW	**σ=2 pb**	
WWZ	**σ=1.6 pb**	
WWWW	**σ=15 fb**	
WWWZ	**σ=20 fb**	
....		

Tasks:

o determine experimental accept/eff's: how high can we go in multiplicity?
o what can we learn on EW interactions at high energy from these studies?
o which variables/correlations to consider?
o can we use dijet decays at high pt(W) ?

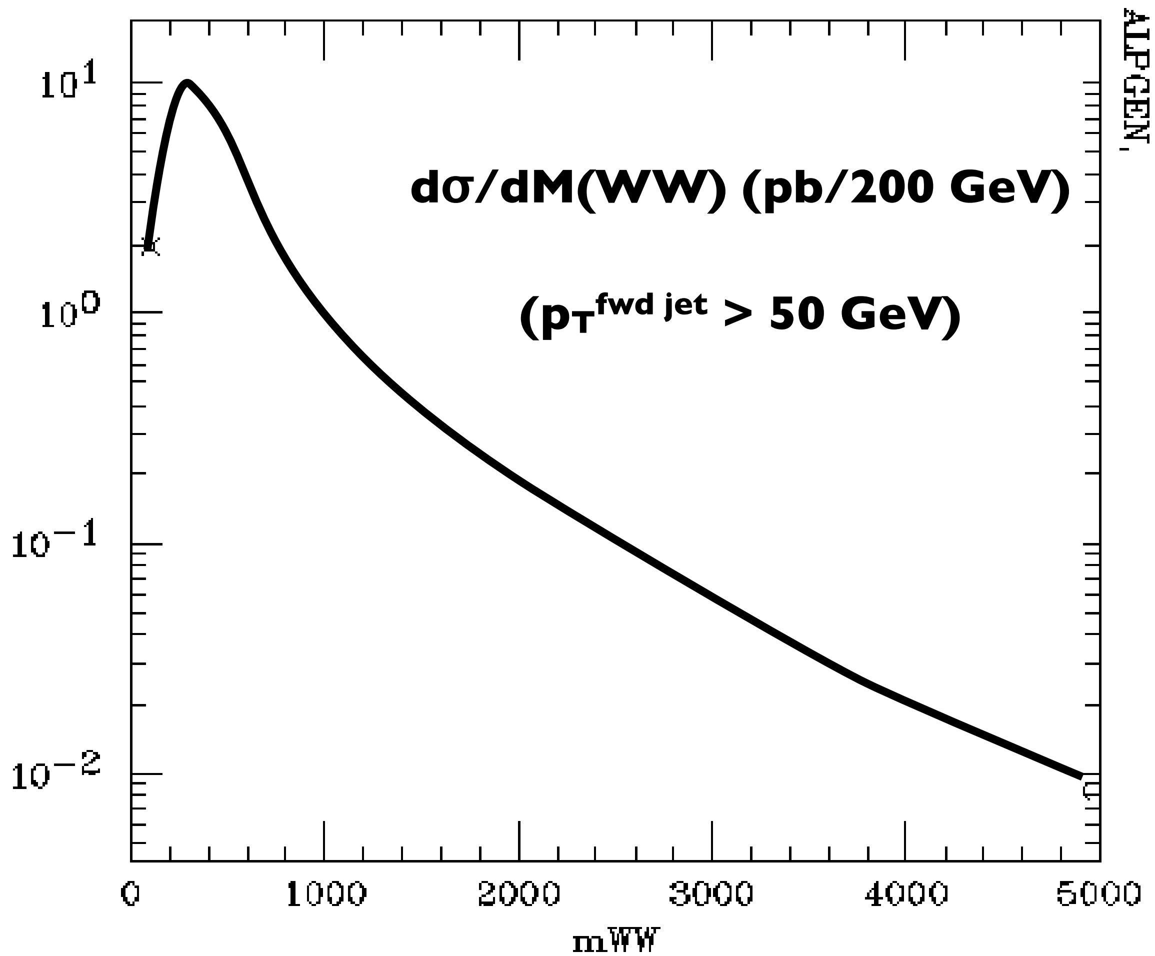
~ 10% probability of W emission from high-energy quark jets

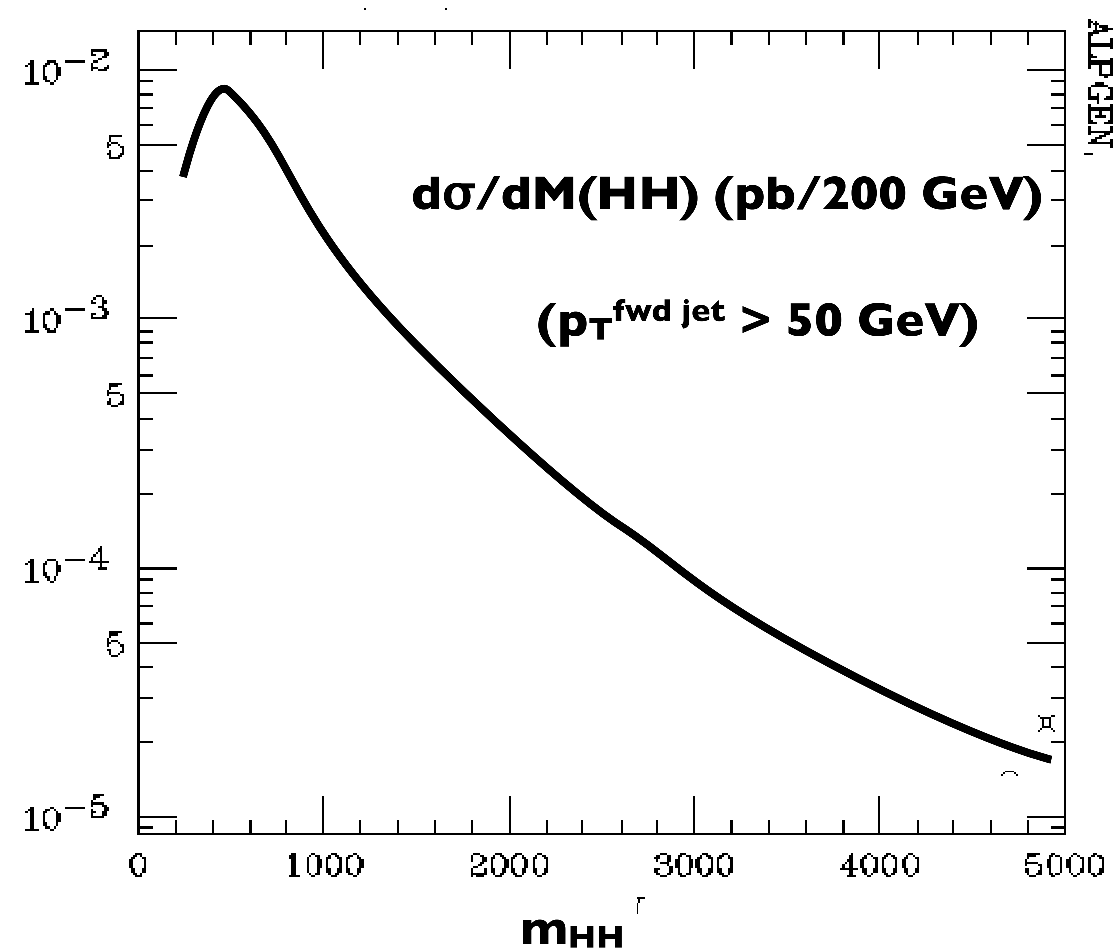


Christiansen

EWSB probes: high mass WW/HH in VBF

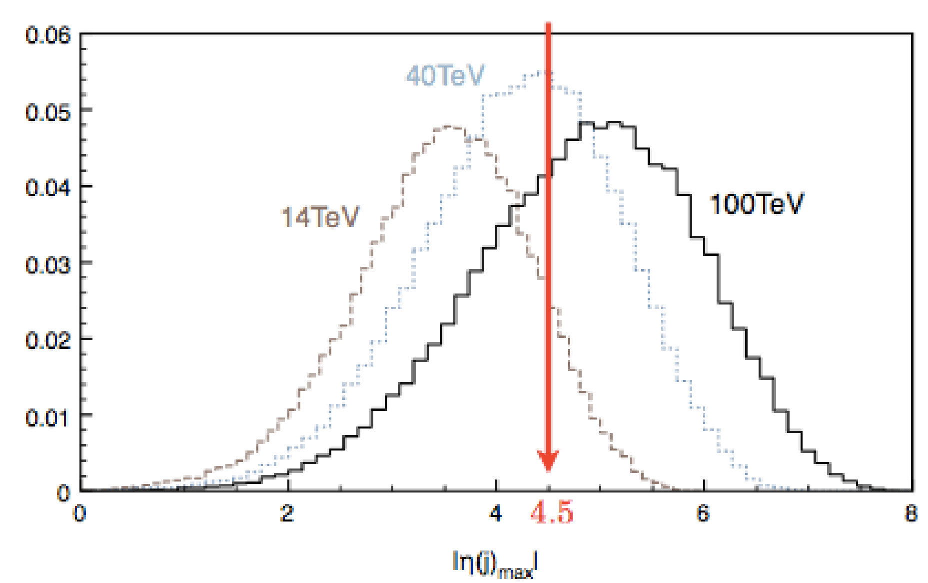
SM rates at 100 TeV



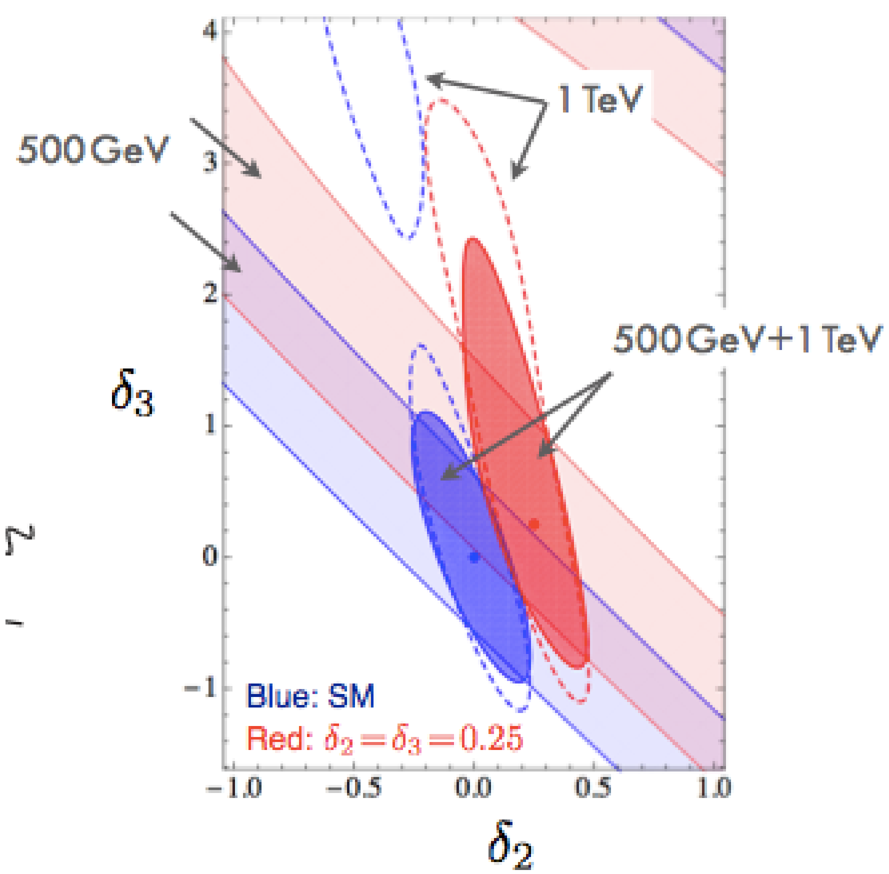


100 fb with M(WW) > ~3 TeV

1 fb with M(HH) > ~2 TeV



ILC



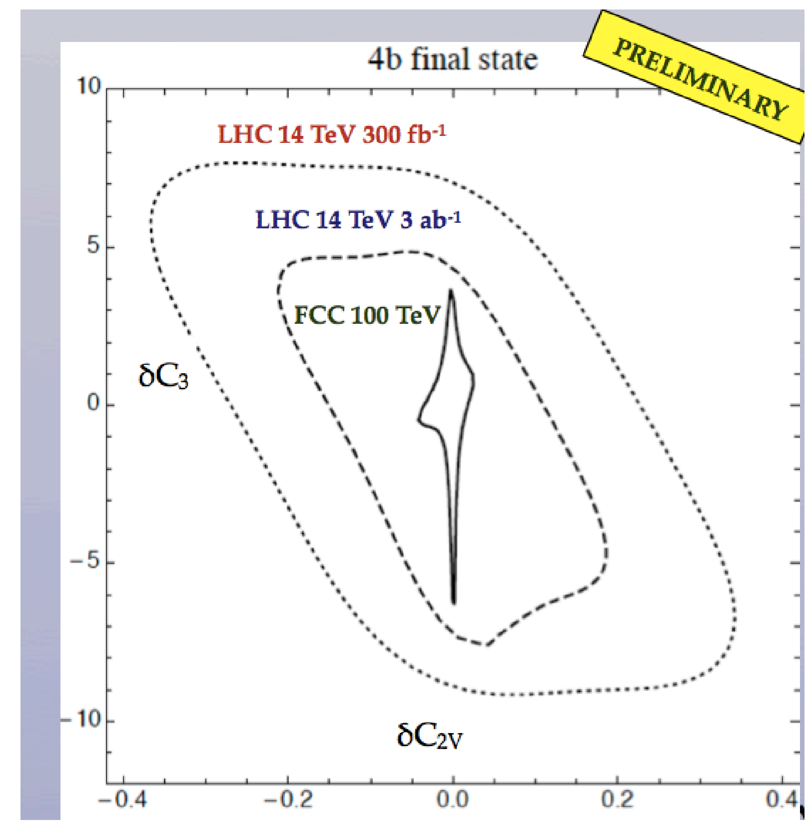
CLIC 3 TeV

Results with 1 ab^{-1}

5% precision on δ_2 ($f \sim 1.1\,\mathrm{TeV}$)

30% precision on δ_3

pp 100 TeV



Contino, O. Bondu, A. Massironi and J. Rojo at the wshop

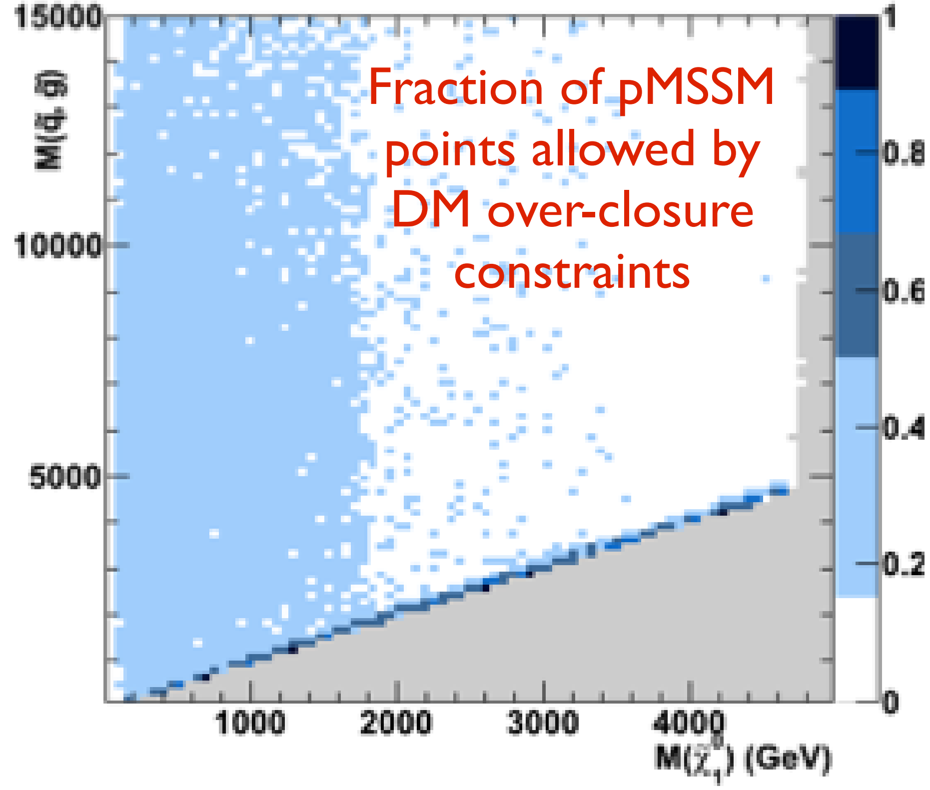
Grojean, Pappadopulo, Rattazzi, Thamm JHEP 1402 (2014) 006

WIMP DM search

Can a 100 TeV collider detect or rule out WIMP scenarios for DM ?

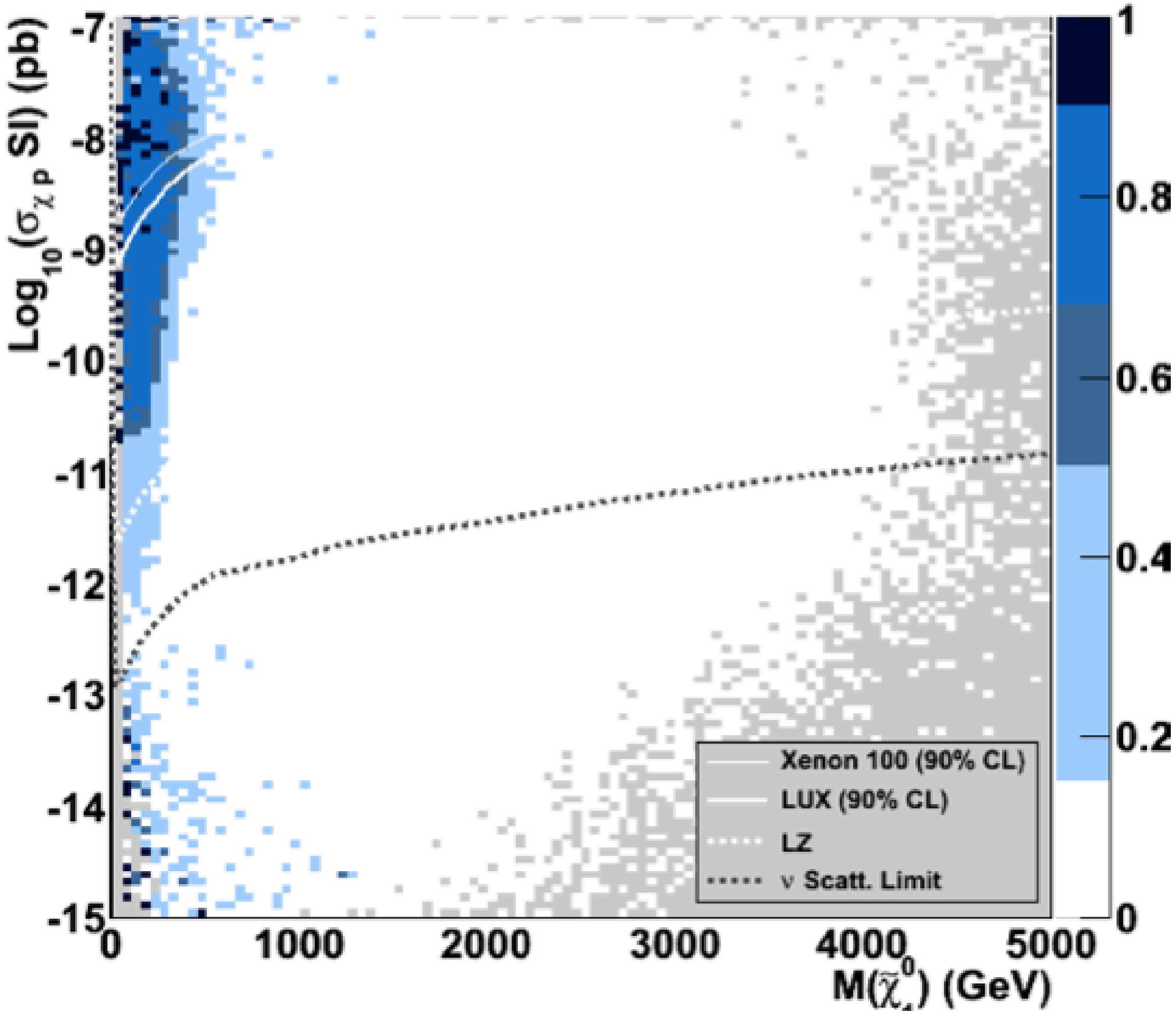
Coverage of pMSSM parameter space using DM constraints and direct searches at 14 and 100 TeV

Arbey, **Battaglia**, Mahmoudi

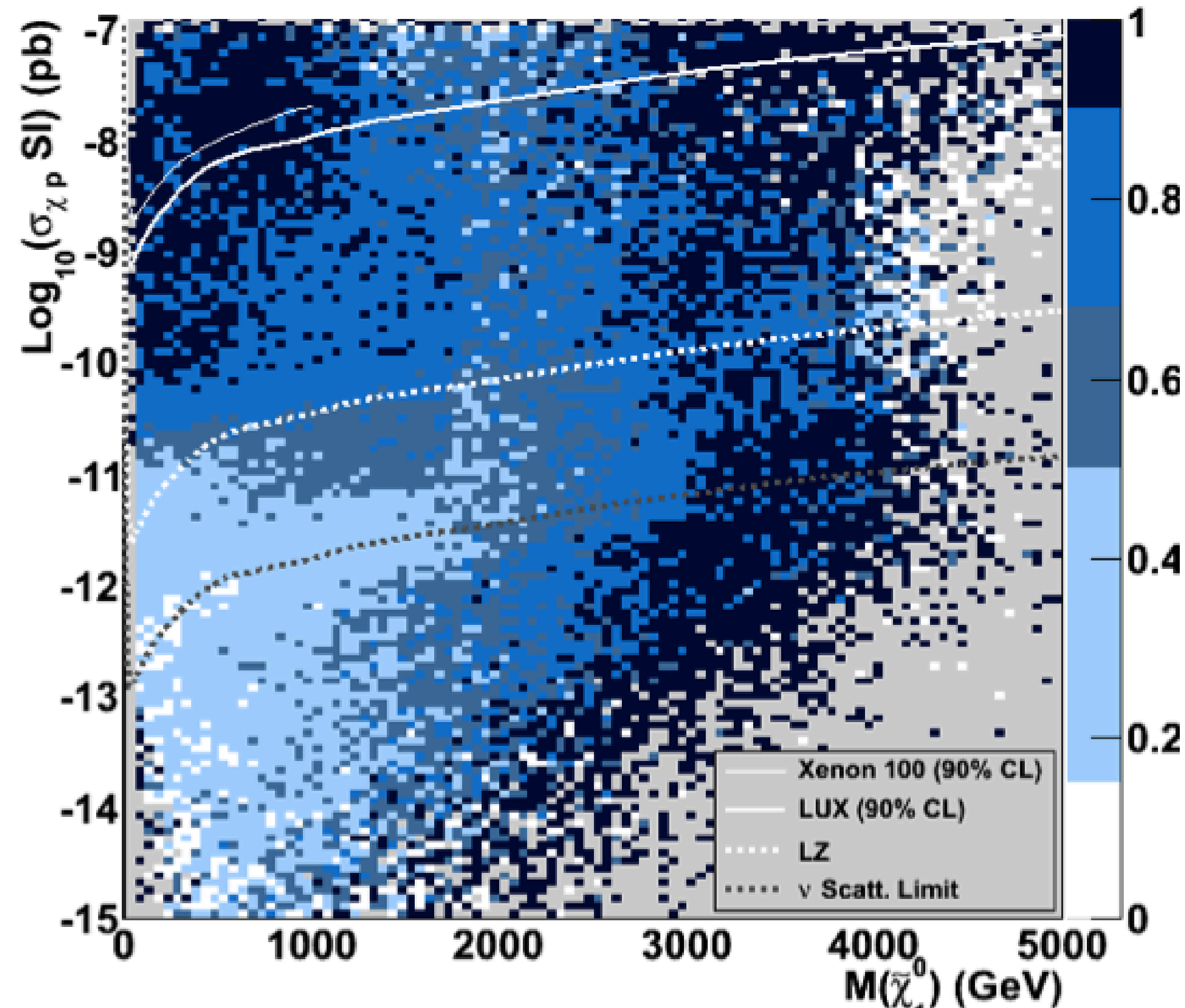


Fraction of pMSSM points that can be excluded at LHC-14 and 100 TeV:

14 TeV



100 TeV



$10\ ab^{-1}$ at 100 TeV imply:

10^{10} Higgs bosons => 10^4 x today

⇒ precision measurements

⇒ rare decays, FCNC probes

10^{12} top quarks => 5 10^4 x today

($H \rightarrow e\mu$, $t \rightarrow cV$ ($V=Z,g,\gamma$), $t \rightarrow cH$, ...)

⇒ CP violation

=> 10^{12} W bosons from top decays

=> 10^{12} b hadrons from top decays (particle/antiparticle tagged)

=> 10^{11} $t \rightarrow W \rightarrow$ taus ⇒ rare decays $\tau \rightarrow 3\mu$, $\mu\gamma$, CPV

=> few x10^{11} $t \rightarrow W \rightarrow$ charm hadrons

⇒ rare decays $D \rightarrow \mu^+\mu^-$, ..., CPV

The possibility of detectors dedicated to final states in the 0.1 - 1 TeV region deserves very serious thinking:

focus on Higgs, DM and weakly interacting new particles, top, W

W decays

Melia

- SM rare decays -- Examples:

$W^\pm \to \pi^\pm \gamma$ $BR_{SM} \sim 10^{-9}$, CDF$\leq 6.4 \times 10^{-5}$

$W^\pm \to D_s^\pm \gamma$ $BR_{SM} \sim 10^{-9}$, CDF$\leq 1.2 \times 10^{-2}$

What is the theoretical interest in measuring these rates? What else ?

- SM inclusive decays -- Examples:

$R = BR_{had} / BR_{lept}$: what do we learn ? Achievable precision for CKM, α_S , ... ?

- W mass ??

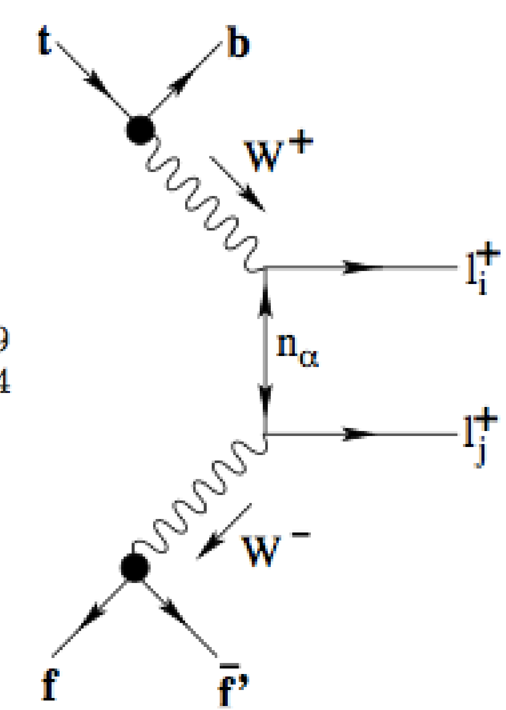
- BSM decays -- Are there interesting channels to consider?

-- Example

BNL-HET-06/9
OITS-784

Majorana neutrinos and lepton-number-violating signals in top-quark and W-boson rare decays

Shaouly Bar-Shalom[a,*] Nilendra G. Deshpande[b,†] Gad Eilam[a,‡] Jing Jiang[b,§] and Amarjit Soni[c,¶]



Top "polarimetry" with ttW, and Tevatron's A_{FB}

Maltoni, MLM, Tsinikos, Zaro, arXiv:1406.3262

gg→W ttbar is clearly forbidden ⇒ presence of W singles out (polarized) q-qbar initial state

		8 TeV	13 TeV	14 TeV	33 TeV	100 TeV
$t\bar{t}$	σ(pb)	$198^{+15\%}_{-14\%}$	$661^{+15\%}_{-13\%}$	$786^{+14\%}_{-13\%}$	$4630^{+12\%}_{-11\%}$	$30700^{+13\%}_{-13\%}$
	$A_C^t(\%)$	$0.72^{+0.14}_{-0.09}$	$0.45^{+0.09}_{-0.06}$	$0.43^{+0.08}_{-0.05}$	$0.26^{+0.04}_{-0.03}$	$0.12^{+0.03}_{-0.02}$
$t\bar{t}W^{\pm}$	σ(fb)	$210^{+11\%}_{-11\%}$	$587^{+13\%}_{-12\%}$	$678^{+14\%}_{-12\%}$	$3220^{+17\%}_{-13\%}$	$19000^{+20\%}_{-17\%}$
	$A_C^t(\%)$	$2.37^{+0.56}_{-0.38}$	$2.24^{+0.43}_{-0.32}$	$2.23^{+0.43}_{-0.33}$	$1.95^{+0.28}_{-0.23}$	$1.85^{+0.21}_{-0.17}$
	$A_C^b(\%)$	$8.50^{+0.15}_{-0.10}$	$7.54^{+0.19}_{-0.17}$	$7.50^{+0.24}_{-0.22}$	$5.37^{+0.22}_{-0.30}$	$3.36^{+0.15}_{-0.19}$
	$A_C^e(\%)$	$-14.83^{-0.65}_{+0.95}$	$-13.16^{-0.81}_{+1.12}$	$-12.84^{-0.81}_{+1.11}$	$-9.21^{-0.87}_{+1.05}$	$-4.94^{-0.63}_{+0.72}$

Expected statistical sensitivity

- 14 TeV ($\mathcal{L} = 3000\ \text{fb}^{-1}$):

  $\delta_{\text{rel}} A_C^t = 14\%,\ \delta_{\text{rel}} A_C^b = 4\%,\ \delta_{\text{rel}} A_C^e = 2\%$
- 100 TeV ($\mathcal{L} = 3000\ \text{fb}^{-1}$):

  $\delta_{\text{rel}} A_C^t = 3\%,\ \delta_{\text{rel}} A_C^b = 2\%,\ \delta_{\text{rel}} A_C^e = 1\%$

Example: sensitivity to axigluon models consistent with Tevatron A_{FB} anomaly

$m_{\tilde{G}} = 200\ \text{GeV}, \Gamma_{\tilde{G}} = 50\ \text{GeV})$

$$\text{Left-handed (I)}: g_L^u = g_L^d = 0.5 g_s\,, \quad g_R^u = g_R^d = 0\,,$$

$$\text{Axial (II)}: g_L^u = g_L^d = -0.4 g_s\,, \quad g_R^u = g_R^d = 0.4 g_s\,.$$

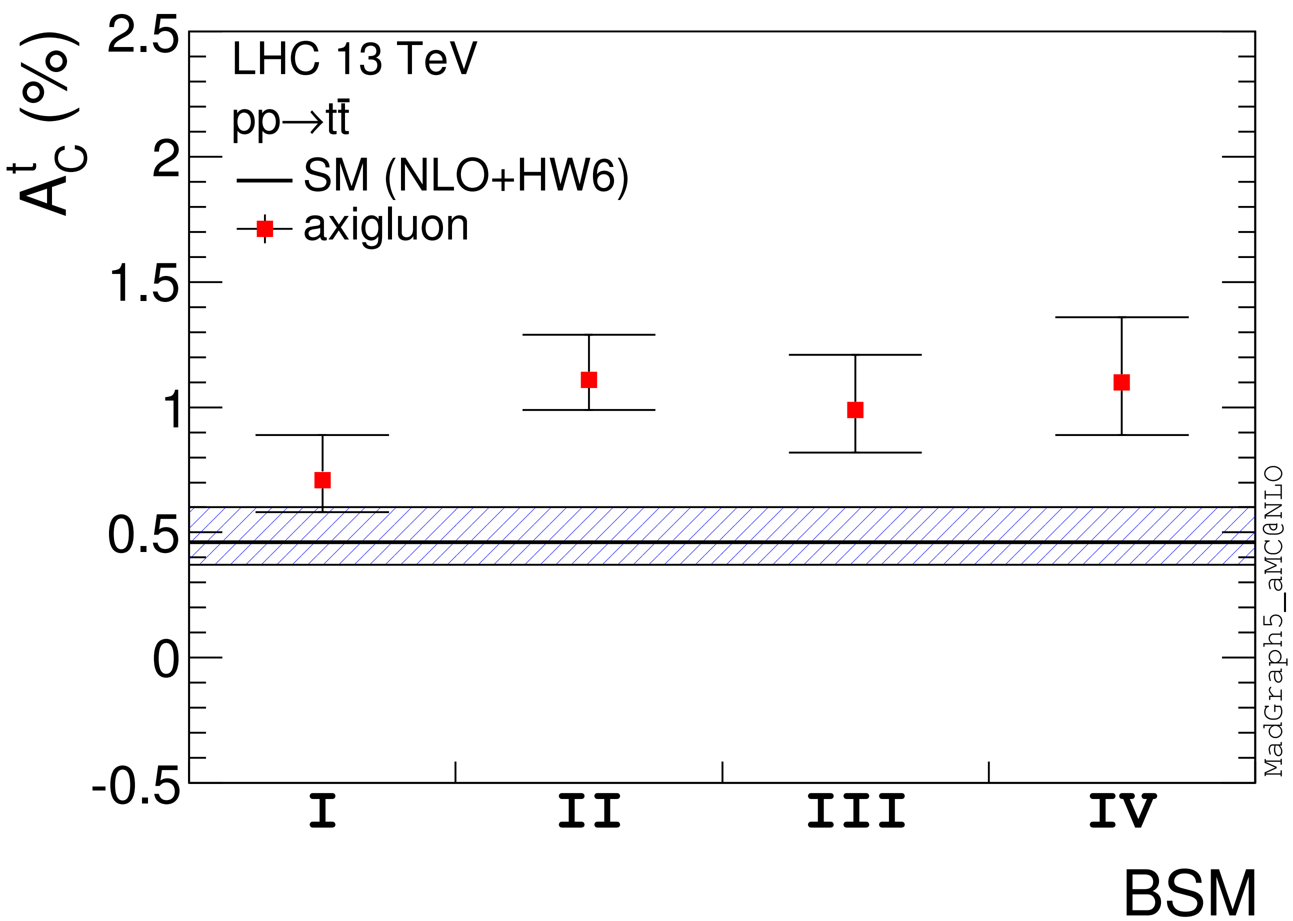
$\text{Left-handed (III)}: \quad m_{\tilde{G}} = 2\ \text{TeV}$

$$g_L^u = g_L^d = -0.8 g_s\,, \quad g_R^u = g_R^d = 0\,,$$
$$g_L^t = 6 g_s\,, \quad g_R^t = 0\,, \quad \Gamma_{\tilde{G}} = 1123\ \text{GeV}\,.$$

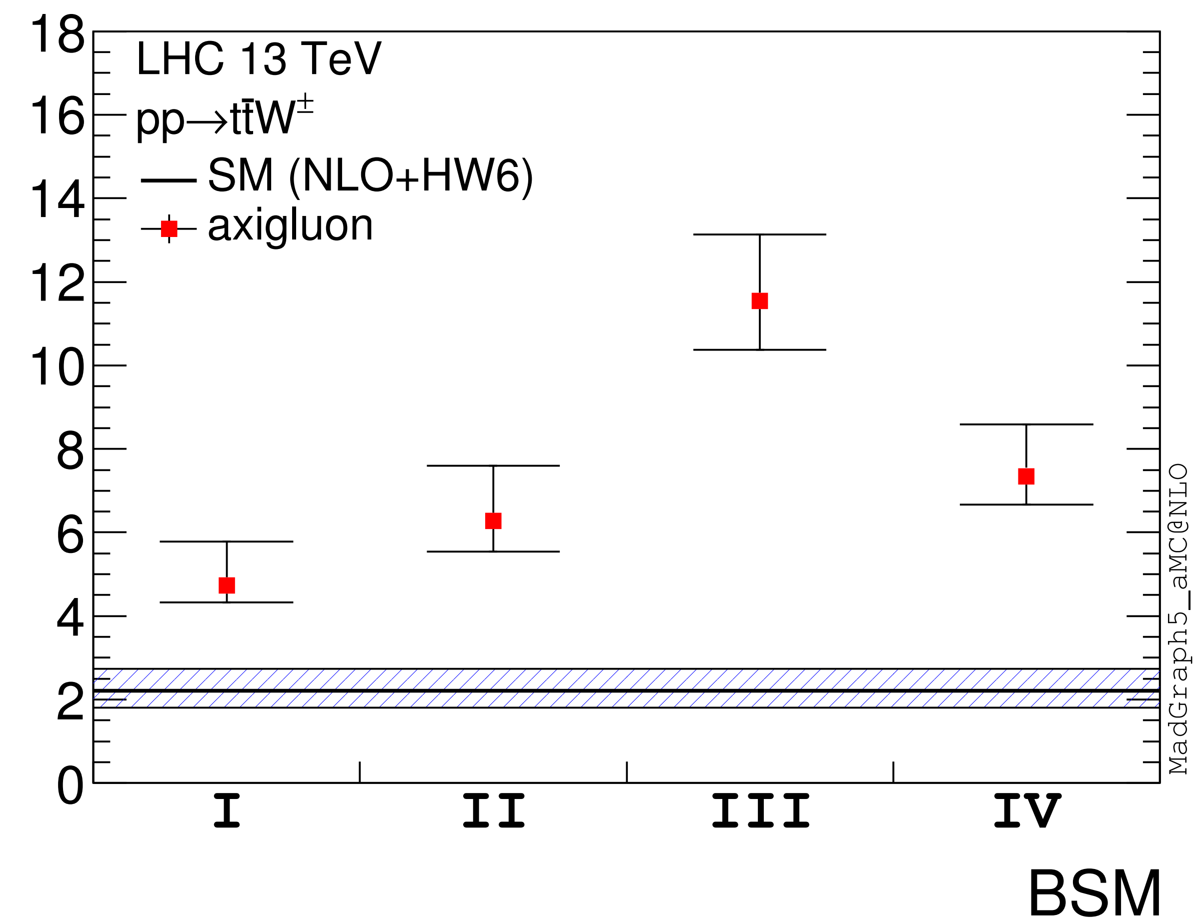
$\text{Axial (IV)}: \quad m_{\tilde{G}} = 2\ \text{TeV}$

$$g_L^u = g_L^d = 0.6 g_s\,, \quad g_R^u = -0.6 g_s\,, \quad g_R^d = 0\,,$$
$$g_L^t = -4 g_s\,, \quad g_R^t = 4 g_s\,, \quad \Gamma_{\tilde{G}} = 742\ \text{GeV}\,.$$

tt



ttW



Probing top couplings

JA Aguilar-Saavedra

Wtb $\quad -\frac{g}{\sqrt{2}}\bar{b}_L\frac{i\sigma^{\mu\nu}q_\nu}{M_W}\, g_R\, t_R W^-_\mu$

Ztt $\quad -\frac{g}{2c_W}\bar{t}\frac{i\sigma^{\mu\nu}q_\nu}{M_Z}\, d_V^Z\, t Z_\mu$

$$g_R = \sqrt{2}\, C_{uW}^{33}\frac{v^2}{\Lambda^2}$$

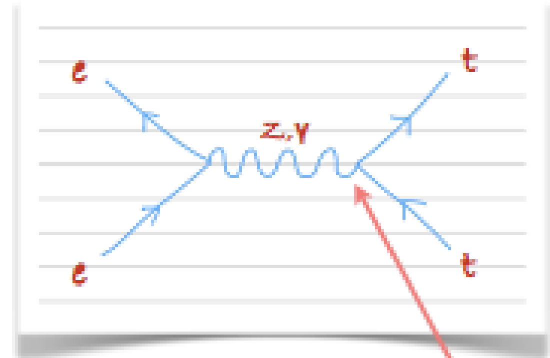
$$d_V^Z = \sqrt{2}c_W\, \mathrm{Re}\, C_{uW}^{33}\frac{v^2}{\Lambda^2} + \text{other}$$

$$d_V^\gamma = \frac{\sqrt{2}}{e}s_W\, \mathrm{Re}\, C_{uW}^{33}\frac{v m_t}{\Lambda^2} + \text{other}$$

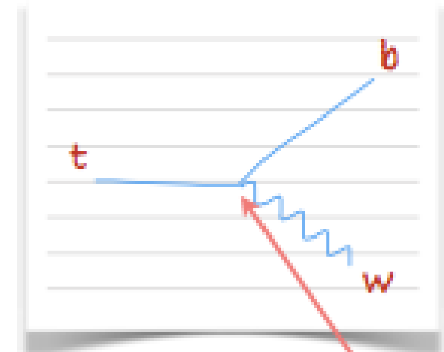
γtt $\quad -e\bar{t}\frac{i\sigma^{\mu\nu}q_\nu}{m_t}\, d_V^\gamma\, t A_\mu$

Weak moments: the contenders

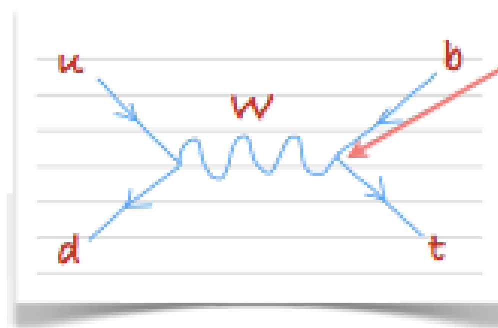
the old favorite: $t\bar{t}$ at ILC



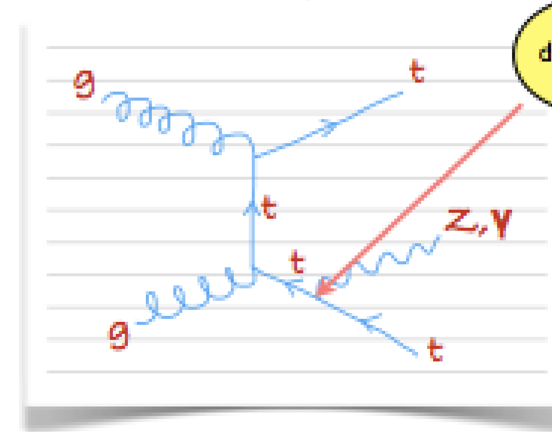
the newcomer: $t\bar{t}$ at TLEP



the underdog: $t\bar{b}$ at FHC



the other: $t\bar{t}Z/\gamma$ at FHC



top dipole int here

top dipole int here

Projected sensitivity reach:

ILC $\quad \mathrm{Re}\, C_{uW}^{33}/\Lambda^2 \in [-0.128, 0.140]\ \mathrm{TeV}^{-2}$ $\quad$ 95% CL $\quad \Lambda > 2.7\sqrt{\mathrm{Re}\, C}\ \mathrm{TeV}$

FCC-ee $\quad \mathrm{Re}\, C_{uW}^{33}/\Lambda^2 \in [-0.083, 0.083]\ \mathrm{TeV}^{-2}$ $\quad$ 95% CL $\quad \Lambda > 3.5\sqrt{\mathrm{Re}\, C}\ \mathrm{TeV}$

FCC-hh $\quad \mathrm{Re}\, C_{uW}^{33}/\Lambda^2 \in [-0.043, 0.046]\ \mathrm{TeV}^{-2}$ $\quad$ 95% CL $\quad \Lambda > 4.7\sqrt{C}\ \mathrm{TeV}$

Plenty of room for new ideas .....

* Off-shell W/Z production above 10 TeV DY mass. E.g.

- measure the running of EW couplings, sensitive to new weakly-interacting particles, possibly hidden from direct discovery (⇒ Rudermann at BSM@100 TeV wshop, Galloway at SLAC)

- 10^4 pp → W^* → top+ bottom with M(tb) > 7 TeV

* QCD jets up to 25-30 TeV ⇒ running of α_S , ...

* SM violation of B+L via EW anomaly (not viable below 30 TeV) (⇒ Khoze and Ringwald at BSM@100 TeV wshop)

* Growth of heavy flavour densities inside proton (c, b and ultimately top) ⇒new opportunities for studies within and beyond the SM (⇒ Perez at BSM@100 TeV wshop)

* ....

Physics topics list, current TH contributors and expressions of interest

FHC.1.1 Exploration of EW Symmetry Breaking (EWSB)

- FHC.1.1.1 High-mass WW scattering, high mass HH production
  - *EPFL/CERN (**Contino**, Son, Liu, Rattazzi, ...), Rojo, ...*
- FHC.1.1.2 Rare Higgs production/decays and precision studies of Higgs properties
  - *aMC@NLO (Torrielli, ...), Djouadi, HXSWG ?*
- FHC.1.1.3 Additional BSM Higgs bosons: discovery reach and precision physics programme
  - *Djouadi, Craig, Katz, ...*
- FHC.1.1.4 New handles on the study of non-SM EWSB dynamics (e.g. dynamical EWSB and composite H, etc)
  - *EPF/CERN*

NB: boldfaced **names**: "volunteered" to convene/steer

Physics topics list, current TH contributors and expressions of interest

FHC.1.2 Exploration of BSM phenomena

- FHC.1.2.1 discovery reach for various scenarios (SUSY, new gauge interactions, new quark and leptons, compositeness, etc.)
  - *Arbey/Battaglia/Mahmoudi, **Torre**/Wulzer/Thamm, Rizzo, ...*
- FHC.1.2.2 Theoretical implications of discovery/non-discovery of various BSM scenarios, e.g. address questions such as:
  - FHC.1.2.2.1 what remains of Supersymmetry if nothing is seen at the scales accessible at 100 TeV?
  - FHC.1.2.2.2 which new opportunities open up at 100 TeV for the detection and study of dark matter?
    - *Wang, **Schwaller**, ABM, ...*
  - FHC.1.2.2.3 which new BSM frameworks, which are totally outside of the HL-LHC reach, become accessible/worth-discussing at 100 TeV ?

Physics topics list, current TH contributors and expressions of interest

FHC.1.3 Continued exploration of SM particles

- FHC.1.3.1 Physics of the top quark (rare decays, FCNC, anomalous couplings, ...)
  - *MLM, Aguilar-Saavedra, Tsinikos, Kamenik, Zupan, Perez, ...*
- FHC.1.3.2 Flavour Physics:
  - charm and bottom quark (rare decays, CPV, ...)
  - tau lepton (e.g. tau -> 3 mu, tau -> mu gamma and other LFV decays)
  - ***Isidori**, Silvestrini,*
- FHC.1.3.2 W/Z physics
  - *Melia, MLM, ...*
- FHC.1.3.3 QCD dynamics
  - *Skands, MLM, ..*

FHC.1.5 Theoretical tools for the study of 100 TeV collisions

- FHC.1.5.1 PDFs
  - ***Rojo**, Melia, Fuks, PDF4LHC*
- FHC.1.5.2 MC generators
  - *Skands (pythia), mg5-aMC@NLO, Alpgen, ...*
- FHC.1.5.3 N^nLO calculations
  - ***Zanderighi***
- FHC.1.5.4 EW corrections
  - *Christiansen, Chiesa/Piccinini/... ,*

Physics topics list, current TH contributors and expressions of interest

FHC.1.4 Opportunities other than pp physics:

- FHC.1.4.1 Heavy Ion Collisions
  - *HI WG (**Dainese, Masciocchi, Wiedemann**)*
- FHC.1.4.2 Fixed target experiments:
  - FHC.1.4.2.2 Heavy Ion beams for fixed-target experiments
    - *HI WG (**Dainese, Masciocchi, Wiedemann**)*
  - FHC.1.4.2.1 "Intensity frontier": kaon physics, mu2e conversions, beam dump experiments and searches for heavy photons, heavy neutrals, and other exotica...
    - *Contacts ongoing:*

We plan to initiate some (mainly brainstorming) activity about opportunities for smaller dedicated collider experiments, as well as fixed-target experiments using beams extracted at different stages of the the injection chain (in strong contacts with the machine experts) → aim at a first workshop in September-October
→ please let us know if you are interested

Plan for the above:

- start documenting what's been discussed so far
- document reference benchmark cross-sections, distributions for relevant SM, Higgs, BSM processes
- organize dedicated mtgs, focused on specific topics, increase interaction TH/exp
- stimulate dedicated simulations, to address issues needed for the progress of the detector designs

=> have report by Winter 2015

- start interaction with FCC-ee/eh physics groups, to study and document synergies/complementarity

Issues for detector studies, and detector/machine interface

-Deciding if we do eta <6 integrated into GPD or separate is rather an important point
=> missET? jet reconstruction? Lepton ID? Tracking?
=> need to define soon physics scenarios to be used for dedicated studies
=> are there scenarios where final states above 5-10 TeV require such eta coverage ?

- We need to decide soon the physics samples that need to be generated and with which level of simulation (DELPHES, full, etc.)

-- Continue and intensify efforts to put in place software infrastructure allowing different levels of simulations.
This is super-critical for any experimental study.
Next check-point: FCC-ee WS on 19-21 June.

- Need more people to work on tracking detector layout and performance: volunteers ???

- Calorimetry issues:
-- need to understand the importance of granularity (e.g. for boosted objects) and the impact on the number of channels and hence cooling (cannot switch power off between trains, as at ILC/CLIC)
-- interplay between ECAL and HCAL important for performance (e.g. compensation) and design (space) reasons

- Trigger (and DAQ): very little done so far, need to ramp up efforts. May organise a dedicated mini-workshop.

- need to see concrete models for the mechanical support structure, in the scenarios with a nested solenoid solution

-do we have to worry about L* reduction ?
   => impact on maintenance scenarios, forw regions, beta* focusing, ...

-can the experiments tolerate the presence of an injector in the FCC tunnel?

- clustered collision points are still an option and have many advantages
   => explore potential issues and opportunities