ATLAS early data plans: selected topics

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NExT @ RAL Wednesday 28th October 2009

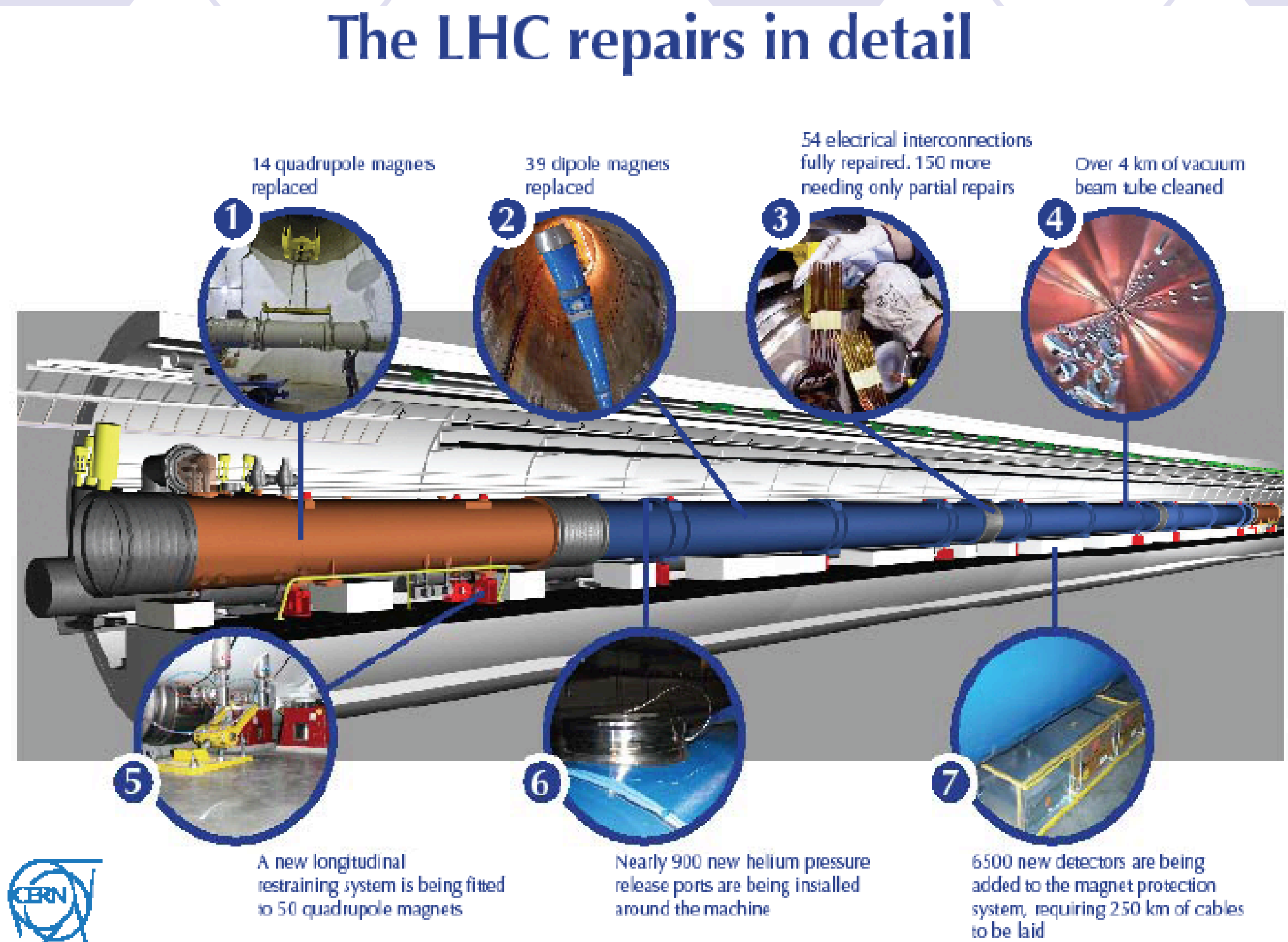
Thanks to:

A. De Santo, P. Teixeira-Dias, T. Berry

Outline

- LHC run plan and schedule
- ATLAS readiness
- Early analyses:
  - SM
  - Top
  - Z', Graviton
  - SUSY trilepton
- Conclusion

LHC status



S. Myers, ATLAS week, October 5th

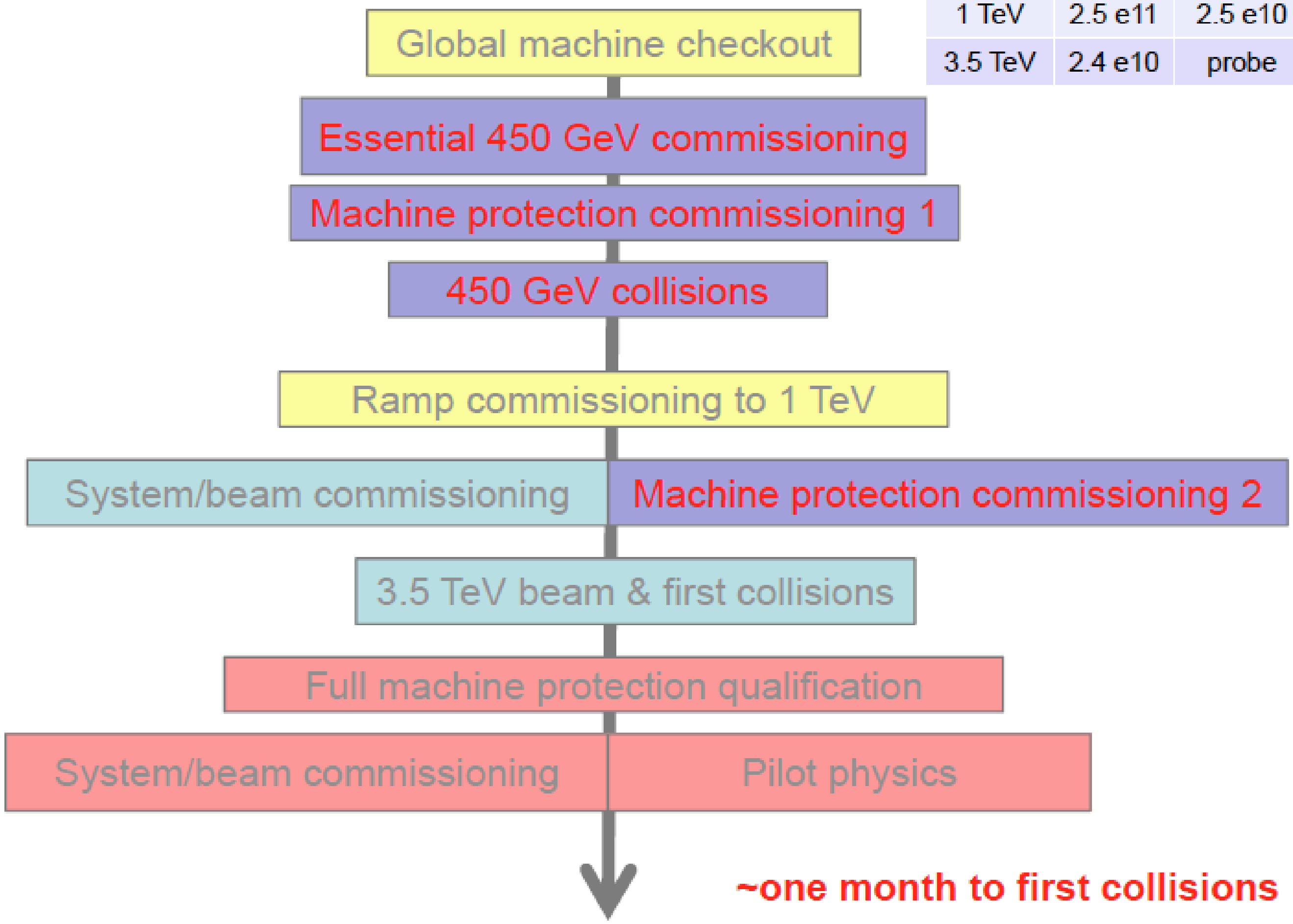
LHC schedule

S. Myers, ATLAS week, October 5th

this is the present plan which will almost certainly be modified on a daily/weekly basis once we start with beam commissioning.
BUT we need a plan!

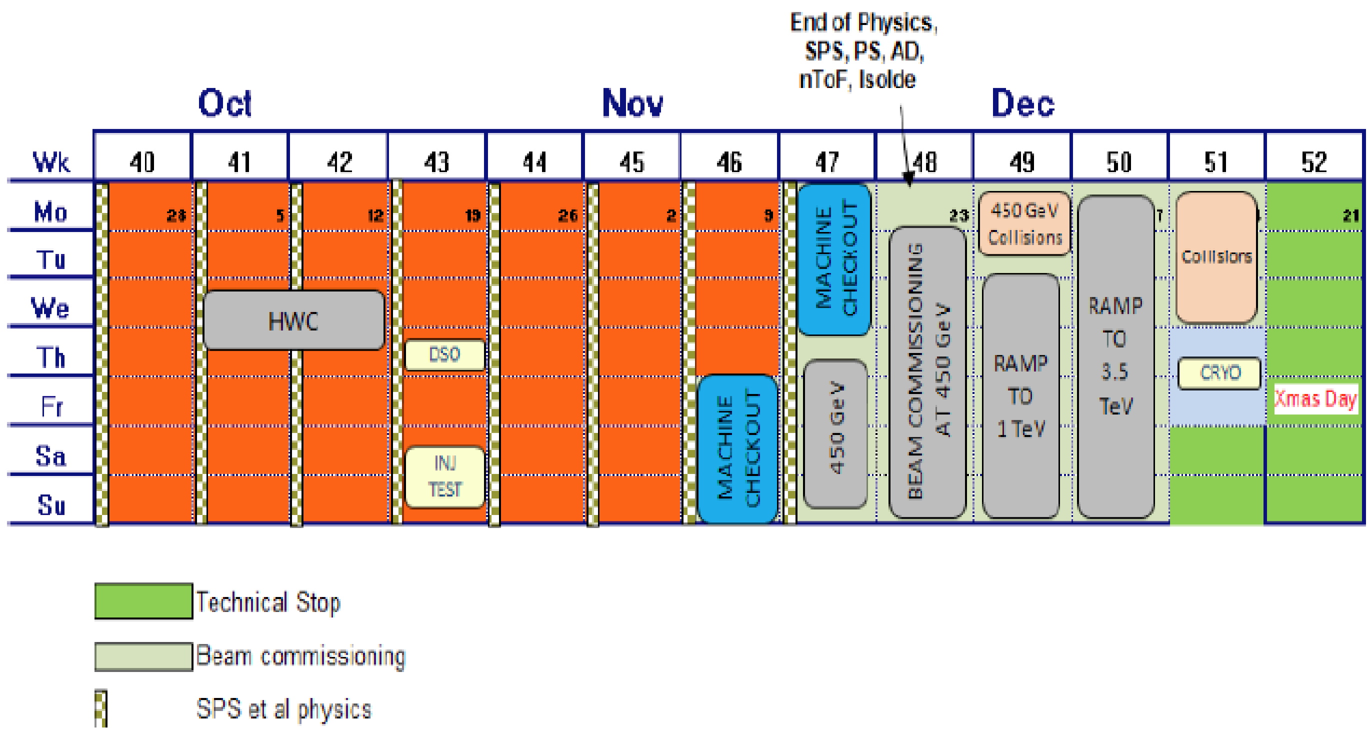
LHC beam commissioning

Energy	Safe	Very Safe
450	1 e12	1 e11
1 TeV	2.5 e11	2.5 e10
3.5 TeV	2.4 e10	probe



~one month to first collisions

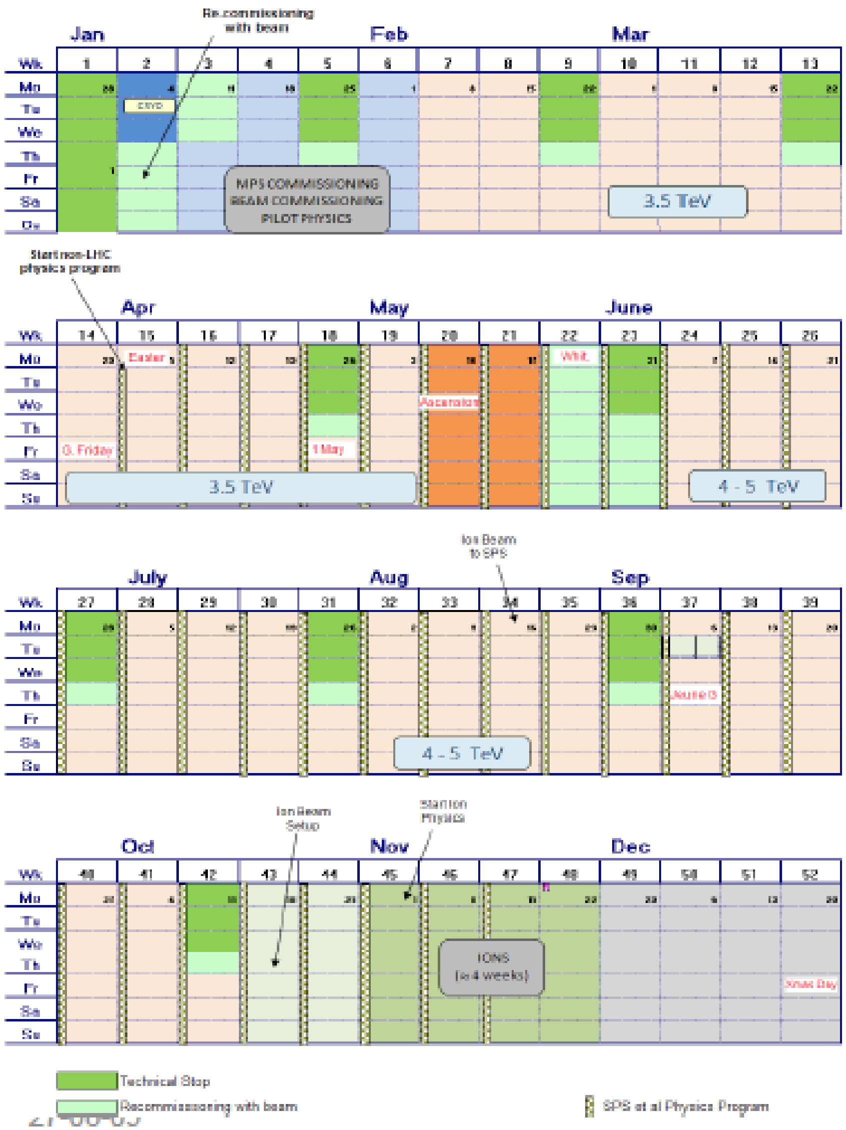
LHC schedule



- All dates approximate…
- Reasonable machine availability assumed

S. Myers, ATLAS week, October 5th

LHC 2010 – very draft



- 2009:
  - 1 month commissioning
- 2010:
  - 1 month pilot & commissioning
  - 3 month 3.5 TeV
  - 1 month step-up
  - 5 month 4 - 5 TeV
  - 1 month ions

LHC 2009 - 2010

S. Myers, ATLAS week, October 5th

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LHC schedule

S. Myers, ATLAS week, October 5th

Plugging in the numbers with a step in energy

Month	OP scenario	Max number bunch	Protons per bunch	Min beta*	Peak Lumi	Integrated	% nominal
1	Beam commissioning						
2	Pilot physics combined with commissioning	43	3×10^{10}	4	8.6×10^{29}	~200 nb^{-1}	
3		43	5×10^{10}	4	2.4×10^{30}	~1 pb^{-1}	
4		156	5×10^{10}	2	1.7×10^{31}	~9 pb^{-1}	2.5
5a	No crossing angle	156	7×10^{10}	2	3.4×10^{31}	~18 pb^{-1}	3.4
5b	No crossing angle – pushing bunch intensity	156	1×10^{11}	2	6.9×10^{31}	~36 pb^{-1}	4.8
6	Shift to higher energy: approx 4 weeks	Would aim for physics without crossing angle in the first instance with a gentle ramp back up in intensity					
7	4 – 5 TeV (5 TeV luminosity numbers quoted)	156	7×10^{10}	2	4.9×10^{31}	~26 pb^{-1}	3.4
8	50 ns – nominal Xing angle	144	7×10^{10}	2	4.4×10^{31}	~23 pb^{-1}	3.1
9	50 ns	288	7×10^{10}	2	8.8×10^{31}	~46 pb^{-1}	6.2
10	50 ns	432	7×10^{10}	2	1.3×10^{32}	~69 pb^{-1}	9.4
11	50 ns	432	9×10^{10}	2	2.1×10^{32}	~110 pb^{-1}	12

64pb^{-1}

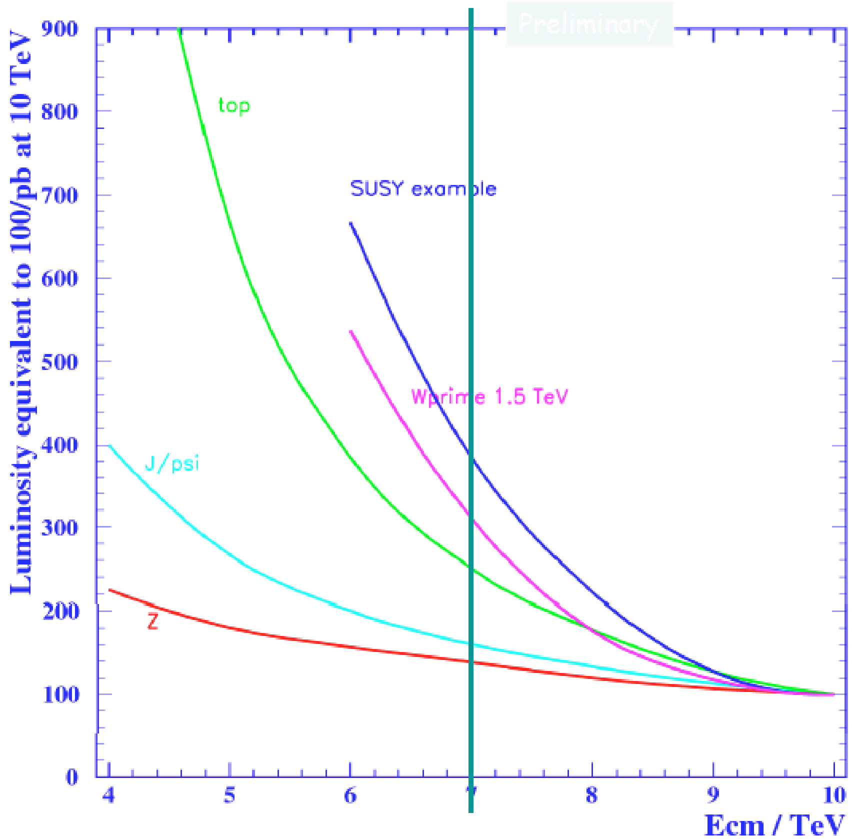
274pb^{-1}

What will be ATLAS efficiency???

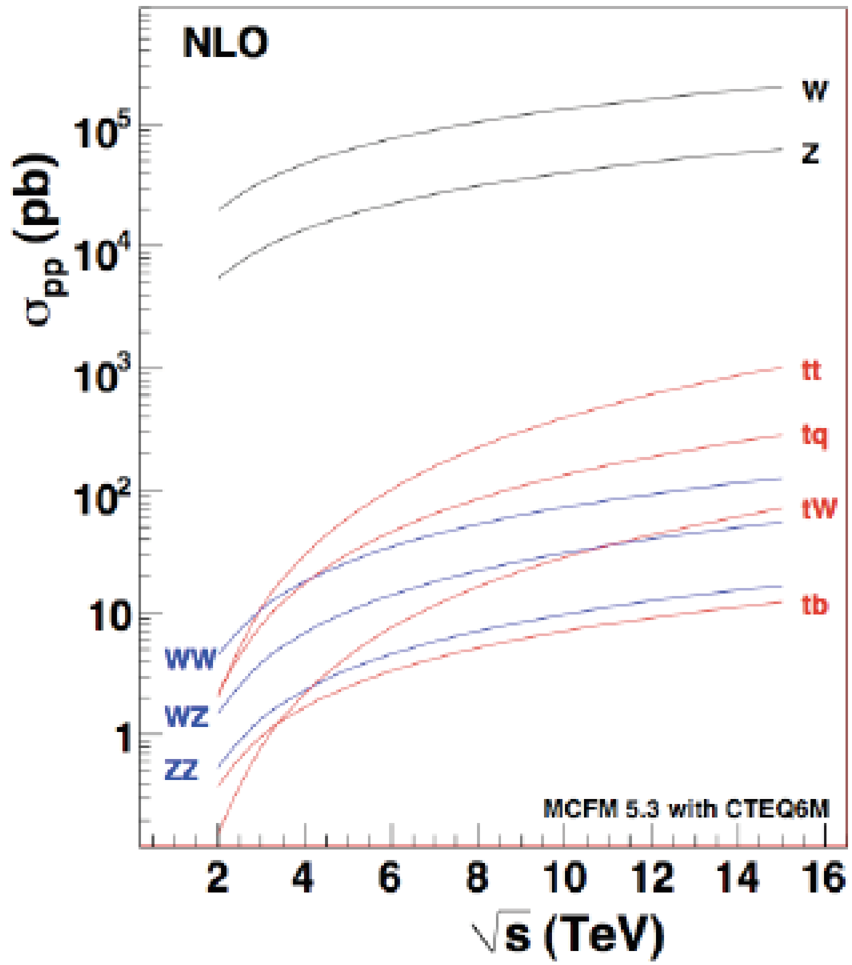
How much data to expect by when?

- 2009: 0
- 2010:
  - about 50pb^{-1} at 7TeV
  - about 200pb^{-1} at 10TeV
- 2011: shutdown
- Expect to have some amount of 14TeV data by end of 2012
- Focus on analyses which need <1fb^{-1}
- Simulation uses 10 TeV or 14 TeV

7 Tev vs 10 TeV vs 14 TeV



S. Myers, ATLAS
week, October 5th



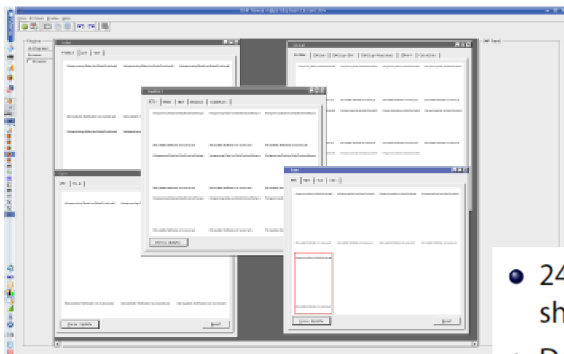
ATL-COM-PHYS-2009-051

ATLAS readiness

- What being ready means:
  - Subdetectors working well
  - Data Quality monitoring done online
  - Software able to reconstruct the data
  - Users able to access the reconstructed data (using the Grid!)
  - Reviewed early data analyses

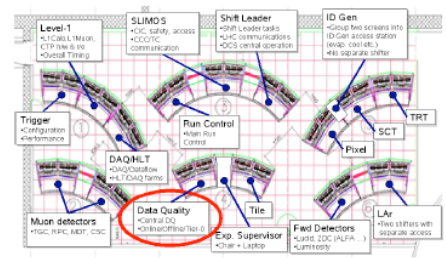
Data Quality Monitoring

- $\mathcal{O}(100)$ primary histograms have been selected for global DQ shifter to look at
  - Produced by online Athena infrastructure
- Implemented in OHP
- Documented in TWiki pages ➡
- Shifter is prompted to review them on an hourly basis and discuss any new anomalies with detector shifters/shift leader



Peter Onyisi | Data Quality

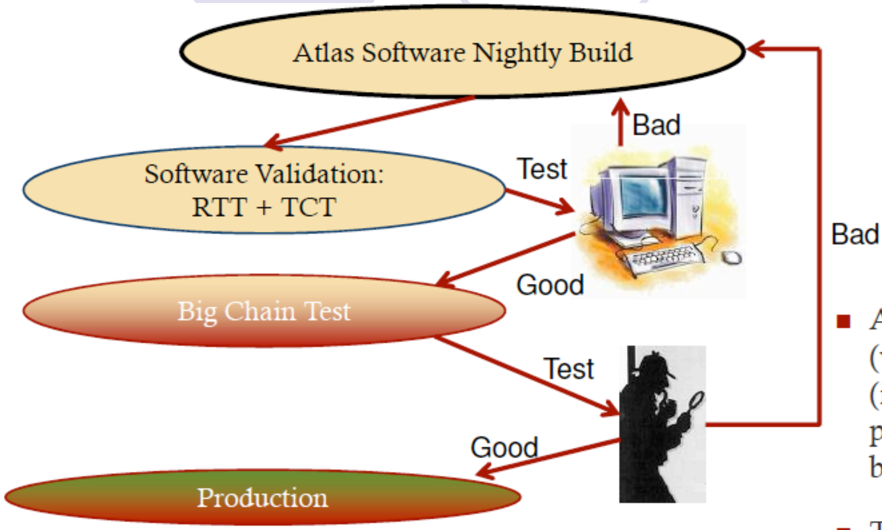
- 24-hour central DQ "online" (ACR) shift
- Detectors have their own DQ shifts
- 24-hour central DQ "offline" (DQ-SCR) shift
- DQ also by CP groups



Peter Onyisi for the DQ group, ATLAS week, October 6th 2009

- During startup, daily meetings to coordinate DQ info
- Daily filling of shifter flags for DQ meeting
- Conditions updates to be coordinated and tested with express stream reprocessing

Software validation



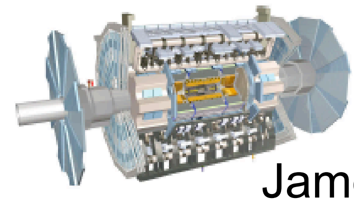
- Once the software test are successful, the release can be deployed on the GRID for its final validation step.
- This consist in the production of a sample of approximately 250K events called SampleA
- The composition of the sample includes single particles, standard model processes (W and Z leptonic decays, top pair production, Higgs production) and non standard model processes (SUSY, black holes production).
- A group of experts, representative for the detector performance and physics groups, runs physics analysis on the produced sample and compare the results with those from previously validated releases.

- ATN+RTT: Since Nov 2008, a **Reconstruction Expert Shifter** (week long part time shifts) monitor build success and subset (integration) tests, submit bug reports or ping developers ⇨ problems are found quicker, and the average quality of the nightly builds is higher
- TCT: Since Jan 2008 **Validation Shifter** (week long part time shifts) monitor success and DQ histograms, submit bug report. If and only if successful, the cache is moved to Tier0 reconstruction of new data
- BCT: **Tier0 shifter** (8 hour 3*8 shifts) monitor success, investigate crashes and submit bug report

Andreu Pacheco Pages, ATLAS week October 6th 2009

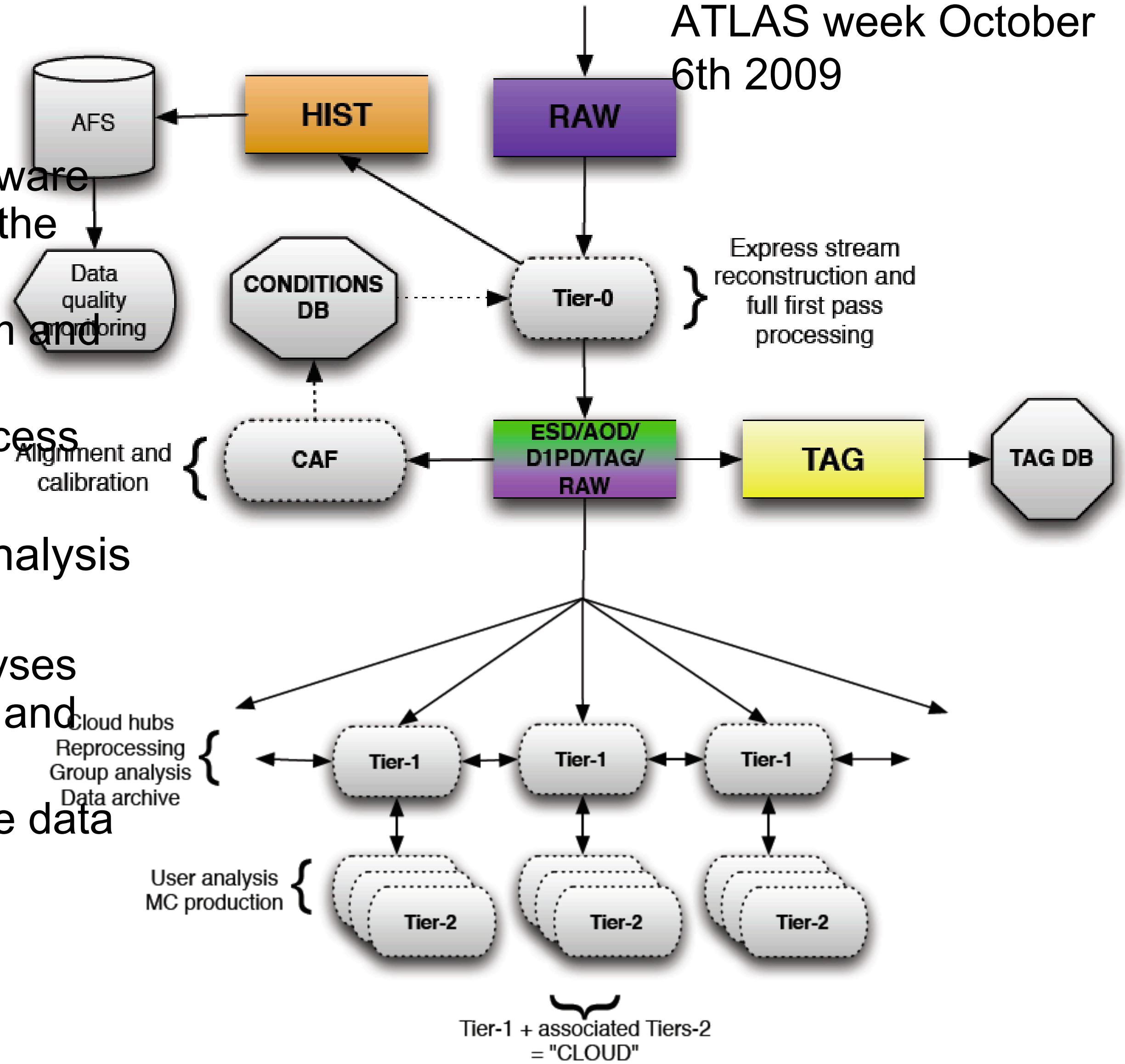
The Grid!

ATLAS
computing model
at CERN



James Catmore,
ATLAS week October
6th 2009

- ATLAS Distributed Computing Review:
  - Ensure that users are aware that jobs go to data not the other way around
  - Improve queuing system and optimization
  - Use FronTier for DB access
  - Etc.
- October 28th-30th: UserAnalysis Test:
  - Send several user analyses on a few large datasets and monitor performance
  - Last of such tests before data taking



Review early data analyses

Analysis Walkthroughs

- We held our first Analysis Readiness Walkthroughs – J/ψ with Muons and Minimum Bias a few weeks ago.
  - Goal: to look at a representative set of very early analyses, to understand individual elements that make up these analyses (from the detector, to the including calibrations, alignment, good run lists and so on all the way to th plots), and to review the present status of these elements. By identifying uncovered or under-covered areas, we hope to be able to direct effort tow them to maximize ATLAS' readiness for the start of LHC operations.

- Approval process:
  - INT note
  - Approval talk
  - PUB note prep
  - Refereeing (incl. Coll. Comments)
  - Average current time from Approval talk to PUB note approved: 56 days

Tom LeCompte,
ATLAS week October
8th 2009

- Shift from MC notes writing to preparation for real data
  - Duplicate events, luminosity blocks, varying detector/trigger conditions, etc.

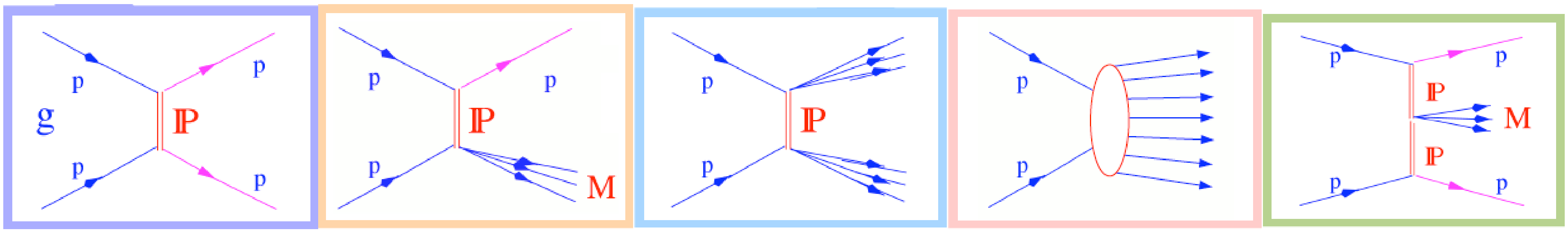
Early Data Analyses

- Standard Model
  - Covering:
    - Minimum Bias analysis
    - W/Z cross-section
    - Diboson
    - Top quark
  - Not covering:
    - Luminosity determination and early forward physics
    - J/Ψ, $\Upsilon \rightarrow \mu\mu$
    - W/Z+jets
    - W mass

Unless specified, studies done at 14TeV

Minimum Bias

$$\sigma_{TOT} = \sigma_{ELAS} + \sigma_{SD} + \sigma_{DD} + \sigma_{ND} + \sigma_{CD}$$



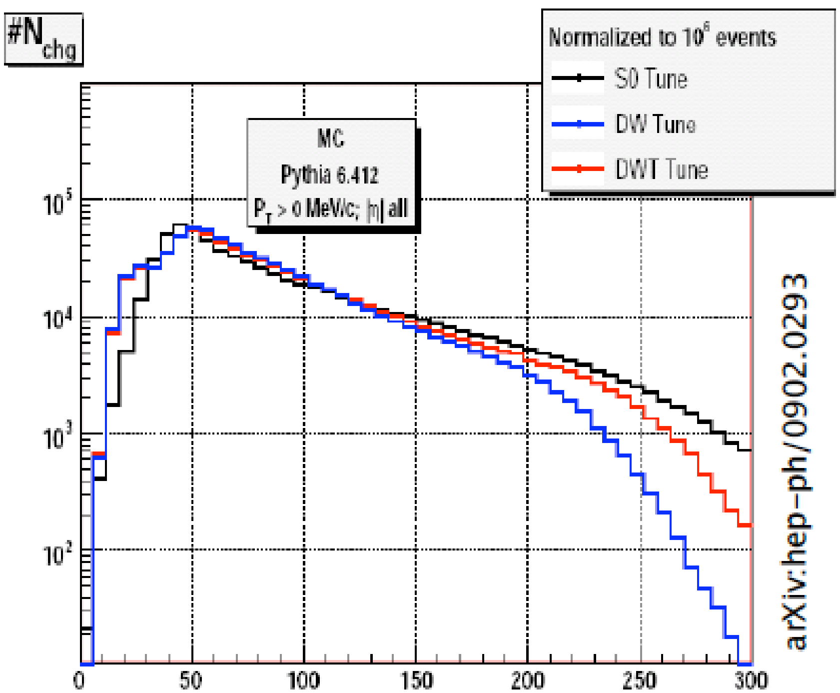
- Crucial for:
  - QCD behavior specially energy dependence
  - Baseline for Heavy Ions physics
  - High p_T physics will have ~25 of these

Process	Cross-section (mb)	
	PHOJET	PYTHIA
non-diff.	69	55
single diff.	11	14
double diff.	4	10
central diff.	1	-
total inelastic	85	79
elastic	35	23
total	120	102

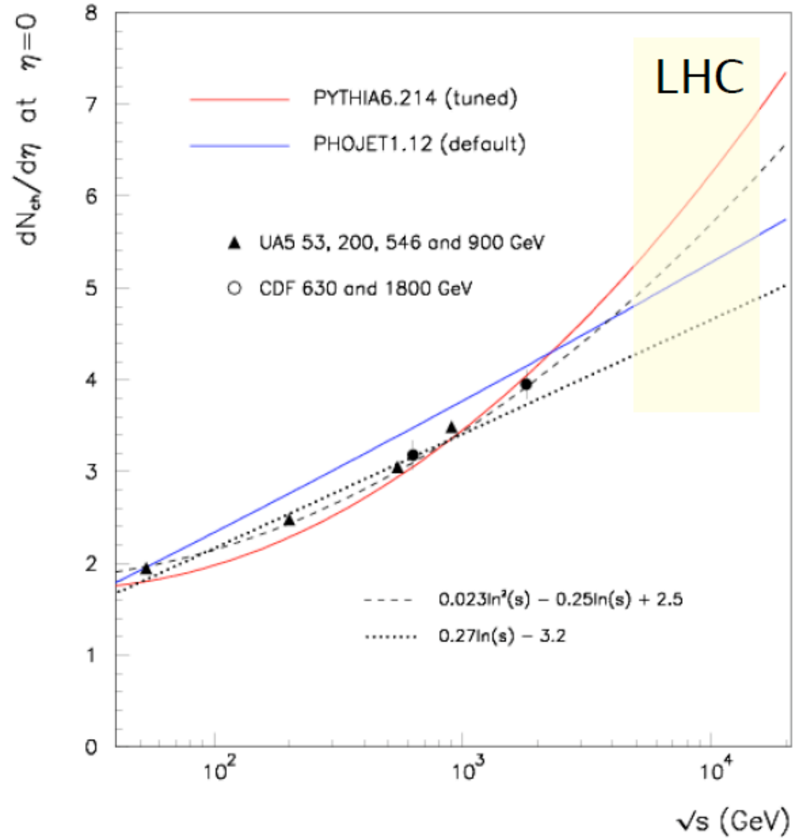
arXiv:0901.0512

Minimum Bias

- Physics observables will be dNch/dη, dNch/dPT
- But also $\langle N_{ch} \rangle$, $\langle p_T \rangle$ vs N, etc.



arXiv:hep-ph/0902.0293

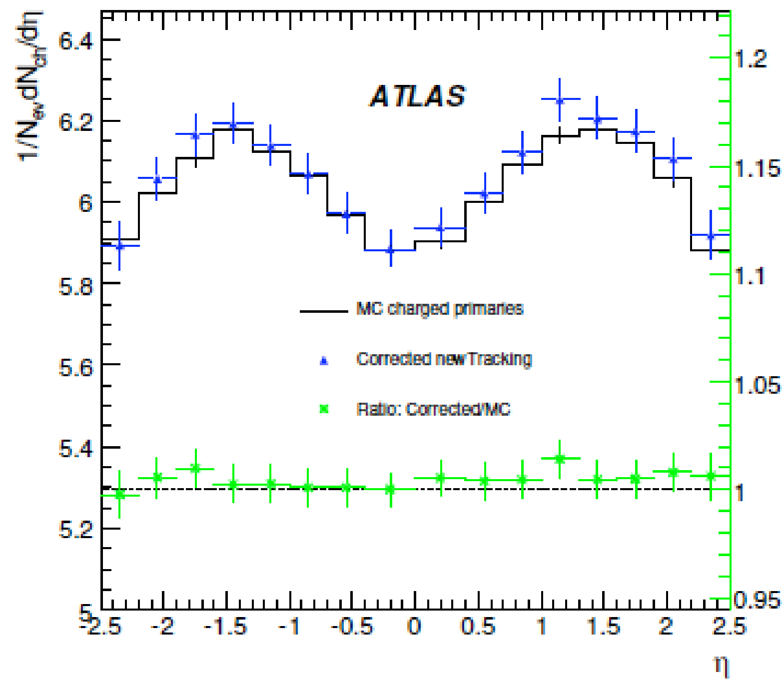


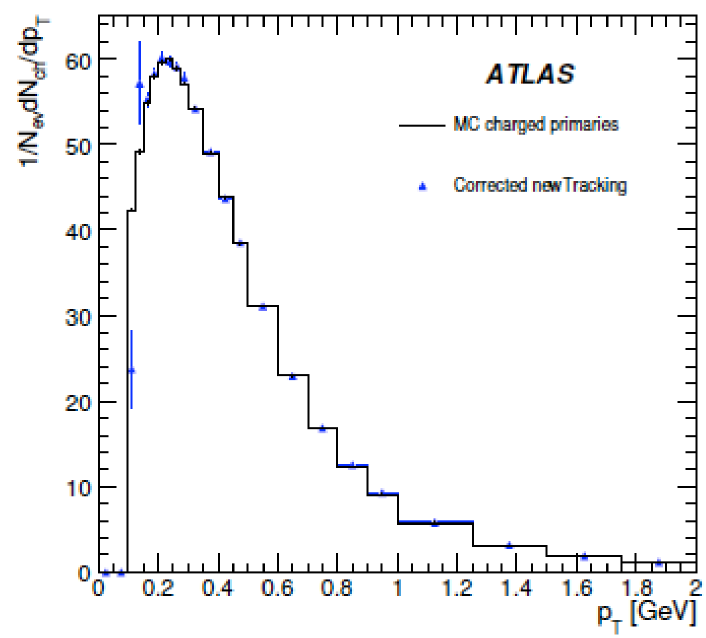
EPJ C 50, 435 (2007)

- Backgrounds:
  - Empty events
  - Beam gas
  - Beam halo

Minimum Bias

- All about the trigger:
  - At luminosity>10^{30}: can use random triggers
  - But at very low L: non-empty event<1%
    - Need Minimum bias trigger
    - Need:
      - MBTS and forward detectors
- Event selection:
  - Low p_T tracks: >150MeV
  - Apply corrections
- About 8% systematics, dominated by alignment





arXiv:0901.0512

W/Z Cross section

- Stringent test of QCD due to small theoretical uncertainty (<1%)
- Z: $d\sigma/dp_T, d\sigma/dy$ constraints on PDF→impacts all analyses
- Z: strong constraints on detector performance
- Fundamental ewk parameters (longer term)

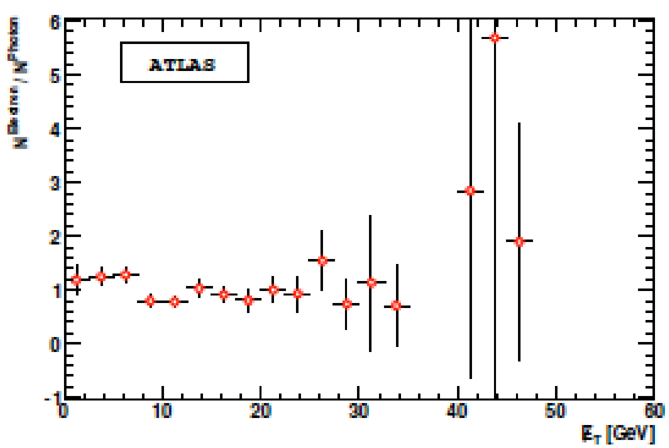
	√s [TeV]	Cross section
W-> lν	14	20.5 nb
	10	14.3 nb
Z-> ll	14	2.02 nb
	10	1.35 nb

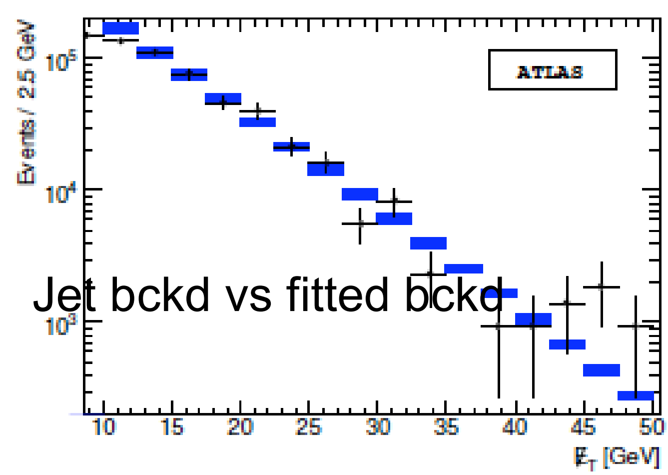
- Backgrounds:
  - e channel: jet: data driven (γ+jets)
  - μ channel: jet bckgd small (assume 100% unc.) rest use MC

50pb^{-1}

Ratio of jet background/ control sample

arXiv:0901.0512





Jet bckd vs fitted bckd

W/Z Cross section

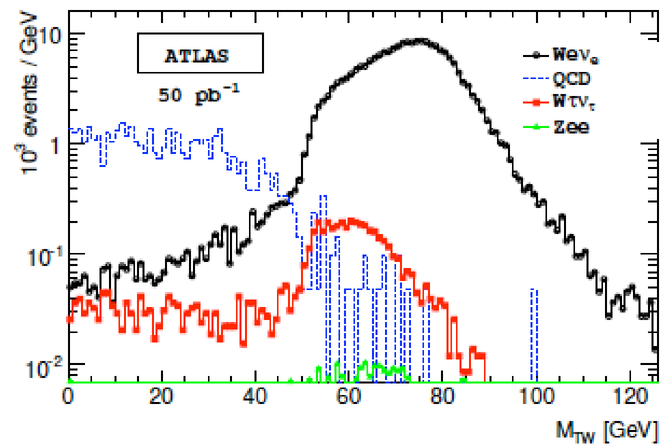
Nx10^4 for 50pb^{-1}

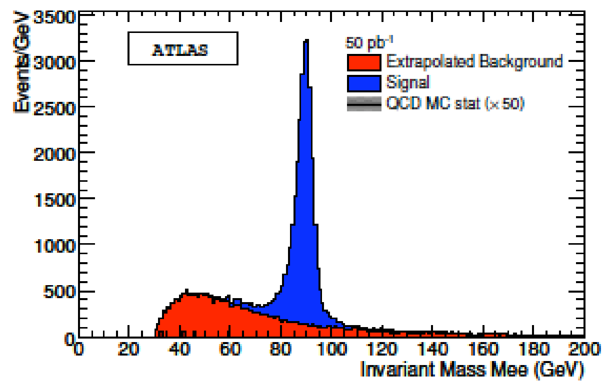
Selection	$W \to e\nu$
Trigger	37.01 ± 0.09
$E_T > 25$ GeV, $\|\eta\| < 2.4$	30.84 ± 0.09
Electron ID	26.77 ± 0.09
$\not{E}_T > 25$ GeV	22.06 ± 0.09
$M_T > 40$ GeV	21.71 ± 0.08

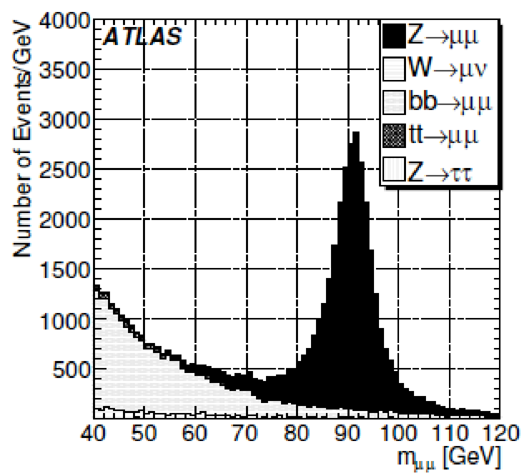
Selection	$Z \to ee$
Trigger	6.70 ± 0.01
$E_T > 15$ GeV, $\|\eta\| < 2.4$, 80 GeV $< M_{ee} <$ 100GeV	2.76 ± 0.01
Electron ID	2.64 ± 0.01
Isolation	2.48 ± 0.01

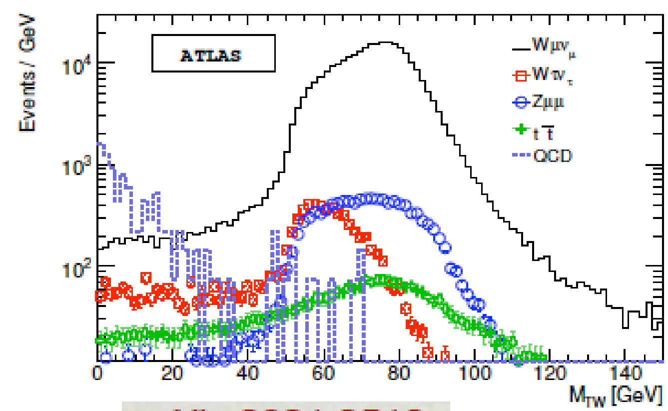
Selection	$W \to \mu\nu$
Trigger	44.44 ± 0.07
$p_T > 25$GeV, $\|\eta\| < 2.5$	35.55 ± 0.06
Isolation	34.80 ± 0.06
$\not{E}_T > 25$ GeV	28.59 ± 0.05
$M_T > 40$ GeV	28.03 ± 0.05

Selection	$Z \to \mu\mu$
Trigger	3.76 ± 0.01
2 muons +	
opp. charge	3.33 ± 0.01
$M_{\mu\mu}$ cut	3.04 ± 0.01
p_T cut	2.76 ± 0.01
Isolation	2.56 ± 0.01









arXiv:0901.0512

W/Z Cross Section

$$\frac{\delta\sigma}{\sigma} = \frac{\delta N \oplus \delta B}{N-B} \oplus \frac{\delta\varepsilon}{\varepsilon} \oplus \frac{\delta A}{A} \oplus \frac{\delta\mathcal{L}}{\mathcal{L}}$$

Not included (10%→2-3%)

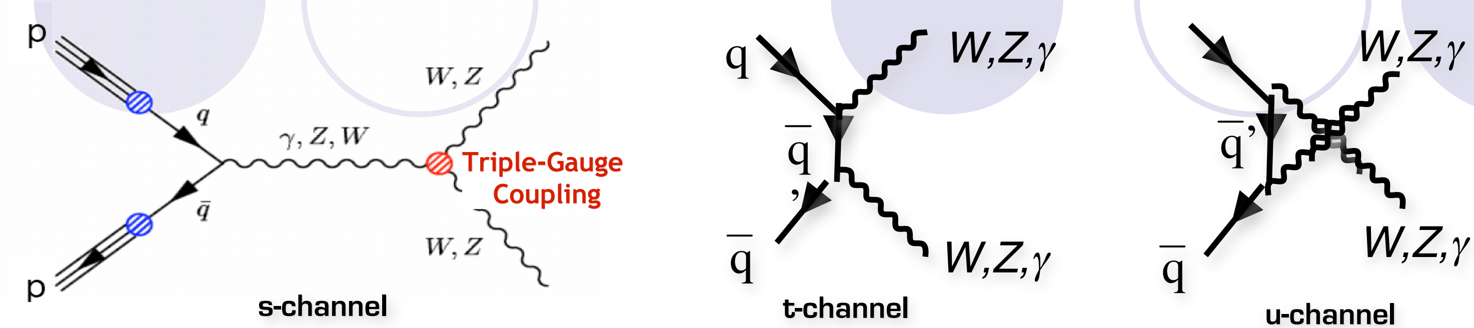
$$\sigma_{W(Z)} \times BR(W(Z) \rightarrow leptons) = \frac{N^{obs}_{W(Z)} - B_{W(Z)}}{\varepsilon_{W(Z)} \cdot A_{W(Z)} \int \mathcal{L}dt}$$

arXiv:0901.0512

Process	$N(\times 10^4)$	$B(\times 10^4)$	$A \times \varepsilon$	$\delta A/A$	$\delta\varepsilon/\varepsilon$	σ (pb)	50pb^{-1}	1fb^{-1}
$W \rightarrow e\nu$	22.67 ± 0.04	0.61 ± 0.92	0.215	0.023	0.02	$20520 \pm 40 \pm 1060$	(0.2±5)%	(0.03±2.3)%
$W \rightarrow \mu\nu$	30.04 ± 0.05	2.01 ± 0.12	0.273	0.023	0.02	$20530 \pm 40 \pm 630$	(0.2±3)%	(0.2±2.4)%
$Z \rightarrow ee$	2.71 ± 0.02	0.23 ± 0.04	0.246	0.023	0.03	$2016 \pm 16 \pm 83$	(0.8±4)%	(0.8±4)%
$Z \rightarrow \mu\mu$	2.57 ± 0.02	0.010 ± 0.002	0.254	0.023	0.03	$2016 \pm 16 \pm 76$		

- Theoretical uncertainties on $\delta A / A$ (use W→eν):
  - Take 20% of the acceptance change:
  - ISR: 2%
  - kT: 0.4%
  - Underlying event: 0.2%
  - PHOTOS: 0.3%
  - PDF (CTEQ6.5):0.9%
  - Matrix element corrections applied to the parton shower:0%
- Acceptance changes by 2.5%(3.2%) for W(Z) between using Pythia, Herwig, MC@NLO

Diboson studies



- Vector boson self-couplings fundamental predictions of SM
- NP model: deviations of gauge couplings
  - Many models predict 10^{-3}-10^{-4} level
- Signature: enhancement of cross-section, specially at high p_T
  - Compare p_T or Mass (M_T) shapes

Diboson mode	Conditions	$\sqrt{s} = 1.96$ TeV $\sigma[pb]$	$\sqrt{s} = 14$ TeV $\sigma[pb]$
W^+W^- [15]	W-boson width included	12.4	111.6
$W^\pm Z$ [15]	Z and W on mass shell	3.7	47.8
ZZ [15]	Z's on mass shell	1.43	14.8
$W^\pm\gamma$ [16]	$E_T^\gamma > 7$ GeV, $\Delta R(\ell,\gamma) > 0.7$	19.3	451
$Z\gamma$ [17]	$E_T^\gamma > 7$ GeV, $\Delta R(\ell,\gamma) > 0.7$	4.74	219

arXiv:0901.0512

Diboson studies

- Generators:
  - WW, WZ, ZZ: MC@NLO+Herwig/Jimmy (no ATGC)
    - No double counting
    - W width and spin-spin correlations included
    - Zero-width approx. used
    - No Z/γ^* interference terms included
  - $gg \rightarrow WW$: gg2ww
  - $W\gamma$, $Z\gamma$: Pythia
  - Off-shell Z and γ^* into ZZ: pythia $Z/\gamma^*+Z/\gamma^*$
    - Z/γ^* mass threshold: 12GeV
  - tt: MC@NLO
  - W+jets/γ, Z+jets/γ: Pythia and Alpgen
  - ATGC: Not Ideal!
    - ZZ, WW, $Z\gamma$: BHO (NLO but no parton showers, so reweighting procedure)
    - WZ, $W\gamma$: BosoMC
    - Those with SM couplings agree with MC@NLO
    - ZZ: NTGC: LO BHO + p_T dep. k-factor from MC@NLO

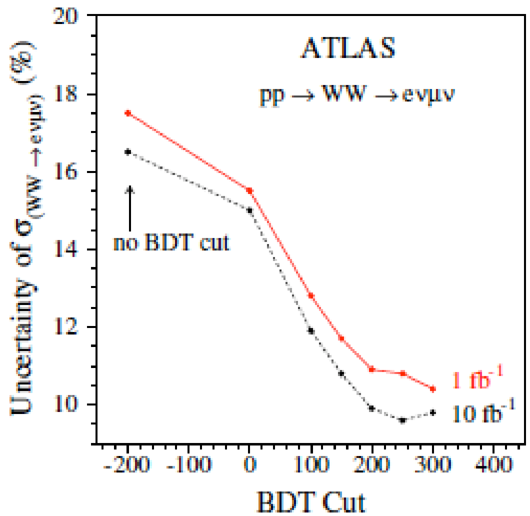
Diboson studies

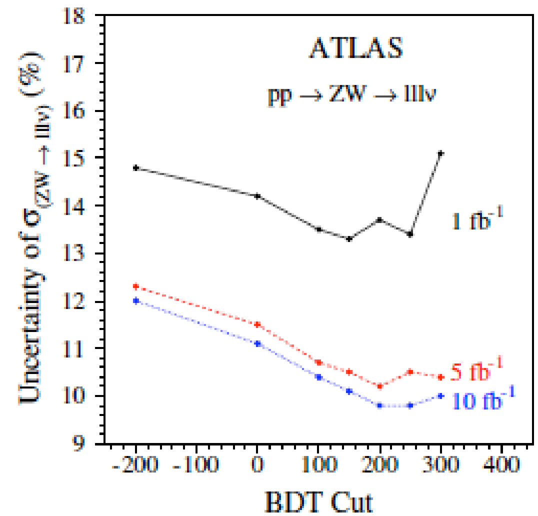
- Event selection & backgrounds…
- Use of Boosted Decision Tree:
  - For 100pb^{-1}: raises WZ sensitivity from 3.6σ to 5.9σ
  - 100pb^{-1} sufficient for 5σ for WW, WZ, Wγ, Zγ, 1fb^{-1} for ZZ

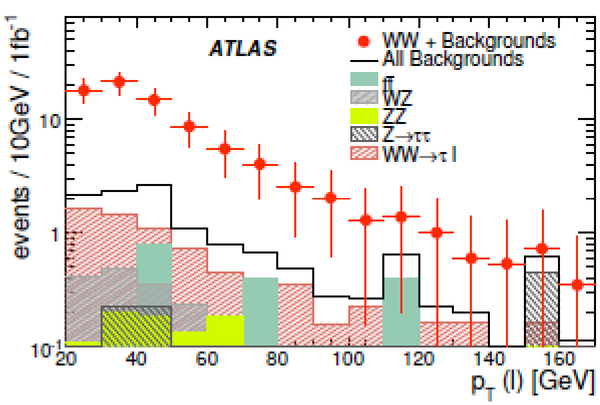
9.2%syst. Included

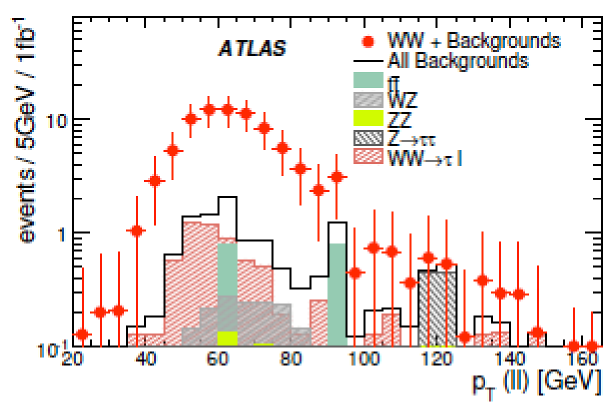
Systematics dominate after 5fb^{-1} (10fb^{-1}) for WW (WZ)

arXiv:0901.0512

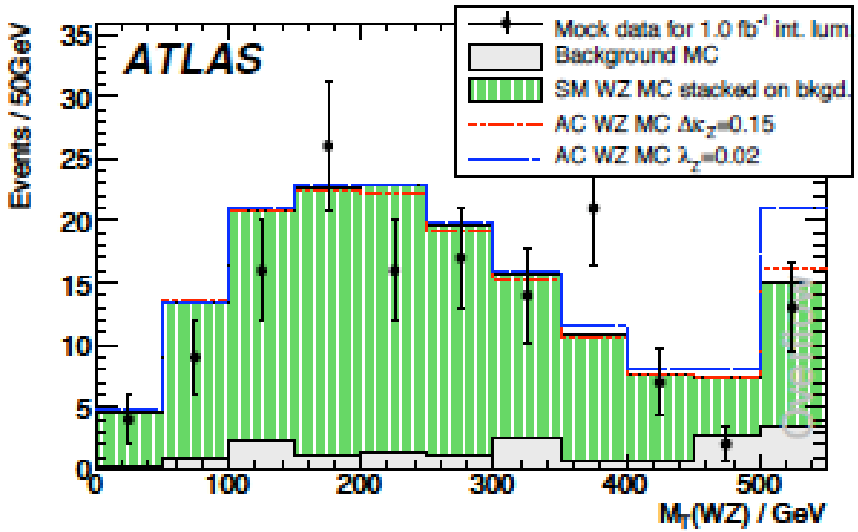


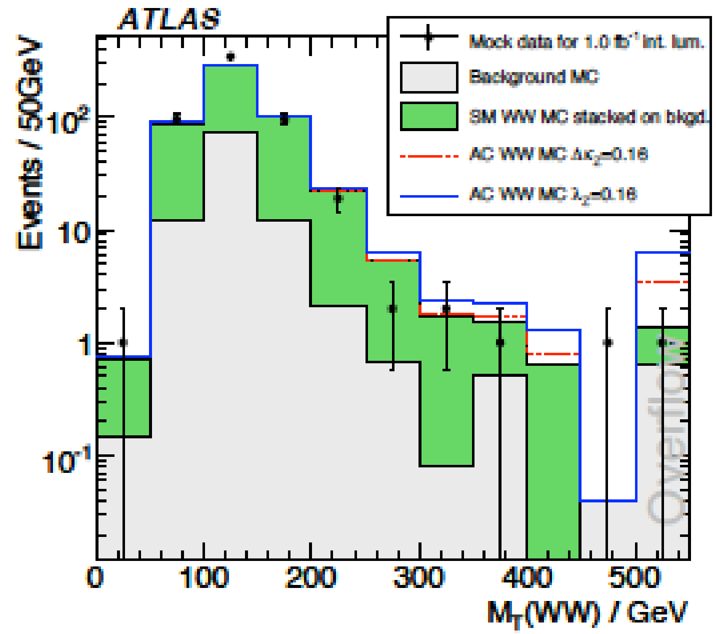


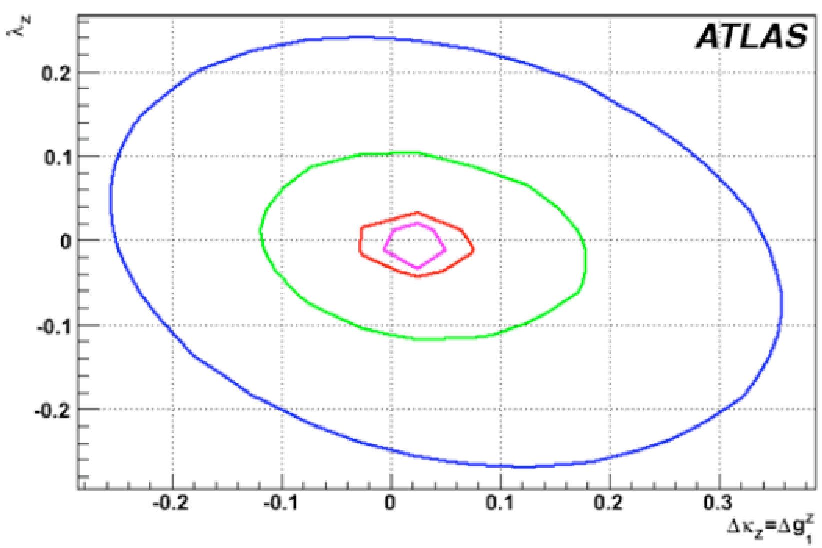


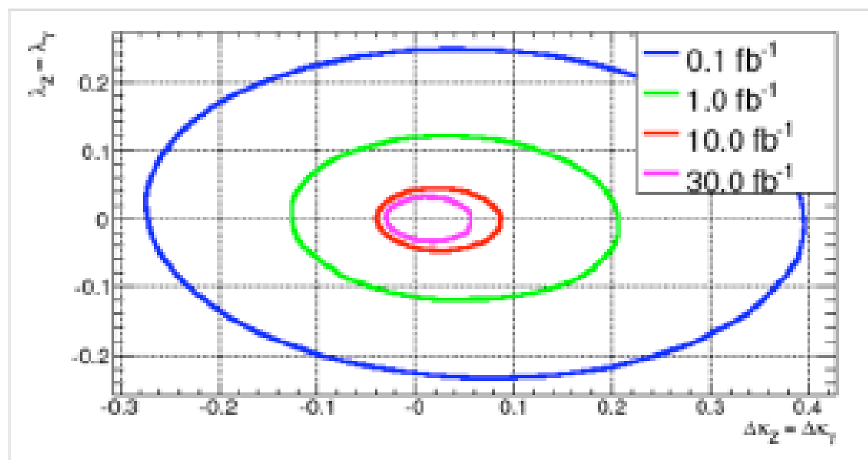


Diboson studies: Sensitivity to ATGC









arXiv:0901.0512

Diboson studies

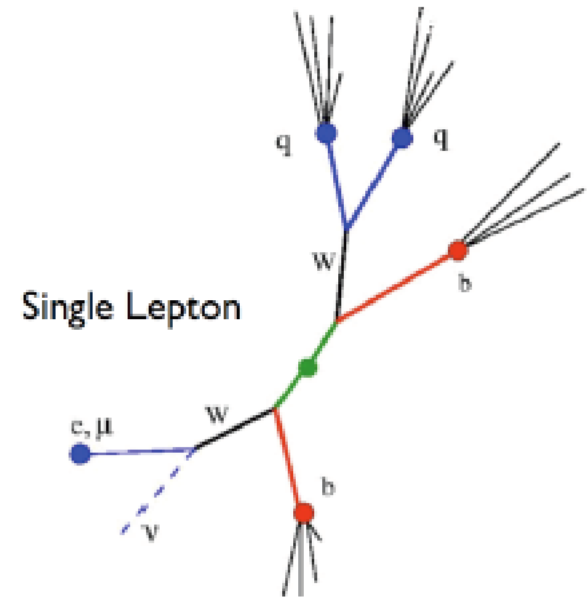
- $10fb^{-1}$: not early data!

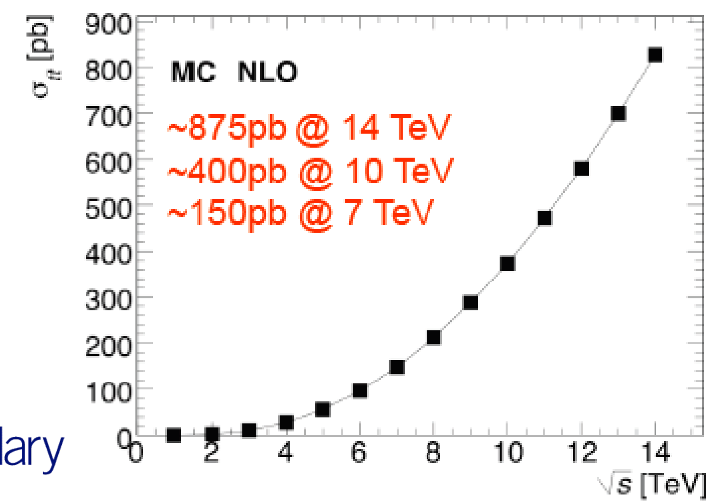
Diboson, (fit spectra)	λ_Z	$\Delta\kappa_Z$	Δg_1^Z	$\Delta\kappa_\gamma$	λ_γ
WZ, (M_T)	[-0.015, 0.013]	[-0.095, 0.222]	[-0.011, 0.034]		
$W\gamma$, (p_T^γ)				[-0.26, 0.07]	[-0.05, 0.02]
WW, (M_T)	[-0.040, 0.038]	[-0.035, 0.073]	[-0.149, 0.309]	[-0.088, 0.089]	[-0.074, 0.165]
WZ, (D0) ($1.0\ fb^{-1}$)	[-0.17, 0.21]	[-0.12, 0.29] ($\Delta g_1^Z = \Delta\kappa_Z$)			
$W^\pm\gamma$ (D0), ($0.16\ fb^{-1}$)				[-0.88,0.96]	[-0.2,0.2]
WW, (LEP) ($\lambda_\gamma = \lambda_Z, \Delta\kappa_Z = \Delta g_1^Z - \Delta\kappa_\gamma \tan^2\theta_W$)			[-0.051,0.034]	[-0.105,0.069]	[-0.059,0.026]

	f_4^Z	f_5^Z	f_4^γ	f_5^γ
$ZZ \to \ell\ell\ell\ell$	[–0.010, 0.010]	[–0.010, 0.010]	[–0.012, 0.012]	[–0.013, 0.012]
$ZZ \to \ell\ell\nu\nu$	[–0.012, 0.012]	[–0.012, 0.012]	[–0.014, 0.014]	[–0.015, 0.014]
Combined	[–0.009, 0.009]	[–0.009, 0.009]	[–0.010, 0.010]	[–0.011, 0.010]
LEP Limit	[–0.30, 0.30]	[–0.34, 0.38]	[–0.17, 0.19]	[–0.32, 0.36]

Top quark production cross section

- Top quark is intimate with Higgs
- Cross-section is test of QCD and sensitive to NP
- Use top samples for in-situ calibrations:
  - B-tagging, JES, etc.
- Baseline analyses don't require b-tagging
  - Sec. vertex method requires good alignment of Silicon detector
  - S/B ratio gets worse going down to 10TeV and 7TeV
  - Since muon will get calibrated quickly use Soft Muon Tagging method





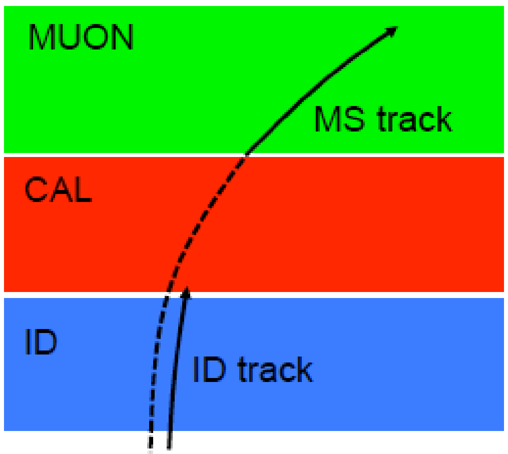
Top quark production cross section

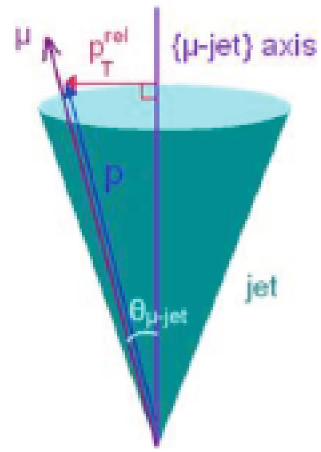
- Baseline analyses achieve 5%-15%stat and <20% syst
  - Should be possible to achieve similar performance using SMT method
- Official SMT based on p_T^{rel}
  - Achieves eff~10% and Light Jet Rejection ~ 170
- p_T^{rel} is not ideal since want to use isolated muons to calibrate algorithm
  - Developing algorithm based on comparing ID track with Muon track
    - Fakes show wider distributions than true muons
  - Get similar performance as official SMT algorithm

200pb-1 @ 10 TeV

Numbers of Selected Events				
	Electron Analysis		Muon Analysis	
Sample	default	$+M_W$-cut	default	$+M_W$-cut
$t\bar{t}$	2600	1286	3144	1584
W+jets	1305	448	1766	628
single top	210	81	227	98
$Z \to ll$ +jets	148	43	144	49
hadronic $t\bar{t}$	16	10	11	5
W $b\bar{b}$	21	7	32	10
WW	11	6	14	7
WZ	3	1	5	2
ZZ	0.4	0.2	0.5	0.2
Signal	2600	1286	3144	1584
Background	1715	598	2199	799
S/B	1.5	2.1	1.4	2.0

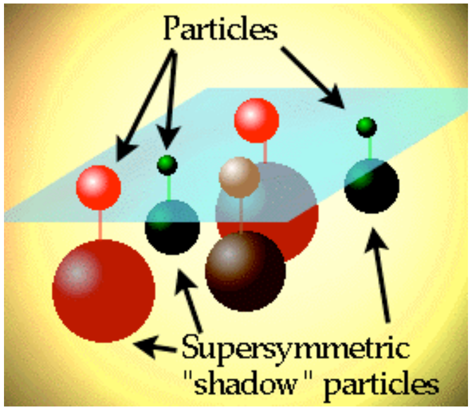
ATL-PHYS-PUB-2009-087





Early searches

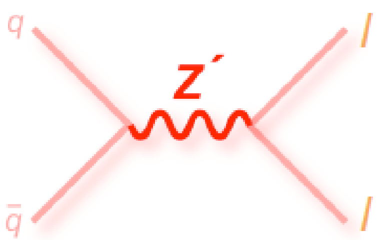
- Z'
- Graviton
- SUSY trilepton

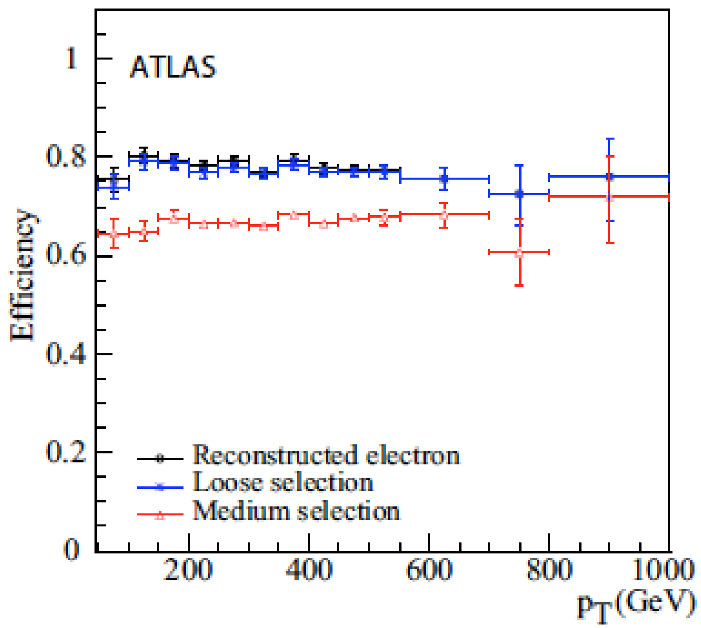


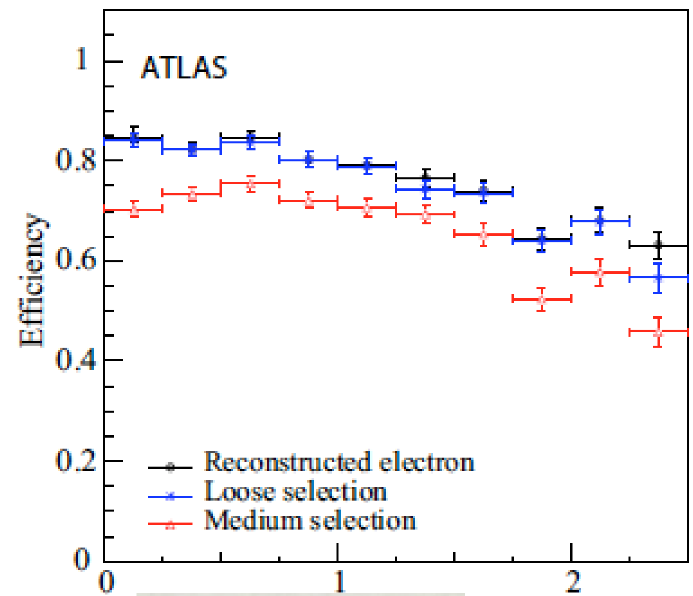
- Backup: "money plots"
  - Z' technicolor
  - W'
  - LQ
  - …

Dilepton resonances at high mass

- New heavy states forming narrow resonances decaying into leptons predicted in many NP:
  - GUT, Technicolor, Little Higgs, ED
- Tevatron reach: ~1TeV while LHC (14TeV): up to 5-6TeV
- Need good lepton id efficiency and good resolution





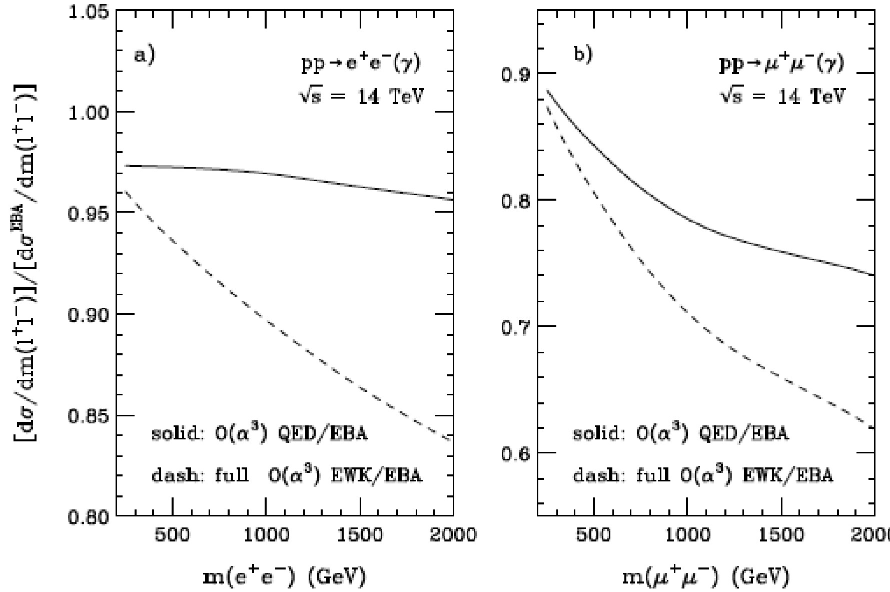


arXiv:0901.0512

Veronique Boisvert, RHU

Dilepton resonances at high mass

- Backgrounds:
  - Left with irreducible DY
  - Number counting, or mass shape template, or parametrized fit
- Theoretical Systematic unc.
  - NLO ewk
  - NLO QCD



- Spin 2 graviton: matching is unsatisfactory, kfactor~1.6 instead of 1.26
- ±8.5% at 1TeV and ±14% at 3TeV

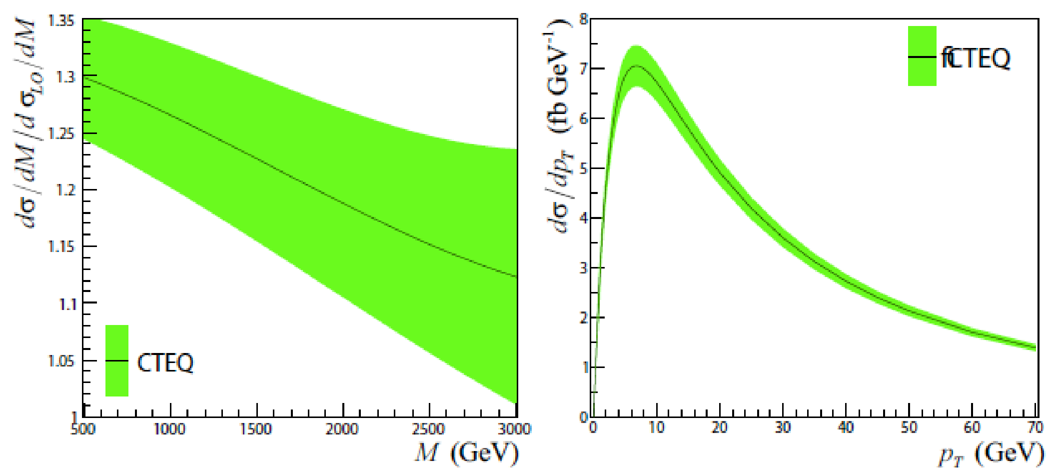


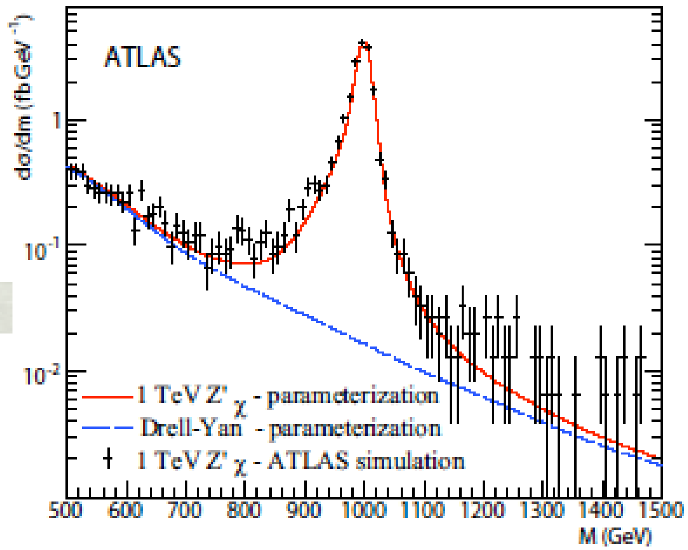
Figure 5: Mass (left) and transverse-momentum (right) spectra after matching the NLO QCD corrections to joint resummation with CTEQ6M parton densities. The mass spectra have been normalized to the LO QCD prediction using CTEQ6L parton densities. The shaded bands indicate the deviations allowed by the up and down variations along the 20 independent directions that span the 90% confidence level of the data sets entering the CTEQ6 global fit.

arXiv:0901.0512

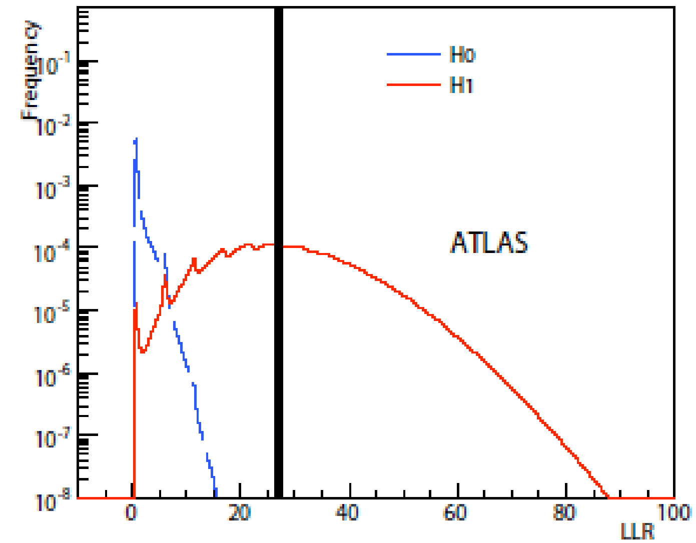
Dilepton resonances at high mass

Z’→ee

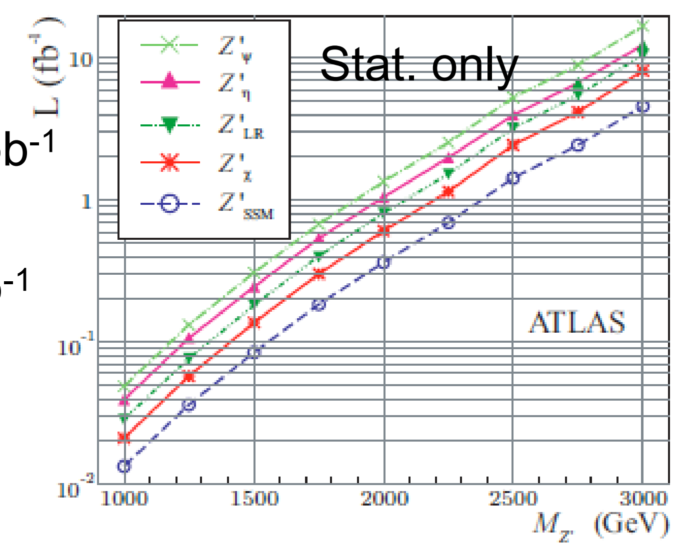
arXiv:0901.0512

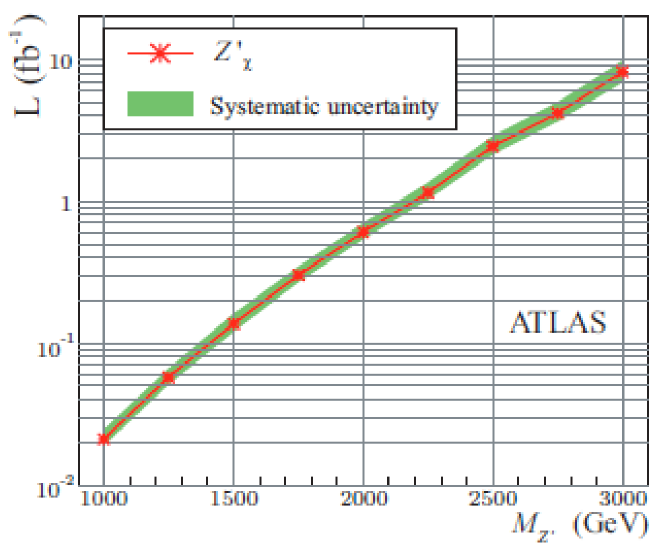


Significance=6.45 Luminosity=1fb^{-1}



- Roughly:
  - 1TeV Z’: ~100pb^{-1}
  - 2TeV Z’: ~ 1fb^{-1}
  - 3 TeV Z’: ~10fb^{-1}

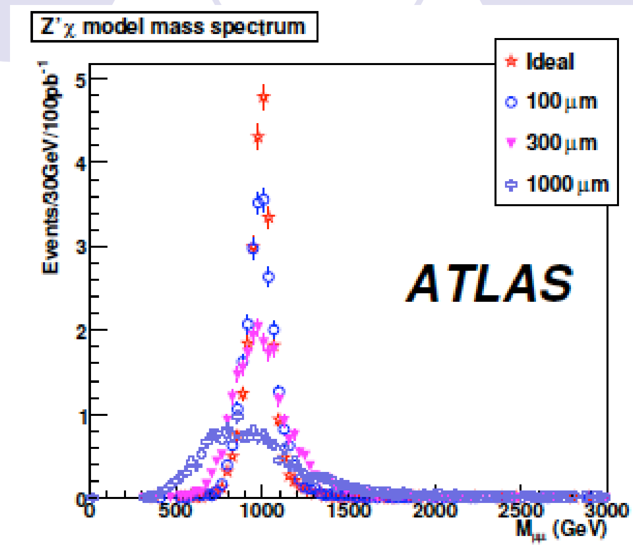




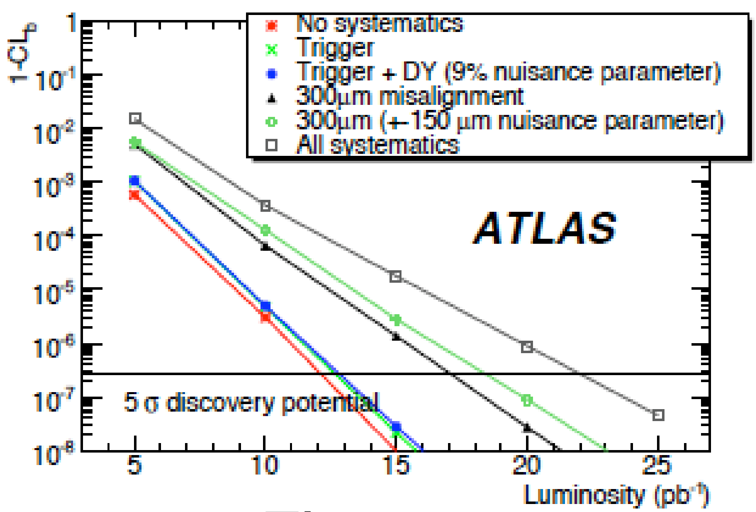
Dilepton resonances at high mass

arXiv:0901.0512

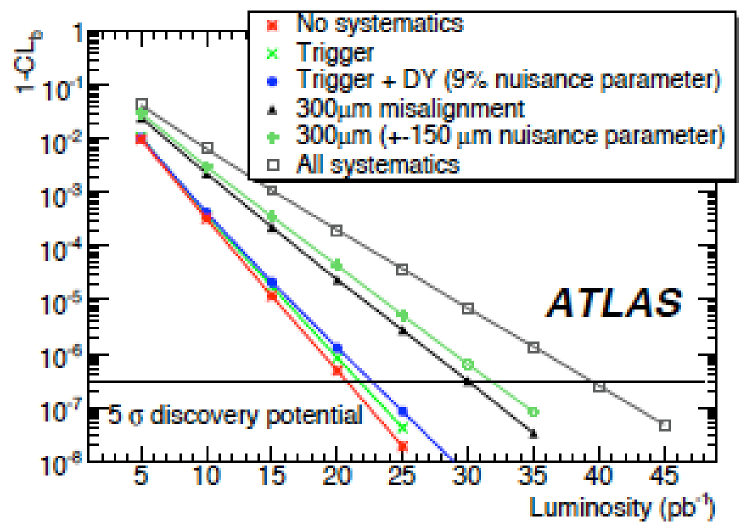
- Muon spectrometer misalignment
  - Ultimate goal: position to 40μm



Misalignment (μm)	Ideal	40	100	200	300	500	700	1000
Relative efficiency	0.984	0.984	0.984	0.98	0.973	0.948	0.918	0.877



$Z'_{SSM} \rightarrow \mu\mu$

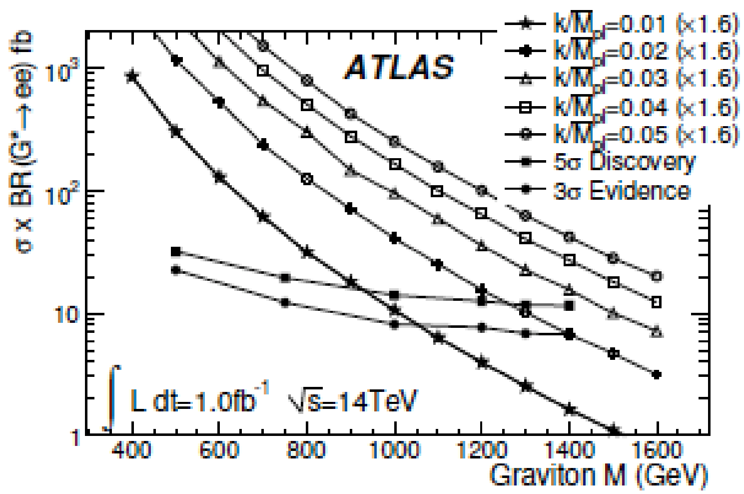


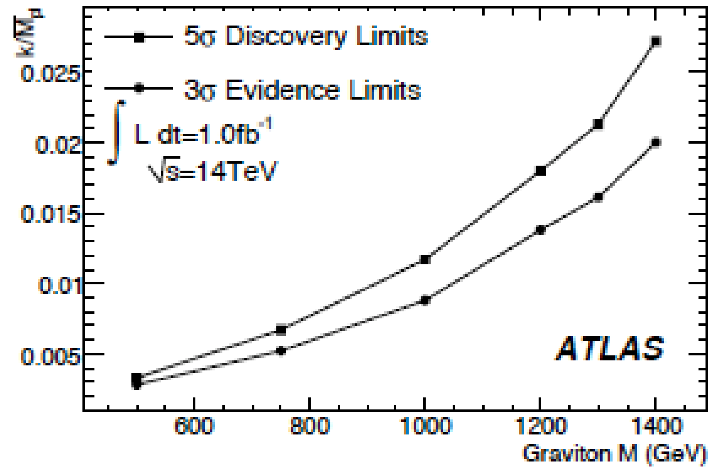
$Z'_{\chi} \rightarrow \mu\mu$

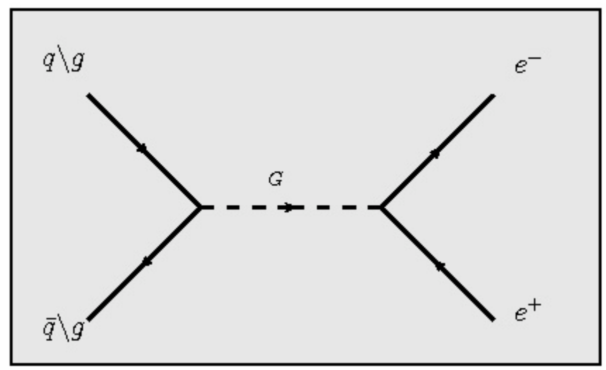
Dilepton resonances at high mass

G→ee

arXiv:0901.0512







- Dr Tracey Berry and Dan Hayden working on G→ee aimed at first data

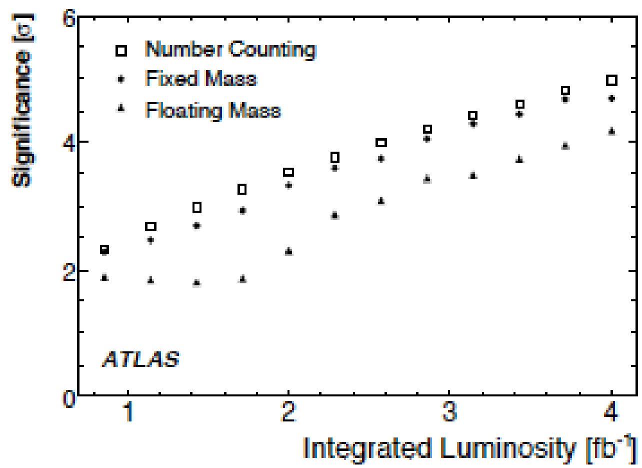
Royal Holloway University of London

Dilepton resonances at high mass

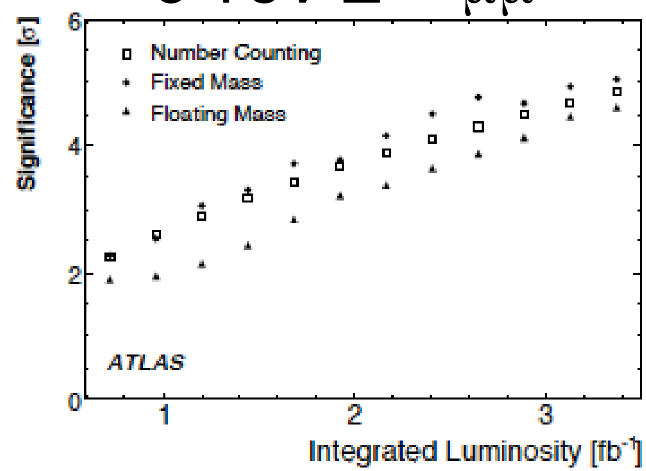
We wont know mass, σ or width!

Max L fits with free parameters: 20% (15%) degradation

3 TeV Z'→ee



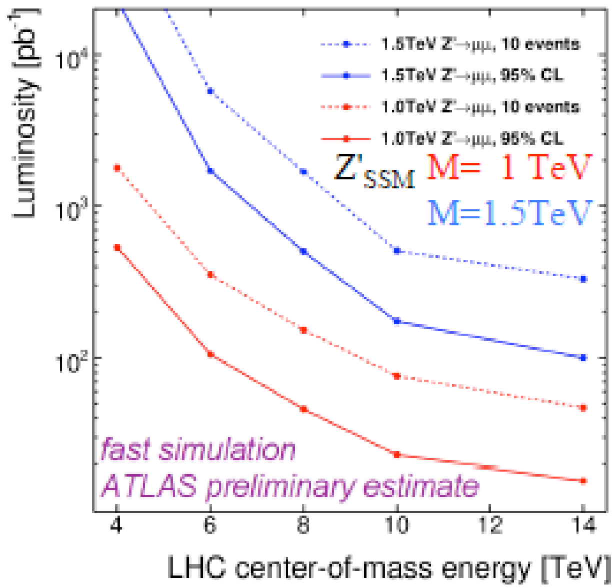
3 TeV Z'→μμ

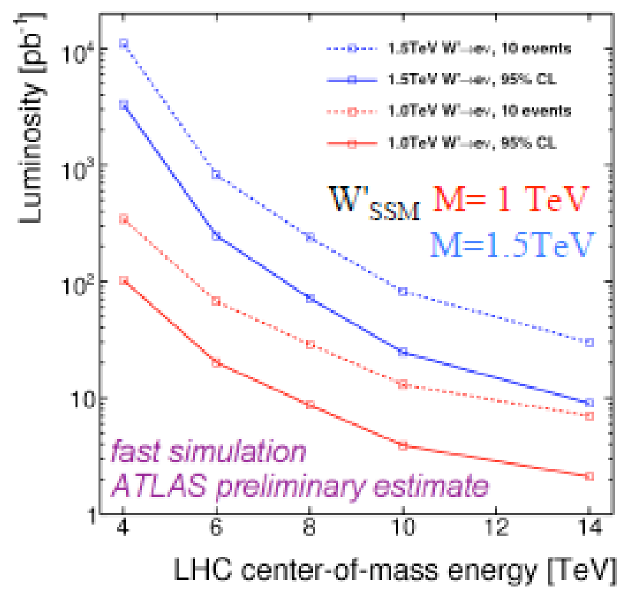


arXiv:0901.0512

Dilepton resonances at high mass

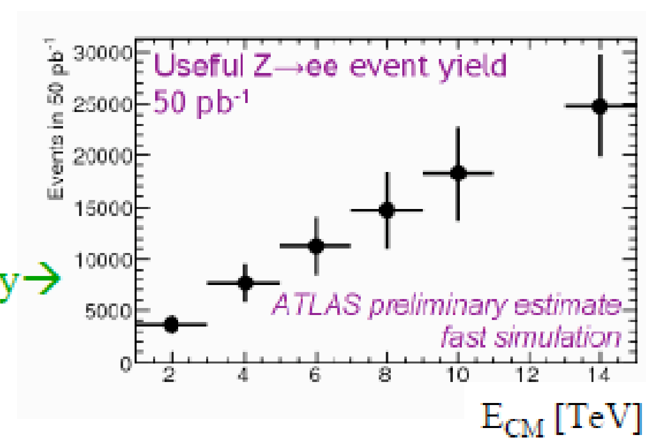
Extrapolation to lower √s





Loose a factor 2 from 14 to 10 TeV
and a factor 4 from 14 to 8 TeV

Z calibration samples decrease linearly→



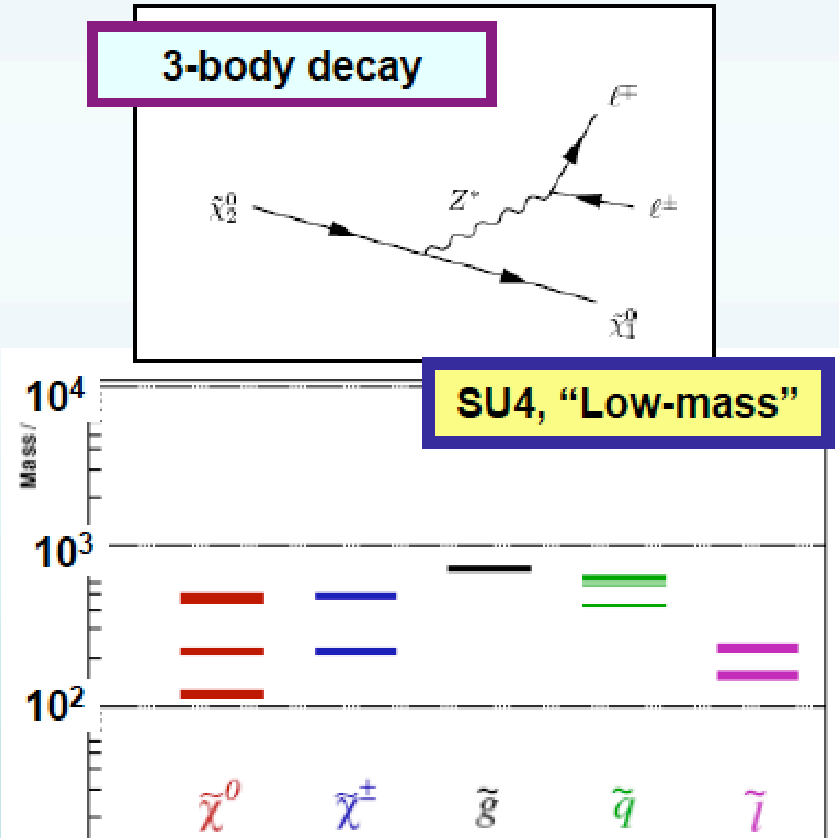
Claudio Gatti, EPS July 2009

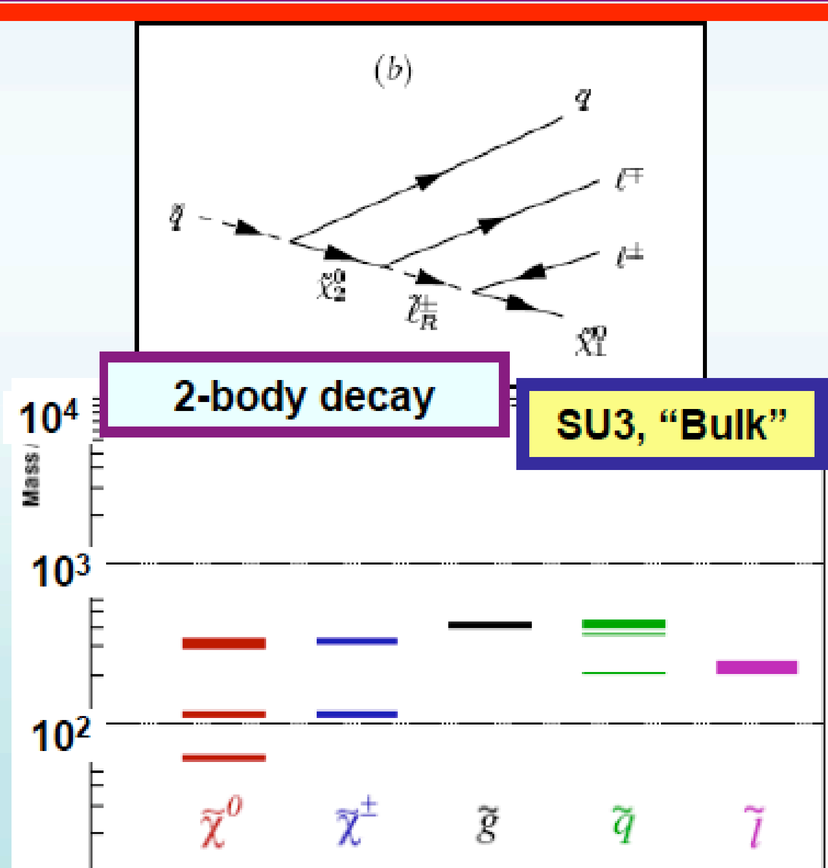
Dr Antonella De Santo, Dr Tina Potter

Early Trileptons at ATLAS

SU3, SU4 – bread & butter SUSY
Also **SU2** – focus point, heavy scalars (not for early physics, ignore here)

Point	mSUGRA Parameters					Cross Sections (pb)	
	m_0	$m_{1/2}$	A_0	tanβ	sgn(μ)	Tot.	3-lep
SU2	3550	300	0	10	+	7.2	0.07
SU3	100	300	-300	6	+	27.7	0.30
SU4	200	160	-400	10	+	402.2	2.5





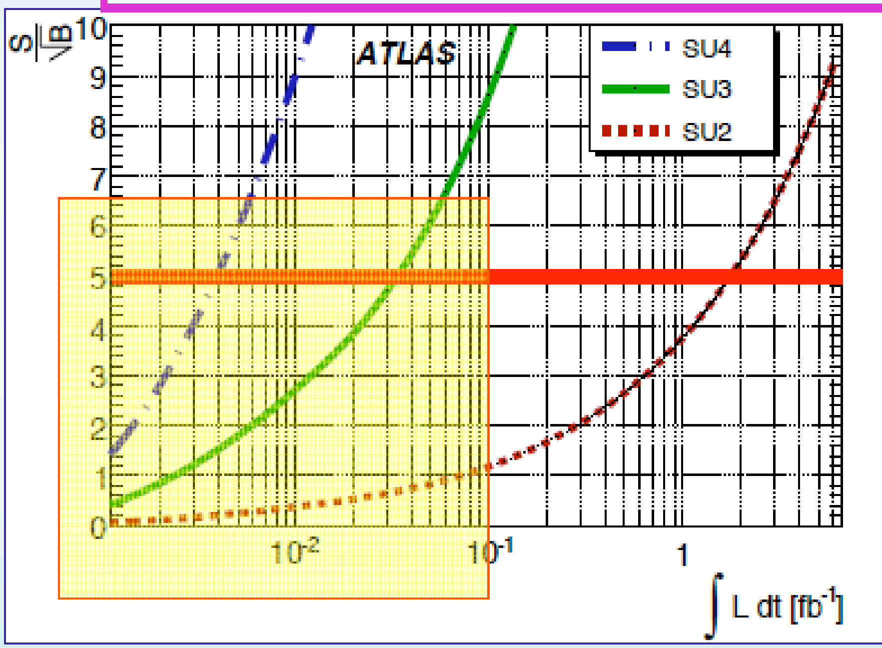
Dr Antonella De Santo, Dr Tina Potter

Inclusive Trilepton Analysis

A. De Santo, C.Potter et al., Expected performance of the ATLAS experiment, CERN-OPEN-2008-020, arxiv:0901.0512

An early SUSY discovery channel !

Significance vs. Integrated Luminosity



Statistical uncertainties only

1 fb^{-1}

	None	N_ℓ	p_T^{jet1}
SU2	7111.7	35.0	13.0
SU3	27304.3	139.3	94.3
SU4	396445.5	1283.9	311.7
$t\bar{t}$	440657.9	444.0	10.6
Zb	159115.7	661.6	0.0
ZW	15672.0	192.7	1.3
ZZ	3820.2	58.9	0.0
WW	40051.7	3.3	0.0
$Z\gamma$	3283.2	9.4	0.0
$\frac{S}{\sqrt{B}}$ SU2	0.9		3.8
$\frac{S}{\sqrt{B}}$ SU3	3.8		27.3
$\frac{S}{\sqrt{B}}$ SU4	34.7		90.3
$\frac{S}{B}$ SU2	0.0		1.1
$\frac{S}{B}$ SU3	0.1		7.9
$\frac{S}{B}$ SU4	0.9		26.2

Crucially simple analysis flow:

- 3 isolated leptons (e, μ) – taus are next step
- At least 1 high-pt jet

  cuts can be further optimized for early physics

Don't need large missing E_T cut – good for early physics

Results are for √s=14TeV, but main conclusions unchanged for √s=10 TeV

Exclusive analysis (direct gaugino production) not for early physics

Dr Antonella De Santo, Dr Tina Potter

University of Sussex

Trileptons at ATLAS – Possible Input from NExT

Is there anything to be learned from studying taus in trilepton events?

-- couplings & mass constraints in "special" scenarios
(eg co-annihilation region)

Trilepton signals also predicted by non-SUSY BSM models

-- for example, "littlest Higgs" models
(eg S.K.Gupta, hep-ph/0910.0830)

Interactions with BSM Higgs searches also a possibility

-- see eg Moretti et al., Eur.Phys.J.C 30, 419-434 (2003)

Which observables should we study to distinguish between models?

-- other than spin correlations

Do we have the necessary MC tools to simulate all interesting scenarios?

-- most likely not

And a lot more…

Conclusions

- ATLAS will focus on detector commissioning with the 2010 data
- But will also be able to do crucial SM physics
- May be we will see a dilepton resonance early on
  - Might need phenomenologists for interpretation
- But for a little while phenomenologists input will be centered on MC generators, PDF, etc.
- Higgs… discovery in single channel: need at least 10fb^{-1}, but combination could give you sensitivity at 2fb^{-1}… but then you need several mature analyses…
  - Data in the can end of 2012… so may be winter conferences of 2014?… summer 2013?

Backup

W/Z Cross section

Selection	$W \to e\nu$	jets	$W \to \tau\nu$	$Z \to ee$
Trigger	37.01 ± 0.09	835 ± 18	1.73 ± 0.02	6.07 ± 0.01
$E_T > 25$ GeV, $\lvert\eta\rvert < 2.4$	30.84 ± 0.09	383 ± 12	1.03 ± 0.01	3.23 ± 0.01
Electron ID	26.77 ± 0.09	110 ± 6	0.91 ± 0.01	2.95 ± 0.01
$\not{E}_T > 25$ GeV	22.06 ± 0.09	4.6 ± 0.7	0.55 ± 0.01	0.06 ± 0.01
$M_T > 40$ GeV	21.71 ± 0.08	1.5 ± 0.4	0.43 ± 0.01	0.04 ± 0.01

N x10^4 for $50 pb^{-1}$

Selection	$Z \to ee$	jets
Trigger	6.70 ± 0.01	3110 ± 40
$E_T > 15$ GeV, $\lvert\eta\rvert < 2.4$, 80 GeV $< M_{ee} <$ 100GeV	2.76 ± 0.01	11.1 ± 0.8
Electron ID	2.64 ± 0.01	0.8 ± 0.2
Isolation	2.48 ± 0.01	0.2 ± 0.1

Selection	$W \to \mu\nu$	$W \to \tau\nu$	$Z \to \mu\mu$	$bb \to \mu X$	$t\bar{t}$
Trigger	44.44 ± 0.07	1.53 ± 0.01	2.03 ± 0.01	83.34 ± 0.09	0.53 ± 0.07
$p_T > 25$ GeV, $\lvert\eta\rvert < 2.5$	35.55 ± 0.06	1.22 ± 0.01	1.62 ± 0.01	68.27 ± 0.08	0.42 ± 0.06
Isolation	34.80 ± 0.06	1.20 ± 0.01	1.59 ± 0.01	9.67 ± 0.03	0.35 ± 0.06
$\not{E}_T > 25$ GeV	28.59 ± 0.05	0.72 ± 0.01	1.10 ± 0.01	1.00 ± 0.01	0.30 ± 0.05
$M_T > 40$ GeV	28.03 ± 0.05	0.57 ± 0.01	1.10 ± 0.01	0.10 ± 0.01	0.24 ± 0.05

Selection	$Z \to \mu\mu$	$b\bar{b} \to \mu\mu X$	$W \to \mu\nu$	$Z \to \tau\tau$	$t\bar{t}$
Trigger	3.76 ± 0.01	10.08 ± 0.04	36.7 ± 0.1	0.09 ± 0.01	0.69 ± 0.01
2 muons + opp. charge	3.33 ± 0.01	3.00 ± 0.04	1.14 ± 0.02	0.04 ± 0.01	0.35 ± 0.01
$M_{\mu\mu}$ cut	3.04 ± 0.01	0.26 ± 0.01	0.04 ± 0.01	$(14 \pm 4) \times 10^{-4}$	0.02 ± 0.01
p_T cut	2.76 ± 0.01	0.125 ± 0.001	0.004 ± 0.001	$(11 \pm 4) \times 10^{-4}$	$(134 \pm 8) \times 10^{-4}$
Isolation	2.56 ± 0.01	$(18 \pm 5) \times 10^{-4}$	$(9 \pm 5) \times 10^{-4}$	$(11 \pm 4) \times 10^{-4}$	$(66 \pm 4) \times 10^{-4}$

arXiv:0901.0512

Money plots: exotics

technicolor

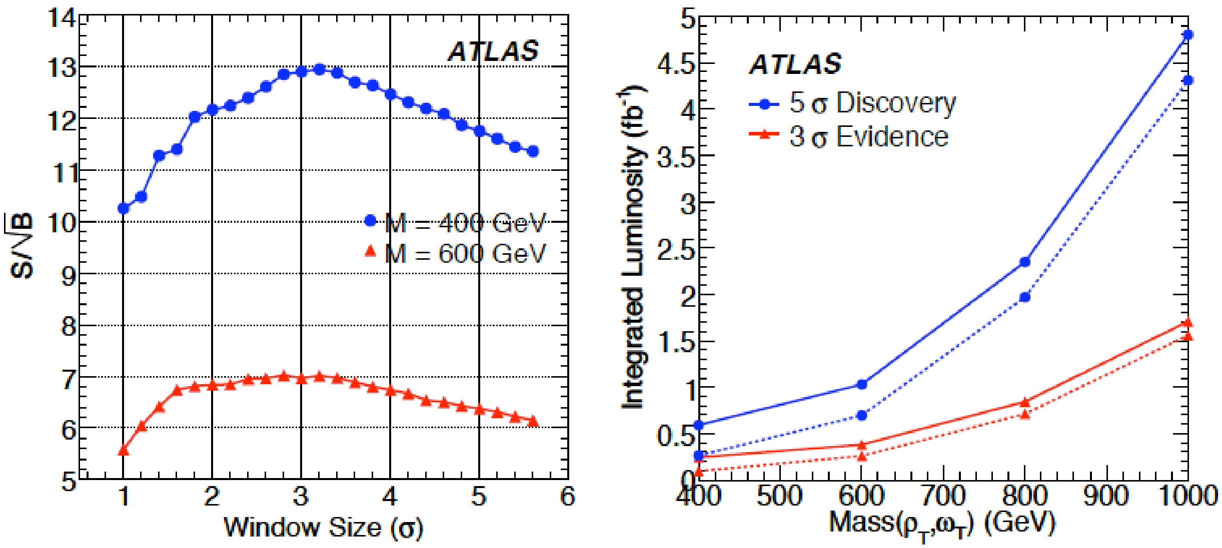
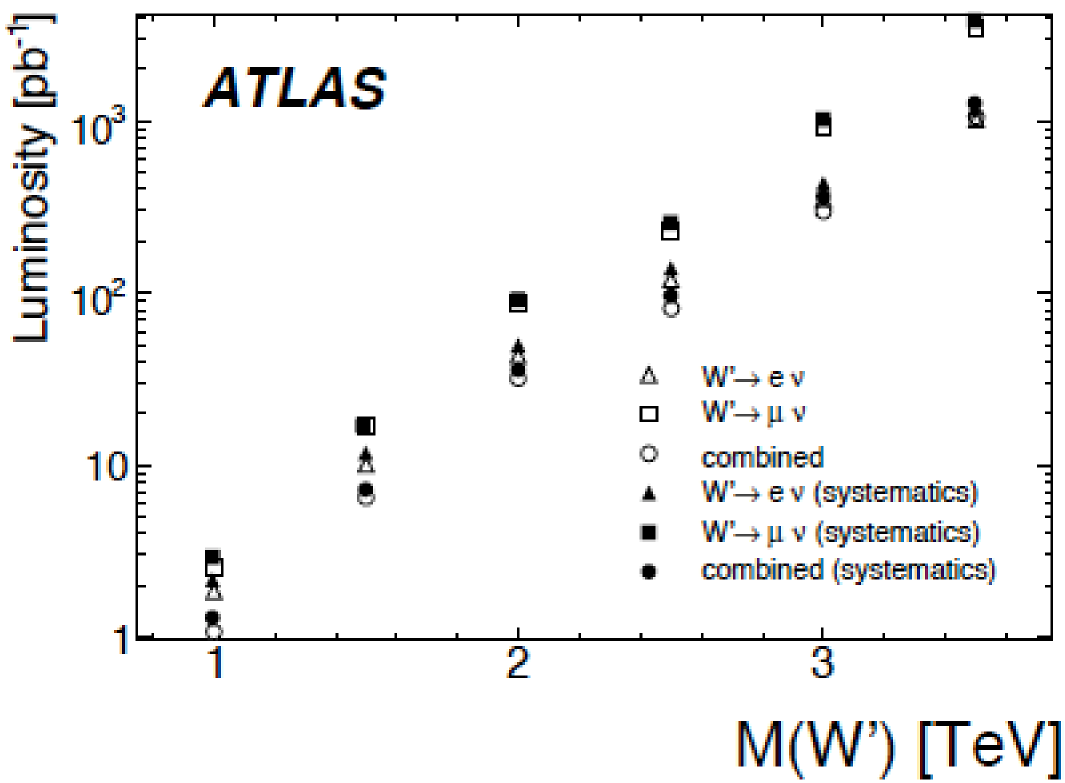


Figure 14: Left: for two different ρ_T, ω_T signal masses, $S/\sqrt{B}$ is plotted as a function of mass-window size for windows centered on the peak mass. Right: integrated luminosity needed for 3σ evidence or 5σ discovery as a function of ρ_T, ω_T mass. The dashed lines include only statistical uncertainties while the solid lines contain the systematic uncertainties as well.



ATLAS
Luminosity [pb^{-1}]
10^3
10^2
10
1
1
2
3
M(W') [TeV]
W'→ e ν
W'→ μ ν
combined
W'→ e ν (systematics)
W'→ μ ν (systematics)
combined (systematics)

Leptoquarks

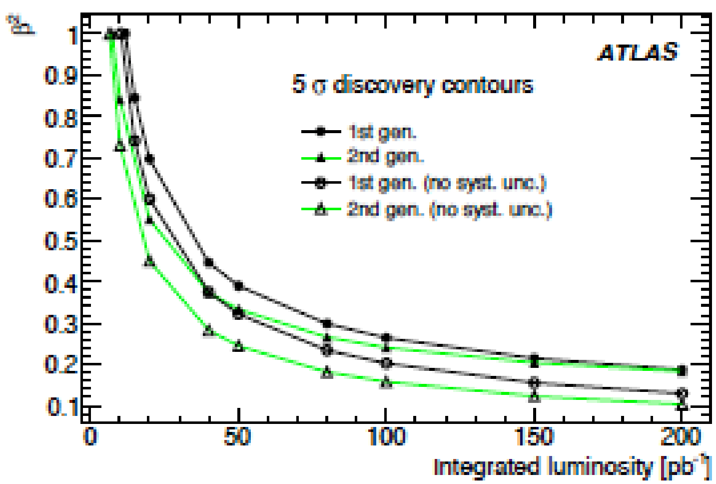


Figure 11: 5σ discovery potential for 1st and 2nd gen. m = 400 GeV scalar leptoquarks versus β^2 with and without background systematic uncertainty included.

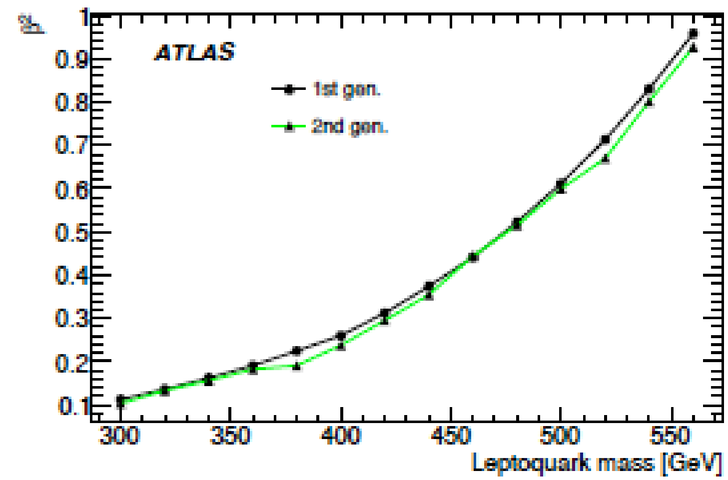


Figure 12: Minimum β^2 of scalar leptoquarks versus leptoquark mass for 100 pb^{-1} of integrated luminosity at 5σ (background systematic uncertainty included.)

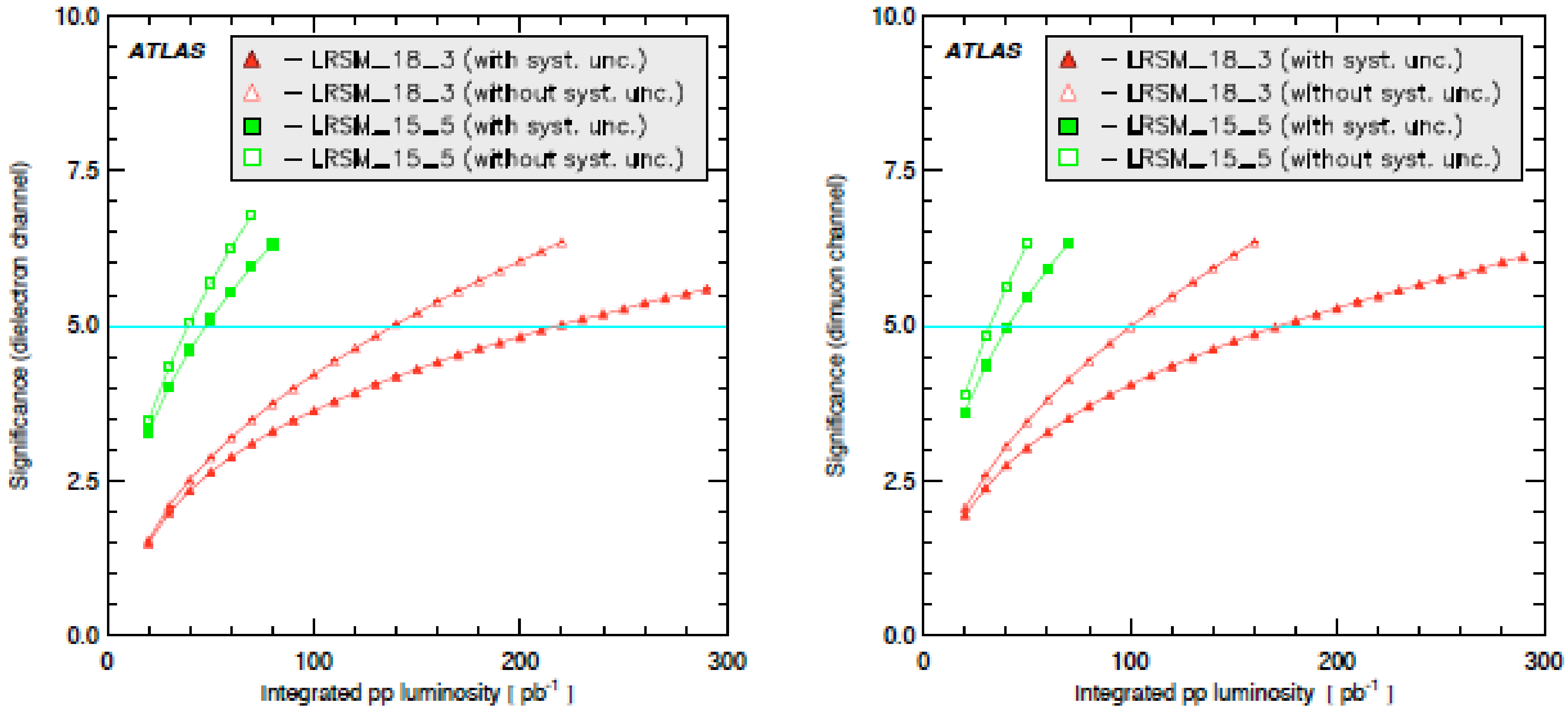


Figure 13: LRSM analysis. Expected signal significances versus integrated luminosity for N_e, N_μ neutrino and W_R boson mass hypotheses, according to signal MC samples LRSM_18_3 and LRSM_15_5. Open symbols show sensitivities without systematic uncertainties. Sensitivities shown with closed symbols include an overall relative uncertainty of 45% (40%) estimated for background contributions in the dielectron (dimuon) analysis. LRSM_15_5 and LRSM_18_3 refer to two sets of LRSM mass hypotheses. See the text for more information.

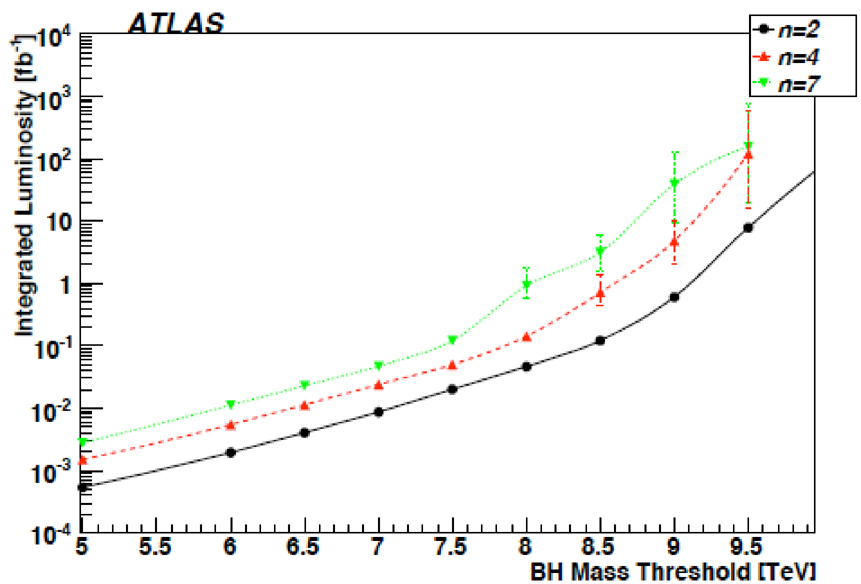


Figure 17: Discovery potential using $\sum |p_T|$ and lepton selections: required luminosity as a function of black hole mass threshold. Error bars reflect statistical uncertainties only.

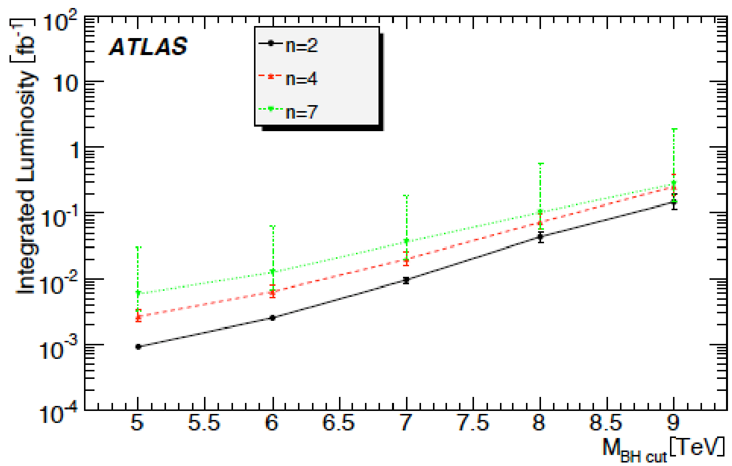


Figure 18: Discovery potential for black holes using four-object and lepton requirements. The required luminosity is shown as a function of the requirement on the reconstructed black hole mass. The error bars correspond to experimental systematic uncertainties. (See text for constraints.)

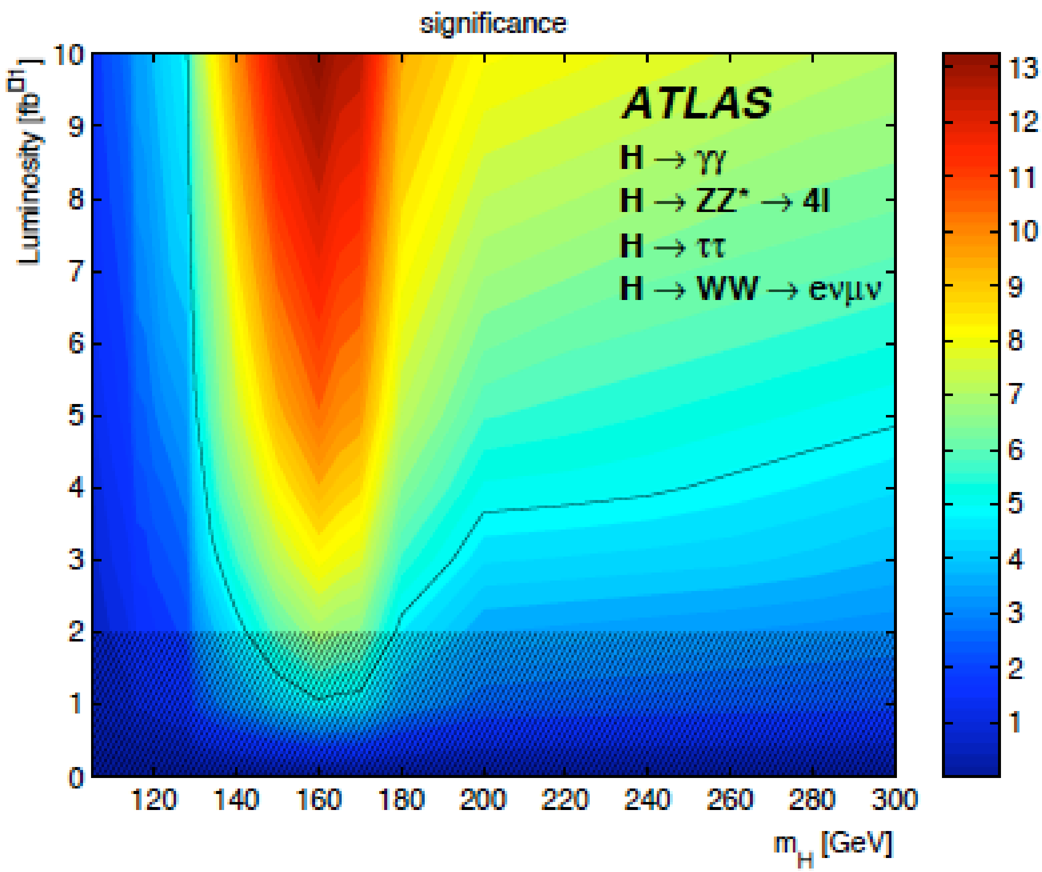
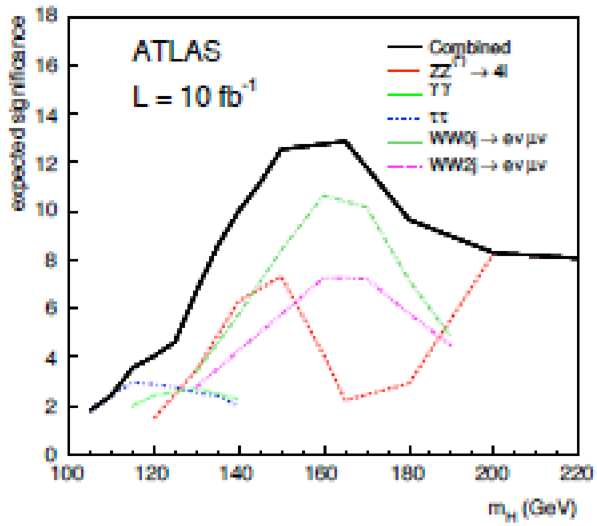
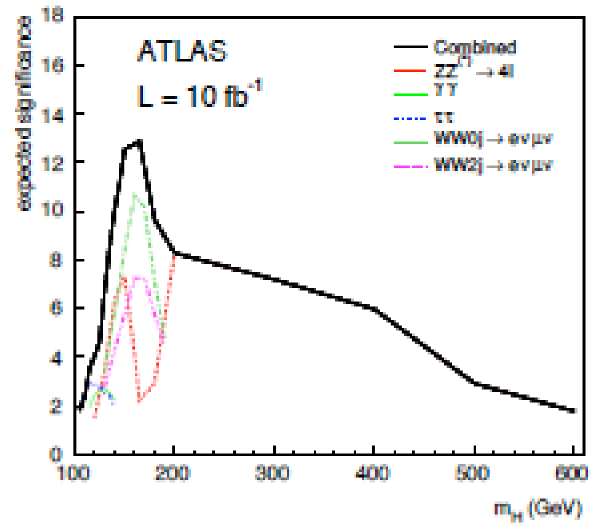


Figure 17: Significance contours for different Standard Model Higgs masses and integrated luminosities. The thick curve represents the 5σ discovery contour. The median significance is shown with a colour according to the legend. The hatched area below 2 fb^{-1} indicates the region where the approximations used in the combination are not accurate, although they are expected to be conservative.


ATLAS
L = 10 fb-1
Combined
ZZ(*) → 4l
γγ
ττ
WW0j → eνμν
WW2j → eνμν
expected significance
0
2
4
6
8
10
12
14
16
18
100
120
140
160
180
200
220
mH (GeV)


ATLAS
L = 10 fb-1
Combined
ZZ(*) → 4l
γγ
ττ
WW0j → eνμν
WW2j → eνμν
expected significance
0
2
4
6
8
10
12
14
16
18
100
200
300
400
500
600
mH (GeV)