The first 3 Months ....

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Selecting an early physics topic

WHY?:

- its 2007+, waited long enough for physics
- students: want to graduate
- postdocs: want to give a jobtalk ;-)

WHAT?:

- new physics insight (unknown parameter space, better precision, hints of new physics)
- high rate ($N = \sigma \cdot L$, $L \leq 10\text{fb}^{-1}$)
- clear trigger
- minimal detector dependence (build-in calibration and cross-checks)

References

- TDR
- ATLAS week talk: F. Gianotti Athens 24/05/2003
- ATLAS week talk: S. Bentvelsen Freiburg 2/10/2004
- hep-ph/0003275
- hep-ph-ex/9606002
- CDF notes and papers ...

Rates

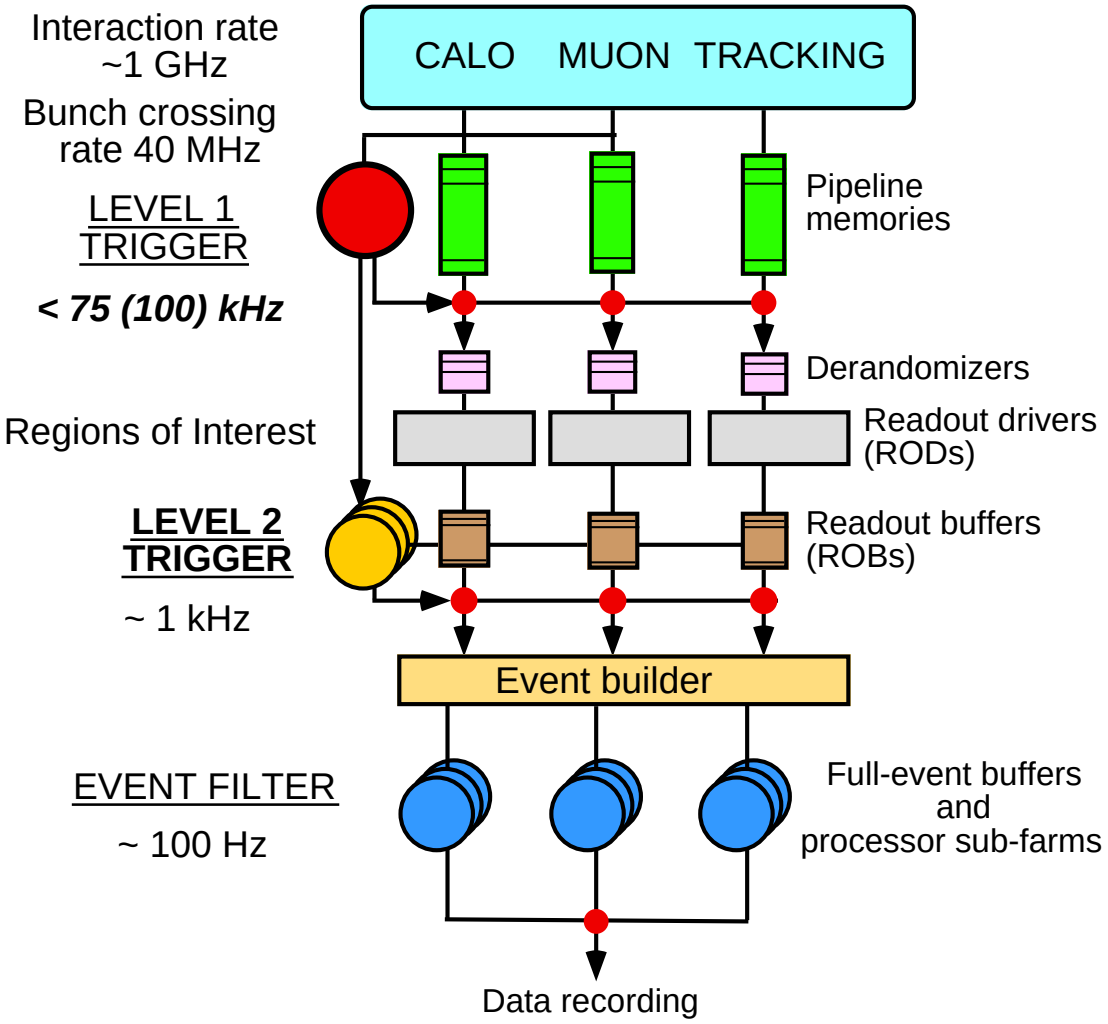
Process	σ	Events/s	Triggered Sample in 10fb^{-1}
$t\bar{t}$	~ 800 pb	1	10^6
$Z \to \mu\mu$	~ 1.5 nb	1	10^7
$b\bar{b}$	$\sim 500\mu b$		10^7
$\text{J}/\psi \to \mu\mu$	~ 10nb	10	10^8

Initial run 1 year at $\mathcal{L} \sim 10^{33}\text{cm}^{-2}\text{s}^{-1} \Longrightarrow 10\text{fb}^{-1}$

$\Longrightarrow$ Huge samples (compare to 10 years at Tevatron)

$\Longrightarrow$ need selection to cope with rates

ATLAS Trigger Scheme



trigger on:

Muons

EM energy

Had energy

miss E_T

Preliminary Trigger Tables

single lepton	$\mathrm{iso}e(25\ \mathrm{GeV})$, $\mathrm{iso}\mu(20\ \mathrm{GeV})$
dilepton	$2e(15\ \mathrm{GeV})$, $2\mu(10\ \mathrm{GeV})$
dilepton	$2\mu(6\ \mathrm{GeV}) + m(\mu\mu)_b$
dilepton	$\mu(6\ \mathrm{GeV})\mu(3\ \mathrm{GeV}) + m(\mu\mu)_{J/\psi}$
photons	$\mathrm{iso}\gamma(60\ \mathrm{GeV}), \mathrm{iso}2\gamma(20\ \mathrm{GeV})$
jet	$j(400\ \mathrm{GeV})$,$3j(165\ \mathrm{GeV})$,$4j(110\ \mathrm{GeV})$
missing E_T	$j(70\ \mathrm{GeV}) + \mathrm{xE}(70\ \mathrm{GeV})$
prescales	

Top mass and cross section

$t\bar{t} \rightarrow WbWb \rightarrow l\nu bjjb$

$\Longrightarrow$ l trigger, $W \rightarrow jj$ in-situ calibration

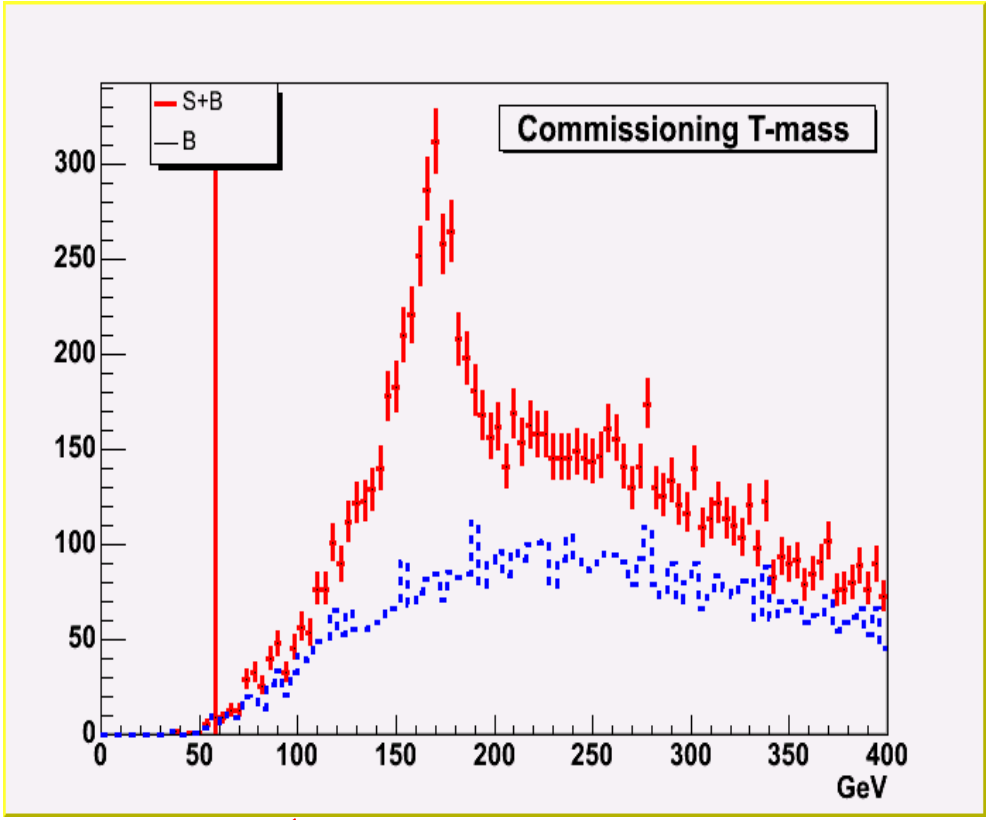
☛ m sensitive to Higgs mass

☛ m ingredient to $t\bar{t}$ resonance reco m($t\bar{t}$)

☛ decays of new physics enhance $\sigma_{\rm top}$

timescale	events	$\delta m_{\rm top}$ stat	$\frac{\delta\sigma_{\rm top}}{\sigma_{\rm top}}$
1 year	3×10^5	0.1 GeV	$\sim 0.2\%$
1 month	7.5×10^4	0.2 GeV	$\sim 0.4\%$
1 week	2×10^3	0.4 GeV	$\sim 2.5\%$
CDF (200 $\rm pb^{-1}$)	~ 200	~ 4 GeV	$\sim 30\%$

Top Reconstruction



BUT NEED:

m: calibrated energy scale

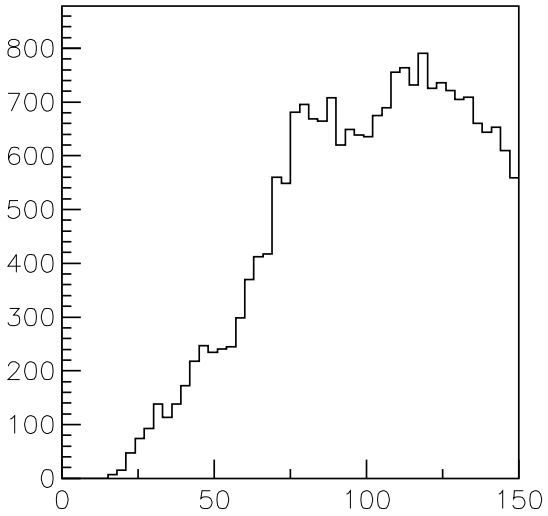
σ: acceptance and efficiency

m and σ: background estimate

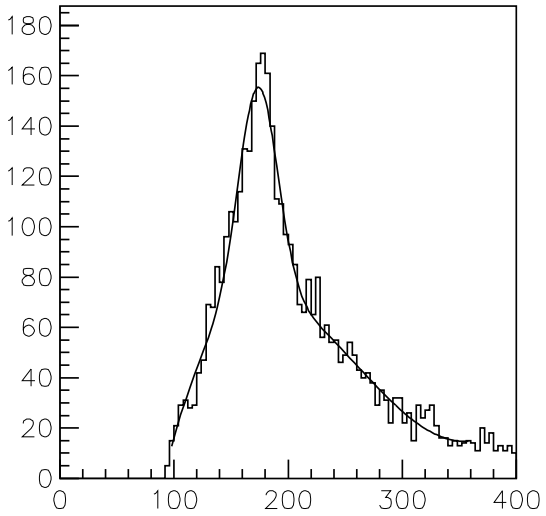
$150\ \mathrm{pb}^{-1}$!, 3 DAYS!, No b-tagging!

Jet in-situ calibration

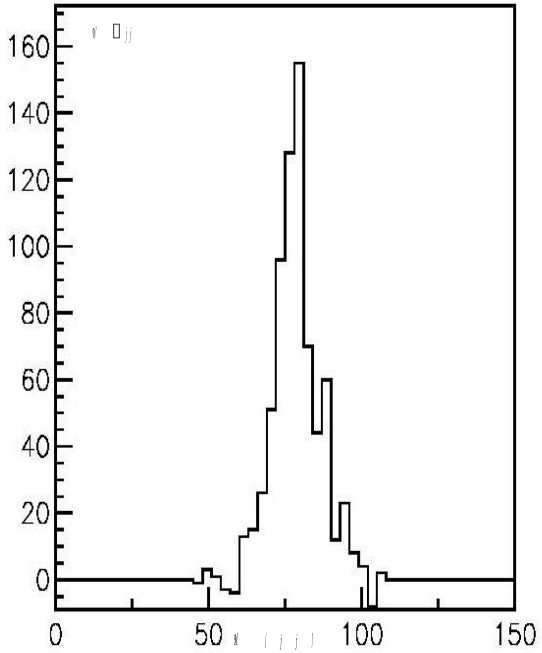
$t \rightarrow Wb \rightarrow jjb$



m(jj)

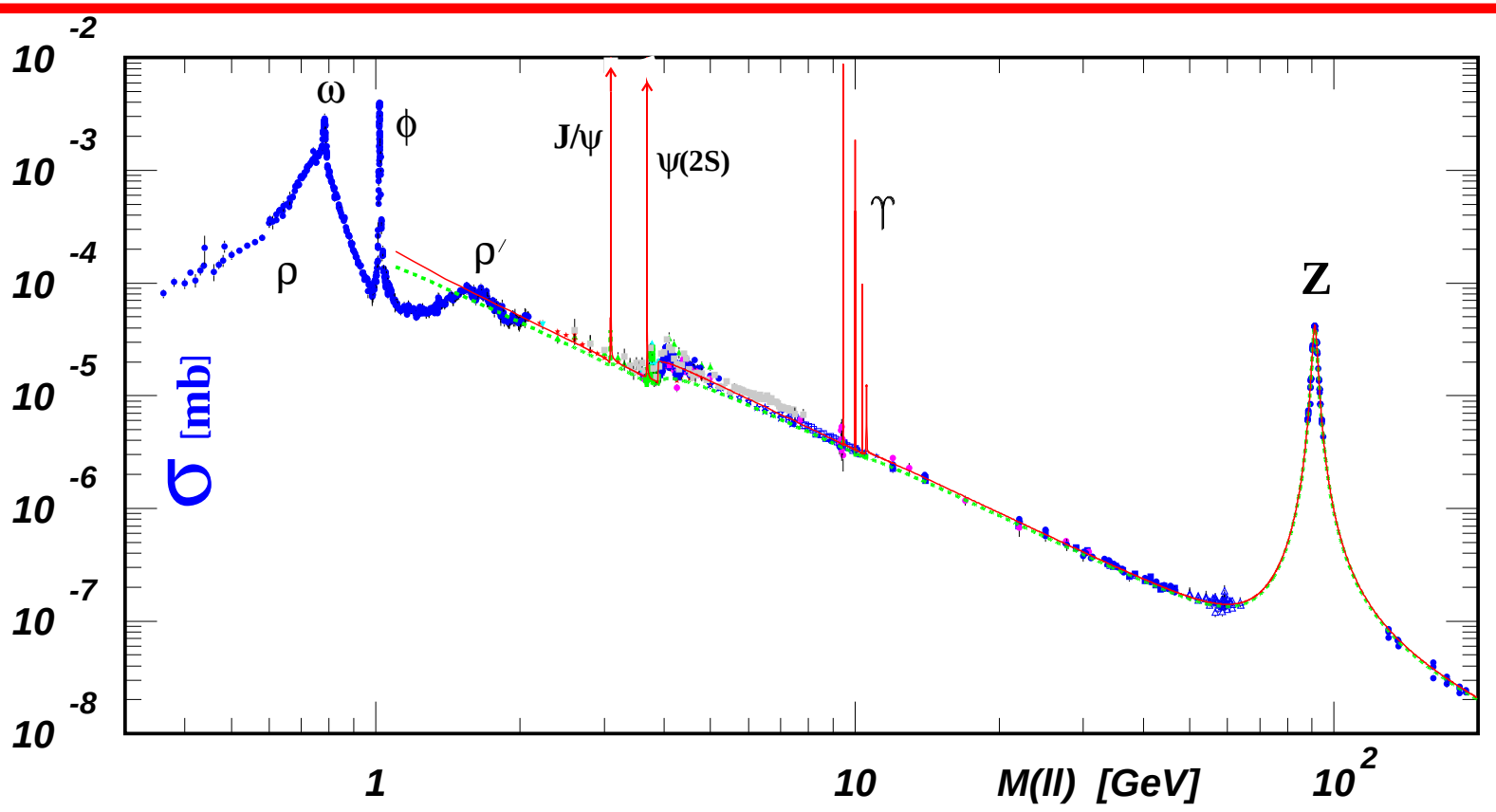


m(jjb)



m(jj)$\rightarrow$m(W) for
m(mjjb)$\sim m_{\rm top}$

Dilepton mass spectrum



note:

this plot is a

cheat

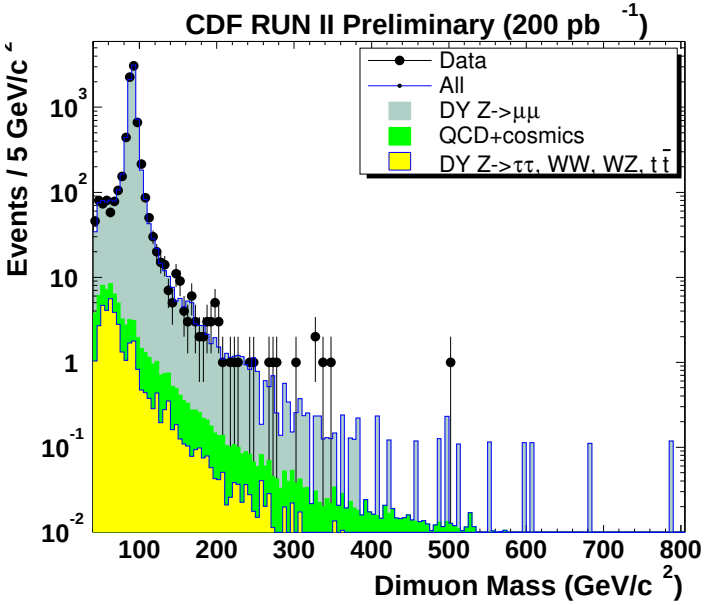
Dilepton mass spectrum has been a constant tool for discovery in the past:

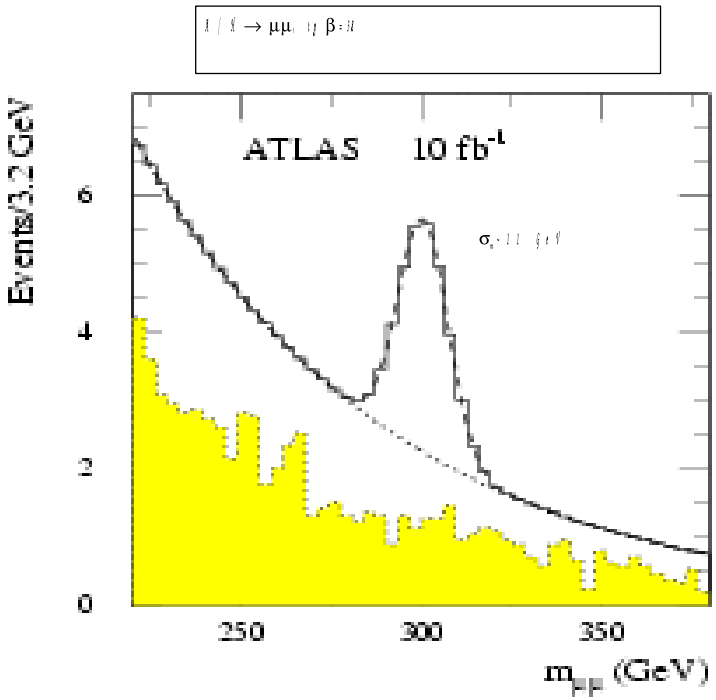
J/ψ, Υ, $Z \Longrightarrow$ today "Standard candles"

Low Dilepton mass: J/ψ Physics

- $\sigma(J/\psi)$
- J/ψ polarization (interesting because of constraints on production models, profits from η coverage)
- $B \rightarrow J/\psi X$
- $\tau(\Lambda_b \rightarrow J/\psi \Lambda)$
- MOSTLY TOO MUCH EFFORT FOR PHYSICS RETURN

High Dilepton mass spectrum





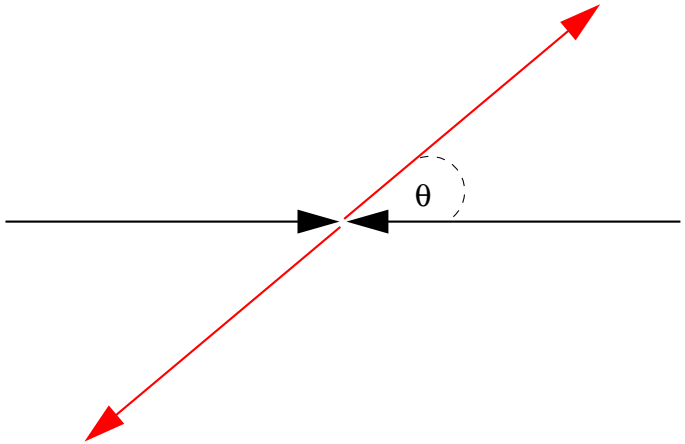
interesting region: above the Z

compare with Tevatron:

higher $\sqrt{s} \Longrightarrow$ higher mass reach reach

Right: many possible signals (Example: $A/H \rightarrow \mu\mu$)

Forward Backward Asymmetry



$$\frac{d\sigma(s)}{d\Omega} = |\gamma(s) + Z(s) + ?|^2$$

$$A_{FB} = \frac{N_F - N_B}{N_F + N_B} = \frac{\int_0^1 d\cos\theta - \int_{-1}^0 d\cos\theta}{\int_{-1}^1 d\cos\theta}$$

Forward Backward Asymmetry

Average over helicity configurations:

In SM:

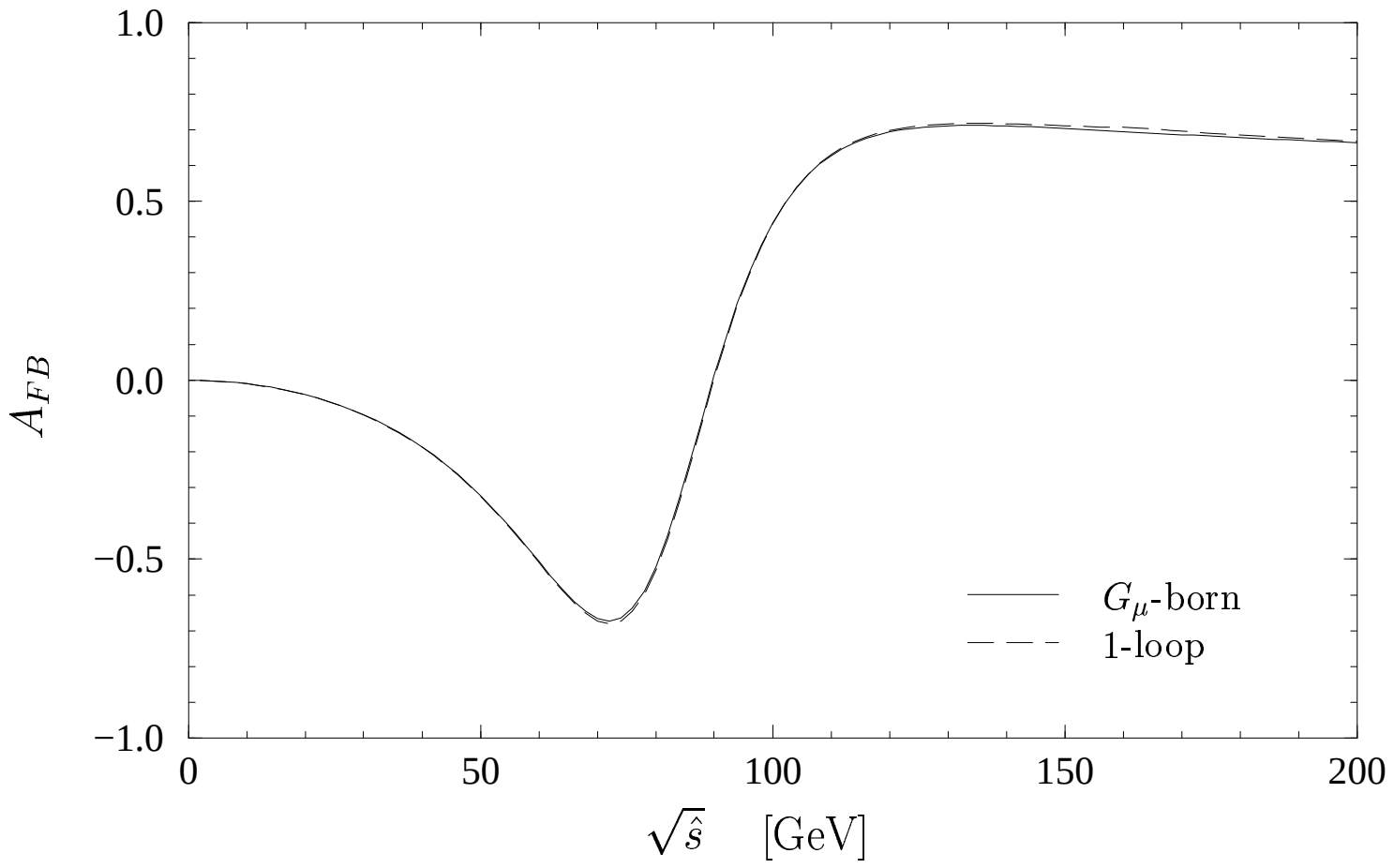
$$\frac{d\sigma(s)(e_L^- e_R^+ \to q_R \bar{q}_R)}{d\Omega} = \frac{N_c \alpha^2}{4s} (1 - cos\theta)^2 \left| Q_q + r(c_V^q - c_A^q)(c_V^e + c_A^e) \right|^2$$

where:

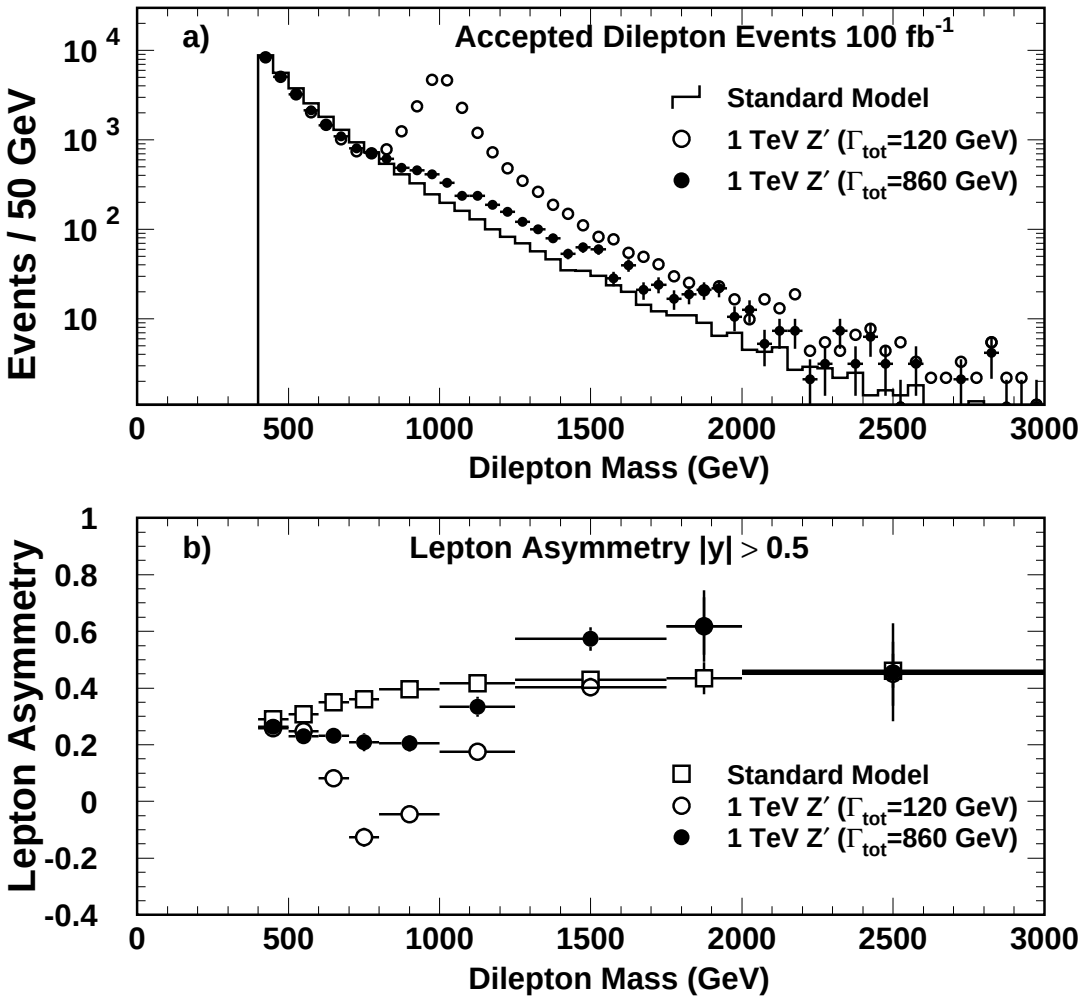
$$r = \frac{\sqrt{(2)} G M_Z^2}{s - M_Z^2 + i M_Z \Gamma_Z} \frac{s}{e^2} \ , \ c_V = I^3 - 2Q_f \sin^2\theta_W \ , \ c_A = I^3$$

$\Longrightarrow$ In SM: $A_{FB} = b(a - \sin^2\theta_{Weff})$

Forward Backward Asymmetry

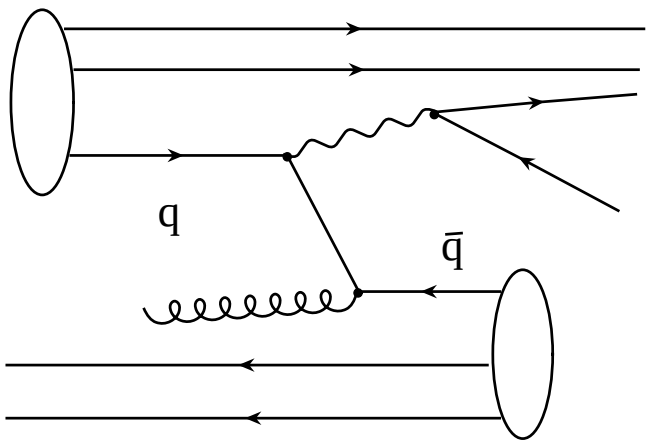


Forward Backward Asymmetry



sensitive to new Z' Gauge bosons complimentary to mass

FB Asymmetry: Complications



at $p\bar{p}$:

☛ mix of u and d quarks

☛ due to transverse momentum need to transform into proper frame

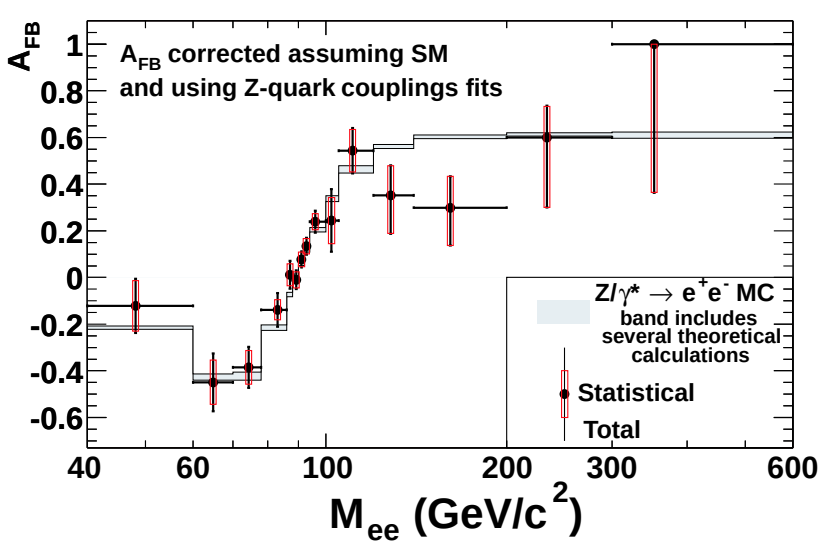
$\Longrightarrow$ solution: Collins-Soper Frame

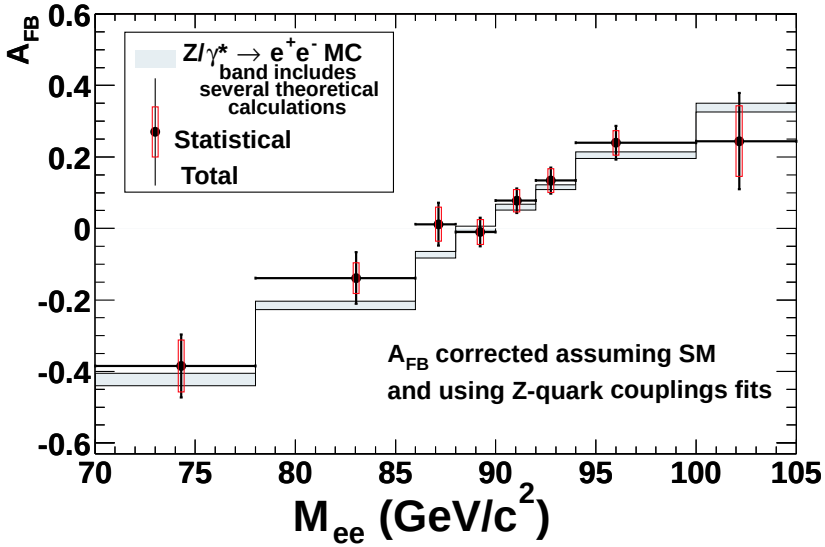
$$\cos\theta = \frac{2(p^+(l^-)p^-(l^+) - p^-(l^-)p^+(l^+))}{m^2(ll) + p_T^2(ll)}$$

$$p^{\pm} = \frac{1}{\sqrt{2}}E \pm p_z$$

FB Asymmetry

at the Tevatron:

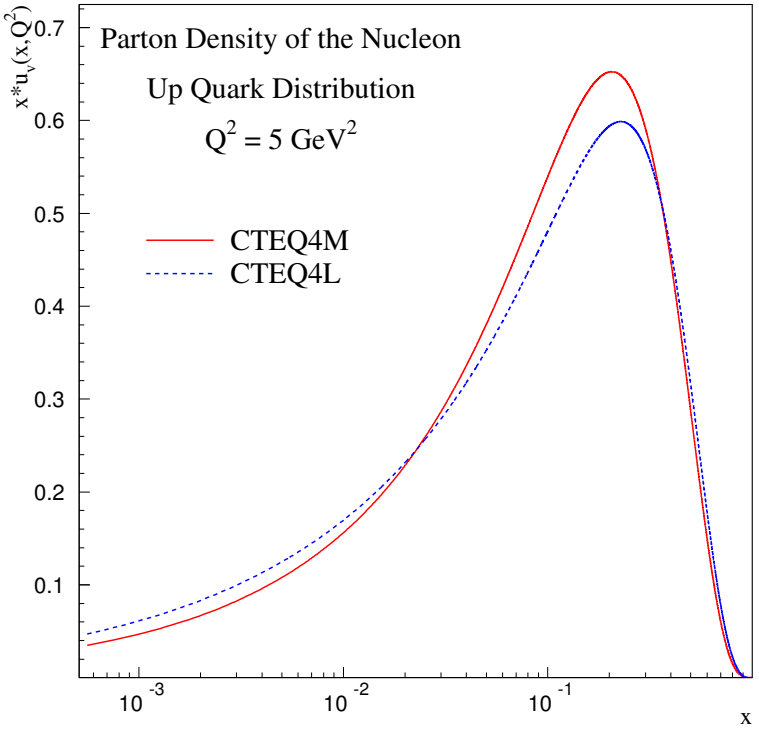


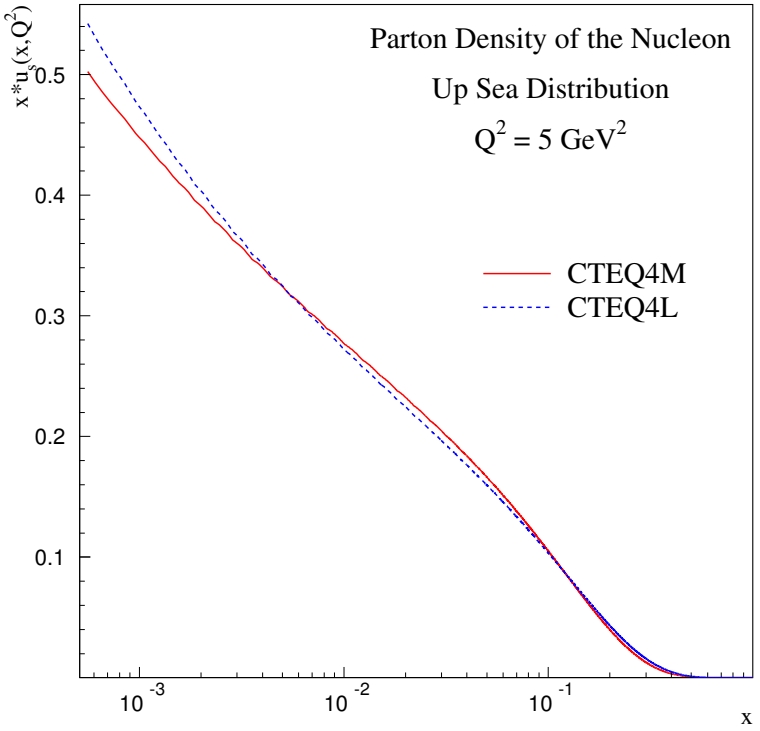


$$\sin^2\theta_W = 0.2238 \pm 0.0040 \pm 0.0030$$

FB Asymmetry: Complications

at pp: which is the $\bar{q}$ direction? sign?





Only from sea quarks are $\bar{q}$.

$\Longrightarrow$ utilize momentum imbalance. sign $\sim \frac{p_z(l^-l^+)}{|p_z(l^-l^+)|}$

Concluding Thoughts

- top looks like the most promising early topic
- dileptons are good tool to explore the detector while exploring physics
- need to think about building up "chains" of analysis to put needed building blocks into place
- discussion: Vast array of topics, what else?