DØ Searches for New Particles and Phenomena

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for the DØ Collaboration

SUSY 2003
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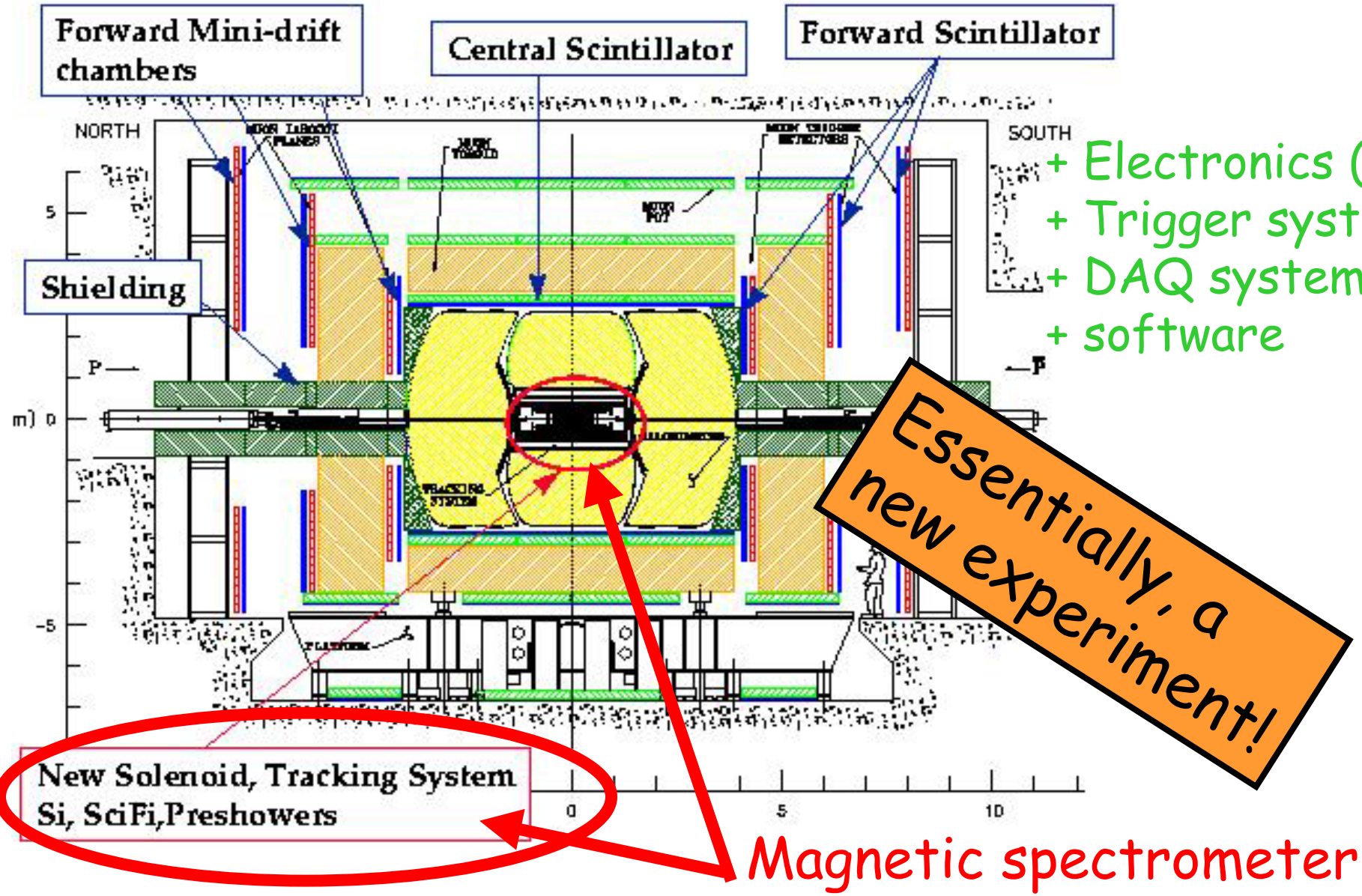
Outline

- "Searches" for known particles
  - DØ Refresher & Status
- Searches beyond the Standard Model
  - Some examples: frame the situation
  - More in parallel session DØ talks
- Searches for Higgs-like final states
  - What for Higgs now?

Not discussing Run I results…

Thanks to my collaborators for help…

The New DØ



+ Electronics (!)
+ Trigger system
+ DAQ system
+ software

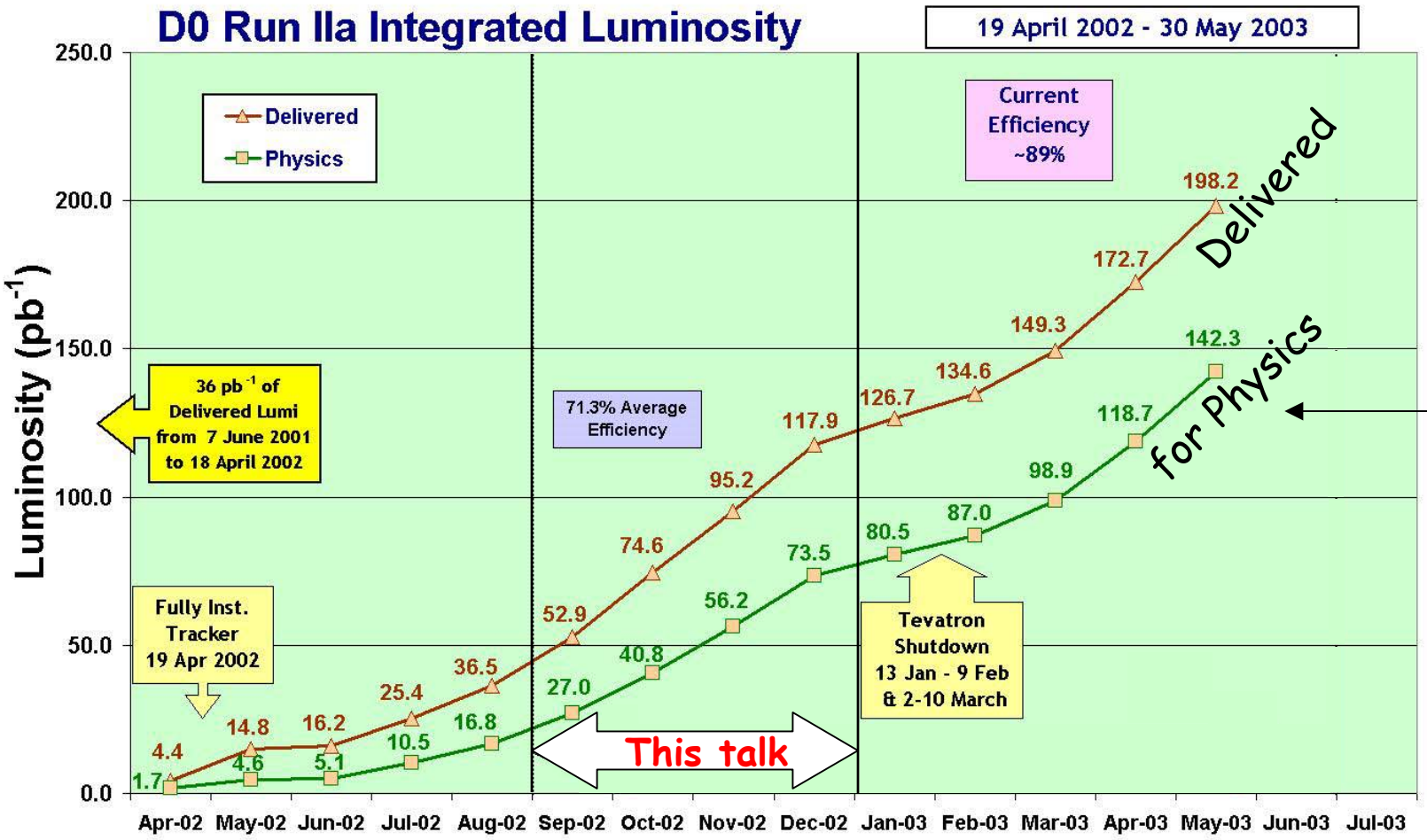
Run II and DØ Operations

- Tevatron (ala searches…)
  - Increased $\mathcal{L}_{inst}$ (now: 4×10^{31} /cm^{2}s)
  - Increased E_{CM}, 10 –30% increase in cross sections
- Detector status
  - Fully operational

    tracker read out final installation, 4/19/2
  - Working well; continuing work on

    detector and software tuning, trigger tuning, trigger commissioning, routine running…
- Recorded > 100 pb^{-1} for physics
  - Today's results, 30 – 50 pb^{-1}

Data Taking



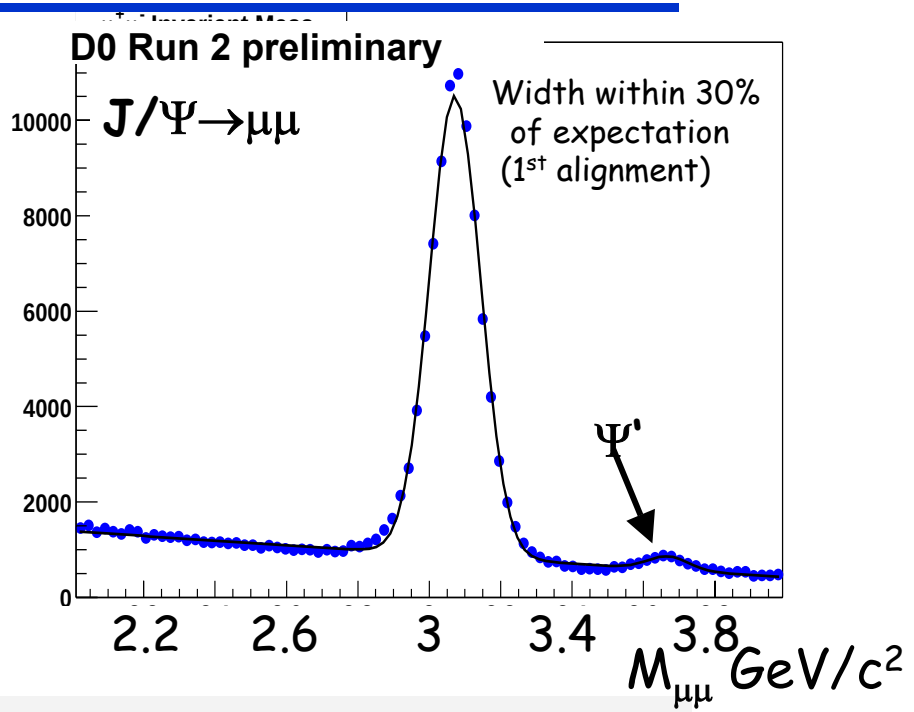
Delivered

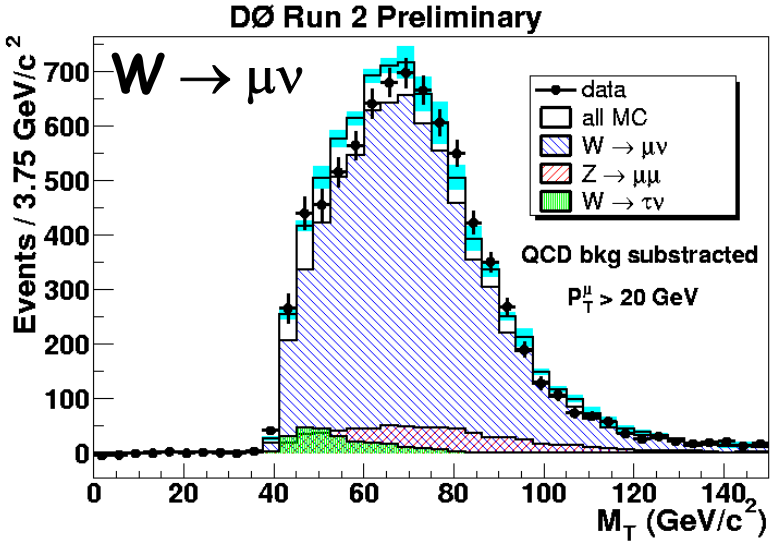
for Physics

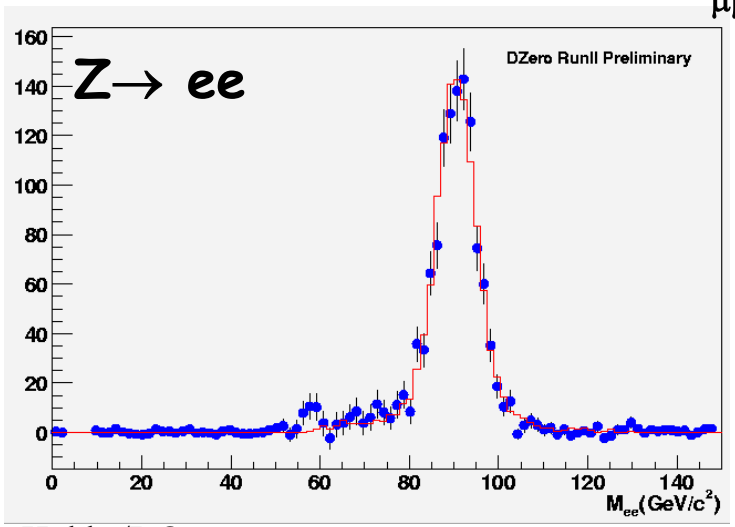
Run I total

"Searches" for Known Particles

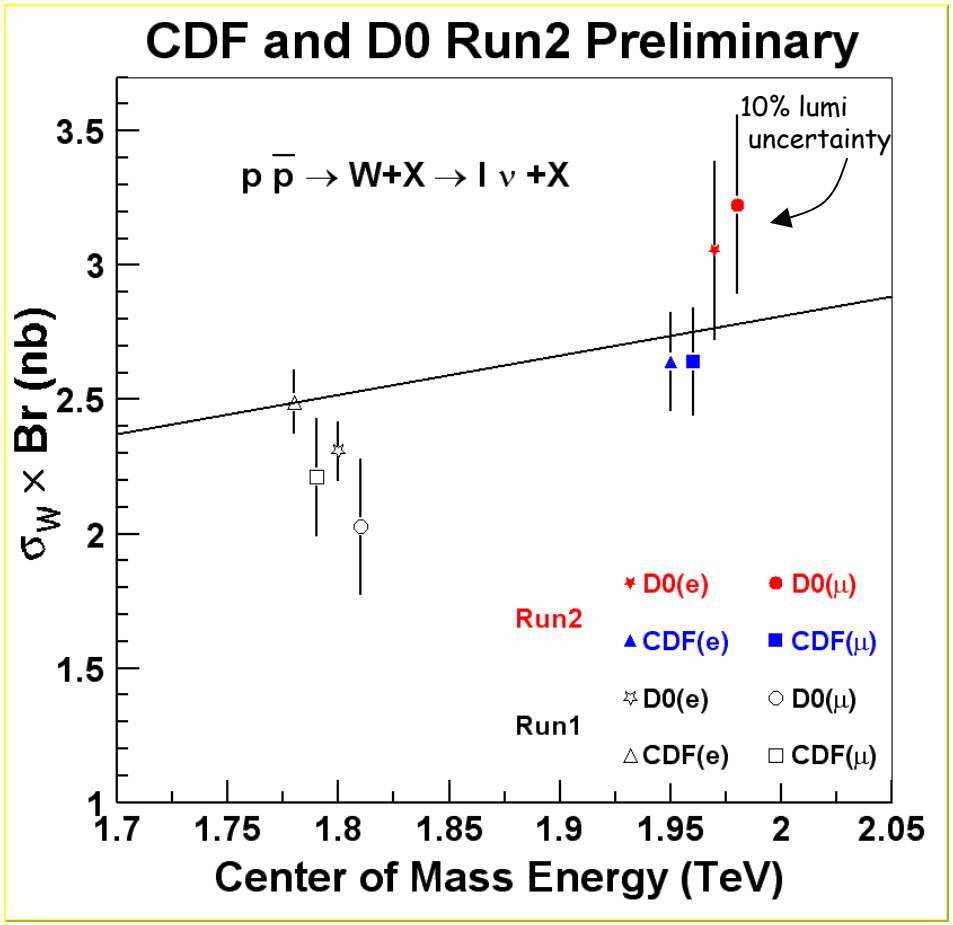
- "New" experiment
  - Calibrate and measure performance
  - verify algorithms
- Standard candles
  - resonances: J/Ψ, Z, …
  - Run I results

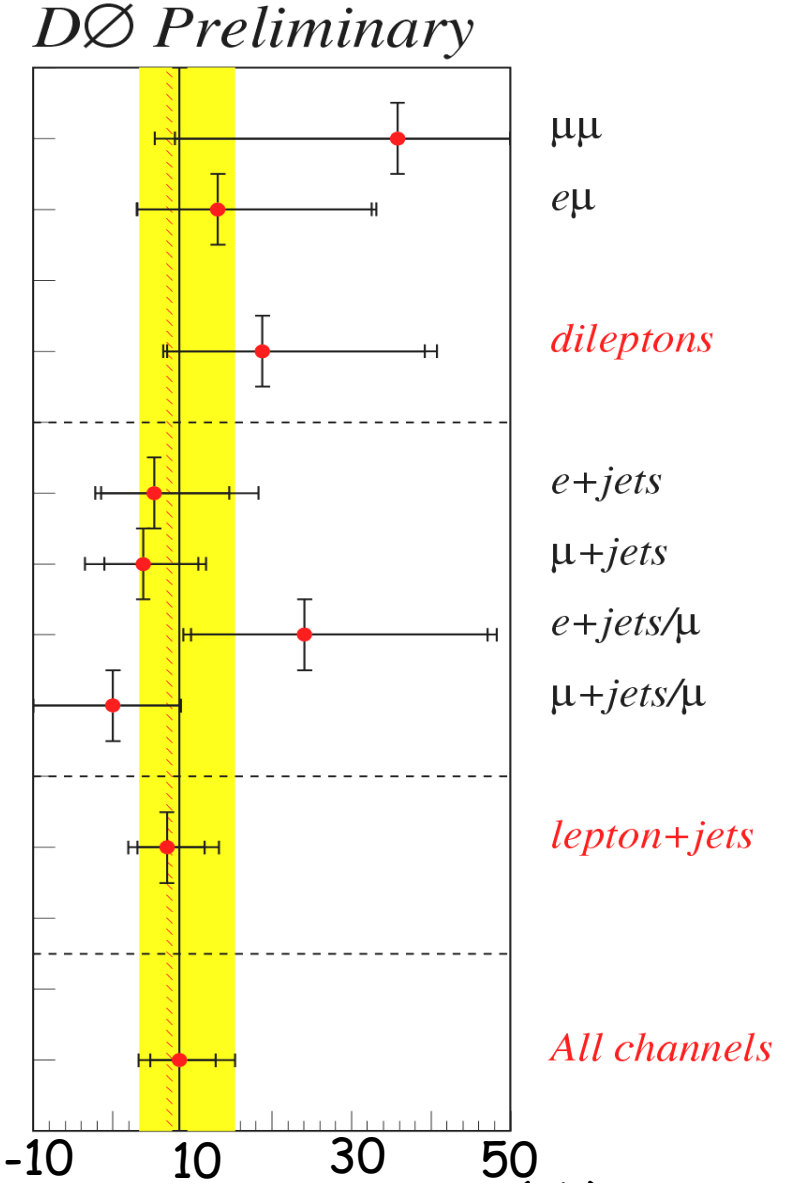






"Searches" for Known Particles





Also have Z measurments

$$\sigma = 8.5\ ^{+4.5}_{-3.6}\ (\text{stat})\ ^{+6.3}_{-3.5}\ (\text{sys}) \pm 0.8\ (\text{lumi})\ \text{pb}$$

Beyond the Standard Model

Model Independent

eμ + X

Supersymmetry

SUGRA jets +MET

tri-leptons

GMSB γγ + MET

Higgs-like final states…

Extra Dimensions

ee, γγ, μμ

Leptoquarks

1st and 2nd generations

New gauge bosons

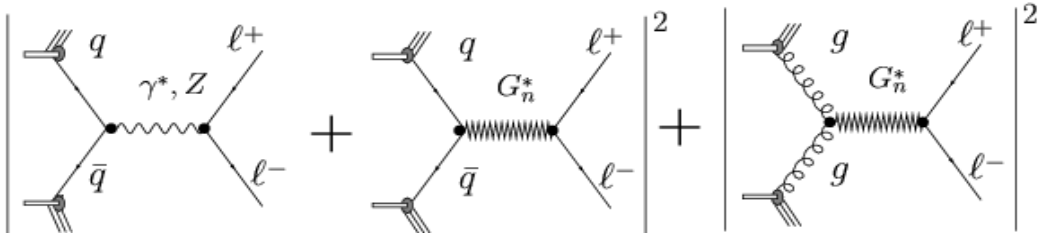
ee

- This talk: context & indicate sensitivity
  - Many of above: similar final states

    Discuss one for each topology (easier to harder)
  - Guide: 2x tighter cross section = +20 GeV
- More in parallel session talks

Extra Dimensions: ee/γγ

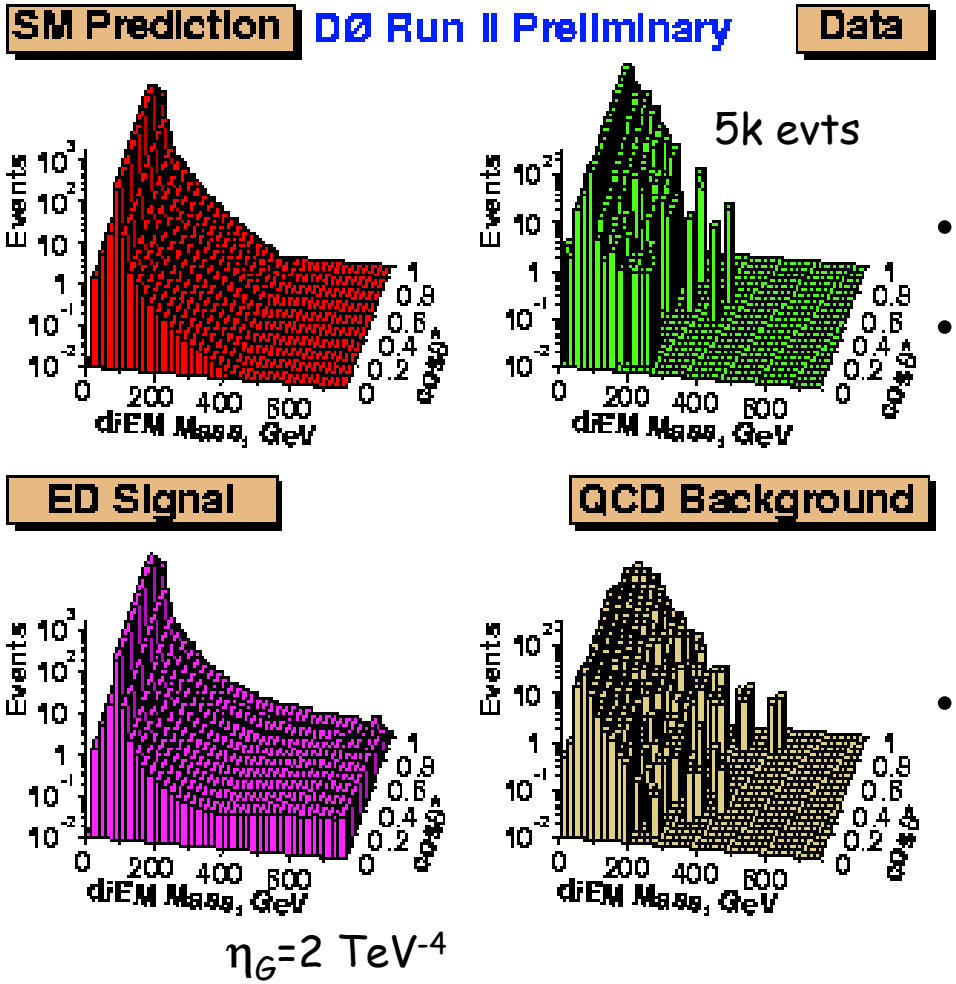
- Look for modification to Z, γ* reactions:
  - Arise from KK graviton
  - Use ee/γγ, μμ final states
- 2 selection variables:
  - M_{ll}
  - Θ*, scattering angle in dilepton(diphoton) rest frame



$$\frac{d^2\sigma}{dM\, d\cos\theta^*} = f_{SM} + f_{interf}\eta_G + f_{KK}\eta_G^2$$

Analysis: Likelihood fit for η_G

Extra Dimensions: ee/γγ

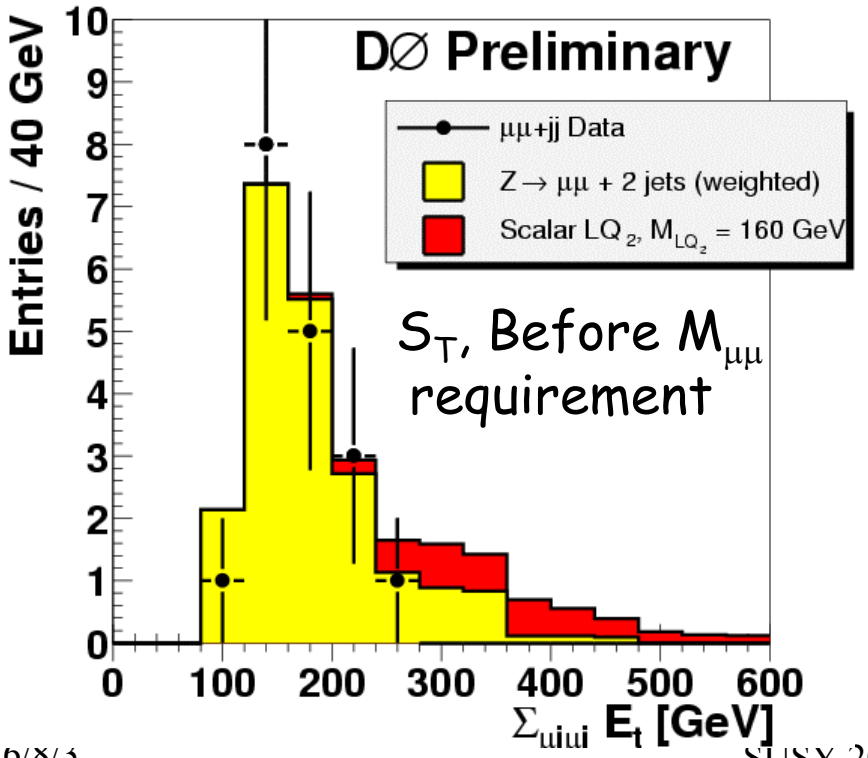


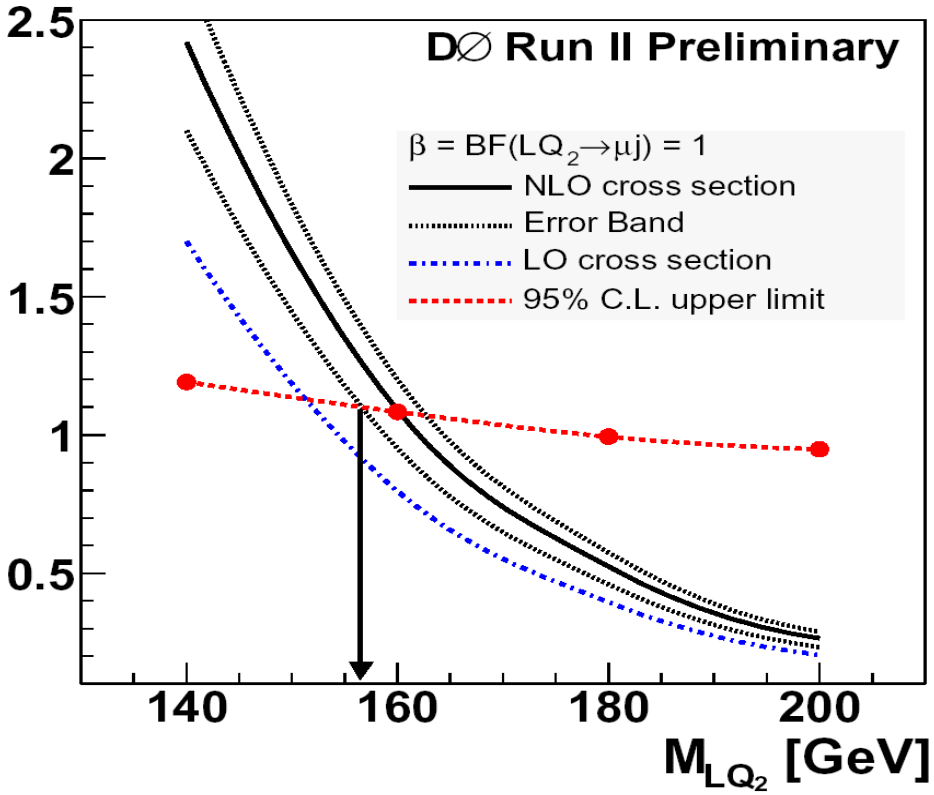
- Selection
  - -2 EM objects, E_T>25 GeV
  - -$\not\!\!E_T$ < 25 GeV (no tails…)
- Approx. 50 pb^{-1}
- Fit gives η_G < 0.628 TeV^{-4}
  - -M_S>1.12 TeV (e.g. GRW)
  - - Run I M_S>1.0 – 1.4 (Models)
  - - LEP, similar range
- Extra Sensitivity from E_{CM}

As for nearly all analyses:
Standard Model bkg. from MC
mis-identification from data
ID efficiencies from data

2nd Generation Leptoquark: LQ→μq

- Selection (30 pb^{-1})
  - 2 μ, p_T > 15 GeV
  - 2 jets, p_T > 20 GeV
  - $M_{\mu\mu}$ > 110 GeV
- 0 events survive



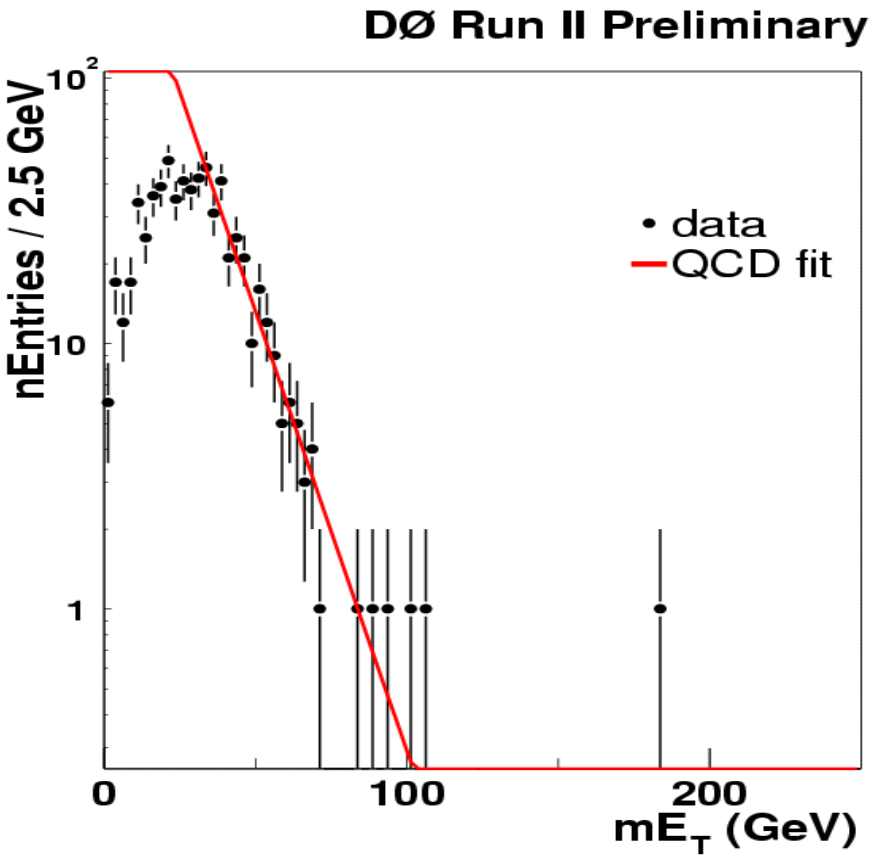


M(LQ2) > 157 GeV

run I, M>200 GeV, 100 pb^{-1}

SUGRA-inspired: Jets + MET

- Generic squark/gluino signature
  - Proof-of-priniciple: 4 pb^{-1}
- Selection
  - >= 1 jet, p_T > 100 GeV
    - ✓Trigger effect
  - Topological cuts: Jet, MET angles…
- Fit for QCD background
- For $\not\!\!E_T$ > 100 GeV



Predicted QCD Bkg: 2.7 ± 1.8

Observed data: 3 giving $A \times \sigma < 2.7$ pb

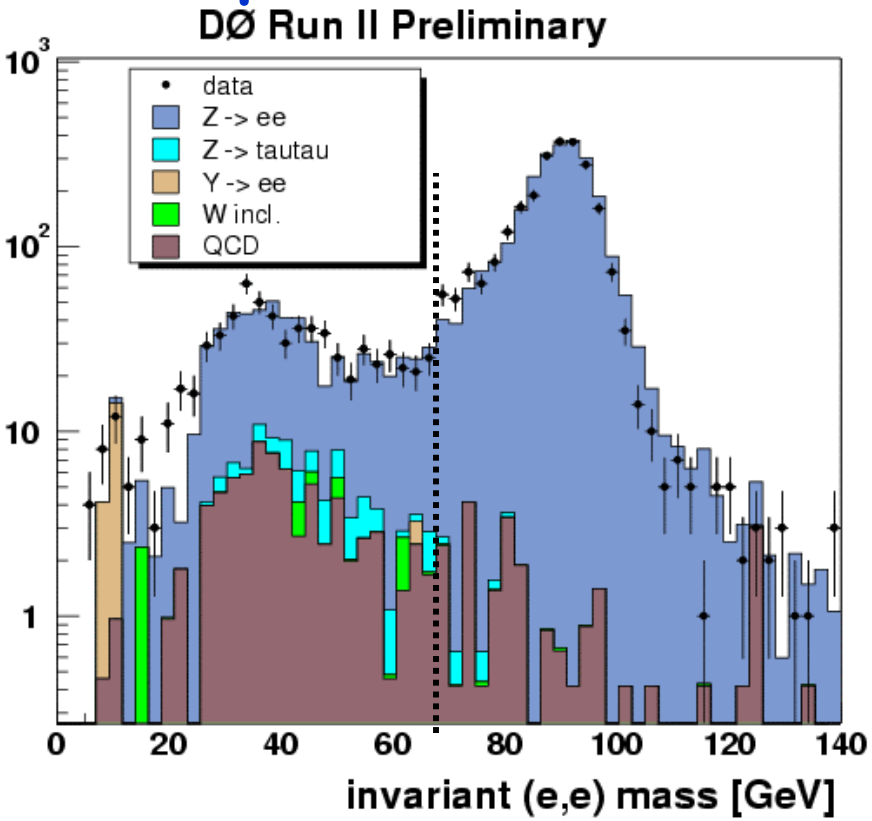
SUGRA-inspired: trileptons, eel

- Assumes

$$p\bar{p} \rightarrow \tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \rightarrow lee\nu\tilde{\chi}_1^0\tilde{\chi}_1^0$$

- Efficiency: 3% - 4%
- Based on 40 pb^{-1}
- Also eμl channel result

need > 300 pb^{-1} to extend excluded region



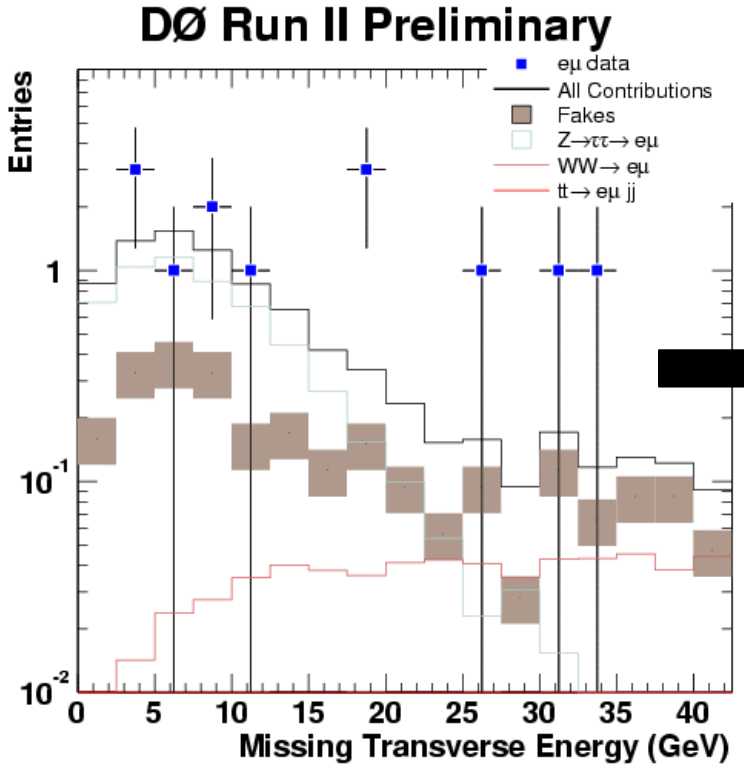
Track only Loose lepton!

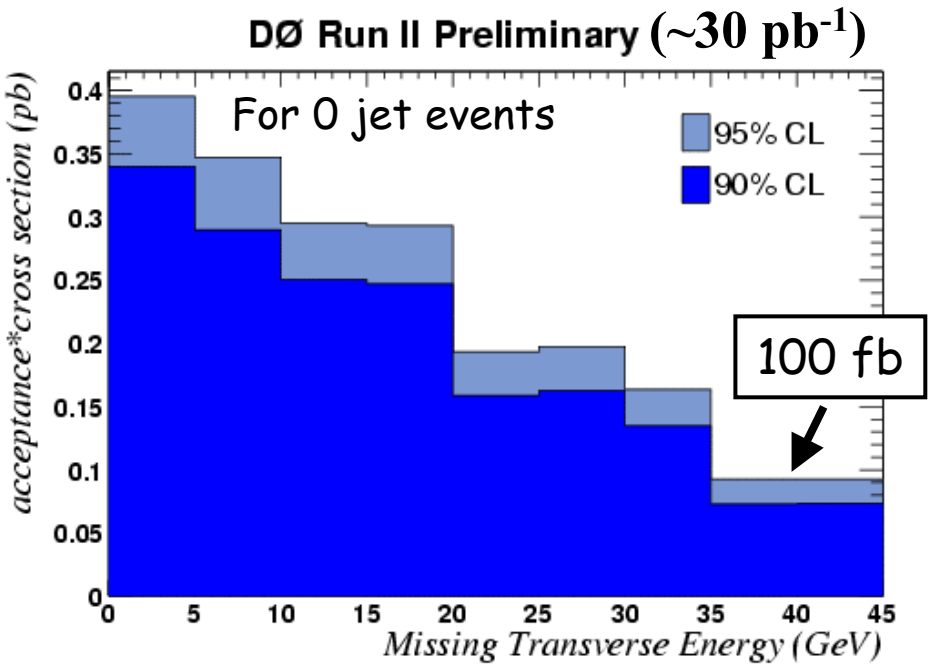
Selection	Bkg.	Data
$p_T(e_1)$ >15 GeV, $p_T(e_2)$ > 10 GeV	3216 ± 43	3132
10 GeV < M_{ee} < 70 GeV	660 ± 19	721
M_T > 15 GeV	96 ± 8	123
3rd isolated track, p_T > 5 GeV	3.2 ± 2.3	3
$\not{E}_T$ > 15 GeV	0 ± 2	0

Model Independent: eμ+X

- Loose selection
  - e, μ; p_T > 15 GeV
- Also, eμl result

- Reasonable agreement
- Limit shown: jet veto





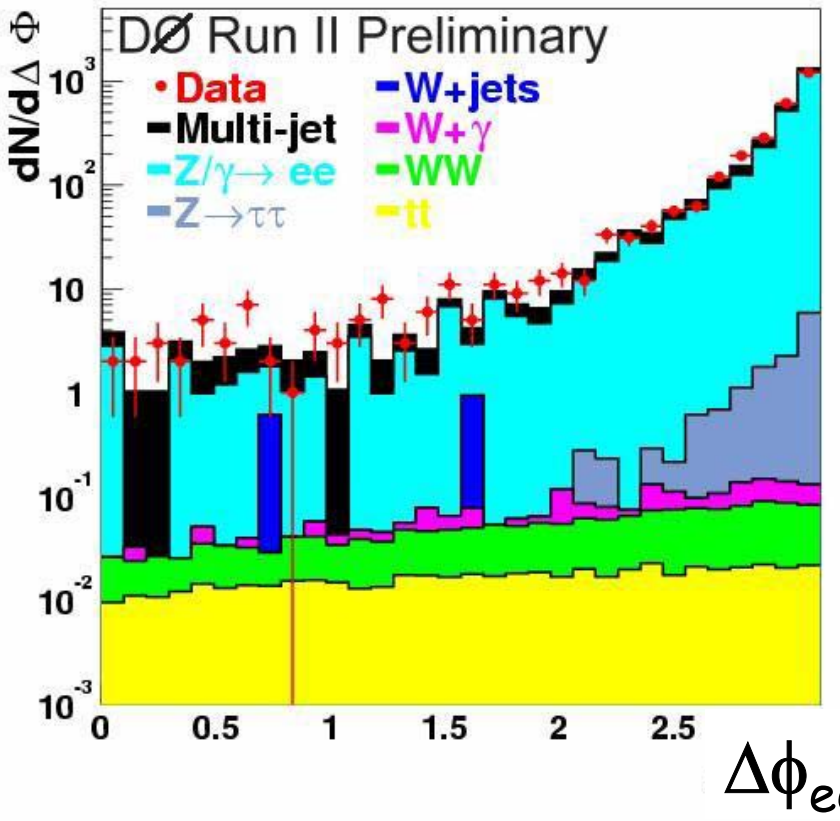
Cross section limit vs Missing E_T cut

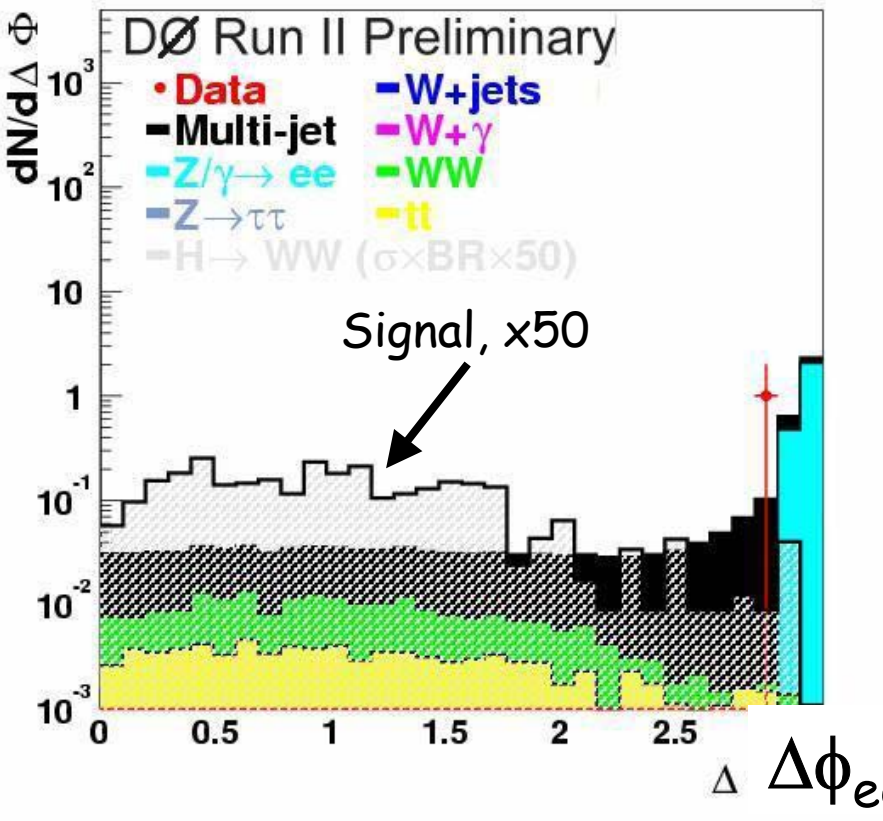
Toward the Higgs

- Know SM Higgs search at Tevatron is a long way off and difficult, but
  - Dominant backgrounds not (well) measured
  - Non SM processes at higher rates
    - Technicolor, 4th generation, SUSY enhanced, fermiophobia, …
  - Begin working on the problems now
    - Do some physics for non SM searches
    - Be ready as the luminosity increases

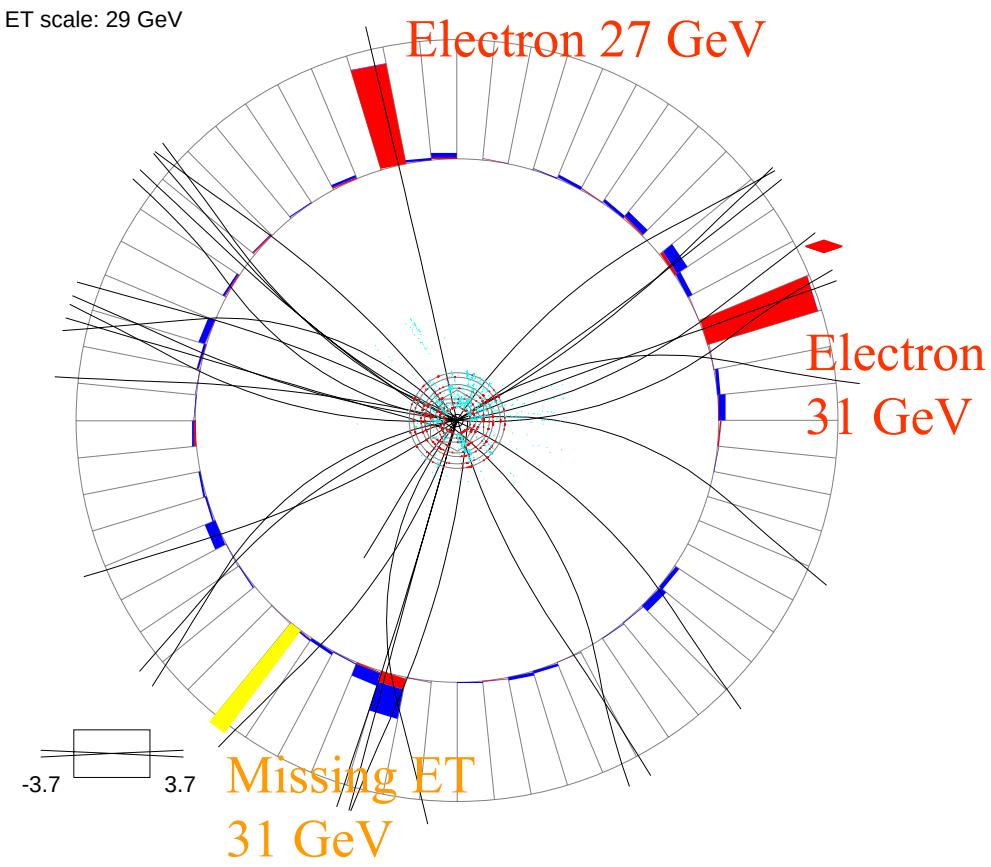
High Mass Higgs

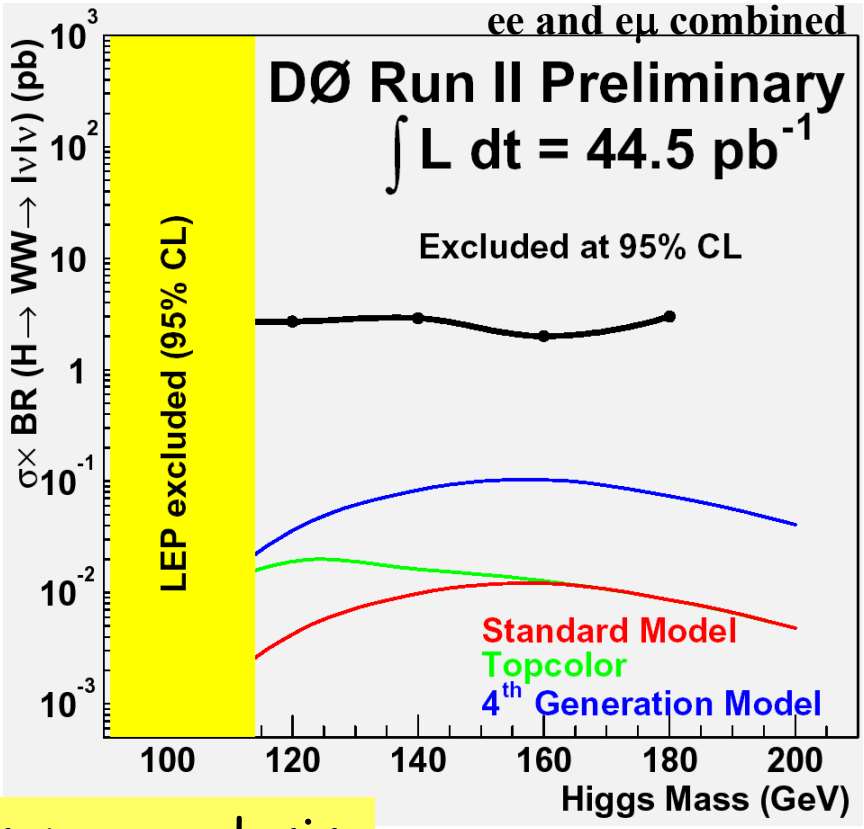
- Prototype is H→WW; W→ eν, μν
- Non-SM production: e.g. 4th generation
- Can we predict event yields? **Yes**





High Mass Higgs-like: Sensitivity

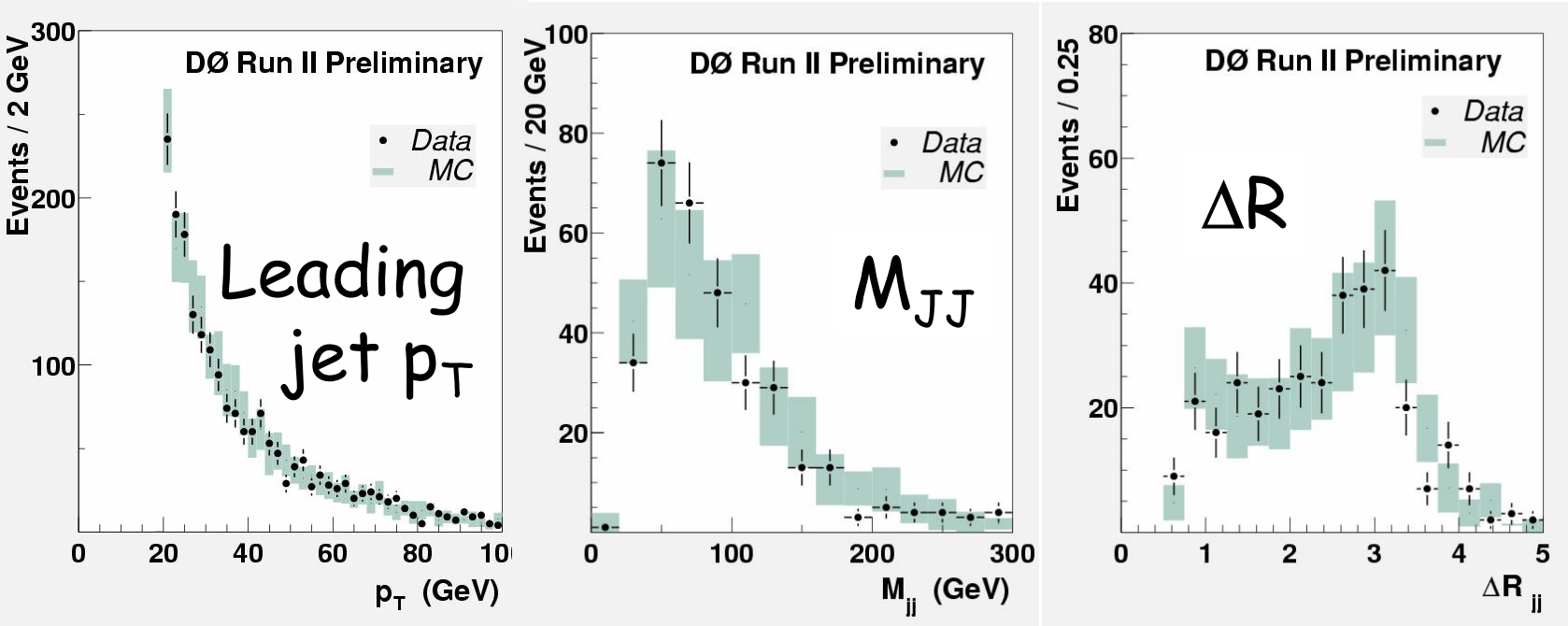




Also: μμ analysis

Low mass Higgs

- Dominant backgrounds
  - -W+bb, Z+bb
  - - tt, WZ, ZZ, …
- Start with W/Z + jets
  - - shape: data vs. Pythia
- Other comparisons
  - e.g. Alpgen & Pythia
  - normalization methods



Conclusions…

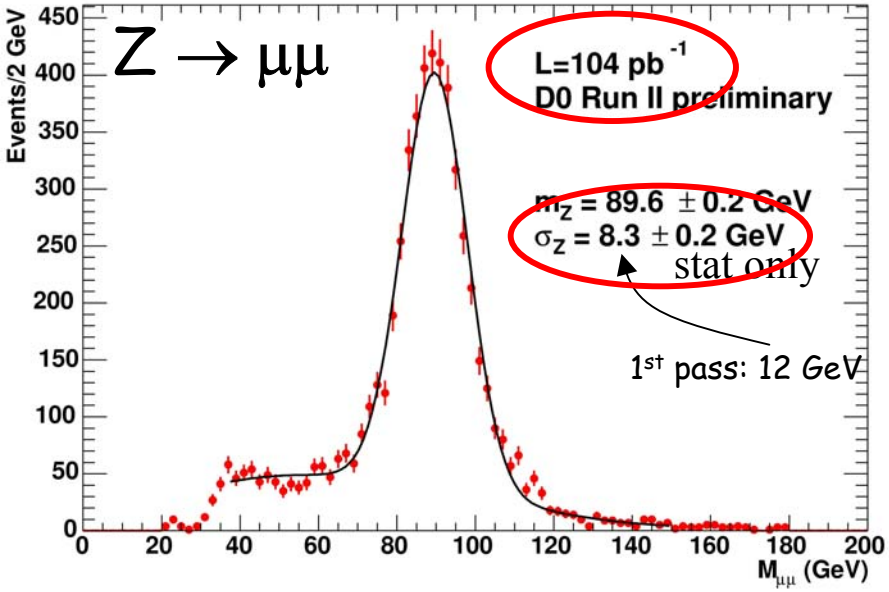
- Detector understanding well along
  - Can well describe backgrounds
- Many searches under way
  - Most final states already with results

    3rd generation soon
  - As expected, "Sensitivity/Luminosity" at or above Run I levels
  - Not shown: GMSB, LQ1, ED(μμ), Z', …

    See parallel sessions

…and a preview

- On the way: pass Run I luminosity
  - Near to a new mass region
- More than just luminosity gains
  - Significantly improved calibration & reconstruction algorithms.
  - And therefore analysis sophistication



so stay tuned…