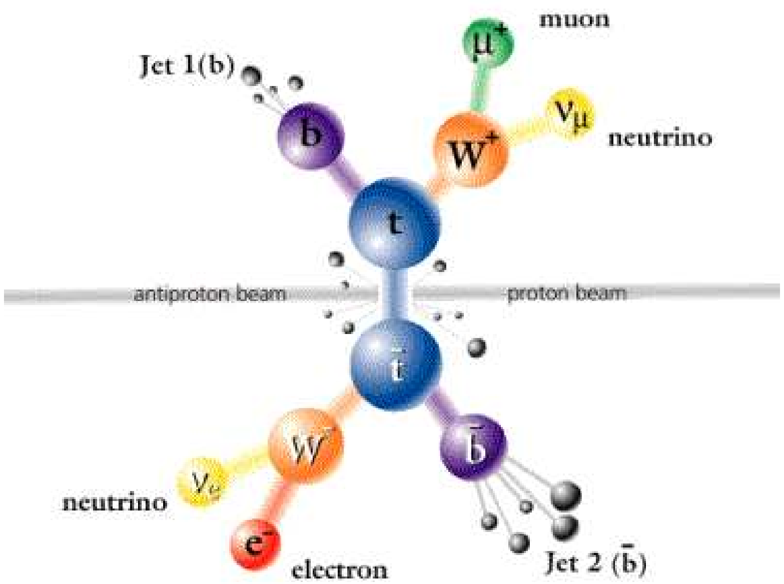
Top Quark Pair Production Cross Section in the Dilepton Channels Using b-tagging

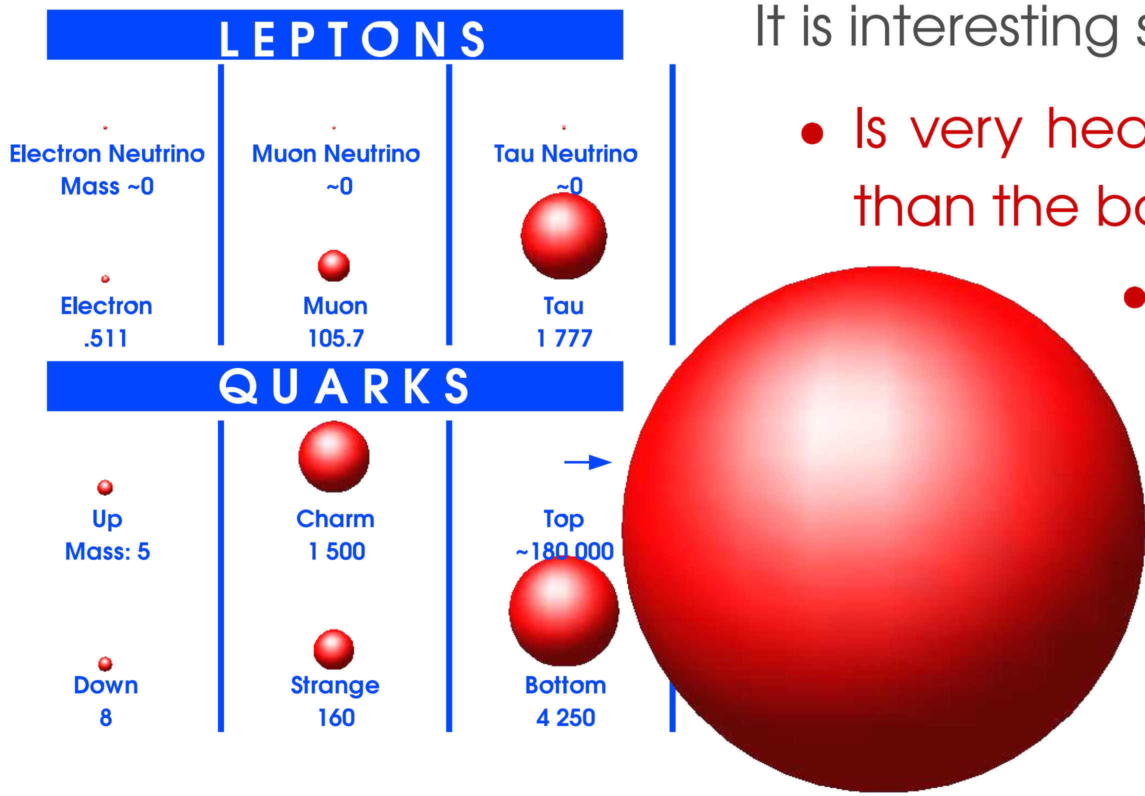


1. Top quark physics
2. Signal and backgrounds
3. Preselection
4. Secondary vertex b-tagging
5. The $e\mu$ analysis.
6. The lepton+track analysis.

Sara Lager
Stockholm University
sara@physto.se

The Top Quark

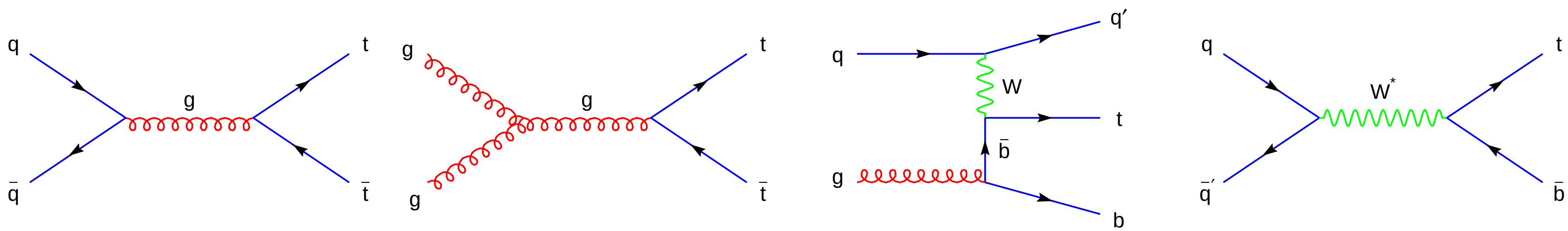
- The top quark was discovered at the Tevatron in 1995.



It is interesting since it:

- Is very heavy (35 times more heavy than the bottom quark).
- Has a very short lifetime (SM $5 \cdot 10^{-25}$ s), shorter than hadronization time.
- Will constrain the mass region allowed for the Higgs boson in the SM.

Top Production

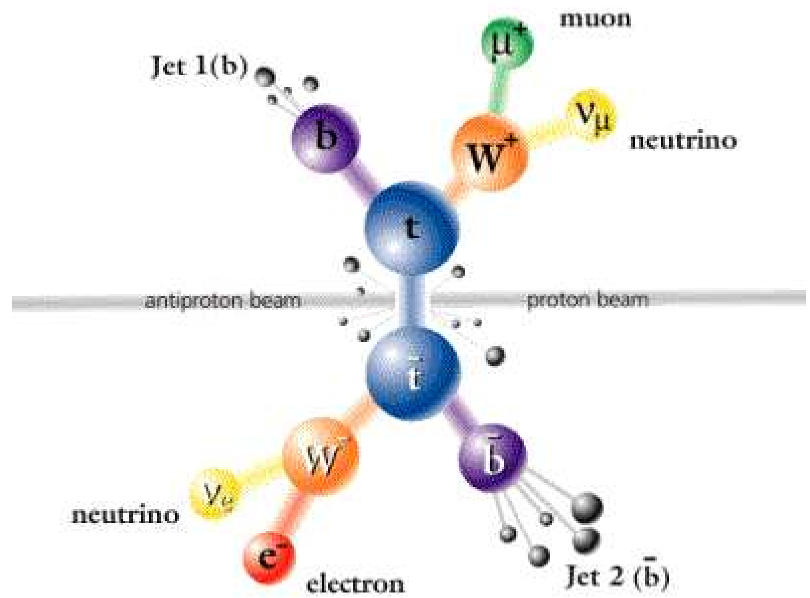


- Top quarks can be produced either in pairs via the strong interaction or singly via the weak interaction.
- Top pair production has been observed at the Tevatron.
- Single top production is yet to be observed.
- Theoretical cross section for pair production ~ 7 pb.

Top Decay

Final states:

- All hadronic Both W bosons decay hadronically. Large BR, difficult to separate from multijet QCD.
- Dilepton Both W bosons decay leptonically. Small BR but clean signature.
- Lepton+jets One W boson decays hadronically and one leptonically.



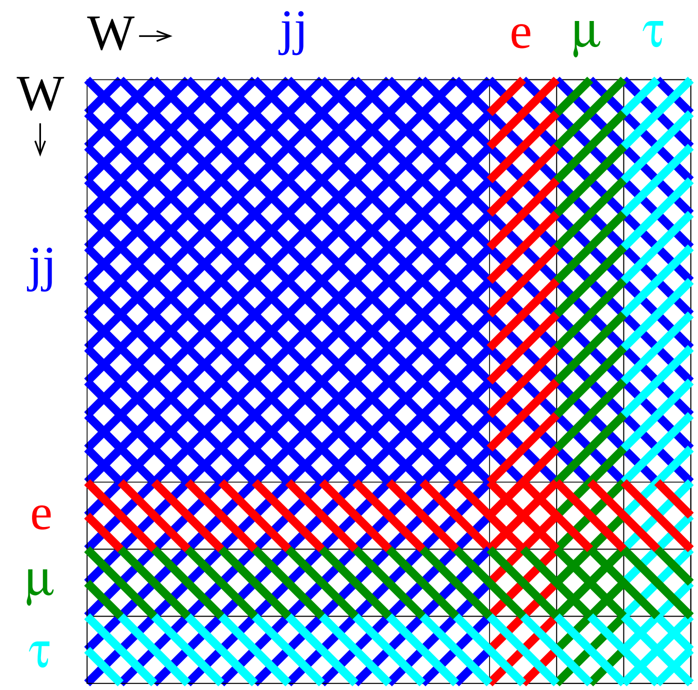
- Experimentally most relevant final states: e+jets, μ+jets, dielectron, dimuon and $e\mu$.
- Hadronic decays of tau leptons are difficult to identify. Leptonic decays of taus are included in the above.

The Dilepton Channels

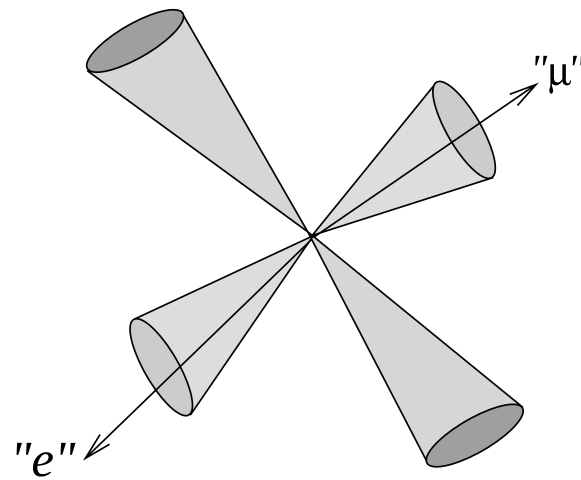
- The channels are characterized by two isolated high p_T leptons (electron or muon in our case), two b-jets and large $\not{E}_{\mathrm{T}}$.
- Extra jets can arise from initial and final state radiation.

$$t\bar{t} \rightarrow W^+b \quad W^-\bar{b}$$
$$\hookrightarrow l^+\nu_l \hookrightarrow l^-\bar{\nu}_l$$

- The $e\mu$ channel has a larger branching fraction and lower backgrounds than ee and $\mu\mu$.



Backgrounds to Dilepton Channels



Physics backgrounds:

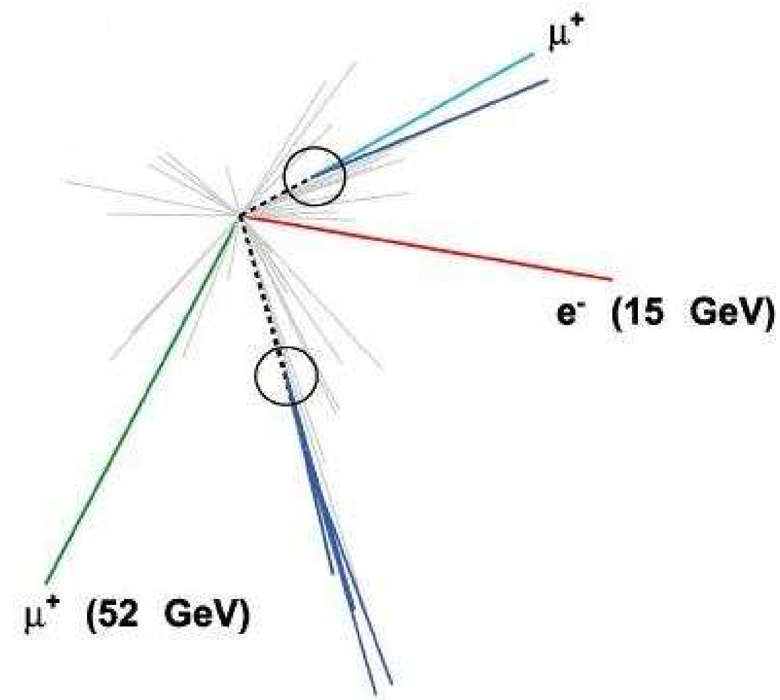
- $Z \to \tau\tau$
- WW

Instrumental backgrounds:

- QCD multijet production (jets are misreconstructed as electrons, muons in jets appear isolated).
- $W \to l\nu$ (one isolated lepton from the W decay, the other isolated lepton is faked).
- $Z \to ll$ (fake $\not\!\!E_{\mathrm{T}}$).

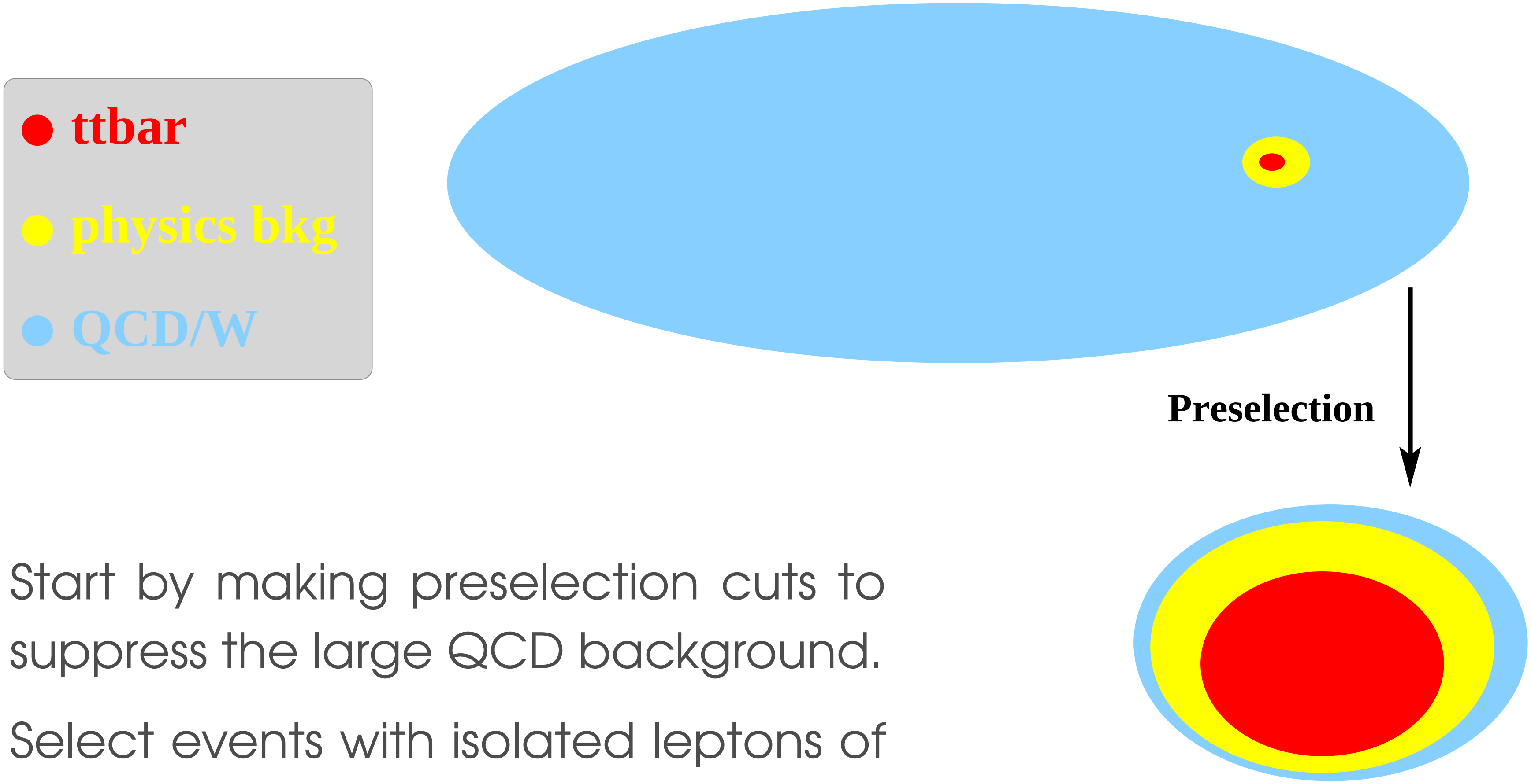
b-jet Identification

- A $t\bar{t}$ event always contains two jets from b quarks.
- Events from other physics processes very seldom contain b-jets.
- The b quark forms a long-lived B-meson which can travel a few mm before it decays.
- Identify a b-jet using secondary vertex tagging (SVT).
- A $\sim$ 35% efficiency to tag a b-jet.
- The mistag rate is $\sim$ 0.5%.



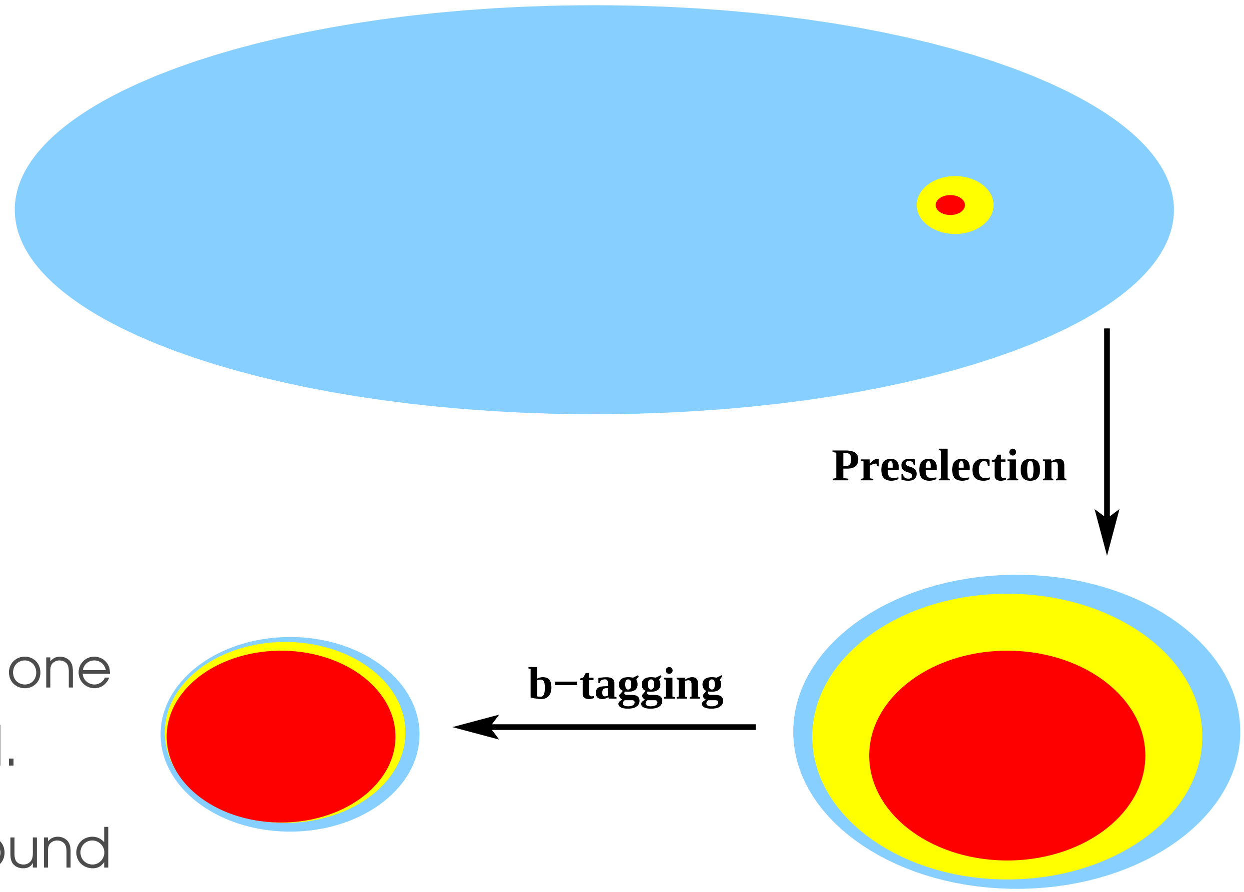
- Discriminate signal from background in top quark events by requiring at least one jet to be b-tagged.

Preselection Overview



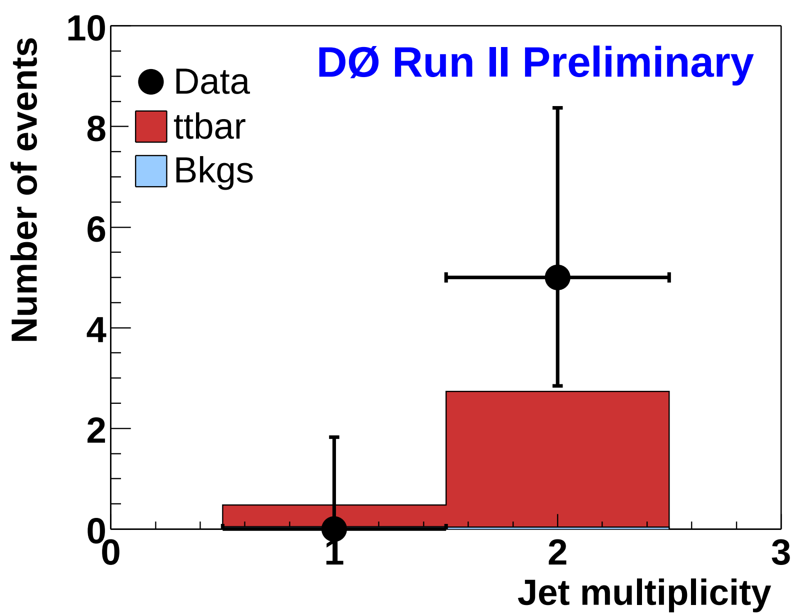
- Start by making preselection cuts to suppress the large QCD background.
- Select events with isolated leptons of high quality.

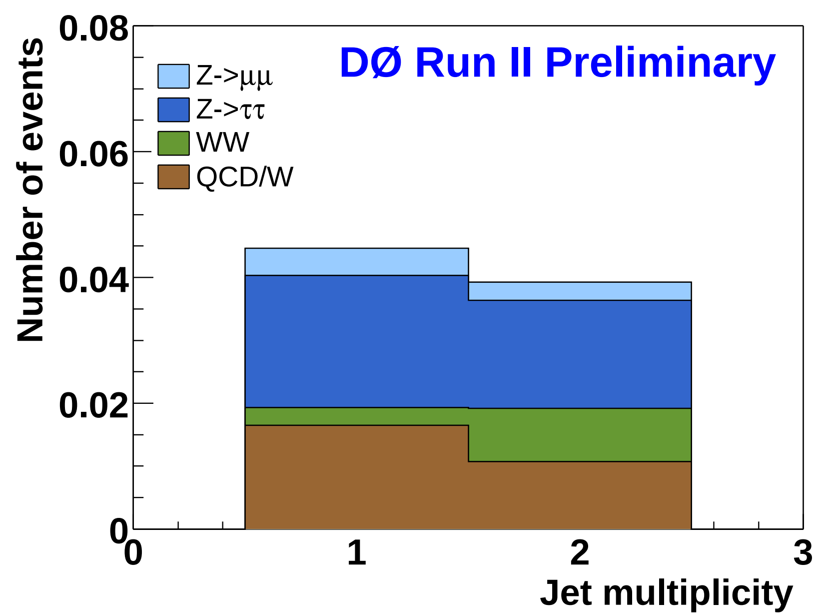
Tagging Overview



- Require at least one jet to be b-tagged.
- Powerful background discrimination.

The $e\mu$ Analysis





$$\sigma_{t\bar{t}} = 11.1^{+5.8}_{-4.3}(\mathrm{stat}) \pm 1.4(\mathrm{syst}) \pm 0.7(\mathrm{lumi})\ \mathrm{pb}$$

- The statistical error dominates.
- Major systematic uncertainties are related to b-tagging and JES.

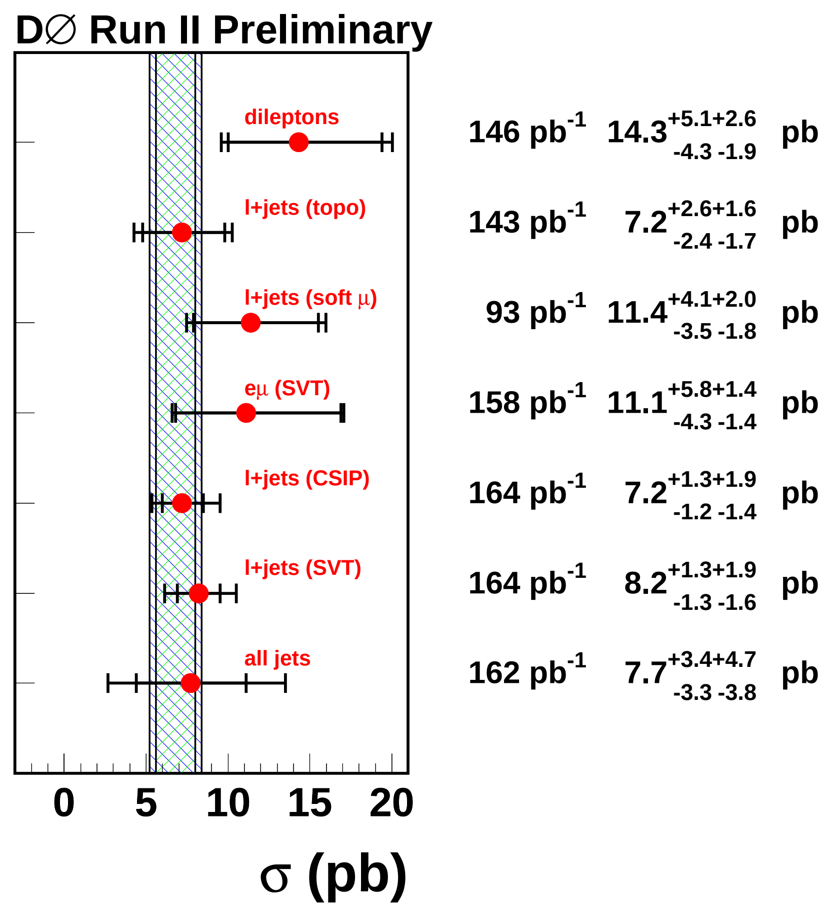
Summary - $e\mu$ Analysis

- First time in DØ to use b-tagging in a dilepton channel.

- Results were presented at APS in May and ICHEP in August.

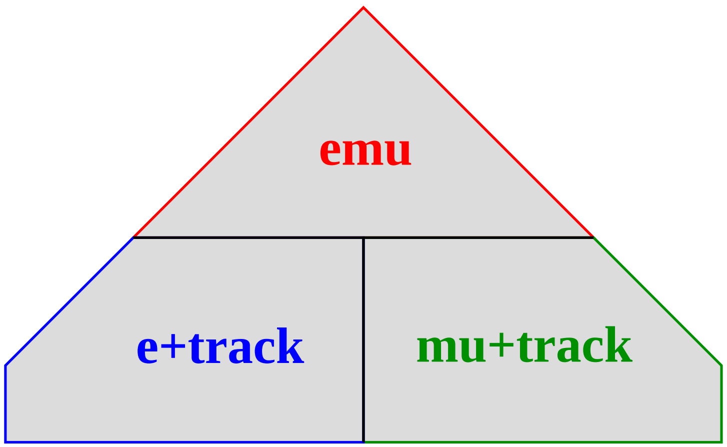
- Based on 158 pb^{-1}. At present DØ has 700 pb^{-1} on tape.

- No need to use b-tagging in the $e\mu$ channel to reject background.



The Lepton+track Analysis

- The selection should be made looser in order to reduce the error on the cross section.
- The largest inefficiencies come from electron and muon ID.
- Move to lepton+track selection.
- Require one well identified lepton and one high p_T isolated track.
- Gain acceptance since tracker has a better coverage than the calorimeter and muon systems.
- Selection is also sensitive to taus.



- Veto $e\mu$ in the lepton+track channels, and combine with the topological $e\mu$ analysis.

Outlook - Lepton+track Analysis

- Work on this analysis started this winter, and we hope to have a result for the summer/fall.
- Expected signal with 365 pb^{-1} is show to the right.