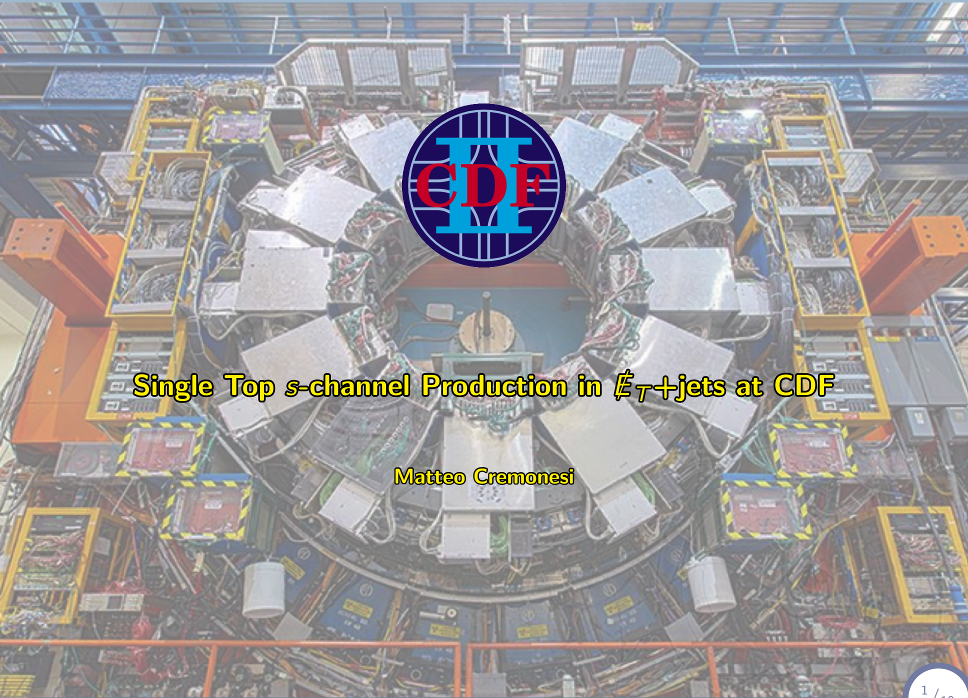


Single Top *s*-channel Production in $\not\!\!E_T$+jets at CDF

Matteo Cremonesi

Introduction/1

Single Top Quark Production

The top quark can be produced:

- in $t\bar{t}$ pairs through strong interaction;
- as **single top via EW interaction**.

Observed by CDF and DØ in 2009:

- T. Aaltonen, et al. [CDF collaboration], Phys. Rev. Lett. 103, 092002 (2009)
- V.M. Abazov et al. [DØ Collaboration], Phys. Rev. Lett. 103, 092001 (2009)

Two dominant processes:

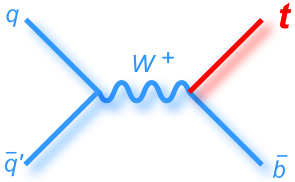
- t-channel;
- s-channel.
  - Wt-channel has a small cross section at the Tevatron.

	σ(pb)
s-ch	1.05 ± 0.05
t-ch	2.08 ± 0.08
Wt-ch	0.25 ± 0.03
$t\bar{t}$	7.08 ± 0.49

Cross sections at Tevatron considering $m_t = 173\text{GeV}/c^2$
arXiv:1205.3453 (May 2012)

Introduction/2

Single Top *s*-channel



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- It has not been observed yet;
  - DØ recently claimed a 3.7 σ evidence[1].
- Difficult at LHC;
  - $\sigma^{SM}_{s-ch} \cong$ 5 pb, $\sigma^{SM}_{t-ch} \cong$ 65 pb at LHC 7 TeV.
- Deviations from SM prediction may indicate new physics, like the existence of a W' or of a charged Higgs boson[2].

At CDF, two statistically independent samples are analyzed:

- the **lepton+jets** sample;
  - one isolated lepton, missing transverse energy and jets are required.
- the **$\not\!\!E_T$+jets** sample.

[1] http://theory.fnal.gov/jetp/talks/WineAndCheese_20130621_v6.pdf

[2] T. M. P. Tait and C. P. Yuan, Single top quark production as a window to physics beyond the standard model, Phys. Rev. D 63 (2000) 014018.

s-channel in $\not{E}_T$+jets/1

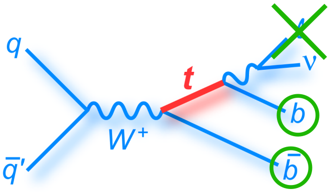
Event Selection

We analyze the **full CDF Run II dataset** (9.5 fb^{-1}) looking for single top s-channel events when t$\rightarrow$Wb and W decays leptonically, but:

- there are no identified leptons.
- there are τs decay hadronically.

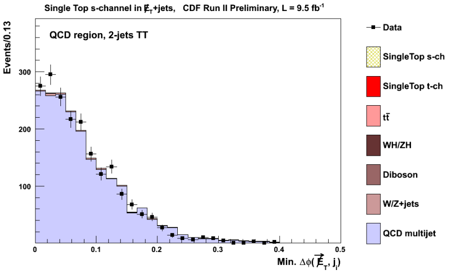
Events are accepted on line by the trigger if they contain large missing transverse energy ($\not{E}_T$) and at least two jets. Off line we require:

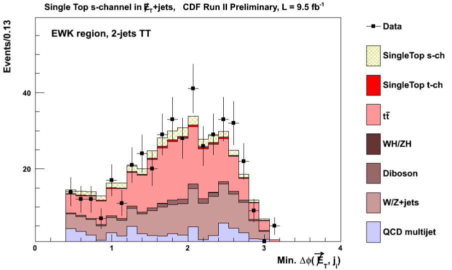
- Large $\not{E}_T$;
- **No isolated leptons**;
  - We use loose identification cuts to reject events with isolated leptons.
- 2 or 3 jets, one or two identified as ***b*-jets**;
- $\Delta\phi(\not{E}_T, j_2) > 0.4$.



s-channel in $\not{E}_T$+jets/2

Signal and Background Composition and Model





TT: double tight *b*-tag region.

Composition:

- QCD multijet production is by far the largest background contribution;
- t-channel and WH/ZH are included as backgrounds.

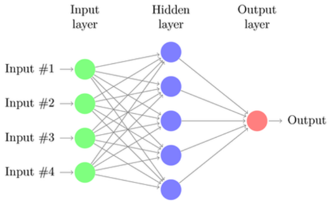
Model:

- Signal: POWHEG
- t-channel: POWHEG
- W/Z+jets: ALPGEN, normalization left unconstrained in the final fit
- $t\bar{t}$, WW/WZ/ZZ, WH/ZH: PYTHIA
  - $t\bar{t}$ is normalized to the measured cross section.

The parton showering is performed by PYTHIA.

QCD multijet is data-derived, validated in several control regions:

- **QCD region**: QCD enriched region, $\Delta\phi(\not{E}_T, j_2) < 0.4$;
- **EWK region**: defined requiring a reconstructed lepton.



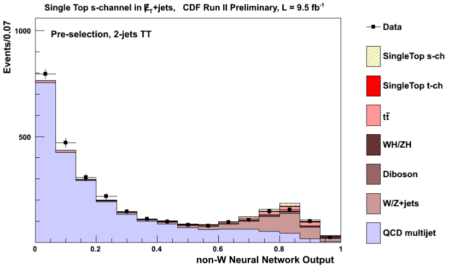
Since we are looking for a small signal in a very large background, we need to use **Multivariate Techniques**. In this analysis we employ:

- a Neural Network (NN) **QCD veto**, to reject the QCD multijet production as much as possible. It reduces this background by an order of magnitude;
- two other dedicated NNs:
  - to distinguish signal from **W/Z+jets** production;
  - to distinguish signal from $t\bar{t}$ background.

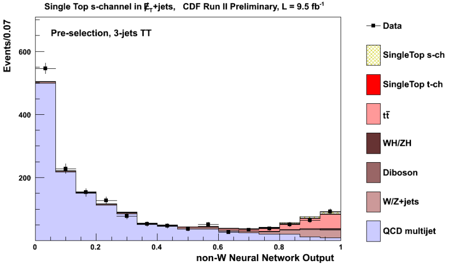
combined together in a **Final Discriminant** used to fit for signal.

Discriminant Output/1

NN QCD Veto



2-jets sample, double tight *b*-tag

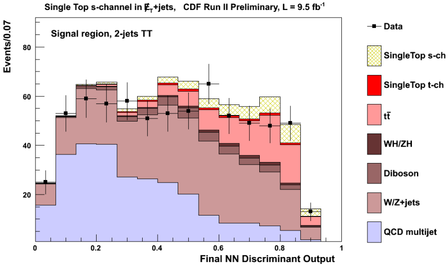


3-jets sample, double tight *b*-tag

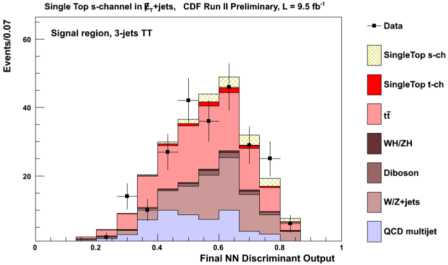
After appying the QCD veto, we derive the QCD multijet normalization in the rejected region.

Discriminant Output/2

Final Discriminant



2-jets sample, double tight *b*-tag



3-jets sample, double tight *b*-tag

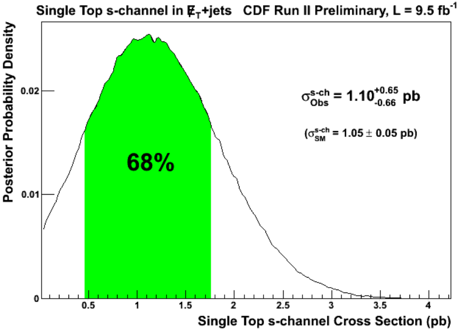
We fit the data distribution of the final discriminant to extract the single top *s*-channel cross section.

Results

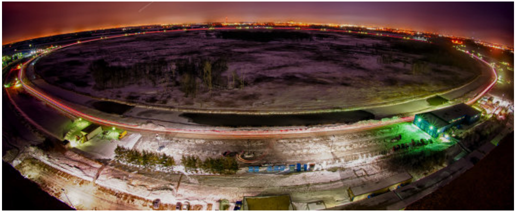
Cross Section Measurement

- Bayesian approach: binned likelihood;
- Uniform, non-negative prior for signal cross section;
- All the uncertainties and their correlations taken into account
- Expected result:
  $\sigma^{s-ch}_{exp} = 1.00^{+0.58}_{-0.60} \times SM$ (stat+syst).
- Measured single top s-channel cross section:
  $\sigma^{s-ch}_{obs} = 1.10^{+0.65}_{-0.66}$ (stat+syst) pb.

This result is consistent with the standard model cross section $\sigma^{s-ch}_{\rm SM} = 1.05 \pm 0.05$ pb.



Summary



- Measured the single top s-channel cross section in $\not\!\!E_T$+jets with the full CDF dataset, 9.5 fb^{-1};
- First time that a single top *s*-channel measurement is performed in the $\not\!\!E_T$+jets final state;
- A legacy measurement from CDF/Tevatron;
- The CDF *s*-channel measurement is lepton+jets is on-going, will combine the results soon;
- Combination with DØ measurement is planned.