Top W Helicity Measurement (lepton p_T method) Update

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synopsis

- We intend to measure F_0 and F_R in the ~ 200 pb^{-1} l+jets and l+track samples.
- We do this by analyzing the charged-lepton p_T spectra of those samples.
- In this talk I'll discuss what's new to this analysis since LP 2003.
- I'll also present our plan for blessing this winter.

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The Likelihood Function

- separation into sub-samples
- per-lepton probability density
- trigger and acceptance bias correction

Parameter and Confidence Interval Estimation

- minimization procedure
- the question of non-physical confidence intervals
- likelihood-ratio method
- the Feldman-Cousins method
- policy

Samples

- lepton+track
- lepton+jets

Conclusions

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separation into sub-samples

- The overall form of the likelihood function will be unchanged from LP 2003.
- However, we are going to separate the likelihood by lepton type,

$$\mathscr{L} = \prod_{s=1}^{S} G(\beta_s; \mu_s, \sigma_s) \prod_{t=1}^{T_s} \prod_{i=1}^{N_{st}} P_{st}(x_i; F_0, F_R, \beta_s).$$

- In this way we avoid "throwing away information."
- Also, our model of signal and bg. is more reliable.
- Sensitivity is improved; potential for bias is reduced.

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per-lepton probability density

- The per-lepton PDF is composed of PDFs which model the signal & bg. components of the sub-samples
- The trigger-lepton PDFs are weighted according to their trigger efficiency as a fcn. of charged-lepton p_T.

$$P_{st}(x_i; F_0, F_R, \beta_s)$$
$$= (1-\beta_s)\{F^{\rm obs}_{0,st}(F_0, F_R)P_{st}(x_i; 0) + F^{\rm obs}_{R,st}(F_0, F_R)P_{st}(x_i; +1)$$
$$+(1-F^{\rm obs}_{0,st}(F_0, F_R)-F^{\rm obs}_{R,st}(F_0, F_R))P_{st}(x_i; -1)\} + \beta_s P_{st}(x_i; \text{b.g.})$$

- Signal PDFs are red, observed signal fractions are blue.

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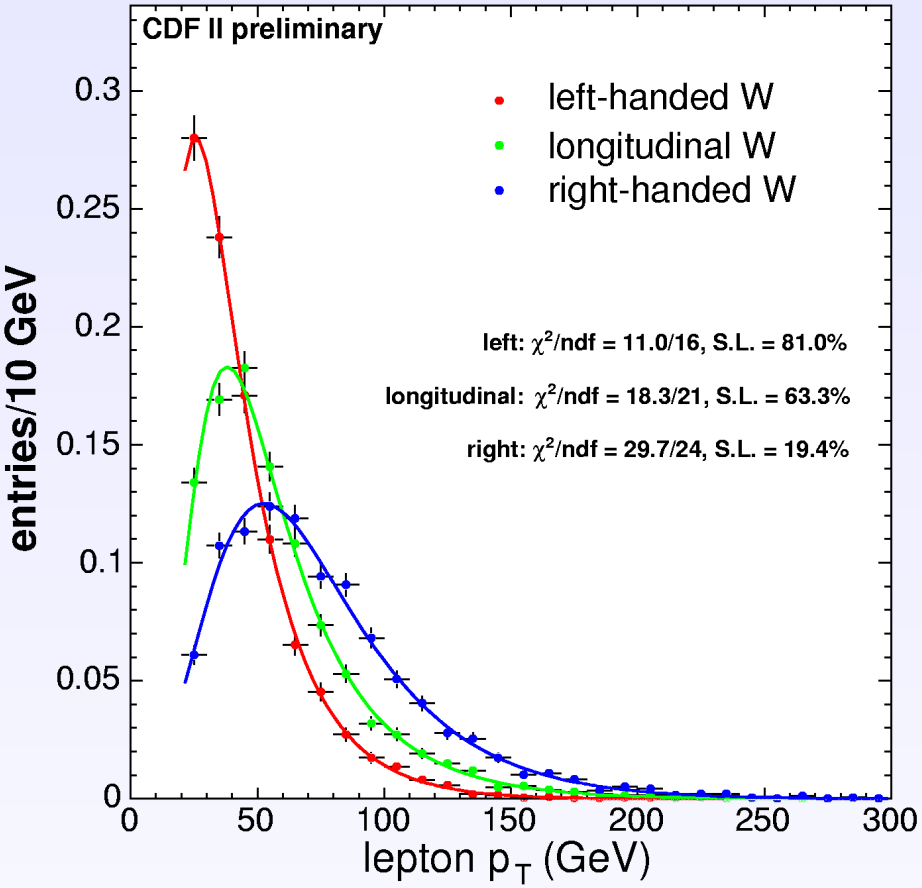
trigger and acceptance bias correction



- The minimum p_T requirement biases us towards higher average helicity.
- Inefficiency from the trigger at lower-p_T has a similar effect.
- We estimate these effects and correct for them in the likelihood function.

$$F_{0,st}^{\mathrm{obs}}(F_0, F_R) = \begin{cases} \left(1 + \frac{A_{L,st}}{A_{0,st}}\left(\frac{1}{F_0} - 1\right) + \frac{F_R}{F_0}\left(\frac{A_{R,st}}{A_{0,st}} - \frac{A_{L,st}}{A_{0,st}}\right)\right)^{-1} & F_0, F_R \in [0,1] \\ F_0 & \text{otherwise} \end{cases}$$

$-\log(\mathscr{L})$ minimization

- We have completely re-written the code which negotiates minimization of $-\log(\mathscr{L})$ by `MINUIT`.
- We've abandoned `RooFit`; it was just too cumbersome, given the complexity of our likelihood fcn.
- We now use `MINUIT` (`MIGRAD`, really) directly to find $\hat{F}_0$ and $\hat{F}_R$.

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$-\log(\mathscr{L})$ minimization (continued)

$$-\log(\mathscr{L}) = \sum_{s=1}^{S} \frac{(\beta_s - \mu_s)^2}{2\sigma_s^2} - \sum_{t=1}^{T_s} \sum_{i=1}^{N_s t} \log(P_{st}(x_i; F_0, F_R, \beta_s)) + \text{constant}.$$

$$P_{st}(x_i; \mathbf{p}) \sim AP(x_i; a) + (1 - A)P(x_i; b)$$

- We now properly handle situations where $P_{st}(x_i; \mathbf{p}) \leq 0$; the new fit procedure is more robust.
- We use `MINOS` to estimate confidence intervals according to the likelihood-ratio method.
- Whether or not we will report the likelihood-ratio intervals is another story....

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confidence interval estimation

- Last time we had trouble where some of the data was very unlikely, given our model.
- $F_0 \in [0, 1]$, however in one case, our estimator $\hat{F}_0$ was well outside the defined range.
- In Run I we had a situation where the estimator was in the defined range, but the 1σ interval was not.
- We've adopted a policy which will avoid these problems and allow us to make coherent statements about the true values F_0 and F_R for all possible outcomes.

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likelihood-ratio method

- With the likelihood-ratio method of $s\sigma$ CI estimation, one finds the parameters $\mathbf{p'}$ that form the contour

$$\log(\mathscr{L}(\mathbf{p'})) = \log(\mathscr{L}(\hat{\mathbf{p}})) - s^2/2.$$

- We use `MINOS` to estimate these intervals
- This method is conventional, but doesn't generally produce intervals within the physically-allowed range, $[0, 1]$.
- If, given the data, this method fails to produce intervals within $[0, 1]$ we'll apply the Feldman-Cousins method.

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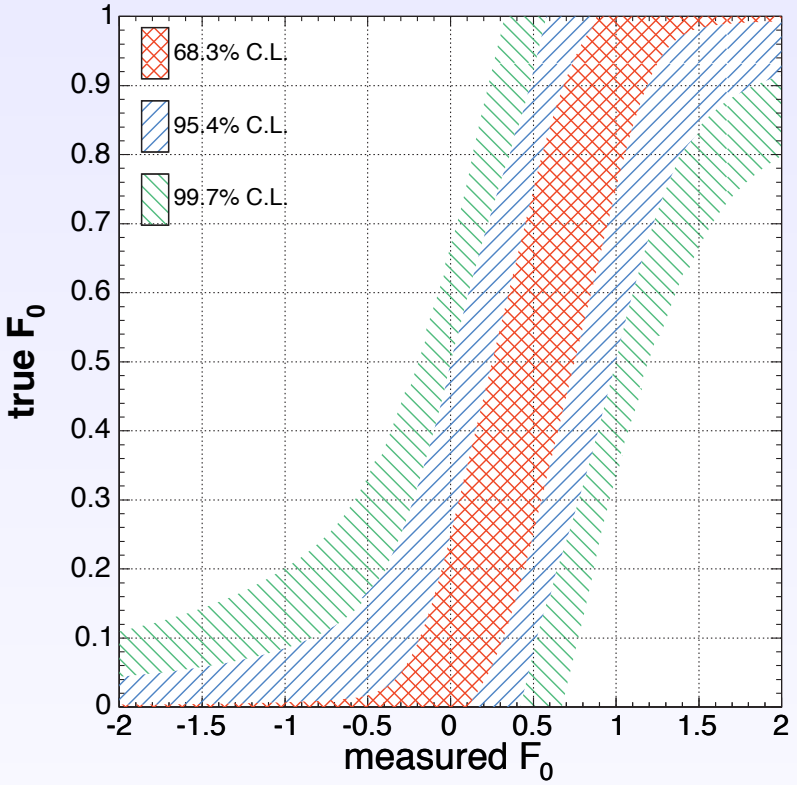
the Feldman-Cousins method

- Where the likelihood-ratio fails to produce a 68% CL interval within the defined range we will apply the Feldman-Cousins method.
- By construction, this method always produces intervals within the defined range.
- We expect we'll use this to set an upper limit on F_R.
- We already have code which calculates FC intervals given a parameterization of *a-priori* experimental sensitivity.



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confidence interval policy

- Where the likelihood-ratio fails to produce a 68% CL interval within the defined range we will apply the Feldman-Cousins method.
- We will also use FC to set upper/lower limits at the 95% or 99% CL, where appropriate.
- An alternative is to use only FC intervals. I think this has merit, especially if pseudo-experiments reveal an uncorrected systematic bias.
- This question is still somewhat open, but not for long.

lepton+track dataset

- We're working to incorporate the lepton+track samples and background estimates into this analysis.
- The l+track group has provided us with histograms of lepton p_T which we'll use model the background content of those samples.
- They have also run their event selection on the fixed-helicity `HERWIG 6.5x` MC samples and provided us with histograms to model the signal.
- We thank them for their kind assistance.

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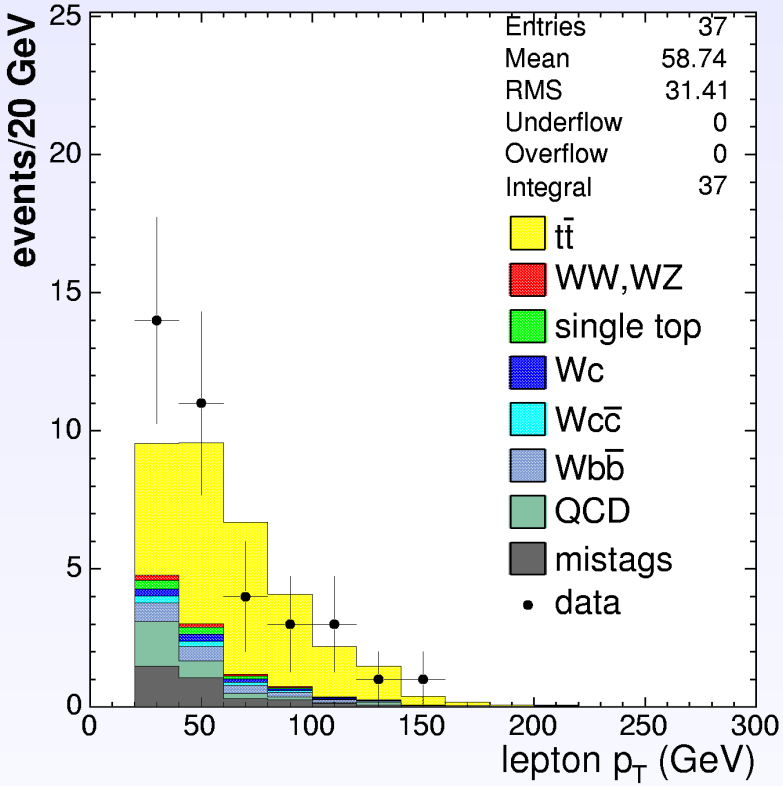
lepton+jets dataset

- We're investigating the use of "optimized" event selection (L4 or L5 jet-corrected $\not\!\!E_T$, L4 jet $E_T > 20 GeV$, $\Delta\phi$ cut).
- Stephen says he expects the Method 2 b.g. estimates for the $\sim 170\ pb^{-1}$ l+jets dataset will soon be blessed.
- Everything else is (more or less) in hand (e.g. lepton p_T shapes from standard and custom MC samples, events from the data).



conclusions

- We're moving ahead and expect to bless in time for Moriond.
- We will not ask the Top Group to bless this analysis until it is fully vetted.
- Once the templates are in hand, estimates of systematic uncertainty should come quickly (we've done it once already).
- No central values 'till the pre-blessing.
- Please visit the analysis web-page by clicking here.

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