CDF/D0 Combined Upper Limit on Higgs Production

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What's New

- Fix the data histogram in D0: $WW \rightarrow \mu\mu$ at mH=150 GeV/c^2 from Wade
- Rerun the observed and expected limited
- Impact of systematic on the limits
- Reminder: A Bayesian framework is used to compute the upper limit with all 13 channels combined.

Individual and Combined Limits

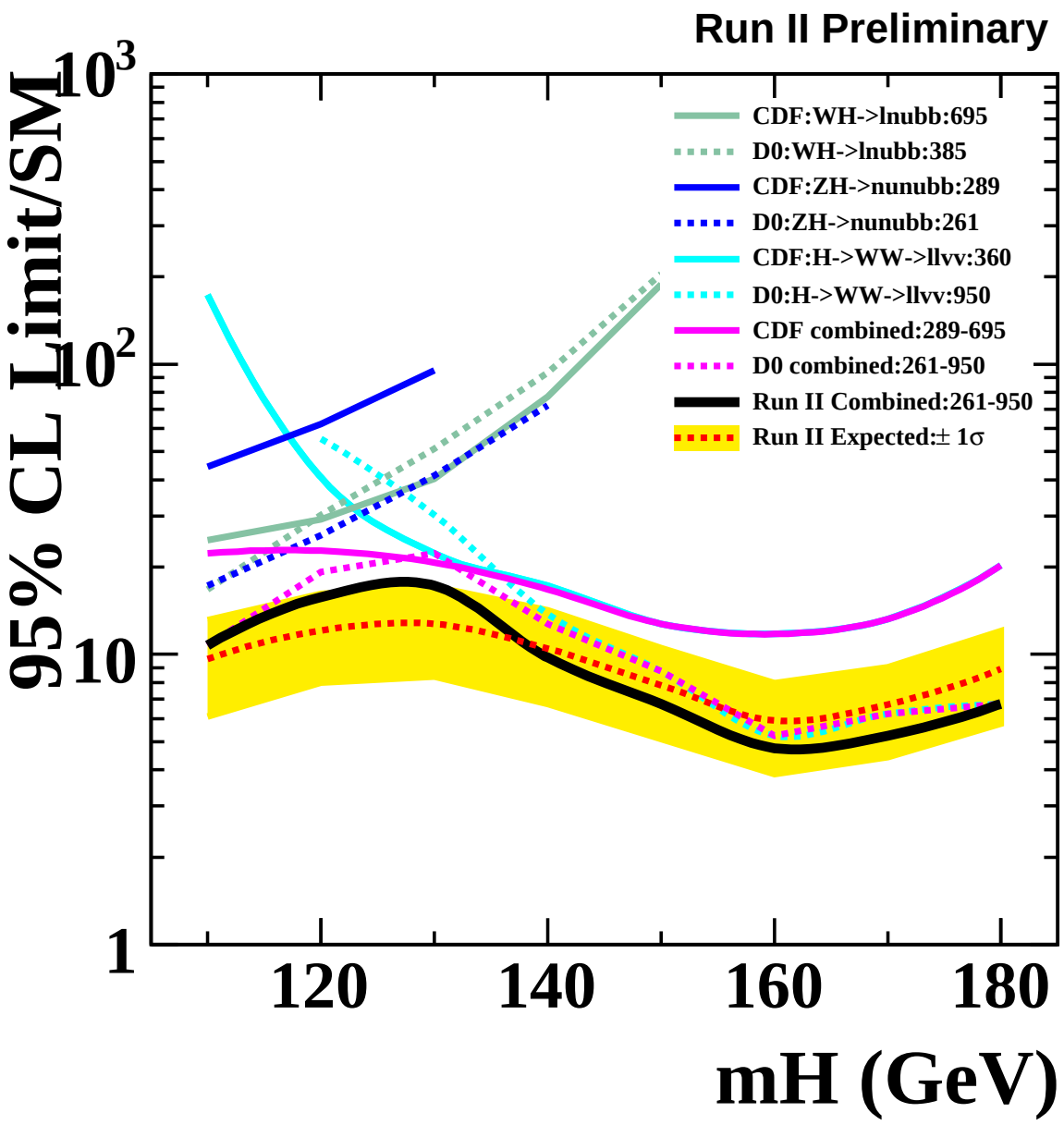
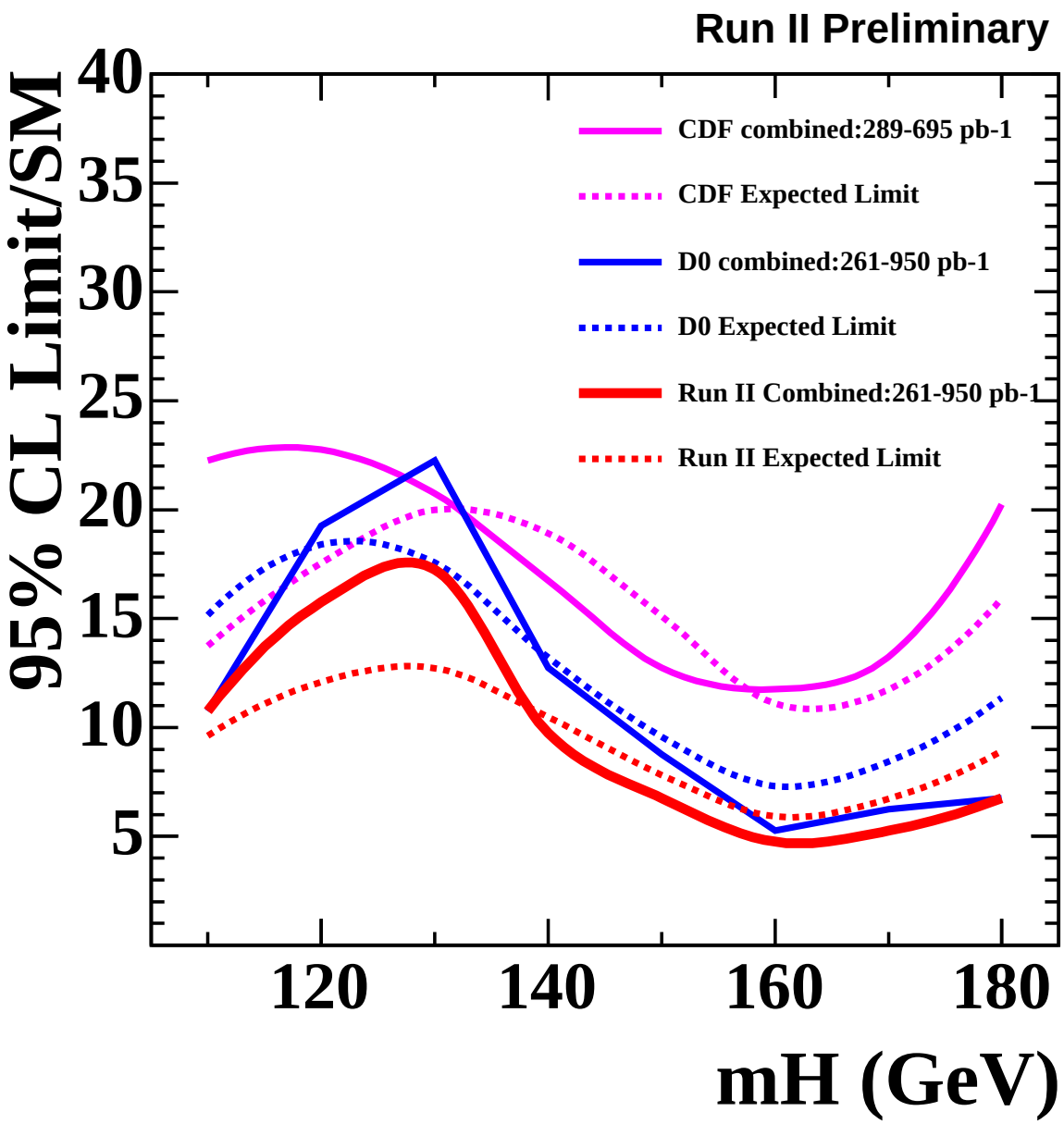


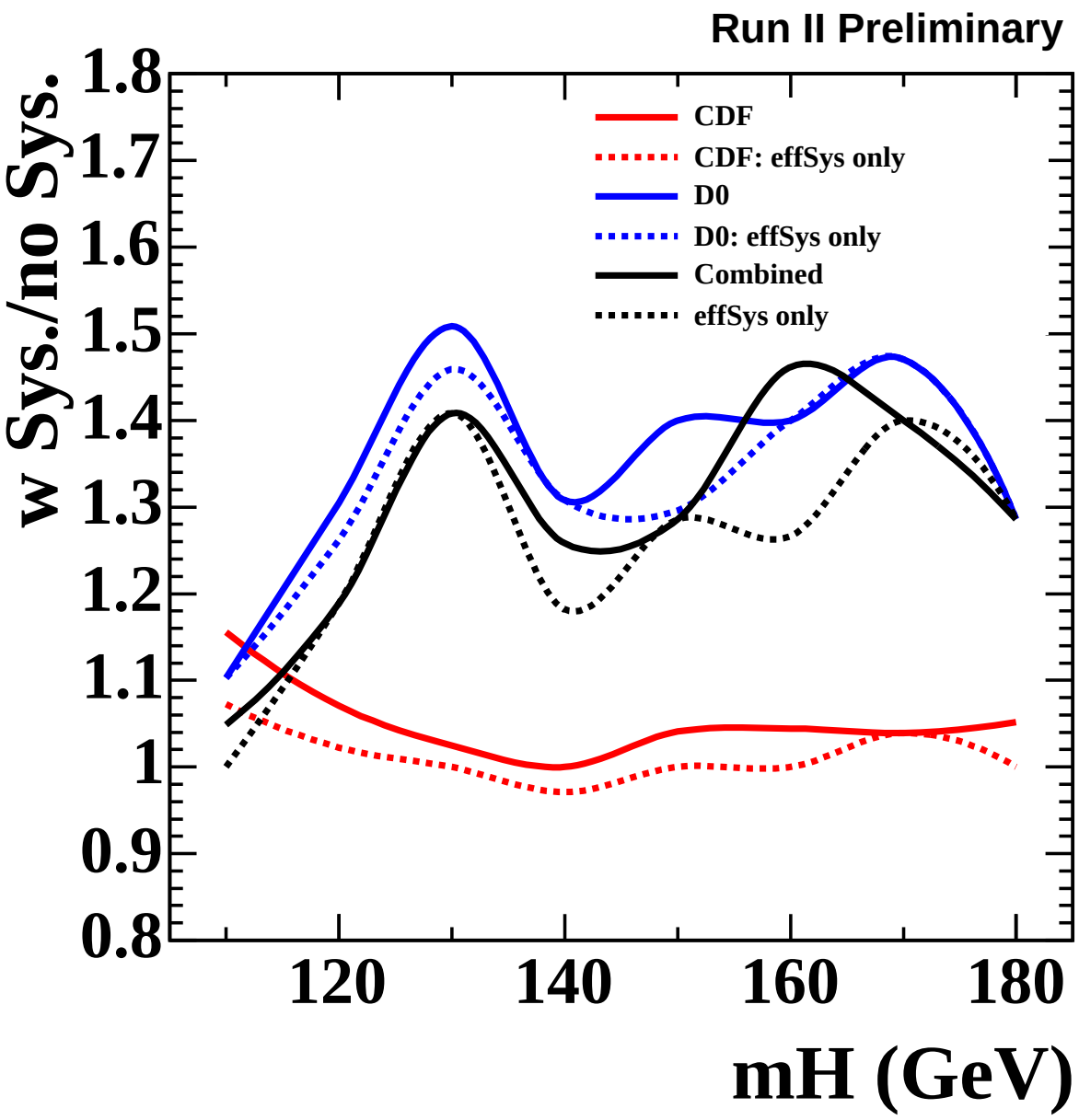
Table of Limits

mh	110	120	130	140	150	160	170	180
CDF:WH	25	29	40	77	189			
D0:WH	17	30	51	94	205			
CDF:ZH	44	62	95					
D0:ZH	17	26	41	72				
CDF:WW	174	41	22	17	13	12	13	20
D0:WW		55	30	14	9	5	6	7
CDF:Comb	22	23	21	17	13	12	13	20
Expected	14	18	20	19	15	11	12	16
D0:Comb	11	19	22	13	9	5	6	7
Expected	15	18	18	13	10	7	8	9
Tev Comb	11	16	17	10	7	5	5	7
Expected	10	12	13	10	8	6	7	9

Observed and Expected Limits



Impact of Systematic on the Limits



Conclusion

- We obtain a combined Higgs limit from CDF/D0 using a Bayesian method.
- The returned limit for each individual channel seems reasonable after fixing D0:$WW \to \mu\mu$ problem.
- The combined limit and expectation of Pseudo-experiments are also consistent.
- The impact of systematic seems small in the CDF model because the correlations between signal and background are minimized.

BACKUP SLIDES

Likelihood Function

- $\mathcal{L}(R, \vec{s}, \vec{b}|\vec{n}) = \prod_{i=1}^{Nc} \prod_{j=1}^{Nbins} \frac{\mu_{ij}^{n_{ij}} \cdot e^{-\mu_{ij}}}{n_{ij}!}$
  - $R = \sigma \cdot B/SM$; s= $\sigma_i^{SM} \cdot B^{SM} \cdot \epsilon_{acc} \cdot L$.
  - $\vec{b}$: backgrounds
  - $\vec{n}$: data
  - N_C: channels
  - N_{bins}: histogram bins.
  - $\mu_{ij} = R \cdot s_{ij} + b_{ij}$.

- The expected signal event depends on:
  luminosity, btag sf, lepton id, jes, ISR/FSR+PDF, and the rest uncertainties

- The background consists of:
  HF, Mistag, top, non-W, diboson (WW), and other.

Priors, Posterior Densities and Upper Limit on R

- The priors for efficiencies and backgrounds are truncated Gaussian densities with its expected value within its uncertainty.

- Assign a flat prior to the number of Higgs events, instead of Higgs xsec.
  $\pi(R, \vec{s}, \vec{b}) = s_{tot} \cdot \theta(R \cdot s_{tot}) \cdot \pi(\vec{s}) \cdot \pi(\vec{b})$

- Posterior density:
  $p(R|\vec{n}) = \frac{\int d\vec{s} \int d\vec{b} \mathcal{L}(R,\vec{s},\vec{b}|\vec{n}) \cdot s_{tot}}{\int dR \int d\vec{s} \int d\vec{b} \mathcal{L}(R,\vec{s},\vec{b}|\vec{n}) \cdot s_{tot}}$

- 95% Upper Limit:
  $\int_0^{R_{0.95}} p(R|\vec{n}) dR = 0.95$

Source of Correlated Systematic (CDF)

Channels	$l\nu b\bar{b}_S$	$l\nu b\bar{b}_D$	$\nu\nu b\bar{b}$	W^+W^-
Luminosity (%)	6.0	6.0	6.0	6.0
btag SF(%)	5.3	16.0	6.3	0.
Lepton ID (%)	2.0	2.0	2.0	3.0
JES (%)	3.0	3.0	8.0	1.0
I(F)SR+PDF(%)	4.0	10.0	2.0	5.0
Trigger (%)	0.0	0.0	0.02	0.0
Backgrounds				
HF (%)	33.0	34.0	0.	0.
Mistag (%)	22.0	15.0	16.0	0.
Top (%)	13.5	20.0	18.0	0.0
QCD (%)	17.0	20.0	-34.0	0.
Diboson (%)	16	25	18	11
Others (%)	0.	0.	0.	-(12-18)

- The positive value means correlated, the negative value means uncorrelated
- The results seems insensitive to these correlations changing from 100% to 0%
- Common to D0: 4% on Luminosity; 8% on σ_t; 6% on σ_{EW}; 10% on $\sigma_{H\to WW}$

Source of Signal Systematic (D0)

0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 ! DZero_sig_Lumi_pos 0

0.05 0.05 0.05 0.05 0.05 0.05 0 0 0 ! DZero_sig_JetID_pos 1

0.04 0.04 0.04 0.04 0.06 0.06 0.04 0.04 0.03 ! DZero_sig_JES_pos 2

0.03 0.03 0.03 0.03 0 0 0 0 0 ! DZero_sig_JetMult_pos 3

0.035 0.035 0.035 0.035 0 0 0 0 0 ! DZero_sig_JetMLM_pos 4

0.03 0.03 0.03 0.03 0.01 0.01 0 0 0 ! DZero_sig_Taggability_pos 5

0.055 0.055 0.04 0.055 0.03 0.07 0 0 0 ! DZero_sig_bTag_HF_pos 6

0.03 0.03 0 0 0 0 0 0 0 ! DZero_sig_EMTrigger_pos 7

0.03 0.03 0 0 0 0 0.03 0.02 0 ! DZero_sig_EMID_pos 8

0.04 0.04 0 0 0 0 0.02 0.02 0 ! DZero_sig_EMSmear_pos 9

0.03 0.03 0 0 0 0 0 0 0 ! DZero_sig_EMlike_pos 10

0 0 0.02 0.02 0 0 0 0 0 ! DZero_sig_MUTrigger_pos 11

0 0 0.02 0.02 0 0 0 0.022 0.03 ! DZero_sig_MUID_pos 12

0 0 0.041 0.041 0 0 0 0.024 0.01 ! DZero_sig_MUSmear_pos 13

0 0 0 0 0.05 0.05 0 0 0 ! DZero_sig_JetSmear_pos 14

0 0 0 0 0.05 0.05 0 0 0 ! DZero_sig_MJETTrigger_pos 15

0 0 0 0 0 0 0.01 0 0 ! DZero_sig_DiEMTrigger_pos 16

0 0 0 0 0 0 0 0.01 0 ! DZero_sig_EMUTrigger_pos 17

0 0 0 0 0 0 0 0 0.01 ! DZero_sig_DiMUTrigger_pos 18

Source of Background Systematic (D0)

0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 0.025 ! DZero_bkgd_Lumi_pos 0
0.05 0.05 0.05 0.05 0.06 0.06 0 0 0 ! DZero_bkgd_JetID_pos 1
0.04 0.04 0.04 0.04 0.06 0.06 0.05 0.05 0.03 ! DZero_bkgd_JES_pos 2
0.03 0.03 0.03 0.03 0 0 0 0 0 ! DZero_bkgd_JetMult_pos 3
0.035 0.035 0.035 0.035 0 0 0 0 0 ! DZero_bkgd_JetMLM_pos 4
0.03 0.03 0.03 0.03 0.01 0.01 0 0 0 ! DZero_bkgd_Taggability_pos 5
0.055 0.055 0.04 0.055 0.04 0.07 0 0 0 ! DZero_bkgd_bTag_HF_pos 6
0.03 0.03 0 0 0 0 0 0 0 ! DZero_bkgd_EMTrigger_pos 7
0.03 0.03 0 0 0 0 0.04 0.03 0 ! DZero_bkgd_EMID_pos 8
0.01 0.01 0 0 0 0 0.03 0.02 0 ! DZero_bkgd_EMSmear_pos 9
0.03 0.03 0 0 0 0 0 0 0 ! DZero_bkgd_EMlike_pos 10
0 0 0.02 0.02 0 0 0 0 0 ! DZero_bkgd_MUTrigger_pos 11
0 0 0.02 0.02 0 0 0 0.029 0.031 ! DZero_bkgd_MUID_pos 12
0 0 0.041 0.041 0 0 0 0.024 0.01 ! DZero_bkgd_MUSmear_pos 13
0 0 0 0 0.02 0.02 0 0 0 ! DZero_bkgd_JetSmear_pos 14
0 0 0 0 0.04 0.04 0 0 0 ! DZero_bkgd_MJETTrigger_pos 15
0 0 0 0 0 0 0.02 0 0 ! DZero_bkgd_DiEMTrigger_pos 16
0 0 0 0 0 0 0 0.02 0 ! DZero_bkgd_EMUTrigger_pos 17
0 0 0 0 0 0 0 0 0.02 ! DZero_bkgd_DiMUTrigger_pos 18
0.08 0.08 0.06 0.08 0.07 0.1 0 0 0 ! DZero_bkgd_bTag_LF_pos 19
0.15 0.15 0.15 0.15 0.15 0.15 0 0 0 ! DZero_bkgd_Xsec_HF_pos 20
0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 ! DZero_bkgd_Xsec_LF_pos 21
0.33 0.33 0.33 0.33 0.33 0.33 0.33 0.33 0.33 ! DZero_bkgd_Xsec_QCD_pos 22

- Generate a common Gaussian for each systematic source
- Multiply them to count for total systematic for each individual backgrounds