CDF Analyses with Photons

Inclusive Photon Cross Section
Search for Fermiophobic Higgs
Search for GMSB in $\gamma\gamma+\not{E}_T$

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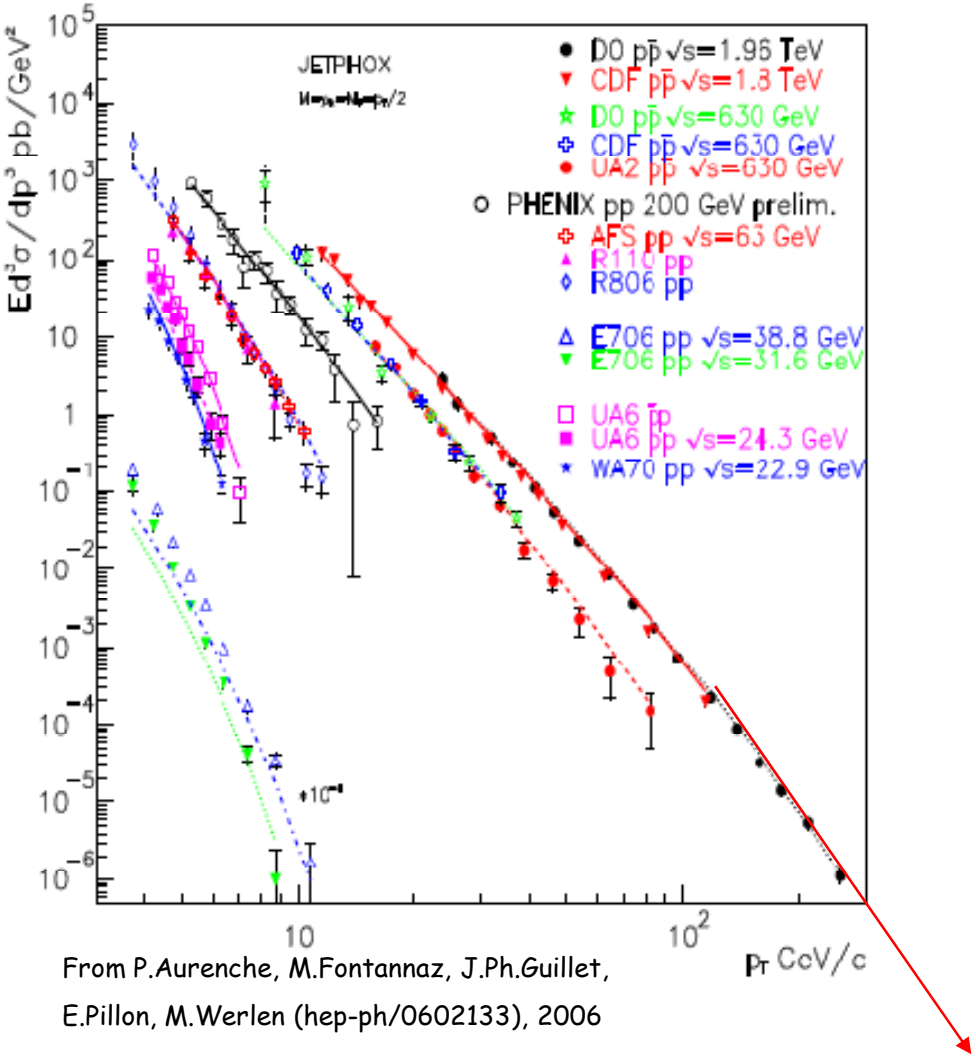
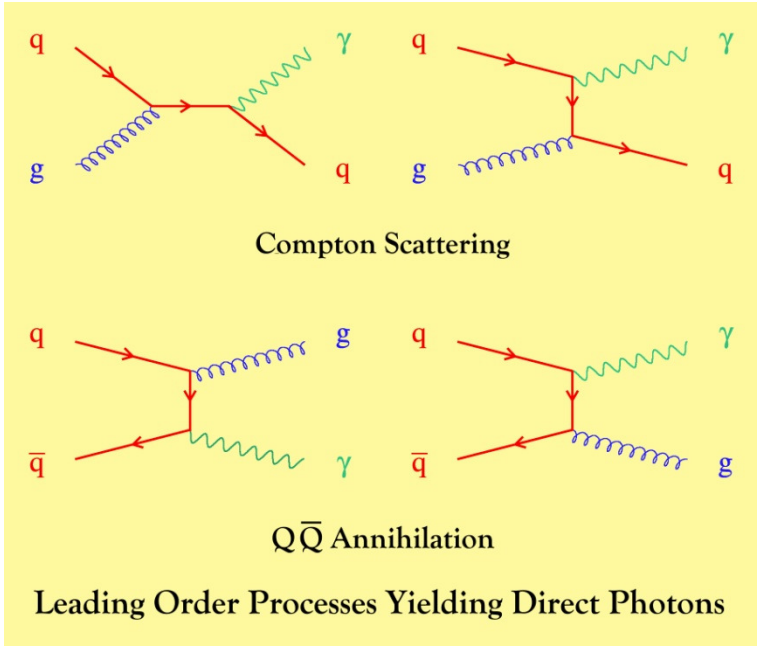
for the CDF Collaboration

Inclusive Photon Cross Section

Inclusive Cross Section



From P.Aurenche, M.Fontannaz, J.Ph.Guillet, E.Pillon, M.Werlen (hep-ph/0602133), 2006



Leading Order Processes Yielding Direct Photons

Sensitive to

- ♦ gluon PDF
- ♦ new physics

Complementary to jets

Dataset

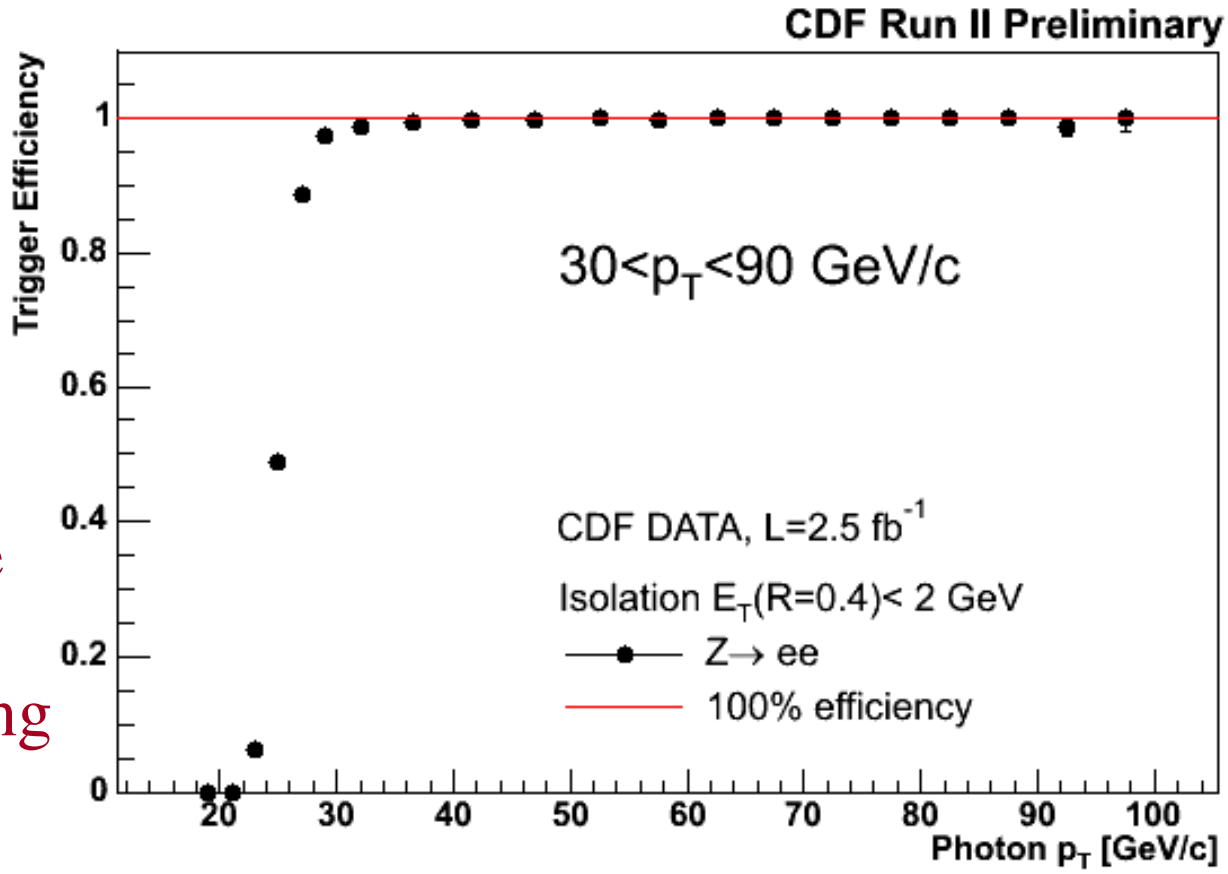
$2.5fb^{-1}$

Event Selection

- E_T>30 GeV, |η|<1.1
- Calorimeter isolation < 2 GeV

Trigger Selection

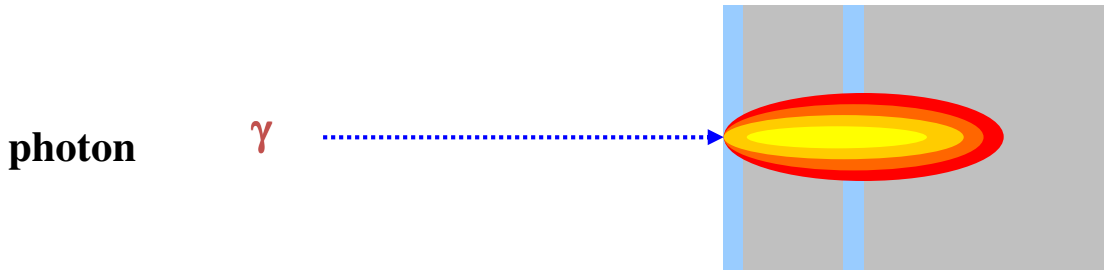
- E_T>25 GeV, calorimeter isolation< 10%
- E_T>50 GeV, only require E_T and had/EM
- Efficiency measured using data Z → ee
- Nearly 100% efficient



Background Subtraction

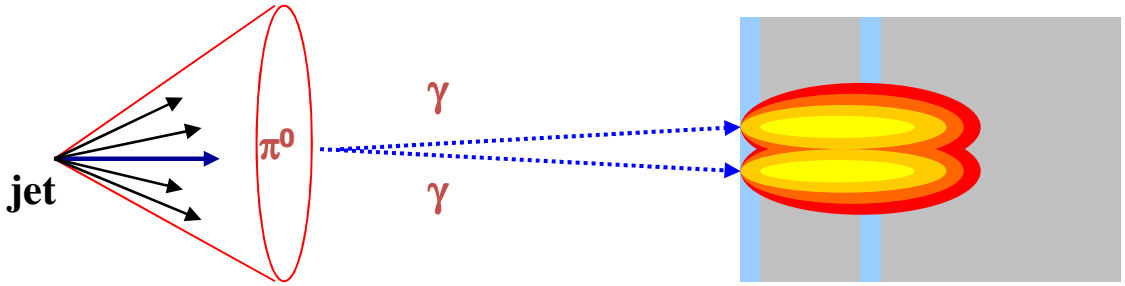
Largest issue:

Separating backgrounds from jets faking photons



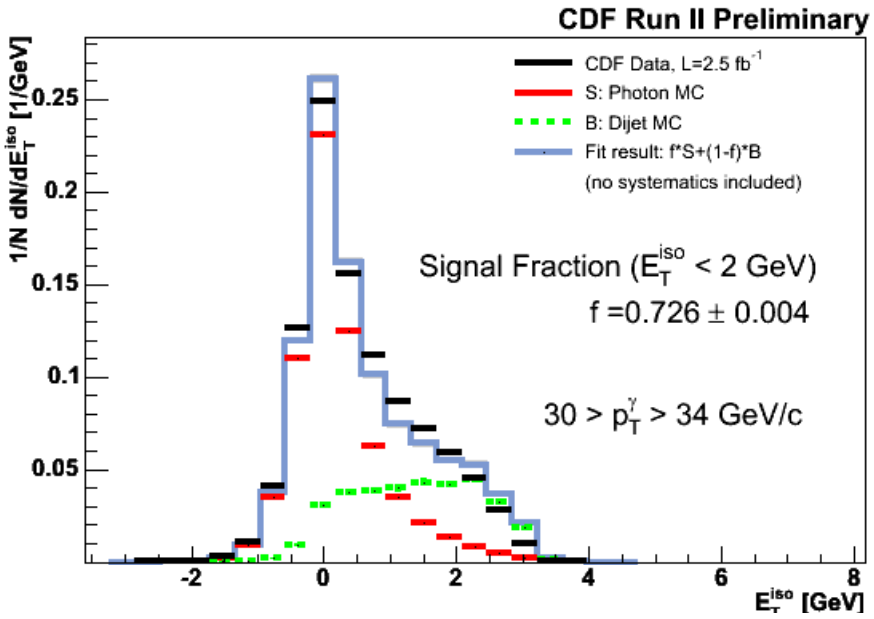
Method:

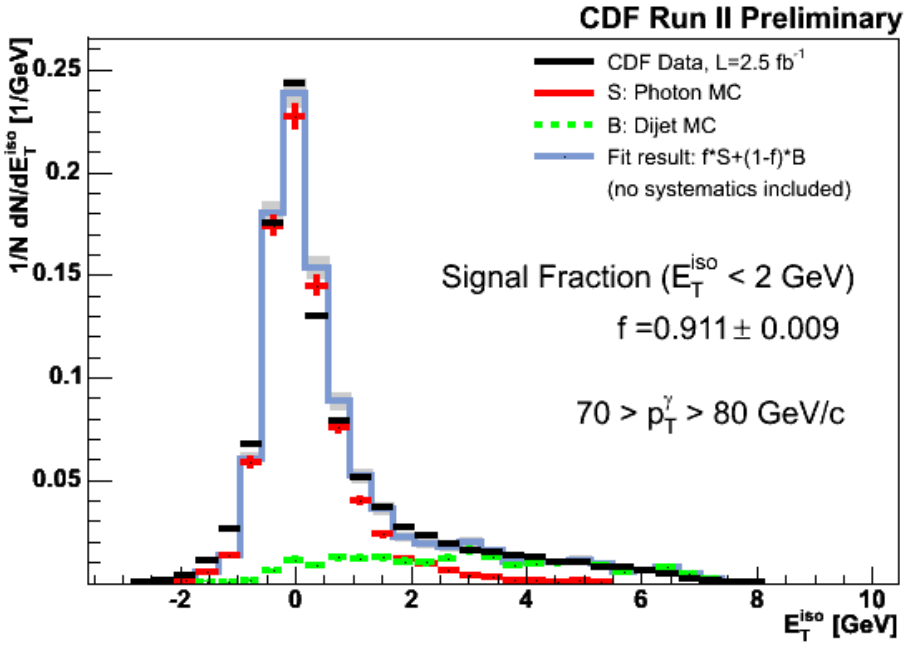
- Fit the distribution of calorimeter isolation
- Templates from CDF full simulation, Pythia+GEANT
- Fit in each E_T bin
- Allow peak of isolated distribution to vary

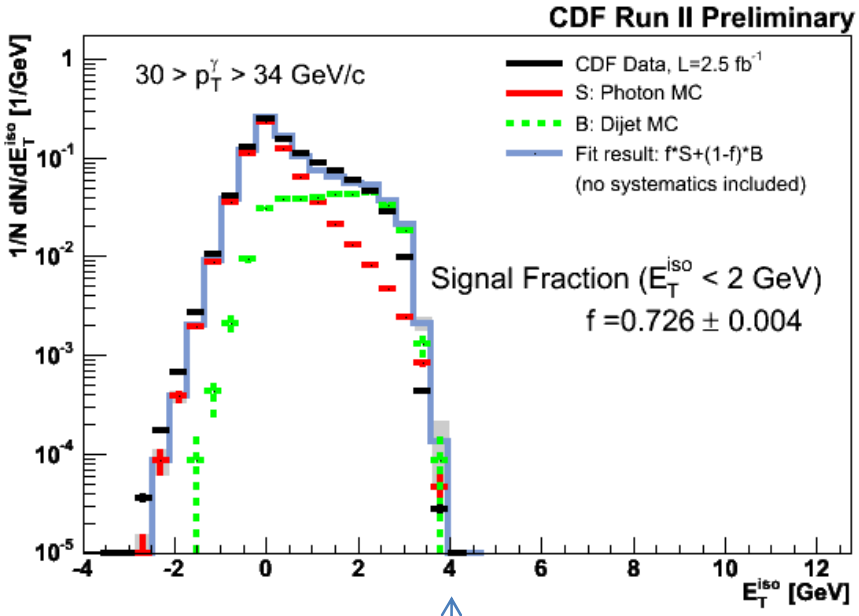


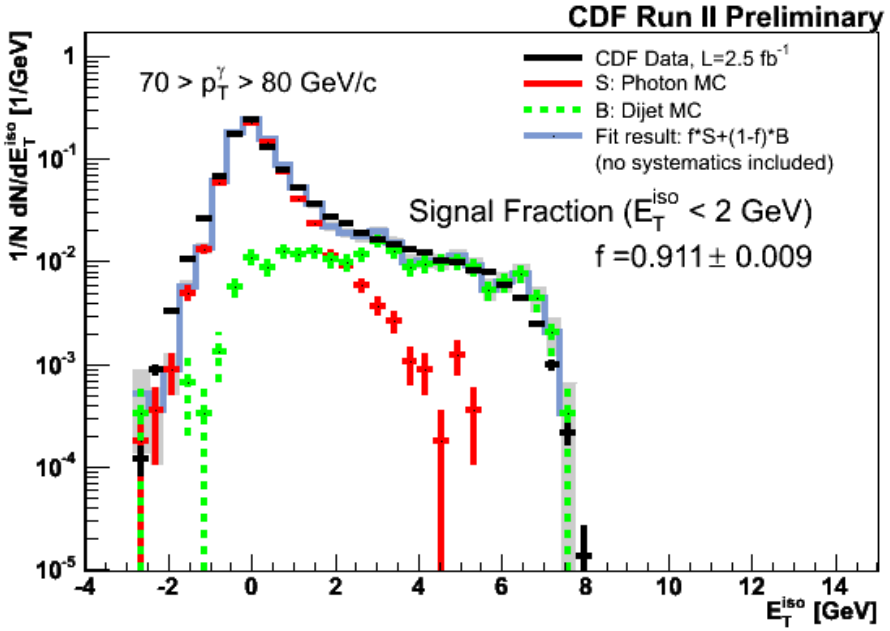
Isolation Fits

Example fits







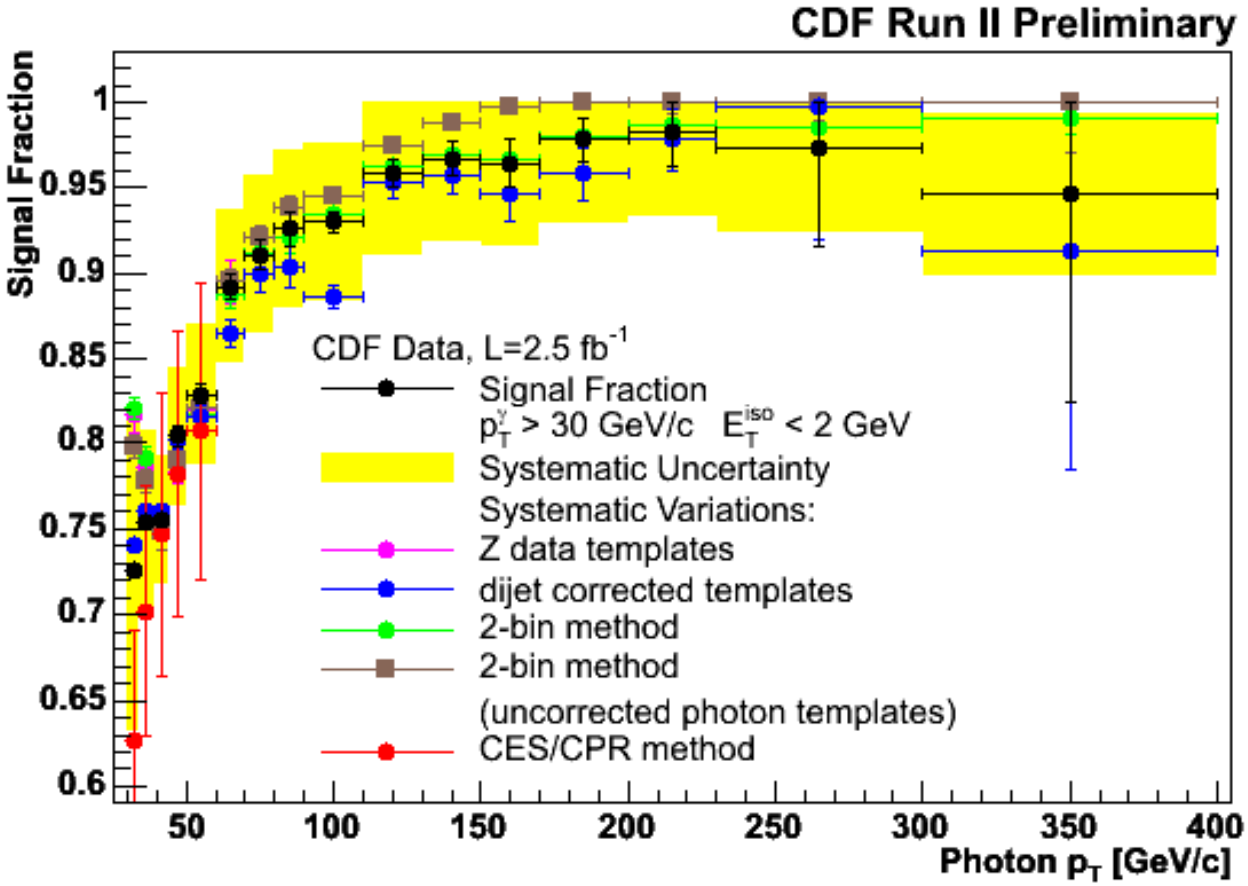


Trigger iso cut

Photon Fraction Results

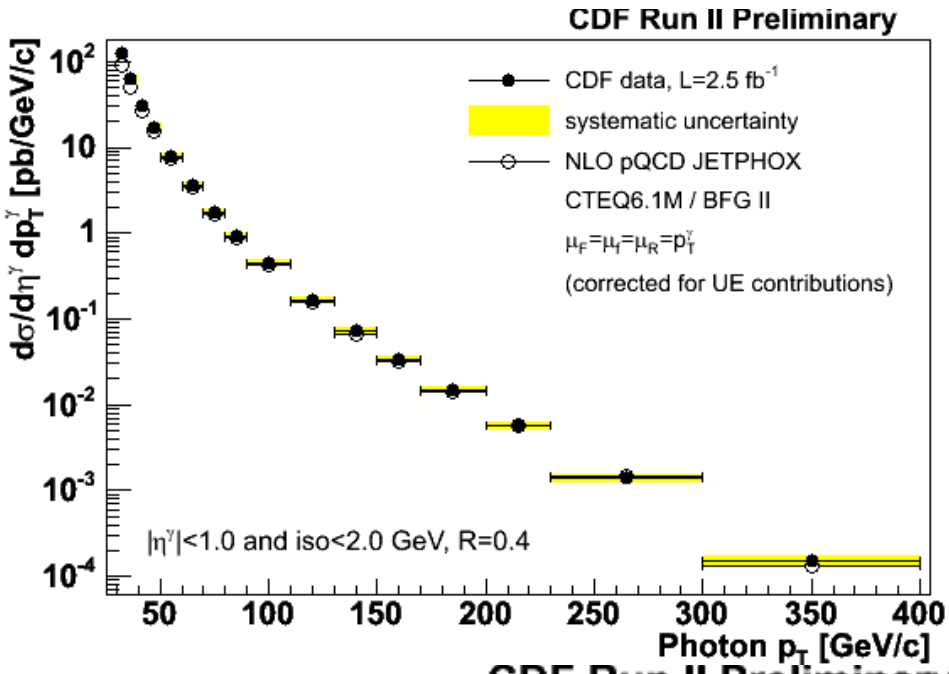
Systematics

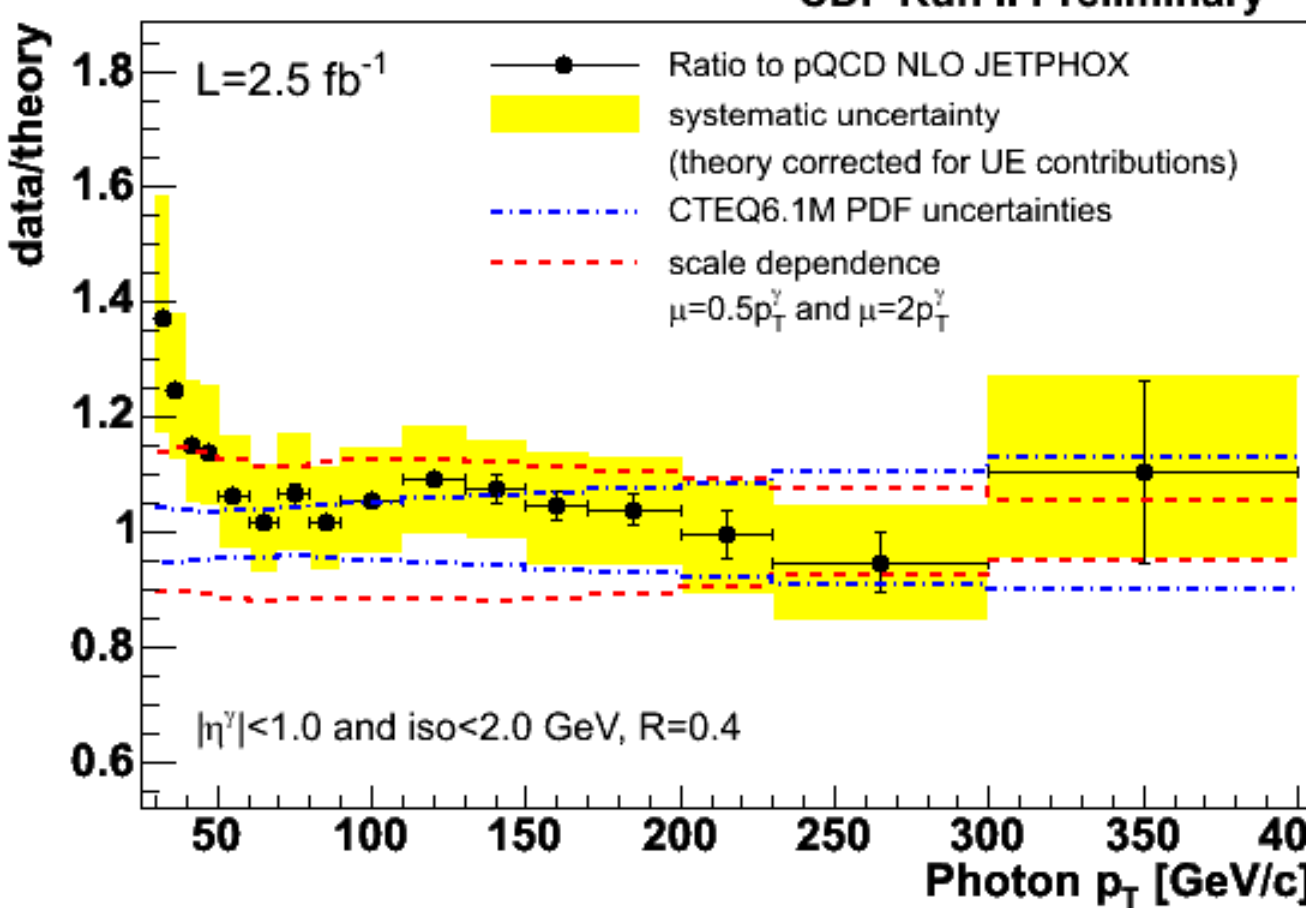
- Templates from Z MC and data
- Reduce the distribution to 2 bins (ignore shape)
- CES/CPR method
- Do not vary isolated peak
- Vary backgrnd templates like signal templates
- Bracket all effects



Inclusive Cross Section

- Unfold to generated spectrum
- Compares well to NLO calculation JETPHOX (*JHEP 0205:028,2002*)
- Low-E_T rise (as in other measurements) - "intrinsic k_T"





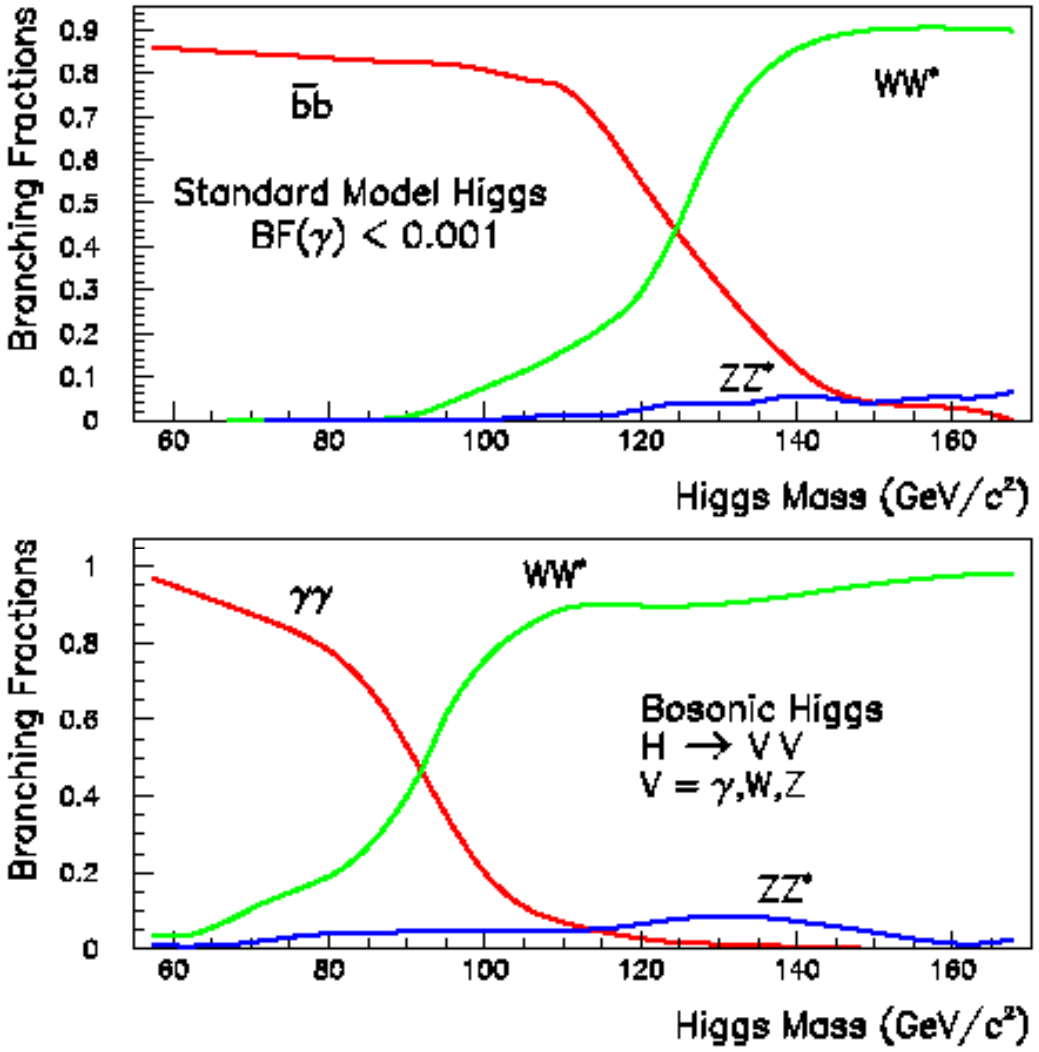
Search for Fermiophobic Higgs

Fermiophobic Higgs

♦ Available in many SM extensions with 2 Higgs doublets

♦ Mild fine tuning can turn off fermion couplings, boson couplings unaffected

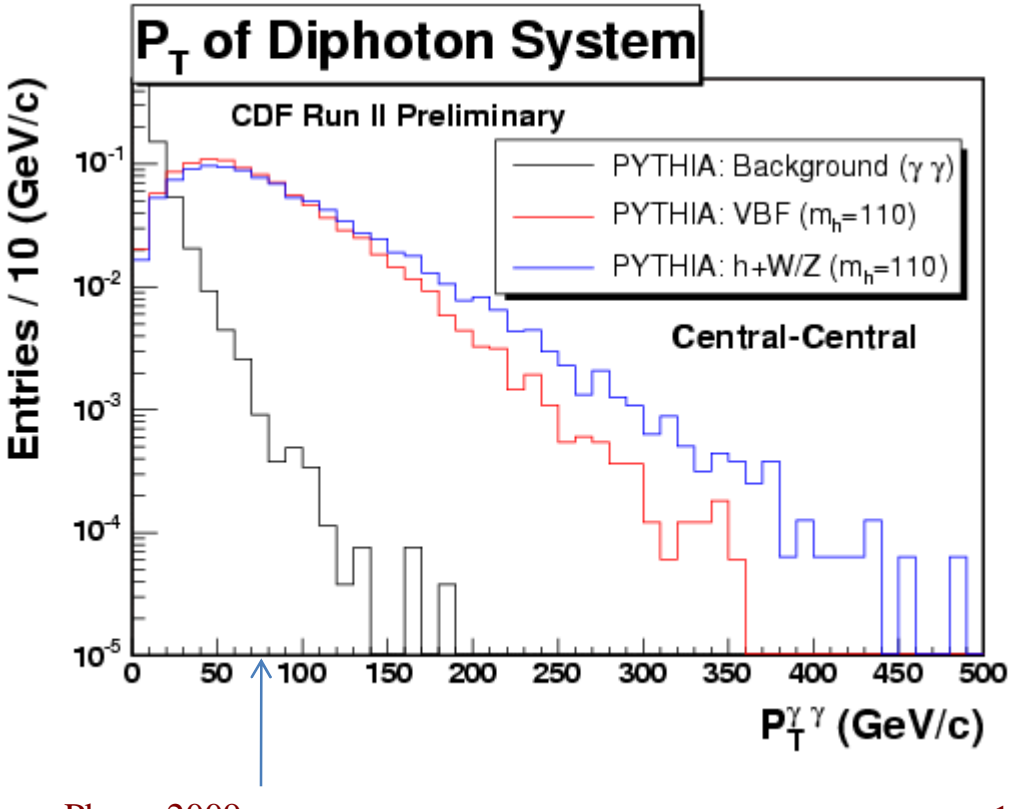
♦ Cross section relative to SM ×0.5, BR ×100

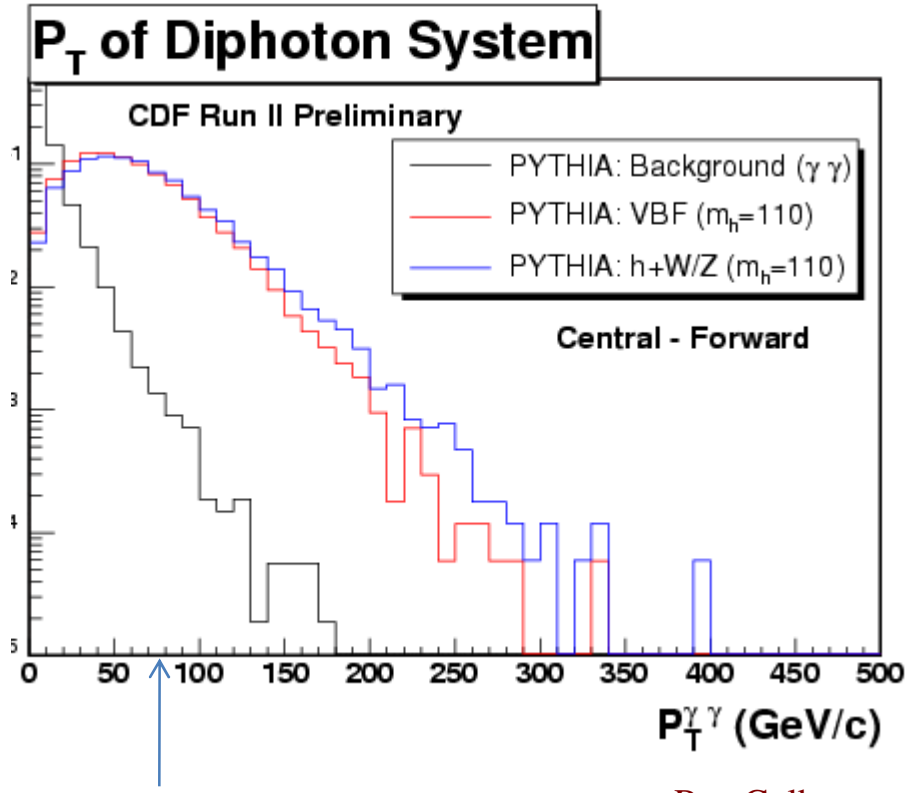


1)~~Gluon Fusion~~ 2)Associated Production 3)Vector Boson Fusion

Optimization

- Look for evidence of associated W's and Z's –
  MET, isolated tracks, 2 jets or…
- Simple $P_T(\gamma\gamma)$ cut - clear winner: $P_T(\gamma\gamma) > 75$ GeV
- Reject 99.7% of background, only 30% of signal (total eff ~5%)
- Confirm with variations of background predictions
- P_T spectrum stable LO to NLO





Data Fits

Dataset

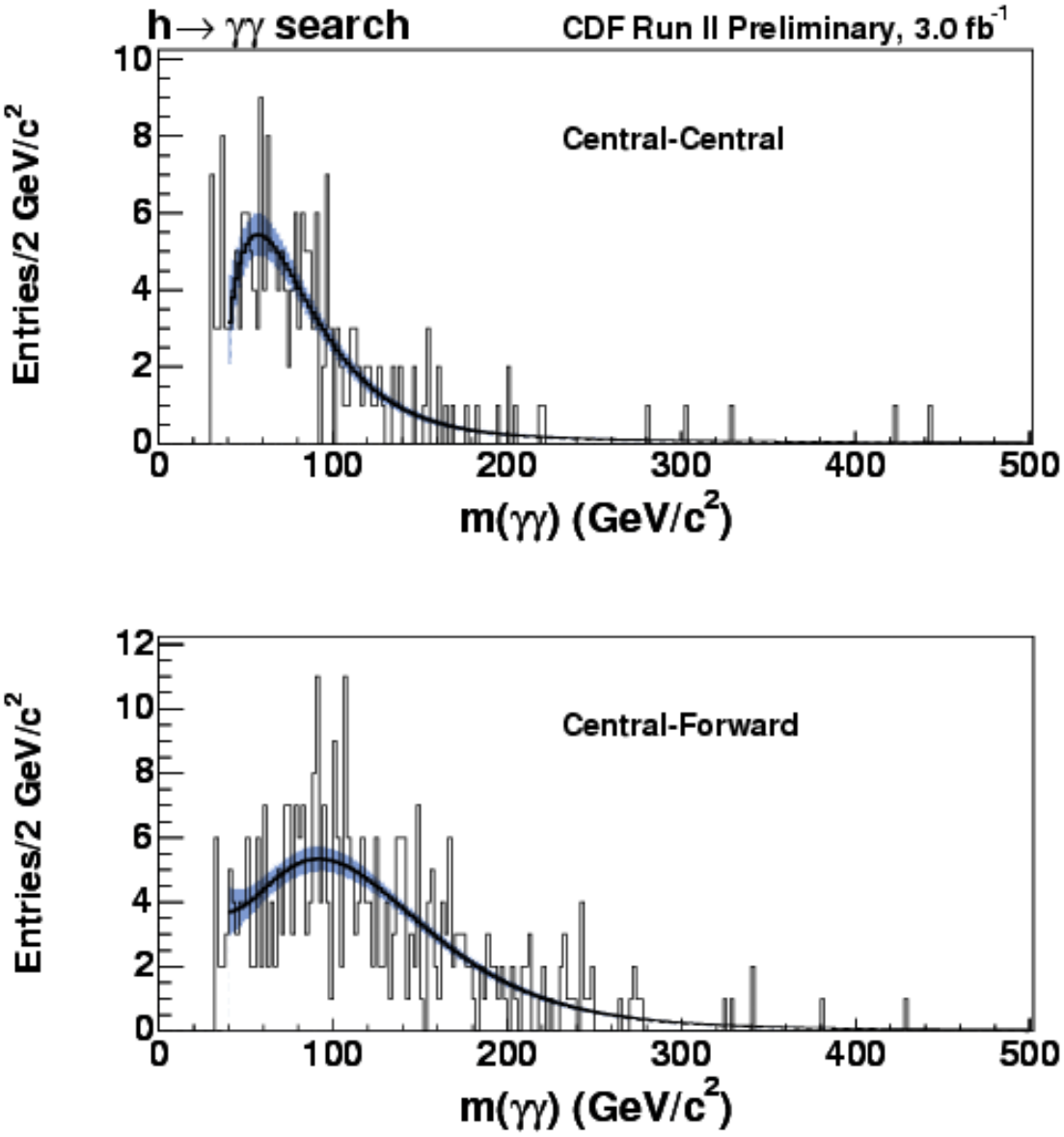
- 3.0 fb^{-1}
- Diphoton plus single photon triggers
- Two isolated, well-identified photons, Et>15GeV

Central -Central($|\eta|<1.1$) or Central-Forward ($2.2<|\eta|<2.8$)

- $P_T(\gamma\gamma) > 75$ GeV

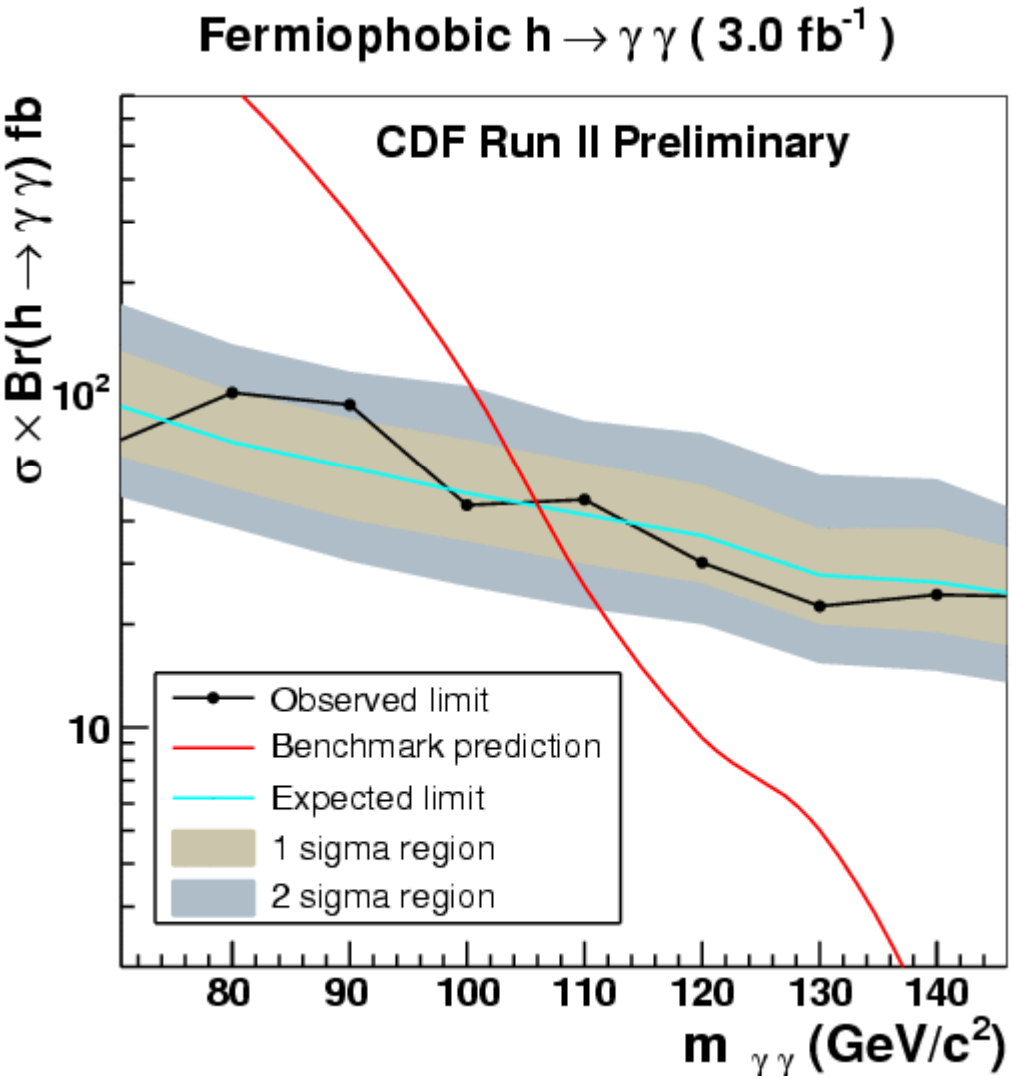
Fit

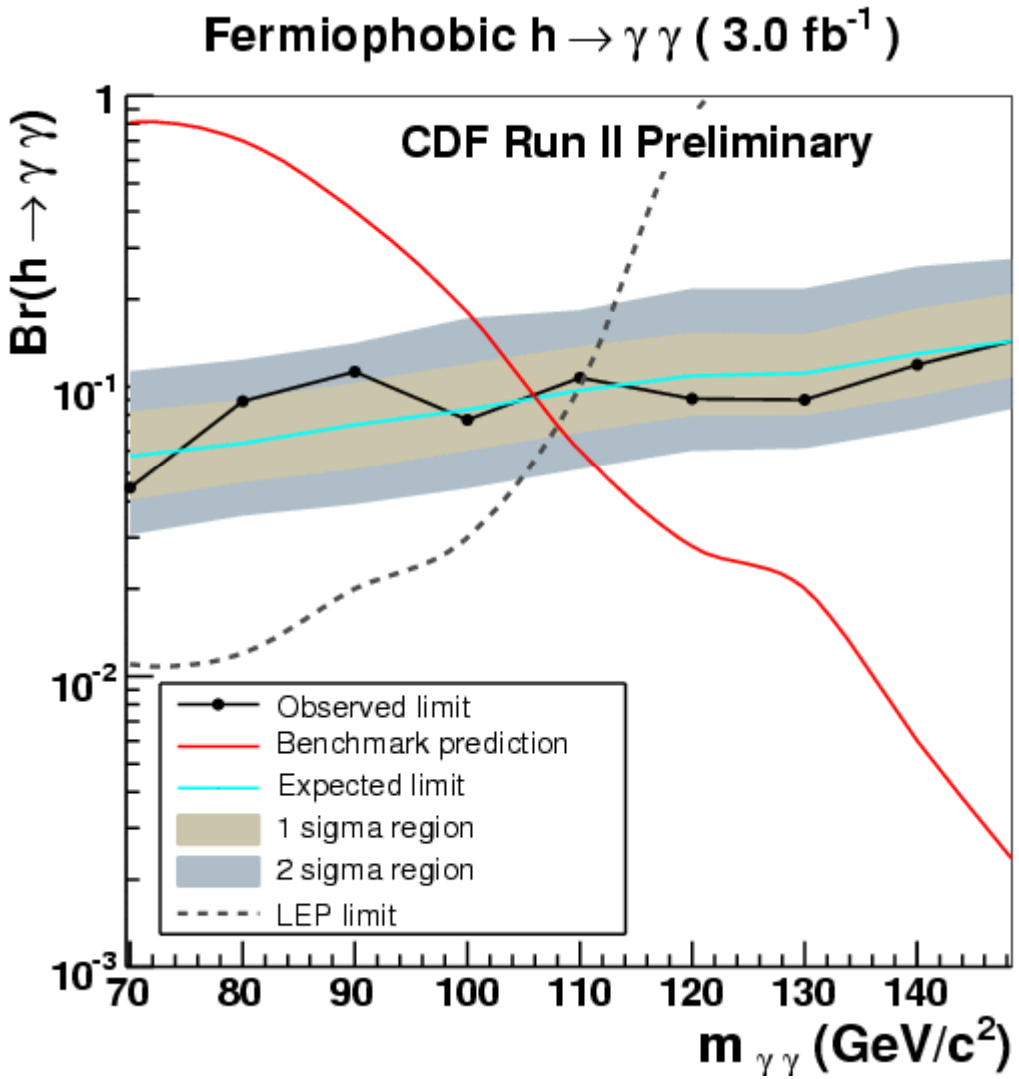
- Binned likelihood
- MC signal line shape
- Exponential eq. for background lineshape
- background shape → 20% σ



Fermiophobic Higgs

Final mass limit m_f>106GeV





(LEP 109.7, D0 preliminary 102.5)

Search for GMSB in $\gamma\gamma$+E_T

Search for Diphoton and MET

Data Sample

♦ 2.6 fb^{-1}

♦ Two photons, $|\eta|<1.1$, $E_T>13GeV$

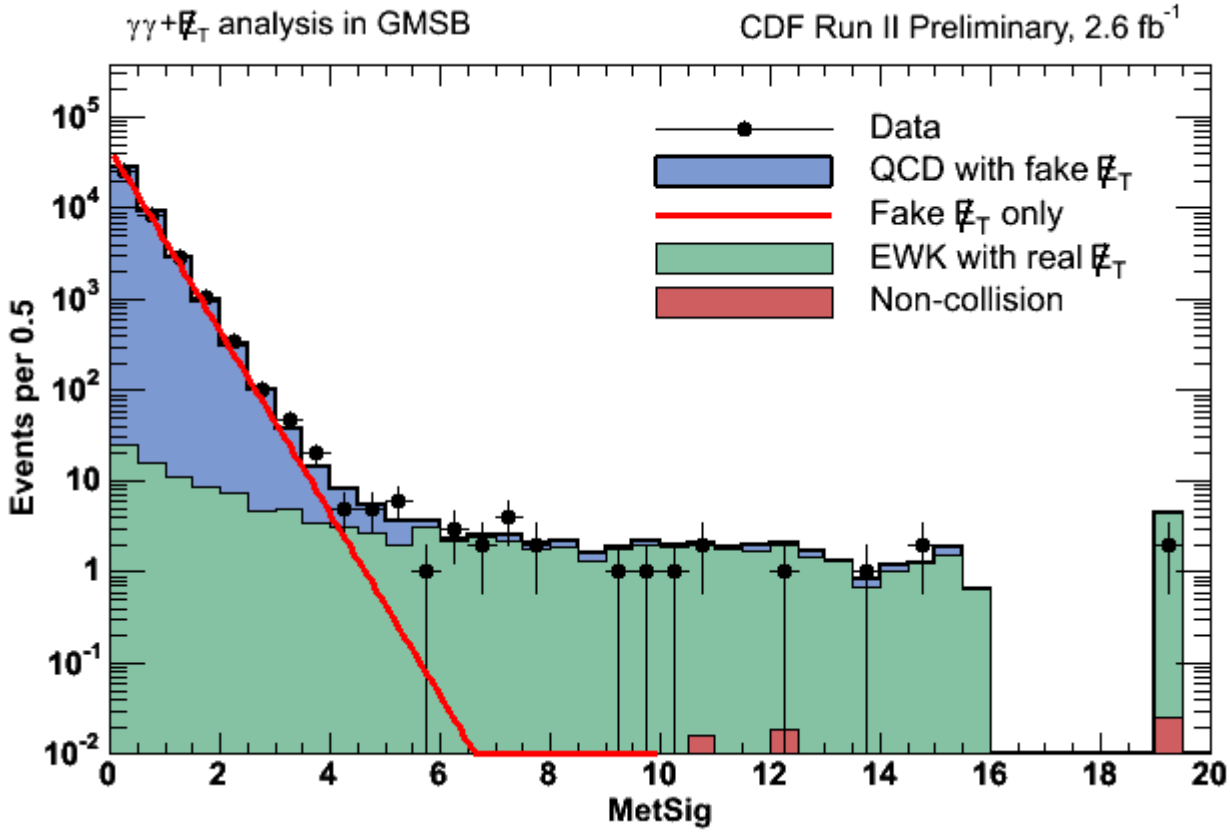
Backgrounds

♦ Non-collision
→topology, EM timing

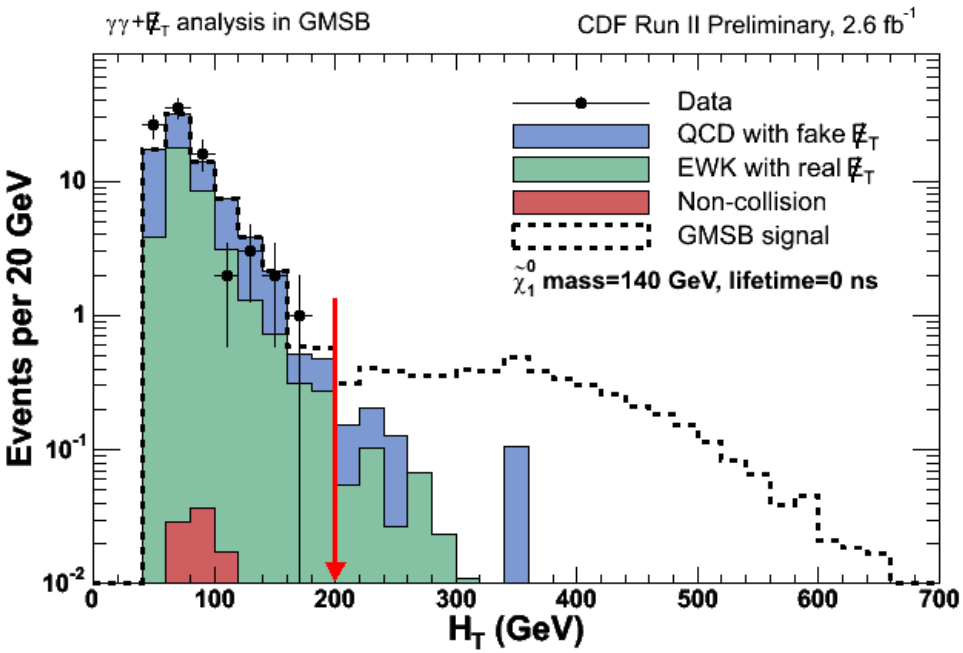
♦ tripho, vtx swap
→MC, norm to data

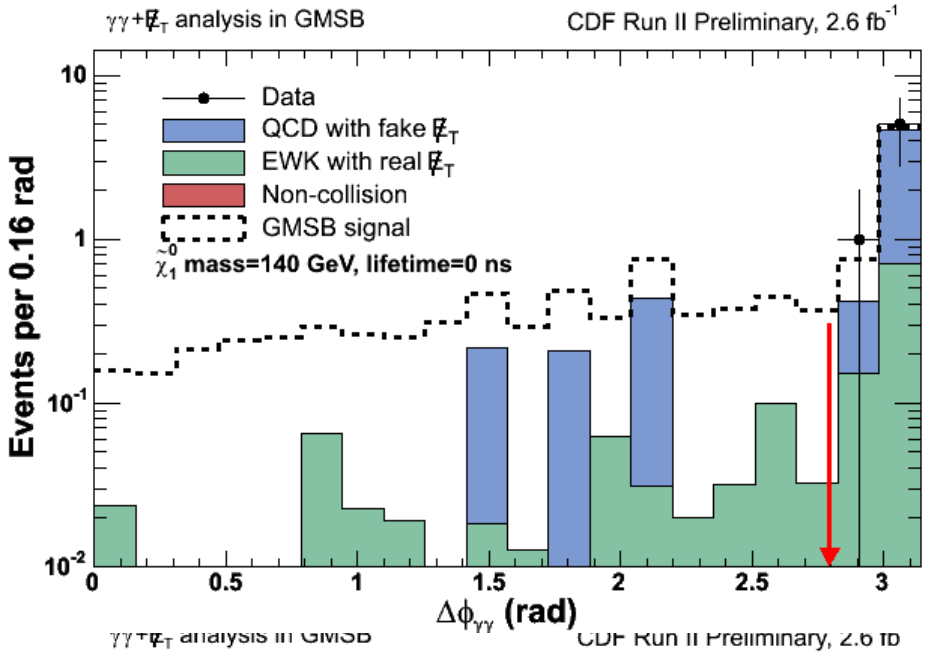
♦ EWK (Wγ), electron faking photon →fake rate

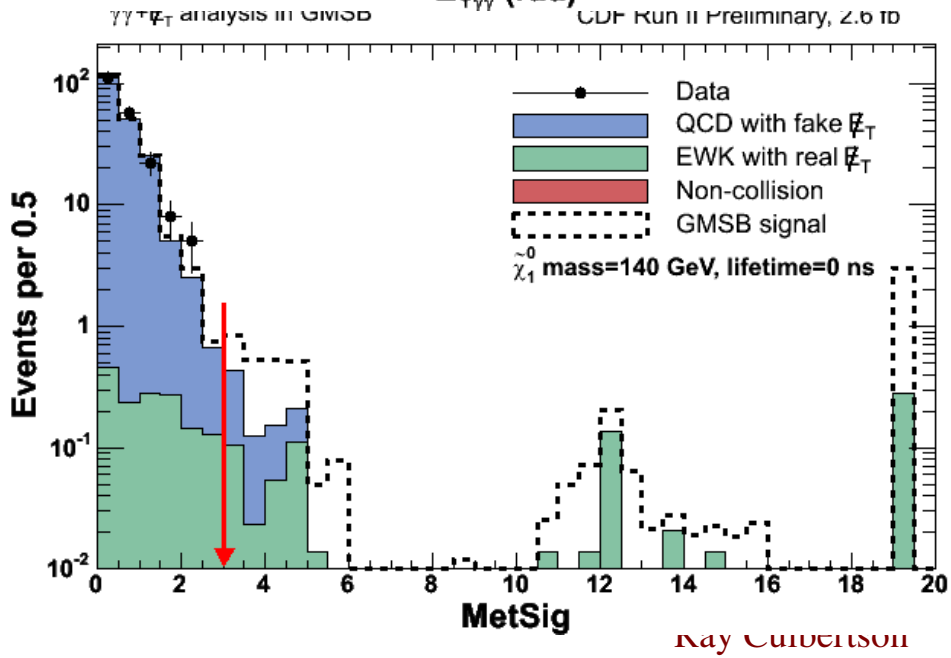
♦ QCD with fake MET
→MET Model of jet resolution



Optimization







In multiple dimensions:

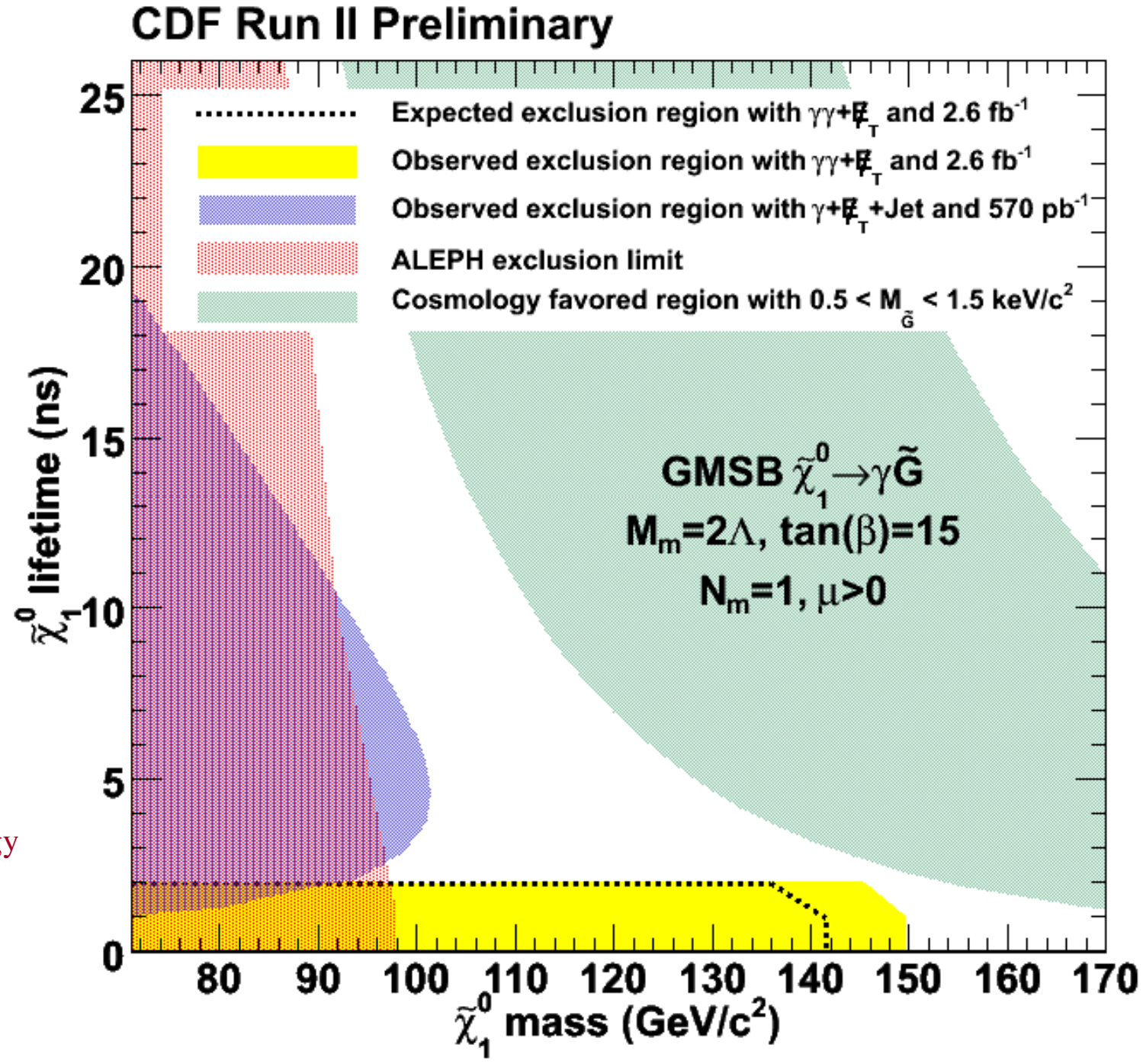
H_T = Scalar sum of photon, jet E_T and MET

$\Delta\varphi$ between photons

METSig

GMSB Limits

With no lifetime, $M(\chi_1)>149$ GeV



B. C. Allanach et al, Eur. Phys. J C25 113 (2002)
E. Blatz et al., J. High Energy Phys. 0305, 067 (2003).

Inclusive cross section consistent with NLO

Fermiophobic Higgs > 106 GeV

GMSB limit χ_1>149 GeV

Thank you…

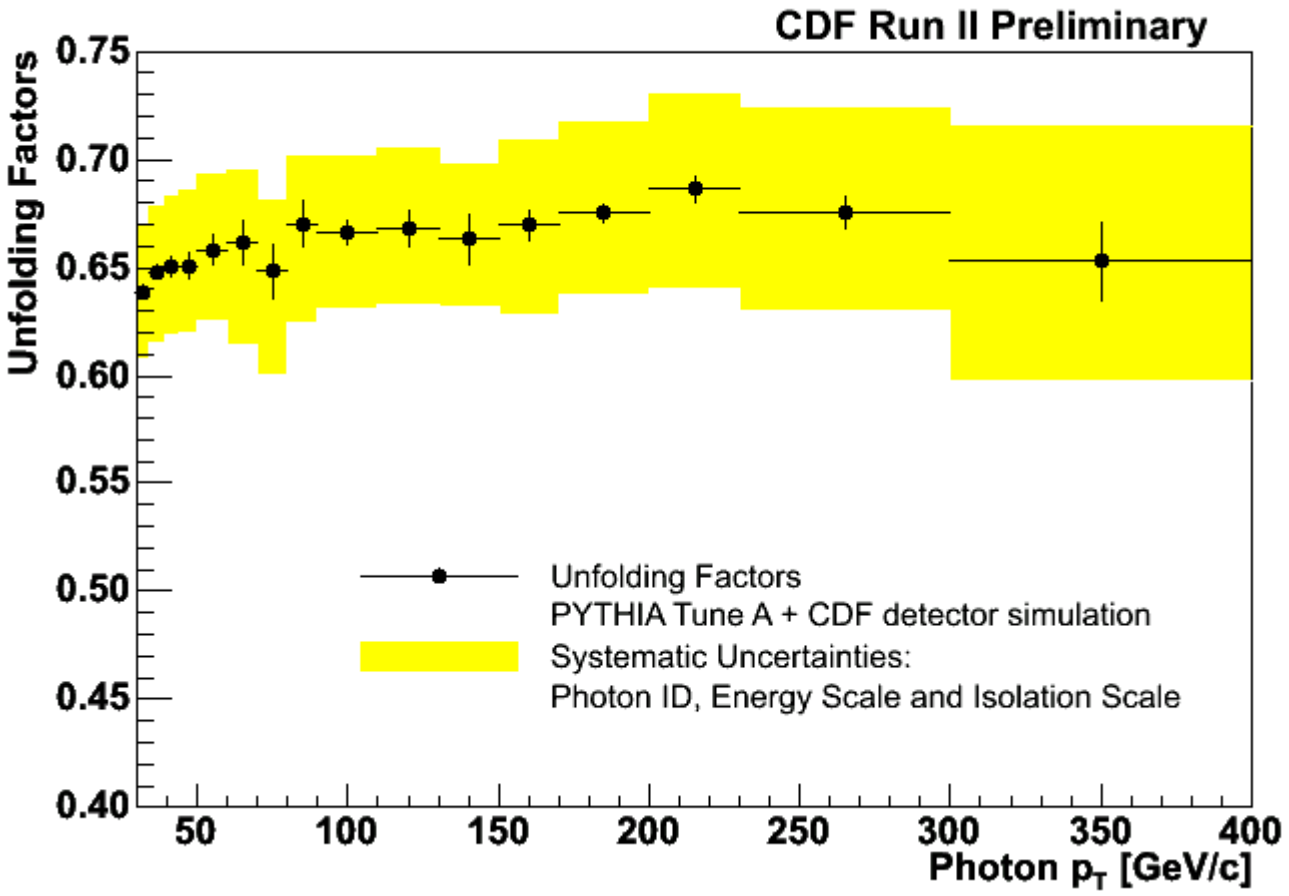
Efficiency Unfolding

Efficiency

♦ Based on Pythia and full CDF simulation (GEANT) MC

♦ Small correction based on data *vs* MC Z→ee

♦ Iterate to improve generated spectrum



Systematics

♦ Photon ID efficiency

♦ Energy scale

♦ Underlying event

Efficiency/Systematics

Acceptance × Efficiency

♦ Small correction based on data *vs* MC Z→ee

Systematics

♦ LO vs NLO, ISR has limited effect on P_T cut efficiency

♦ Luminosity 6%

Acceptance (%)				
	$h + W/Z$		VBF	
M_h	CC	CF	CC	CF
70	2.9	1.8	3.8	2.1
80	3.7	2.4	4.1	2.6
90	4.4	3.1	4.5	3.1
100	5.0	3.8	4.7	3.5
110	5.5	4.5	5.0	3.9
120	6.1	5.2	5.1	4.3
130	6.6	5.7	5.2	4.5
140	7.1	6.3	5.5	4.8
150	7.6	6.9	5.6	5.0

	Systematic Errors (%)	
	Central - Central	Central - Forward
PDF	2	2
IFSR	4	4
E Scale	2	3
NLO v/s LO	4	4
Luminosity	6	6
Conversions	0.2	3
Photon/Electron ID	1	2.6
Run Dependence	1.5	2.0
Data/MC fits	0.2	0.8

Limit Projections

Project
$\gamma\gamma$+ME_T
and
γj+ME_T +EM time
analyses