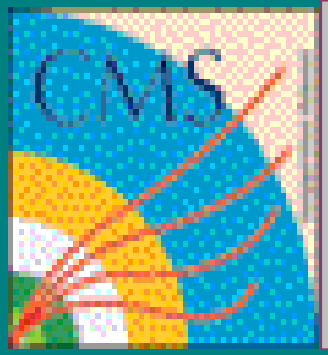


MSUGRA Trileptons

V. Zhukov

W. de Boer, M. Niegel, C. Sander

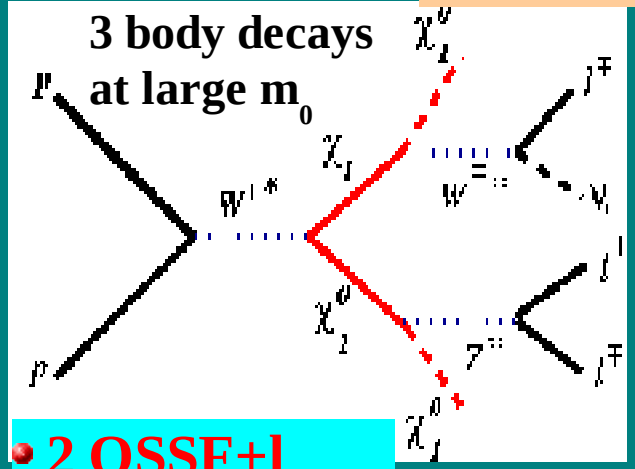
University Karlsruhe

OUTLOOK

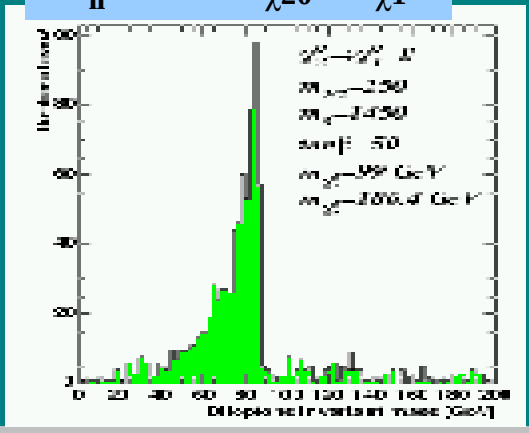
Signature

'Discovery' channel at Tevatron
but only in the bulk region (2body)

3 body decays at large m_0

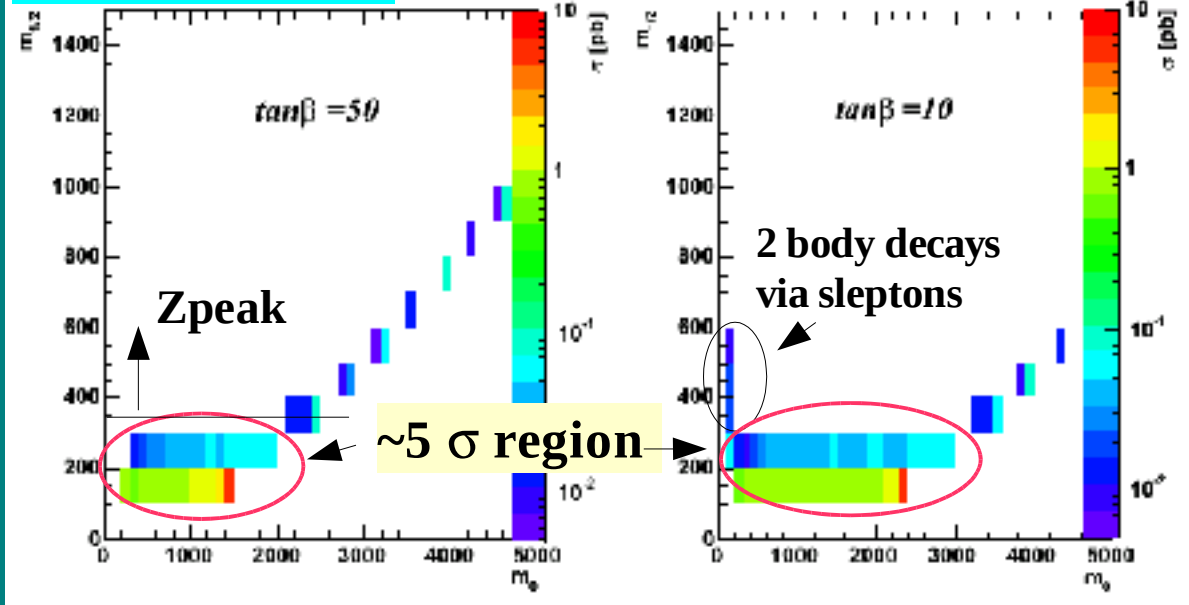


$M_{ll}^{max} = m_{\chi 20} - m_{\chi 10}$

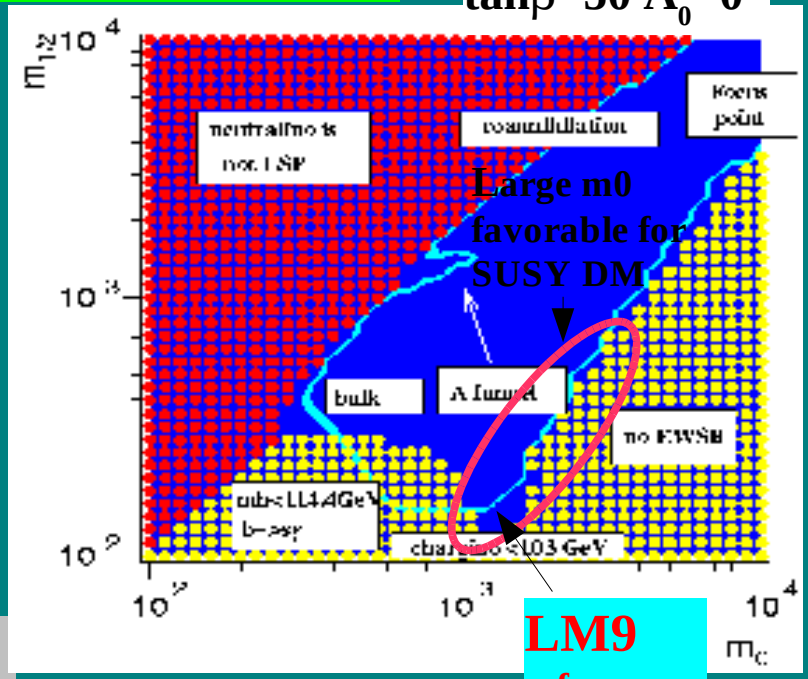


- 2 OSSF+l
- No Jets
- small MET

Trilepton cross section $\sigma \sim m_{1/2}^{-4}$



tanβ=50 A_0=0



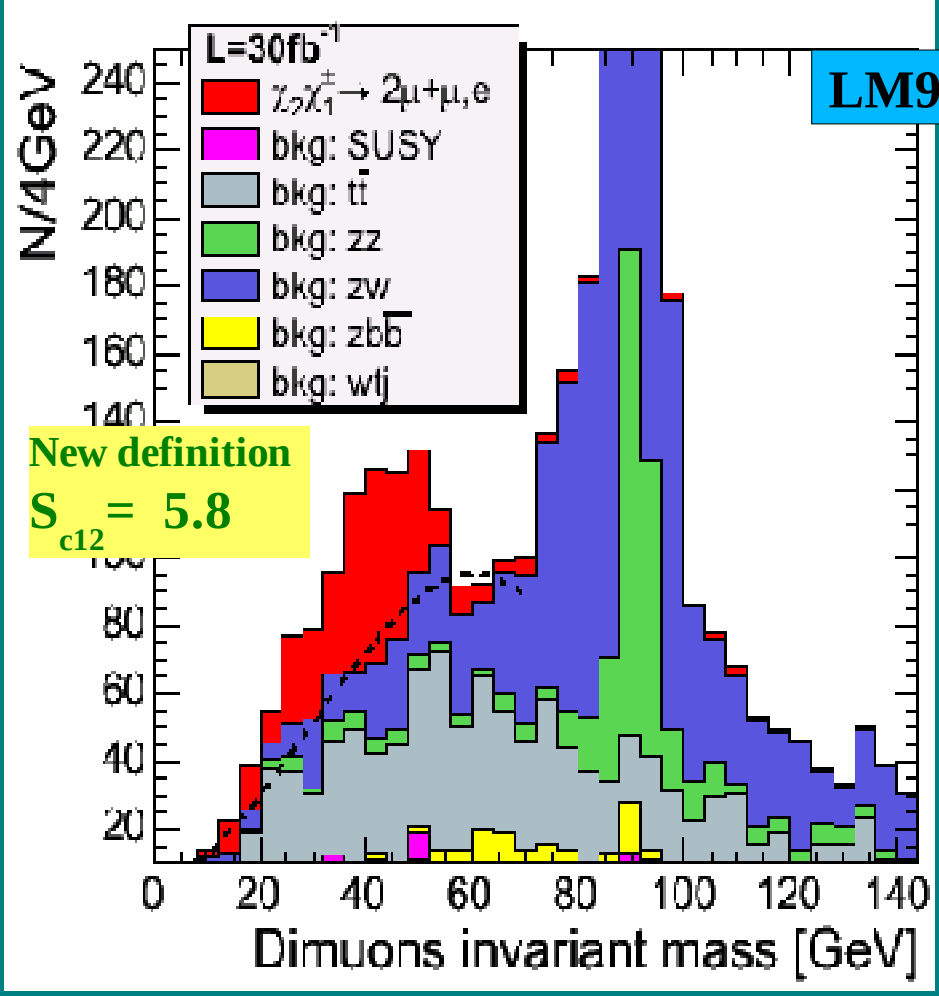
Benchmark points : susy total and trileptons

K_{NLO} ~1.3

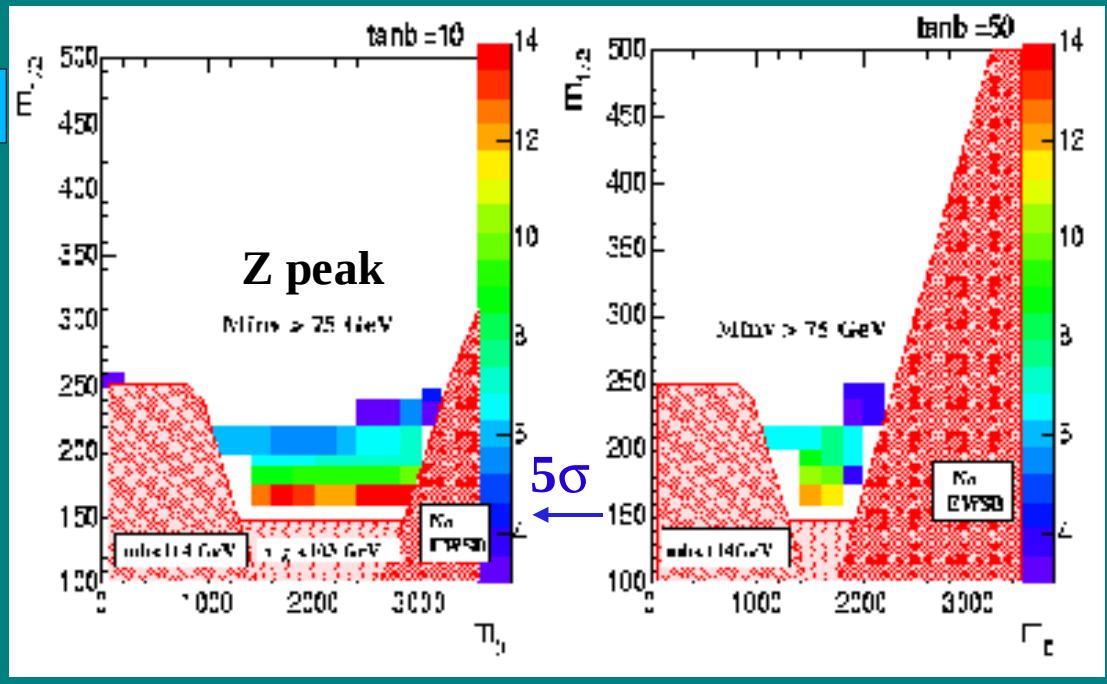
	$m_{1/2}$	m_0	tanβ	σ_{tot}^{LO},pb	σ_{3l}, fb
LM1	250	60	10	42.	41.
LM2	350	175	35	7.3	~0.
LM3	240	330	20	31.	9.4
LM4	285	210	10	19.	9.0
LM5	360	230	10	6.	~0.4
LM6	400	85	10	4.	9.8
LM7	230	3000	10	8.4	39.
LM8	300	500	10	8.9	7.9
LM9	175	1450	50	25.	95.

STATUS

October 7 SUSY BSM meeting



MSUGRA 5 discovery reach



- Not all bkg considered (Zjets,WWjets,DY..)
- Electrons identification
- selection cuts optimization
- uncertanities

CROSS SECTIONS

	σ_{LO},pb	σ_{NLO},pb	σ_{3l}^{NLO},pb	$N_{NLO}(30fb^{-1})$
LM9 signal	**25**	**42**	**0.123**	**3700**
LM9bkg	25	42	13.1	$3\ 10^5$
ZZ	11.8	15.8	0.16	4800
ZW	30.0	51.6	1.68	$5\ 10^4$
ttbar	486	830	88	$2.6\ 10^6$
Wtj	60	102	10	$3.0\ 10^5$
WWjets	317		19.8	$6.0\ 10^5$ (LO)
Zjets(>20)	$1.2\ 10^3$		$4.4\ 10^6$	$4.0\ 10^8$ (LO)
Wjets(>30)	$4.1\ 10^4$		$2.7\ 10^4$	$1.2\ 10^9$ (LO)
DY (>15)	$4\ \ 10^3$		$4\ \ 10^3$	$1.2\ 10^8$ (LO)
QCD(>20)	$1.6\ 10^8$			

CMKIN_4_3_1
LO PYTHIA 6.225 +ISASUGRA 7.69 (TopRex for ttbar,Wt)
PDF: CTEQ5l
NLO: MCNLO, Prospino

Generator preselections:
Z,W->μ,e,τ; τ->e,μ

DATA SAMPLES

Access:

- DST ORCA_8_7_3 via CRAB (~10^6 ev)
- FAMOS_1_3_2 via GRID (~ 7 10^6 ev)
- local production (Karlsruhe) FAMOS&DST ~10^6

No major problems

In total ~5000 PC hours in ~14 days

GRID DST	
jm03_TTbar_leptonic	10^5
jm03b_Zjets20_...1100	3 10^5
jm03b_WWjets_leptonic	10^5
jm03b_Wjets_30_...1000	2 10^5
hg03_DY2mu_shat80	3 10^5
jm03b_ZWjets_leptonic	5 10^4
jm03_qcd_30_...1000	10^4
Local DST	
lm9_3l	10^4
ZW_3l	5 10^4
ZZ_4l	10^4

FAMOS	
ttbar_toprex_2l	1.5 10^6
zjets_20...1000	3 10^6
wwjets	10^5
wt_toprex	3 10^5
DY_2l	10^6
lm9bkg	5 10^5
susyscan	5 10^5
qcd_30_...1000	10^6
Wjets_20..1000	10^6
lm9_3l	10^4
zw	10^5
zz	10^4

Large data samples are produced and analyzed

CMS FRAMEWORK

- *DST : OSCAR 3.6.0 + ORCA 8.7.3*
- *FAST : FAMOS 1.3.2*

Low Luminosity PU

Same analyzis for FAMOS and ORCA custom compact Tree (<2Mb/ev)

Algorithms

	ORCA	FAMOS
TRIGGER	*LI, HLT*	*L1, HLT emulator*
MUONS	*GlobalMuobReconstructor (L3MuonReconstructor)*	
isolation	*MuIsoByTrackerPt(1.5)*	
	MuIsoByCaloEt(5.) R<0.3	
ELECTRONS	*ElectronCandidate*	
isolation	*no tracks Pt>1.5GeV R<0.3*	
	HOE<0.1 0.9 < E/P<1.5 1/E-1/P>0.02	
	ElectronLiklihood>0.65	
JETS	*IterativeCone(R=0.5)*	
	EcalPlusHcalTowerInput	
	Calibration GammaJet	
MET	*METfromEcalPlusHcalTower*	*METfromCaloTower*
	LeptonCorrection	*no corrections(only μ)*
	Tower Correction	

TRIGGER

L1

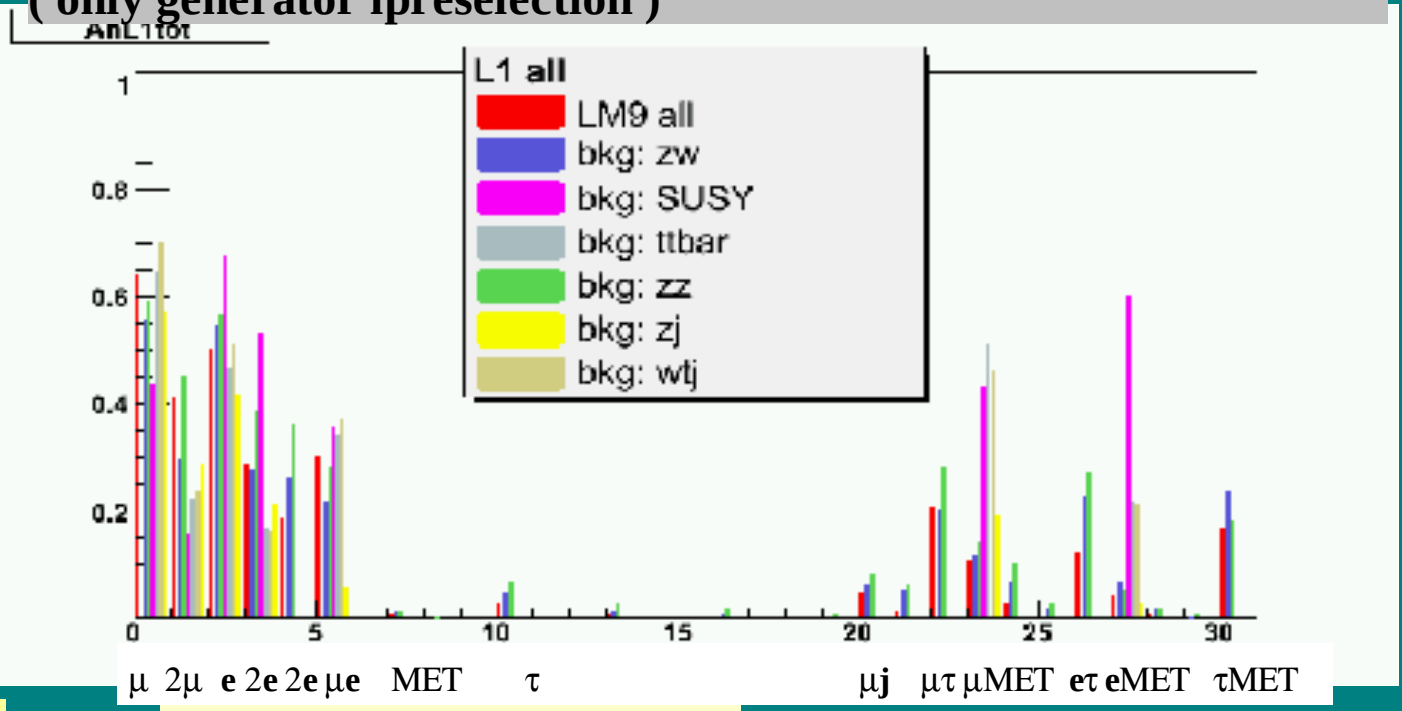
bit	item	thr, GeV(LL HL)	
0	μ	14	20
1	2μ	3	5
2	e/γ (all)	29	34
3,4	2e/2γ	17	19
5	μ+e/γ isol	5,15	7,17
20,21	μ+cj,fj	5,30	14,40
22	μ+τ	5,25	12,30
23	μ+MET	5,45	16,80
24,25	e/γ +cj,fj	21,45	25,52
26	e/γ +τ	14,52	25,52
27	e/γ+MET	21,74	25,150
10, 13,16	1,2,3τ	86,59,40	101,67,70
30	τ +MET	35,40/60,60	

HLT

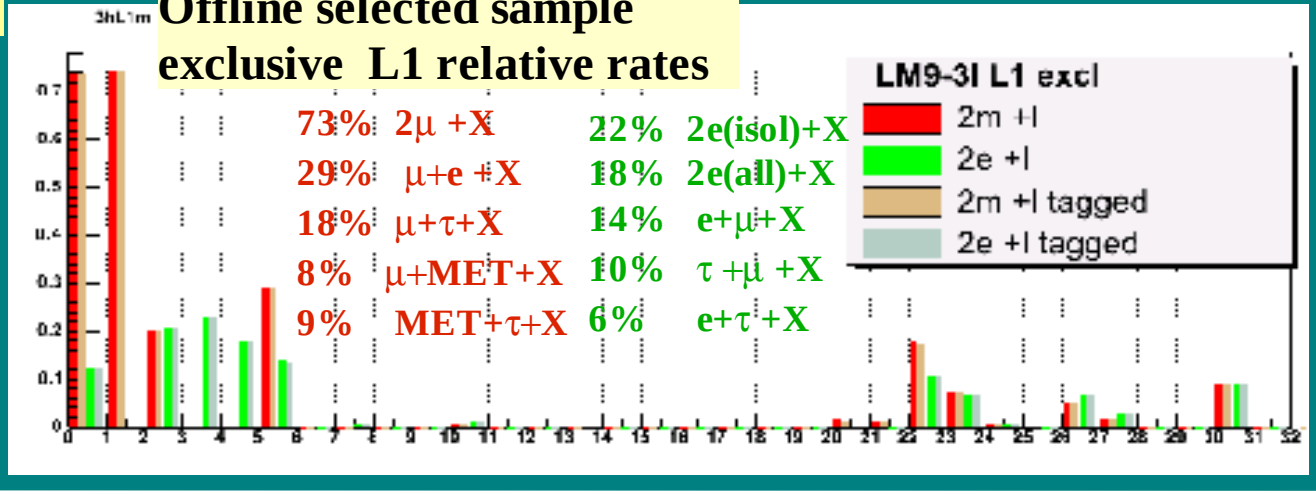
bit	item	thr(LL HL), GeV	
2	e	26	31
6	2e	14.5	16.9
13	2e rel	21.8	21.8
43	m	19	31
54	2m	7	10
...			

Trigger: L1 streams before selection

(only generator lpreselection)



Offline selected sample exclusive L1 relative rates



OFFLINE SELECTION

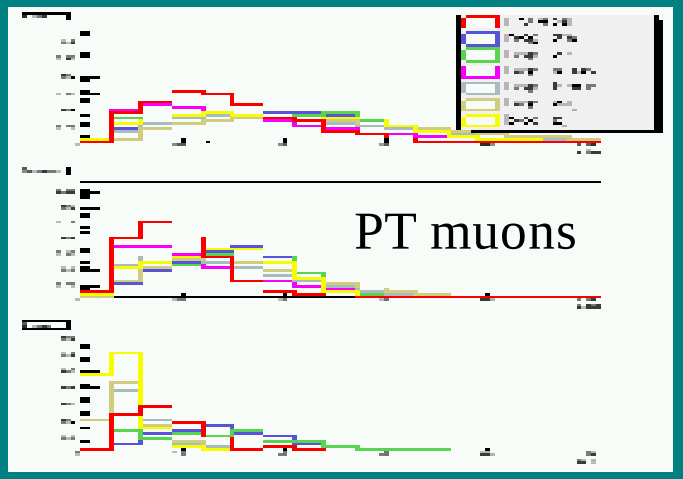
Isolated leptons:

2 OSSF PTμ>5 GeV/c Pte>17GeV/c η<2.4

M_{ll} < 75 GeV out of Z peak

PT3μ>5 GeV/c Pte> 5 GeV/c

(cant be very low due to Zjets)

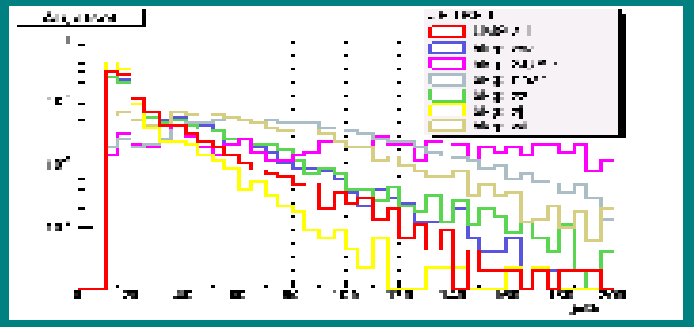


Jets:

ET>20 GeV (lowest possible) η<2.4

(keep cut as low as possible)

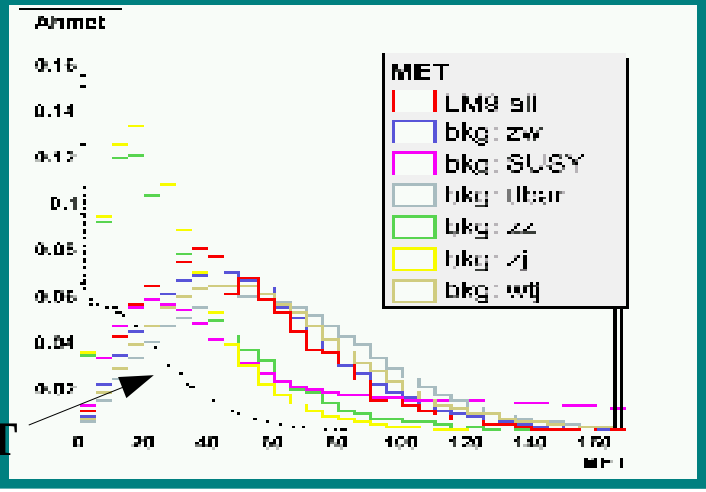
also use jets ET>10 GeV and η<4



MET:

MET>15 GeV

(not very effective in No Jets events!)



Zjets MC MET

SELECTION EVOLUTION

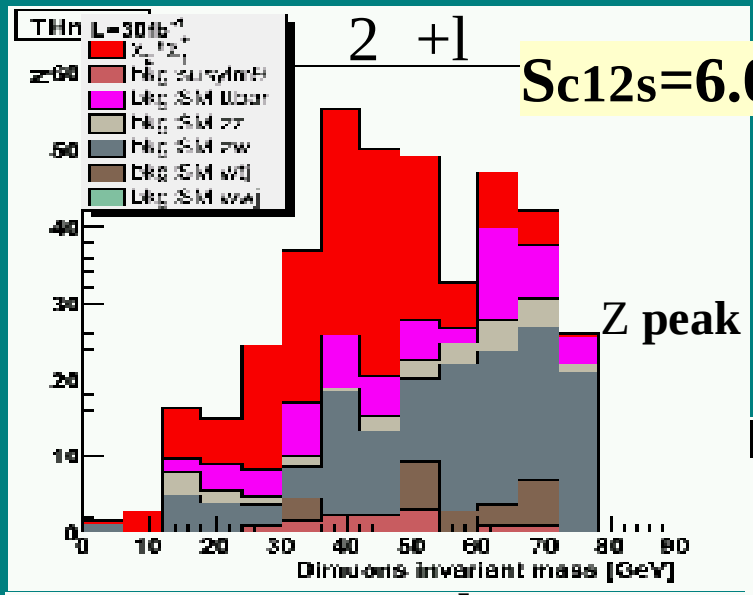
Channel	30fb^{-1}	Nsim	L1	HLT	NoJet	3recl	2OSSF	2OSSF+1	Minv≠z	MET	2m+l	2e+l
lm9_3l	3700	5000	4229	3909	2930	1041	581	448	400	373	255	91
zw	5 10^4	5 10^4	3.910^4	3.610^4	2.610^4	5847	3470	2601	439	423	419	156
zz		10^4	8036	7351	7300	2776	1694	1257	253	156	84	37
ttbar	2.6 10^6	1.5 10^6	1.2 10^6	-	3.1 10^4	1.6 10^4	3823	207	105	95	73	22
lm9bkg	4 10^5	5 10^5	2.4 10^5	-	11302	723	137	80	43	32	21	8
wt	3 10^5	10^5	8.9 10^4	-	13297	4964	1352	63	32	27	23	4
wwjets	6 10^5	10^5	5.8 10^4		17018	1237	110	3	1	1	1	0
DY(>15)	1.2 10^8	10^6	2.610^5		1.6 10^5	2268	1215	14	6	5	4	1
Zjets>20	4 10^8	2.6 10^6	8 10^5		1.2 10^5	15200	6325	105	69	19	18	1
wj >20	1.2 10^9	10^6	8.1 10^5		1.3 10^4	32	2	0				
qcd>30	10 ^{13}	10^6	10^4		1360	62	0					

Zjets, DY needs more statistics and preselection.
-> Dont consider Zjets and DY further at that moment.
QCD,Wj only low limits can be set.

INVARIANT MASS

OSSF invariant mass with cuts selection high Pt combination for LM9

Without Zjets and DY



Sc12s=6.0

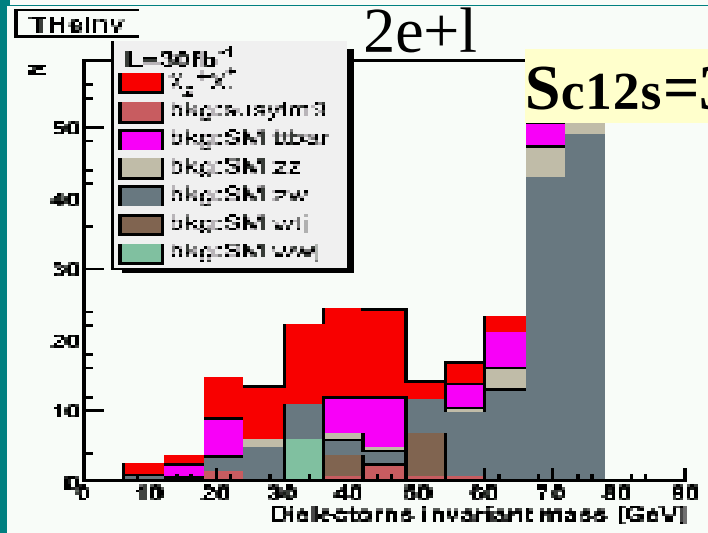
Z peak

Significance estimator

Bitioukov, Krasnikov, Nikitenko et al : scpf.f

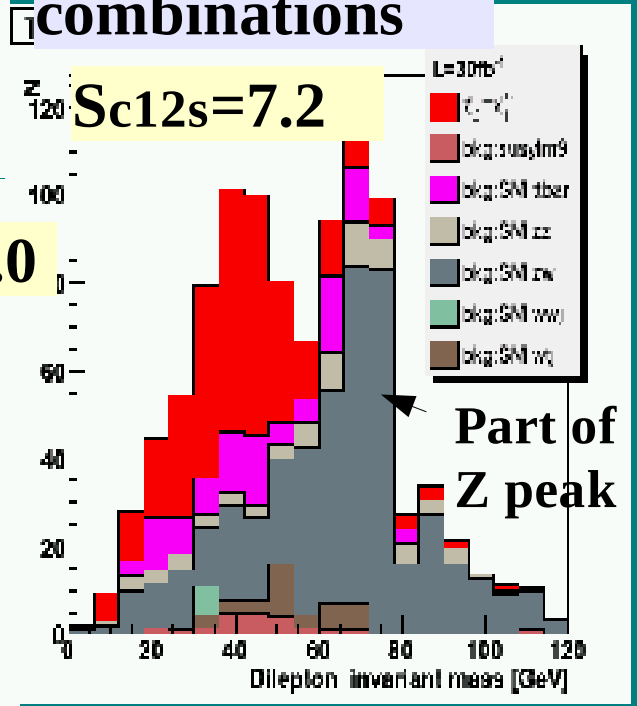
$S_{c12}=2\,(\sqrt{(ns+nb)}-\sqrt{nb}\,)$ *

$=\sqrt{nb}/(ns+nb)$



Sc12s=3.0

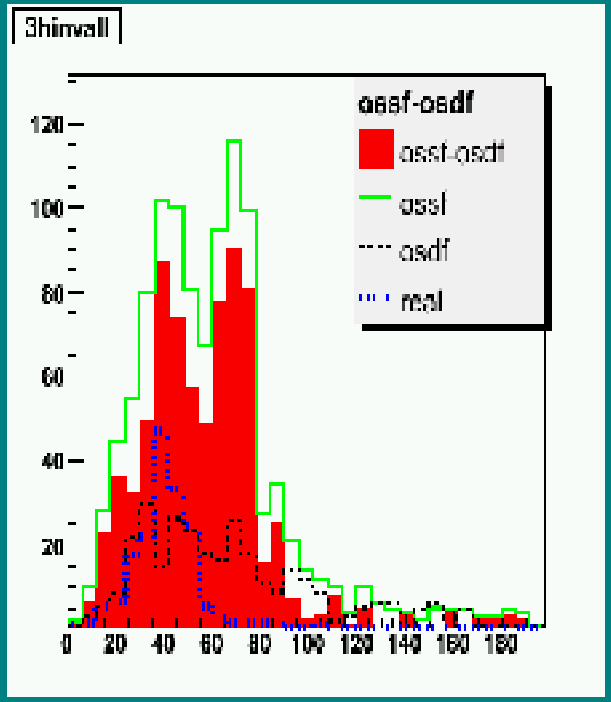
All OSSF combinations



Sc12s=7.2

Part of Z peak

DFOS subtracted



Neural Network

Neurobayes© package available from <phi-t> at Karlsruhe
(used at CDF)

NN selector for trileptons

Steps:

- **use data after cuts selection to train Network for each background separatly (ttbar, zw,zz..).**
- **pass the selected with cuts data through different networks simultanously using output as a discriminant**

Parameters used in training :

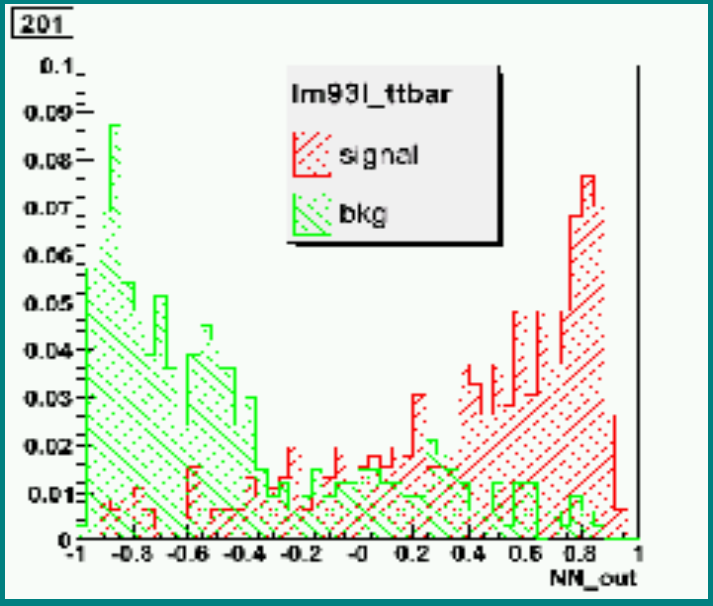
- ***Njets before selection (ET>10 GeV,*** η ***<4)***
- ***highets jet ET before selection***
- ***highest jet*** η ***before selection***
- ***Minv (OSSF highest Pt pair)***
- ***MET***
- ***Heff=MET+*** $\sum$ ***Pt leptons***
- ***Assym=Pt1-Pt2/Pt1+Pt2 OSSF leptons***
- ***Pt3 of third lepton***

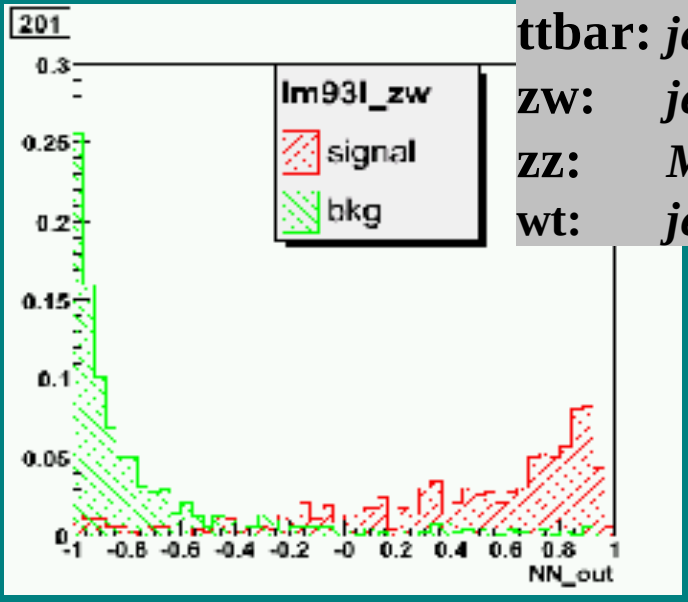
Difficulties:

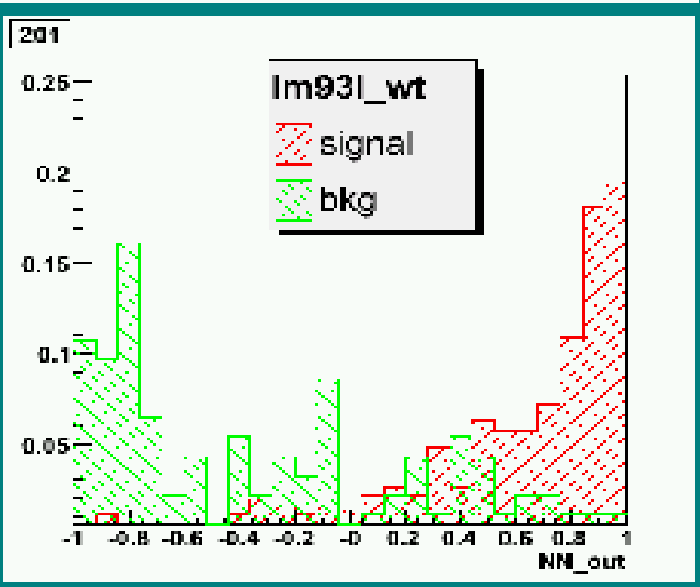
- Small statistics for training ->use relaxed cuts
- sensitivity to the uncertanities (MC and reconstruction)

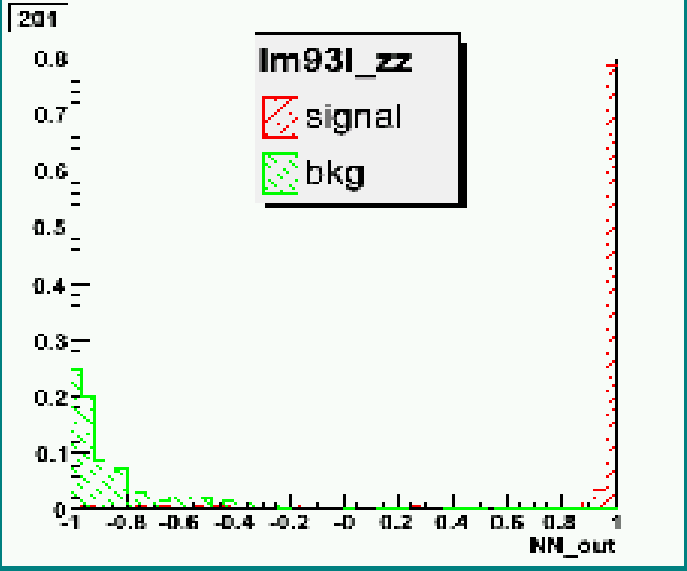
SELECTION with NN

NN training outputs









Parameters significance order:

ttbar: ***jetETR,jetETA, Nj, Ass, Minv***

zw: ***jetET, Minv, MET,Ass,Meff***

zz: ***Meff, jetET,Ass, Pt3***

wt: ***jetETR, jetETA, Nj, Ass, Minv***

Networks:

lm93l_ttbar

lm93l_zw

lm93l_zz

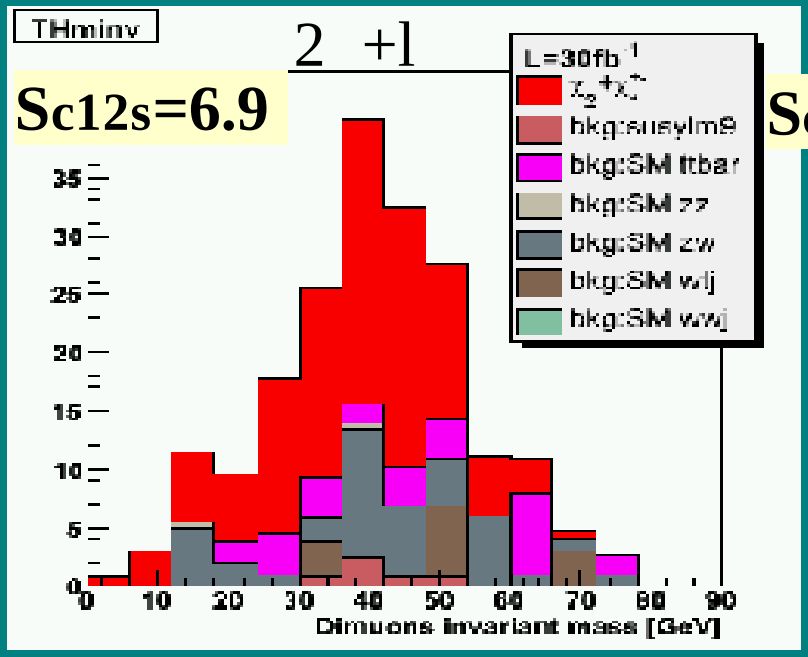
lm93l_wt

Cuts(preliminary):

contamination<0.2

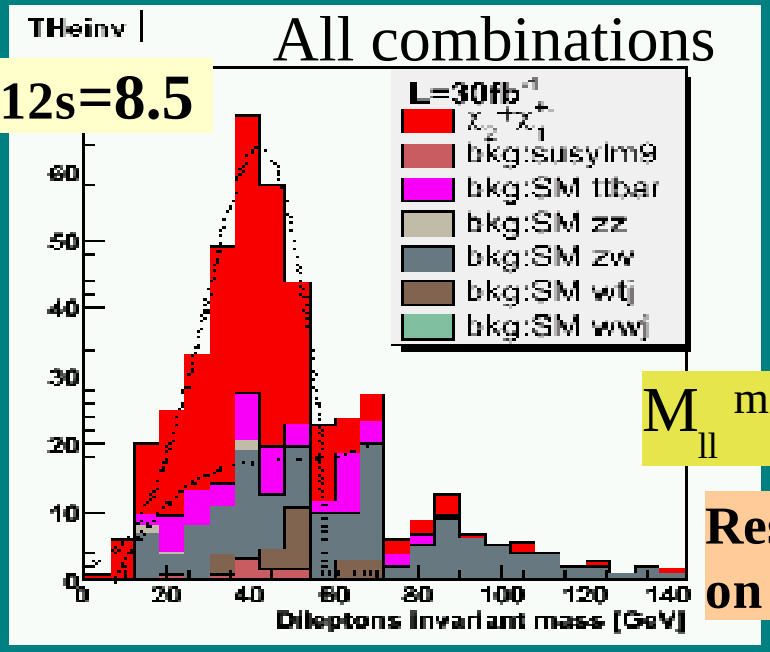
for equal samples

NN RESULTS



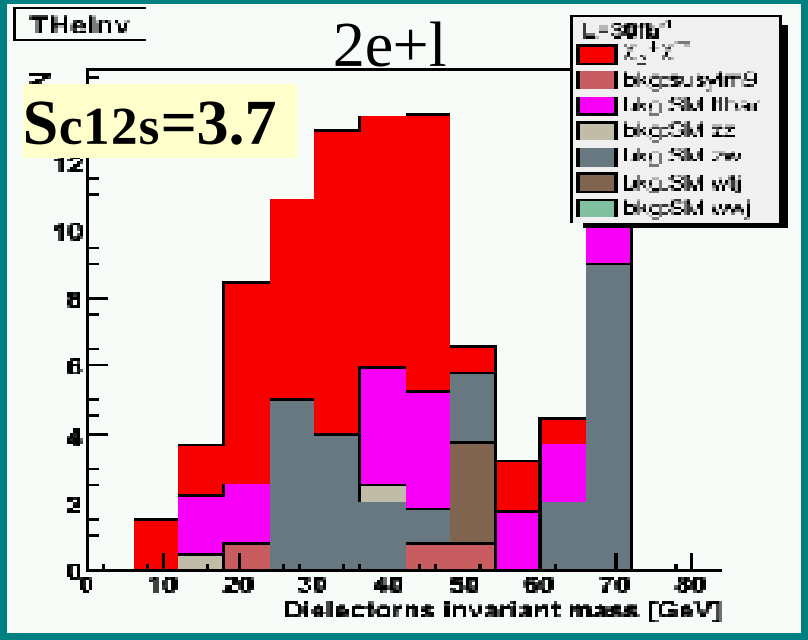
Sc12s=6.9

Sc12s=8.5



M_{ll}^{max}=57± 1.5 GeV

Resolution depends on the bkg selection.



Sc12s=3.7

	All	2m	2e
Ns	218	114	43
Nbkg	229	84	47
Sc12	8.5	6.9	3.7
ScL	12.7	10.6	5.6

A litle improvement in significance values

PDF UNCERTANITIES

PDF reweighting:

Q scale $M^2 \sim x_1 x_2 s$ (t, Z,W, χ) , $x \sim p_L$

assign for each event the weight :

W_i= PDF(pid1, pid2, x1,x2, Q)/ $PDF_{ref(}$(pid1, pid2, x1,x2, Q)

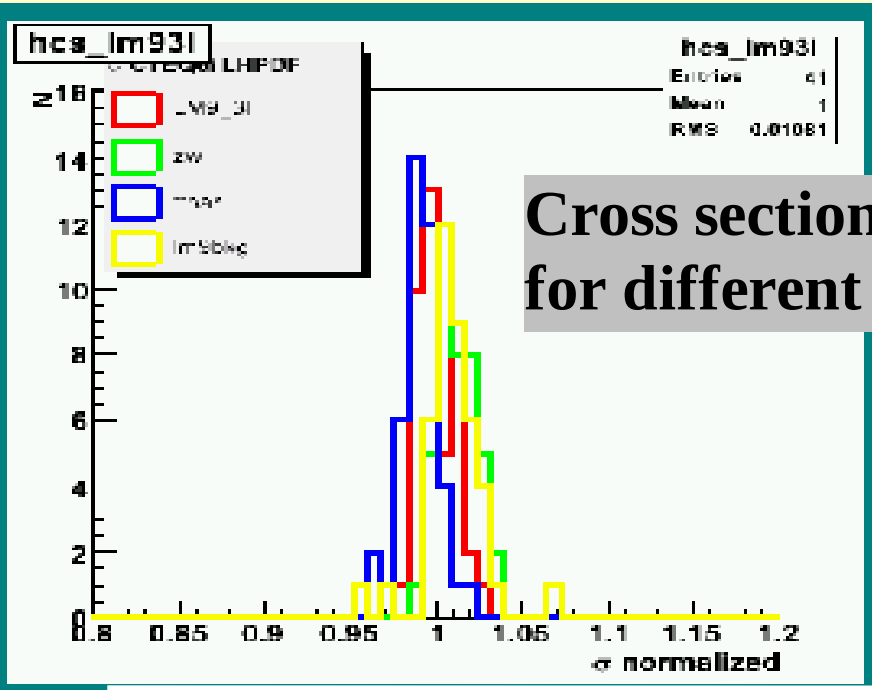
where pid= quarks or gluon id in hard process

Calculate for each PDF subset :

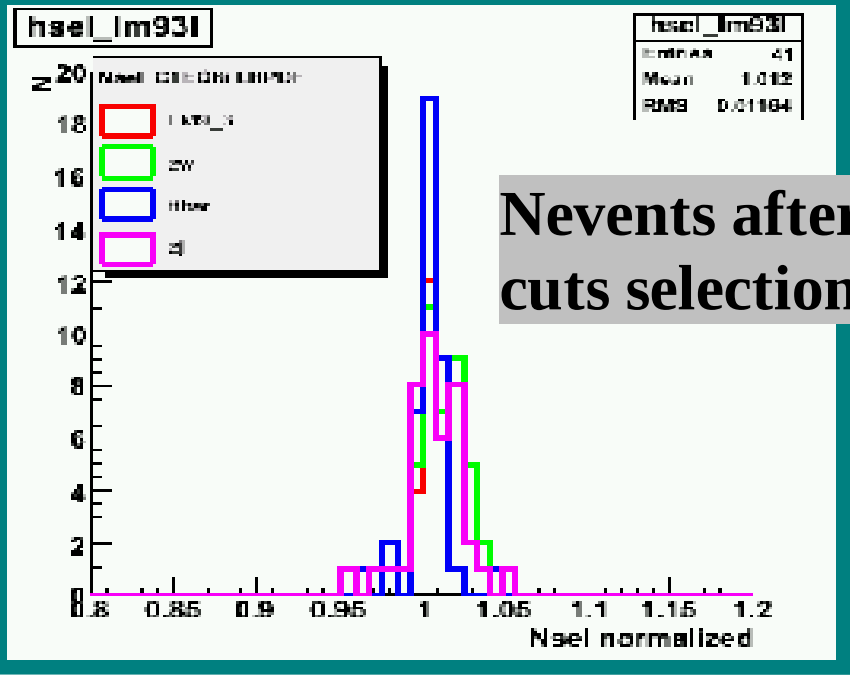
→ Nevtot=$\sum W_i$, Nev selected=$\sum W_i$

Use LHPDF 4.1.1
41 subsets
cteq61.LHgrid

Uncertanities on Nev
Signal (LM9) +/- 1.2%
Bkgs < +/- 2%



Cross section (3l) for different PDFs

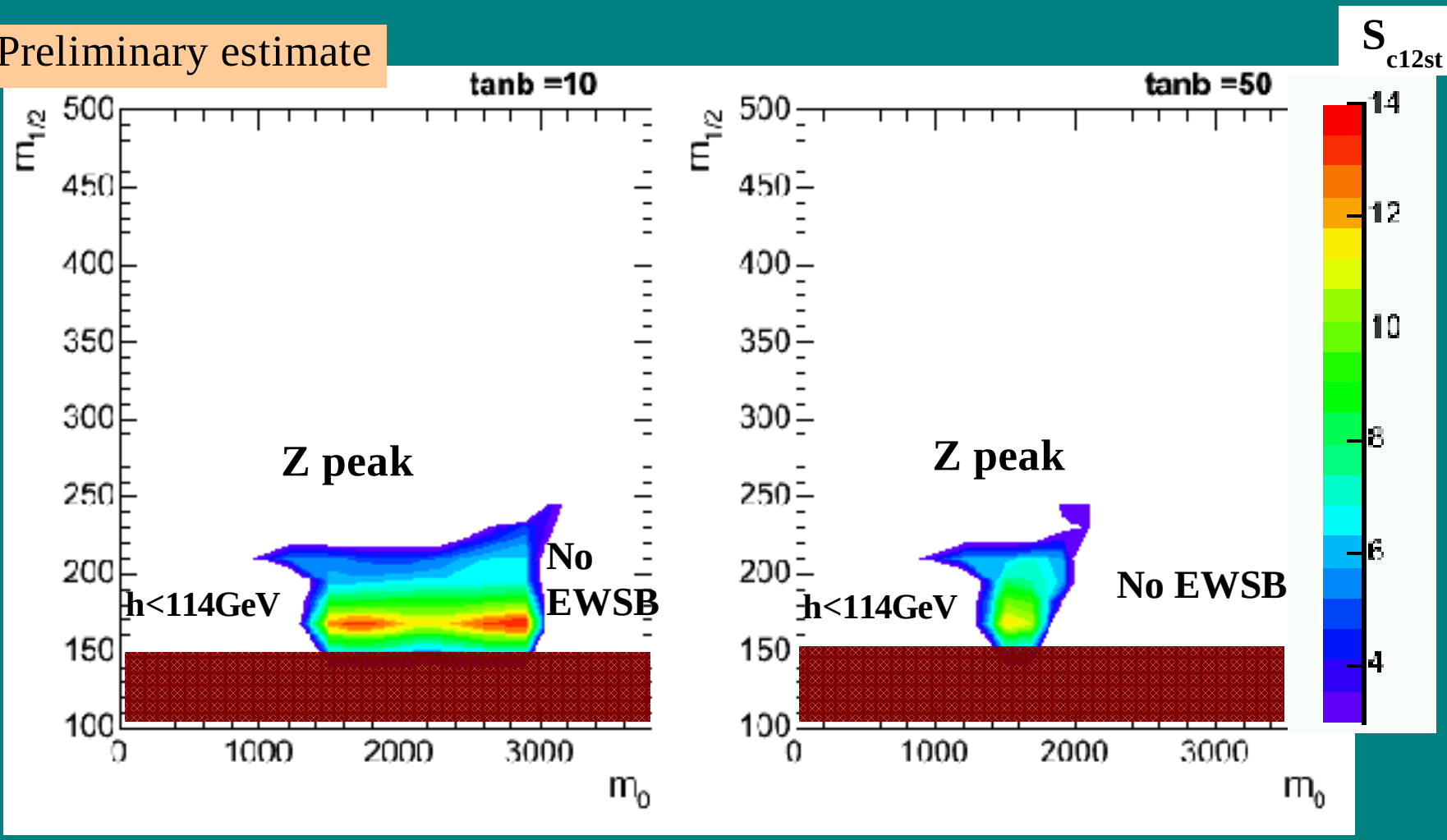


Nevents after cuts selection

MSUGRA discovery reach

Trilepton Significance S_c12st with cuts +NN selection

Preliminary estimate



No Zjets and DY

SUMMARY

Trilepton mSUGRA signal has been considered for the mSUGRA plane together with 'all' relevant backgrounds.

Most of the backgrounds (zw,zz,ttbar..) are under control.
But the large Zjets and DY require an additional consideration.

The significance for 30 fb^{-1} depends upon $m_{1/2}$ and for LM9 S_c12= 8.5.

The 5σ region is limited by $m_{1/2}$<220 (Zpeak)

CTEQ6i PDF uncertanities on the N signal and bkg events are below 2%.

The reconstruction uncertanities are much more important.
For.ex. energy scale accuracy (~10%) leads to dNbkg~ 40%.

Probably will need another round in december