

Tool to study power of dilepton signatures

- Generate large number of models and allow to map where certain signatures are relevant or not eg.
 - Same flavor (SF DL)/ different flavor dileptons (DF DL)
 - Anything you can imagine...
- Primary goal: where are SF DL and DF DL relevant, powerful, less powerful,...
- Constraints on models from eg. SF DL/DF DL ratio ...
- Build tool that generates a ntuple, each entry being a model with relevant quantities

Developed a tool "DecayChainAnalysis"

- > Checked on focus point and SU5
- > parses isasugra outputs and derive ALL decays chains
- > Defines filter to select some chains:
 - BR > x%
 - Chains with electron
 - Chains with muon, top
- > Look into BR(SUSY->emu) x Sigma(SUSY)

Example filter out all decay chains with BR(->e+X)>0.1% (focus point)

```
ParticleMap["GLSS"]->Print();  
ParticleMap["GLSS"]->MakeDecayChains(vector_of_decay_chains);  
if((*iter)->ElectronBranching() > 0.0001)
```

Number of decay chains from GLSS = 243125

```
GLSS -> W1SS BT TP ( 0.072115 )  
W1SS -> Z1SS E NUE ( 0.11108 )  
BR(->e+X) = 0.000120158
```

```
GLSS -> W1SS TP BT ( 0.072115 )  
W1SS -> Z1SS E NUE ( 0.11108 )  
BR(->e+X) = 0.000120158
```

```
GLSS -> Z1SS TP TP ( 0.038003 )
```

```
BR(->e+X) = 0.000570045
```

```
Total BR(GLSS->e+X) = 0.000931865
```

W2SS -> Z1SS UP DN (1.3919e-09)
 W2SS -> Z1SS UP DN (1.3919e-09)
 W2SS -> Z1SS E NUE (3.1222e-09)
 W2SS -> Z1SS MU NUM (3.1222e-09)
 W2SS -> Z1SS TAU NUT (3.3107e-09)
 W2SS -> Z1SS W (0.048214)
 W2SS -> Z2SS UP DN (7.8543e-10)
 W2SS -> Z2SS UP DN (7.8543e-10)
 W2SS -> Z2SS E NUE (3.6166e-10)
 W2SS -> Z2SS MU NUM (3.6166e-10)
 W2SS -> Z2SS TAU NUT (4.1855e-10)
 W2SS -> Z2SS W (0.6276)
 W2SS -> Z3SS UP DN (0.00046046)
 W2SS -> Z3SS UP DN (0.00046046)
 W2SS -> Z3SS E NUE (0.00015348)
 W2SS -> Z3SS MU NUM (0.00015348)
 W2SS -> Z3SS TAU NUT (0.00015348)
 W2SS -> W1SS Z0 (0.3228)
 W2SS -> W1SS DN DN (1.55e-09)
 W2SS -> W1SS DN DN (1.55e-09)
 W2SS -> W1SS UP UP (1.5451e-09)
 W2SS -> W1SS UP UP (1.5451e-09)
 W2SS -> W1SS NUE ANUE (5.2647e-10)
 W2SS -> W1SS NUM ANUM (5.2647e-10)
 W2SS -> W1SS NUT ANUT (5.4425e-10)
 W2SS -> W1SS E E (5.2704e-10)
 W2SS -> W1SS MU MU (5.2704e-10)
 W2SS -> W1SS TAU TAU (5.3565e-10)

Example filter out all decay chains with BR(->e+X)>0.1% (focus point)

Number of decay chains from W2SS = 2637

W2SS -> Z1SS W (0.048214)
 BR(->e+X) = 0.00520711

W2SS -> Z2SS W (0.6276)
 Z2SS -> Z1SS E E (0.034371)
 BR(->e+X) = 0.00232969

W2SS -> W1SS Z0 (0.3228)
 W1SS -> Z1SS E NUE (0.11108)
 BR(->e+X) = 0.00118327
 Total BR(SUSY->e+X) = 0.008725

UPL -> Z4SS UP (0.032222)

Z4SS -> W2SS NUE E (3.3903e-09)

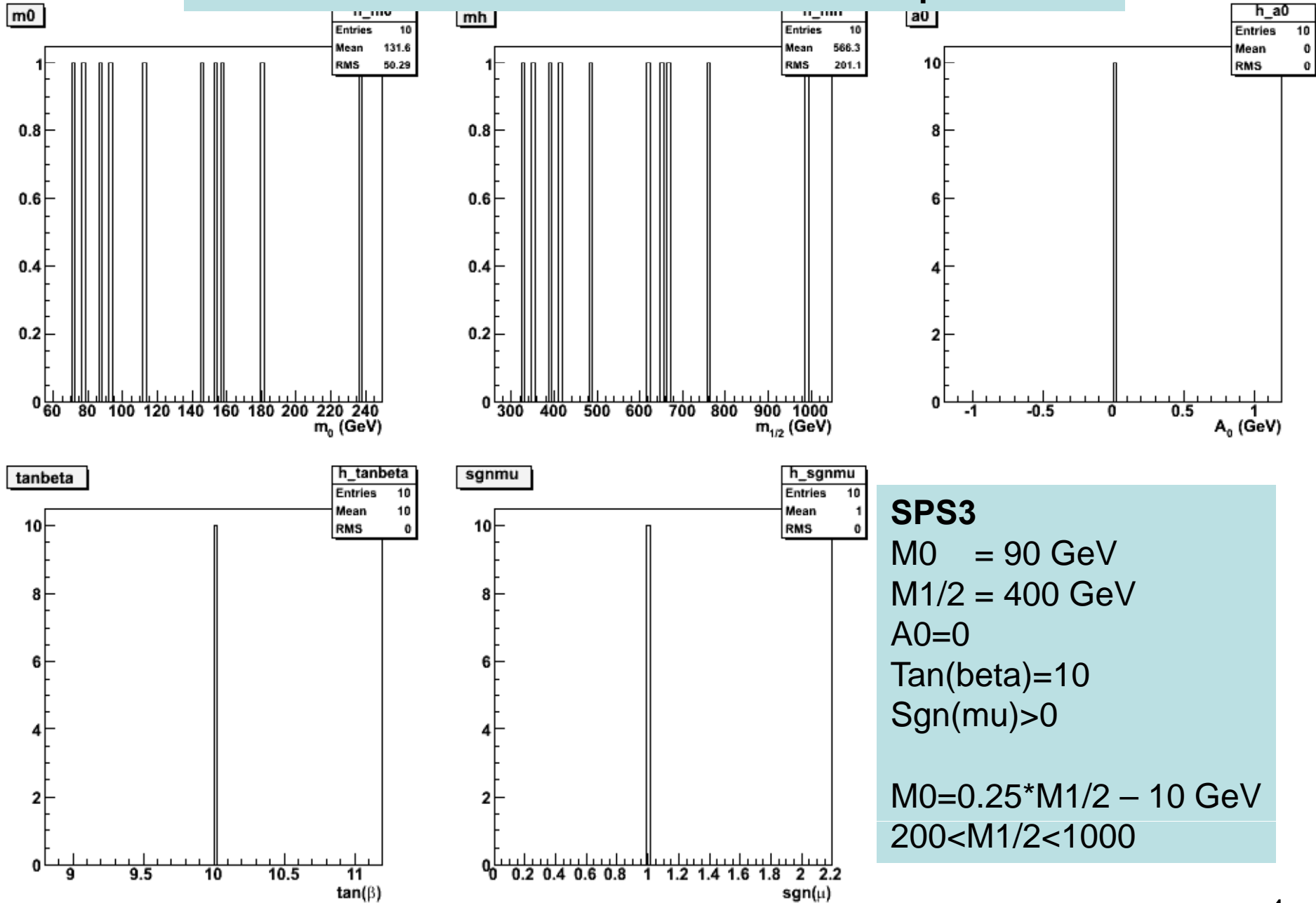
W2SS -> Z3SS E NUE (0.00015348)

Z3SS -> W1SS E ANUE (0.00042047)

W1SS -> Z2SS MU NUM (1.7644e-12)

Z2SS -> Z1SS NUT ANUT (0.068567)

Micro mSUGRA scan around SPS3: scanned parameters

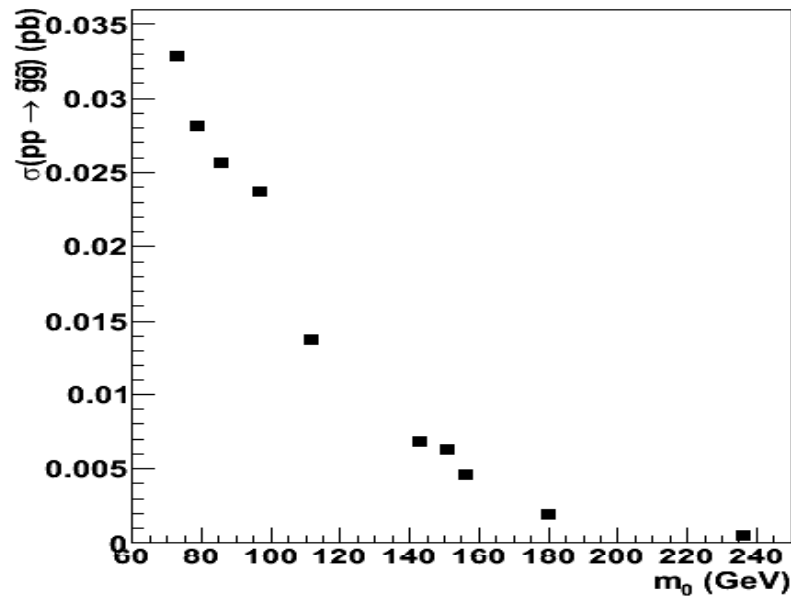


SPS3
 $M_0 = 90 \text{ GeV}$
 $M_{1/2} = 400 \text{ GeV}$
 $A_0 = 0$
 $\tan(\beta) = 10$
 $\text{sgn}(\mu) > 0$

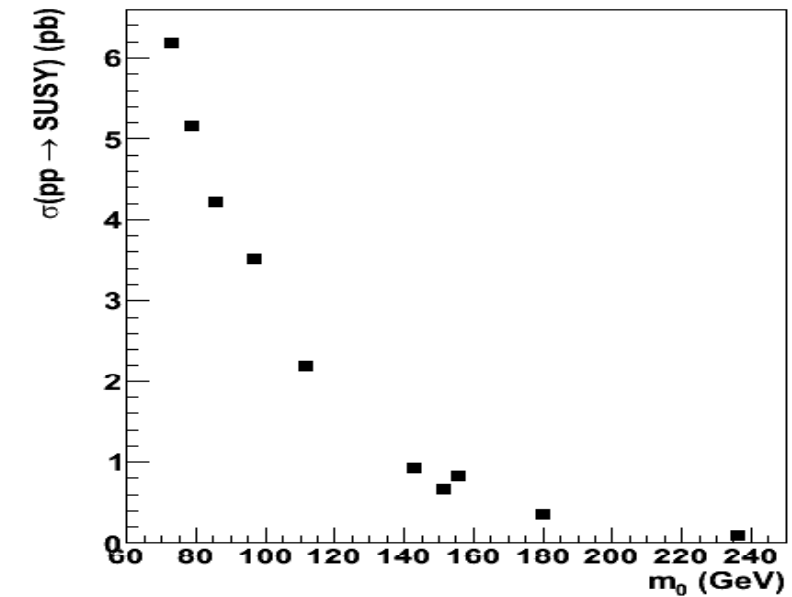
$M_0 = 0.25 \cdot M_{1/2} - 10 \text{ GeV}$
 $200 < M_{1/2} < 1000$

Cross sections: Total SUSY, gluino-gluino, squark-gluino, squark-squark

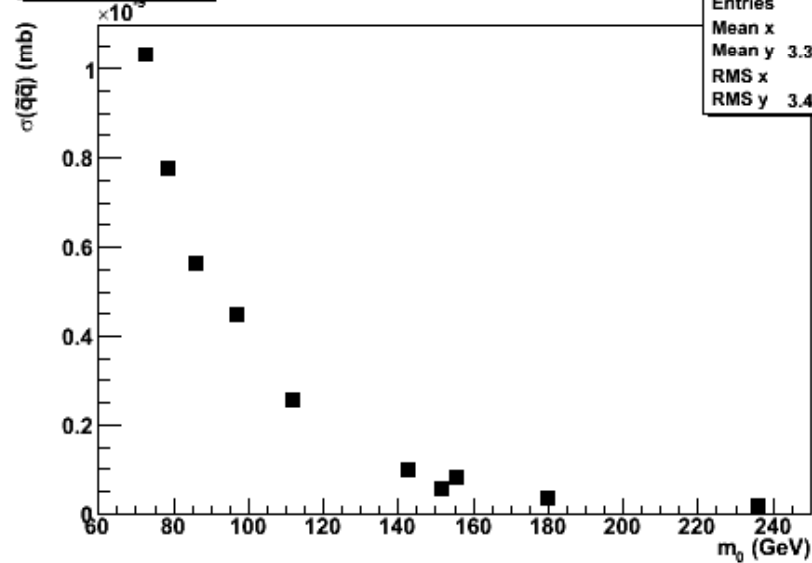
XS_GLSS_GLSS:m0



XS_SUSY:m0

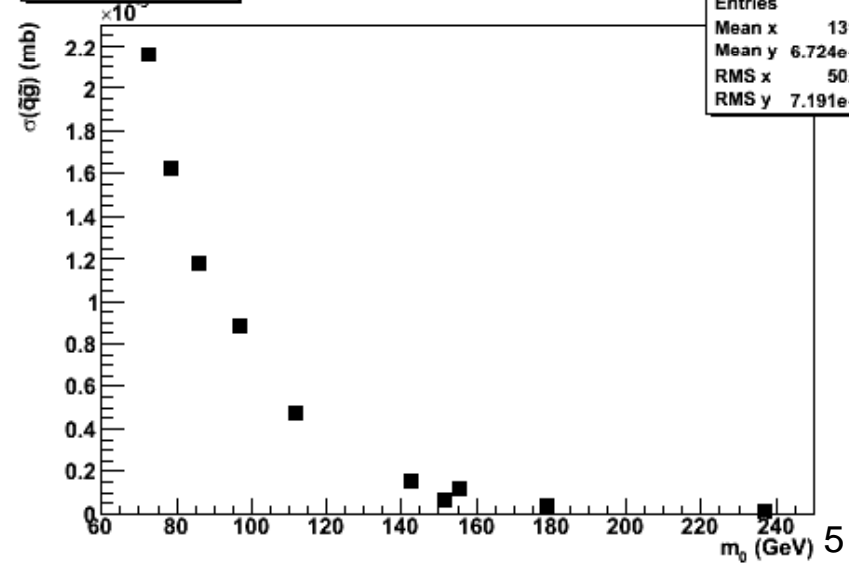


sq_sq_xs:m0



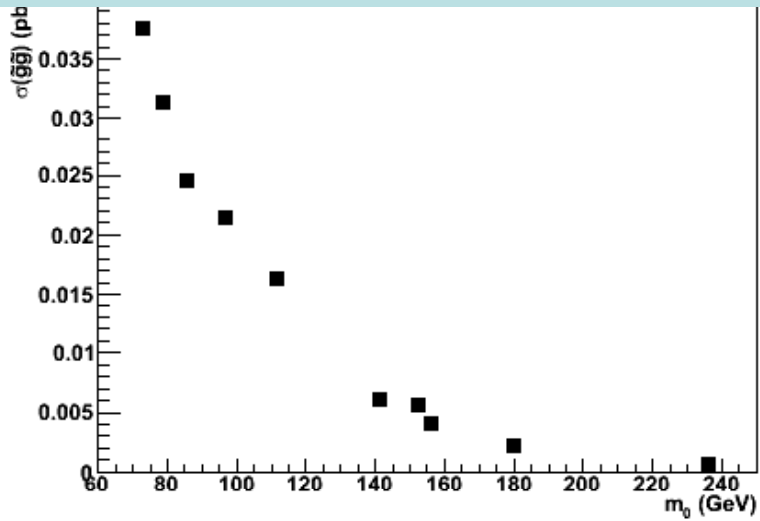
h_sq_sq_xs_vs_m0	
Entries	10
Mean x	131.6
Mean y	3.397e-10
RMS x	50.29
RMS y	3.453e-10

sq_glss_xs:m0

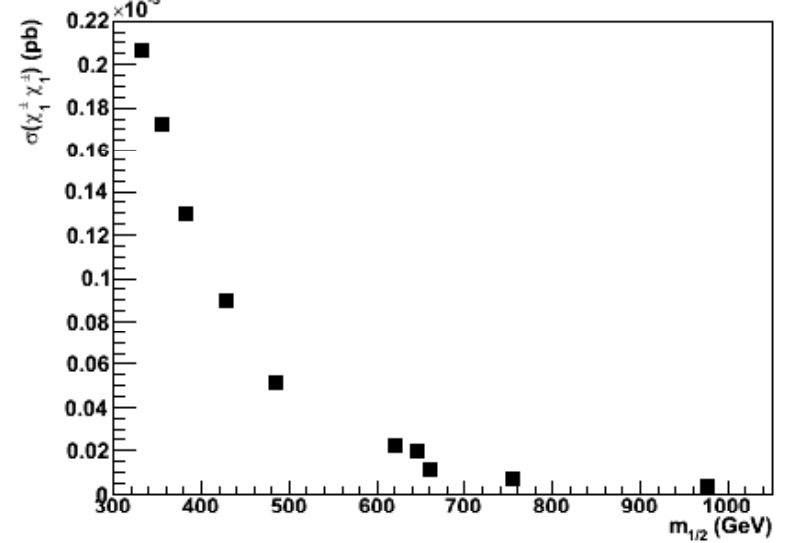


h_sq_glss_xs_vs_m0	
Entries	10
Mean x	131.6
Mean y	6.724e-10
RMS x	50.29
RMS y	7.191e-10

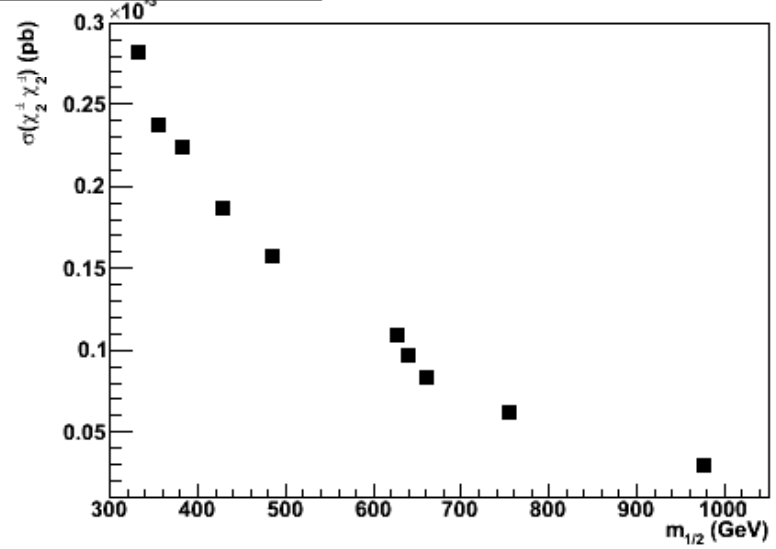
More cross sections: Chargino pairs



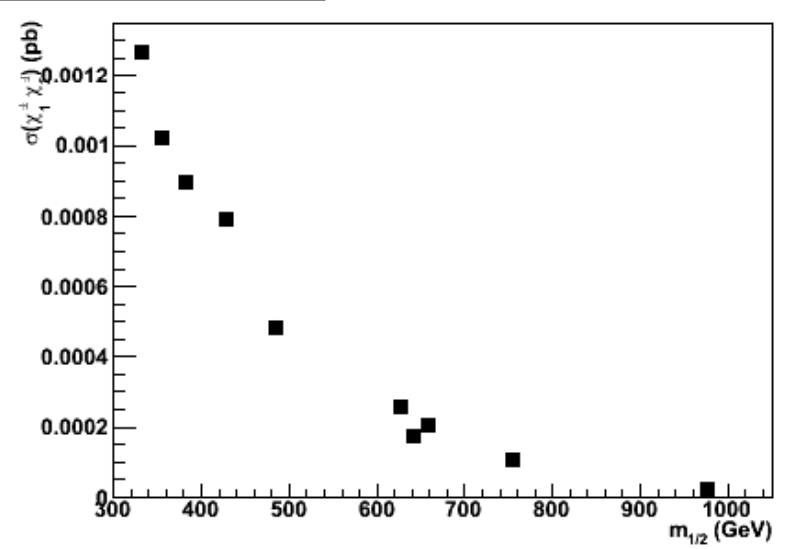
XS_W1SSM_W1SSP:mh



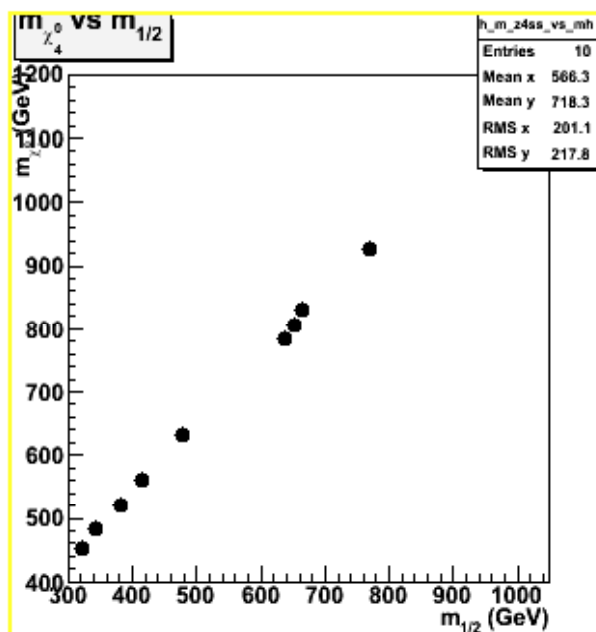
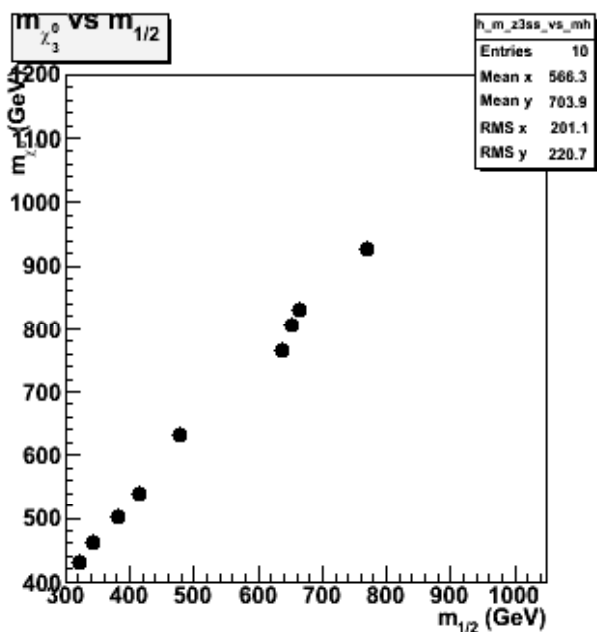
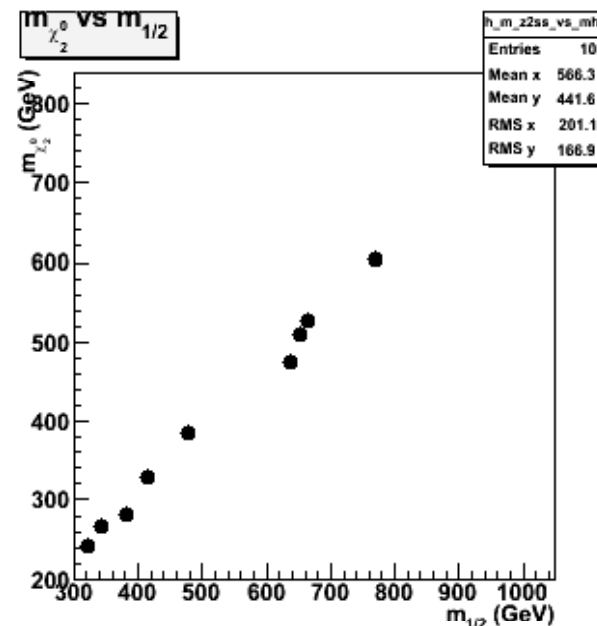
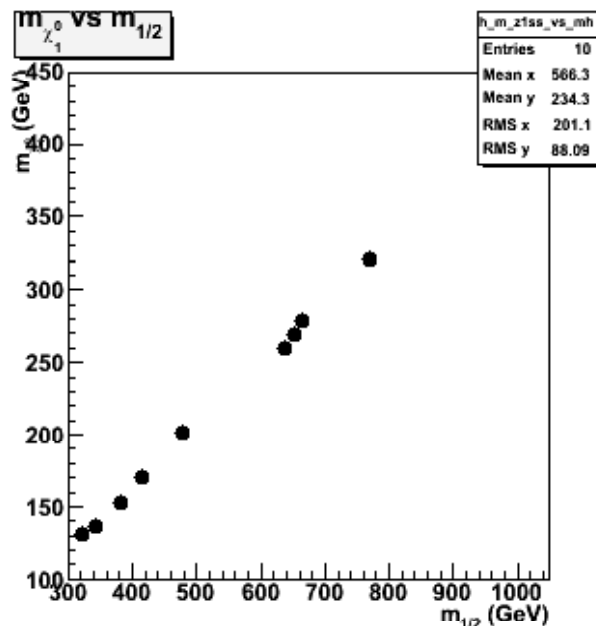
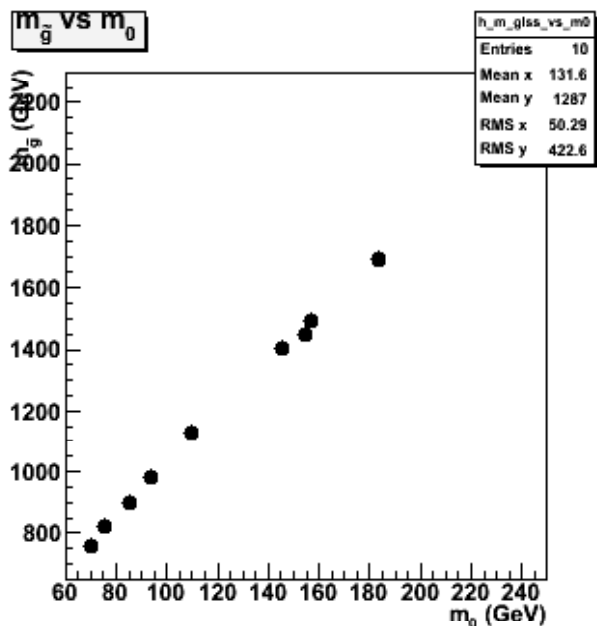
XS_W2SSM_W2SSP:mh



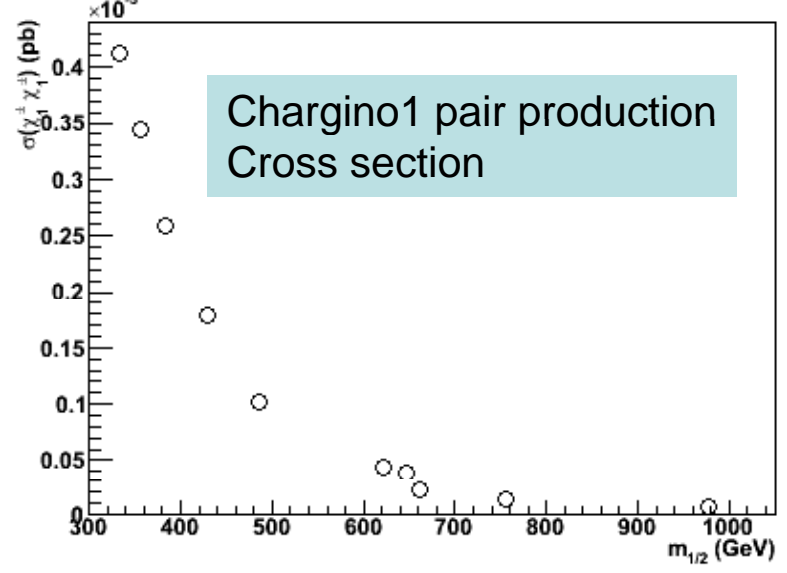
XS_W1SSM_W2SSP:mh



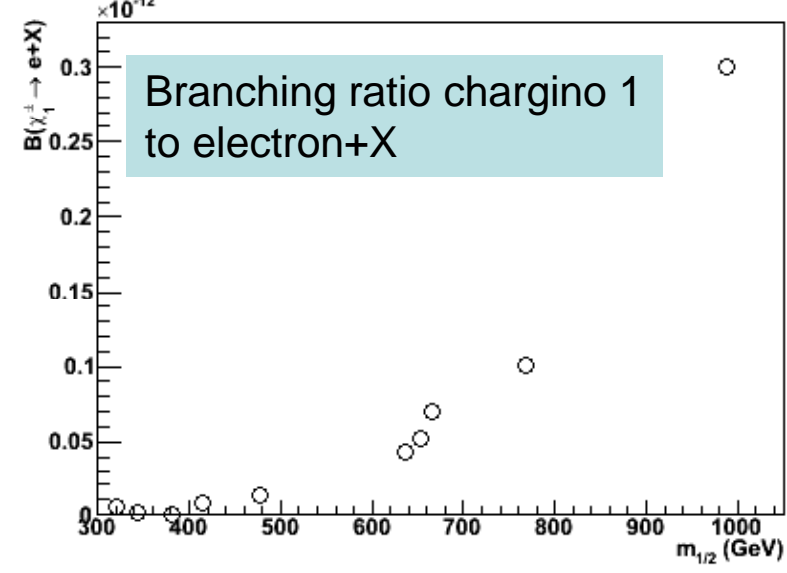
Correlation b/w masses and model parameters



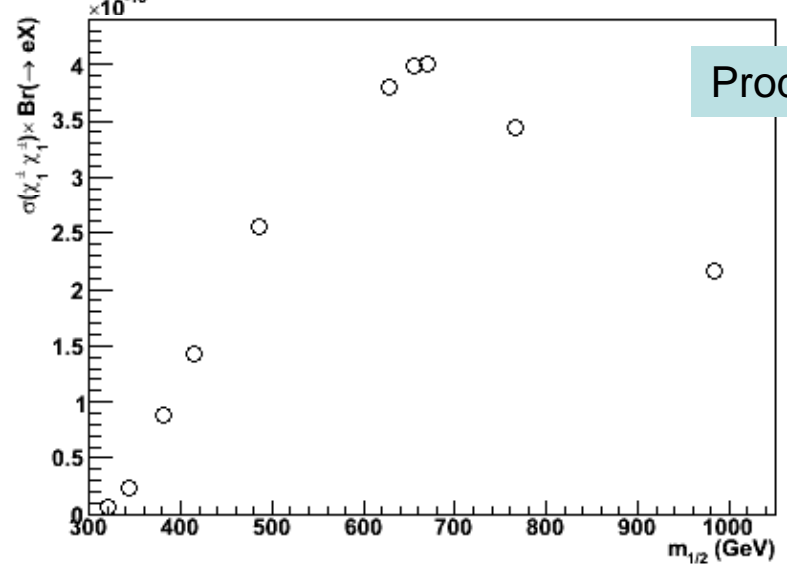
2*XS_W1SSM_W1SSP:mh



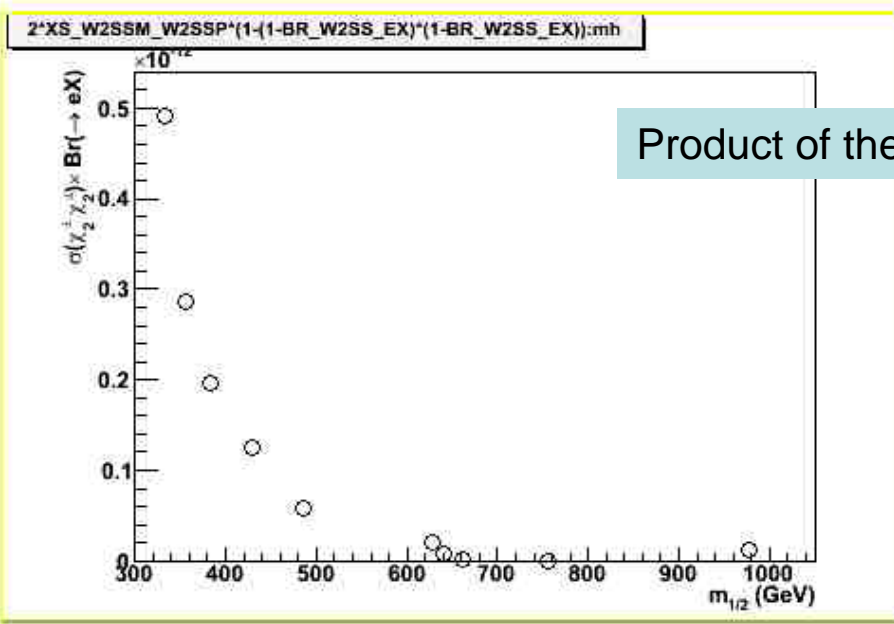
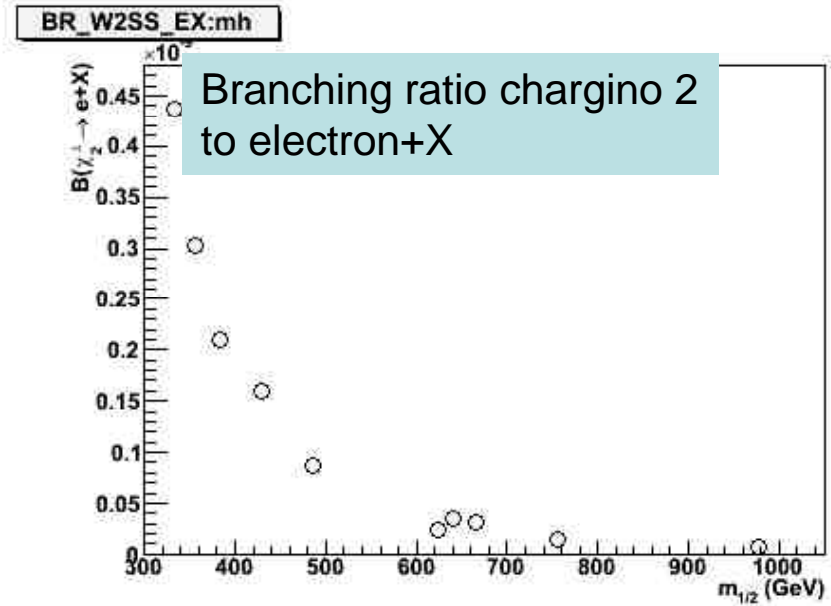
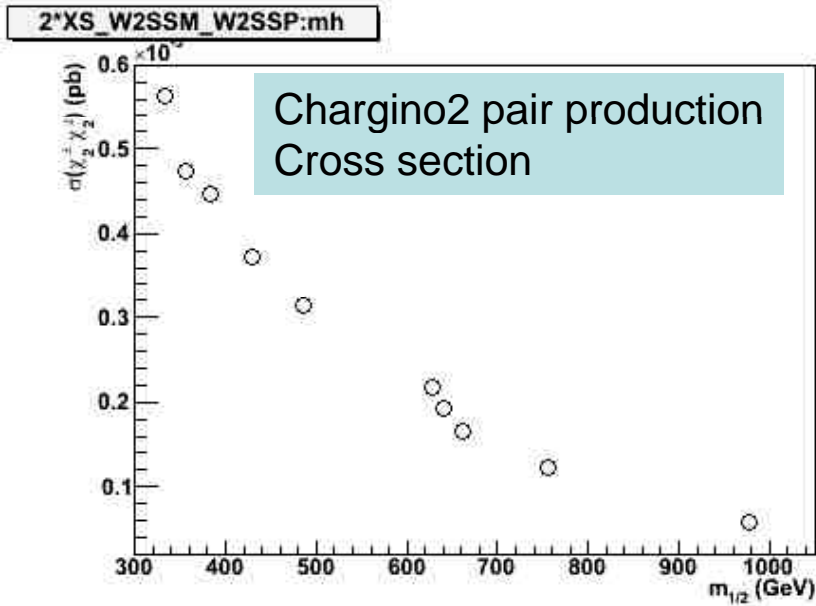
BR_W1SS_EX:mh



2*XS_W1SSM_W1SSP*(1-(1-BR_W1SS_EX)*(1-BR_W1SS_EX)):mh



Non trivial maximum:
measurement of Susy->dilepton cross section
could select pockets of parameter space.



First steps towards code validation

Validation with SU1 (Ref. ATL-PHYS-CONF-2007-002)

$M_0 = 70 \text{ GeV}$

$M_{1/2} = 350 \text{ GeV}$

$A_0 = 0$

$\tan(\beta) = 10$

$\text{Sgn}(\mu) > 0$

$\sigma(\text{SUSY}) = 7.8 \text{ pb (all) or } 5.6 \text{ pb (no sleptons nor gauginos)}$

$\sigma(\text{SUSY}) = 9.3 \text{ pb (all) using Herwig in note ATLAS-PHYS-PUB-2005-003}$

\Rightarrow **I find $\sigma(\text{SUSY}) = 5.1 \text{ pb}$ (no sleptons nor gauginos)**

difference seems to come from $\sim g\bar{g}$ production cross section (0.6 in Ref. & 0.1 for me)

Compare branching ratios & masses / in progress

Also look at pdf choice, Isajet version / to do

Other points.

My code using isajet 7.74 vs Ref.

Neutralino masses :

M(Z1SS) 139.881	137 GeV
M(Z2SS) 261.92	264 GeV
M(Z3SS) 462.658	
M(Z4SS) 480.805	

Chargino masses :

M(W1SS) 262.261	
M(W2SS) 479.989	

Glunos+ squarks masses :

M(GLSS) 829.389	832 GeV
M(UPSSL) 760.628	760 GeV
M(DNSSL) 765.1	765 GeV
M(STSSL) 765.1	765 GeV
M(CHSSL) 765.1	760 GeV
M(BTSS1) 702.505	
M(TPSS1) 564.602	
M(UPSSR) 735.644	
M(DNSSR) 733.768	
M(STSSR) 733.768	
M(CHSSR) 733.768	
M(BTSS2) 732.057	
M(TPSS2) 756.371	

Plan

- * link Isajet fortran lib from my C++ code / DONE
- * Access/modify content of Isajet common blocks / DONE
- * Compute SUSY cross section from C++ code using Isajet / DONE
- * Create some a loop over some mSUGRA models / DONE
- * In each loop:
 - compute the main production channels and cross sections / DONE
 - compute the $BR(SUSY \rightarrow ee)$, $BR(SUSY \rightarrow e\mu)$, $BR(SUSY \rightarrow \mu\mu)$
 - + - DONE / need to implement specifically the signatures we want to study
- * Speed up code IN PROGRESS
- * validate the code on known SUSY points IN PROGRESS
- * compute $\text{Sigma}(SUSY) * BR(SUSY \rightarrow ll')$ over various regions of SUGRA
- * study result
- * **regions of mSUGRA not accessible with ll' signatures??**
- * Do the same with AMSB, GMSB, NUHM
- * Study constraints on parameter space imposed by measurements of $BR(SUSY \rightarrow ll')$ or $BR(I)/BR(II)$
- * Other very specific signatures like $SUSY \rightarrow \text{top} + l$
- * Look into extra dimension models?