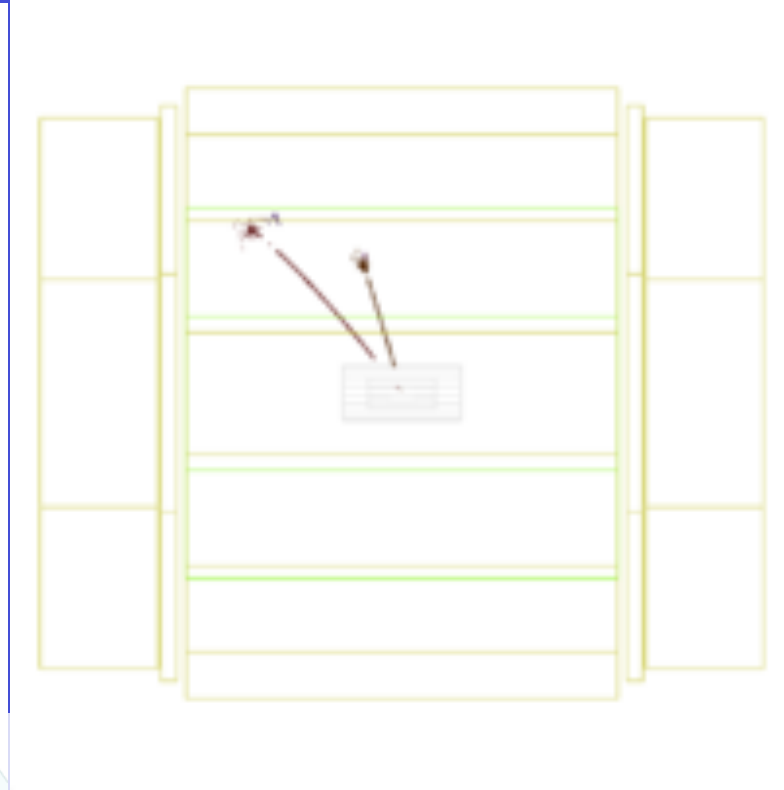
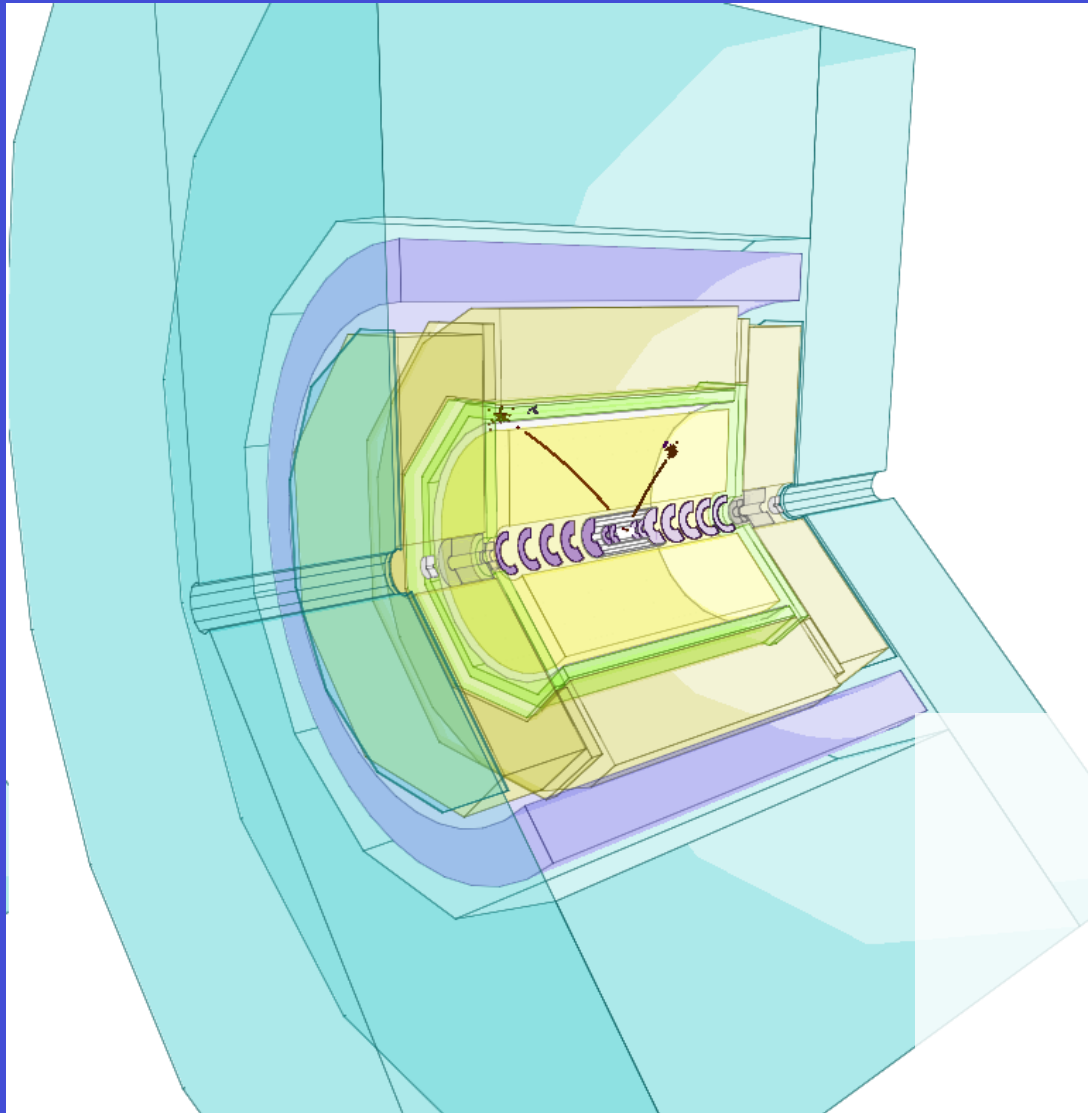


# Characterizing Light Higgsinos from Natural SUSY at ILC $\sqrt{s} = 500$ GeV

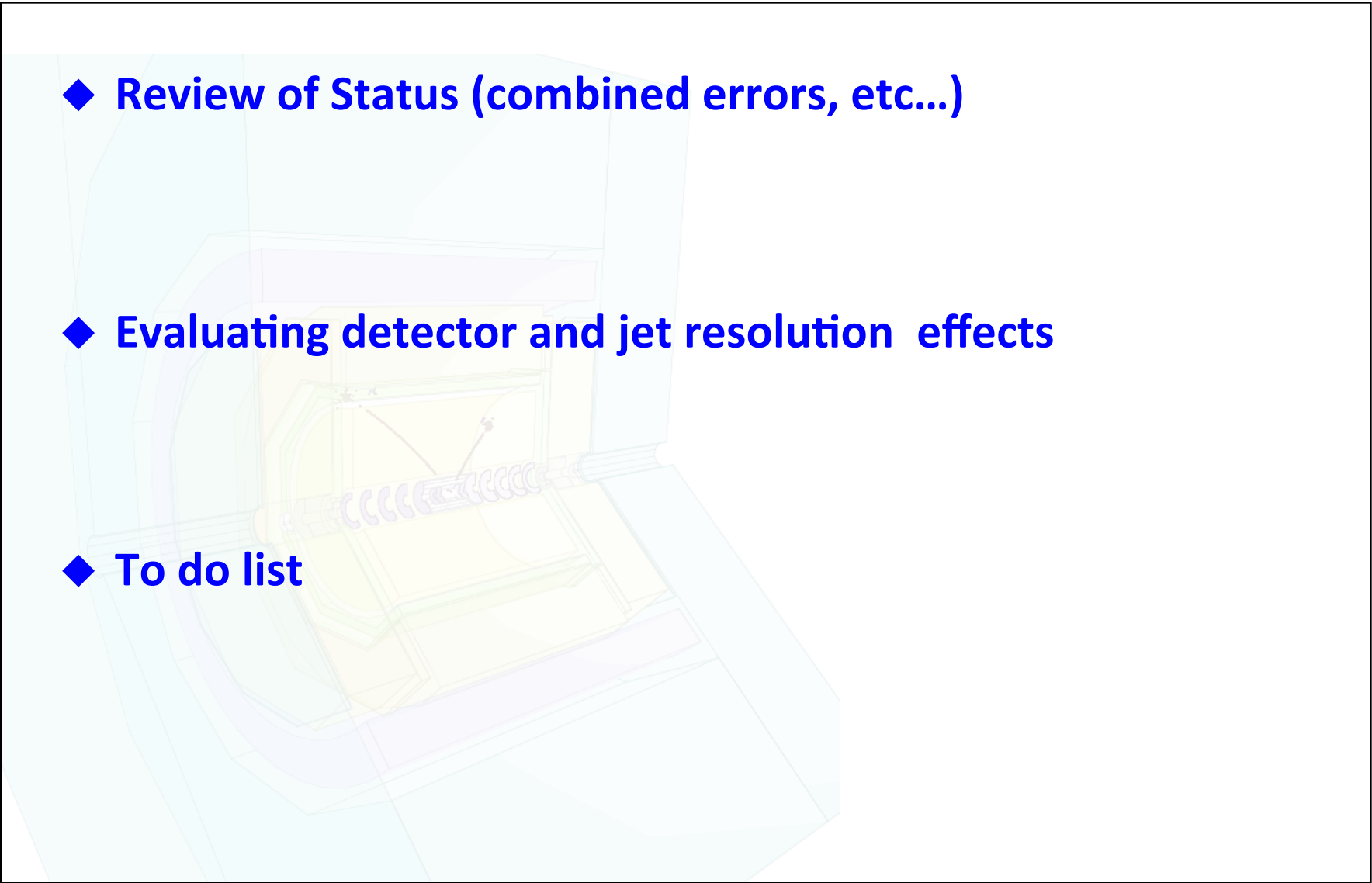


Jacqueline Yan (KEK)

Friday Meeting

9/16/2016

# Outline of Today's Talk

- ◆ Review of Status (combined errors, etc...)
  - ◆ Evaluating detector and jet resolution effects
  - ◆ To do list
- 
- A faint, semi-transparent background image of a particle detector, likely a calorimeter or similar detector component, showing various internal structures and layers. The image is centered and slightly tilted, providing a technical context for the talk's outline.

# Summary of Mass Precisions

Edge precision propagated to mass precision  
Detailed plots in 1<sup>st</sup> part of backup slides

## N1N2:

- edge precision  $\sim 1\%$ , mass precision about 1 – 2%
- Left polarization ee has worse precision :  
high bkg w.r.t right pol + wider distribution than mumu

**C1C1:** mass precision is better for left polarization by a factor of 2 (statistics)

## N1N2

polarization		MN1	MN2	$\Delta$ MN1	$\Delta$ MN1/ MN1	$\Delta$ MN2	$\Delta$ MN2/ MN2
left	mm	102.26	123.02	1.77	1.7%	1.76	1.4%
left	ee	100.30	120.81	2.17	2.2%	2.15	1.8%
right	mm	103.06	123.99	1.82	1.8%	1.81	1.5%
right	ee	103.41	124.30	1.44	1.4%	1.43	1.1%

**Theoretical values: MN1 = 102.7 GeV MN2 = 124.0 GeV, MC1 = 117.8 GeV**

## C1C1

polarization		MN1	MC1	$\Delta$ MN1	$\Delta$ MN1/ MN1	$\Delta$ MC1	$\Delta$ MC1/ MC1
left	mu tag	113.50	129.14	0.82	0.7%	0.82	0.6%
left	e tag	122.96	140.37	1.19	1.0%	1.18	0.8%
right	mu tag	116.42	132.44	1.76	1.5%	1.75	1.3%
right	e tag	125.34	142.98	2.20	1.8%	2.18	1.5%

# Summary of Mass Precisions (Combined Results)

Chi square fit of “observed” variables (E<sub>ll\_max</sub>, E<sub>jj\_max</sub>, M<sub>ll\_max</sub>, M<sub>jj\_max</sub>) for each channel (muon, electron, left and right polarizations)

N1N2	fit of 2 variables (E <sub>ll_max</sub> , M <sub>ll_max</sub> )			4 channels (mm, ee, left, right)						
	MN1	Δ MN1	Δ MN1/MN1	MN2	Δ MN2	Δ MN2/MN2				
	102.54	0.777125	0.758%	123.355	0.8488	0.688%				
H20			0.424%			0.385%				
C1C1	fit of 2 variables (E <sub>jj_max</sub> , M <sub>jj_max</sub> )			4 channels (m tag, e tag, left, right)						
	MN1	Δ MN1	Δ MN1/MN1	MC1	Δ MC1	Δ MC1/MC1				
mu	116.60	0.52108	0.447%	132.79	0.577491	0.435%				
fit all	fit of 4 variables (E <sub>ll_max</sub> , E <sub>jj_max</sub> , M <sub>ll_max</sub> , M <sub>jj_max</sub> )						8 channels (m, e, left, right, N1N2, C1C1)			
	MN1	Δ MN1	Δ MN1/MN1	MN2	Δ MN2	Δ MN2/MN2	MC1	Δ MC1	Δ MC1/MC1	
	110.56	0.447387	0.405%	130.903	0.4866	0.372%	126.09	0.49884	0.396%	
H20			0.226%			0.208%				0.221%

Default : 500 fb<sup>-1</sup> for each polarization

H20: 1600 fb<sup>-1</sup> for each polarization

- Combined statistical mass precision  $\sim 0.2\%$  (H20)
- N1N2 has not shift outside of statistical uncertainties very nice !
- C1C1 has better statistical precision (higher cross section)
- We need to justify that deviation for C1C1 is from jet energy resolution

# Summary of Cross Section Precisions

- For N1N2: right polarization benefits from low bkg
- For C1C1, no bkg anyhow, so left polarization is better due to higher statistics (cross section is larger by a factor of 4-5)

N1N2	$\Delta \sigma / \sigma$
left, mumu	3.49%
left, ee	3.17%
right mumu	2.80%
right ee	2.41%

C1C1	$\Delta \sigma / \sigma$
left, mu-tag	0.85%
left, e-tag	0.83%
right mu-tag	1.75%
right e-tag	1.71%

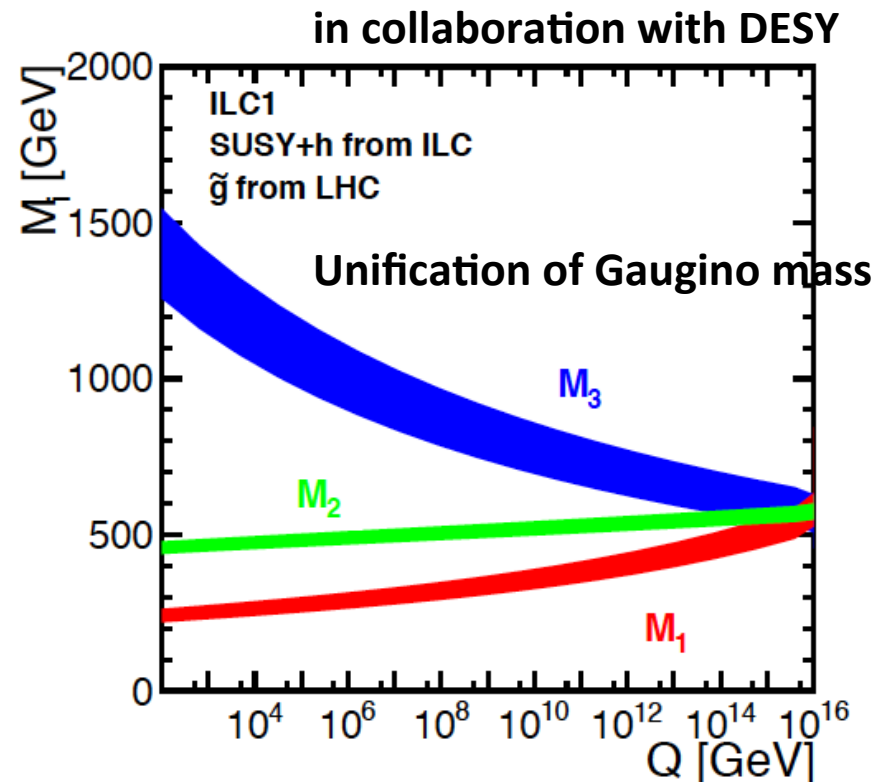
# Plan for Analysis

## converge current results

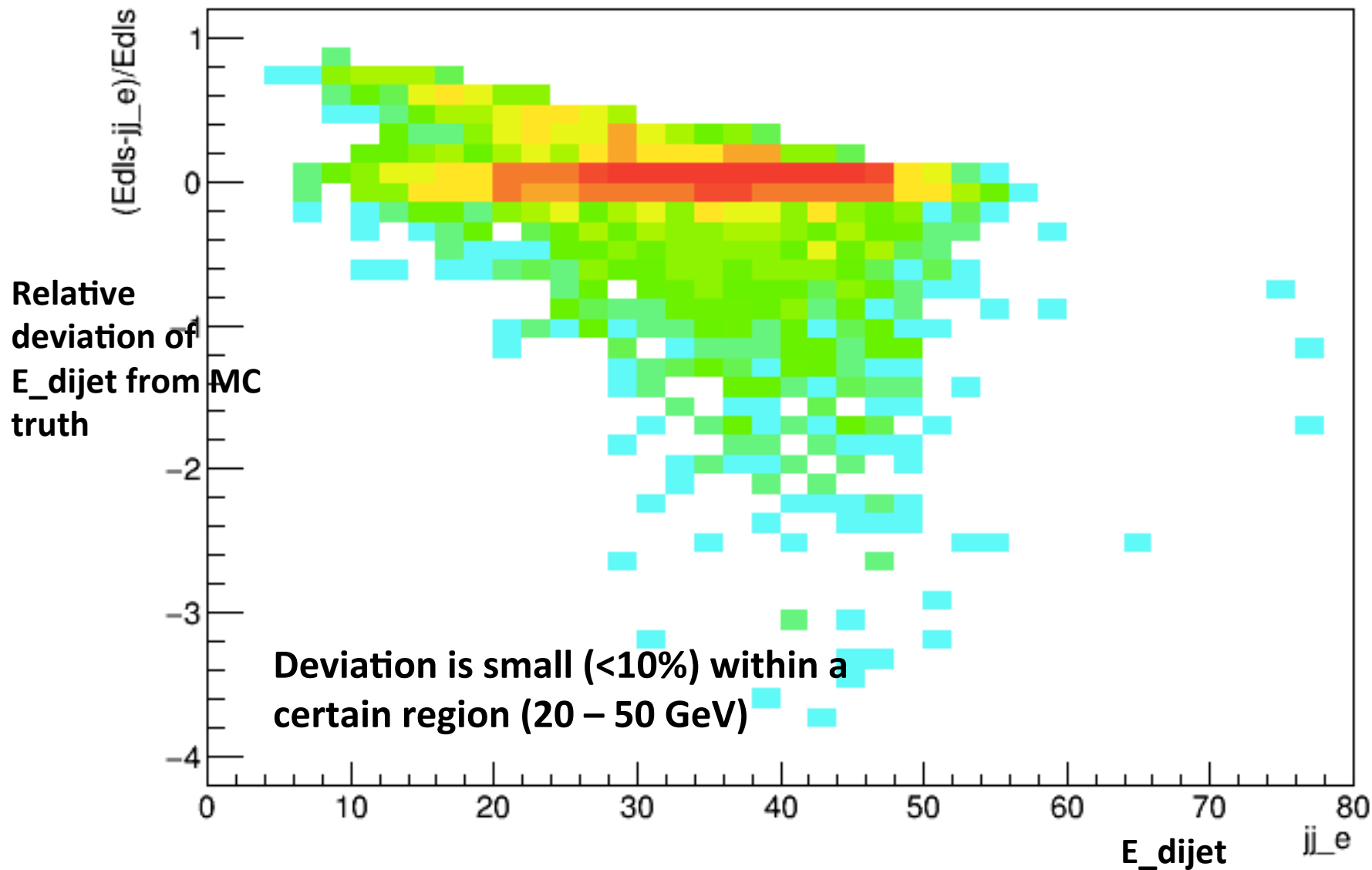
- Statistic precision obtained using current toy MC
- Demonstrate systematic shift is due to detector and jet energy resolution

## Other Plans

- Follow up document to ICFA letter (section on new particle discovery: 1<sup>st</sup> draft ~ end of September)
- Goal: write section on Light Higgsino by end of next week
- JSPS application form for Higgsino research (若手B)
- Publication for Higgsino studies
- Begin Dark Matter study  
hope to have some result by LCWS

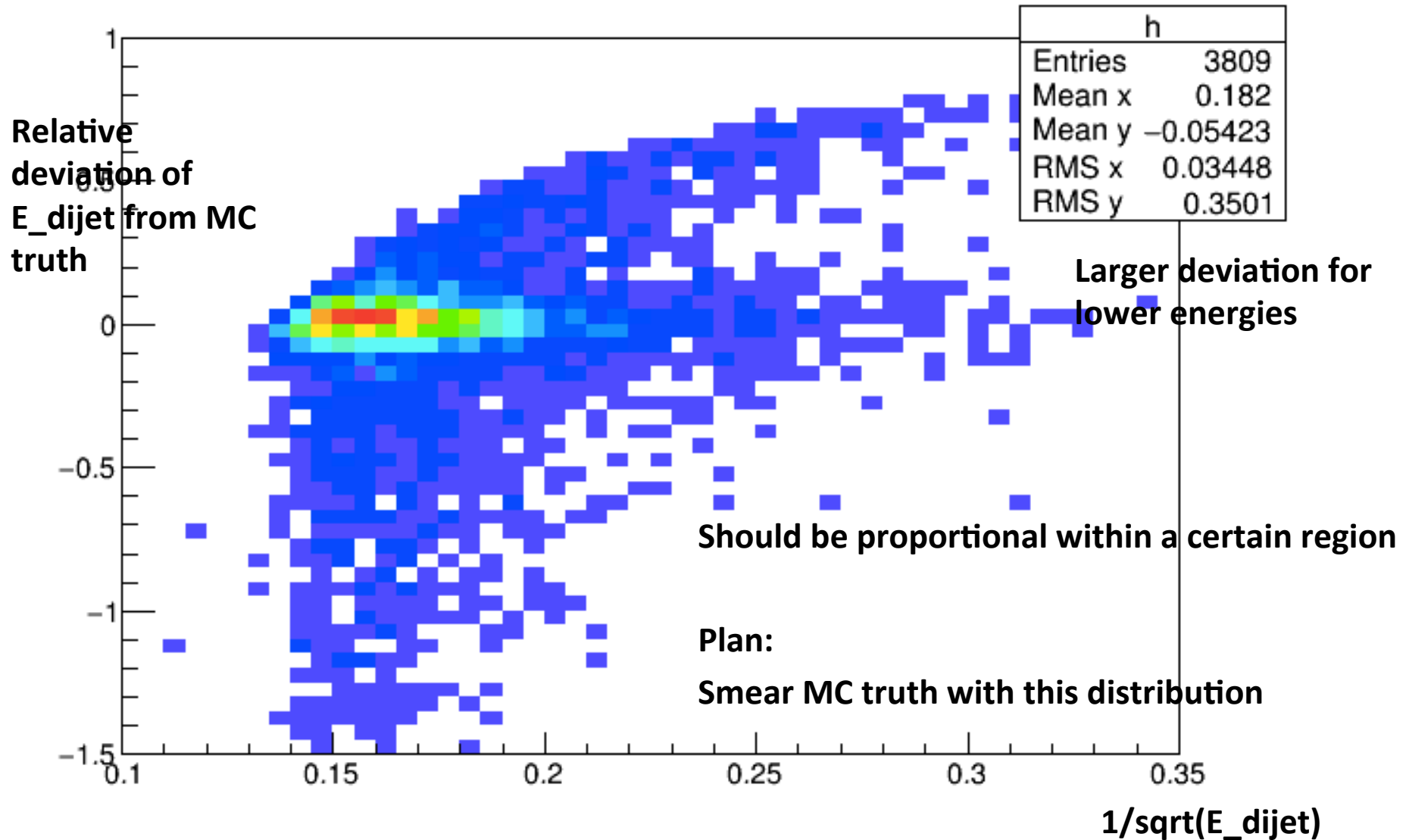


# **Additional Material**





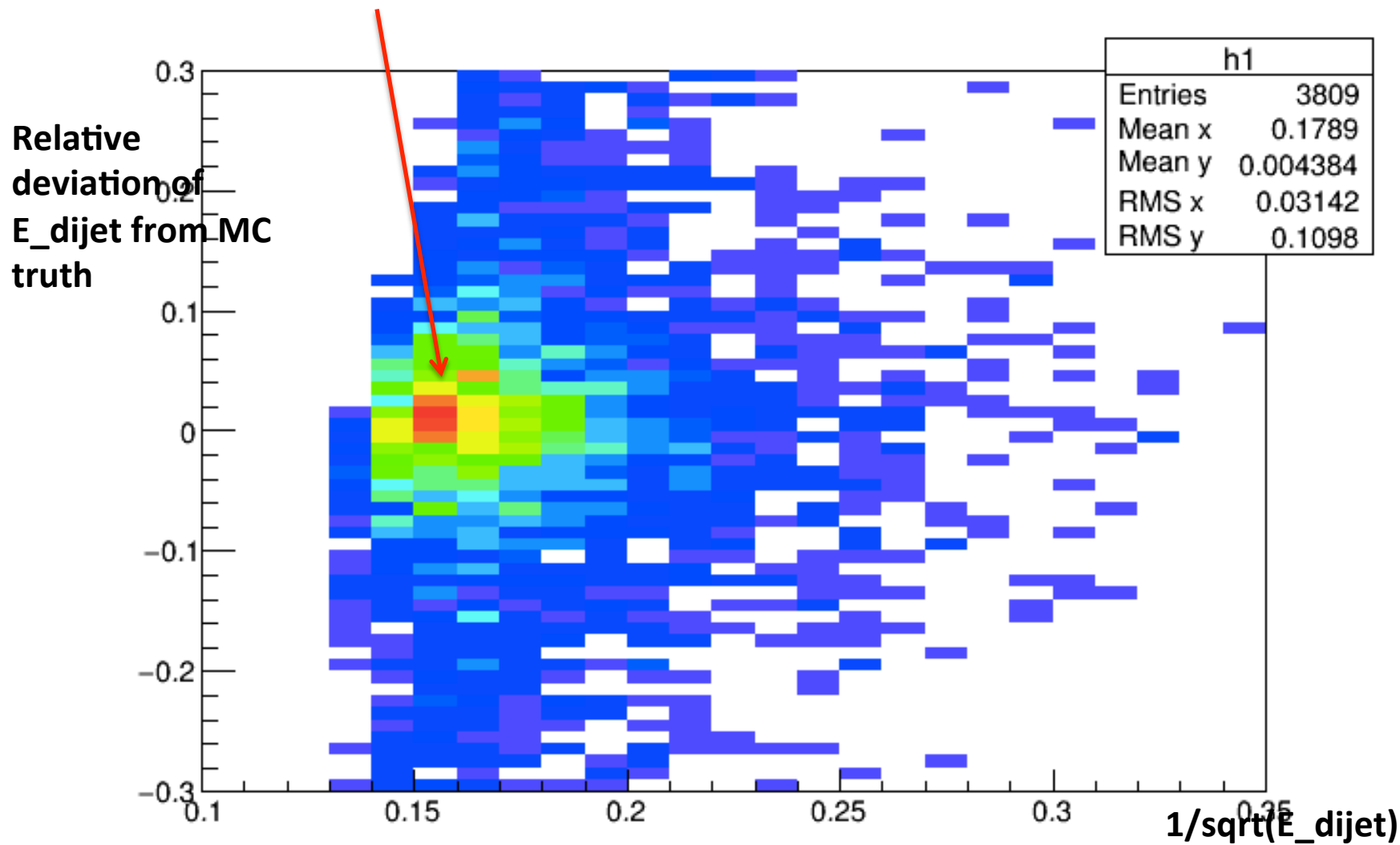
# deviation between extracted and theoretic edge values



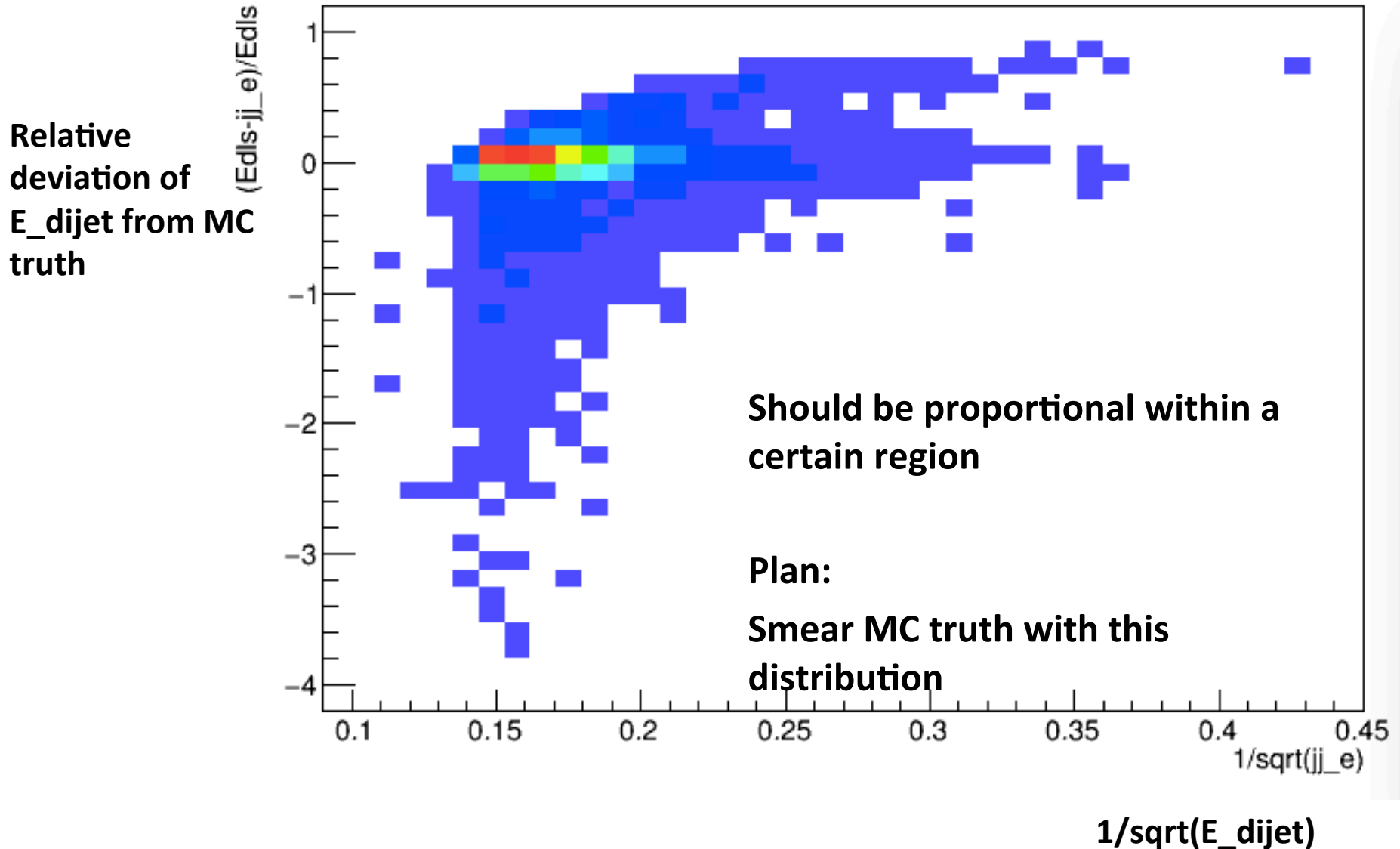
# deviation between extracted and theoretic edge values (enlarged)

About 0.3% ( $E_{\text{dijet}} 40 - 45 \text{ GeV}$ )

Match prediction in TDR



# deviation between extracted and theoretic edge values



# Summary of Mass Precisions (Combined Results)

- Combined statistical mass precision better than 0.4%
- Now we juts need to calibrate for systematical shift !

Chi square fit of 4 variables (Ell\_max, Ejj\_max, Mll\_max, Mjj\_max)

polarization		$\Delta MN1/MN1$	$\Delta MN2/MN2$	$\Delta MC1/MC1$
left	mu	0.602%	0.548%	0.580%
left	e	0.772%	0.730%	0.765%
right	mu	1.053%	0.950%	1.027%
right	e	1.019%	0.930%	1.018%
<b>combined</b>		<b>0.398%</b>	<b>0.366%</b>	<b>0.389%</b>
<b>H20</b>		<b>0.223%</b>	<b>0.205%</b>	<b>0.218%</b>

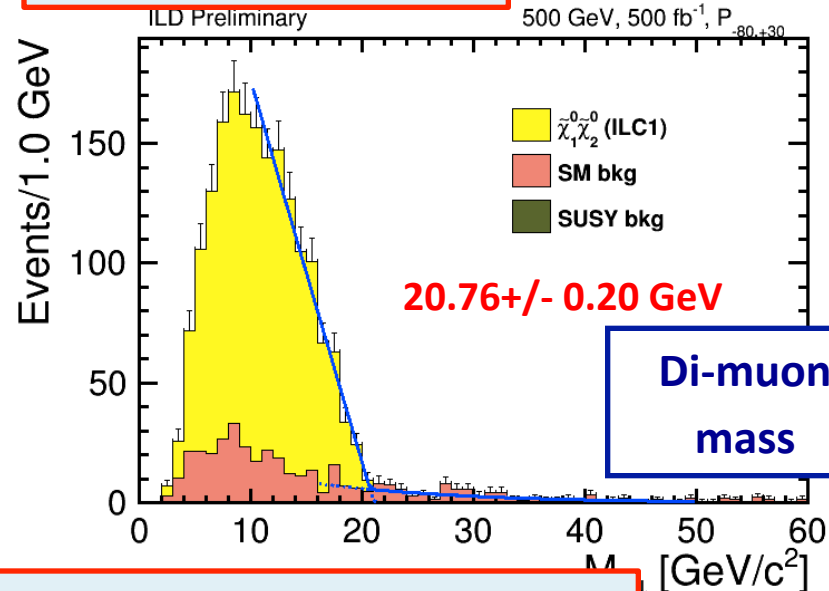
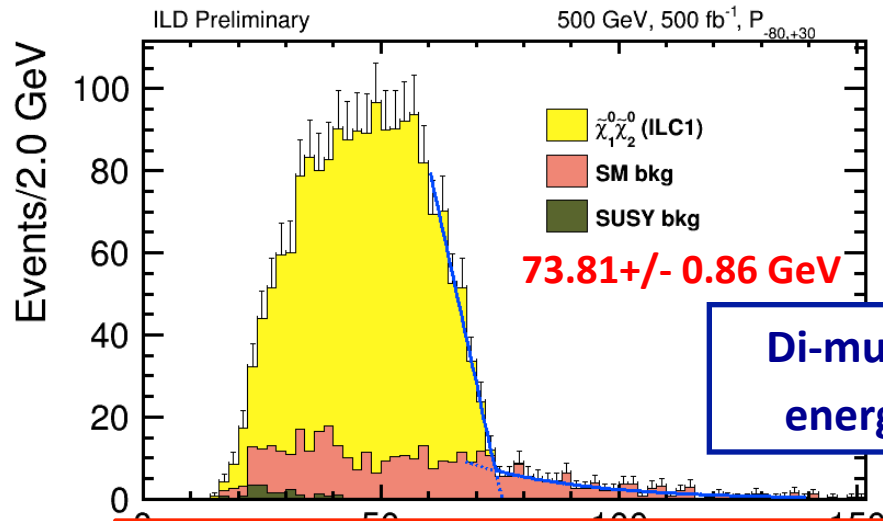
Default : 500 fb-1 for each polarization  
H20: 1600 fb-1 for each polarization

**Neutralino mixed production with leptonic decay**

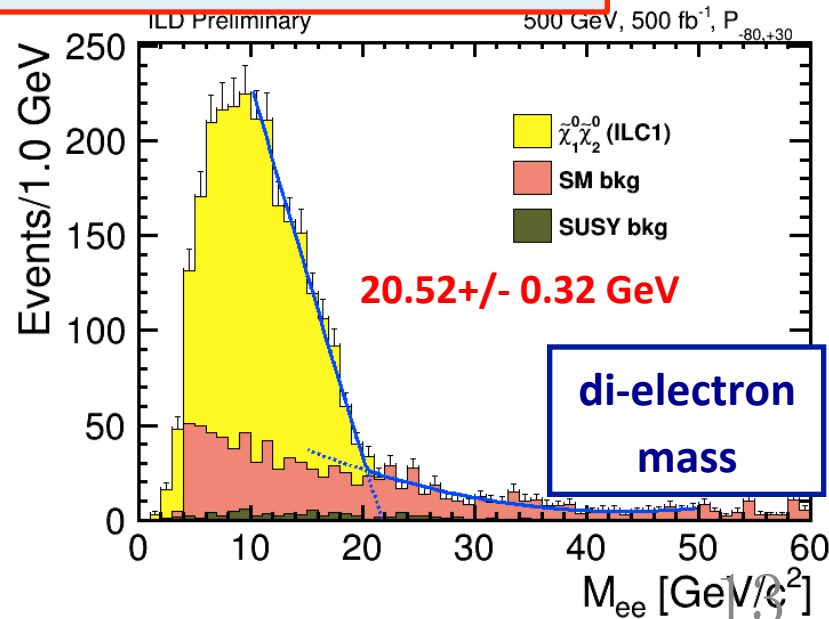
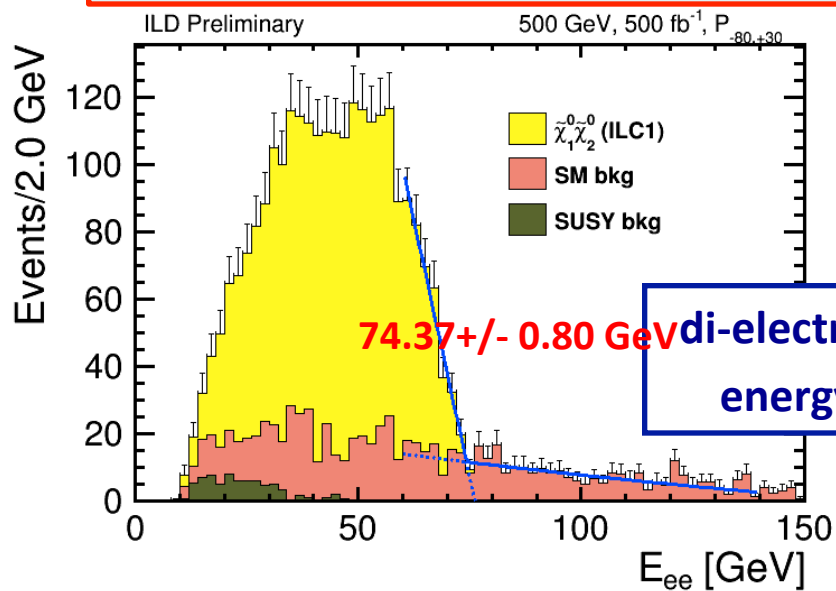
$$e^+e^- \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0 l^+ l^-$$

**Left Polarization (Pe-,Pe+) = (-0.8, +0.3)**

**Edge precision  $\sim 1\%$**



**Theoretical values: E\_max = 74.9 GeV  $\Delta M = 21.3$  GeV**



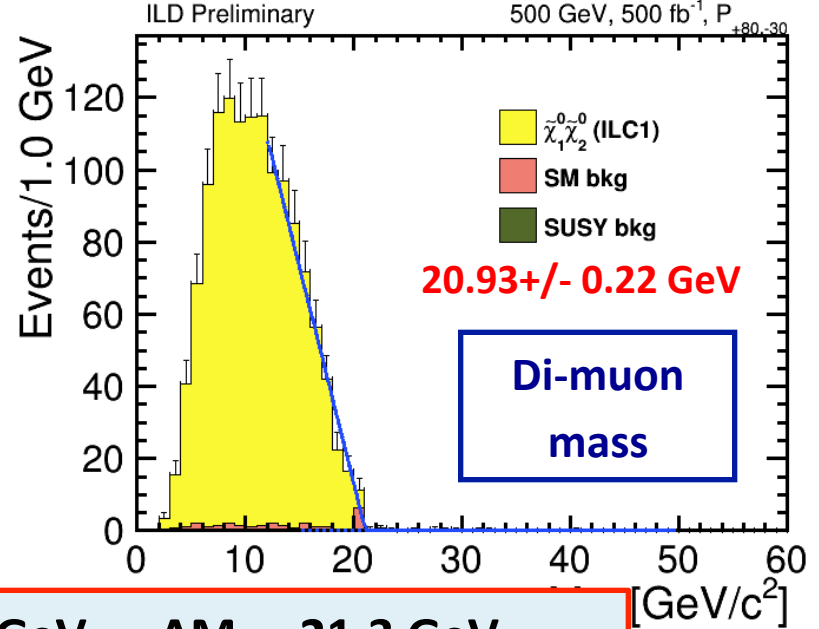
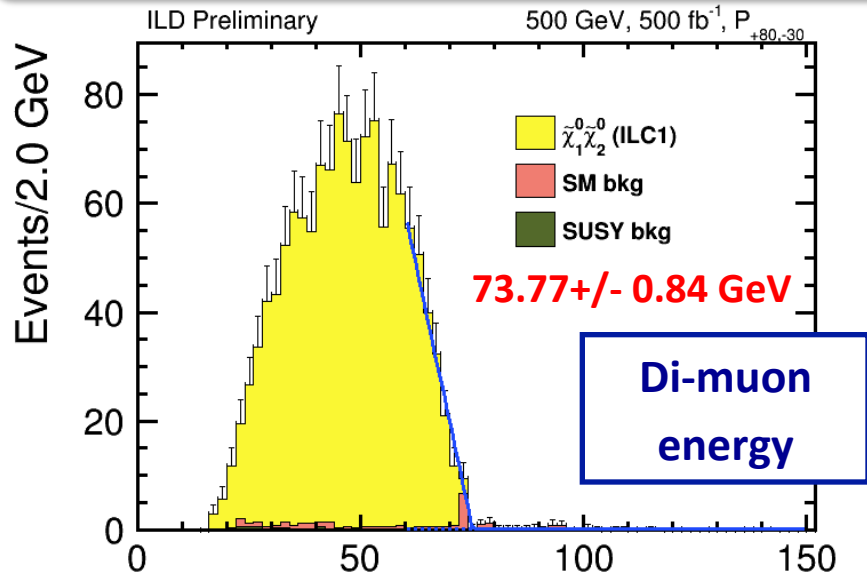
**Neutralino mixed production with leptonic decay**

$$e^+e^- \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0 \ell^+ \ell^-$$

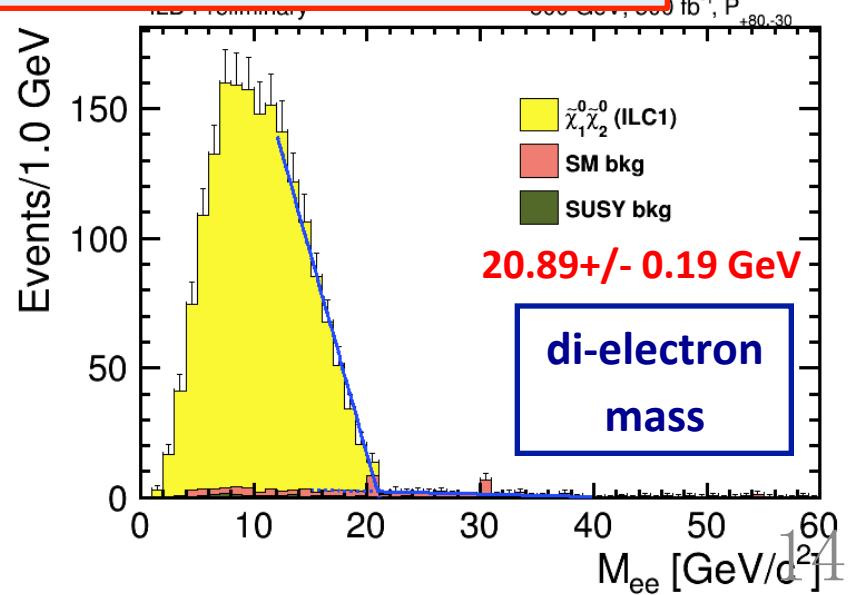
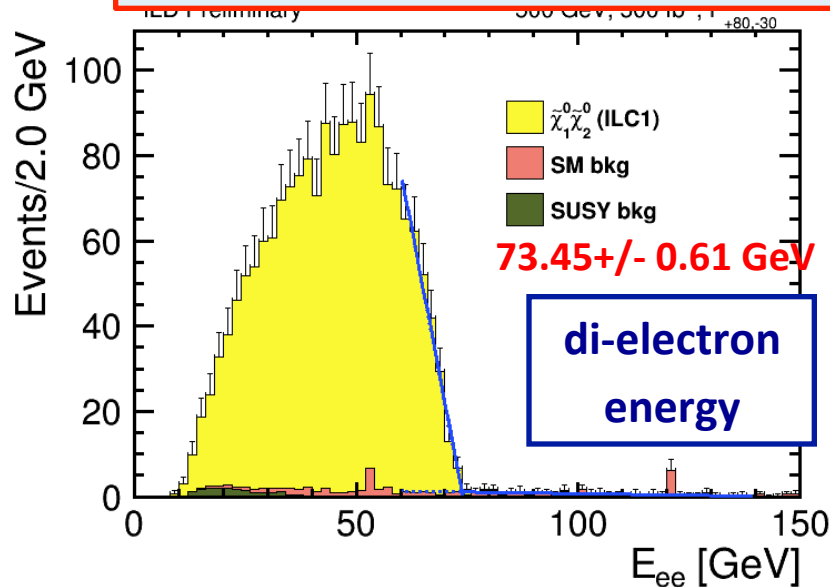
**Right Polarization** (Pe-,Pe+) = (+0.8, -0.3)

**Much less bkg**  
**Precision slightly better**

**Edge precision < ~ 1%**



**Theoretical values: E<sub>max</sub> = 74.9 GeV ΔM = 21.3 GeV**

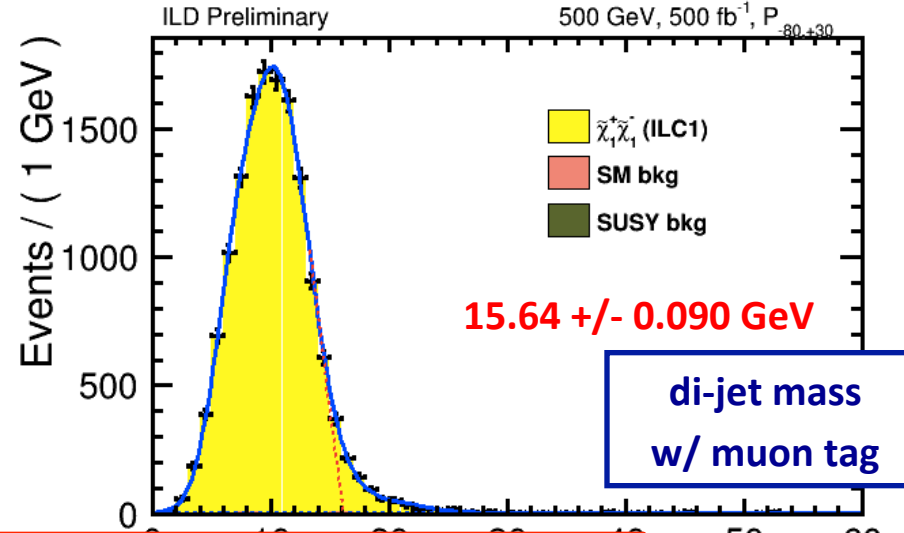
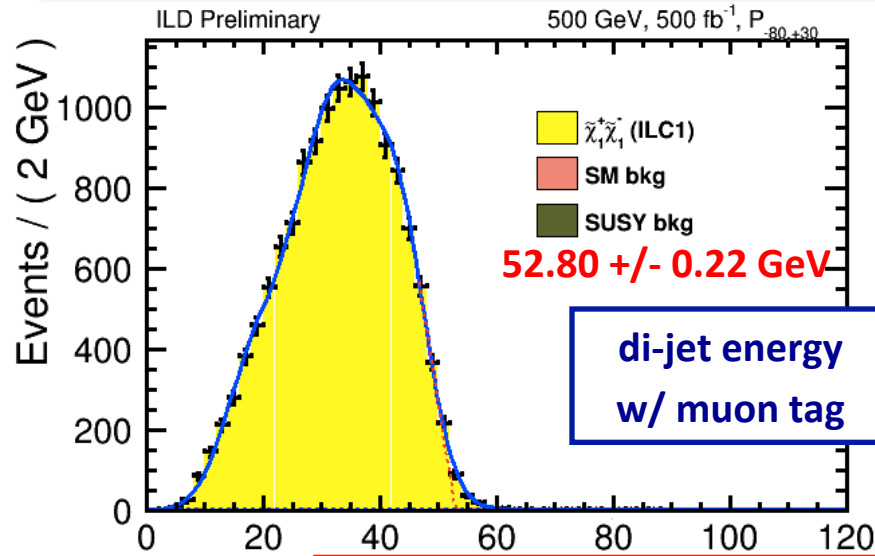


# Chargino pair production with semileptonic decay

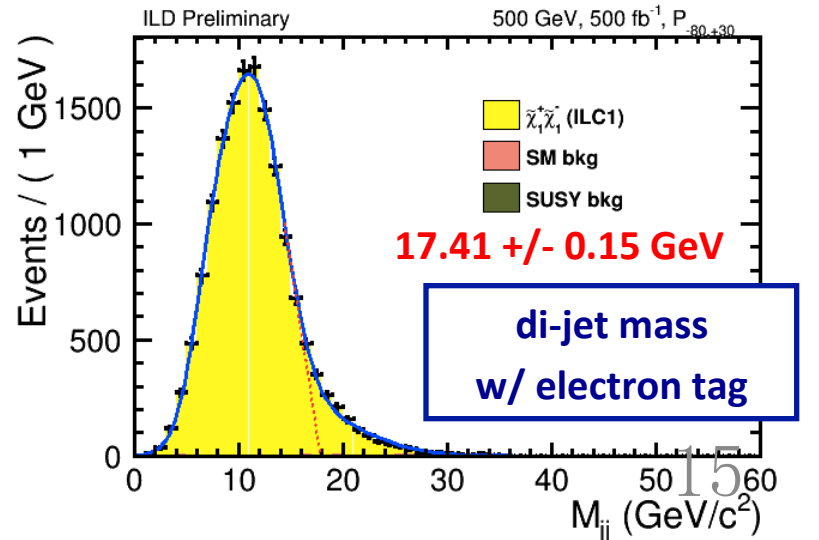
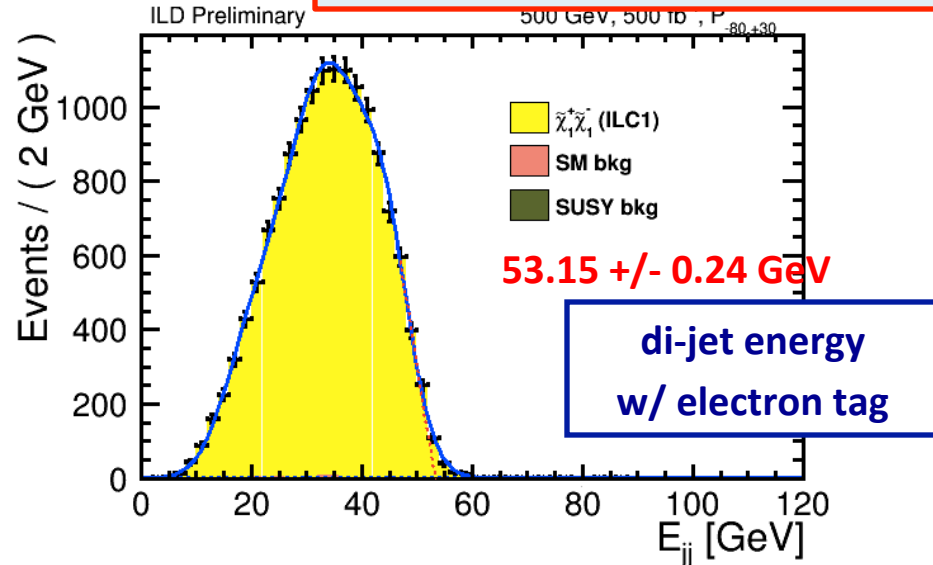
$$e^+ e^- \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^- \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0 qq' \ell \nu$$

Left Polarization (Pe-,Pe+) = (-0.8, +0.3)

Almost all bkg rejected



**Theoretical values: E\_max = 56.4 GeV    ΔM = 15.1 GeV**

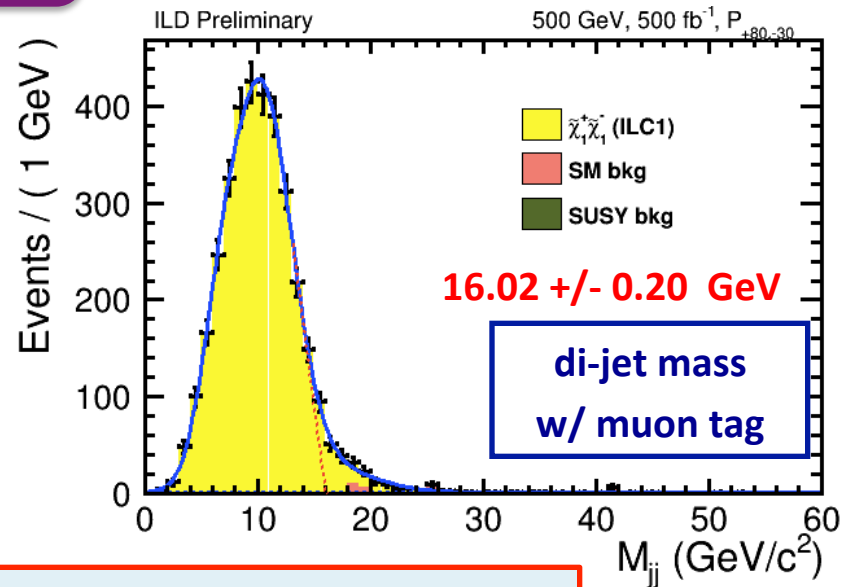
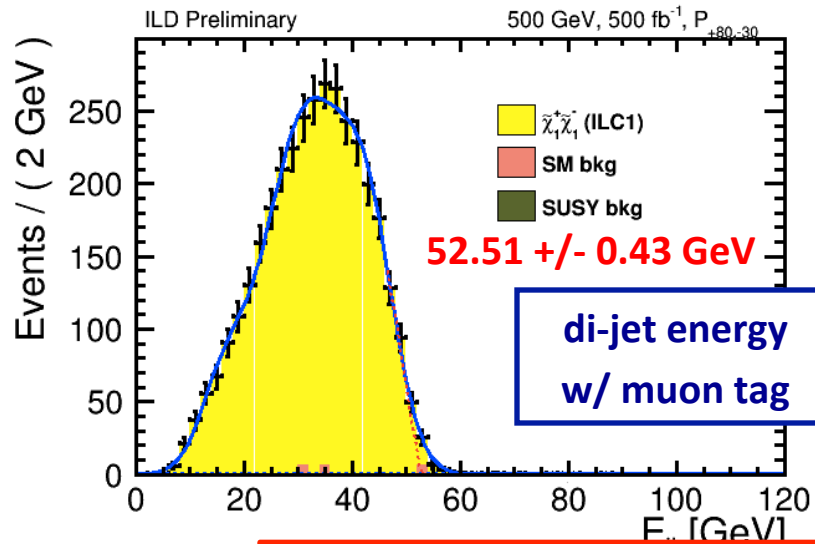


# Chargino pair production with semileptonic decay

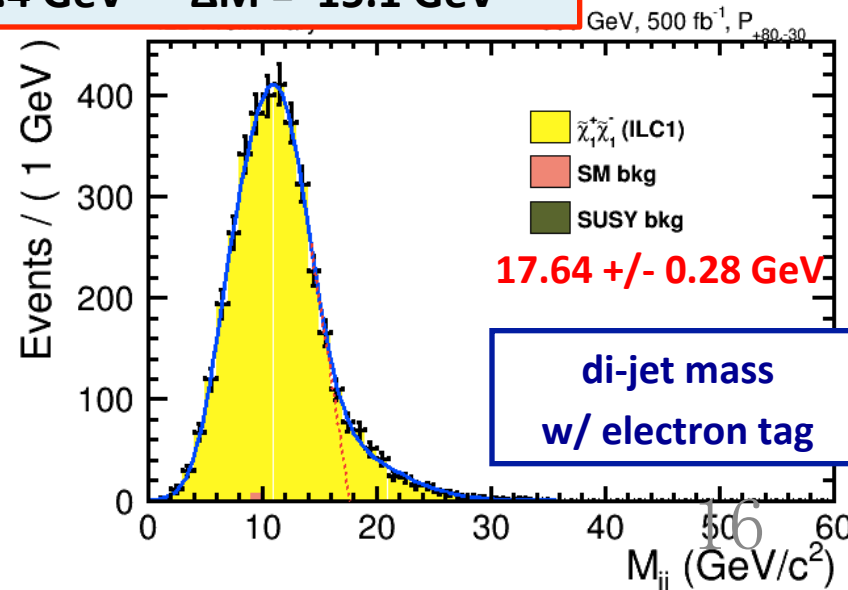
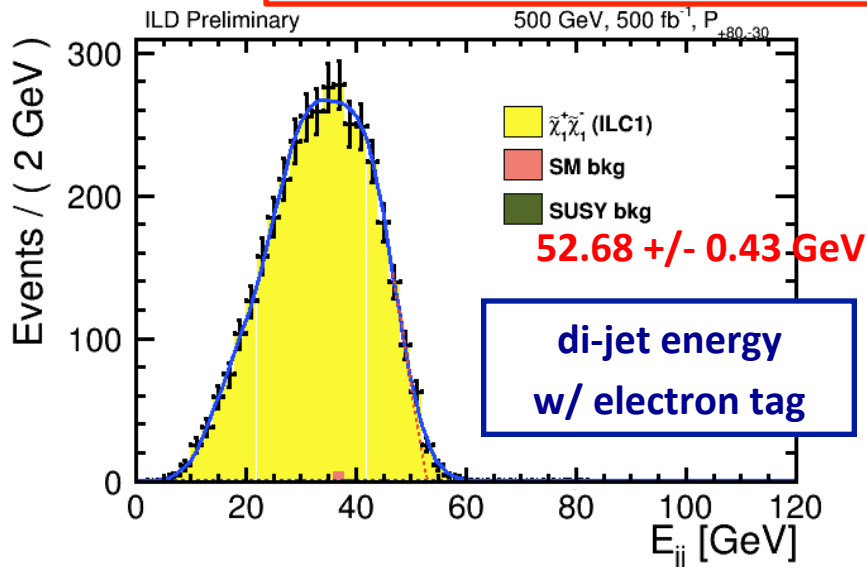
$$e^+ e^- \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^- \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0 qq' l \nu$$

Left Polarization (Pe-,Pe+) = (+0.8, -0.3)

Cross section  $\sim 1/5$  of left polarization



Theoretical values: E<sub>max</sub> = 56.4 GeV ΔM = 15.1 GeV

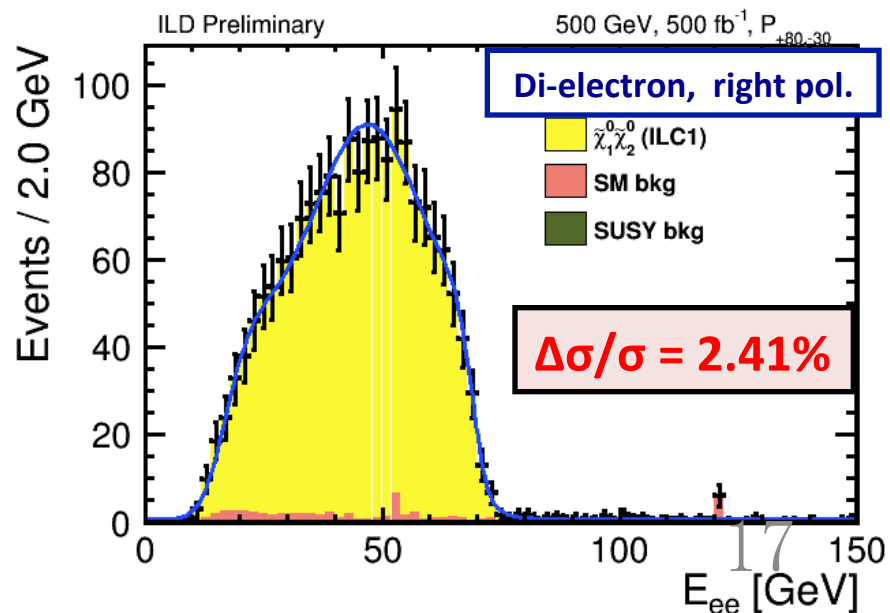
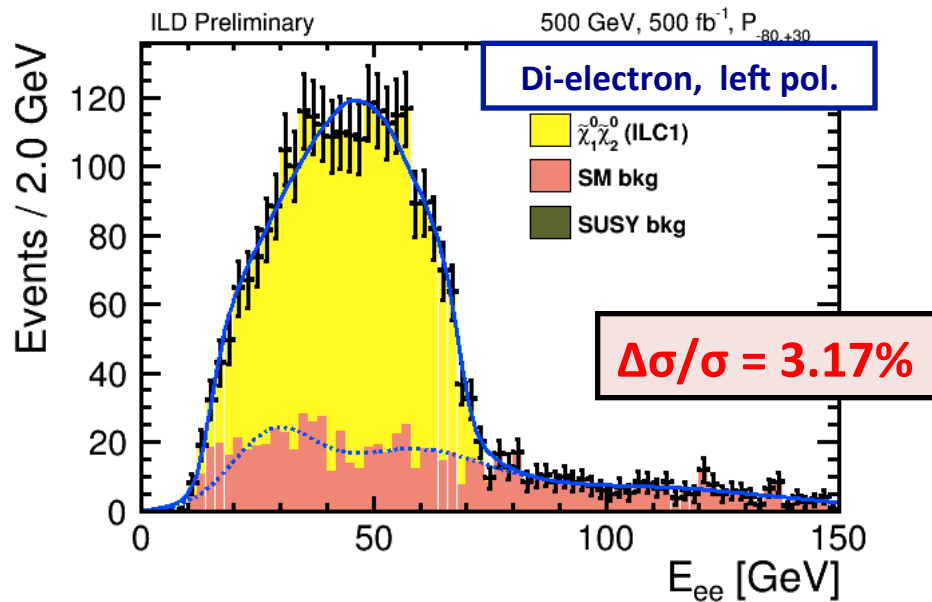
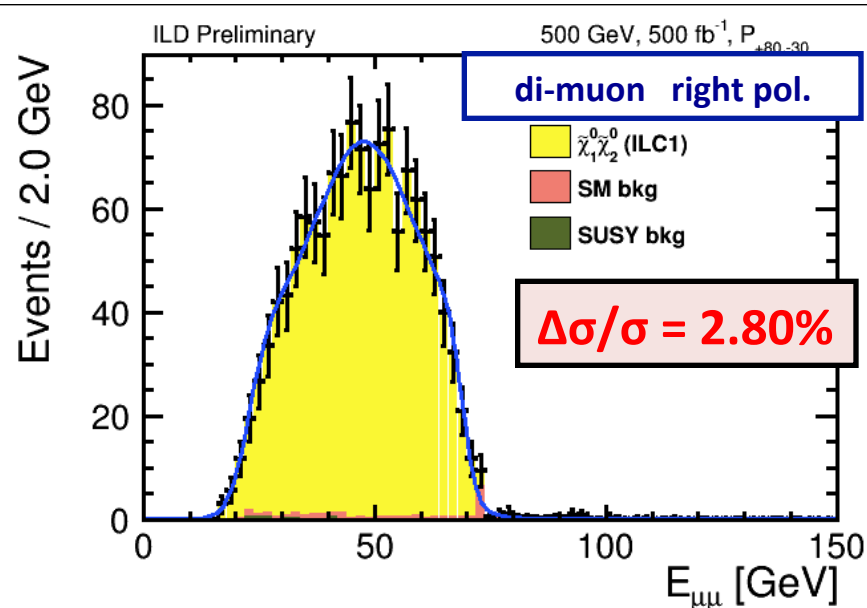
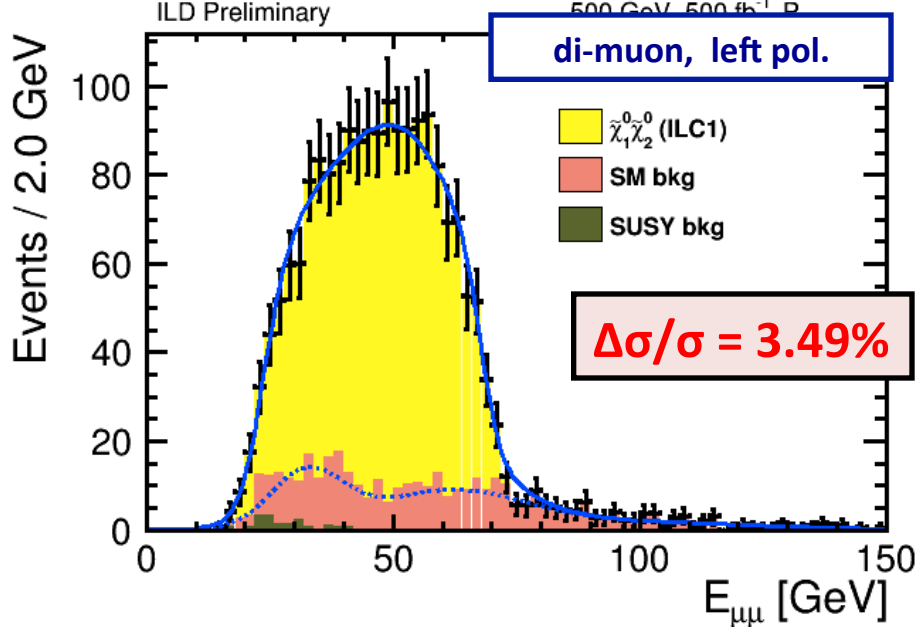




# Extraction of Cross Section

Uncertainty of right pol is about 3 / 4 of left pol dependent on statistics (evaluated using Toy MC)

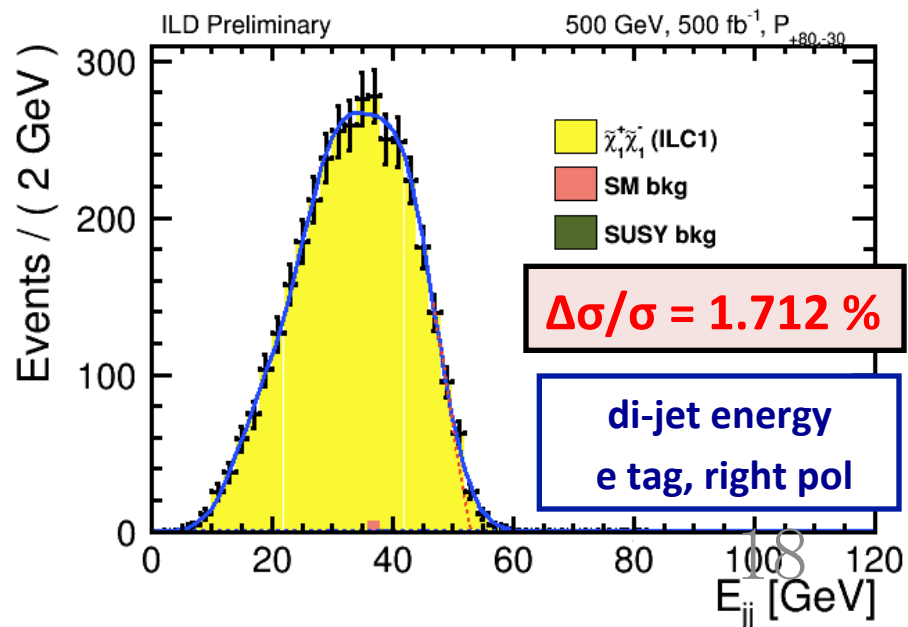
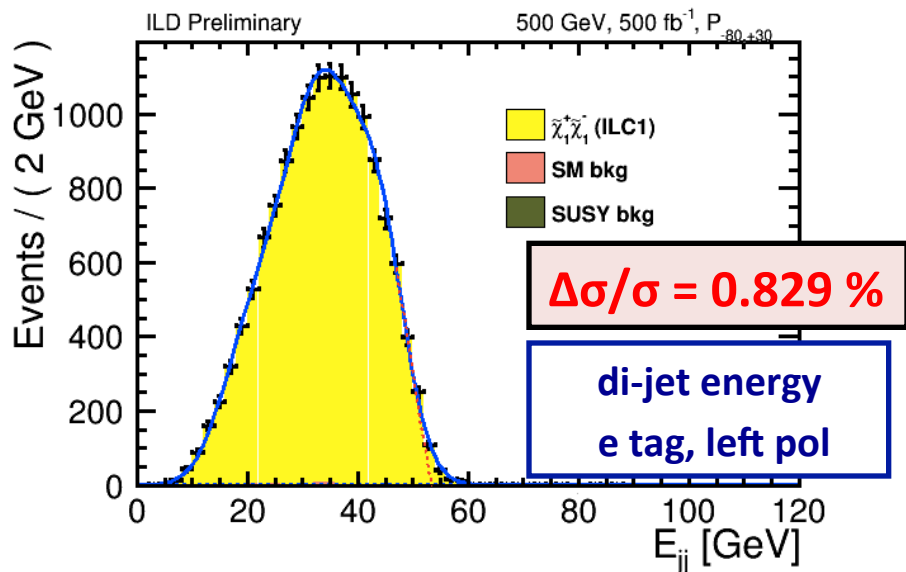
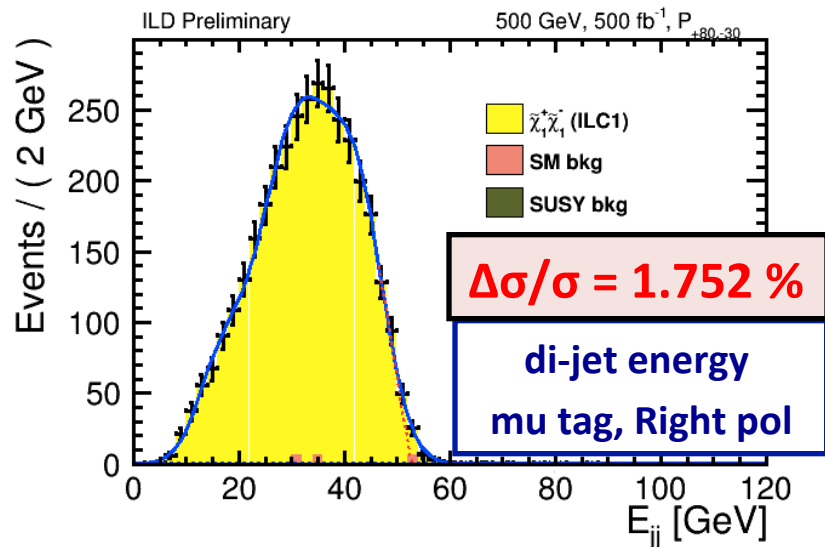
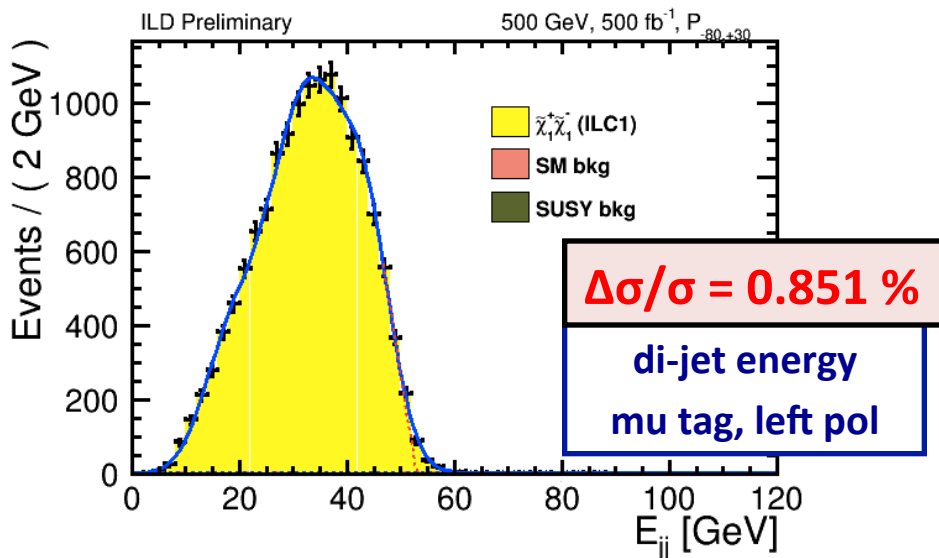
## N1N2

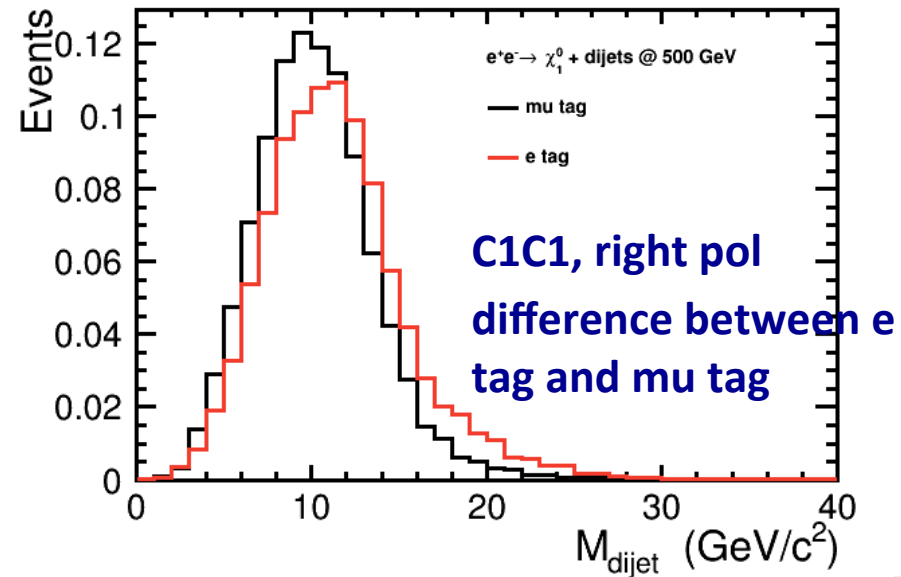
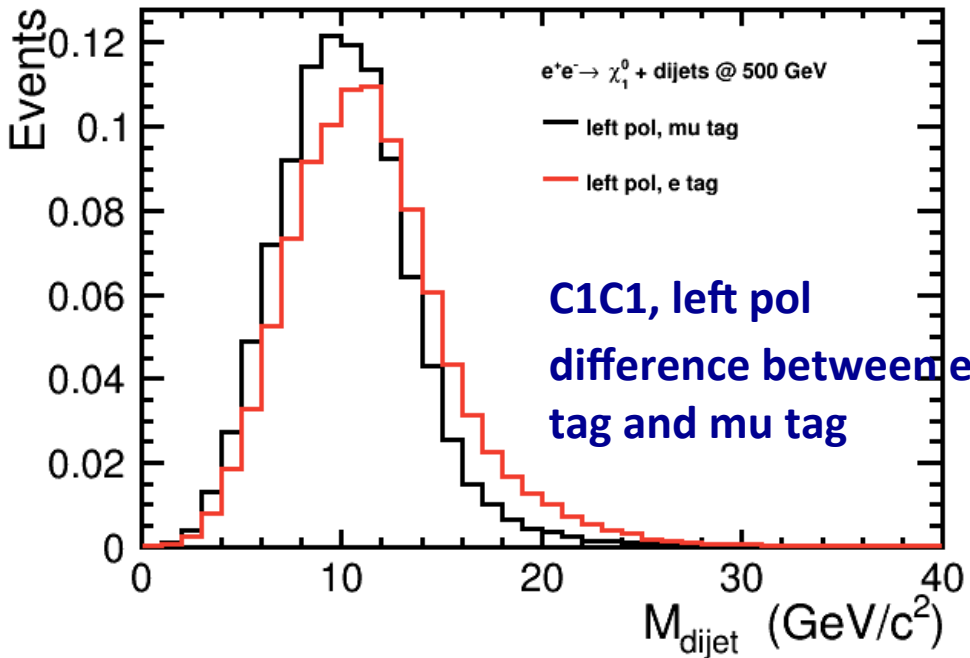


# Extraction of Cross Section

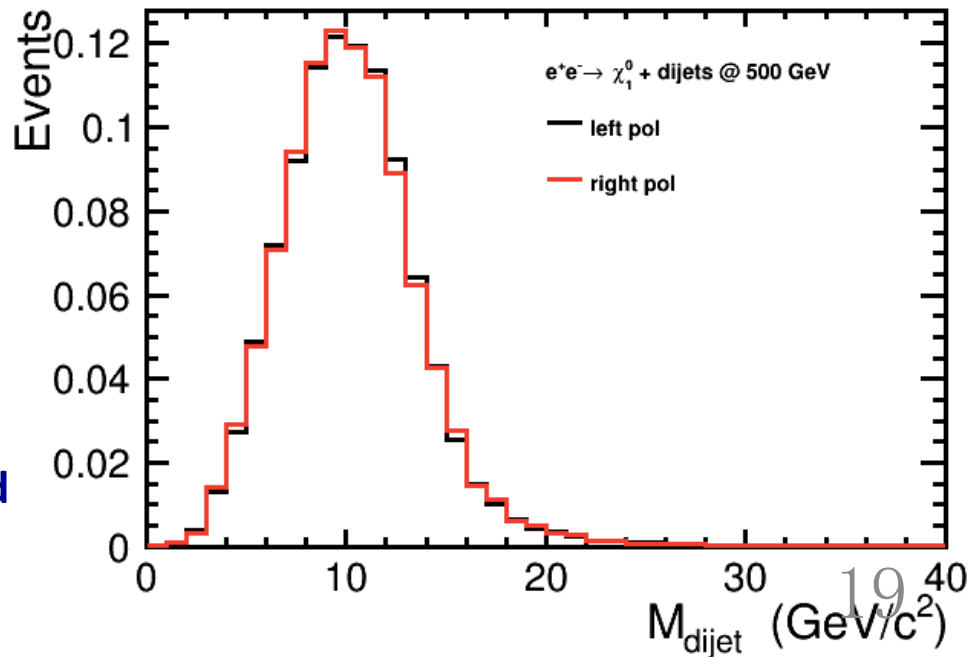
## C1C1

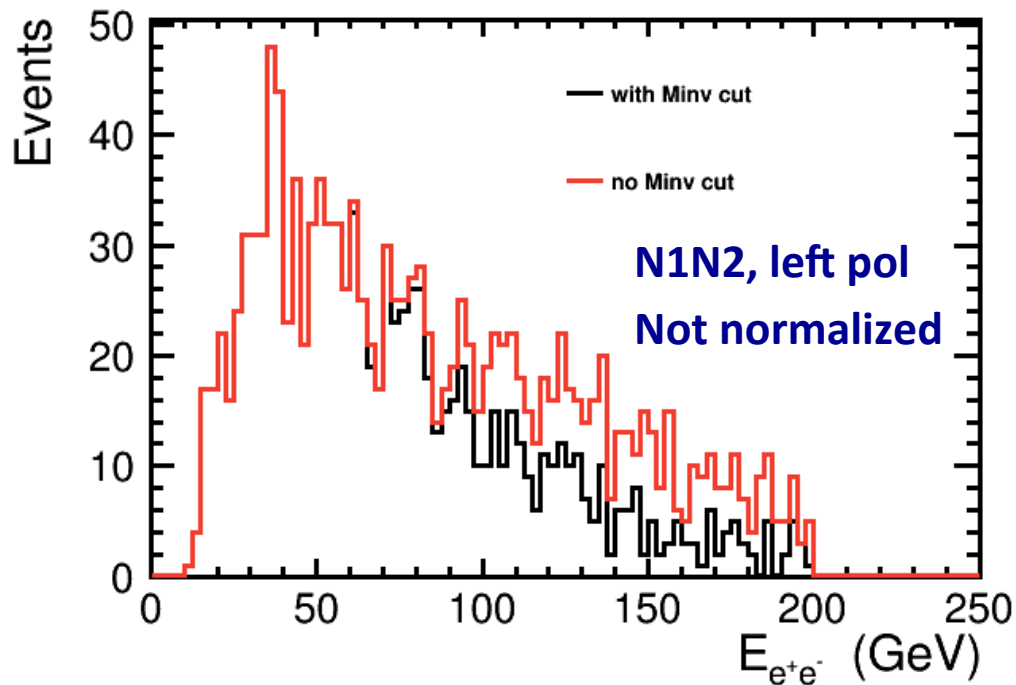
- Left pol has x2 better precision
- dependent on statistics





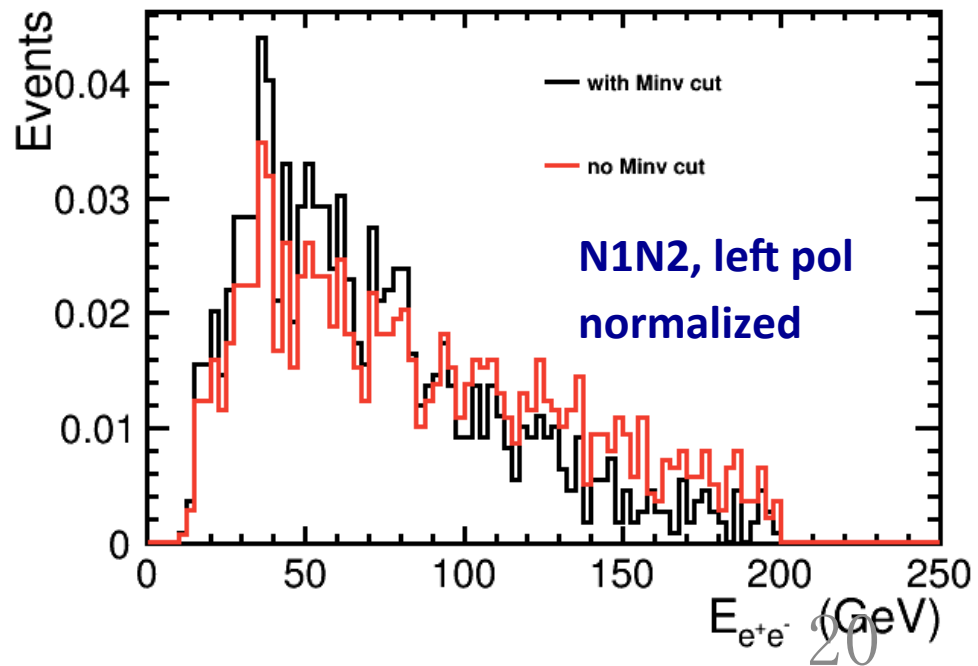
**C1C1 left:  
no difference between left and  
right polarization**

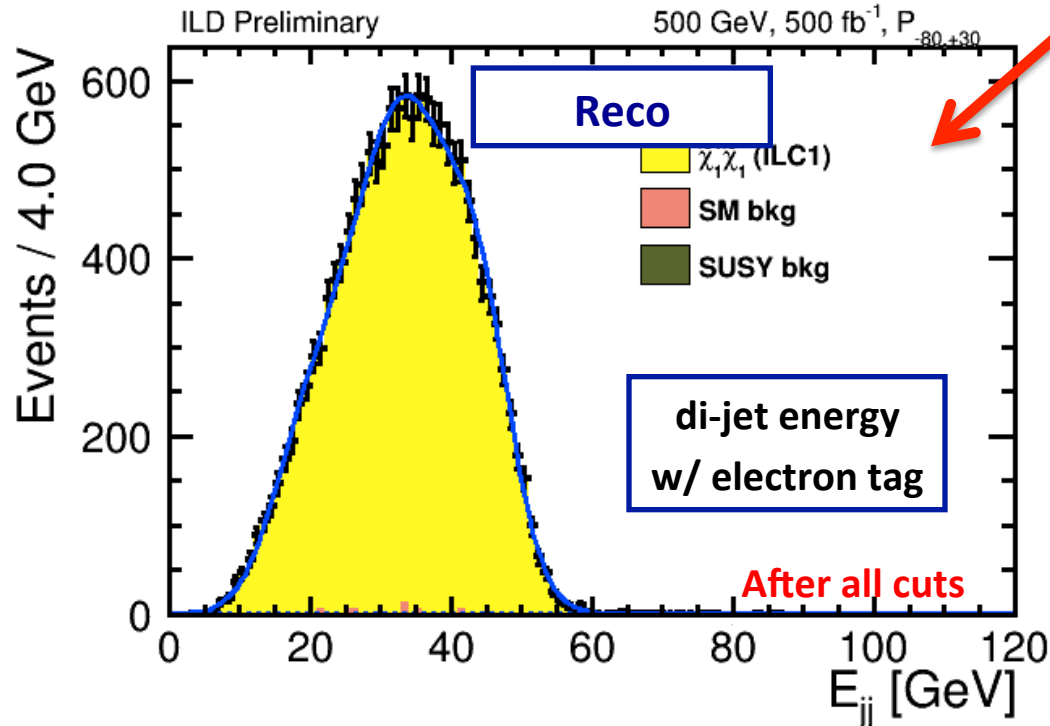
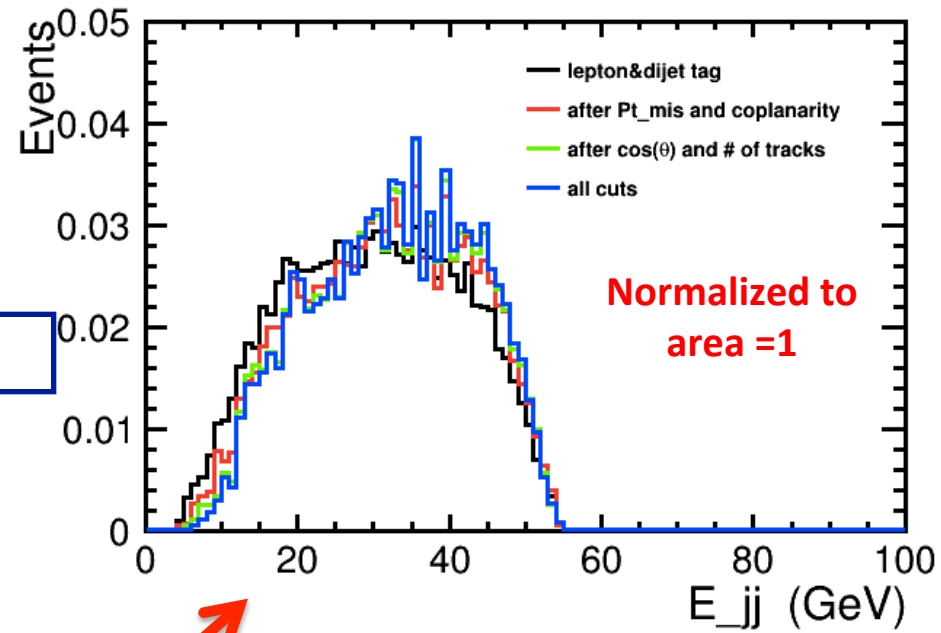
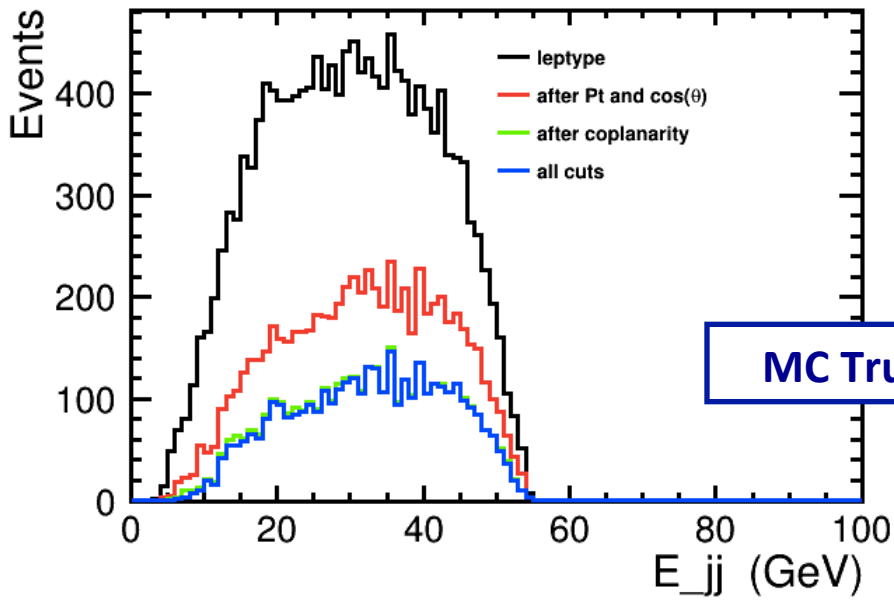




4f\_szeorsw\_l\_lr bkg

**Flatter bkg (without Minv cut)  
has better precision**





Looks SAME

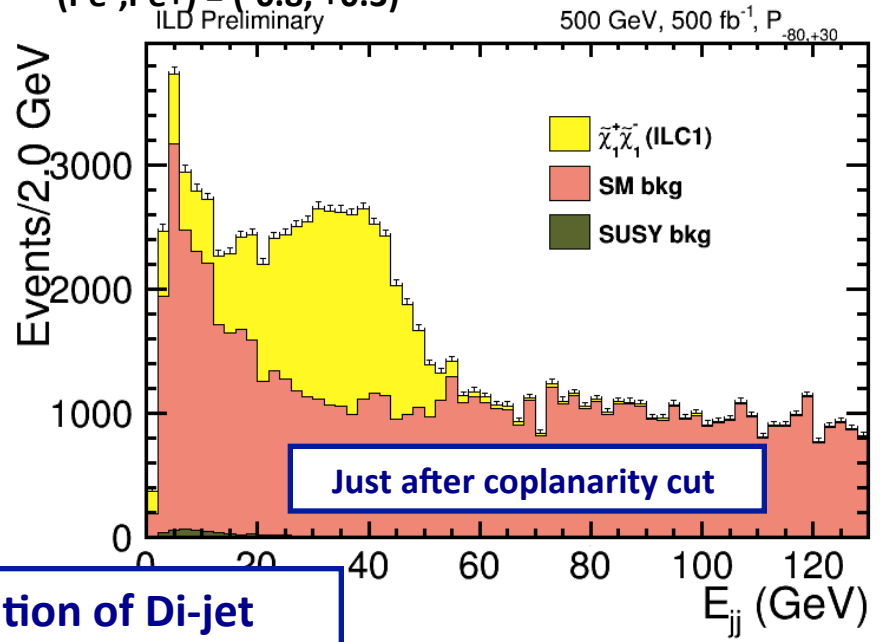
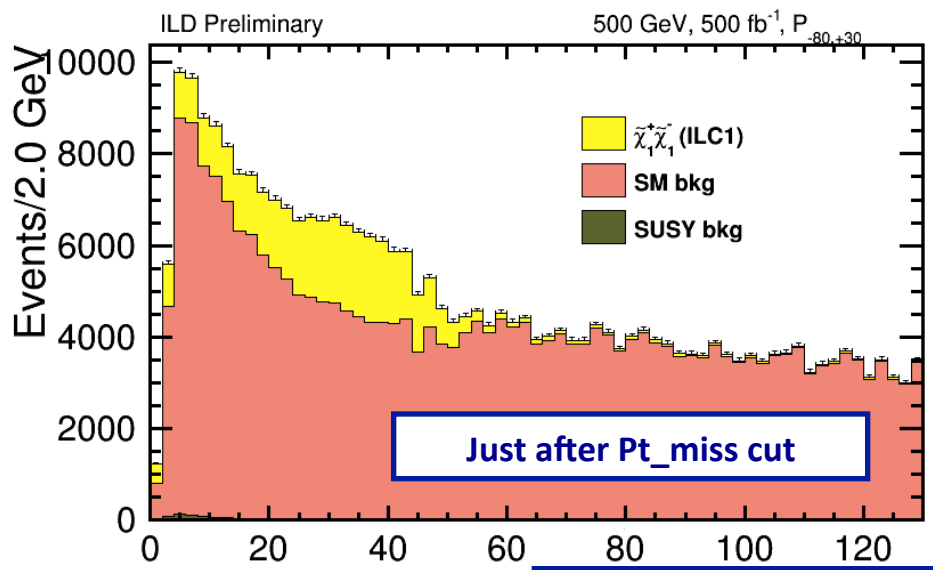
Change in distribution of Di-jet energy with respect to cuts (SIGNAL)

Cuts applied on Reconstructed variables

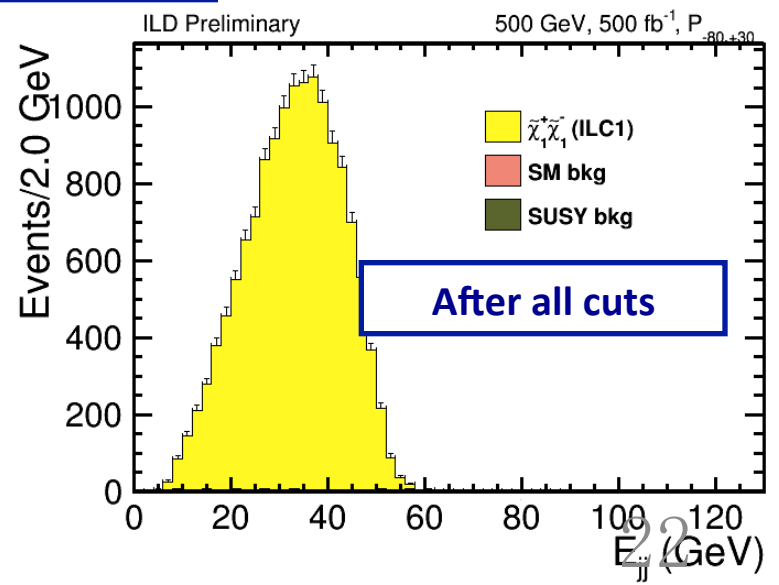
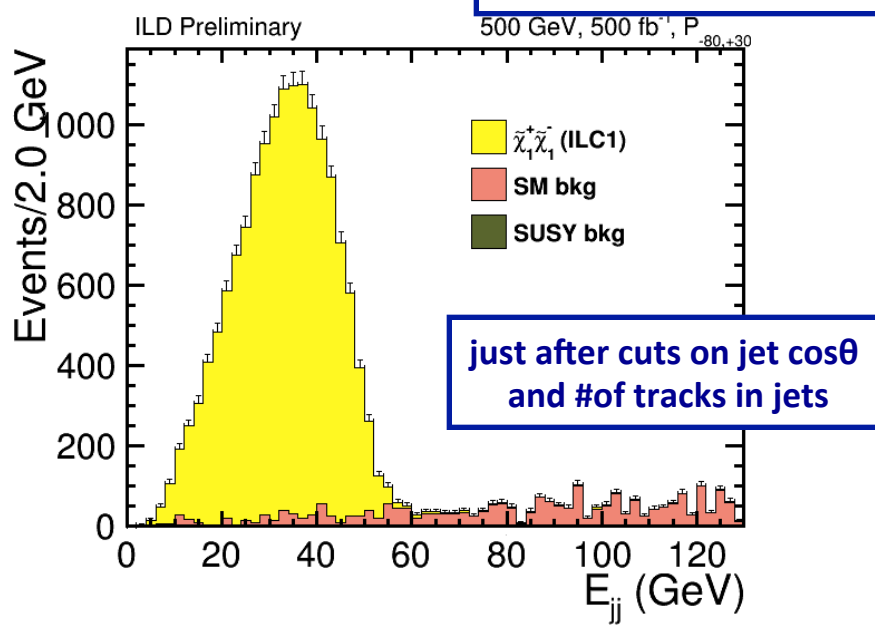
# Chargino pair production with semileptonic decay

$$e^+ e^- \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^- \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0 qq' \ell \nu$$

$(P_{e-,Pe+}) = (-0.8, +0.3)$



**Change in distribution of Di-jet energy with respect to cuts (BKG)**



## Cuts for N1N2

- **lepton type ( $\mu\mu$  or  $ee$ )** : the two leptonic channels of N1N2 analysis
- **nTrack = 2** : number of charged tracks
- **no hit in BeamCal** : veto  $\gamma\gamma$ 2f BG
- **Pt\_lep1,2 > 6 GeV and  $|\cos\theta_{lep1,2}| < 0.95$ :**
- **Coplanarity < 1.0 rad** : angle between leptons in x-y plane
- **Evis – E $\gamma$ max < 40 GeV** : visible energy (very small for signal)
- **Emis > 300 GeV** : missing energy (very large for signal)
- **$|\cos\theta_{missing}| < 0.98$**  :  $\theta$  of missing energy events
- **$|\cos\theta_Z| < 0.98$**  :  $Z^*$  production angle
- **Pt\_dl < 80 GeV** : transverse momentum of dilepton
- **Minv < 50 GeV** : dilepton invariant mass: determines  $\Delta M$

last of all observe distributions of Minv and dilepton energy (E\_dl)

Kinematic edge is a function of Higgsino mass and  $\Delta M$

## Cuts for C1C1

- lepton type ( $\mu$  or e tag) and # of lepton =1
- $Pt_{mis} > 10$  GeV
- Jet Coplanarity  $< 1.0$  rad
- $|\cos\theta_{jet1,2}| < 0.95$ :
- nTrack(in jet)  $> 1$  :
- no hit in BeamCal :
- $\cos\theta_{jet1-lep} < 0.2$ ,  $\cos\theta_{jet2-lep} < 0$  angle between jets and leptons
- $E_{vis} - E_{\gamma max} < 60$  GeV :
- $E_{mis} > 400$  GeV :
- $|\cos\theta_{missing}| < 0.98$  :
- $|\cos\theta_Z| < 0.98$  :
- $Pt_{jj} < 50$  GeV :
- $Minv < 30$  GeV :

last of all observe distributions of  $Minv$  and dijet energy ( $E_{jj}$ )

Kinematic edge is a function of Higgsino mass and  $\Delta M$



## ILC1

Cross sections (pure beam polarizations)  
 $\sqrt{s}=500$  GeV with TDR beam parameters

(Pe-, Pe+)	(-1.0,+1.0)	(+1.0,-1.0)
$\sigma(\chi_1^+ \chi_1^-)$ [fb]	1800	335
$\sigma(\chi_1^0 \chi_2^0)$ [fb]	491	379
$\sigma(\chi_2^0 \chi_3^0)$ [fb]	11.0	8.42
$\sigma(\chi_1^0 \chi_1^0)$ [fb]	2.03	1.56
$\sigma(\chi_2^0 \chi_2^0)$ [fb]	0.53	0.41
$\sigma(\chi_1^0 \chi_3^0)$ [fb]	0.28	0.20

Branching ratios

$\text{BR}(\chi_1^+ \rightarrow \chi_1^0 qq')$	67%
$\text{BR}(\chi_1^+ \rightarrow \chi_1^0 lv)$ (l=e, $\mu$ )	22%
$\text{BR}(\chi_2^0 \rightarrow \chi_1^0 qq')$	58%
$\text{BR}(\chi_2^0 \rightarrow \chi_1^0 ll)$ (l=e, $\mu$ )	7.4%

# Cut table $N_1 N_2, \mu\mu$ ( $P_{e-}, P_{e+}$ ) = (-80,+30)

	sig	bkg	4f_l	aa_2f	ae_3f	SUSY bkg
xsec	300.8	3.00E6	10566.2	2.68E6	261580	1065.2
N_gen	150395	1.50E9	5.28E6	1.34E9	1.31E8	532585
Lep_type nTrack=2	1974	9.1E8	444255	8.9E8	2.2E7	2426
BCAL veto	1950	6.0E6	149871	5.5E6	965354	2411
Pt_lep,1,2	1675	2.0E6	105721	1.4E6	295459	1986
cos $\theta$ _lep	1624	1.3E6	56001	910330	167734	1950
coplanarity	1407	48366	5272	3509	33067	22
Evis	1404	14325	2465	2248	4743	22
Emis, cos $\theta$ mis	1393	1063	929	34	9	19
cosZ, Pt_ll, Minv	1393	545	429	34	9	19

# Cut Table: N1N2 left polarization, mumu

Polarization: (e-,e+) = (-0.8,+0.3)

Reduction Table														
Process	:	2f_l	2f_h	4f_l	4f_sl	4f_h	aa_2f	Ch	aa_4f	ae3f	BG	Signal	Signf	
Cross Section	:	6773.07	19625.1	10566.2	13232.1	8648.64	2.6771e+06	1065.17	26.0064	261580	2.99861e+06	300.791	0	
Generated	:	949500	2.3467e+06	5.58174e+06	1.2138e+06	704600	7.17376e+07	2.33207e+06	8300	2.26291e+07	1.07503e+08	1.0963e+06	1.0963e+06	
Expected	:	3.38654e+06	9.81253e+06	5.28308e+06	6.61606e+06	4.32432e+06	1.33855e+09	532585	13003.2	1.3079e+08	1.49931e+09	150395	150395	3.8839
Cut0	:	1.84022e+06	62768.8	1.46378e+06	1.98579e+06	430258	1.845e+09	6227.38	0	4.83904e+07	1.89918e+09	16478.1	16478.1	0.378114
Cut1	:	185899	0.376323	89936.7	12.9538	0	8.71657e+08	2425.99	0	2.19281e+07	8.93864e+08	2121.19	2121.19	0.0709487
Cut2	:	176420	0.376323	62927.4	12.9538	0	5.41902e+06	2410.6	0	965354	6.62614e+06	2105.07	2105.07	0.817649
Cut3	:	175961	0.376323	54146.6	12.9538	0	1.35490e+06	1985.79	0	295459	1.88255e+06	1804.44	1804.44	1.3145
Cut4	:	120835	0.376323	32485.6	0.373803	0	895478	1950	0	167734	1.21848e+06	1749.98	1749.98	1.5842
Cut5	:	5708.39	0.376323	3408.47	0.373803	0	3496.68	21.7669	0	33867	46503.1	1530.26	1530.26	6.98221
Cut6	:	4935.45	0.376323	1656.45	0	0	2188.4	21.7669	0	4743.09	13545.5	1527.48	1527.48	12.4416
Cut7	:	6.4366	0	795.253	0	0	33.6364	20.6055	0	23	878.932	1520.51	1520.51	31.0408
Cut8	:	0	0	785.559	0	0	33.6364	19.4559	0	9.00002	847.652	1515.69	1515.69	31.1779
Cut9	:	0	0	500.845	0	0	33.6364	19.4559	0	9.00002	562.937	1515.69	1515.69	33.2447
Cut10	:	0	0	374.054	0	0	33.6364	19.4559	0	9.00002	436.147	1515.69	1515.69	34.3075

# Cut Table: N1N2 right polarization, mumu

Polarization: (e-,e+) = (+0.8,-0.3)

Reduction Table

Process	2f_l	2f_h	4f_l	4f_sl	4f_h	aa_2f	Ch	aa_4f	ae3f	BG	Signal	Signf	
Cross Section	5960.13	11663.4	7482.28	2943.64	741.331	2.6771e+06	258.908	26.0064	254270	2.96044e+06	239.406	0	
Generated	949500	2.3467e+06	5.58174e+06	1.2138e+06	704600	7.17376e+07	2.33207e+06	8300	2.26291e+07	1.07503e+08	1.0963e+06	1.0963e+06	
Expected	2.98006e+06	5.83168e+06	3.74114e+06	1.47182e+06	370665	1.33855e+09	129454	13003.2	1.27135e+08	1.48022e+09	119703	119703	
Cut0	1.63749e+06	1.04914e+06	1.02859e+06	464566	66725.6	1.845e+09	1494.25	0	4.81962e+07	1.89744e+09	14056.7	14056.7	0.3227
Cut1	144315	6.28997	56432.7	7.00049	0	8.71657e+08	575.444	0	2.19218e+07	8.93781e+08	1781.29	1781.29	0.0595826
Cut2	137150	6.28997	29836.6	7.00049	0	5.41902e+06	571.984	0	962865	6.54945e+06	1767.65	1767.65	0.690612
Cut3	136659	6.28997	21961.7	7.00049	0	1.35498e+06	474.46	0	294052	1.80814e+06	1512.68	1512.68	1.12448
Cut4	96749.2	6.28997	12751.4	6.24784	0	895478	464.893	0	166132	1.17159e+06	1474.04	1474.04	1.36098
Cut5	4614.82	6.28997	2205.53	6.24784	0	3496.68	4.81973	0	33726.8	44061.2	1288.01	1288.01	6.0483
Cut6	4023.45	6.28997	422.329	0	0	2188.4	4.81973	0	4609.83	11255.1	1285.62	1285.62	11.4802
Cut7	0.385096	0	81.538	0	0	33.6364	4.55483	0	17	137.114	1280.97	1280.97	34.0164
Cut8	0	0	76.6121	0	0	33.6364	4.48605	0	1	115.735	1276.45	1276.45	34.2102
Cut9	0	0	41.2362	0	0	33.6364	4.48605	0	1	80.3587	1276.45	1276.45	34.6534
Cut10	0	0	32.922	0	0	33.6364	4.48605	0	1	72.0445	1276.45	1276.45	34.76

# Cut Table: N1N2 left polarization, ee

Polarization: (e-,e+) = (-0.8,+0.3)

Reduction Table

Process	2f_l	2f_h	4f_l	4f_sl	4f_h	aa_2f	Ch	aa_4f	ae3f	BG	Signal	Signf	
Cross Section	6773.07	19625.1	10566.2	13232.1	8648.64	2.6771e+06	1065.17	26.0064	261580	2.99861e+06	300.791	0	
Generated	949500	2.3467e+06	5.58174e+06	1.2138e+06	704600	7.17376e+07	2.33207e+06	8300	2.26291e+07	1.07503e+08	1.0963e+06	1.0963e+06	
Expected	3.38654e+06	9.81253e+06	5.28308e+06	6.61606e+06	4.32432e+06	1.33855e+09	532585	13003.2	1.3079e+08	1.49931e+09	150395	150395	3.8839
Cut0	1.84022e+06	62768.8	1.46378e+06	1.98579e+06	430258	1.845e+09	6227.38	0	4.83904e+07	1.89918e+09	16478.1	16478.1	0.378114
Cut1	370709	7.90279	202605	232.557	0	9.34249e+08	3491.12	0	1.15692e+07	9.46396e+08	3829.66	3829.66	0.124487
Cut2	339108	7.15014	131982	161.026	0	5.11411e+06	3468.38	0	553509	6.14234e+06	3796.34	3796.34	1.53131
Cut3	326820	0	109309	53.7053	0	4.05147e+06	3056.24	0	446325	4.93703e+06	2721.13	2721.13	1.22432
Cut4	124943	0	58984.8	6.28981	0	2.54505e+06	2950.29	0	242702	2.97463e+06	2611.06	2611.06	1.51325
Cut5	3756.07	0	9005.42	6.28981	0	29306.4	82.7328	0	54031.4	96188.3	2020.56	2020.56	6.44759
Cut6	495.138	0	5388.26	0	0	22010.1	82.4337	0	15209	43184.9	2017.23	2017.23	9.48802
Cut7	9.70654	0	2064.4	0	0	208.738	77.8352	0	133	2493.68	2007.8	2007.8	29.9256
Cut8	1.13998	0	2021.29	0	0	16.8989	75.2367	0	27.5	2142.06	1999.13	1999.13	31.0655
Cut9	1.13998	0	1050.45	0	0	16.8989	75.2367	0	27.5	1171.23	1998.89	1998.89	35.5019
Cut10	0	0	811.285	0	0	16.8989	75.2367	0	27.5	930.921	1998.89	1998.89	36.9291

# Cut Table: N1N2 right polarization, ee

Polarization: (e-,e+) = (+0.8,-0.3)

Reduction Table

Process	2f_l	2f_h	4f_l	4f_sl	4f_h	aa_2f	Ch	aa_4f	ae3f	BG	Signal	Signf	
Cross Section	5960.13	11663.4	7482.28	2943.64	741.331	2.6771e+06	258.908	26.0064	254270	2.96044e+06	239.406	0	
Generated	949500	2.3467e+06	5.58174e+06	1.2138e+06	704600	7.17376e+07	2.33207e+06	8300	2.26291e+07	1.07503e+08	1.0963e+06	1.0963e+06	
Expected	2.98006e+06	5.83168e+06	3.74114e+06	1.47182e+06	370665	1.33855e+09	129454	13003.2	1.27135e+08	1.48022e+09	119703	119703	3.11118
Cut0	1.63749e+06	1.04914e+06	1.02859e+06	464566	66725.6	1.845e+09	1494.25	0	4.81962e+07	1.89744e+09	14056.7	14056.7	0.3227
Cut1	349759	132.089	140208	287.044	0	9.34249e+08	849.63	0	1.15507e+07	9.46291e+08	3285.12	3285.12	0.106792
Cut2	319574	119.509	70240.6	165.335	0	5.11411e+06	842.994	0	553112	6.05816e+06	3255.98	3255.98	1.3225
Cut3	307849	0	51039.2	32.9169	0	4.05147e+06	741.733	0	445954	4.85709e+06	2365.01	2365.01	1.07285
Cut4	115411	0	23288.3	0.376313	0	2.54505e+06	718.003	0	242956	2.92742e+06	2276.54	2276.54	1.33004
Cut5	3759.68	0	4729.55	0.376313	0	29306.4	18.6288	0	53498.5	91313.1	1758.58	1758.58	5.7644
Cut6	551.189	0	1282.24	0	0	22010.1	18.4154	0	14991	38852.9	1754.82	1754.82	8.70822
Cut7	16.9496	0	263.857	0	0	208.738	18.1403	0	197	704.685	1745.14	1745.14	35.2584
Cut8	5.52449	0	231.035	0	0	16.8989	17.7894	0	42.5	313.748	1736.16	1736.16	38.3463
Cut9	5.52449	0	139.325	0	0	16.8989	17.7894	0	42.5	222.038	1736.15	1736.15	39.2338
Cut10	0	0	115.859	0	0	16.8989	17.7894	0	42.5	193.048	1736.15	1736.15	39.5274

# Cut Table: C1C1 left polarization, mu-tag

Polarization: (e-,e+) = (-0.8,+0.3)

Reduction Table

Process	2f_l	2f_h	4f_l	4f_sl	4f_h	aa_2f	N1N2	aa_4f	ae3f	BG	Signal	Signf	
Cross Section	6773.07	19625.1	10566.2	13232.1	8648.64	2.6771e+06	300.791	26.0064	261500	2.99785e+06	1065.17	0	
Generated	949500	2.3467e+06	2.84884e+06	1.9401e+06	704600	7.17376e+07	1.0963e+06	8300	2.26291e+07	1.04261e+08	2.33207e+06	2.33207e+06	
Expected	3.38654e+06	9.81253e+06	5.28308e+06	6.61606e+06	4.32432e+06	1.33855e+09	150395	13003.2	1.3079e+08	1.49892e+09	532585	532585	13.7538
Cut0	2.5406e+06	0	3.21083e+06	1.6053e+06	1463	1.34285e+09	6448.59	0	1.23824e+08	1.47404e+09	139638	139638	3.63688
Cut1	166279	0	2.05938e+06	12369.8	121.502	1.18992e+06	1135.45	0	860560	4.28976e+06	57982.8	57982.8	27.0078
Cut2	116859	0	2.03424e+06	6042.91	32.1319	465397	964.755	0	519208	3.14274e+06	38240.3	38240.3	21.4408
Cut3	24514.9	0	1.82201e+06	838.307	0	83683.4	530.5	0	109325	2.04091e+06	26085.4	26085.4	18.1438
Cut4	507.2	0	1.75586e+06	541.814	0	554.622	22.288	0	2234.05	1.75972e+06	14611.8	14611.8	10.9695
Cut5	345.949	0	1.75524e+06	514.594	0	131.168	0	0	511.501	1.75674e+06	14307.6	14307.6	10.7511
Cut6	152.933	0	1.75387e+06	6.28999	0	100.16	0	0	41	1.75417e+06	14295.4	14295.4	10.7497
Cut7	20.8147	0	1.75325e+06	0	0	3.20718	0	0	0	1.75327e+06	14230.5	14230.5	10.7039
Cut8	20.8147	0	1.75325e+06	0	0	3.20718	0	0	0	1.75327e+06	14229.6	14229.6	10.7032
Cut9	20.8147	0	1.75325e+06	0	0	3.20718	0	0	0	1.75327e+06	14180.9	14180.9	10.6667
Cut10	14.0019	0	1.75324e+06	0	0	3.20718	0	0	0	1.75325e+06	14173	14173	10.6608



# Cut Table: C1C1 right polarization, mu-tag

Polarization: (e-,e+) = (+0.8,-0.3)

Reduction Table

Process	2f_l	2f_h	4f_l	4f_sl	4f_h	aa_2f	N1N2	aa_4f	ae3f	BG	Signal	Signf	
Cross Section	5960.13	11663.4	7482.28	2943.64	741.331	2.6771e+06	239.406	26.0064	254270	2.96042e+06	258.908	0	
Generated	949500	2.3467e+06	2.84884e+06	1.9401e+06	704600	7.17376e+07	1.0963e+06	8300	2.26291e+07	1.04261e+08	2.33207e+06	2.33207e+06	
Expected	2.98006e+06	5.83168e+06	3.74114e+06	1.47182e+06	370665	1.33855e+09	119703	13003.2	1.27135e+08	1.48021e+09	129454	129454	3.3646
Cut0	2.26597e+06	0	1.39709e+06	442986	828.809	1.34285e+09	5485.37	0	1.70482e+08	1.51745e+09	33665.7	33665.7	0.864224
Cut1	130158	0	1.22904e+06	13533.9	44.7051	1.18992e+06	962.212	0	1.29565e+06	3.85931e+06	13977.6	13977.6	7.1022
Cut2	89687.9	0	1.22424e+06	9467.88	14.401	465397	812.04	0	778546	2.56816e+06	9252.8	9252.8	5.76343
Cut3	18798	0	1.19803e+06	4459.45	0	83683.4	426.7	0	169508	1.47491e+06	6311.94	6311.94	5.18624
Cut4	437.624	0	1.1903e+06	4027.72	0	554.622	16.6869	0	887.673	1.19622e+06	3562.7	3562.7	3.25258
Cut5	315.191	0	1.19023e+06	3887.03	0	131.168	0	0	218.5	1.19478e+06	3499.75	3499.75	3.19712
Cut6	90.6055	0	1.19012e+06	0.376324	0	100.16	0	0	79.0001	1.19039e+06	3496.48	3496.48	3.2
Cut7	26.3086	0	1.19005e+06	0	0	3.20718	0	0	0	1.19008e+06	3479.9	3479.9	3.18526
Cut8	26.3086	0	1.19005e+06	0	0	3.20718	0	0	0	1.19008e+06	3479.85	3479.85	3.18521
Cut9	26.3086	0	1.19005e+06	0	0	3.20718	0	0	0	1.19008e+06	3468.72	3468.72	3.17504
Cut10	19.6352	0	1.19005e+06	0	0	3.20718	0	0	0	1.19007e+06	3466.3	3466.3	3.17283



# Cut Table: C1C1 left polarization, e-tag

Polarization: (e-,e+) = (-0.8,+0.3)

Reduction Table

Process	2f_l	2f_h	4f_l	4f_sl	4f_h	aa_2f	N1N2	aa_4f	ae3f	BG	Signal	Signf	
Cross Section	6773.07	19625.1	10566.2	13232.1	8648.64	2.6771e+06	300.791	26.0064	261580	2.99785e+06	1065.17	0	
Generated	949500	2.3467e+06	2.84884e+06	1.9401e+06	704600	7.17376e+07	1.0963e+06	8300	2.26291e+07	1.04261e+08	2.33207e+06	2.33207e+06	
Expected	3.38654e+06	9.81253e+06	5.28308e+06	6.61606e+06	4.32432e+06	1.33855e+09	150395	13003.2	1.3079e+08	1.49892e+09	532585	532585	13.7538
Cut0	2.5406e+06	0	3.21083e+06	1.6053e+06	1463	1.34285e+09	6448.59	0	1.23824e+08	1.47404e+09	139638	139638	3.63688
Cut1	440593	0	2.18564e+06	1.41835e+06	1303.09	4.69081e+06	2280.9	0	6.68666e+06	1.54256e+07	72311.8	72311.8	18.3684
Cut2	183455	0	2.11847e+06	1.29514e+06	363.816	2.01091e+06	1892.27	0	4.70162e+06	1.03118e+07	47855.5	47855.5	14.8682
Cut3	32097.7	0	1.81125e+06	254878	6.65116	448367	1198.9	0	1.50445e+06	4.05224e+06	26589.9	26589.9	13.1659
Cut4	1312.43	0	1.75645e+06	193270	0	51091.1	109.868	0	270643	2.27280e+06	15180.8	15180.8	10.036
Cut5	1194.81	0	1.7549e+06	158984	0	37688.8	15.579	0	228069	2.18085e+06	14591.6	14591.6	9.84785
Cut6	132.869	0	1.75377e+06	187.228	0	16862.3	13.8184	0	7410.43	1.77837e+06	14582.2	14582.2	10.8903
Cut7	0.376225	0	1.75326e+06	0	0	0	11.3776	0	0	1.75327e+06	14507	14507	10.911
Cut8	0.376225	0	1.75326e+06	0	0	0	11.3776	0	0	1.75327e+06	14506.4	14506.4	10.9106
Cut9	0.376225	0	1.75326e+06	0	0	0	11.1108	0	0	1.75327e+06	14455.1	14455.1	10.8721
Cut10	0.376225	0	1.75324e+06	0	0	0	11.1108	0	0	1.75325e+06	14437	14437	10.8586

# Cut Table: C1C1 right polarization, e-tag

Polarization: (e-,e+) = (+0.8,-0.3)

Reduction Table

Process	2f_l	2f_h	4f_l	4f_sl	4f_h	aa_2f	N1N2	aa_4f	ae3f	BG	Signal	Signf	
Cross Section	5960.13	11663.4	7482.28	2943.64	741.331	2.6771e+06	239.406	26.0064	254270	2.96042e+06	258.908	0	
Generated	949500	2.3467e+06	2.84884e+06	1.9401e+06	704600	7.17376e+07	1.0963e+06	8300	2.26291e+07	1.04261e+08	2.33207e+06	2.33207e+06	
Expected	2.98006e+06	5.83168e+06	3.74114e+06	1.47182e+06	370665	1.33855e+09	119703	13003.2	1.27135e+08	1.48021e+09	129454	129454	3.3646
Cut0	2.26597e+06	0	1.39709e+06	442986	828.809	1.34285e+09	5485.37	0	1.70482e+08	1.51745e+09	33665.7	33665.7	0.864224
Cut1	408536	0	1.2458e+06	292785	769.328	4.69081e+06	1939.71	0	8.56541e+06	1.5206e+07	17442.5	17442.5	4.47045
Cut2	162682	0	1.23234e+06	203724	227.131	2.01091e+06	1617.4	0	6.18691e+06	9.79841e+06	11534.6	11534.6	3.68273
Cut3	28823.9	0	1.19771e+06	46402.5	6.63723	448367	1019.19	0	1.94867e+06	3.671e+06	6444.33	6444.33	3.3605
Cut4	1154.06	0	1.19045e+06	24827.9	0	51091.1	105.147	0	167309	1.43494e+06	3696.41	3696.41	3.0818
Cut5	1056.88	0	1.19025e+06	17561.6	0	37688.8	12.5028	0	154031	1.4006e+06	3565.4	3565.4	3.00884
Cut6	101.927	0	1.19011e+06	245.621	0	16862.3	11.0623	0	8875.34	1.21621e+06	3562.3	3562.3	3.22546
Cut7	6.28833	0	1.19005e+06	0	0	0	10.2488	0	0	1.19007e+06	3544.71	3544.71	3.24451
Cut8	6.28833	0	1.19005e+06	0	0	0	10.2488	0	0	1.19007e+06	3544.68	3544.68	3.24448
Cut9	6.28833	0	1.19005e+06	0	0	0	9.78778	0	0	1.19007e+06	3533.2	3533.2	3.23399
Cut10	6.28833	0	1.19005e+06	0	0	0	9.78778	0	0	1.19007e+06	3528.21	3528.21	3.22943