

Top threshold Monte Carlo generator

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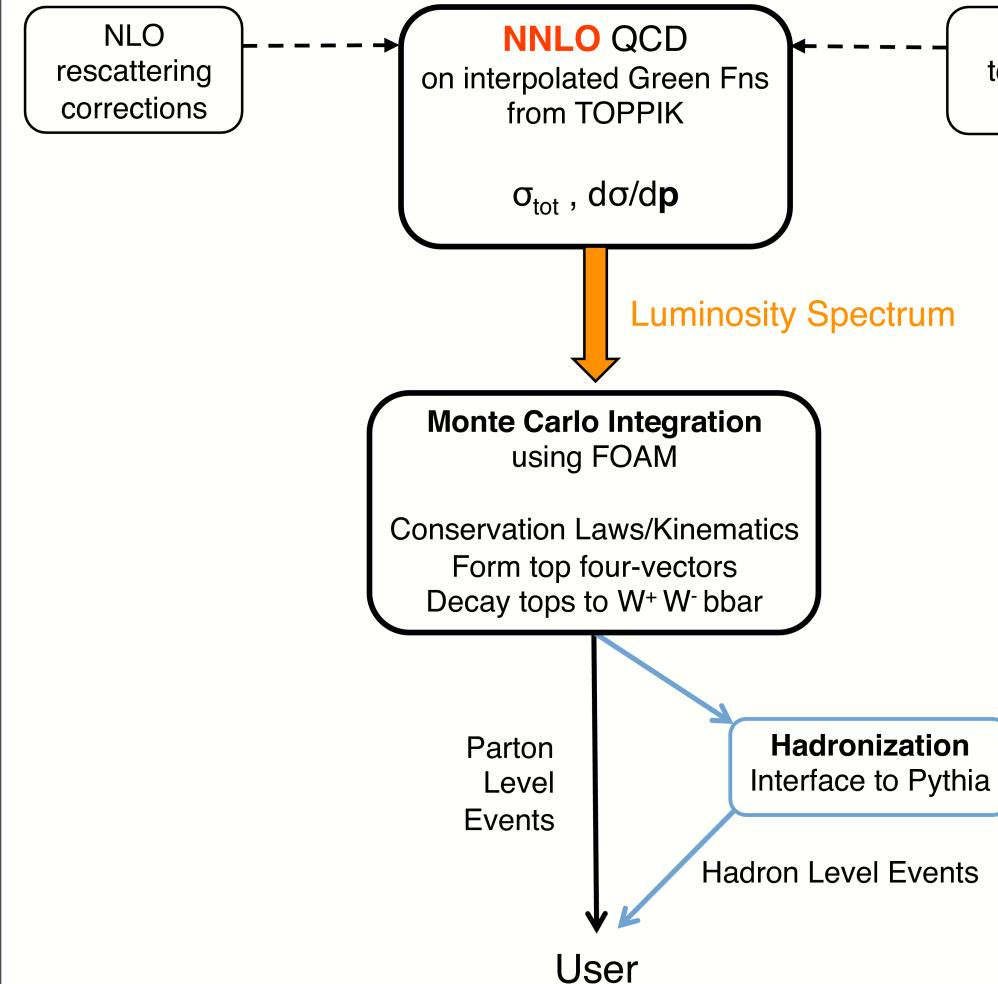
LCWS 2008, Chicago

QCD-top/loopverein

Overview

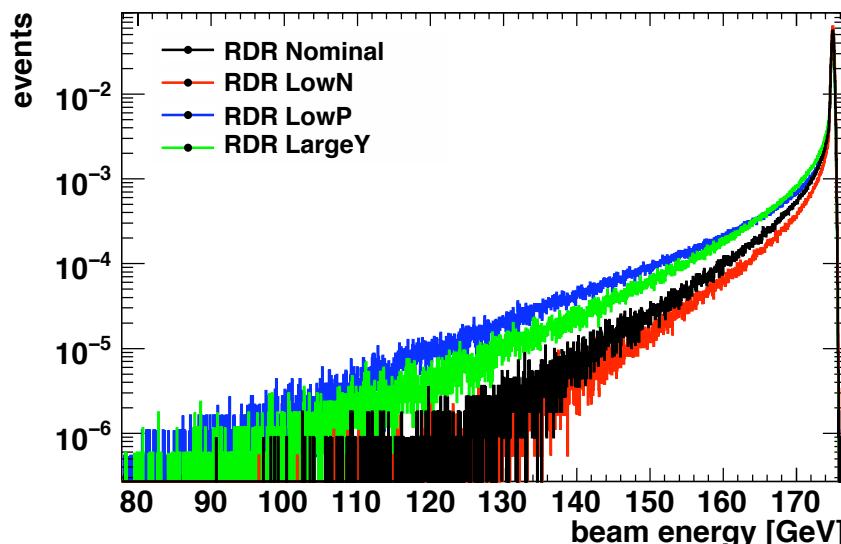
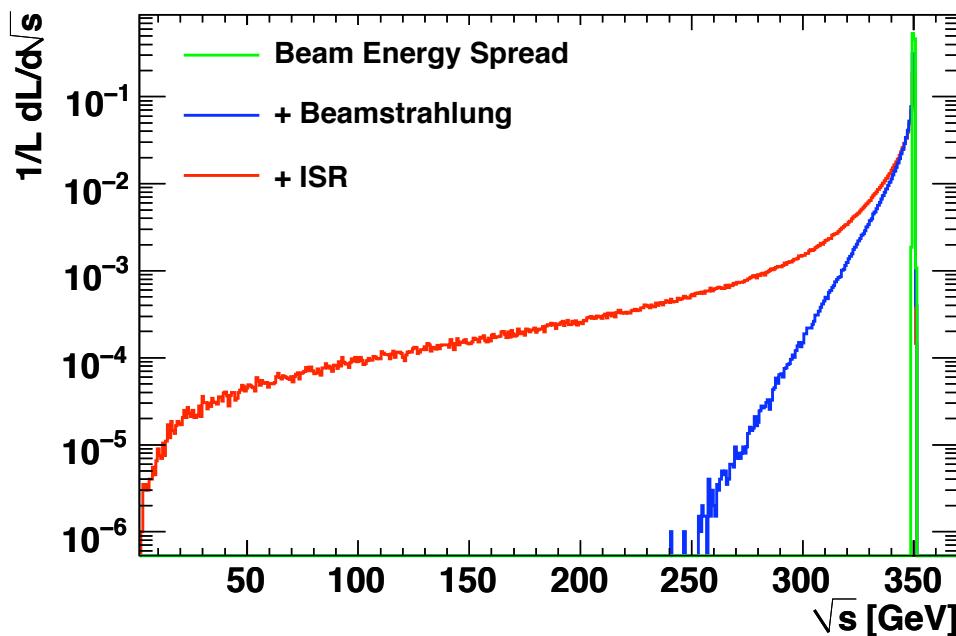
- Develop code to generate top pair events
 - Outline framework of generator
 - Include effects of luminosity spectrum
 - Current calculations two slow and difficult to perform analyses
 - Boost from asymmetric beam energies effect differential variables
- Outline of analysis
 - Selection cuts for 6j and 4j+l nu samples
 - Efficiency/purity

Simulation framework



- Interface to TOPPIK
 - Interpolate Green's functions rapidly to compute momentum and angular distributions
- Use FOAM to generate events including beam effects (lumi spectrum)
- Hadronisation performed using Pythia
- Analysis presented mainly at hadron level

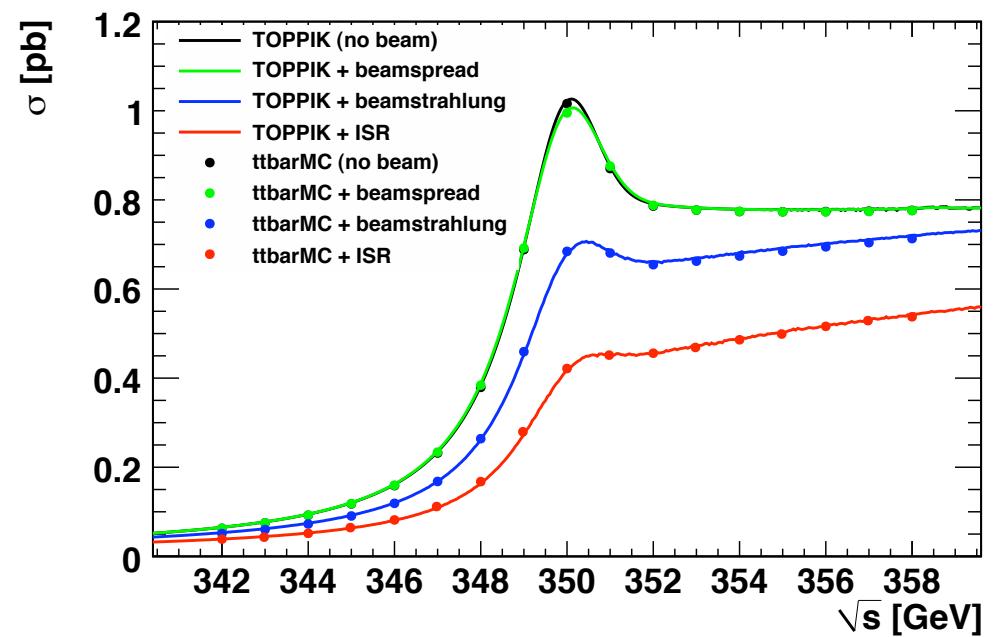
Luminosity spectrum



- Major components
 - Beam energy spread (BES)
 - Beamstrahlung
 - Most machine input
- Initial state radiation
- RDR reference parameters
- See luminosity spectrum talk in MDI session

Propagation to top threshold

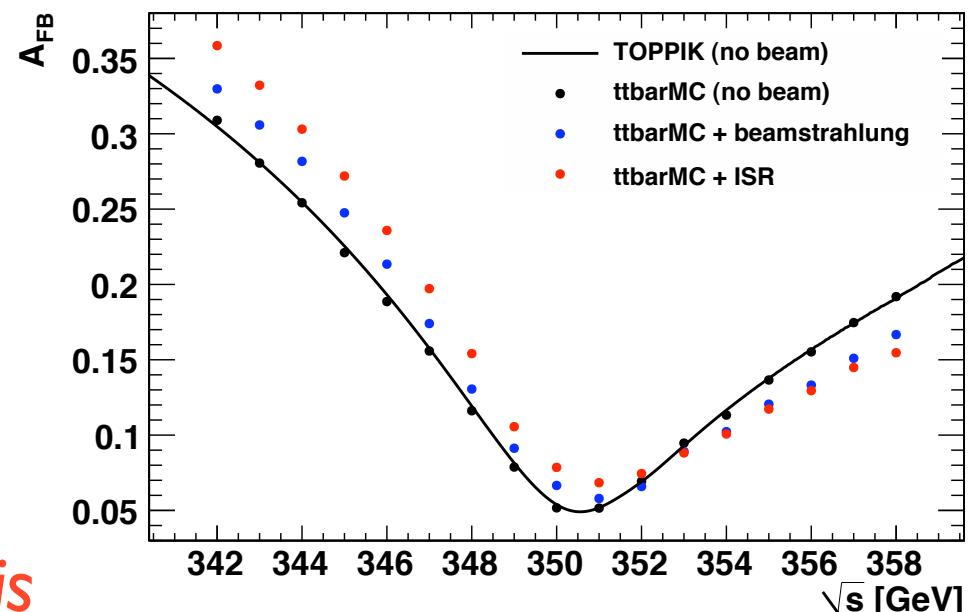
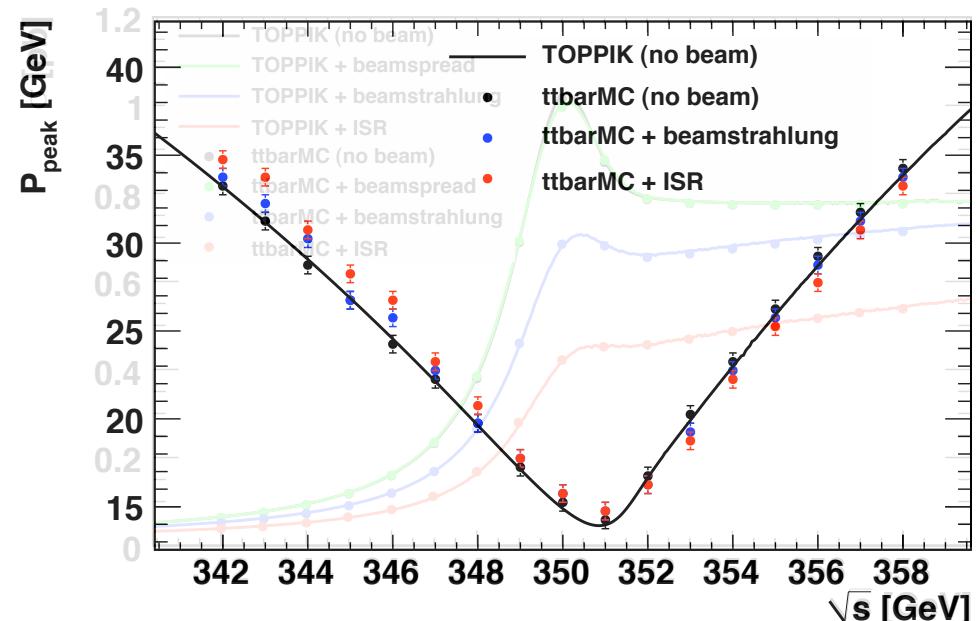
- Top threshold significantly modified by luminosity spectrum
 - Effective reduction in luminosity at threshold compared with continuum process
- Threshold location not significantly modified due to luminosity spectrum



Parton level analysis

Generate differential distributions

- Interest in P_{peak} and A_{FB}
- Luminosity spectrum effect on peak of momentum distribution and forward-back asymmetry
 - Does this add to mass precision?
 - Minimum shifted towards higher centre of mass energies

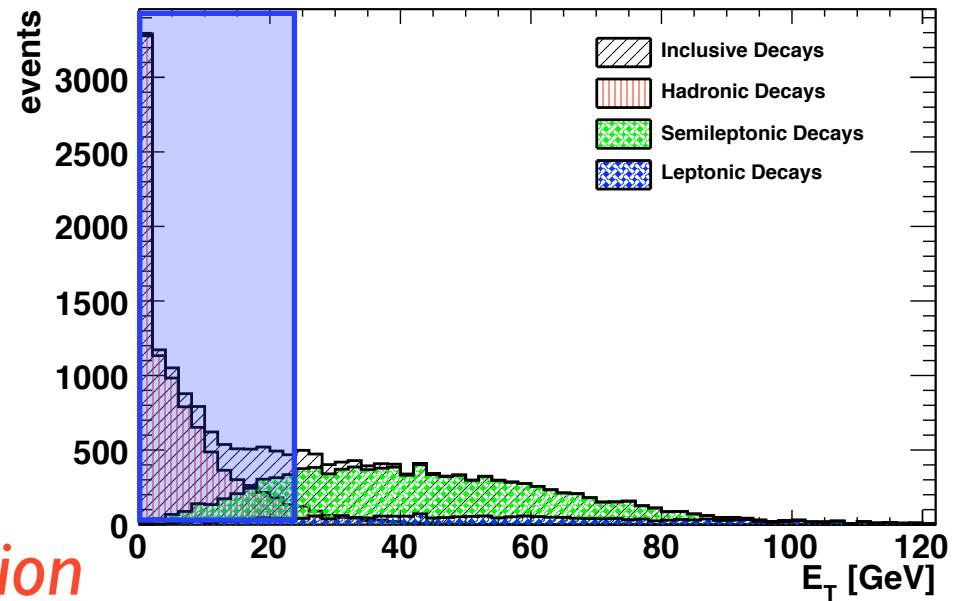
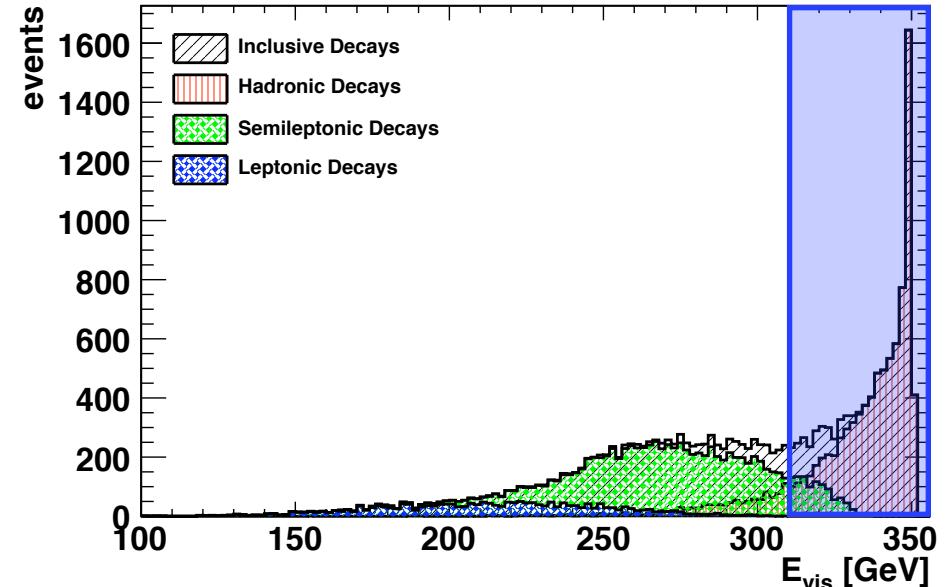


Parton level analysis

Event selection (hadronic case)

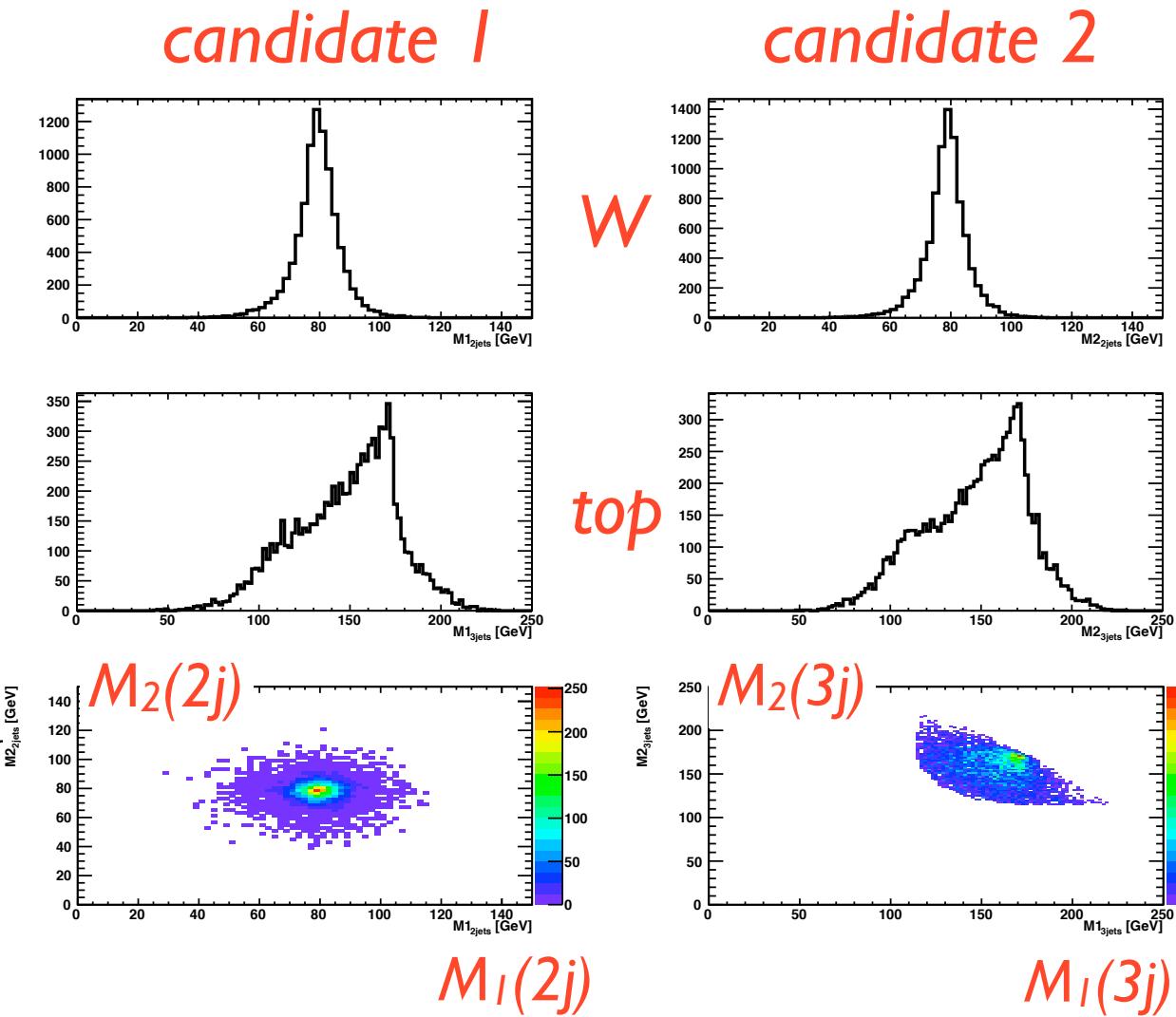
- $\sqrt{s} = 352 \text{ GeV}$, 20k events
- Selection
 - Require 6 jet (Kt)
 - Charged tracks > 20
 - $E_{vis} > \sqrt{s} - 40 \text{ GeV}$
 - $E_T < 25 \text{ GeV}$
 - $Thrust < 0.85$
- Jet cuts
 - $|M_{jj} - M_W| < 60 \text{ GeV}$
 - $|M_{j,jj} - M_W| < 60 \text{ GeV}$

After Pythia hadronisation



Event selection (jets)

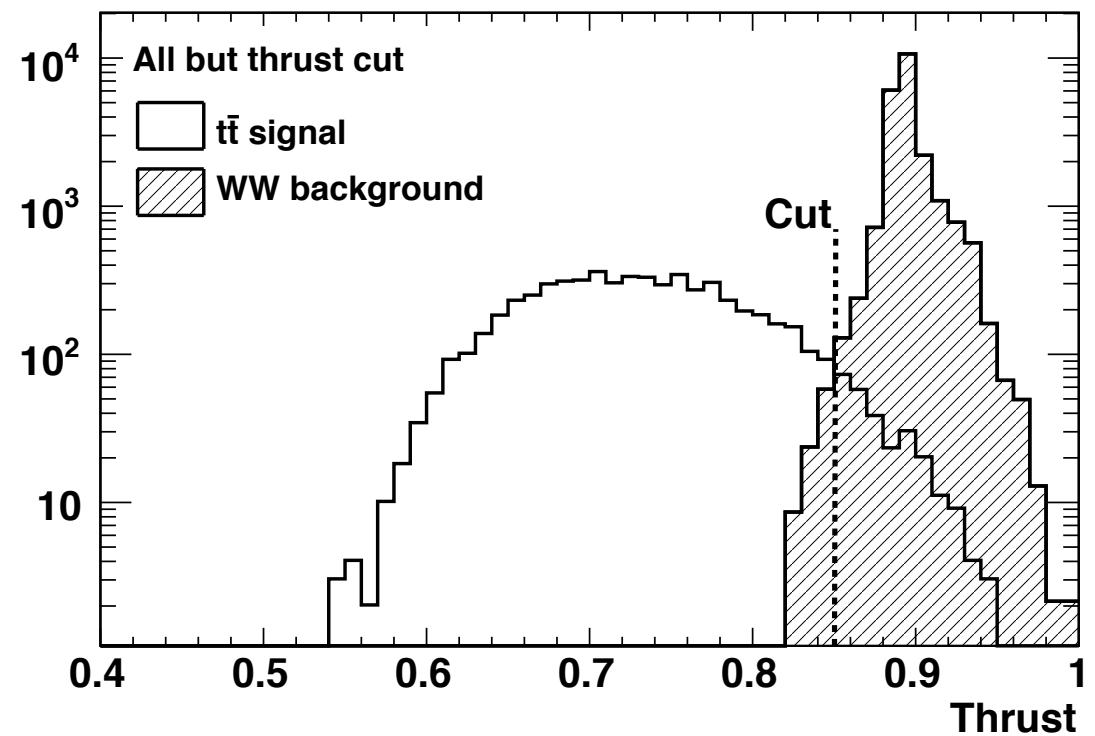
- Require 6 jets
 - Compute 2 jet combinations
 - Find best 2 W candidates
- $|M_{jj} - M_W| < 60\text{GeV}$
- Compute top candidates
- $|M_{jjj} - M_W| < 60\text{GeV}$



Background rejection

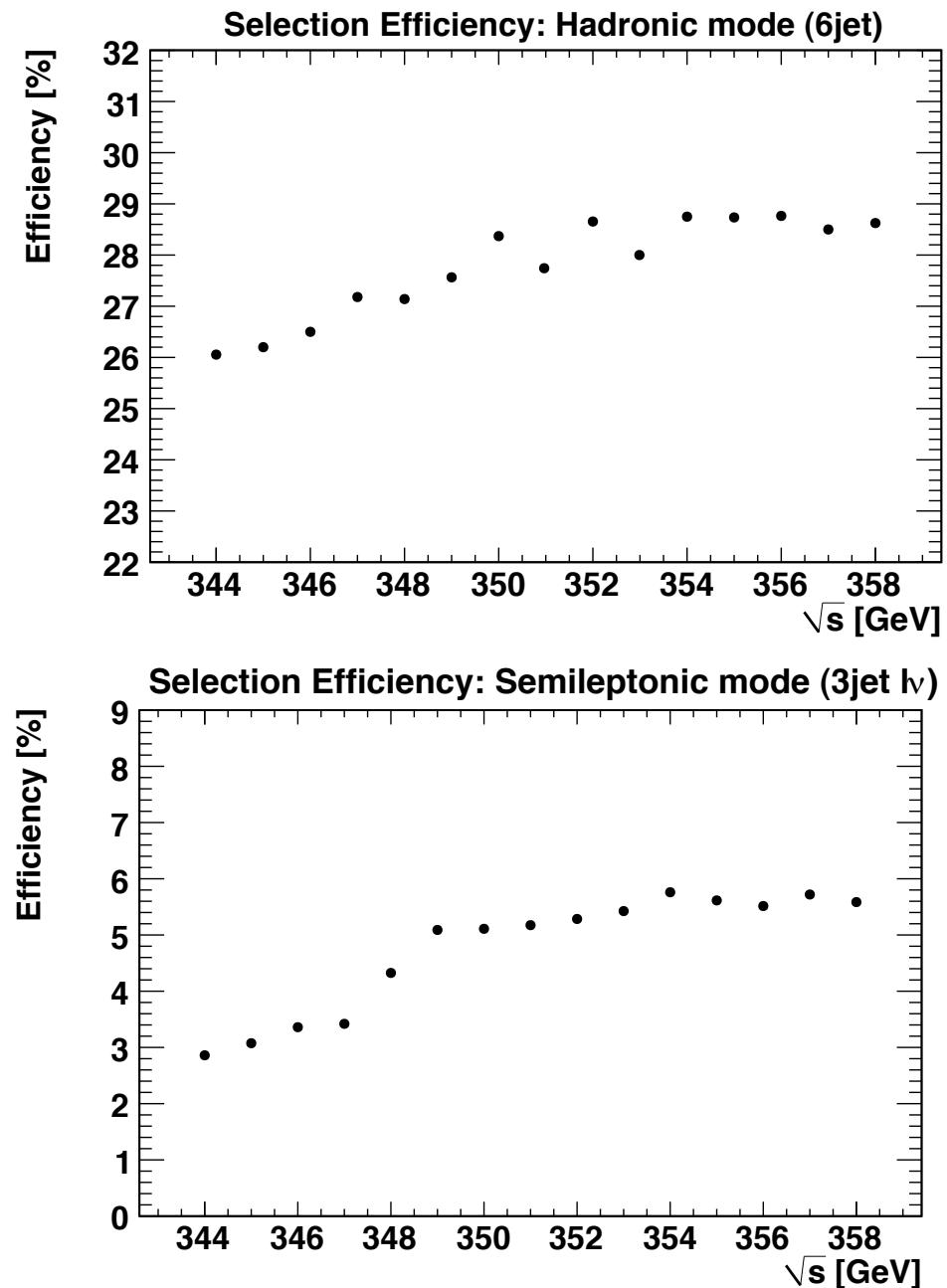
- Thrust cut to remove WW background
 - Not significant for threshold with top mass ~ 175
- Thrust cut removes most of background

$Thrust < 0.85$



Event selection efficiency

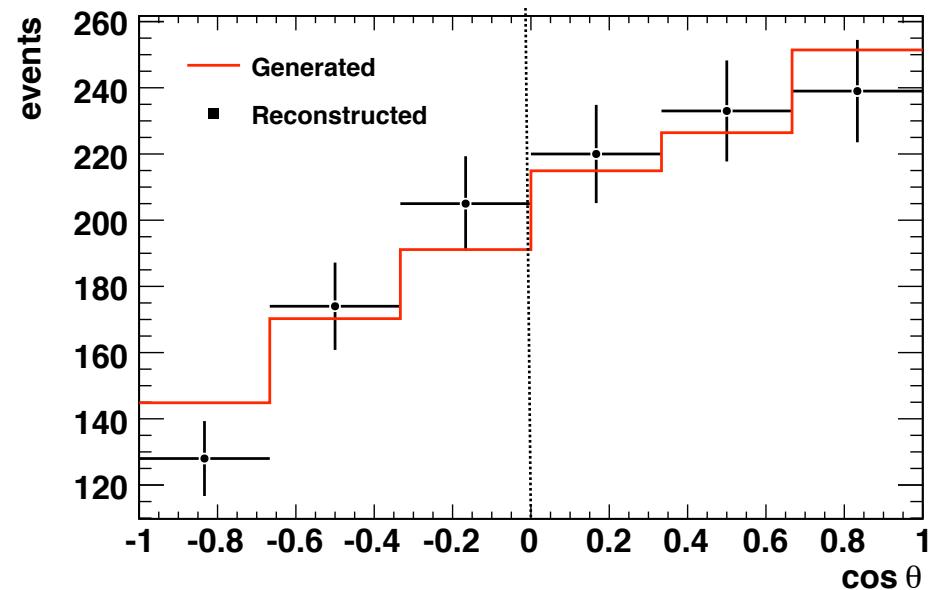
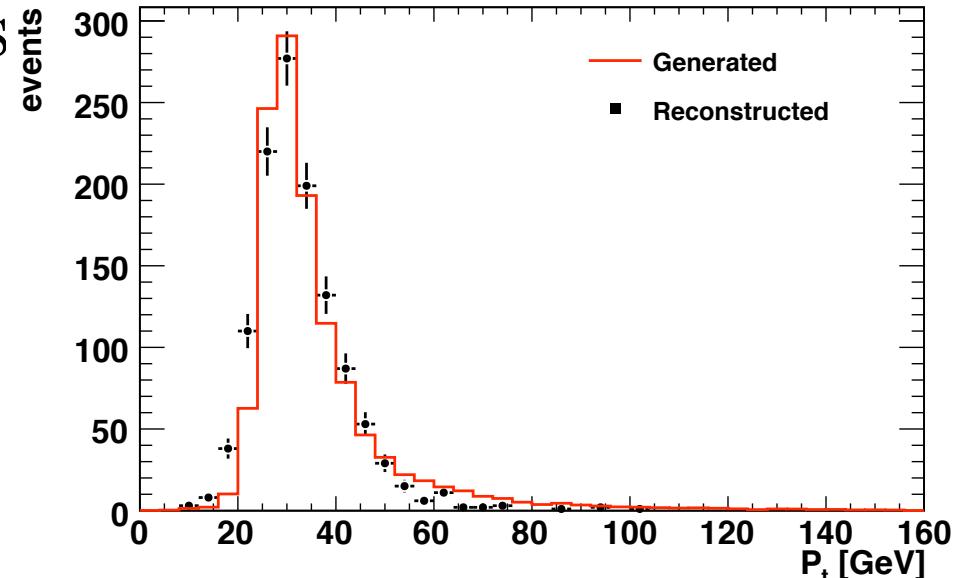
- Efficiencies similar to previous studies
 - Includes branching fractions
 - Cuts not tuned for each energy point
- Efficiency significantly lower for 4j+l nu
 - Mainly due to B tagging
 - Purity very high negligible background



Momentum and forward-backward

$\sqrt{s} = 355 \text{ GeV}$, 20k events

- Consider only 4j+1 nu case
 - Selection modified (include b tags)
 - Tag charge of lepton from W decay
 - Avoid jet charge
 - Fully reconstruct 3j hadronic system from top
 - Compute momentum and angle



Summary

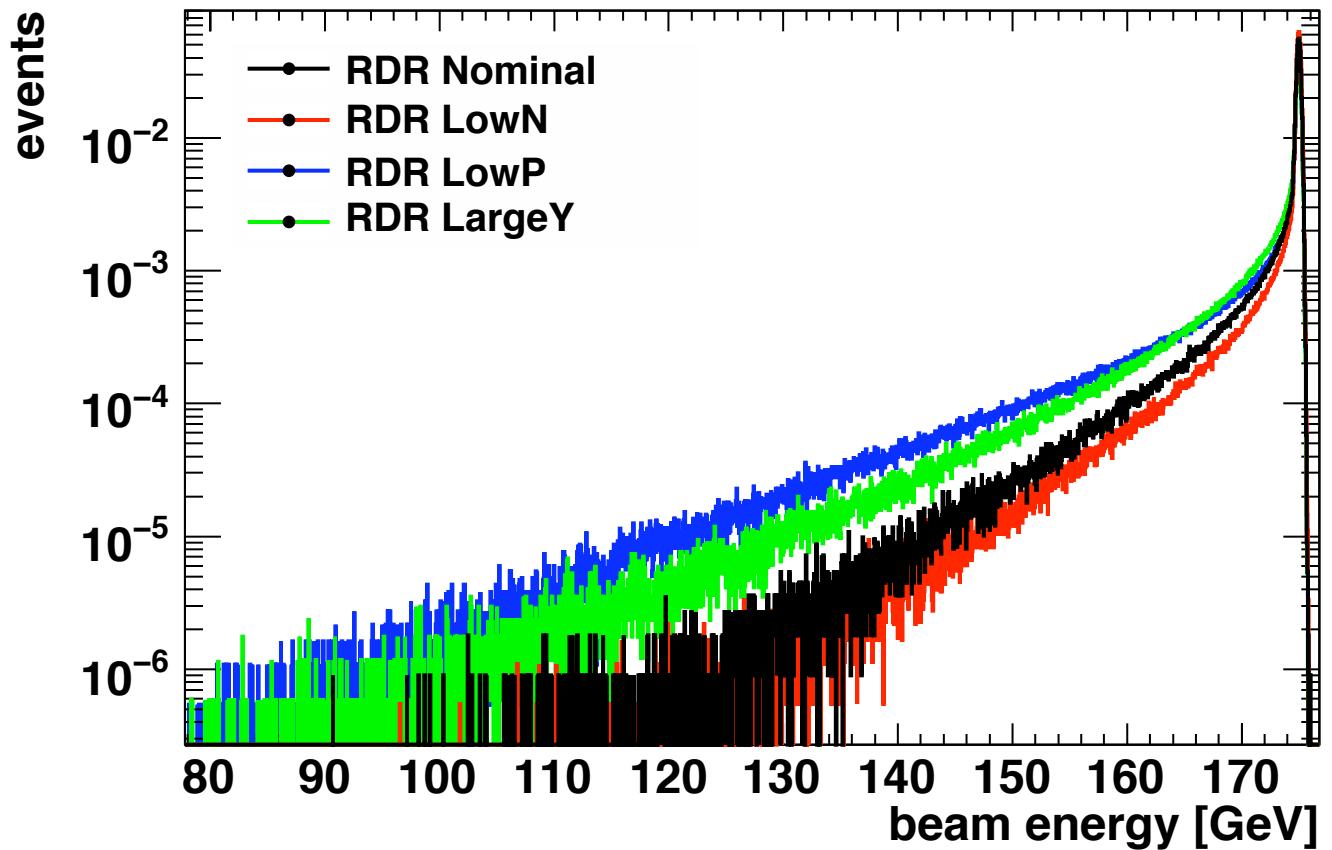
- Hadron analysis of top threshold almost complete
 - Investigate effect of luminosity spectrum
 - Mainly for differential quantities and also machine operation parameters
- Generation of large event samples possible (necessary) for extraction of physics parameters
 - Analysis continuing should be finished end of this year
 - Extract top mass, width and strong coupling constant
- Detector effects not included
 - Will suspend for future study

Lumi-spectrum backup slides

- Lots of work on luminosity spectrum

RDR beam spectra

- Generated using GP++
- Top threshold centre of mass energy
- Most concern is LowP and LargeY option
- Clear luminosity loss for threshold scans



Usually deal with fractional energy, compared with nominal beam energy

$$x = \frac{E_b}{E_n}$$

Beamstrahlung parametrisation

- Beta function parameterization chosen

$$f(x) = a_0 \delta(0) + a_1 x^{a_2} (1 - x)^{a_3}$$

- Problems with logarithmic transforms easier fitting
 - Due to energy spread

$$x' = \log(x - 1)$$

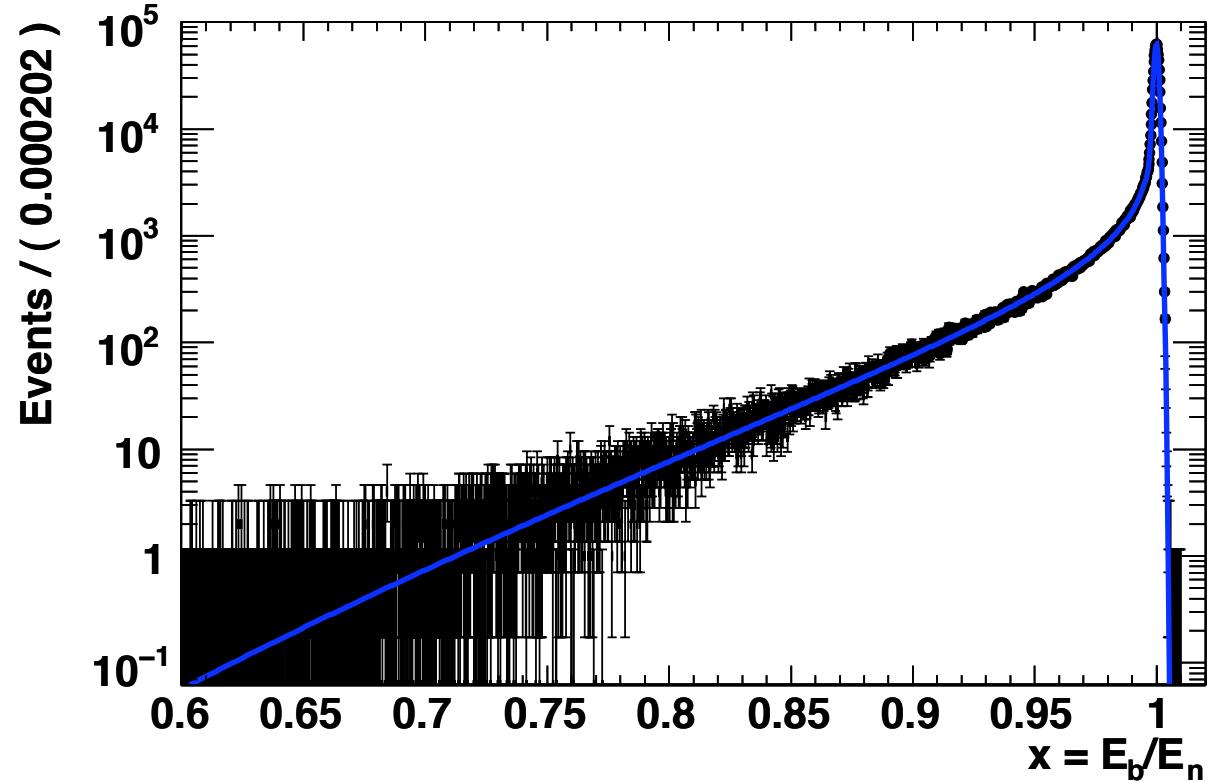
- Convolute with beam energy spread

$$D_{e^\pm}^*(x) = a_0 BES(1, \sigma) + a_1 \int_0^{x_{max}} BES(x, \sigma) \cdot x^{a_2} (1 - x)^{a_3} dx$$

- Numerically calculate integral

Beamstrahlung fits

- Fit parameterisations
 - Blue curve fit
 - Histogram with errors GP++ simulation
- Performed for all parameter sets



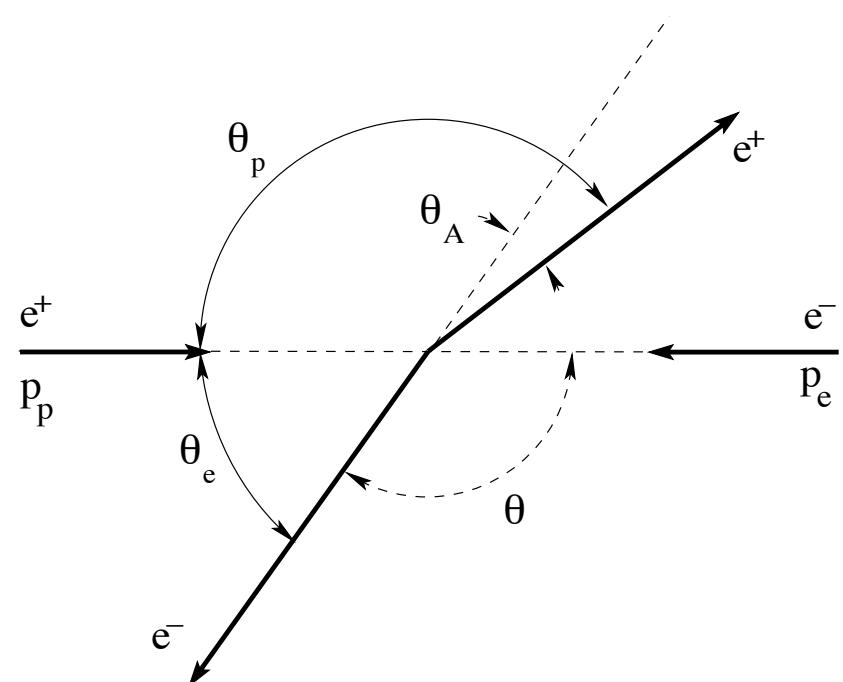
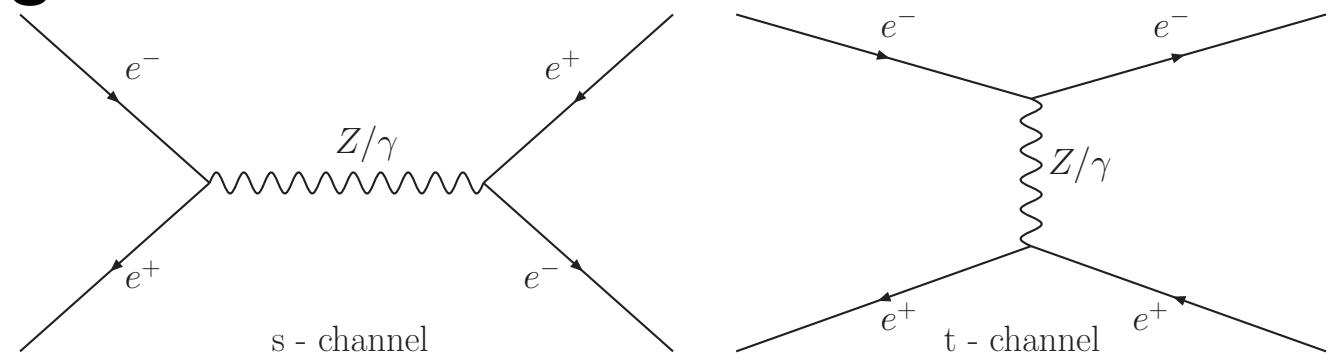
*Beamstrahlung parameters
and energy spread fitted to
GP++ simulations*

	Nominal	Low-N	Large-Y	Low-P
a_0	0.606	0.705	0.445	0.531
a_2	15.340	15.869	11.192	8.026
a_3	-0.708	-0.744	-0.690	-0.642
σ_E [GeV]	0.175	0.175	0.174	0.176
$\langle E \rangle$ [GeV]	173.58	174.05	172.26	171.62

Bhabha acolinearity

- Monitor low angle Bhabha events
 - >7 degrees
- Simulation
 - Generated using BHWIDE
 - Fold in luminosity spectrum for a given centre of mass energy
- Measure final state angles and compute

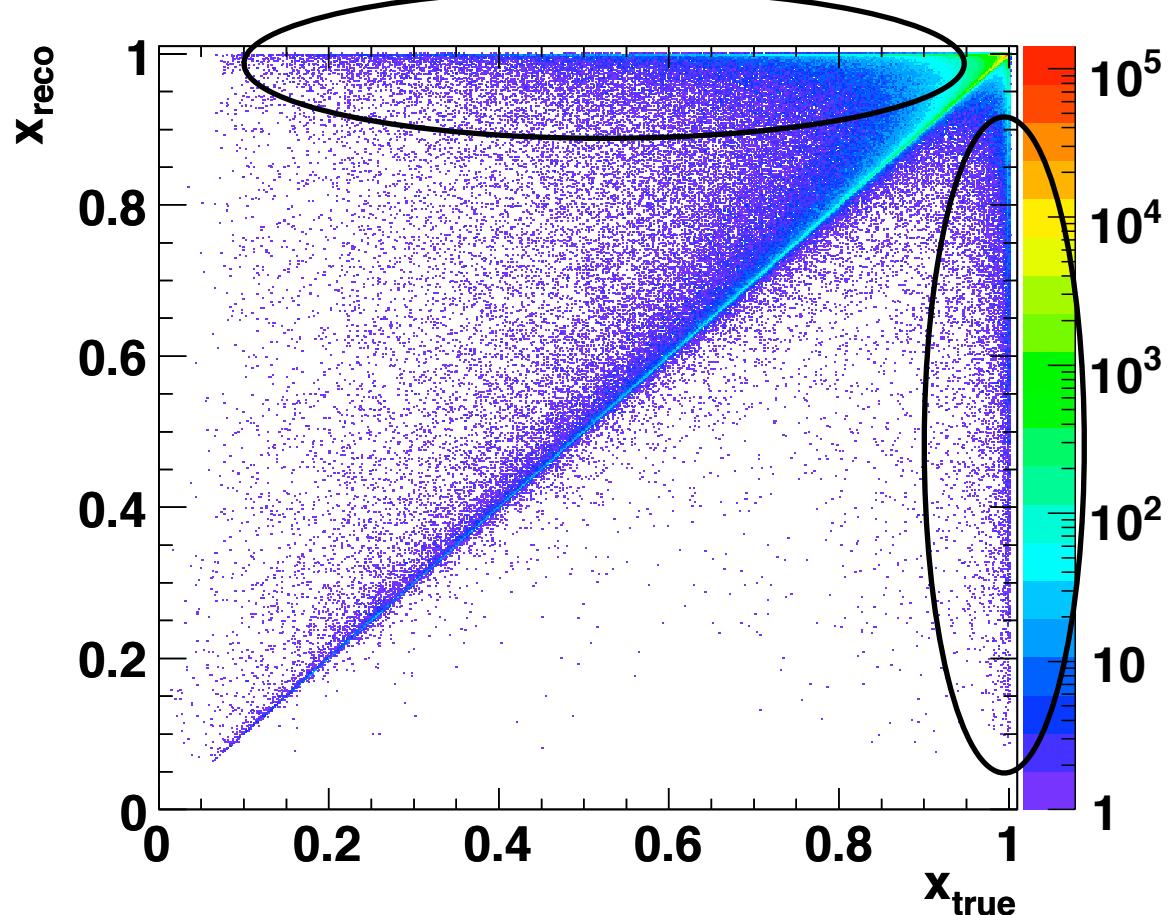
$$x_{acol} = \sqrt{\cot \frac{\theta_e}{2} \cot \frac{\theta_p}{2}}$$



Assuming single photon radiation

Reconstructed energy loss

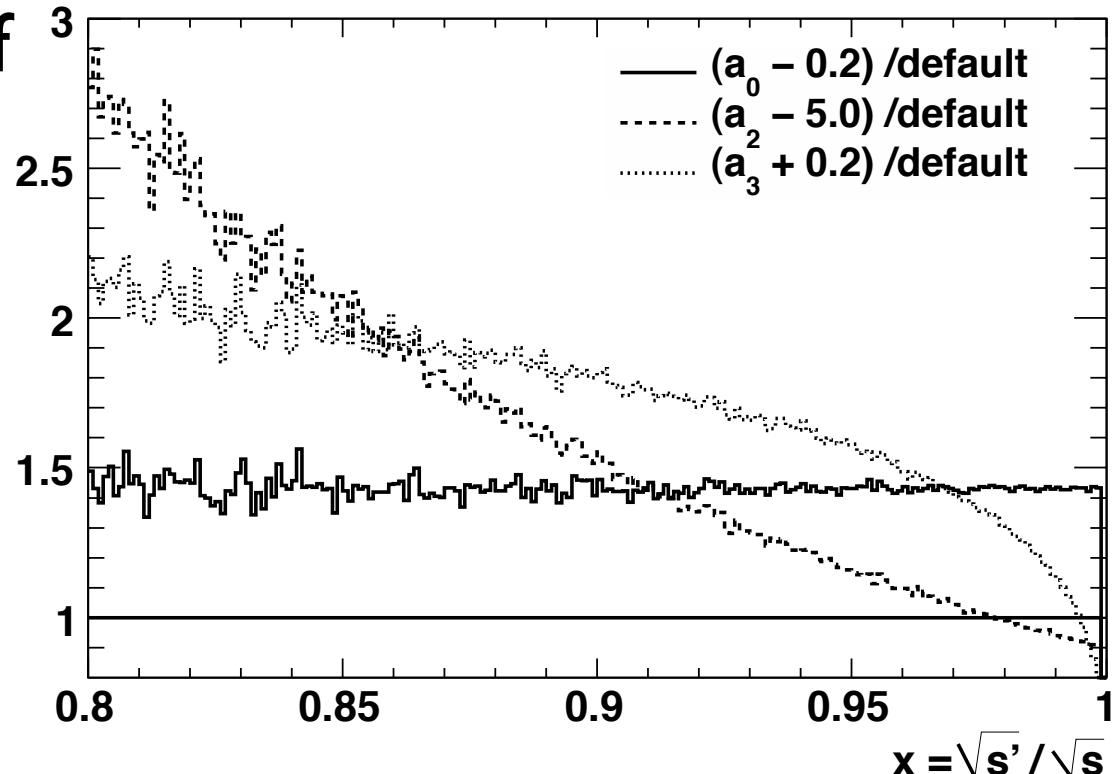
- Compare reconstructed x and true x
- Nominal parameter set
- Large deviations from main diagonal
 - Multiple photon radiation
 - Final state radiation



Logarithmic z scale

Beamstrahlung measurement

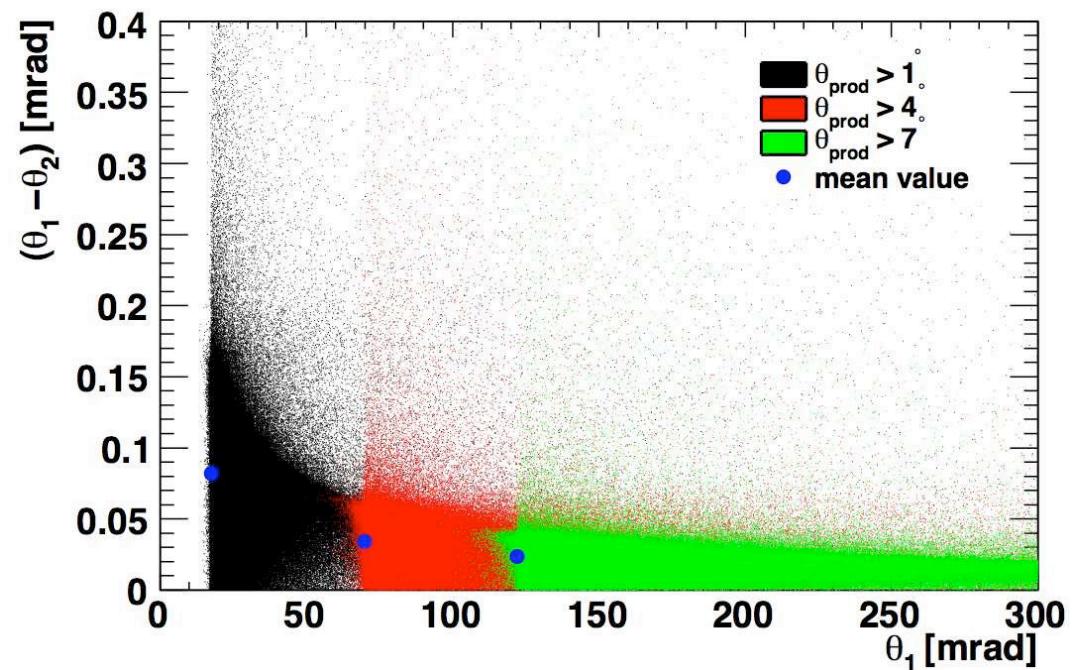
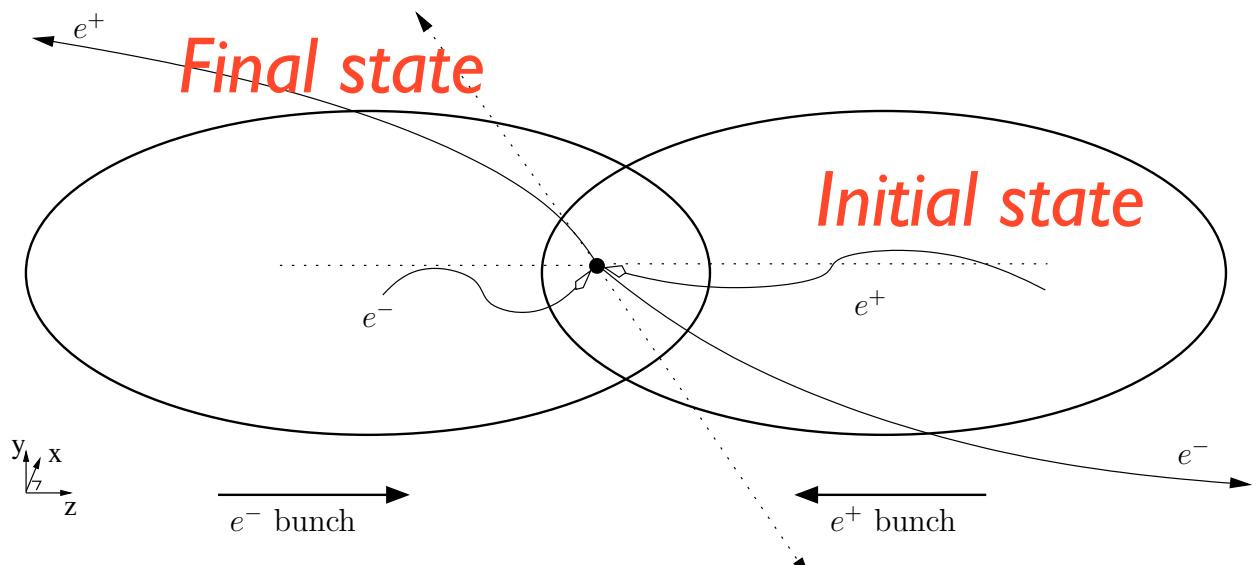
- Simulate various sets of Bhabha events with different a parameters
- Create histograms of x_{acol}
- Minimize to determine beamstrahlung parameters which best describe sample



$$x_j^{fit}(\mathbf{a}) = x_j^0 + \sum_i \frac{a_i - a_i^0}{\delta a_i} (x_j^i - x_j^0)$$

Effect of bunch fields

- Look at effect of
 - initial and final state perturbation of Bhabha scattered particles
- Final state is not a problem
 - <5 micro-rad
- Initial state
 - 150 micro-rad



Summary of extracted spectra

- Extract beamstrahlung parameters for each set
 - Largest effect for LowP
 - Problem exasperated due to initial state momentum
 - Nominal and LowN fine, LargeY a problem

Correlations Effect				
Parameter	Nominal	LowN	LargeY	LowP
a_0	0.623	0.712	0.463	0.597
a_2	15.669	16.347	11.549	8.257
a_3	-0.688	-0.727	-0.684	-0.717
σ_x	$1.0061 \cdot 10^{-3}$	$1.0001 \cdot 10^{-3}$	$1.0069 \cdot 10^{-3}$	$1.0080 \cdot 10^{-3}$
Δa_0	2.78%	2.25%	4.17%	12.40%
Δa_2	2.14%	3.01%	3.12%	2.87%
Δa_3	2.77%	2.18%	0.84%	-11.63%
$\Delta \sigma_x$	0.61%	0.01%	0.69%	0.80%
$\Delta \langle E \rangle [\text{MeV}]$	-5.3	11.2	109.4	1070.0

Initial State Transverse Momentum Effect				
Parameter	Nominal	LowN	LargeY	LowP
a_0	0.623	0.726	0.465	0.657
a_2	15.799	16.335	11.655	8.315
a_3	-0.685	-0.722	-0.683	-0.697
σ_x	$1.2503 \cdot 10^{-3}$	$1.1550 \cdot 10^{-3}$	$1.3400 \cdot 10^{-3}$	$1.3007 \cdot 10^{-3}$
Δa_0	2.71%	2.99%	4.61%	23.62%
Δa_2	2.99%	2.93%	4.14%	3.60%
Δa_3	3.28%	2.90%	1.08%	-8.60%
$\Delta \sigma_x$	25.03%	15.50%	34.00%	30.07%
$\Delta \langle E \rangle [\text{MeV}]$	-7.5	7.8	124.5	1275.8

Conclusions

- Simplistic extraction of luminosity spectrum parameters
 - Small shifts for Nominal and LowN parameter sets
 - Shifts significant for LowY and LowP
 - Problem is exasperated for LowY and LowP when pre-collision disruption is included
 - Must check with traveling focus solutions for LowP
- Detector effects are not significant compared with deflections due to high bunch fields