Progress on the Γ_{ee} Efficiency Measurement

Jim Pivarski

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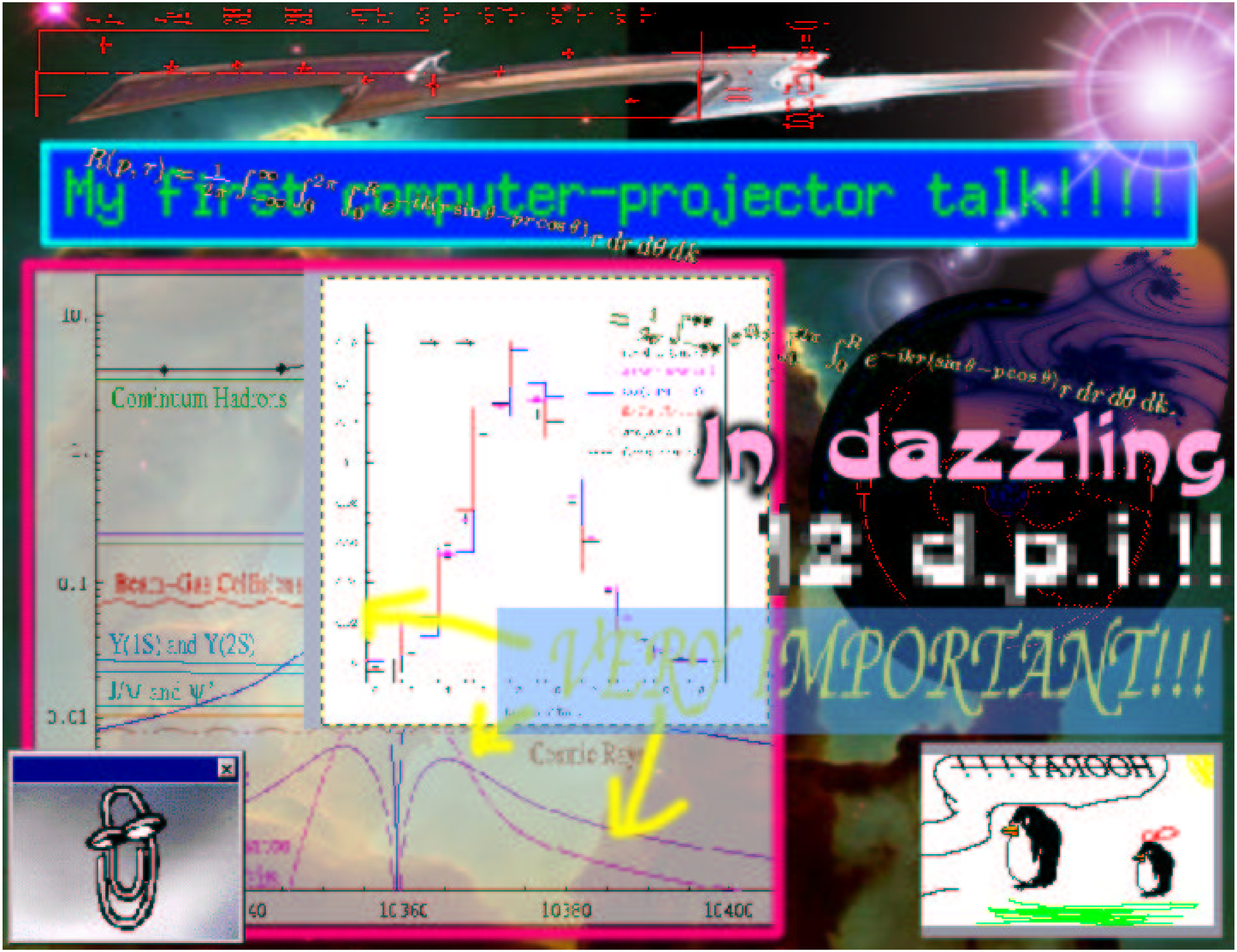
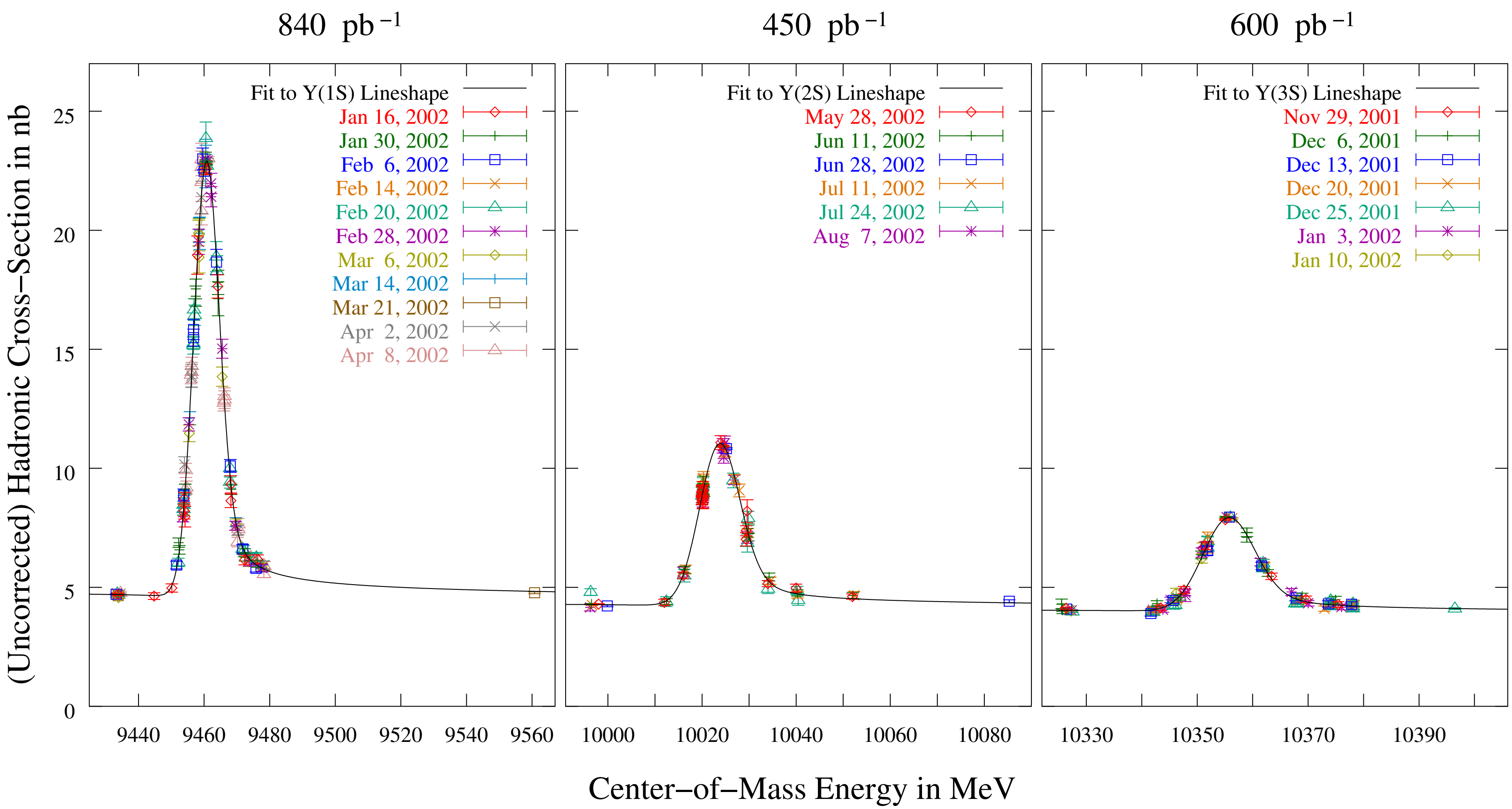


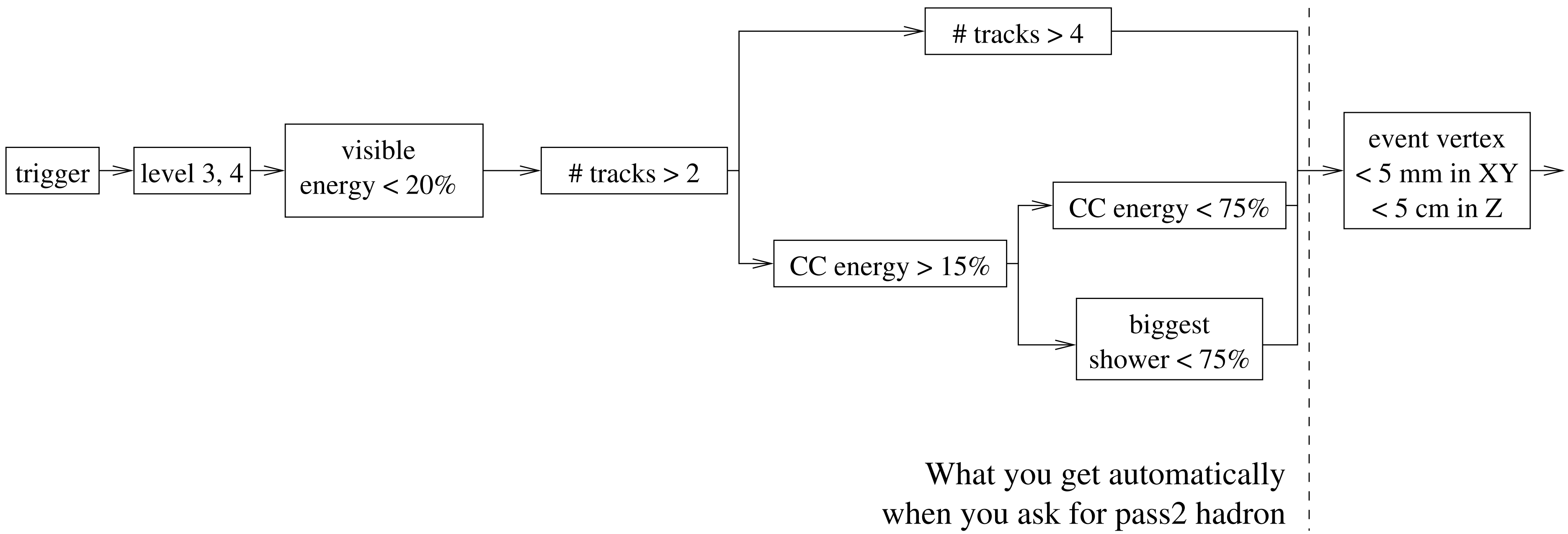
My first computer-projector talk!!!!
In dazzling
12 d.p.i.!!
VERY IMPORTANT!!!
Continuum Hadrons
Beam-Gas Collisions
Υ(1S) and Υ(2S)
J/ψ and ψ'
Cosmic Rays
YAHOO!!!

Remember Γ_{ee}?

- data16–27 included 21 lineshape scans of $\Upsilon(1S)$, $\Upsilon(2S)$, $\Upsilon(3S)$
- Statistical uncertainties are negligible $\sim$0.4%
- Background systematics reduced to $\sim$0.2%
- Efficiency measurement currently limited by a data/MC disagreement ($\sim$1.7%)
- Luminosity and energy-wiggle studies to follow.

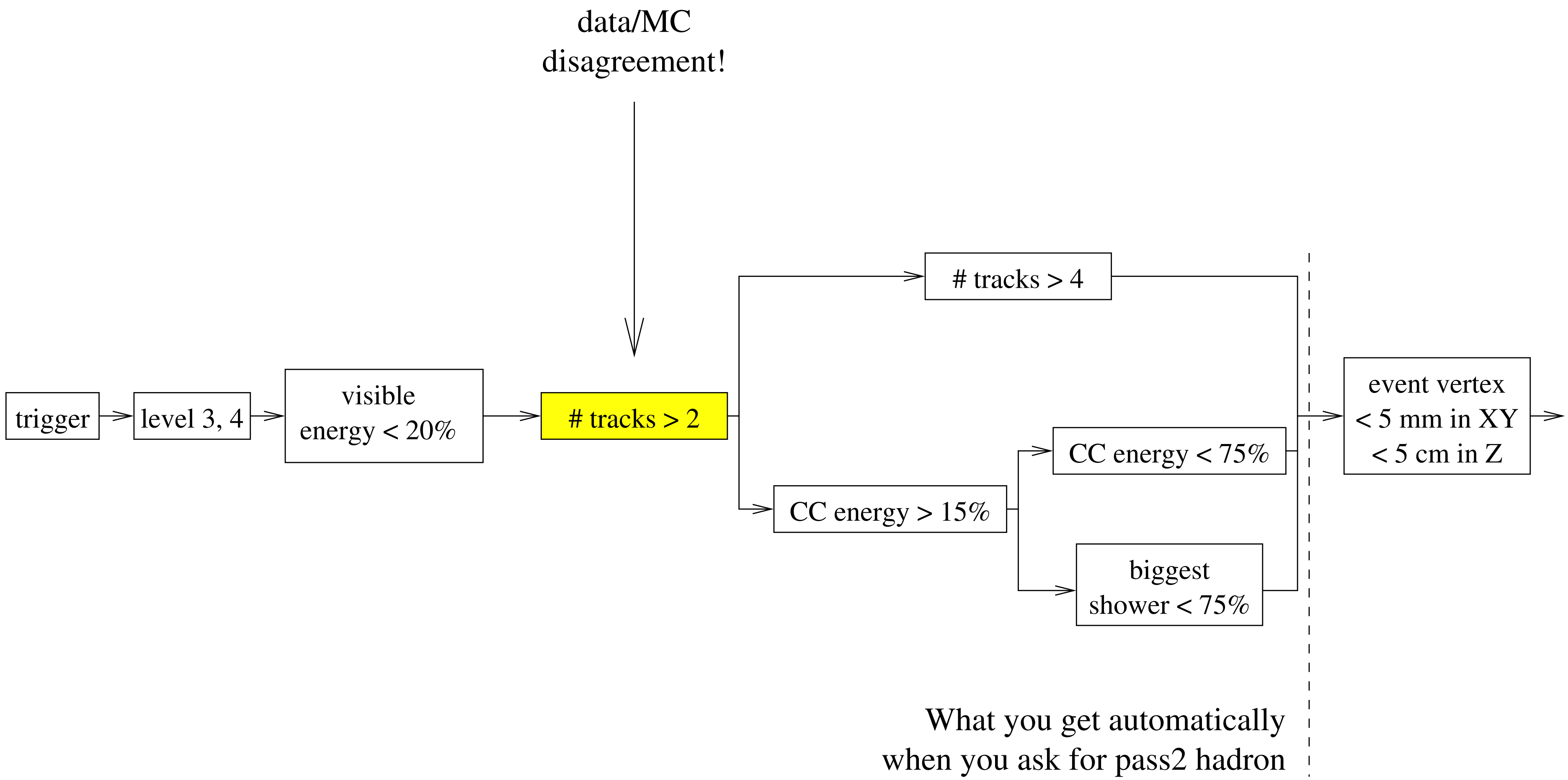


Analysis cuts



To loosen these cuts, I will need to get raw data

Analysis cuts



To loosen these cuts, I will need to get raw data

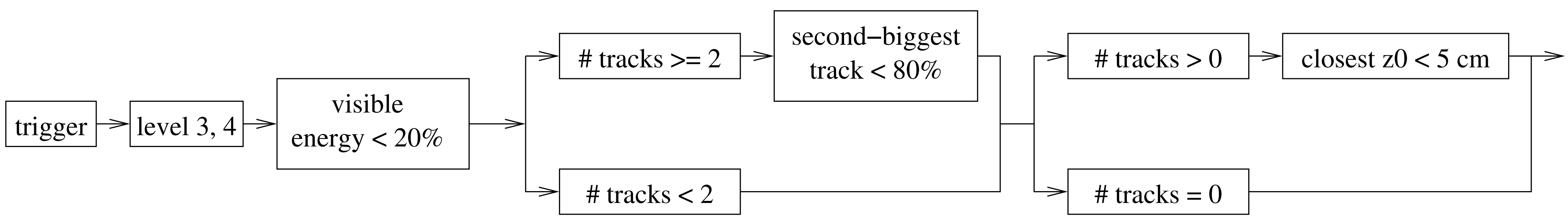
Comparing raw data with resonance Monte Carlo

Raw data contains continuum processes (bhabhas, two-photon, continuum hadrons) which will need to be removed by a continuum subtraction.

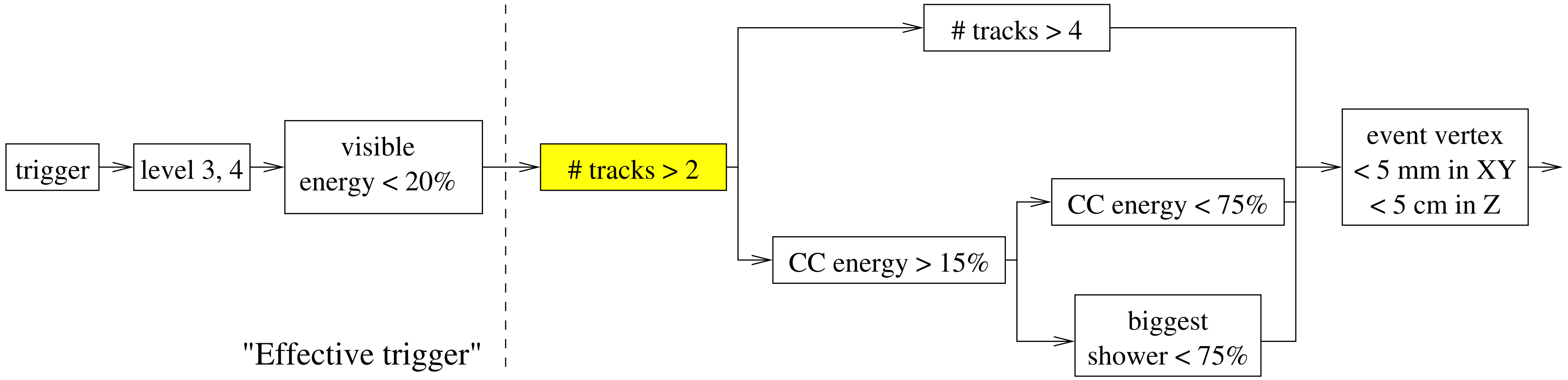
That subtraction will have more statistical power if some large continuum processes are first cut.

The three remaining backgrounds— beamgas, beamwall, and cosmic rays— will need to be cut out in any case.

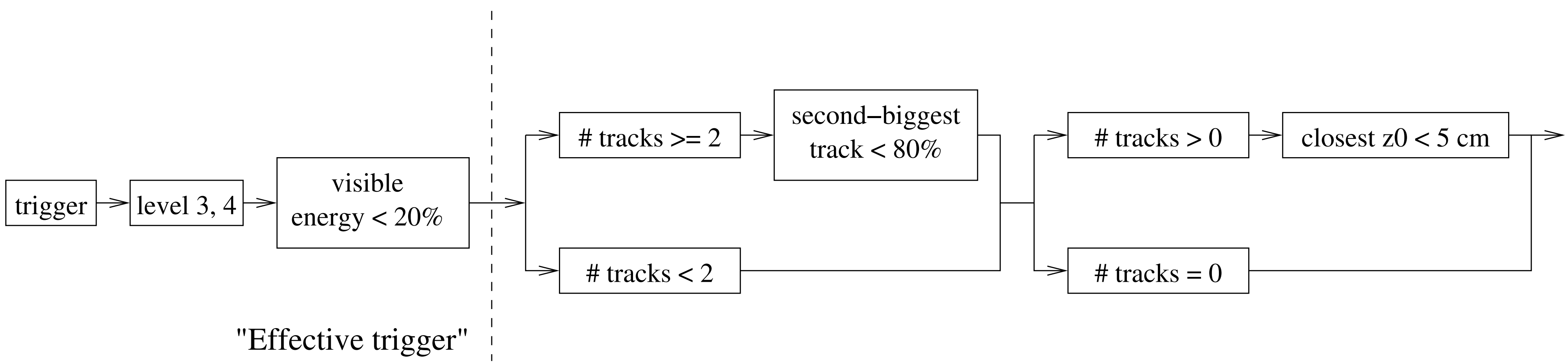
Efficiency cuts



Analysis cuts

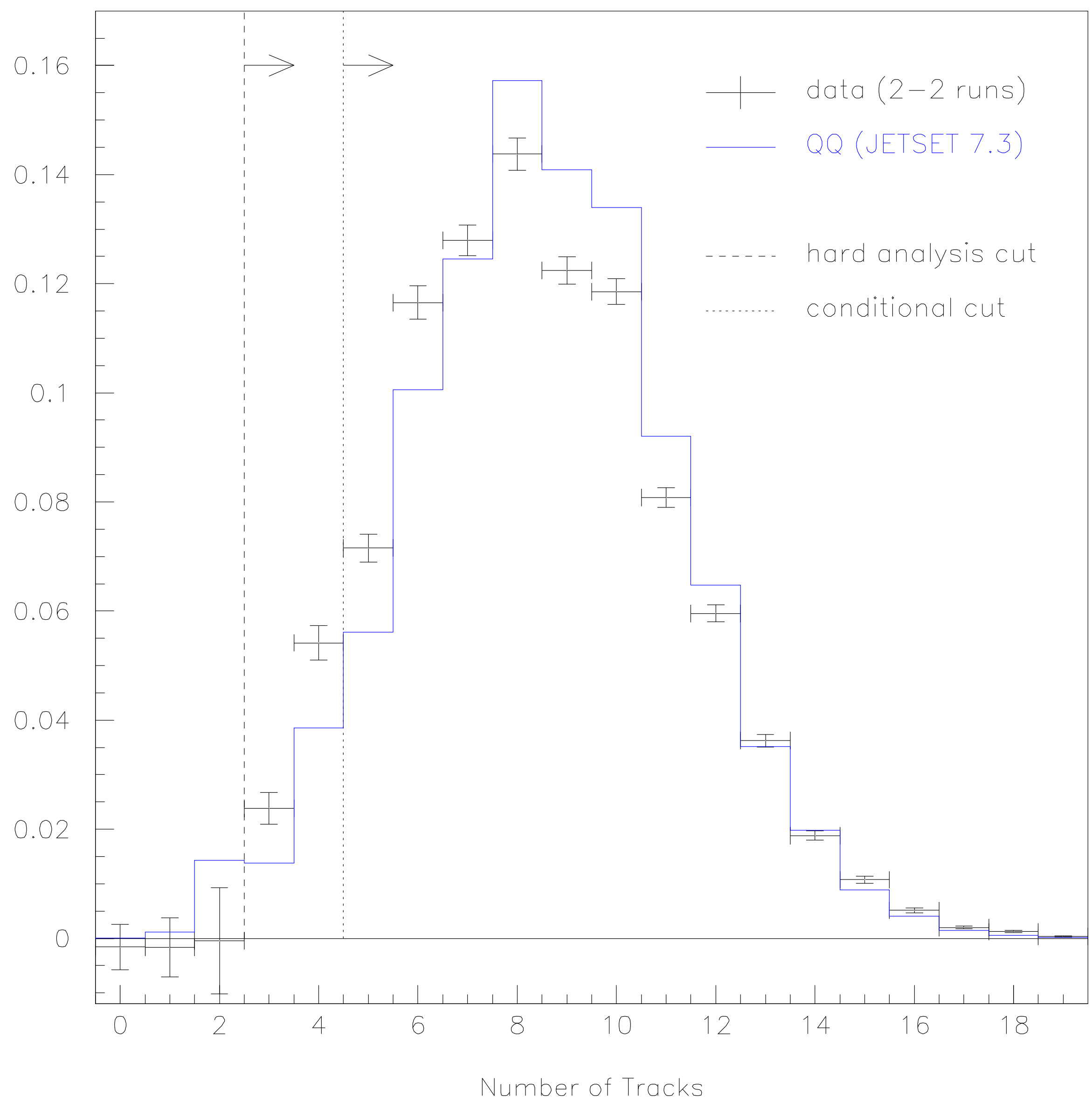


Efficiency cuts



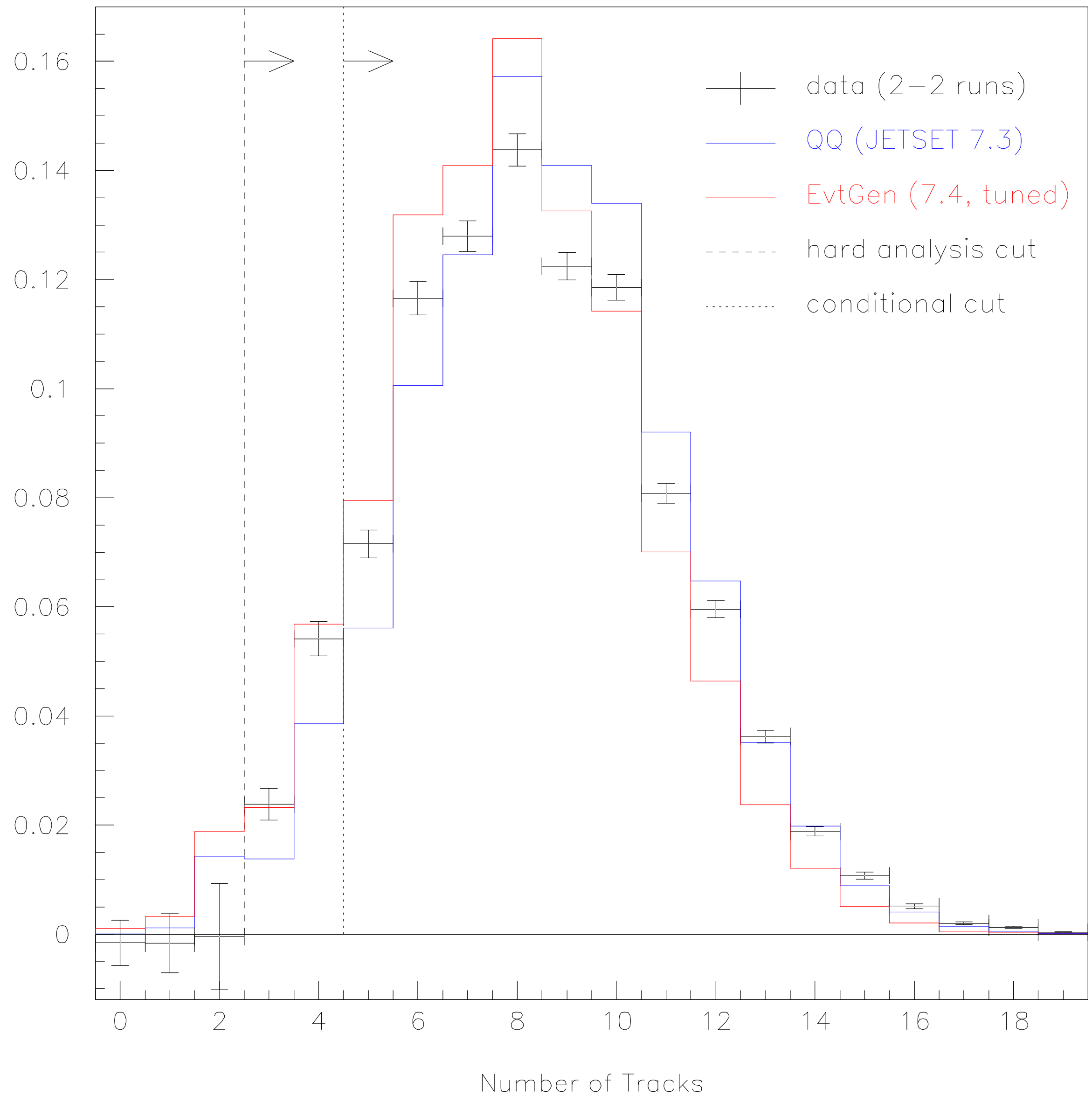
Now I can finally show you the data/MC disagreement

Continuum-subtracted $\Upsilon(2S)$ with efficiency cuts



Now I can finally show you the data/MC disagreement

EvtGen improves low multiplicity agreement

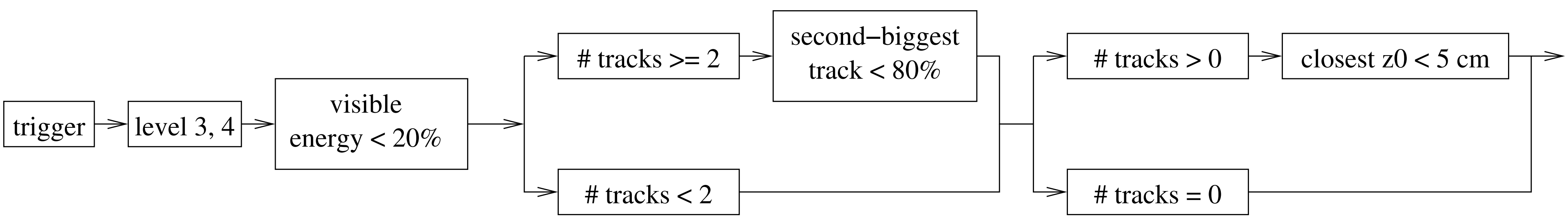


Maybe I can use the raw data to measure efficiency

Events that pass the efficiency cut and continuum subtraction are almost all Υ events. (Beamgas/wall/cosmic are controlled just as they were for the background study).

In fact, they are almost all one kind of Υ decay:

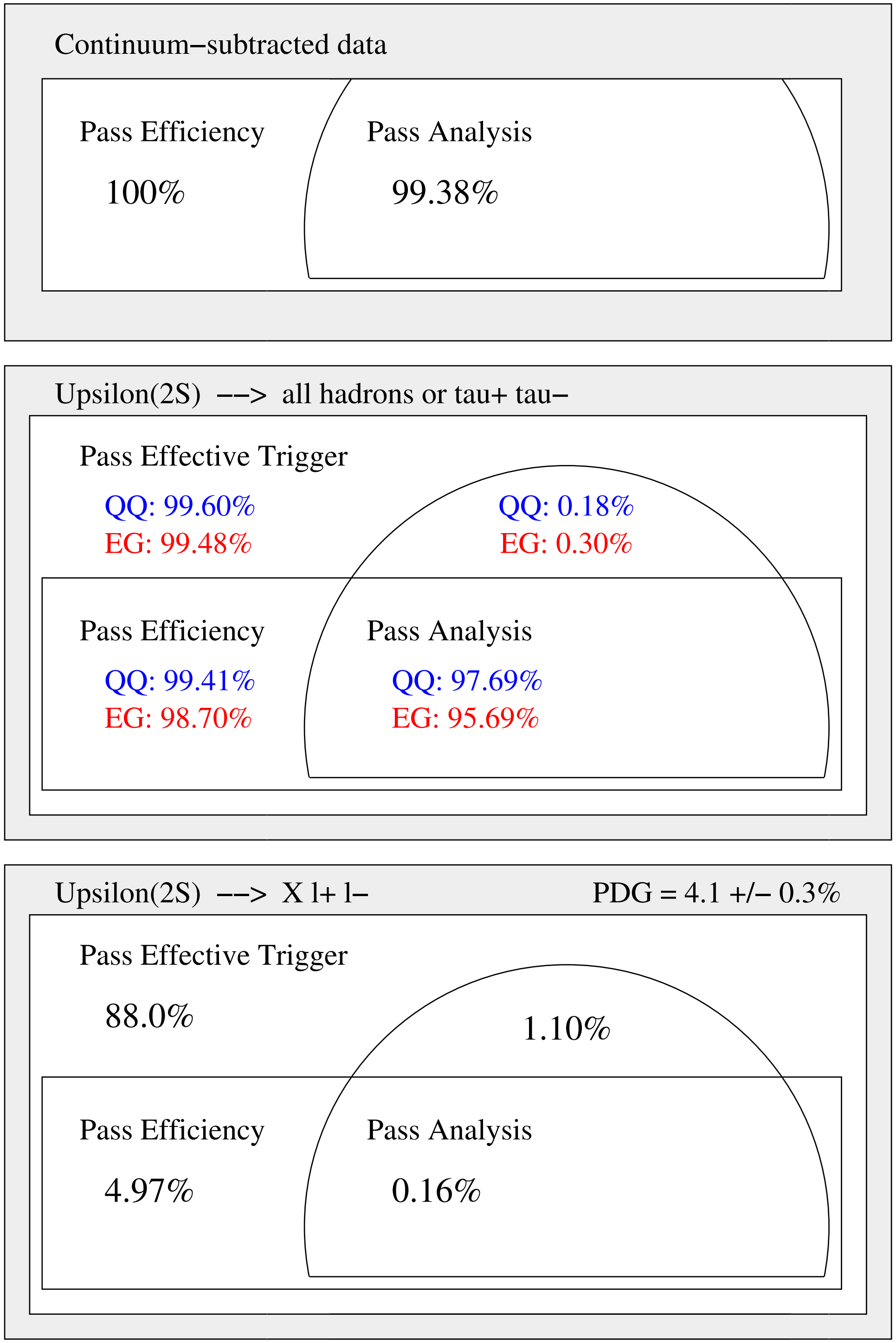
Class of decays	Fraction that pass efficiency cut
$\Upsilon \to$ all hadrons or $\tau^+\tau^-$	99%
$\Upsilon \to \ldots \to X\ell^+\ell^-$	5%



Decay Mode	Branching Ratio	Uncertainty
$\Upsilon(1S) \to e^+e^-$	0.0251	0.00050
$\Upsilon(1S) \to \mu^+\mu^-$	0.0251	0.00050
$\Upsilon(1S) \to \ldots \to X\ell^+\ell^-$	0.0502	0.0010

Decay Mode	Branching Ratio	Uncertainty
$\Upsilon(2S) \to e^+e^-$	0.0125	0.0014
$\Upsilon(2S) \to \mu^+\mu^-$	0.0125	0.0014
$\Upsilon(2S) \to \pi^+\pi^-\Upsilon(1S) \to e^+e^-$	0.00472	0.00018
$\Upsilon(2S) \to \pi^+\pi^-\Upsilon(1S) \to \mu^+\mu^-$	0.00472	0.00018
$\Upsilon(2S) \to \pi^0\pi^0\Upsilon(1S) \to e^+e^-$	0.00226	0.00020
$\Upsilon(2S) \to \pi^0\pi^0\Upsilon(1S) \to \mu^+\mu^-$	0.00226	0.00020
$\Upsilon(2S) \to \gamma\chi_{b0}(1P) \to \gamma\Upsilon(1S) \to e^+e^-$	0.0000573	8.6×10^{-6}
$\Upsilon(2S) \to \gamma\chi_{b0}(1P) \to \gamma\Upsilon(1S) \to \mu^+\mu^-$	0.0000573	8.6×10^{-6}
$\Upsilon(2S) \to \gamma\chi_{b1}(1P) \to \gamma\Upsilon(1S) \to e^+e^-$	0.000598	0.00015
$\Upsilon(2S) \to \gamma\chi_{b1}(1P) \to \gamma\Upsilon(1S) \to \mu^+\mu^-$	0.000598	0.00015
$\Upsilon(2S) \to \gamma\chi_{b2}(1P) \to \gamma\Upsilon(1S) \to e^+e^-$	0.000387	0.000078
$\Upsilon(2S) \to \gamma\chi_{b2}(1P) \to \gamma\Upsilon(1S) \to \mu^+\mu^-$	0.000387	0.000078
$\Upsilon(2S) \to \ldots \to X\ell^+\ell^-$	0.0410	0.0030

Decay Mode	Branching Ratio	Uncertainty
$\Upsilon(3S) \to e^+e^-$	0.0181	0.0017
$\Upsilon(3S) \to \mu^+\mu^-$	0.0181	0.0017
$\Upsilon(3S) \to \pi^+\pi^-\Upsilon(1S) \to e^+e^-$	0.00113	0.000058
$\Upsilon(3S) \to \pi^+\pi^-\Upsilon(1S) \to \mu^+\mu^-$	0.00113	0.000058
(68 more...)	$\ddots$	$\ddots$
$\Upsilon(3S) \to \ldots \to X\ell^+\ell^-$	0.0444	0.0034



$$\text{uncorrected efficiency} = \frac{\text{data “Pass Analysis”}}{\text{data “Pass Efficiency”}}$$

Uncertainties:

- 0.66% counting statistics
- 5.0% from int. luminosity *statistical error*

Numerator (multiplicative) corrections:

$$(1 - \text{PDG})\,0.18\% + (\text{PDG})\,1.10\%, \text{ or}$$

$$(1 - \text{PDG})\,0.30\% + (\text{PDG})\,1.10\%$$

Denominator (multiplicative) corrections:

$$(1 - \text{PDG})\,99.60\% + (\text{PDG})\,4.97\%, \text{ or}$$

$$(1 - \text{PDG})\,99.48\% + (\text{PDG})\,4.97\%$$

Uncertainties:

- Numerator uncertainties are negligible
- 0.28% from PDG branching fraction
- 0.34% from choice of MC generator

$$\boxed{\begin{array}{c}\pm 5.0\% \text{ statistical } \pm 0.44\% \text{ systematic} \\ \pm \text{ small background contribution}\end{array}}$$

Why am I not giving you a number? (Conclusions Slide)

1. The 5% uncertainty contribution from int. luminosity statistics

   The int. luminosity fraction between peak and continuum is known to ±1.6% (in this sample), but appears between large numbers:

   $$\frac{\text{“Pass Analysis”}_{\text{peak}} - \text{“Pass Analysis”}_{\text{continuum}} \times (\text{int. luminosity fraction})}{\text{“Pass Efficiency”}_{\text{peak}} - \text{“Pass Efficiency”}_{\text{continuum}} \times (\text{int. luminosity fraction})}$$

   If int. luminosity fraction is known to ±0.16%, it would have a 0.5% impact on the final result.

   This uncertainty can be minimized by adding more data *and* by optimizing the $e^+e^- \to \gamma\gamma$ cuts. For this sub-analysis, an energy-indepdendent systematic error in the int. luminosity measurement doesn't matter.

2. I need to look at single-beam runs again to quantify the impact of beamgas, beamwall, and cosmic rays.

3. I'm not certain I understand what defines a failed trigger.