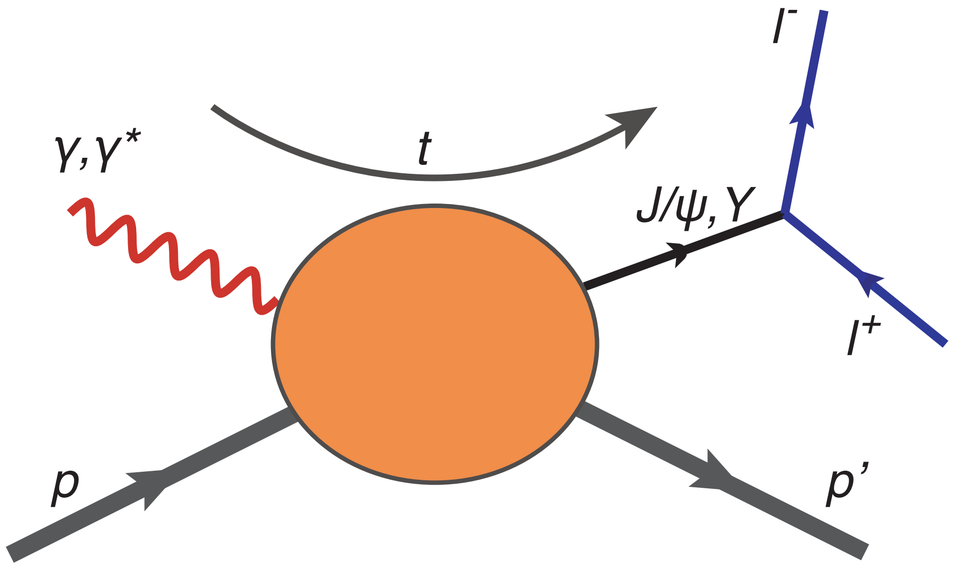
VM PRODUCTION: ELECTRONS AND MUONS



SYLVESTER JOOSTEN
sjoosten@anl.gov

This work is supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under contract DE-AC02-06CH11357.

EICUG Yellow Report
Pavia Meeting, May 20-22, 2020

J/PSI STUDIES WITH HANDBOOK DETECTOR

(relevant parameters in a nutshell)

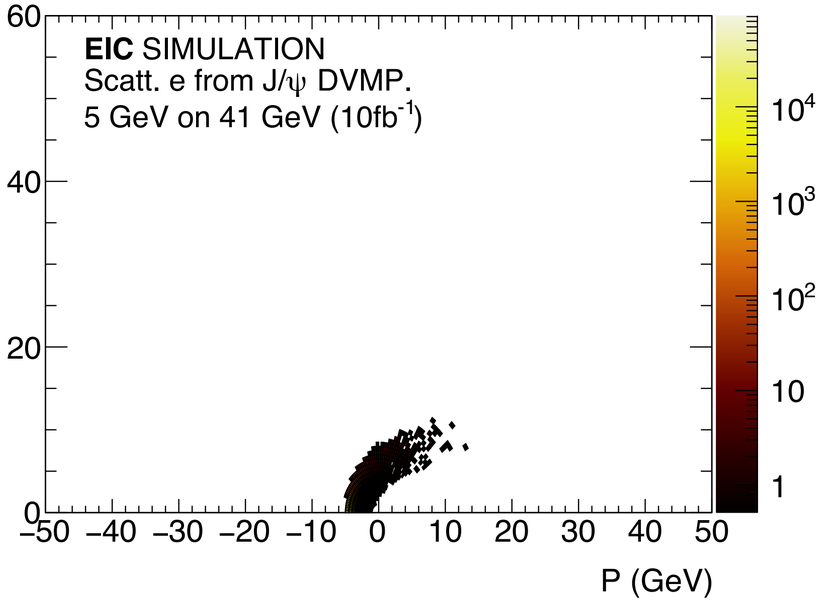
EIC Detector Requirements

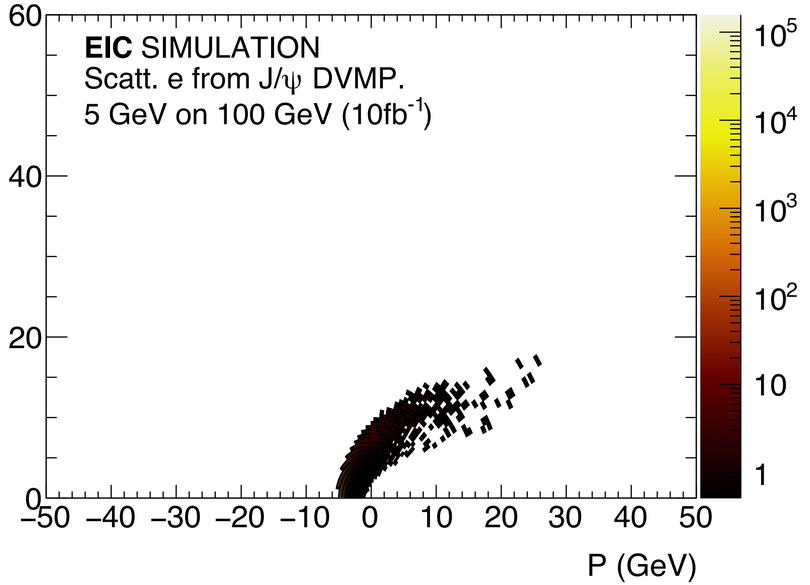
η	Nomenclature			Tracking			Electrons		π/K/p PID		HCAL	Muons
				Resolution	Allowed X/X$_0$	Si-Vertex	Resolution σ_E/E	PID	p-Range (GeV/c)	Separation	Resolution σ_E/E	
-6.9 — -5.8	↓ p/A	Auxiliary Detectors	low-Q^2 tagger	$\delta\theta/\theta < 1.5\%$; $10^{-6} < Q^2 < 10^{-2}$ GeV^2								
…												
-4.5 — -4.0			Instrumentation to separate charged particles from photons									
-4.0 — -3.5												
-3.5 — -3.0		Central Detector	Backwards Detectors	$\sigma_p/p \sim 0.1\% \times p + 2.0\%$	~5% or less	TBD	2%/√E	π suppression up to 1:10^4	≤ 7 GeV/c	≥ 3σ	~50%/√E	
-3.0 — -2.5												
-2.5 — -2.0												
-2.0 — -1.5				$\sigma_p/p \sim 0.05\% \times p + 1.0\%$			7%/√E					
-1.5 — -1.0												
-1.0 — -0.5			Barrel	$\sigma_p/p \sim 0.05\% \times p + 0.5\%$		$\sigma_{xyz} \sim 20$ μm, $d_0(z) \sim d_0(r\Phi) \sim 20/p_T$ GeV μm + 5 μm	(10-12)%/√E		≤ 5 GeV/c		TBD	TBD
-0.5 — 0.0												
0.0 — 0.5												
0.5 — 1.0												
1.0 — 1.5			Forward Detectors	$\sigma_p/p \sim 0.05\% \times p + 1.0\%$		TBD			≤ 8 GeV/c		~50%/√E	
1.5 — 2.0												
2.0 — 2.5									≤ 20 GeV/c			
2.5 — 3.0				$\sigma_p/p \sim 0.1\% \times p + 2.0\%$								
3.0 — 3.5									≤ 45 GeV/c			
3.5 — 4.0	↑e	Auxiliary Detectors	Instrumentation to separate charged particles from photons									
4.0 — 4.5												
…												
> 6.2			Proton Spectrometer	$\sigma_{intrinsic}(l\delta)/ltl < 1\%$; Acceptance: $0.2 < p_T < 1.2$ GeV/c								

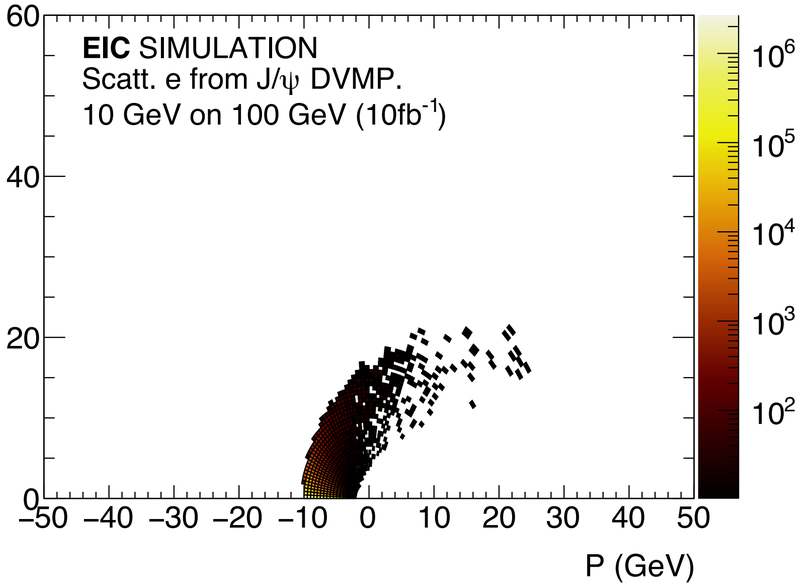
- Electron pseudo-rapidity between -4.5 and 4.5
- Muon between -3.5 and 3.5
- Protons above 6.2 (pT between 0.2 and 1.2 GeV)
- Extra cut of 0.01 < y < 0.8
- *Did not yet use low-Q2 tagger in these studies. Relevant for threshold physics.*

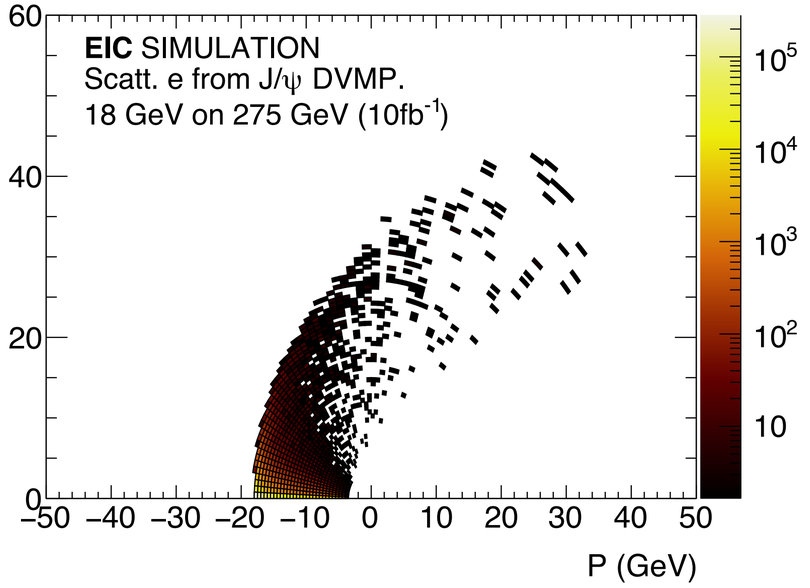
- Considered all 4 beam settings
- Using J/psi production as main DVMP channel

SCATTERED ELECTRON



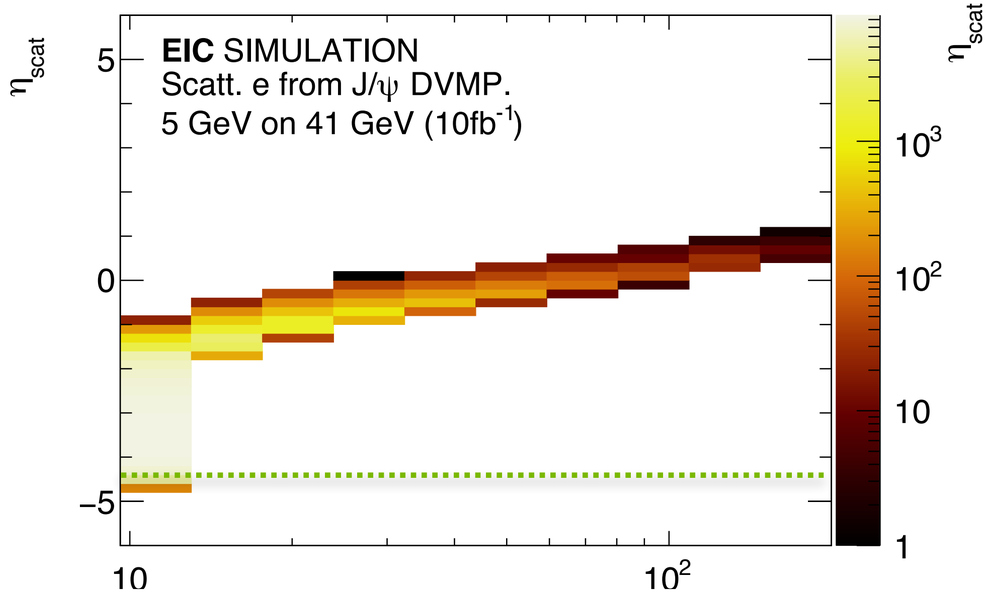


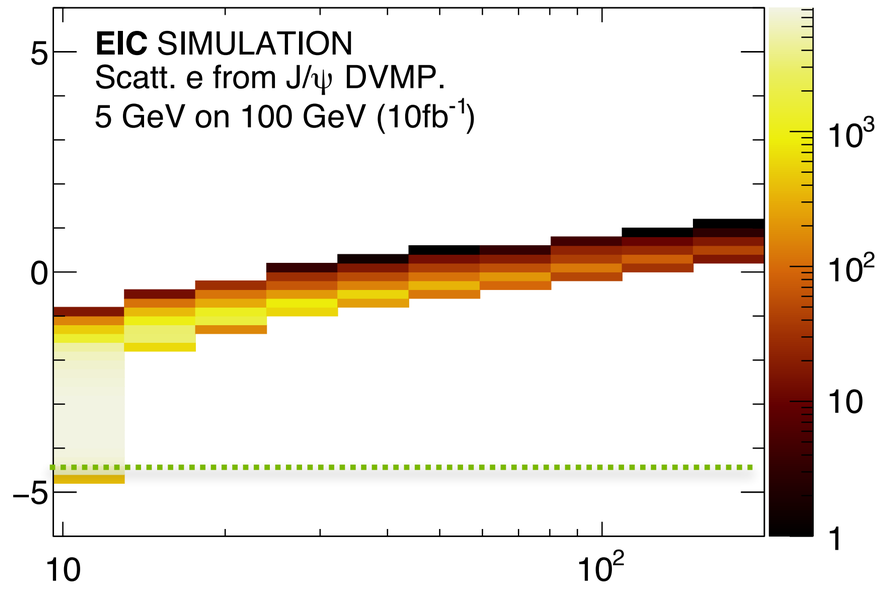


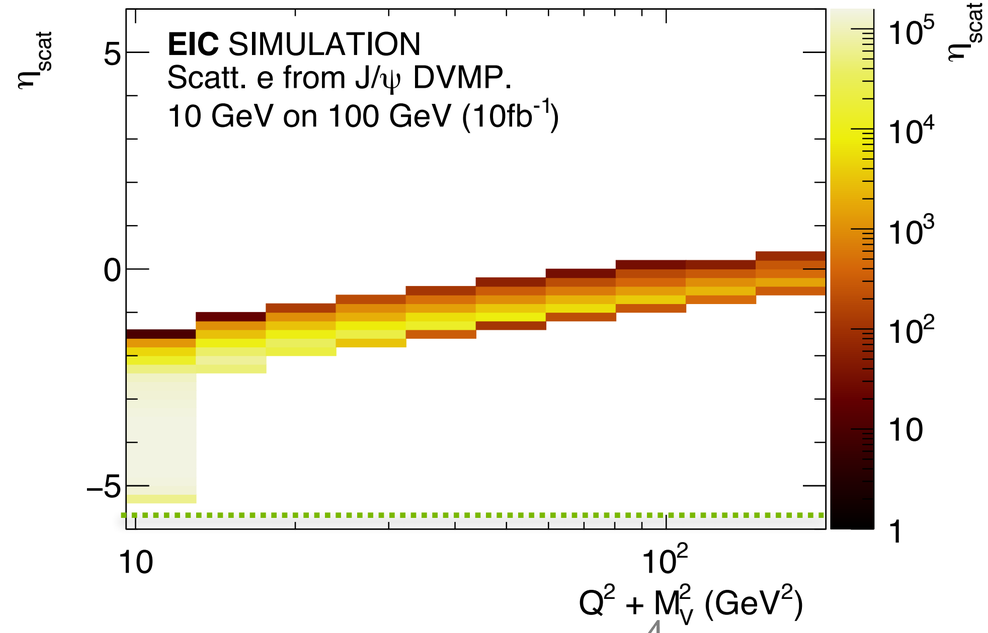


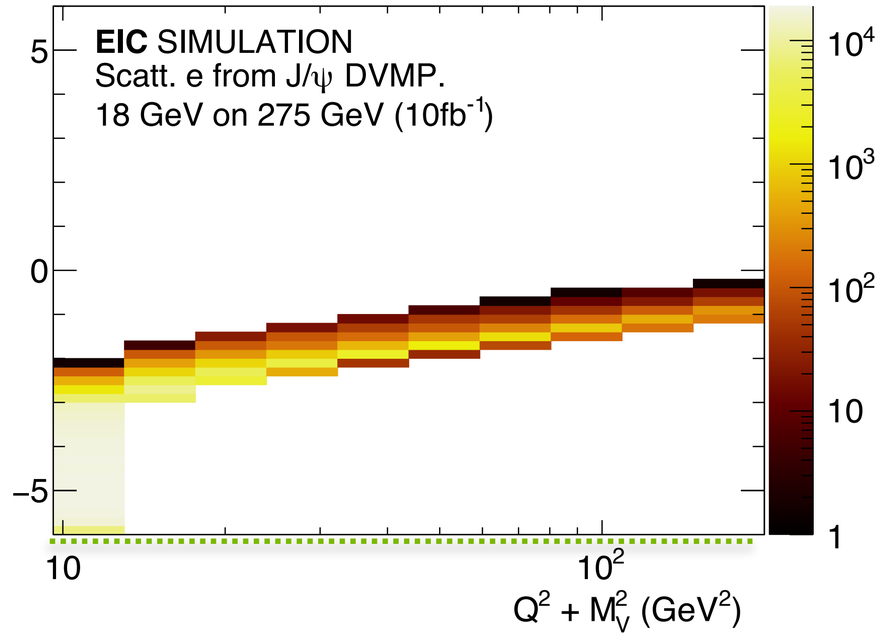
Q2 ACCEPTANCE

- Good acceptance for full Q2 range



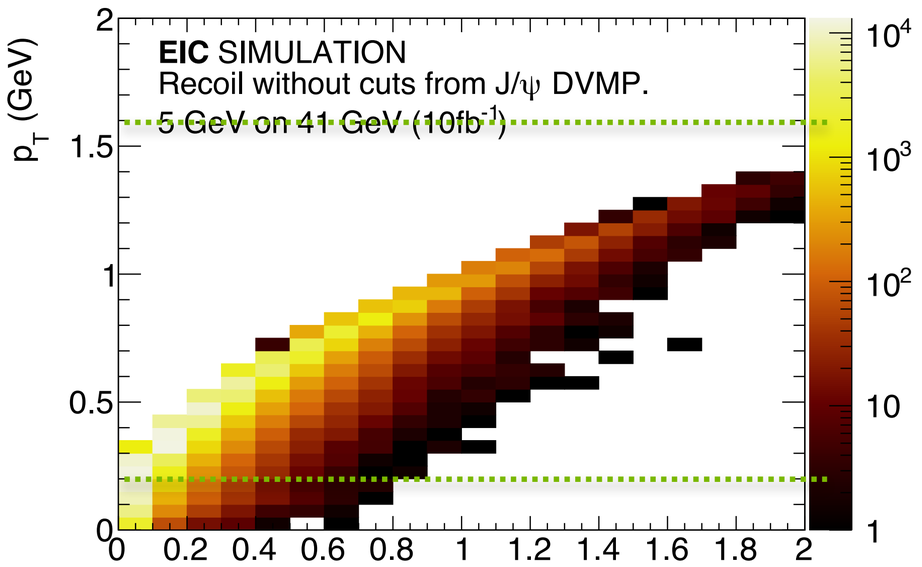


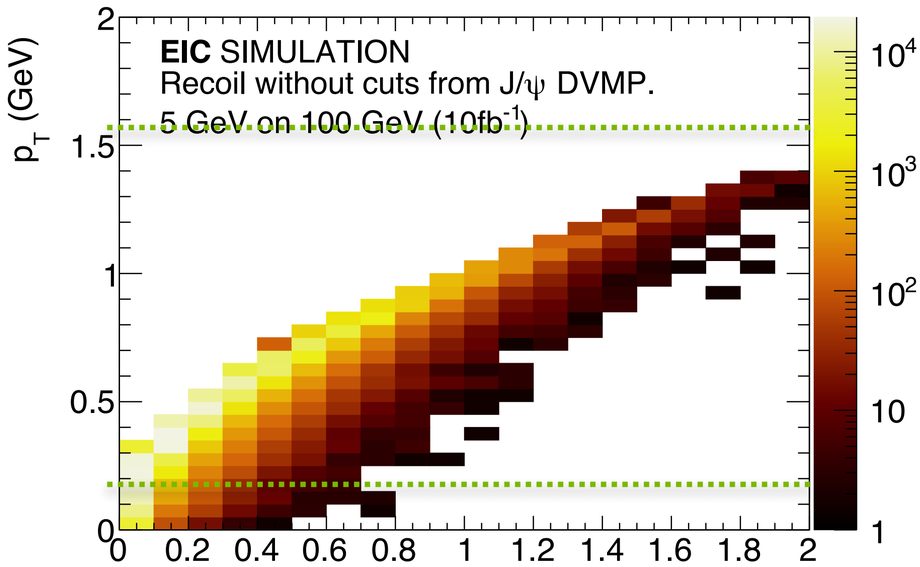


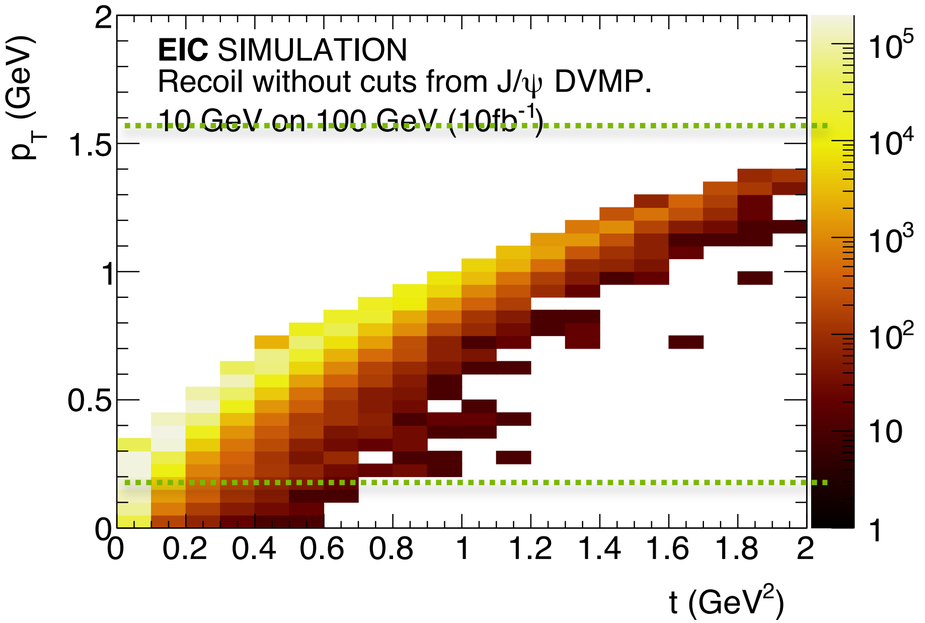


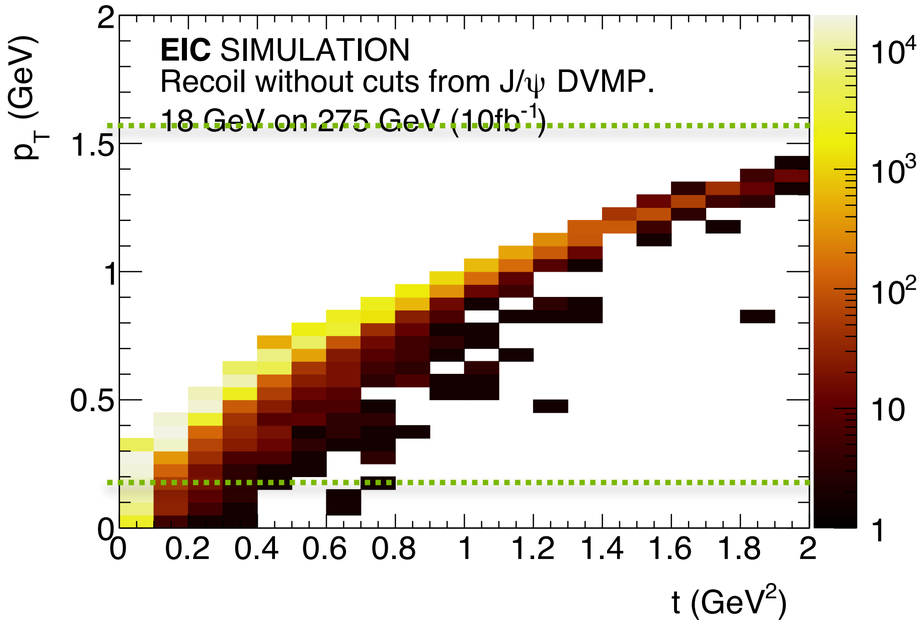
RECOIL PROTON AND t ACCEPTANCE

- Protons with pseudo-rapidity above 6.2 and pT between 0.2 and 1.2 GeV
- pT cut seems reasonable
- Acceptance for full t-range



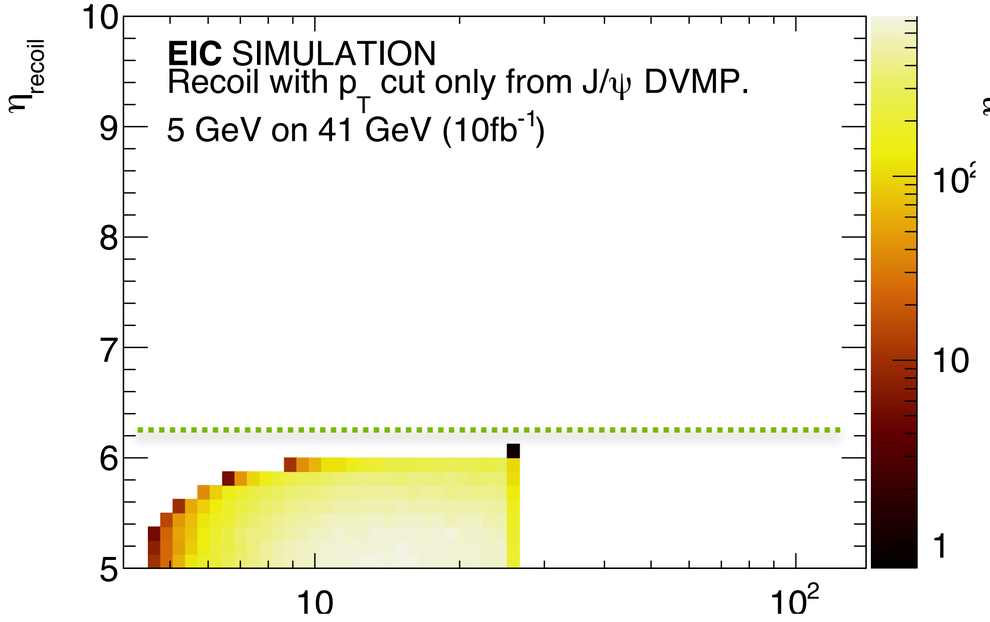


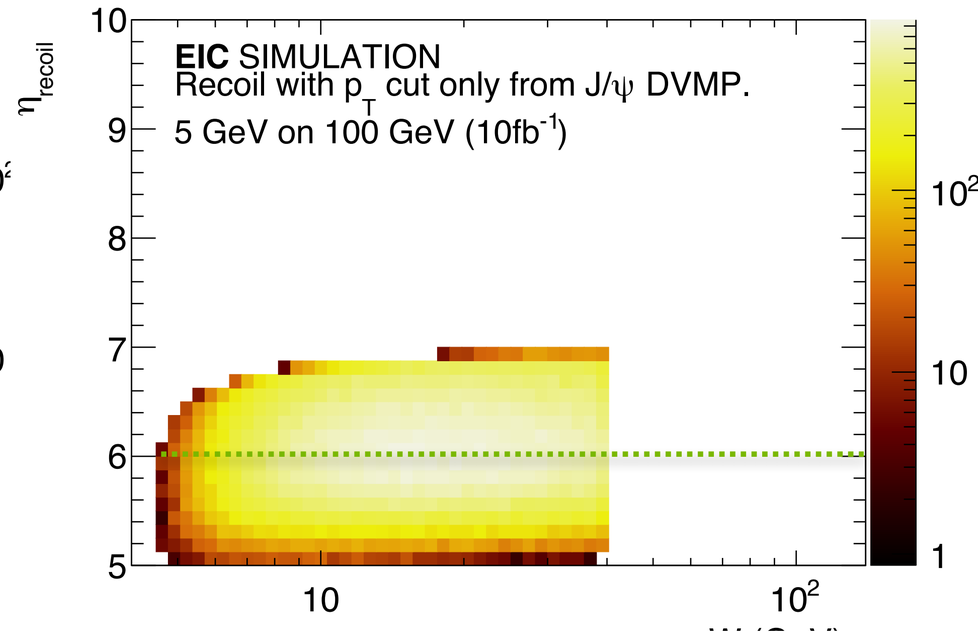


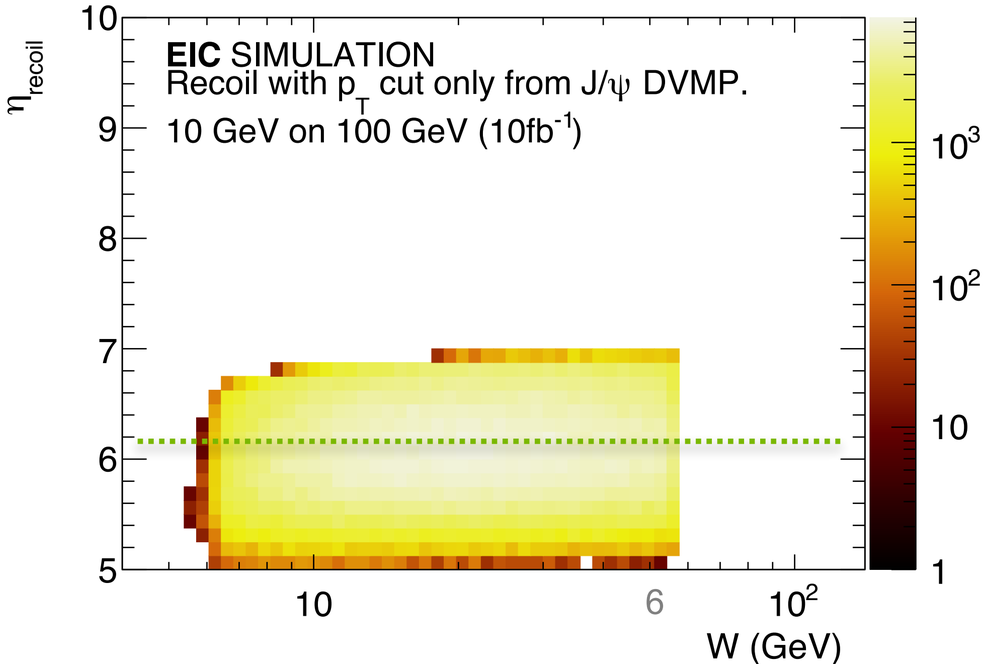


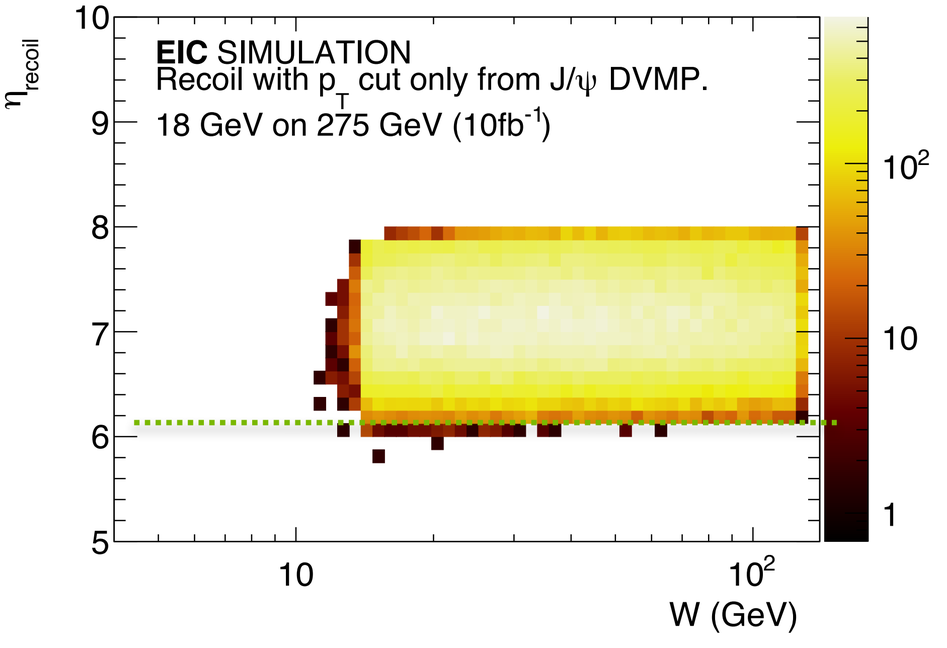
RECOIL PROTON AND W ACCEPTANCE

- Protons with pseudo-rapidity above 6.2 and pT between 0.2 and 1.2 GeV
- Lower proton rapidity cut kills the low-energy setting. Is this realistic?
- J/psi threshold physics difficult.

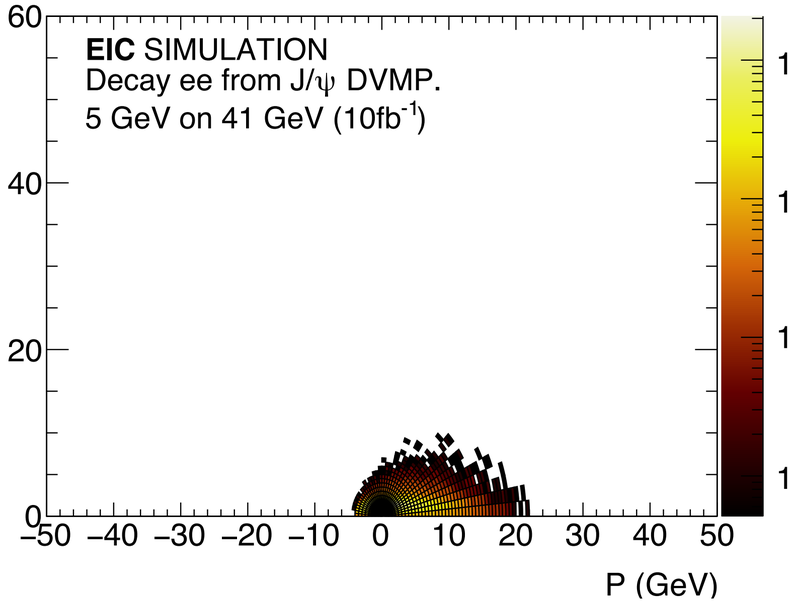


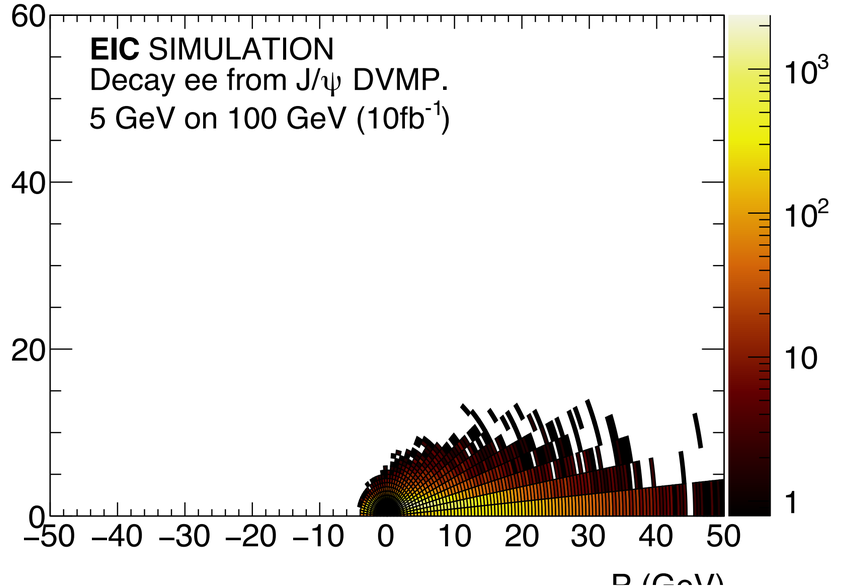


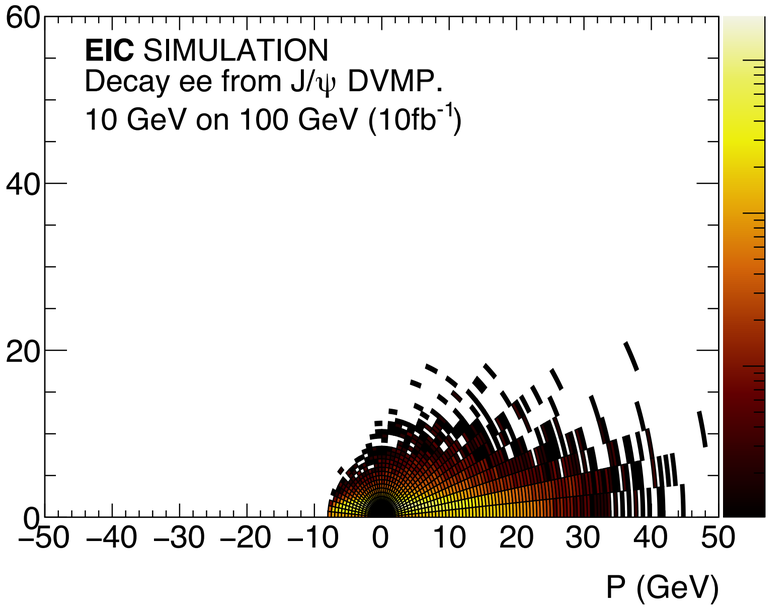


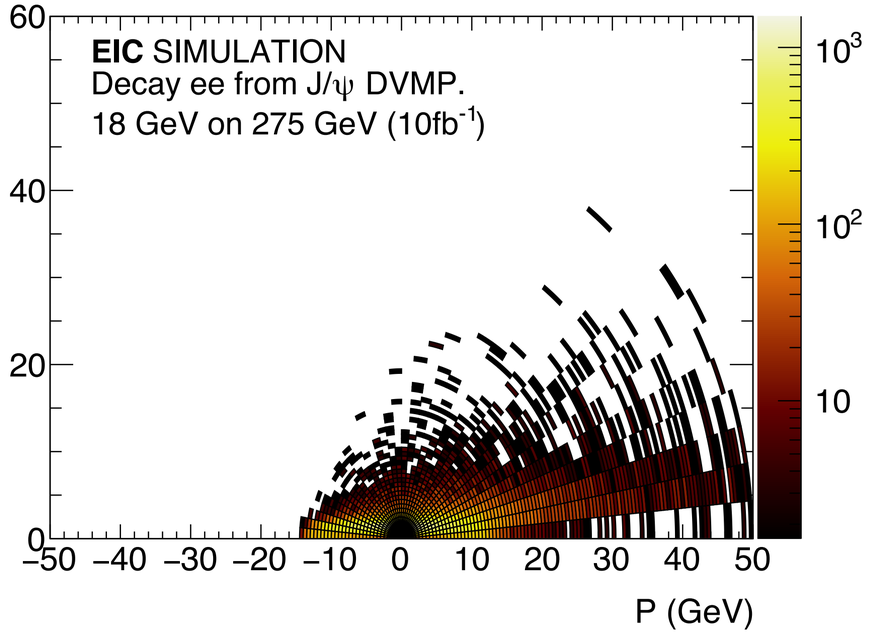


DECAY LEPTON



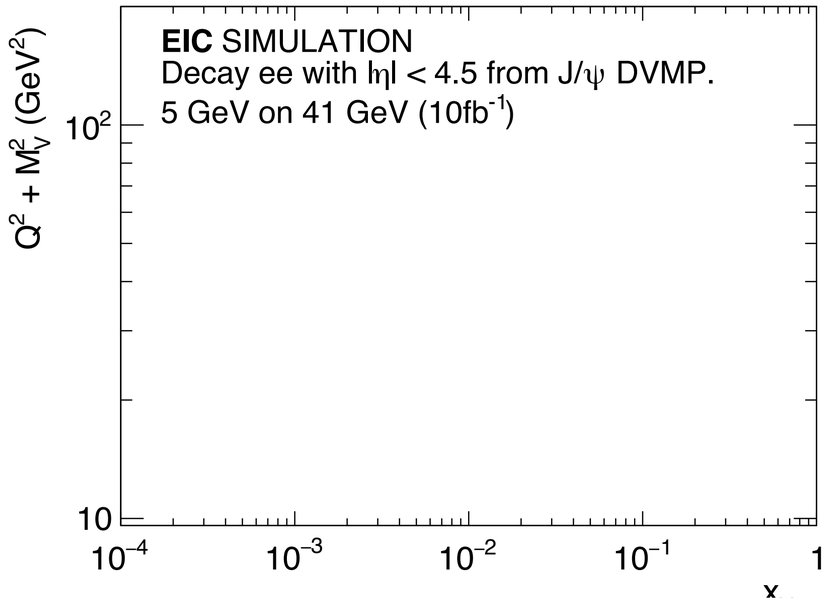


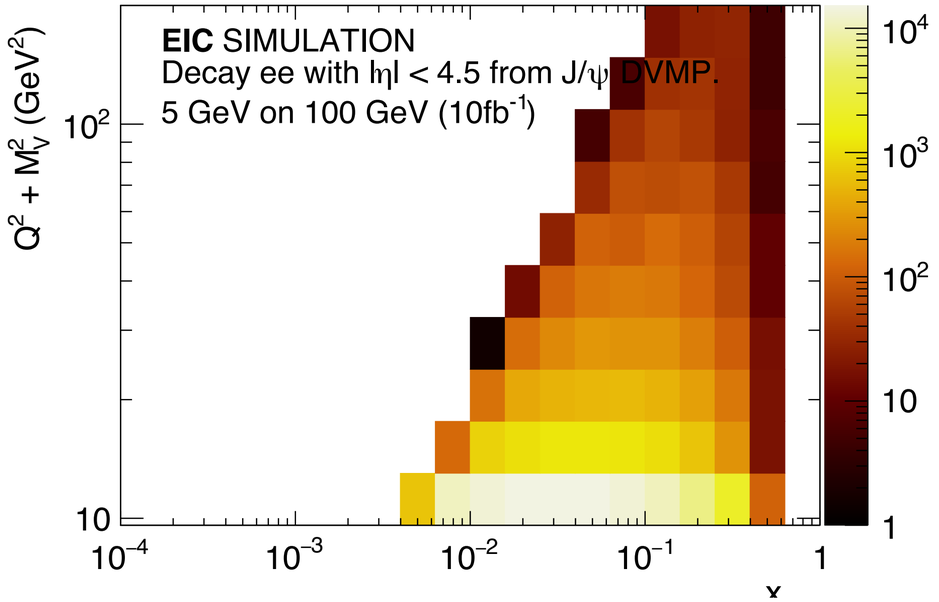


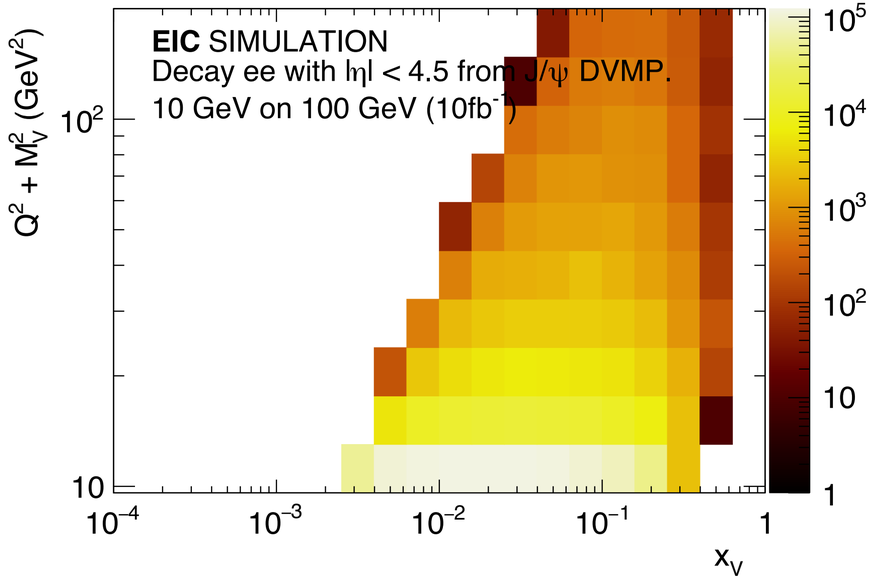


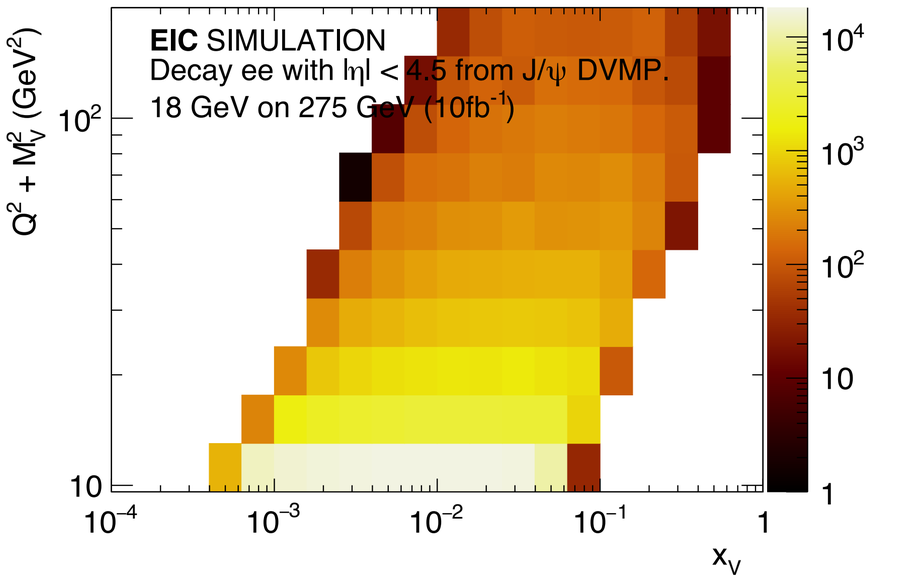
PHASE SPACE COVERAGE

- With current setup no measurement at the lowest energy
- Remaining 3 settings go from valence region to deep into the sea



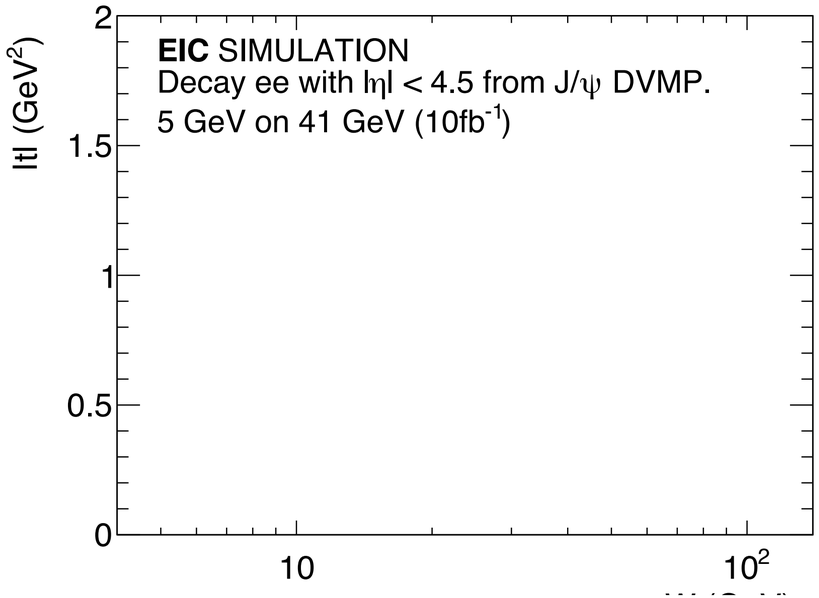


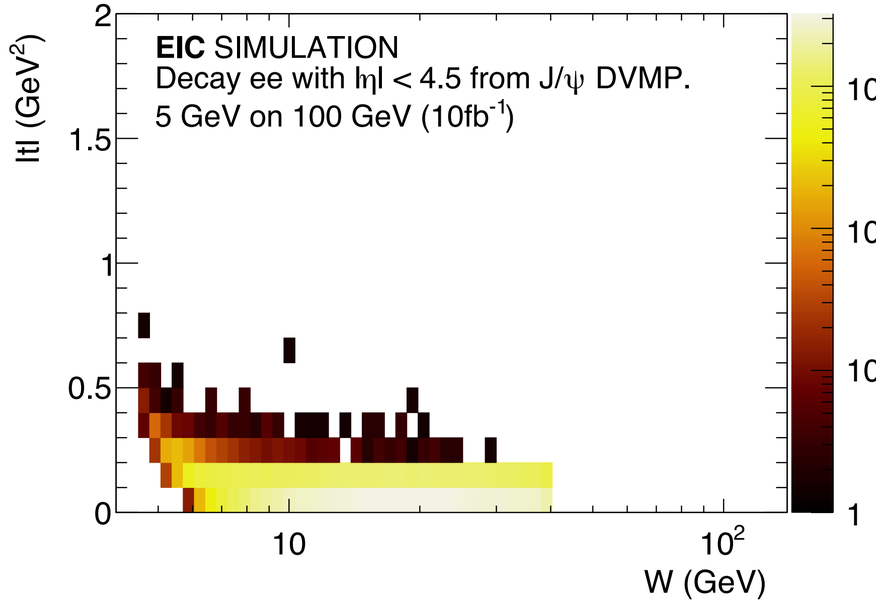


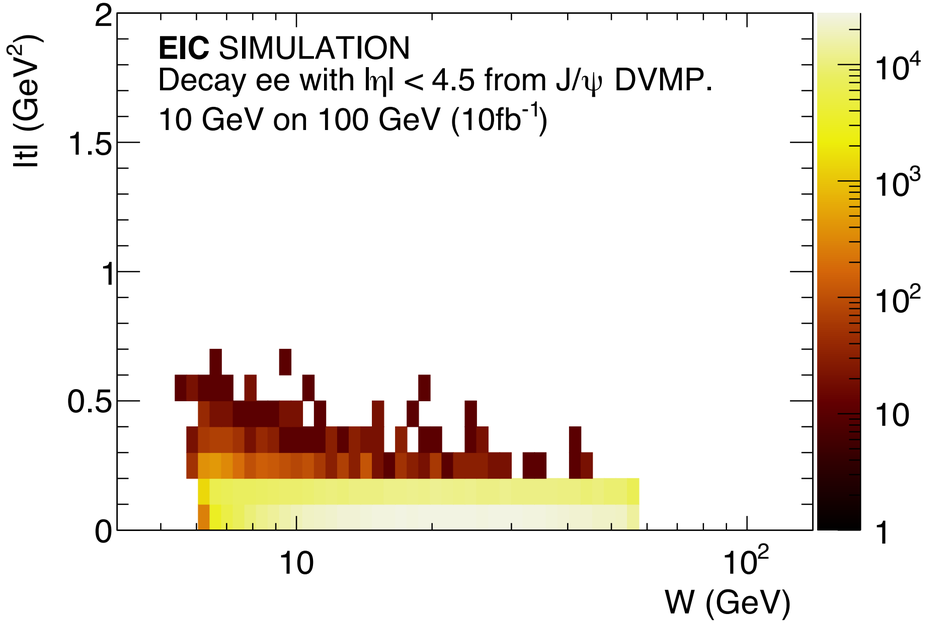


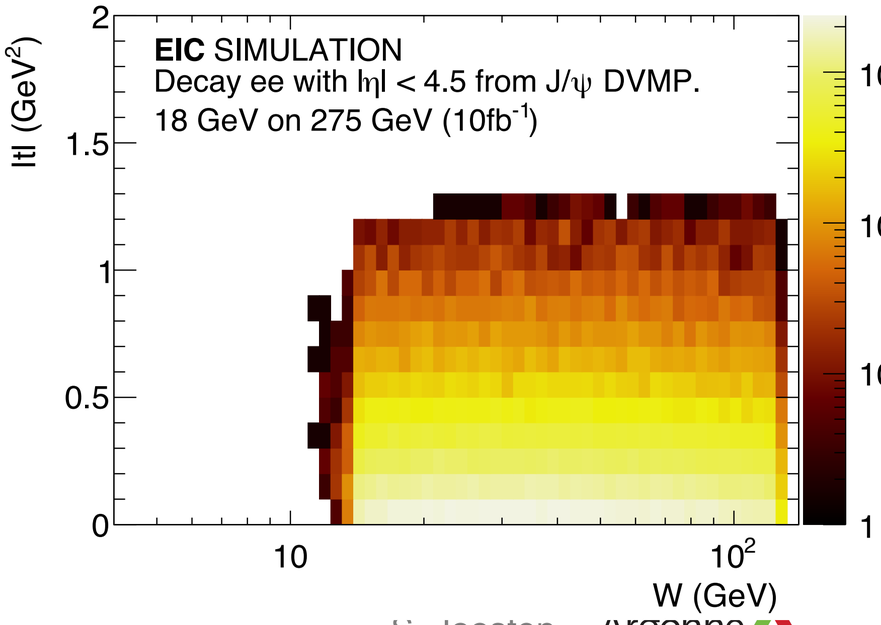
PHASE SPACE COVERAGE 2

- High-t acceptance truncated a lower momentum settings due to lower eta cut
- If this is correct, than this will prevent J/psi threshold physics



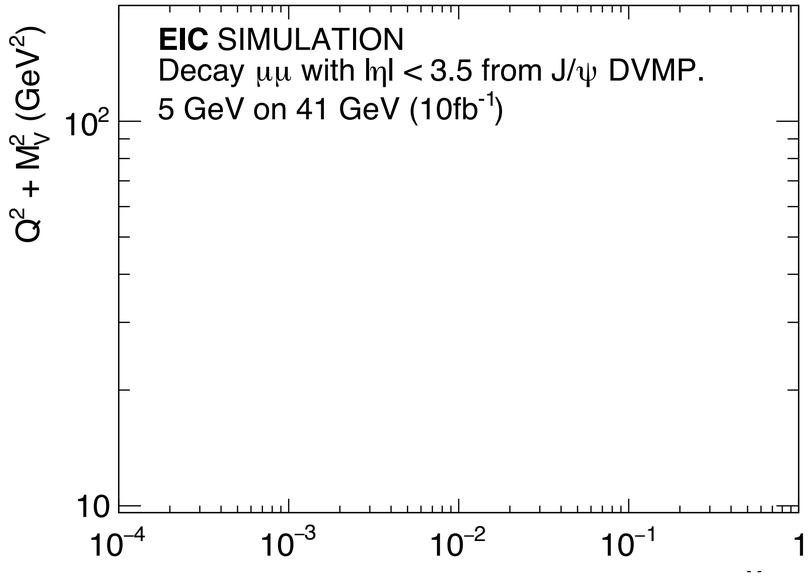


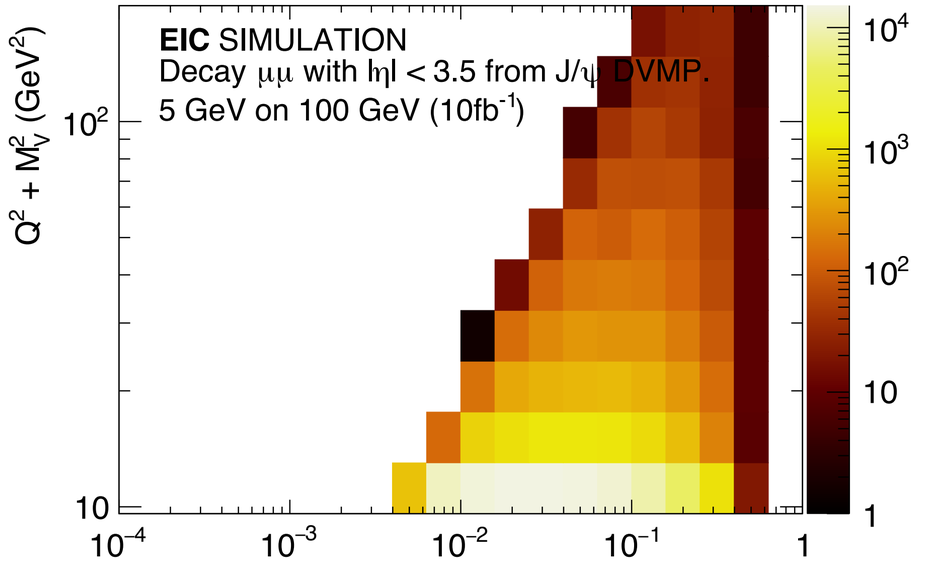


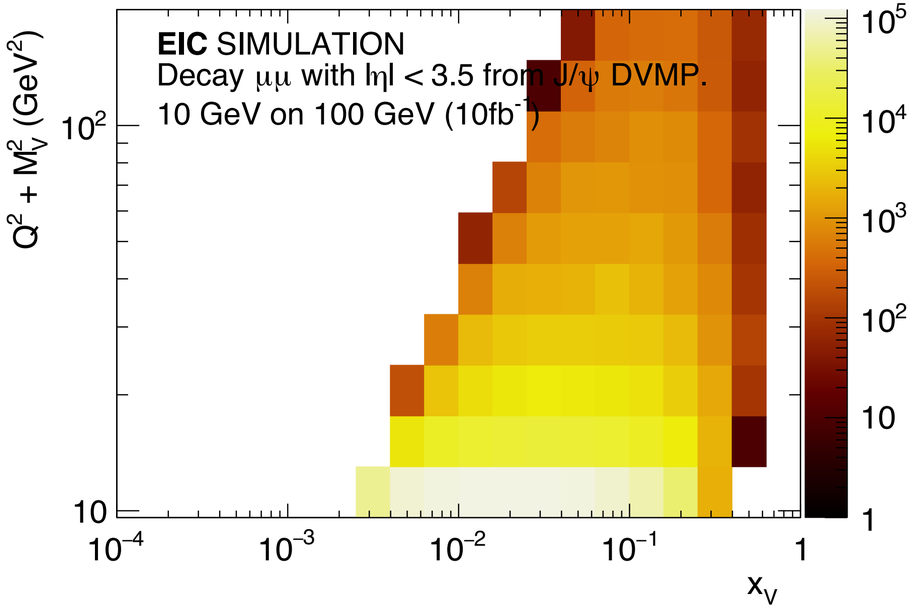


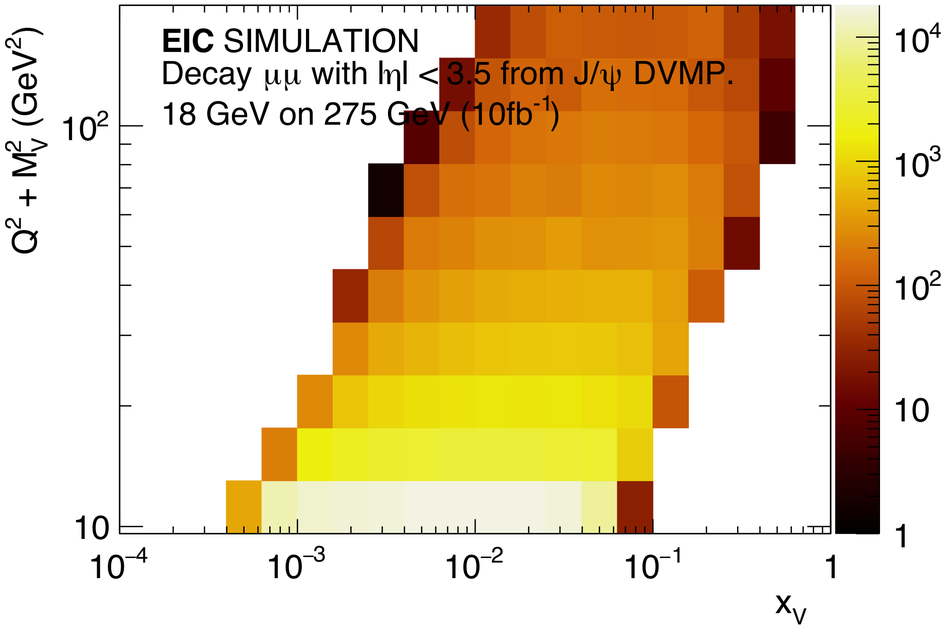
THINGS LOOK FINE FOR MUONS?

- Assume muons can only be measured in tracker (-3.5 < eta < 3.5)
- Only minor drop in statistics, so no extra detectors required



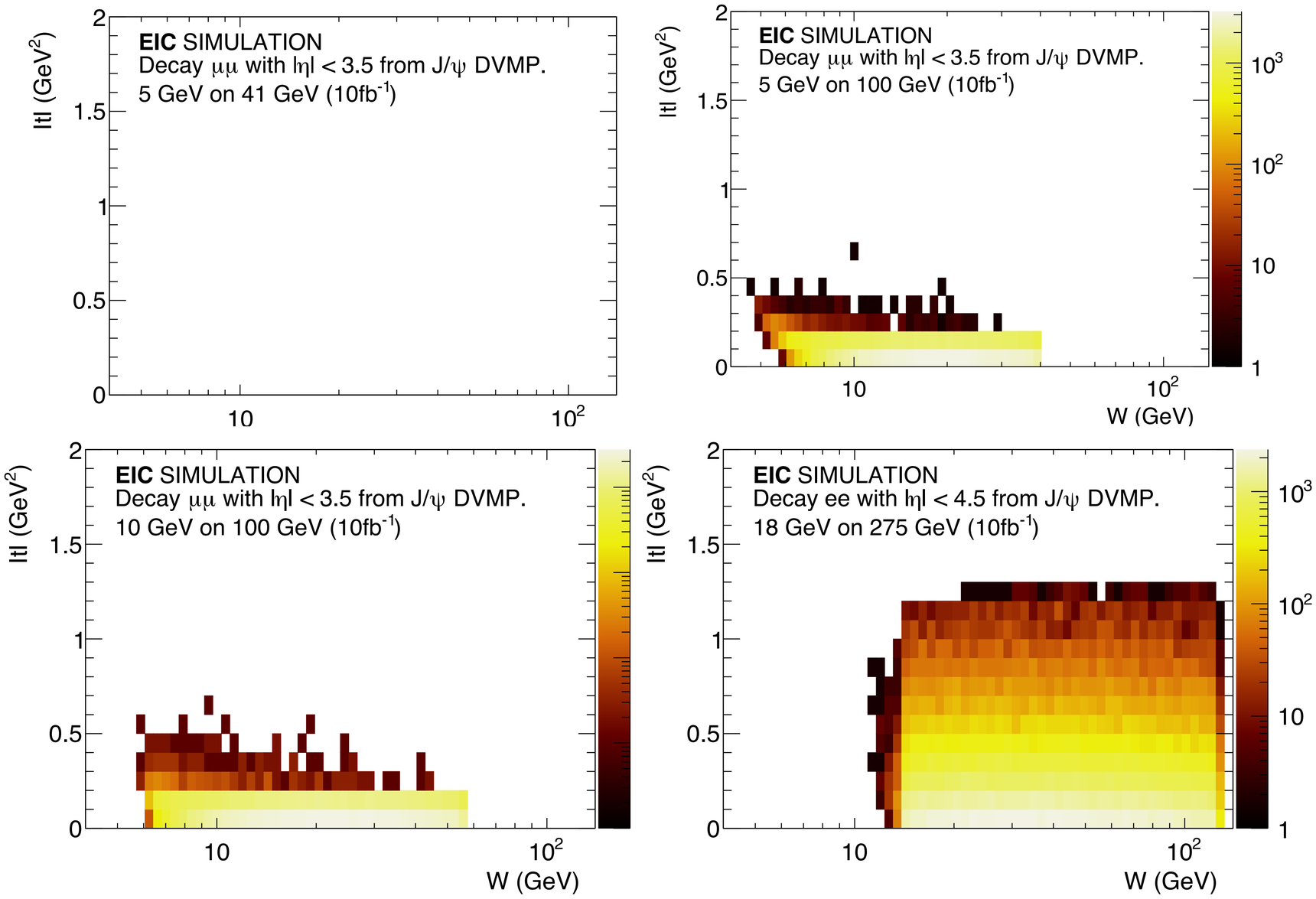






HOWEVER…

- Assume muons can only be measured in tracker (-3.5 < eta < 3.5)
- Less reach towards threshold due, as near threshold the muons go more in the forward direction
- Extra muon detection would certainly help here!



WHAT IS NEXT

- Evaluation of continuum background using GRAPE-dilepton (almost finished)
- More precise evaluation of resolution effects
- Sensitivity of measurement to changes in acceptance?

BRAND NEW WORK ON UPSILON PRODUCTION AT EIC!

https://arxiv.org/abs/2005.09293

Υ photo-production on the proton at the Electron-Ion Collider

Oleksii Gryniuk,[1] Sylvester Joosten,[2] Zein-Eddine Meziani,[2] and Marc Vanderhaeghen[1]

[1] *Institut für Kernphysik & PRISMA$^+$ Cluster of Excellence, Johannes Gutenberg Universität, D-55099 Mainz, Germany*

[2] *Argonne National Laboratory, Lemont, IL 60439, USA*

(Dated: May 20, 2020)

We present a dispersive analysis with the aim to extract the Υ-p scattering length from $\gamma p \to \Upsilon p$ experiments. In this framework, the imaginary part of the Υ-p forward scattering amplitude is obtained from $\gamma p \to \Upsilon p$ cross section measurements, and is constrained at high energies from existing HERA and LHC data. Its real part is calculated through a once-subtracted dispersion relation, and the subtraction constant is proportional to the Υ-p scattering length. We perform a feasibility study for Υ photo-production experiments at an Electron-Ion Collider and discuss the sensitivity and precision that can be reached in the extraction of the Υ-p scattering length.