UNIVERSITY OF BIRMINGHAM | SCHOOL OF PHYSICS AND ASTRONOMY

Plans for inclusive systematics studies

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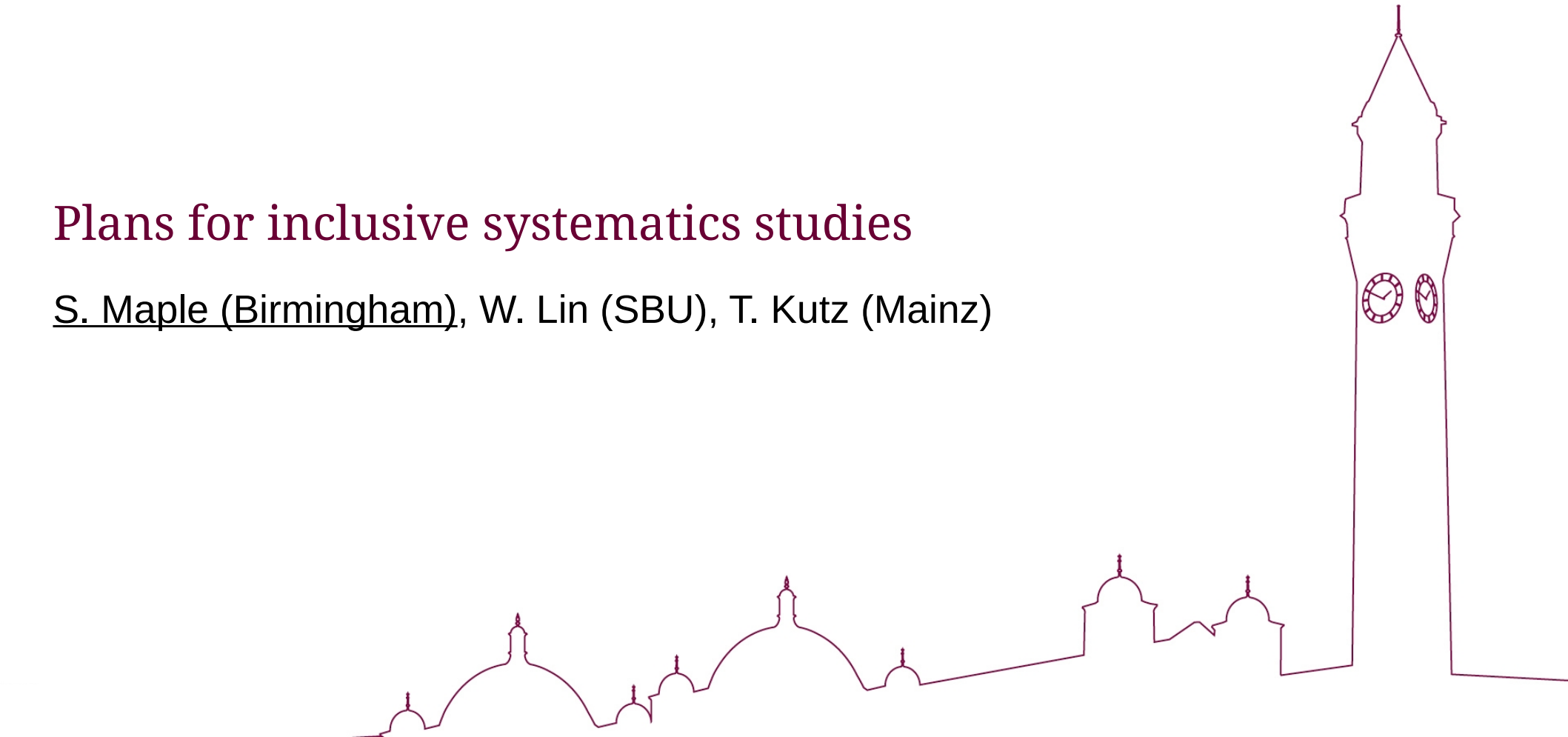

Inclusive Systematics

- Inclusive measurements usually start from the reduced cross section
  - Structure functions for ep/eA: $F_{2,L}$ from xsec and model or Rosenbluth separation, double spin asymmetries from xsec in different beam polarisations
  - Focus on systematics for inclusive NC cross section for now
  - CC to come when we have someone working on the analysis

- Systematics for inclusive cross section measurements in ep were well studied at HERA
  - Where there are no MC studies that can be done to give an informed/justified value for a systematic, we can refer to previous HERA values as (hopefully pessimistic) estimates

What systematics are we concerned with?

- There are many possible sources of systematic uncertainties → just look at H1/ZEUS papers
- Some contribute more than others

- Some of the most impactful ones are:
  - Electron Finding Efficiency
  - Electron Energy scale
  - Electron Polar Angle
  - Hadronic Energy scale
  - Background modelling
  - QED Radiative Corrections

- ...and of course, luminosity/polarisation measurements

Source	Region	Uncertainty
Electron energy scale	$z_{\rm imp} \leq -150\,{\rm cm}$	0.5% unc. $\oplus$ 0.3% corr.
	$-150 < z_{\rm imp} \leq -60\,{\rm cm}$	0.3% unc. $\oplus$ 0.3% corr.
	$-60 < z_{\rm imp} \leq +20\,{\rm cm}$	0.5% unc. $\oplus$ 0.3% corr.
	$+20 < z_{\rm imp} \leq +110\,{\rm cm}$	0.5% unc. $\oplus$ 0.3% corr.
	$z_{\rm imp} > +110\,{\rm cm}$	1.0% unc. $\oplus$ 0.3% corr.
Electron scale linearity	$E'_e < 11\,{\rm GeV}$	0.5%
Hadronic energy scale	LAr & Tracks	1.0% unc. $\oplus$ 0.3% corr.
	SpaCal	5.0% unc. $\oplus$ 0.3% corr.
Polar angle	θ_e	1 mrad corr.
Noise	$y < 0.19$	5% energy not in jets , corr.
	$y > 0.19$	20% corr.
Trigger efficiency	*high y*	$0.3 - 2\%$
	nominal	0.3%
Electron track and vertex efficiency	*high y*	1%
	nominal	$0.2 - 1\%$
Electron charge ID efficiency	*high y*	0.5%
Electron ID efficiency	*high y* $z_{\rm imp} < 20\ (> 20)$ cm	0.5% (1%)
	nominal $z_{\rm imp} < 20\ (> 20)$ cm	0.2% (1%)
Extra background suppression	$E'_e < 10\,{\rm GeV}$	$D_{ele} > 0.80 \pm 0.04$ corr.
High y background subtraction	*high y*	1.03 ± 0.08 corr.
QED radiative corrections	$x < 0.1\,,\ 0.1 \leq x < 0.3\,,\ x \geq 0.3$	0.3% , 1.0%, 2.0%
	high y: $y < 0.8\ (y > 0.8)$	1% (1.5%)
Acceptance corrections	*high y*	0.5%
	nominal	0.2%
Luminosity		4% corr.

https://arxiv.org/abs/1312.4821

Systematic uncertainty	Achieved at H1/ZEUS*	Expected at EIC†	Comments
Electron finder efficiency	0.2-5% (increase w y)	???	E-finder still being developed. Need efficiency benchmarks before uncertainty studies can begin.
Electron energy scale	0.5-1.9% (increase w y) (1-5% on σ)	???	ElCrecon defaults to tracks for electron “energy” → Work on combining track+calo info for e^- recon, and study energy scale unc (input from calo groups?)
Electron polar angle	1mrad	???	Input needed from tracking group on precision that modern alignment techniques offer
Hadronic energy scale	2% (0.5-4% on σ)	???	Input from calo groups needed?
Photoproduction background	10% (0.5-3% on σ)	2% on σ	Need generated photoproduction-only/merged events that use multiple event generators
QED radiative corrections	0.3-2% (increase w x,y)	1%	Need simulations with QED ISR/FSR switched on. Djangoh can be used, likely Pythia too
Luminosity	1.5%	1%	Is 1% still reasonable?
Polarisation	N/A	<1% ?	Is 1% still reasonable?

* choosing the better of the values in previous publications from H1, ZEUS

† numbers from YR

Systematic uncertainty	Achieved at H1/ZEUS*	Expected at EIC†	Possible studies
Electron finder efficiency	0.2-5% (increase w y)	???	Tighten and relax cuts used in e-finding → study variation in efficiency
Electron energy scale	0.5-1.9% (increase w y) (1-5% on σ)	???	Take single value estimate inspired by HERA?
Electron polar angle	1mrad	???	Take single value estimate inspired by HERA?
Hadronic energy scale	2% (0.5-4% on σ)	???	Take single value estimate inspired by HERA?
Photoproduction background	10% (0.5-3% on σ)	2% on σ	Compare number of events produced by different generators that are reconstructed as DIS
QED radiative corrections	0.3-2% (increase w x,y)	1%	Compare size of radiative correction in bins with two different event generators
Luminosity	1.5%	1%	Use 1%?
Polarisation	N/A	<1% ?	Use 1%?

* choosing the better of the values in previous publications from H1, ZEUS

† numbers from YR

Plan moving forward

- Some work already started: see inclusive meeting from June 17th

- Analysers with relatively complete analyses are to repeat their analyses with the estimated fluctuations in the systematic uncertainties and investigate the variations in the measured quantities.

Results

- After repeating the same analysis procedure (same acceptance and BCC), compare result to original analysis
- Note: at fixed x, lower Q^2 = lower y
- Systematics can be addressed in different ways
  - E scale uncertainty? DA method
  - Extend/merge bins in x/Q^2

Very preliminary