Extraction Line Polarimeter Studies

ECFA/DESY Linear Collider Workshop

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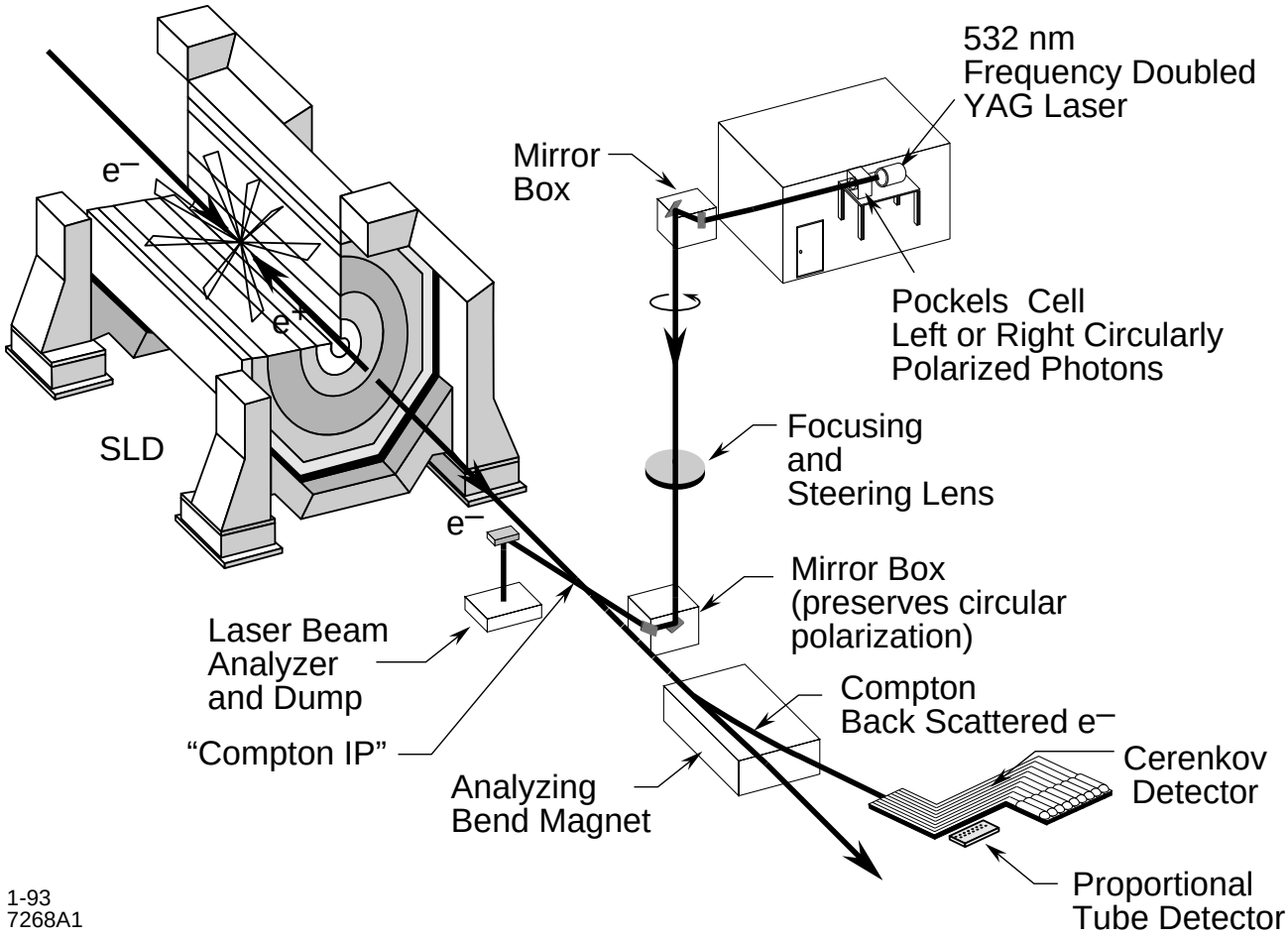
⇛ Don’t focus too much on the details...

`http://www.slac.stanford.edu/~torrence/ipbi/`

X-Line polarimetry



Historical preference for downstream polarimeter

NLC design specifies polarimeter
at downstream chicane

Is there a good reason why?

Luminosity Weighting

Fundamental Problem

$$\langle P \rangle_{lum} \; != \; P_{beam}$$

Collision-related

- Sokoloff-Ternov spin flips
- BMT spin precession

⇛ Due to large fields seen in collision process

Spin transport

$$\gamma \frac{(g-2)}{2} = \frac{E(GeV)}{0.441}$$

At 250 GeV, 50 μRad bend ⇛ 28 mRad spin

Significant change to spin vector
99% ⇛ 98.6%

- Spin orientation
- Spin diffusion (dispersion)

Equally important before/after IP
Collision-related can only be studied post-IP

Why Downstream

Effects equally important before/after IP

Only way to verify/validate
collision-based depolarization (in/out)

Can (potentially) study correlations
of polarization with energy and dL/dE

⇛ But will it work?

Can always run out-of-collision
(pulse stealing) for background reasons

Tools Needed

- GuineaPig (or similar) with spin vectors + some physics
- Liar (or similar) with spin transport

Tools Available

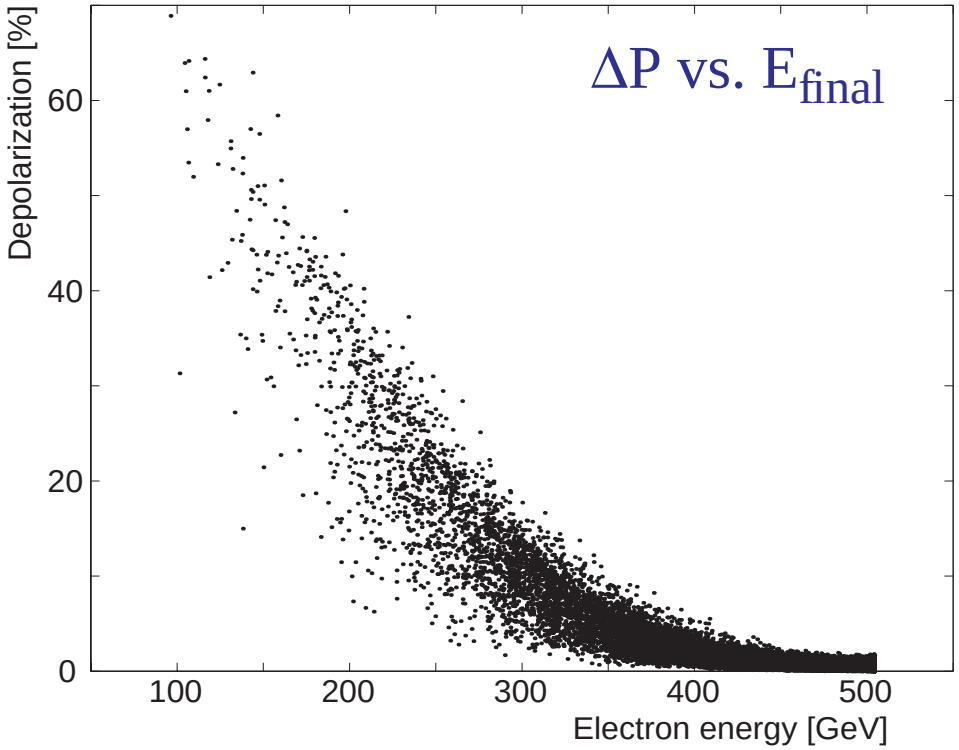
- Cain
- Yokoya-Chen semi-analytic calculation

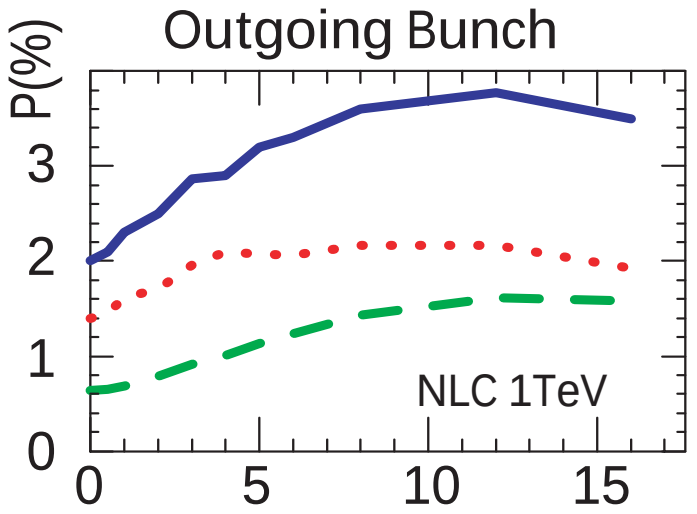
⇛ K. Thompson study (2001)

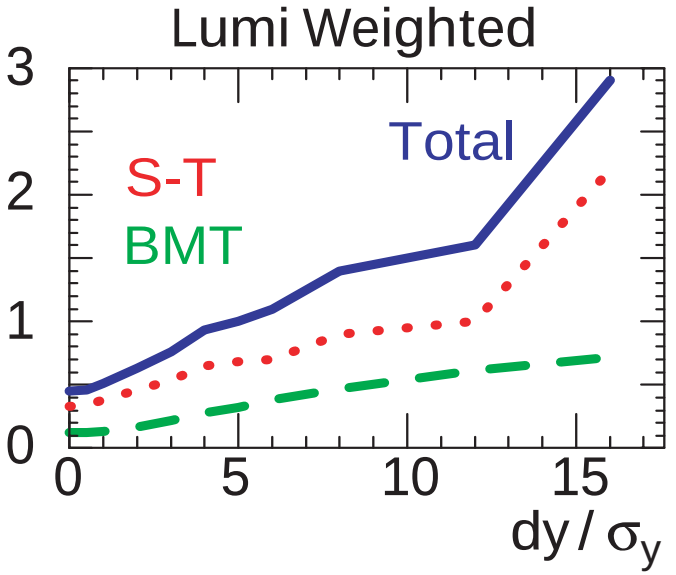
- MAT-Liar + A. Seyri (TRC code)
  Produce 'realistic' incoming beam profiles
- GuineaPig - collision simulation
- MAT-Liar
  extraction line
- GEANT + Takashi M.
  extraction line + backgrounds
- $\Delta\theta = \gamma\frac{(g-2)}{2}\theta_0$

⇛ K. Moffeit + M. Woods

Collision Effects







Lumi weighted ~ 25%
of bunch average ΔP

K. Thompson
January 2001
SLAC PUB 8716

Some Numbers

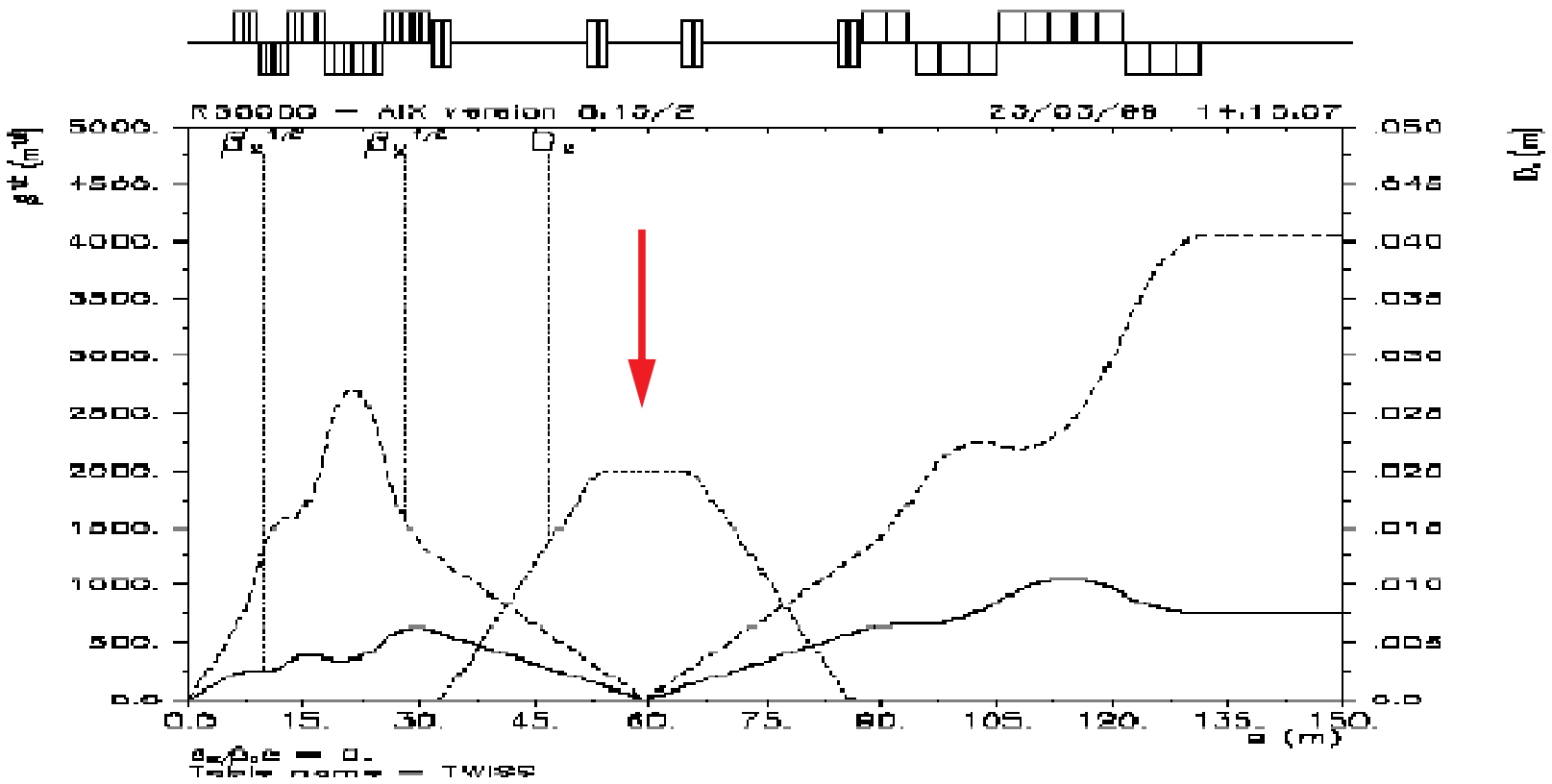
	Semi-Analytic			Simulation		
NLC-B	**Total**	**Lumi**	**Diff**	**Total**	**Lumi**	**Diff**
500	1.1%	0.3%	0.8%	0.9%	0.2%	0.7%
1000	2.5%	0.7%	1.8%	2.0%	0.5%	1.5%
1500	3.2%	0.9%	2.3%	2.7%	0.6%	2.1%

Agreement (0.1% level) between simulation and semi-analytic calculation

Significant effects, even at 500 GeV

Lumi-weighted polarization is closer to incoming beam than outgoing beam

Chicane Layout

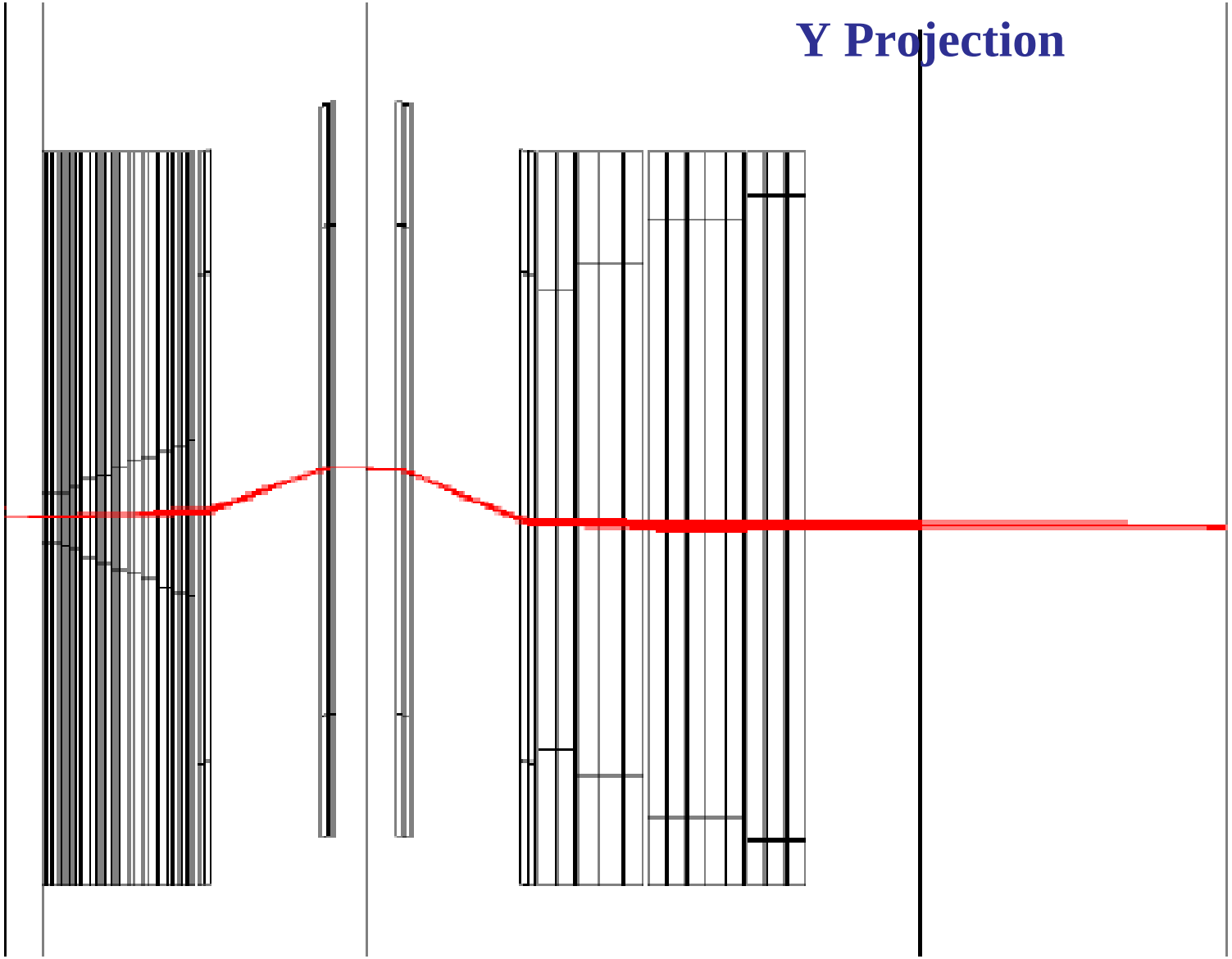


SLAC-PUB-8096 (Nosochkov)
also SLAC-PUB-8871 (Nosochkov & Raubenheimer)

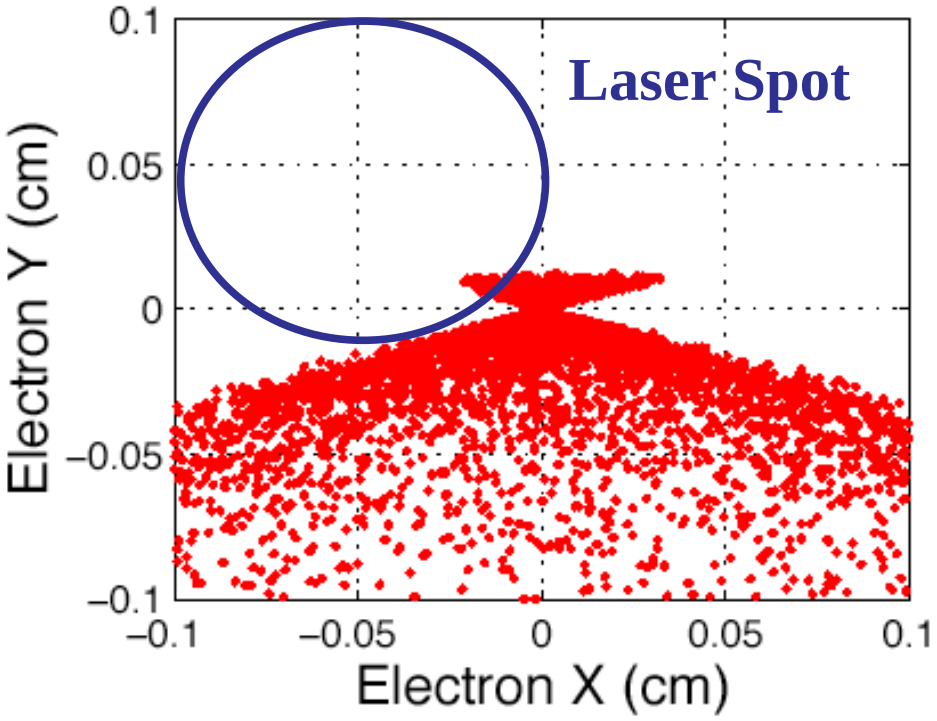
Secondary focus with 20mm dispersion

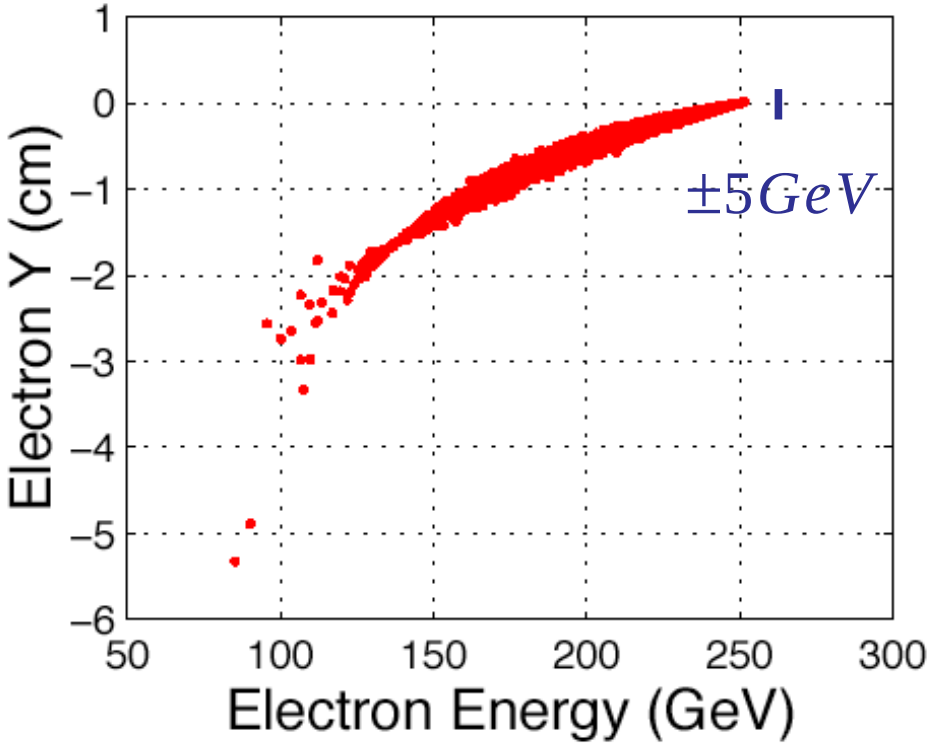
Beam Envelope

Y Projection

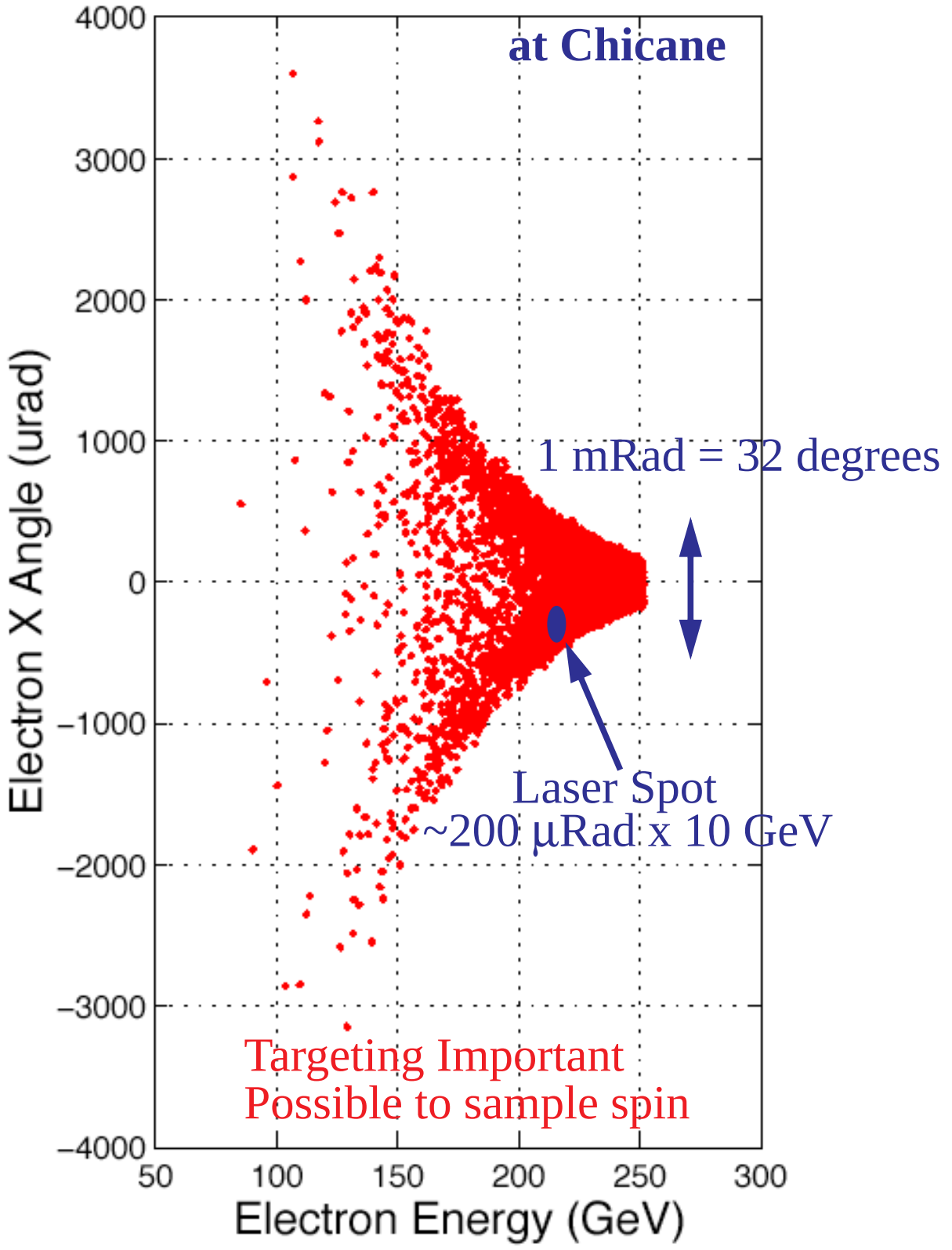


Chicane Distributions





Angular Dispersion



Rough Guess

Spin diffusion due to angular dispersion
NLC 500 simulations

	RMS Θ_x (μRad)		RMS Θ_y (μRad)		ΔP
	IP	CIP	IP	CIP	CIP-IP
1	240	330	99	42	0.17%
2	230	280	53	30	0.08%
3	230	320	98	49	0.16%
4	210	240	52	27	0.04%
5	240	320	88	44	0.15%
6	220	320	118	59	0.16%

Simple model (not simulation) of
lumi-weighted polarization
$\Delta P_{lum} \sim 1/4\ \Delta P$

Laser spot-size tends to mitigate this effect...

But Wait...

Don’t take the dispersion numbers literally:

It was found recently that there was a bug in our FF optics deck.

All quad excitations are reversed

More H focusing, less V focusing
‘secondary focus’ not really a focus at all

This is a ‘possible’ deck, but not the currently foreseen extraction line...

Conclusions

Much work to be done,
but at least somebody is working...

Beam-Beam effects can lead to
0.2% level depolarization

Pure dispersion effects can reach
similar levels.

Neither upstream or downstream polarimeters
can directly sample lumi-weighted polarization

Downstream detectors can (possibly)
allow direct measurements

⇛ Need to demonstrate feasibility...