Start2End Simulations for Micro–Bunching Experiments at FLASH

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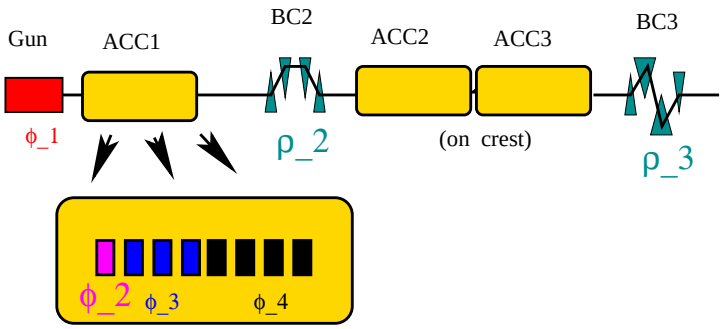
lots of input from: Donghoon Kuk, B.Beutner, W.Decking, M.Dohlus, K.Flöttmann, L.Fröhlich, S.Meykopff, T.Limberg, I.Zagorodnov,

- **Set Up**
- **Scans**
- **A Candidate . . .**

Set Up

S2E–range



- Most parameters taken from D.Kuk (→talk 23.07.2007)
- BC2 : ρ_2= 2.57m (lattice: $\rho_2 = 1.62$m)
  ←D.Kuk : scan ρ_2 2.52m - 2.61m
  ⇒ weak dependence of ps
  $R_{56}^{(2)} = -0.1$m (lattice: -0.25m)
- BC3 : ρ_3= 3.6m - 4.4m
  (lattice: $\rho_3 = 7.5$m)
  $R_{56}^{(3)} = -0.025$m - -0.038m
  (lattice: -0.009m)

ϕ_1	ϕ_2	ϕ_3	ϕ_4	ACC2&3
(gun)	ACC1.1	ACC1.2-4	ACC1.5-8	
$-0.55°$	$-90°$ - $-105°$	$0°$	$-8.667°$	on crest
	VB!!	accel.	corr. chirp	accel.

with long. Gaussian bunch from cathode

Scanning ϕ_2 and ρ_3

Goal of S2E Scans :

- $I(z)$ moderately large over sufficiently large length
- . . . separated from spike !
- transv. ps: not first priority
- . . . but transport should be save

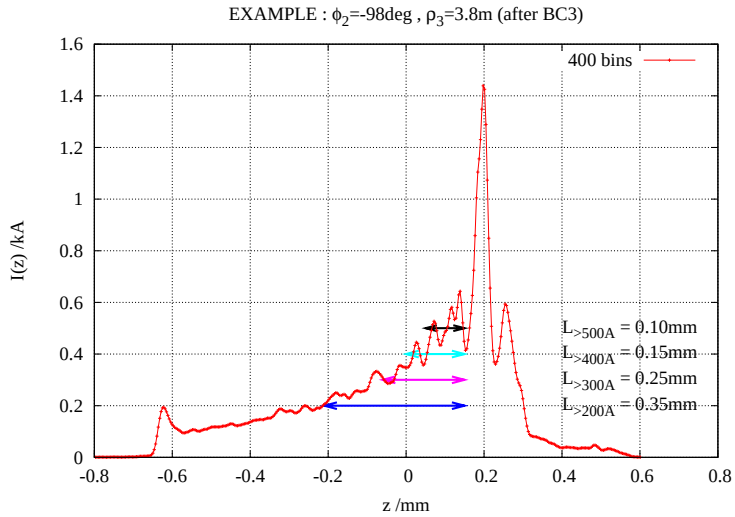
Evaluation :

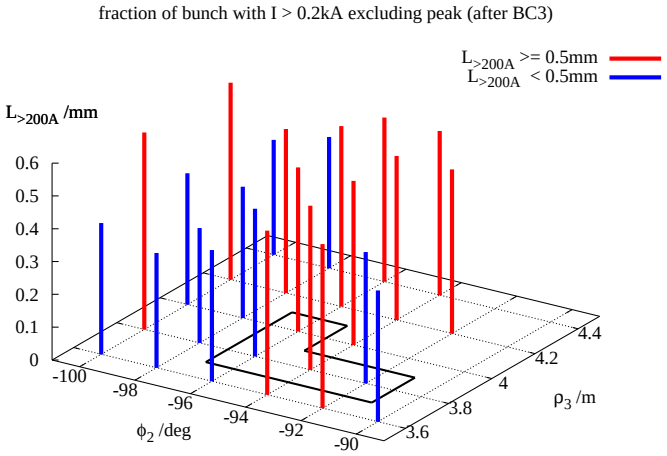
- scan ϕ_2 first
- fix ρ_2
- look at

  length scales supporting various currents

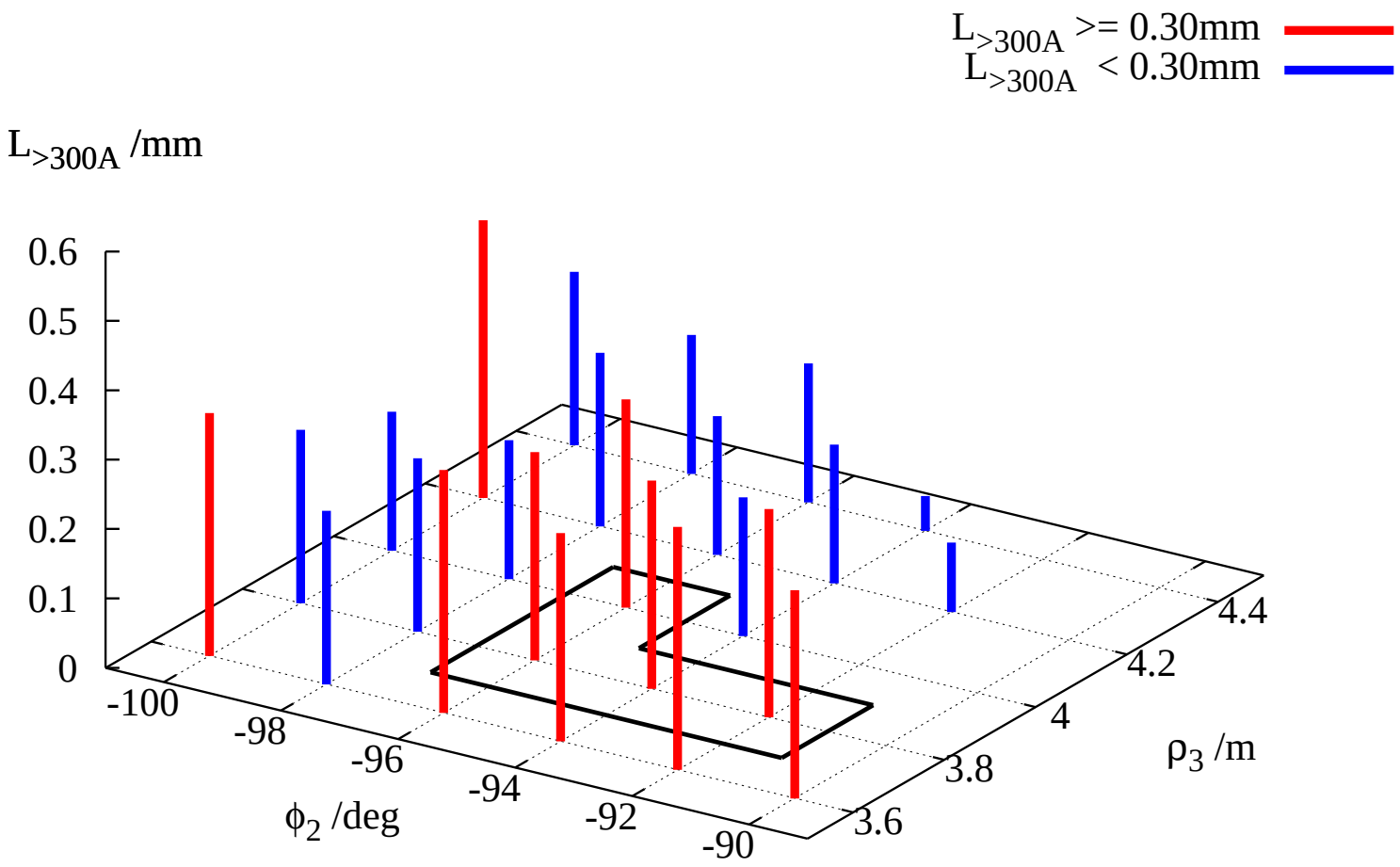
  as function of ϕ_2 and ρ_3

  (watch the black "L" !!)

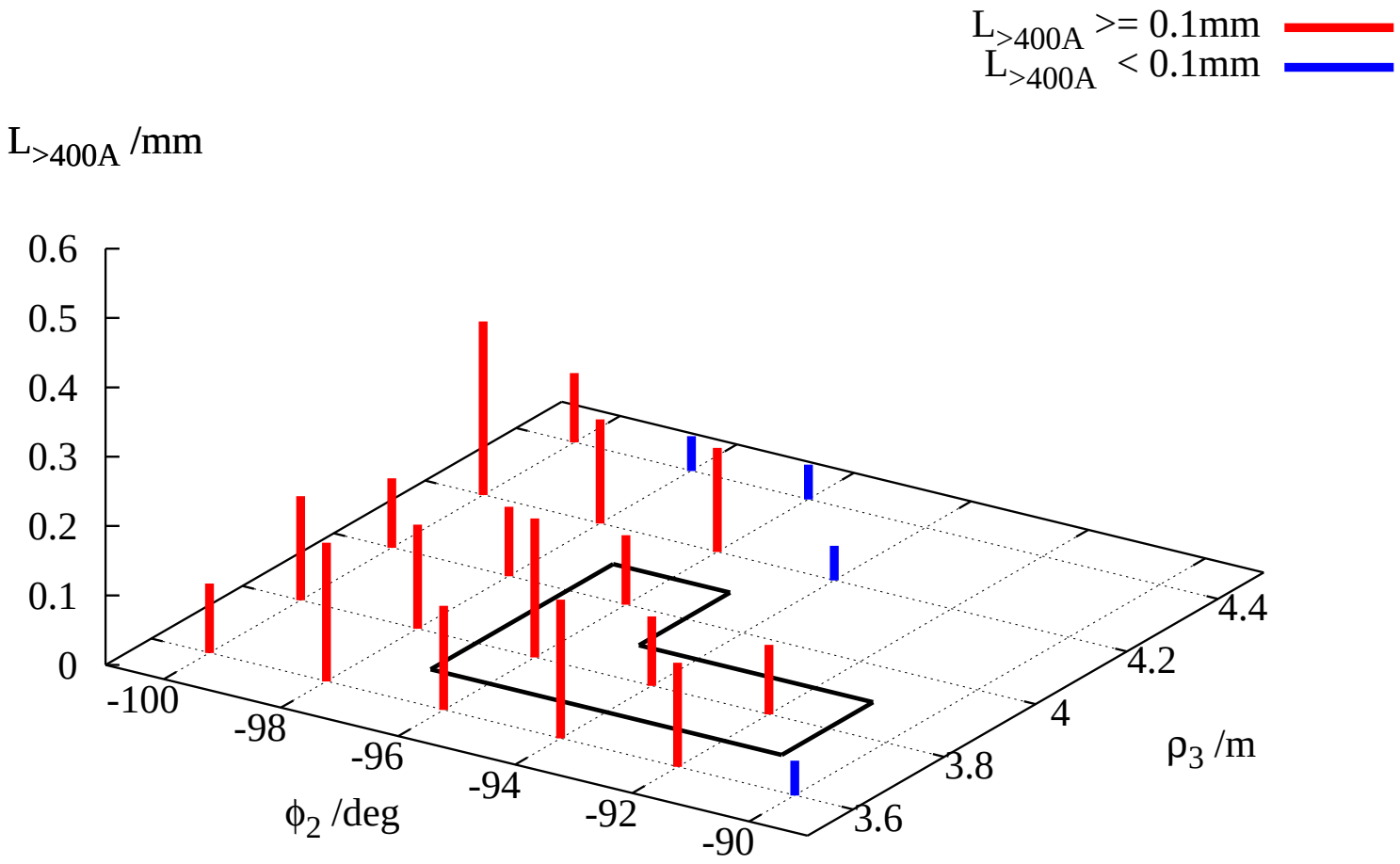




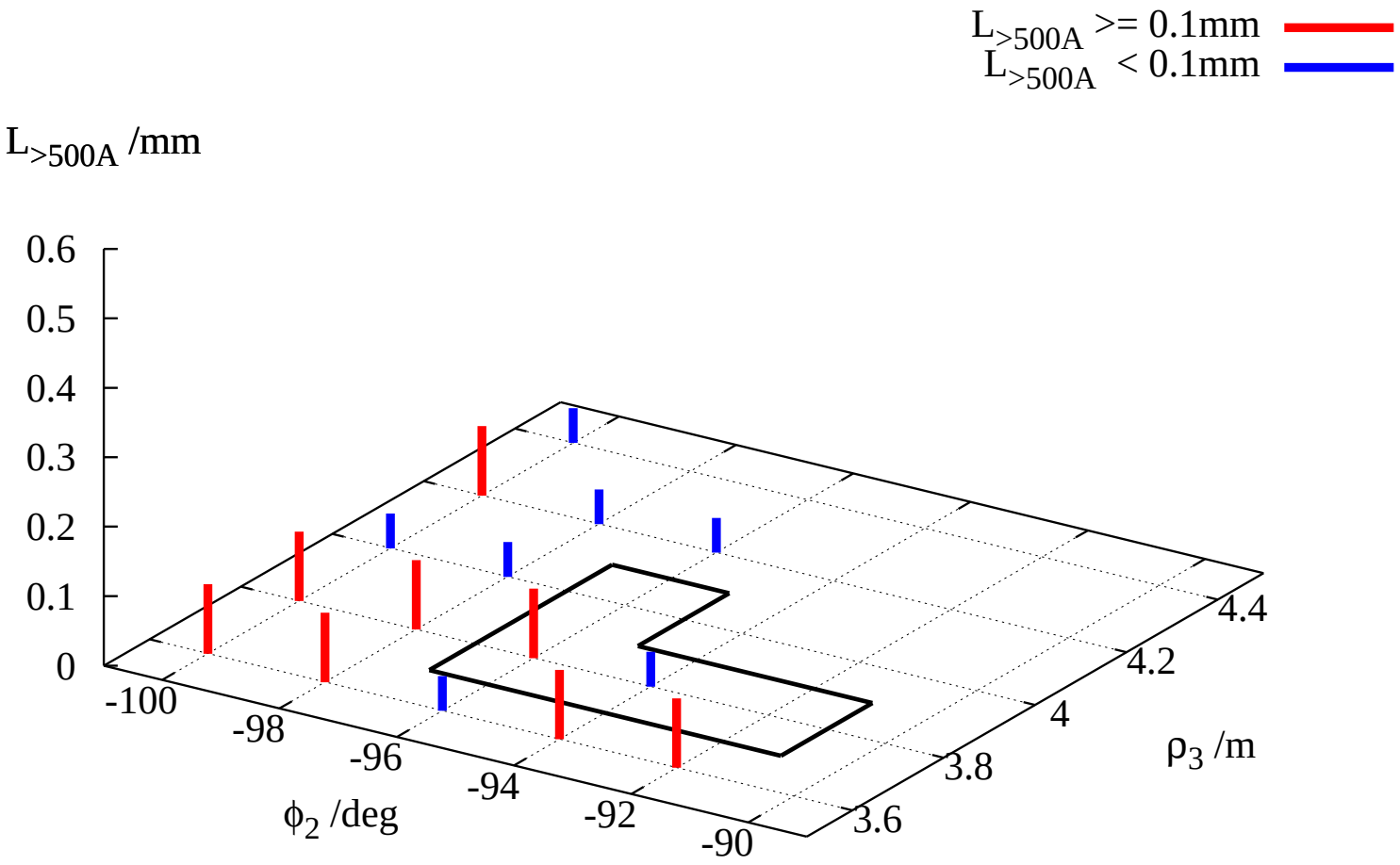
fraction of bunch with I > 0.3kA excluding peak (after BC3)



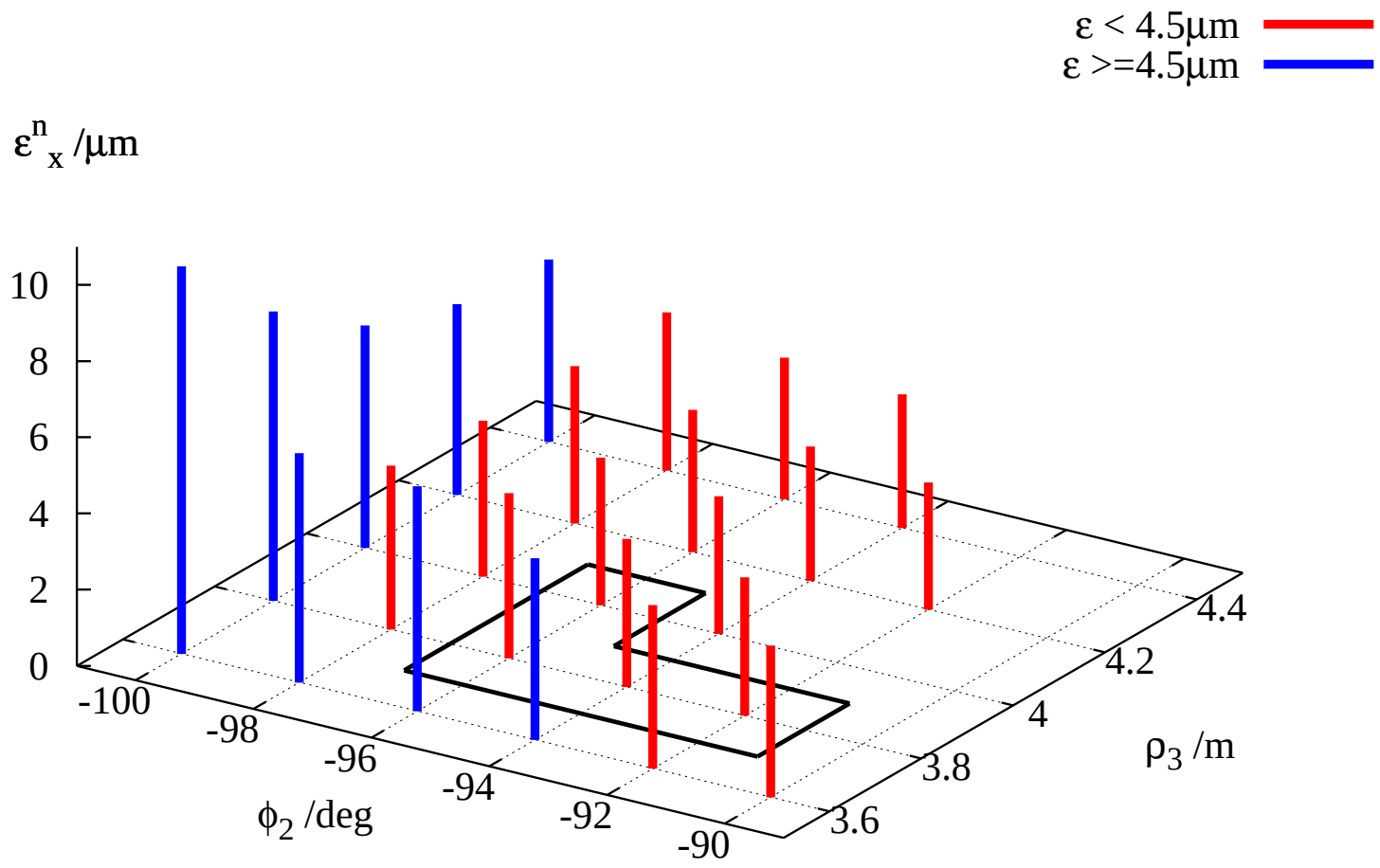
fraction of bunch with I > 0.4kA excluding peak (after BC3)



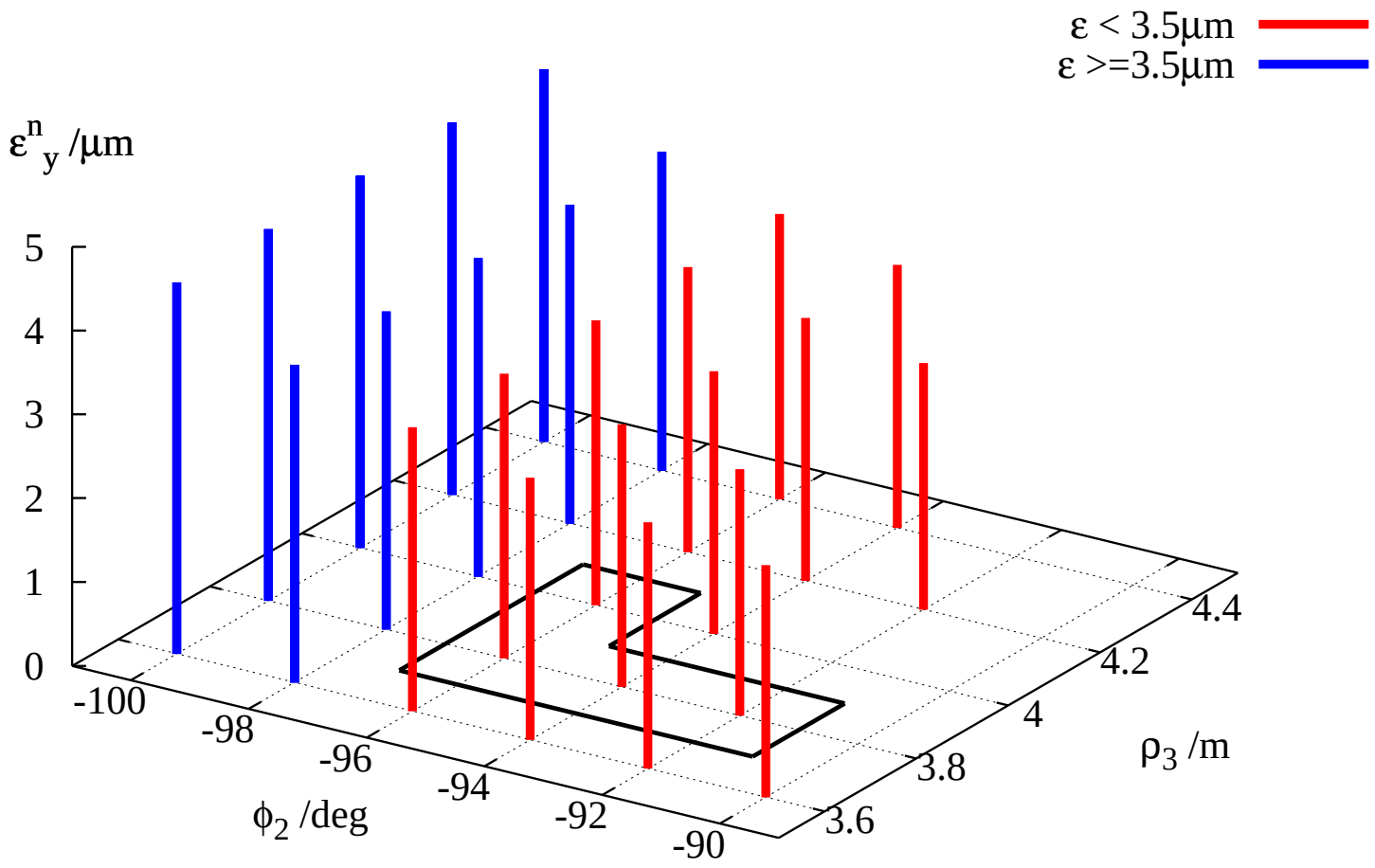
fraction of bunch with I > 0.5kA excluding peak (after BC3)



projected normalized horizontal emittance (after BC3)

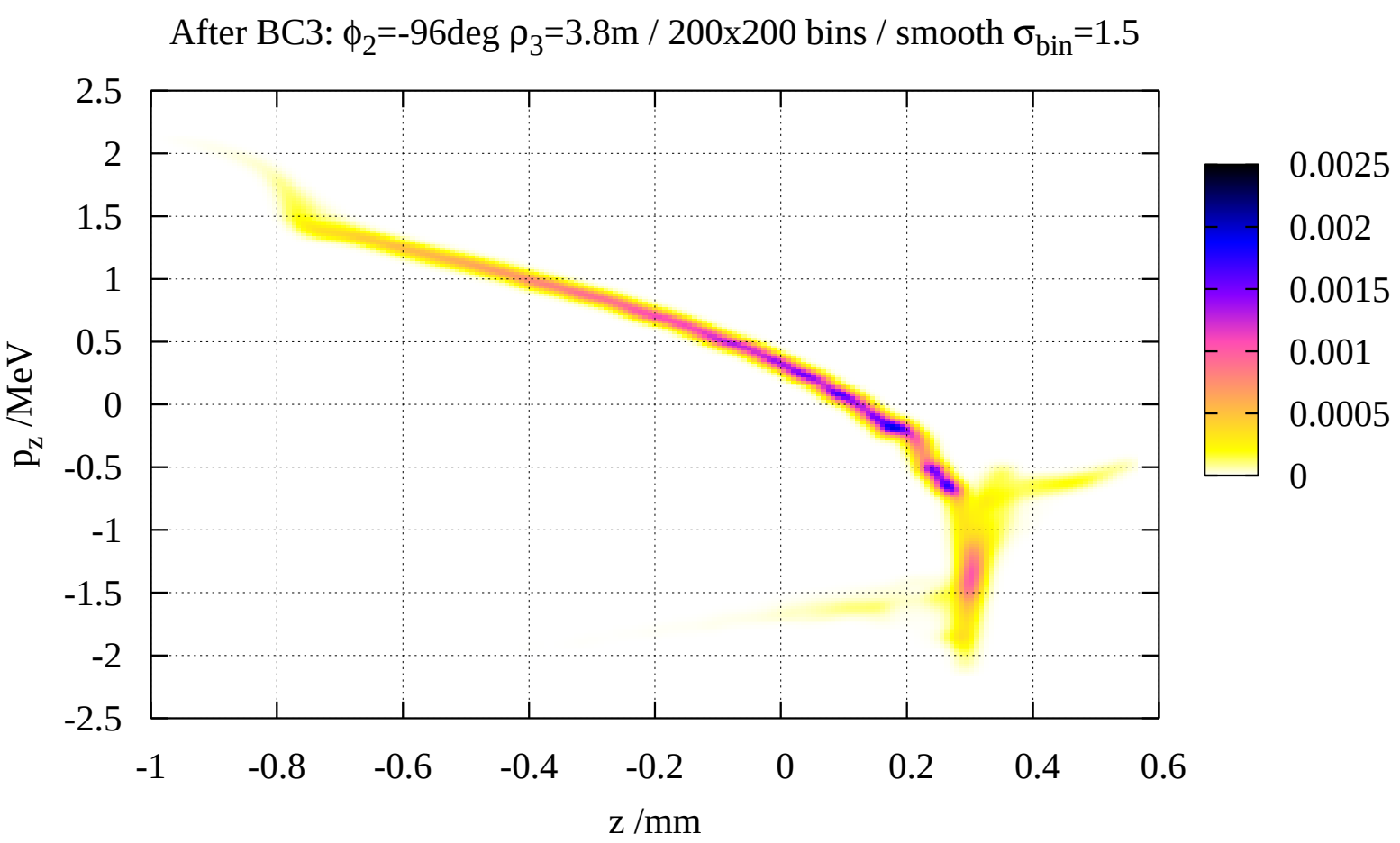


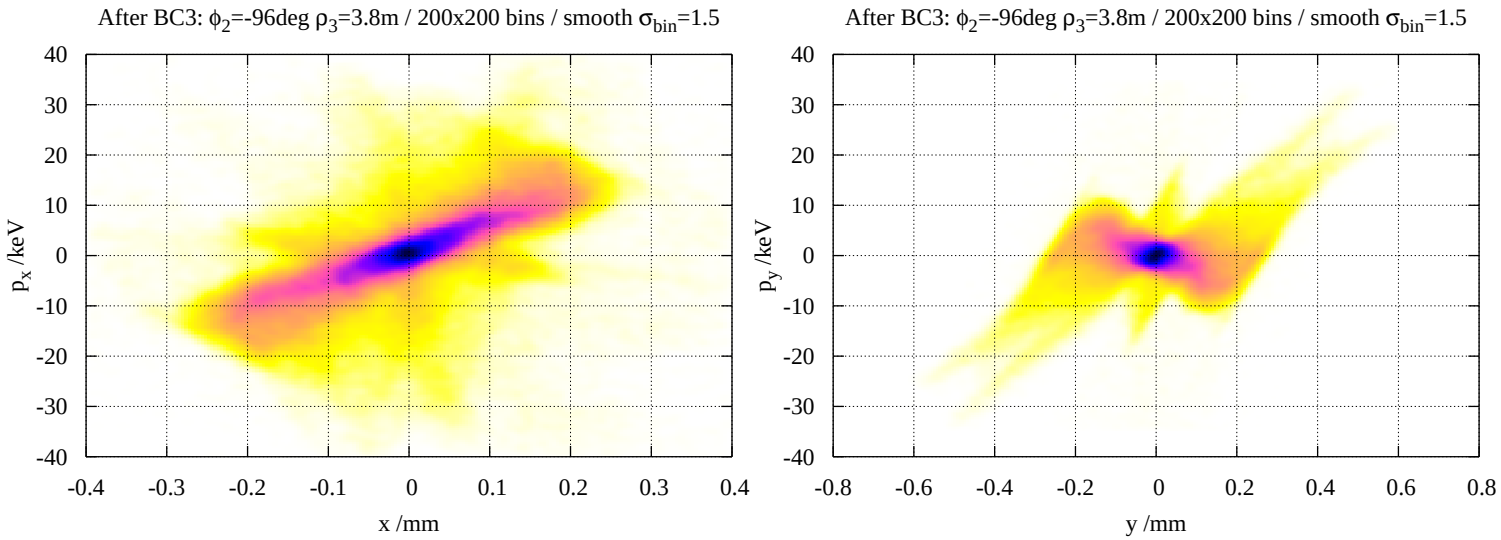
projected normalized vertical emittance (after BC3)



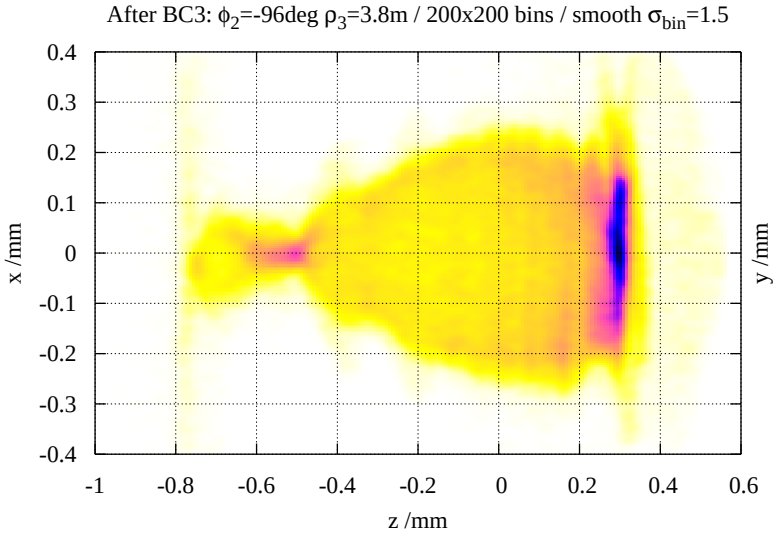
$\phi_2/^\circ$	ρ_3/m	$L_{>300A}$/mm	$L_{>400A}$/mm	$L_{>500A}$/mm	I_{peak}/kA	ϵ_x^n/μm	ϵ_y^n/μm
-94	4.4	0.05	0.00	0.00	0.70	3.507	3.138
-96	4.4	0.20	0.05	0.00	0.75	3.716	3.402
-98	4.4	0.20	0.05	0.00	0.65	4.152	3.801
-100	4.4	0.25	0.10	0.05	1.15	4.784	4.443
-92	4.2	0.10	0.00	0.00	0.75	3.334	2.942
-94	4.2	0.20	0.05	0.00	0.80	3.525	3.136
-96	4.2	0.20	0.15	0.05	0.90	3.738	3.400
-98	4.2	0.25	0.15	0.05	0.75	4.131	3.800
-100	4.2	0.40	0.25	0.10	1.35	5.005	4.441
-94	4.0	0.20	0.00	0.00	0.90	3.610	3.134
-96	**4.0**	0.30	0.10	0.00	1.10	3.875	3.398
-98	4.0	0.20	0.10	0.05	0.95	4.090	3.797
-100	4.0	0.20	0.10	0.05	1.50	5.838	4.438
-92	**3.8**	0.30	0.10	**0.00**	1.10	3.631	2.939
-94	**3.8**	0.30	0.10	**0.05**	1.05	3.884	3.132
-96	**3.8**	0.30	0.20	0.10	1.50	4.335	3.393
-98	3.8	0.25	0.15	0.10	1.45	4.305	3.793
-100	3.8	0.25	0.15	0.10	2.30	7.591	4.434
-90	3.6	0.30	0.05	0.00	1.30	3.983	2.770
-92	3.6	0.35	0.15	0.10	1.45	4.290	2.937
-94	3.6	0.30	0.20	0.10	1.65	4.770	3.128
-96	3.6	0.35	0.15	0.05	1.90	5.903	3.389
-98	3.6	0.25	0.20	0.10	3.00	6.019	3.789

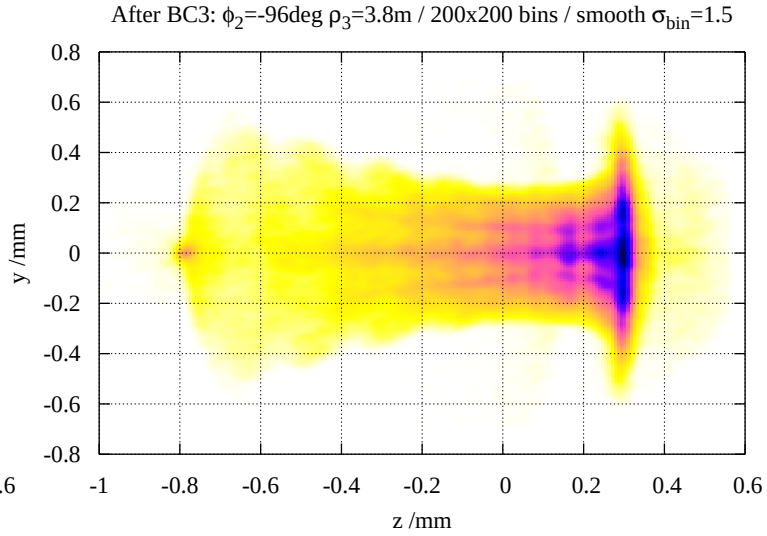
A Candidate . . .

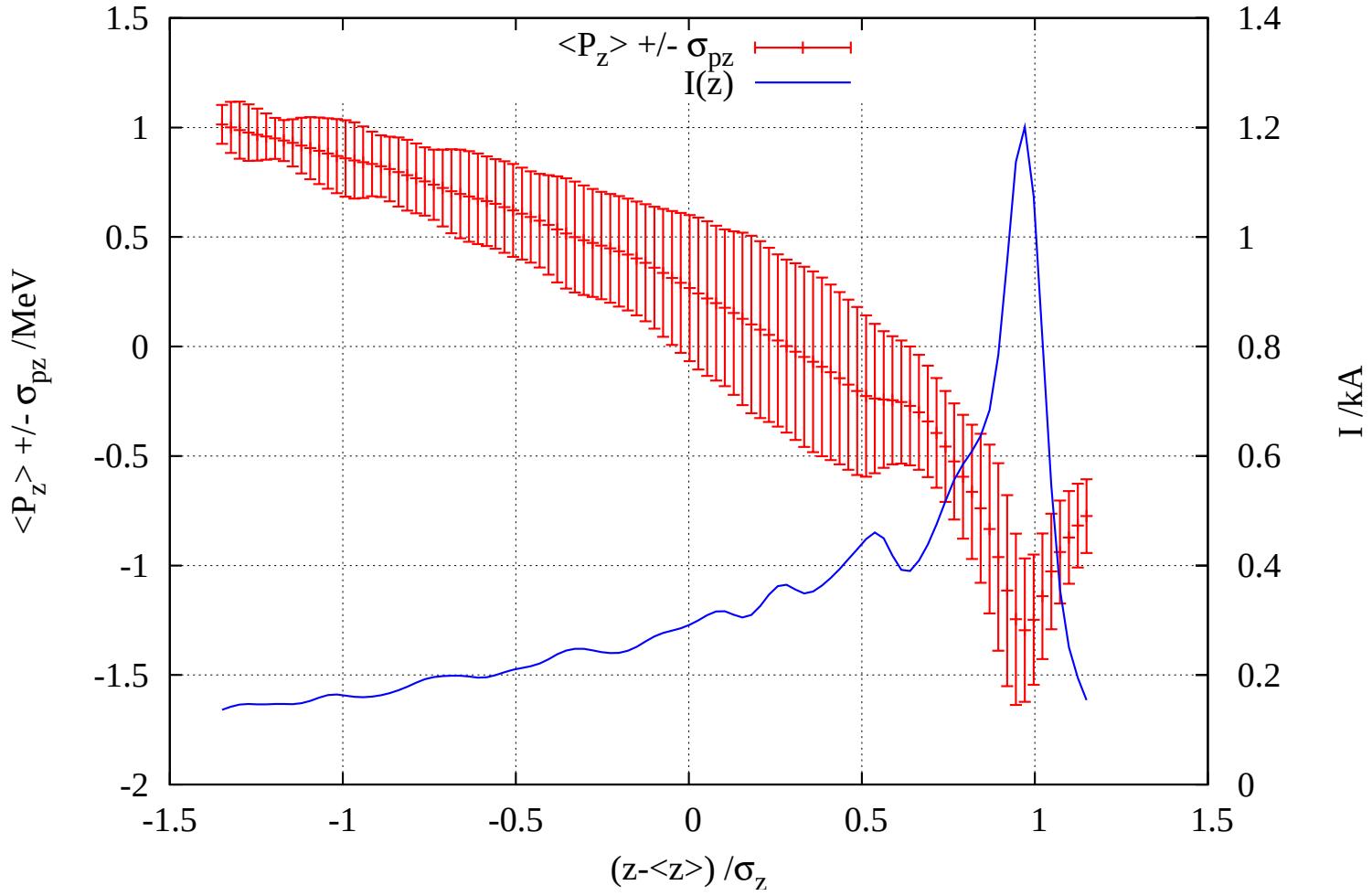

After BC3: ϕ_2=-96deg ρ_3=3.8m / 200x200 bins / smooth σ_{bin}=1.5
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
p_z /MeV
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
z /mm
0.0025
0.002
0.0015
0.001
0.0005
0

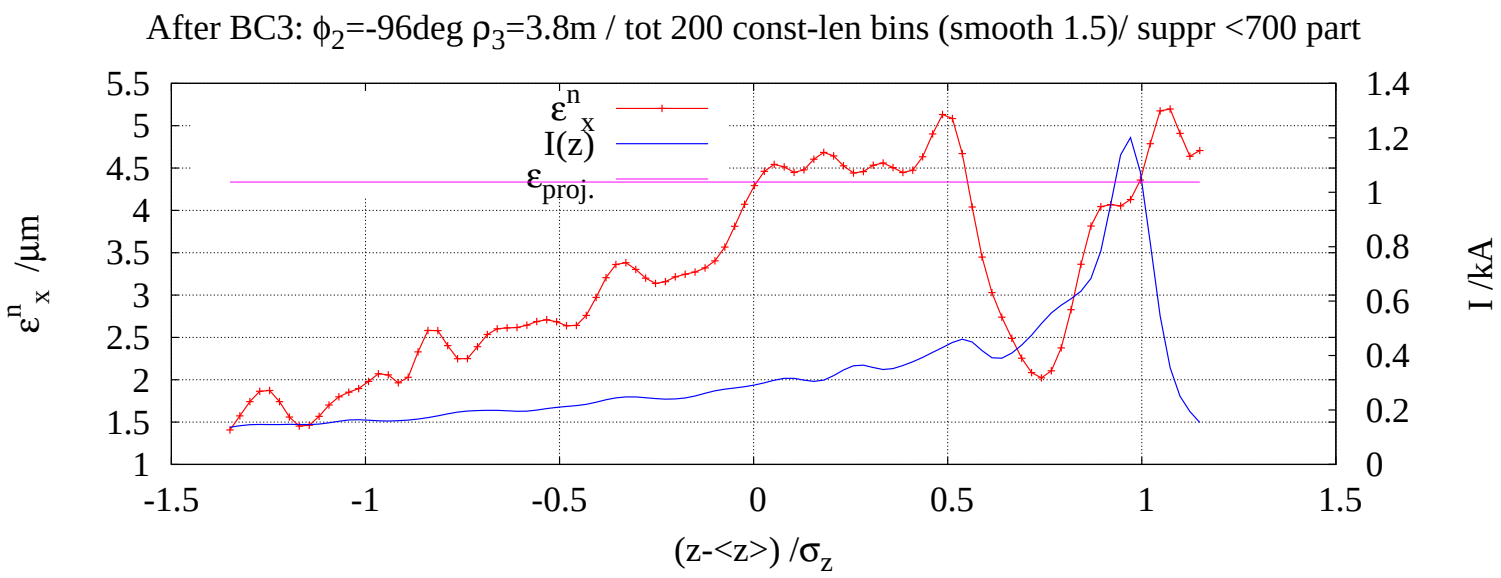

After BC3: ϕ_2=-96deg ρ_3=3.8m / 200x200 bins / smooth σ_{bin}=1.5
p_x /keV
x /mm

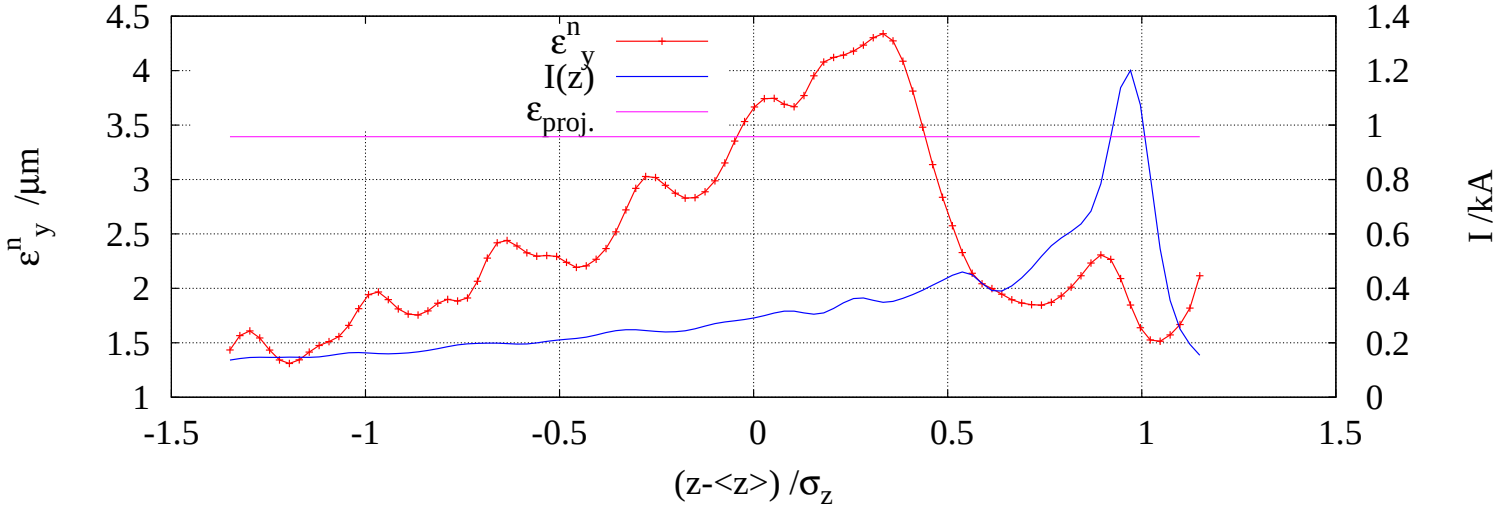
After BC3: ϕ_2=-96deg ρ_3=3.8m / 200x200 bins / smooth σ_{bin}=1.5
p_y /keV
y /mm


After BC3: ϕ_2=-96deg ρ_3=3.8m / 200x200 bins / smooth σ_{bin}=1.5
x /mm
z /mm


After BC3: ϕ_2=-96deg ρ_3=3.8m / 200x200 bins / smooth σ_{bin}=1.5
y /mm
z /mm


After BC3: ϕ_2=-96deg ρ_3=3.8m / tot 200 const-len bins (smooth 1.5)/ suppr <700 part
<Pz> +/- σpz
I(z)
<Pz> +/- σpz /MeV
I /kA
(z-<z>) /σz
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-1.5
-1
-0.5
0
0.5
1
1.5


After BC3: ϕ_2=-96deg ρ_3=3.8m / tot 200 const-len bins (smooth 1.5)/ suppr <700 part
ε^n_x
I(z)
$\varepsilon_{proj.}$
ε^n_x /µm
I /kA
(z-<z>) /σ_z


After BC3: ϕ_2=-96deg ρ_3=3.8m / tot 200 const-len bins (smooth 1.5)/ suppr <700 part
ε^n_y
I(z)
$\varepsilon_{proj.}$
ε^n_y /µm
I /kA
(z-<z>) /σ_z

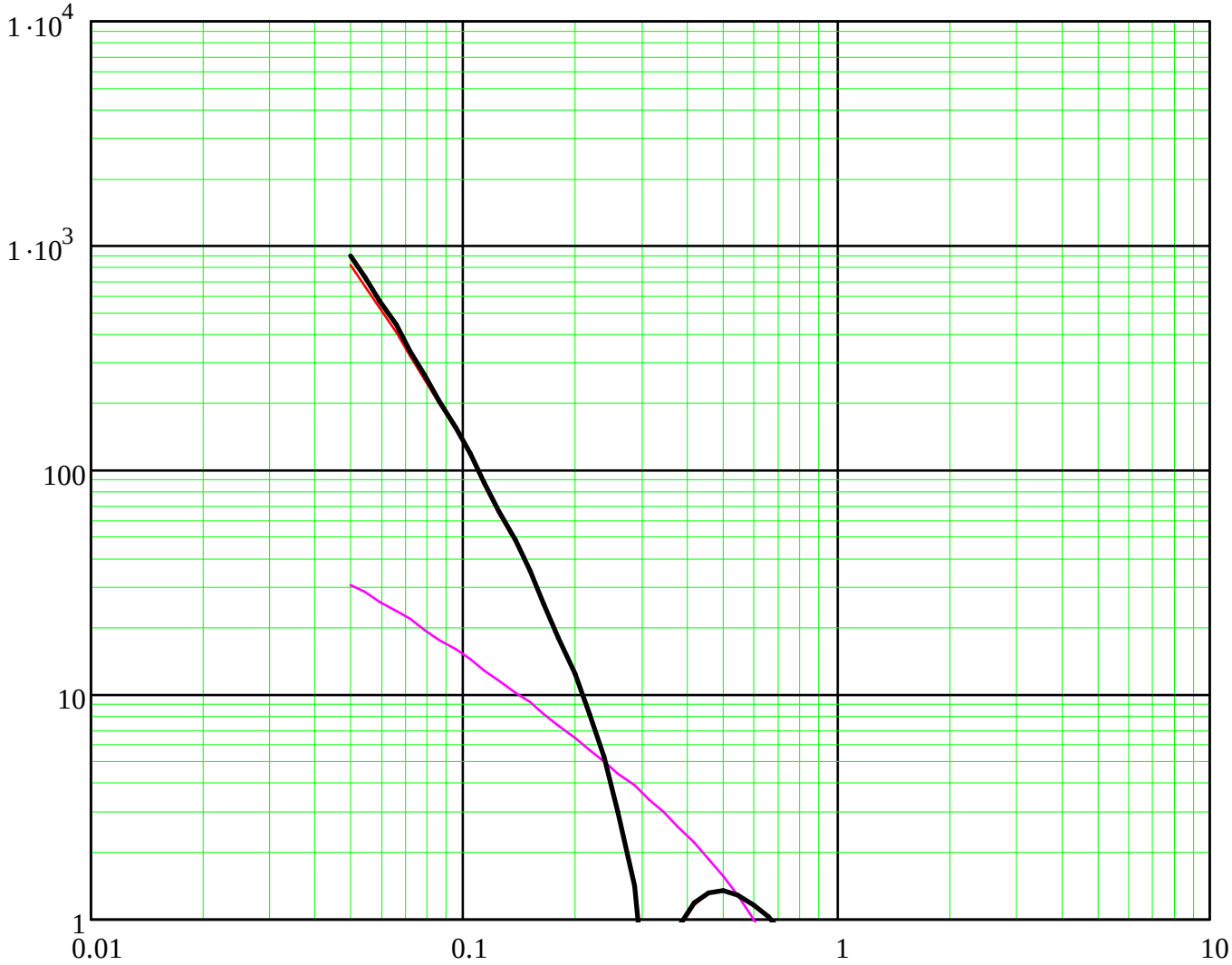
finally. . . A Gain Curve

- For $\phi_2 = -96°$, $\rho_2 = 2.565$m, and $\rho_3 = 3.8$m :
- SliceAnalysis : Fit $\langle \delta p_z \rangle(z)$ to straight line $\Rightarrow$ chirp $h = \frac{d\langle \delta p_z \rangle(z)}{p_0\, dz}$
- **chirps fitted from slice analysis** $\Rightarrow$
-

	BC2	BC3	($\rightarrow$dogleg)
h	5.5/m	3.1/m	6.8/m
R_{56}	-0.1m	-0.034m	$5 \cdot 10^{-4}$m
$\rightarrow C$	2.25	1.12 (?)	0.996

- insert into a spreadsheet (by M.Dohlus) $\Rightarrow$

finally. . . A Gain Curve



Alternative Gain Curve

- everything as before . . .
- **IGNORE fitted chirps $\rightarrow$ guess C from $\frac{I_{\mathrm{final}}}{I_{\mathrm{initial}}}$ $\Rightarrow$**
-

	BC2	BC3	($\rightarrow$dogleg)
R_{56}	-0.1m	-0.34m	$5 \cdot 10^{-4}$m
$\rightarrow C$	2.25	2.6	0.996

- insert into a spreadsheet (by M.Dohlus) $\Rightarrow$

. . . Alternative Gain Curve