GdfidL Simulations of ESA Prototype Collimators

Jonathan Smith
(Lancaster University/Cockcroft Institute)

Summary
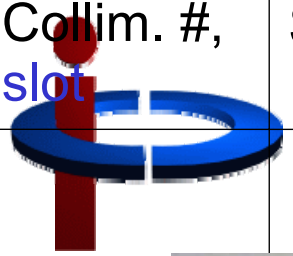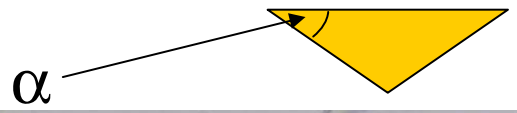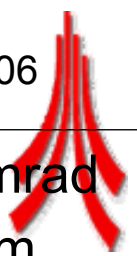
- Methods of estimation

- ESA Run 1 & 2 Collimators (simulation results)

- New prototype collimator profiles

- Mesh stability

- Simulation of "real world" effects

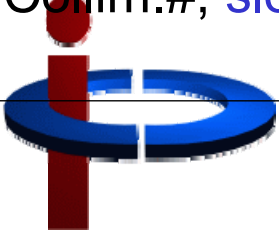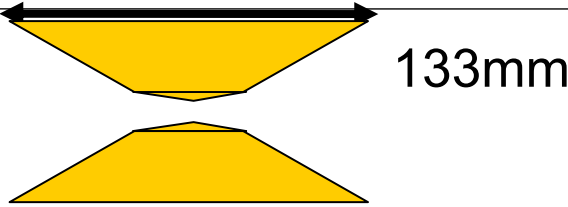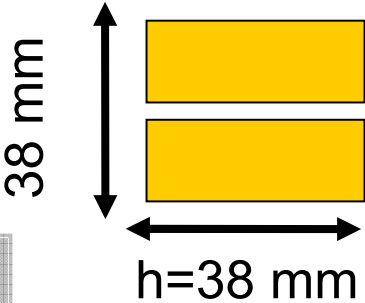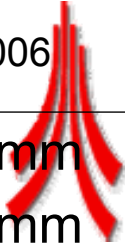- Comparison with other simulation packages
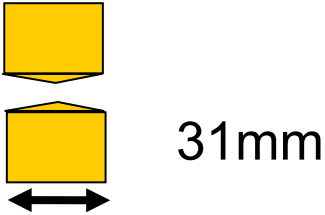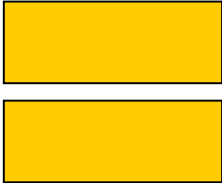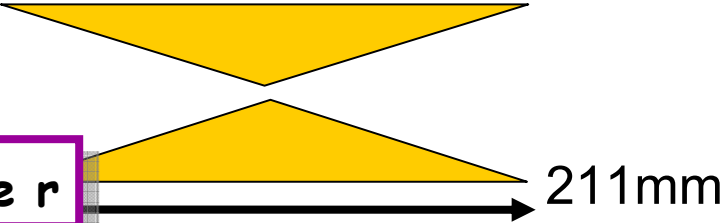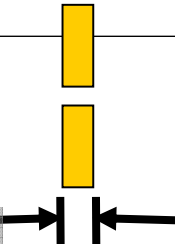
Methods of estimation

- Real beam tests

- Bench tests

- Analytical estimates

- Numerical simulation

Collim. #, slot	Side view ("DESY sandwich")	Beam view	Revised 4-May-2006
1, 1 **As pe**	α	mm	α=324mrad r=2.0mm
2, 2 **Exter**			=324mrad =1.4mm
3, 3			=324mrad =1.4mm
4, 4 **cf. same r, tapered**			=π/2rad =4.0mm

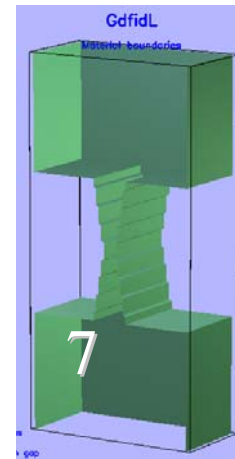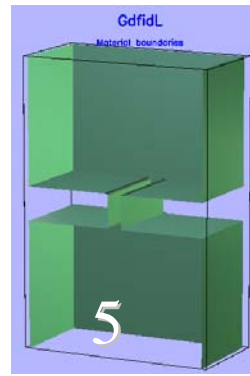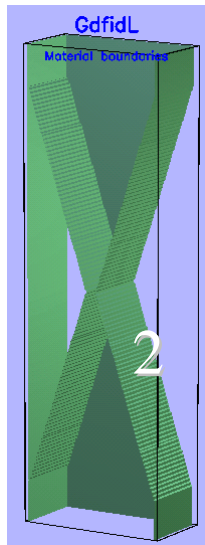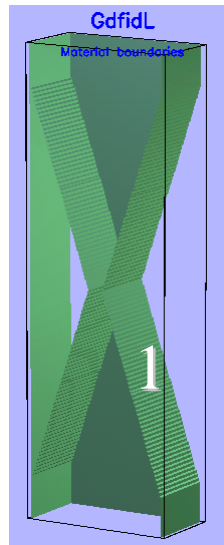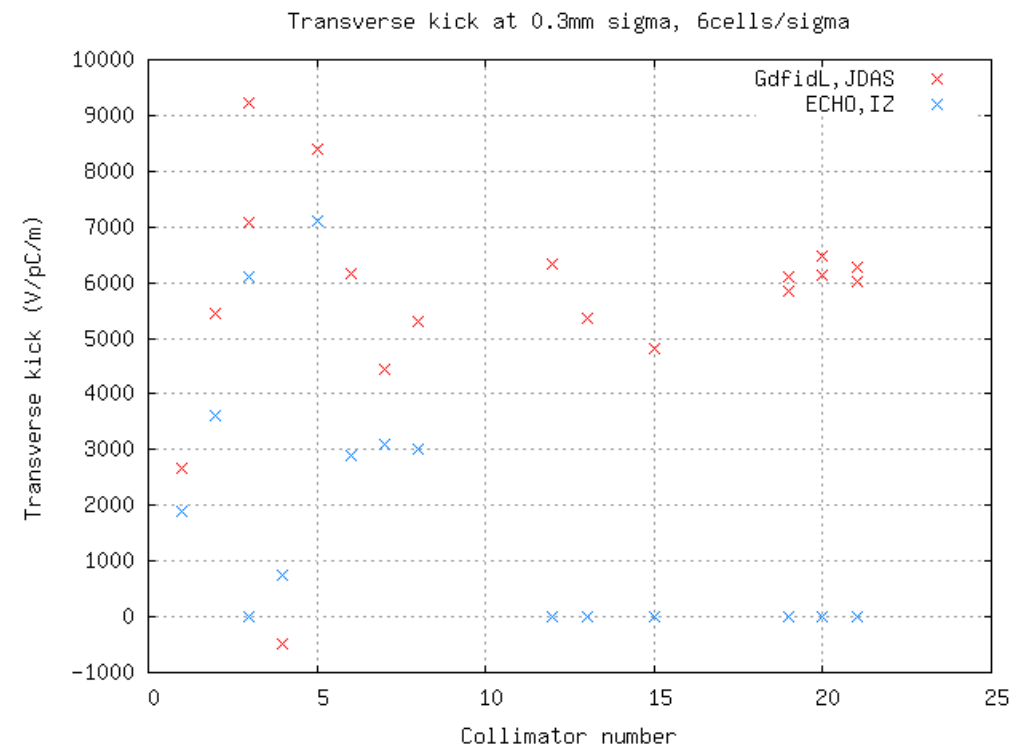| Collim.#, slot	Side view ("SLAC sandwich")	Beam view	Revised 4-May-2006
8, 1	133mm	38 mm / h=38 mm	r_1 =4.0mm r_2 =1.4mm α_1=289mrad α_2=166mrad
cf. collim. 7, and same step in/out earlier data			
7, 2	31mm		α_1=π/2 rad α_2=166mrad r_1=4.0mm r_2=1.4mm
cf. collims. 4 and 6			
6, 3	211mm		α=166mrad r=1.4mm
cf. collim. 2, same r			
5, 4	7 mm		α=π/2rad r=1.4mm
cf. collim. 4 smaller r			

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EM Simulations with GdfidL

Wakefields @300μm

(6 cells/sigma)

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Wakefields @500μm

(12 cells/sigma)

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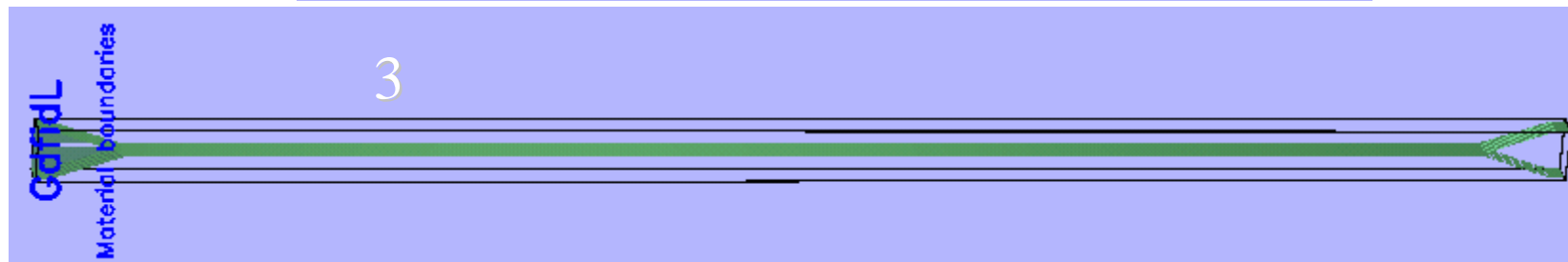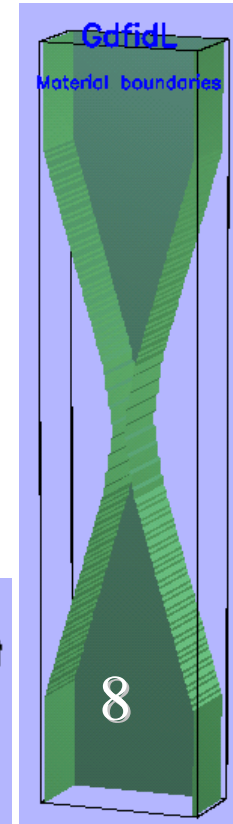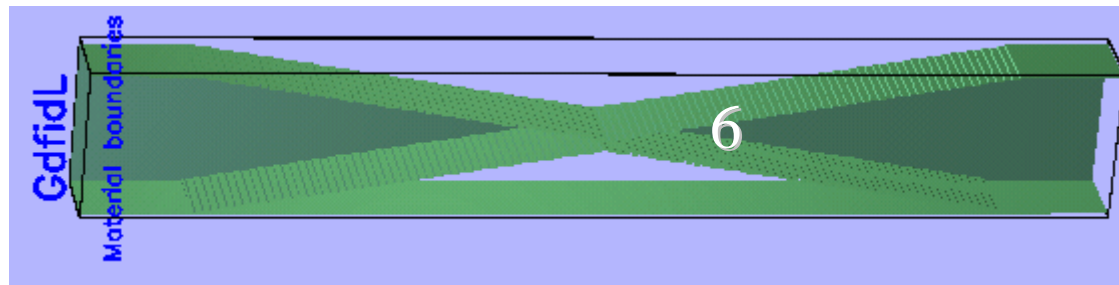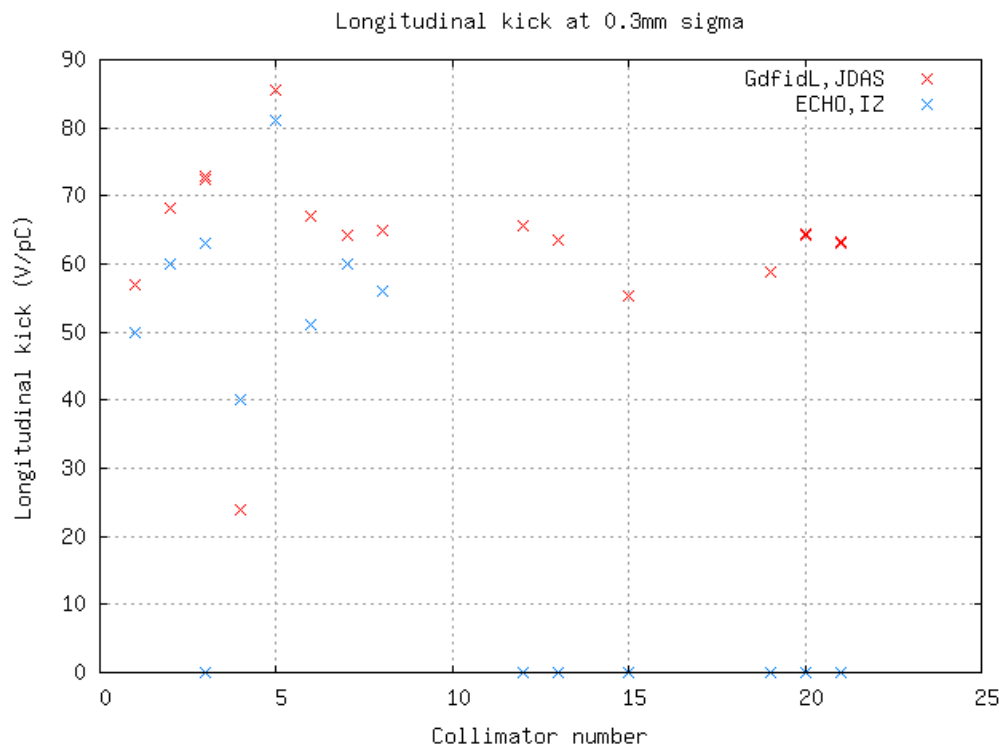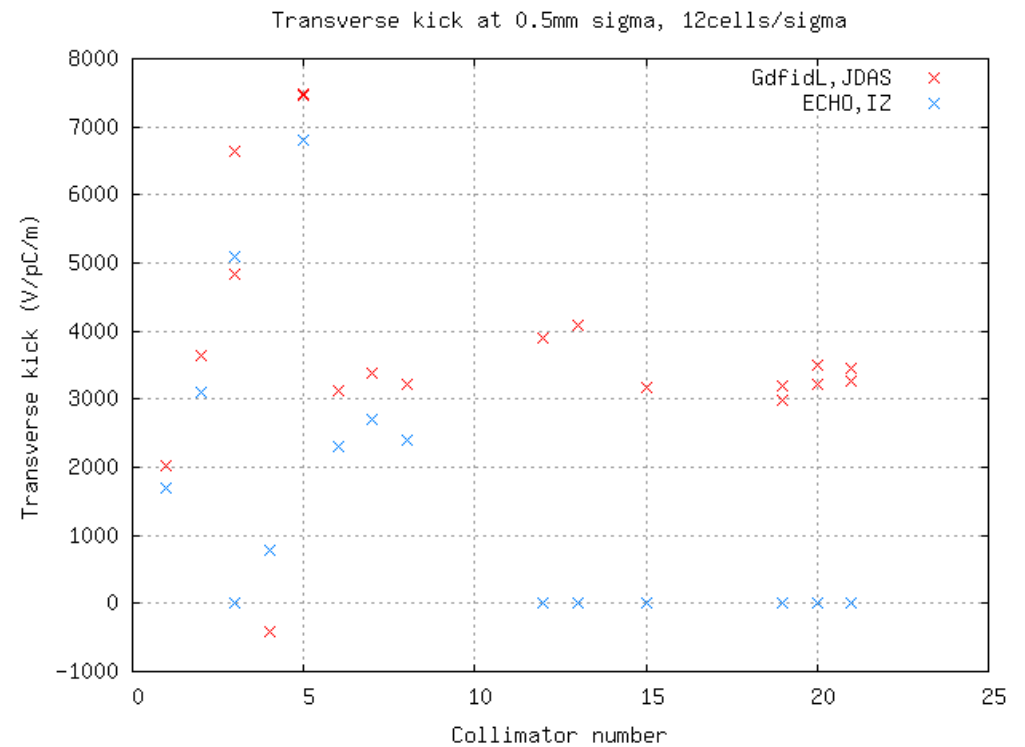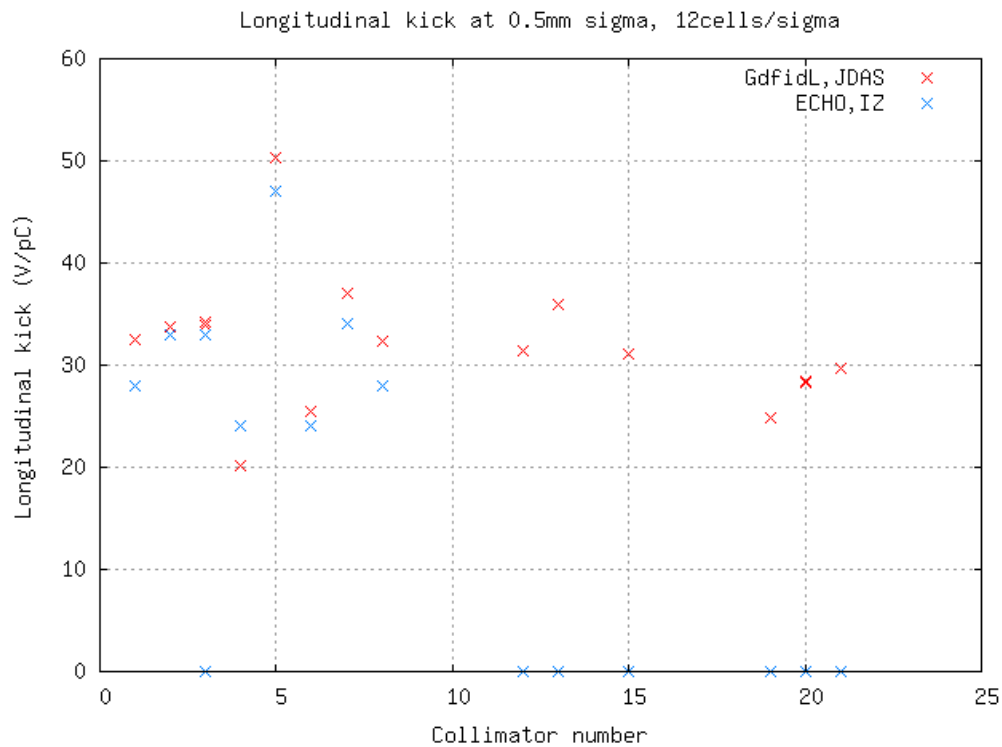
Mesh stability: Collimators 1&2

- Only 3 decent points at 300μm for most collimators

- More at 500μm

- 1mm ~ OK – can use spline fit on data to get an estimate – not done so far – further analysis to see if this takes us closer to ECHO/PBCI.

What do we do about it? (1)

Dependence on col1 kick at 0.5mm with mesh

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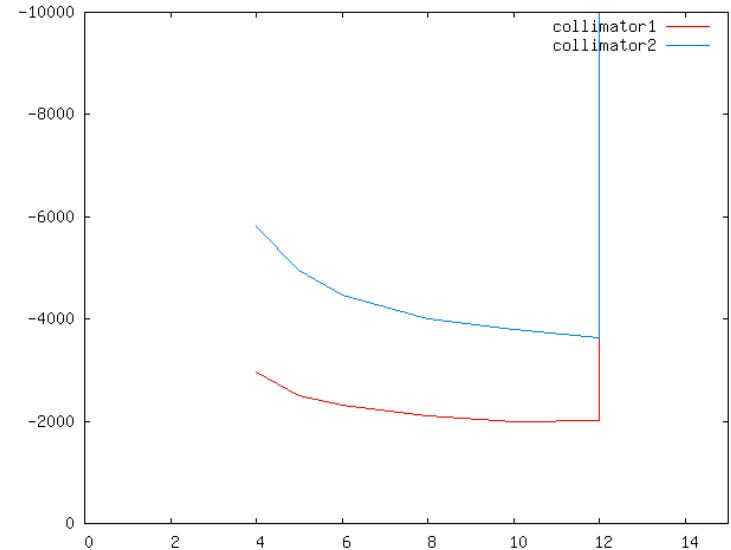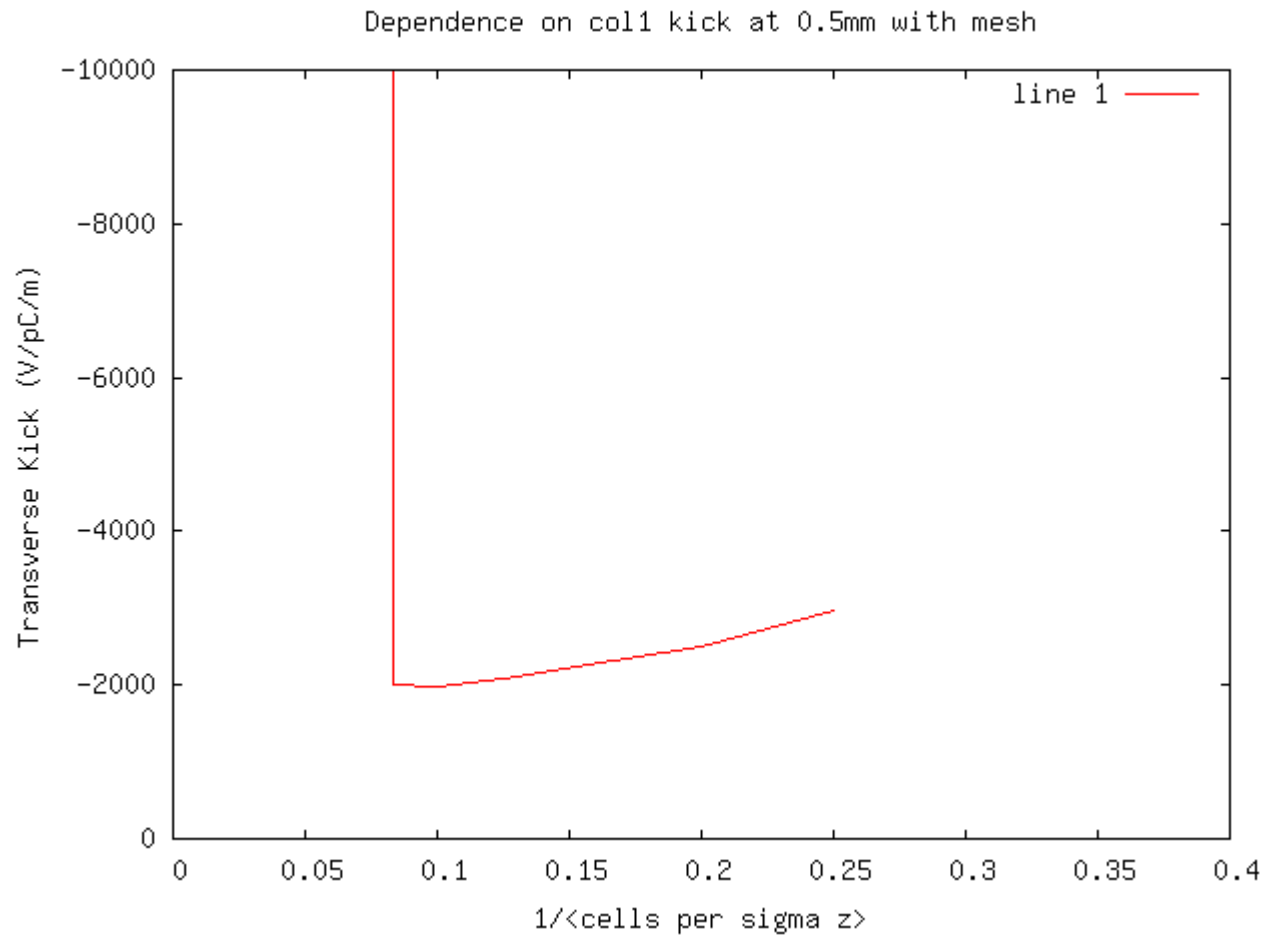
What do we do about it? (2)
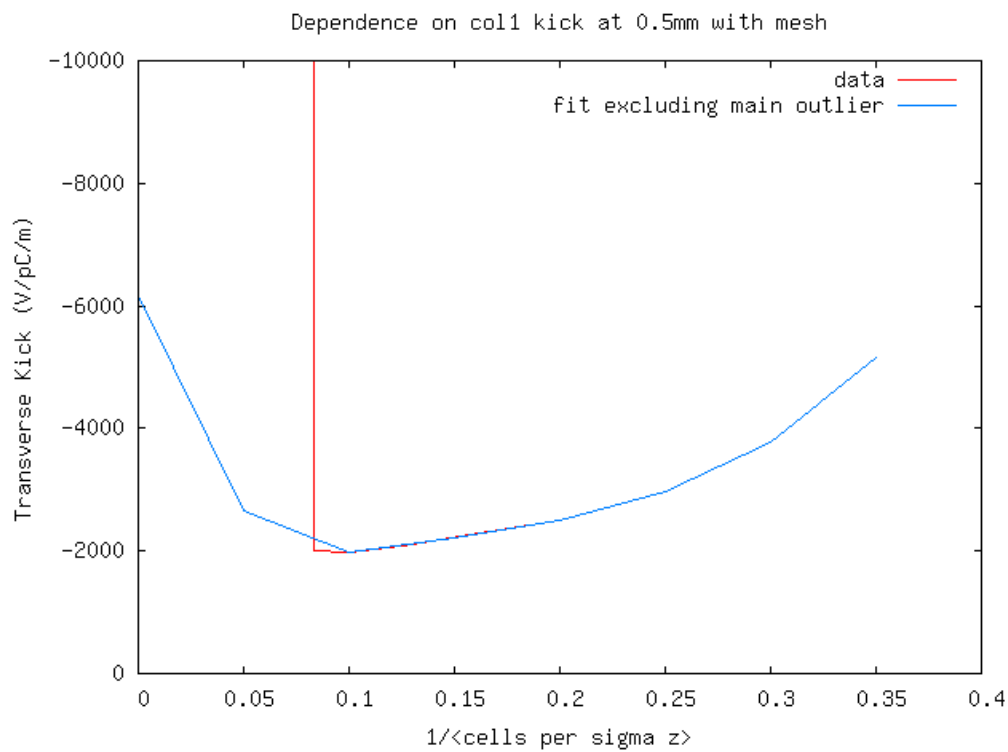
Effect of mesh filtering…

007, Daresbury

Further collimator designs
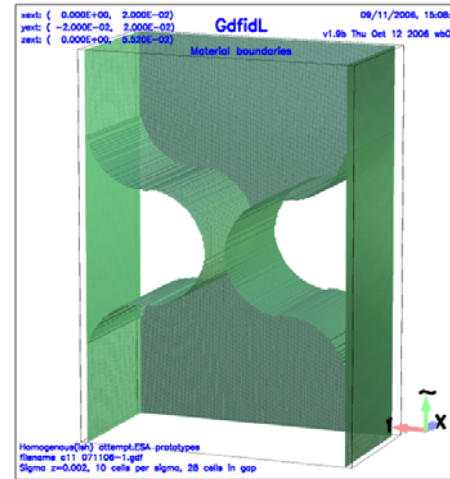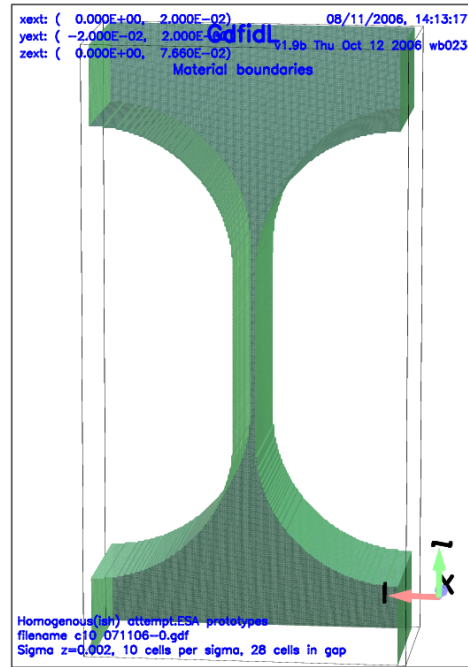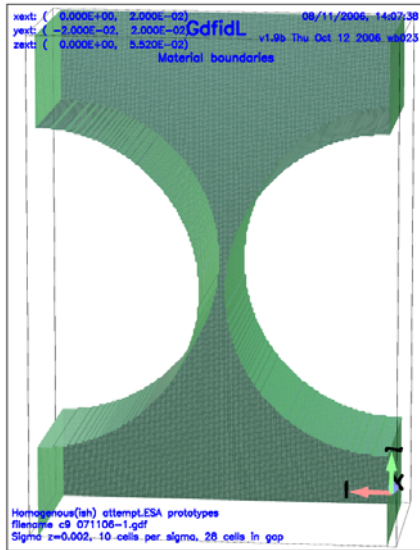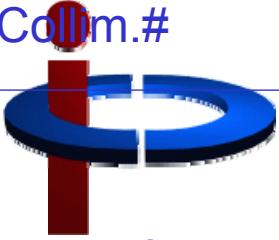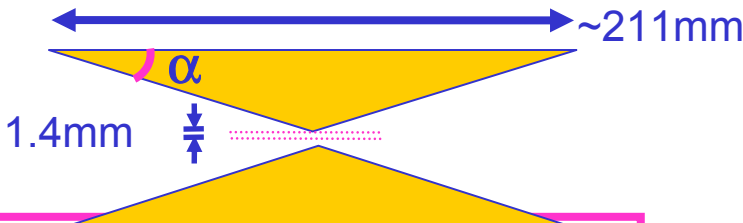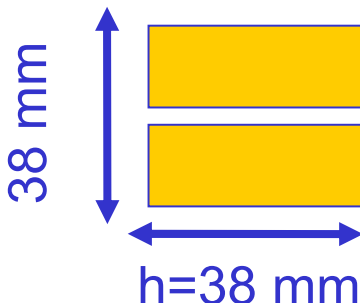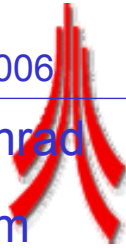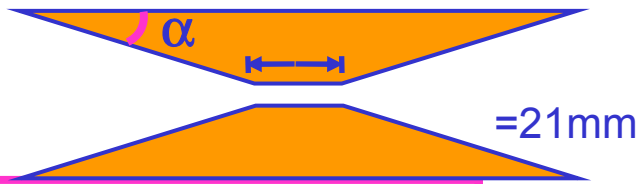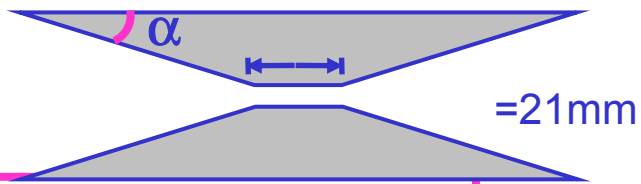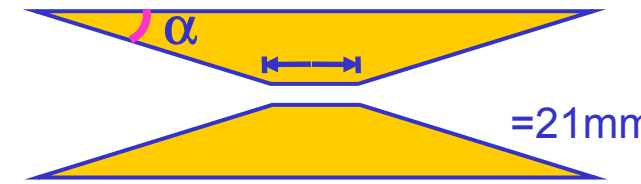
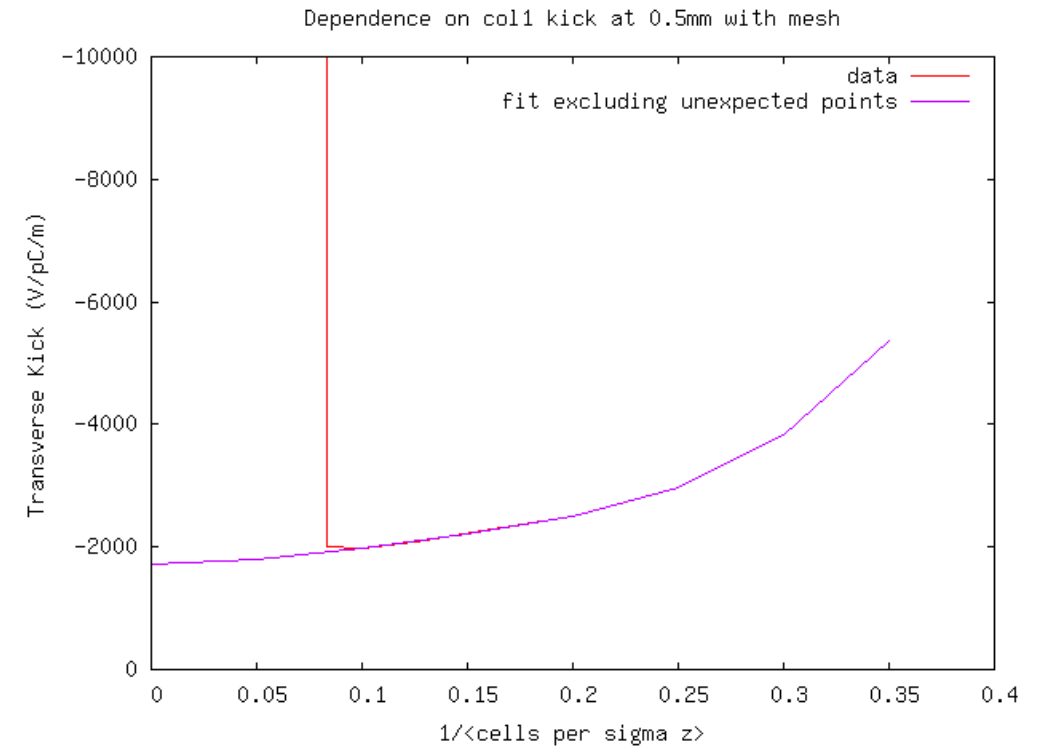semi-circle, with[9]/without[10] flat,
opposing demi-circles[10], 8 with flat[11].

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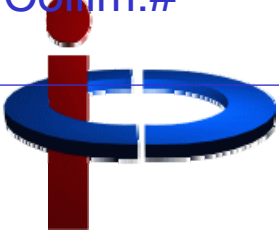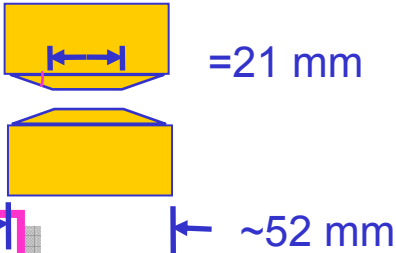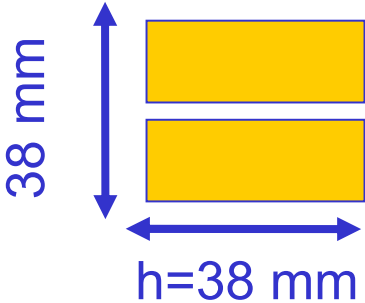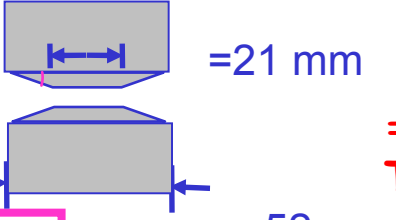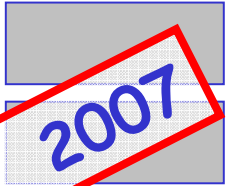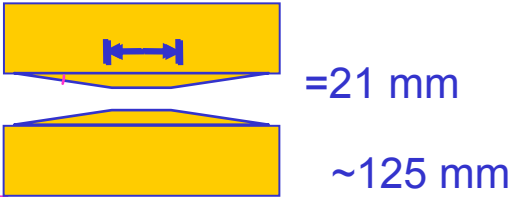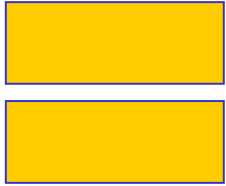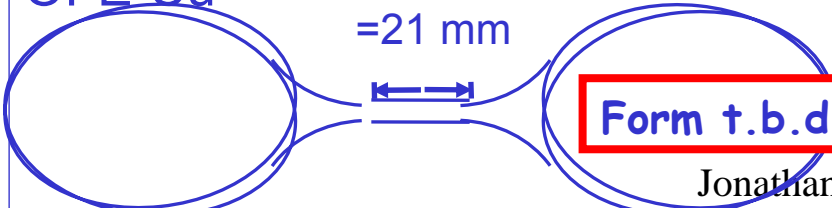
More possible collimators

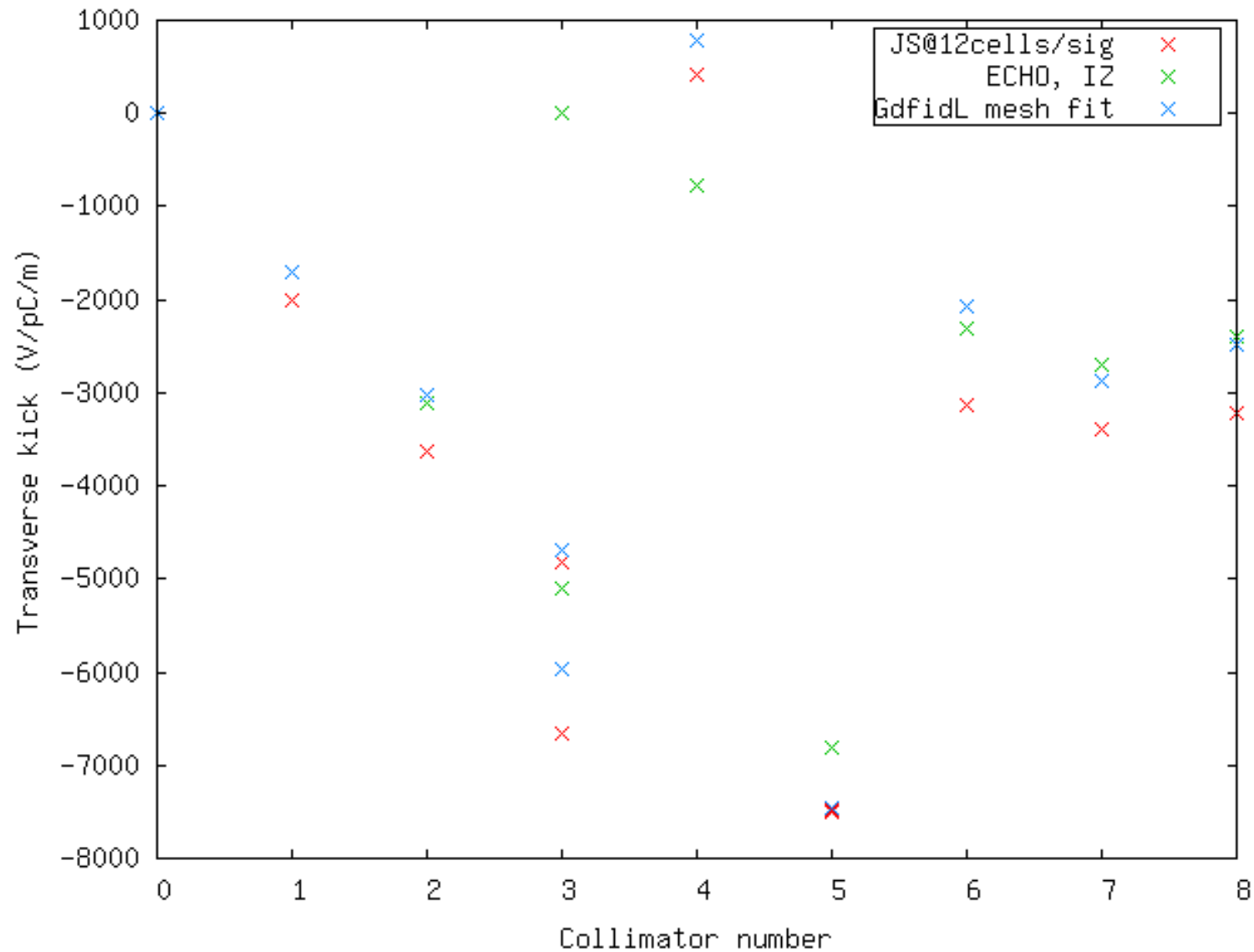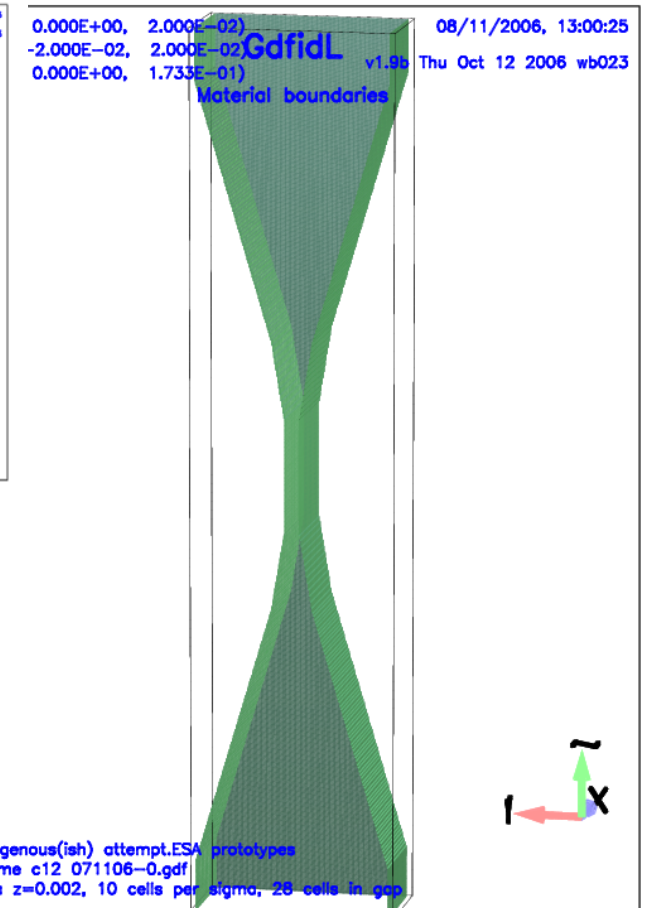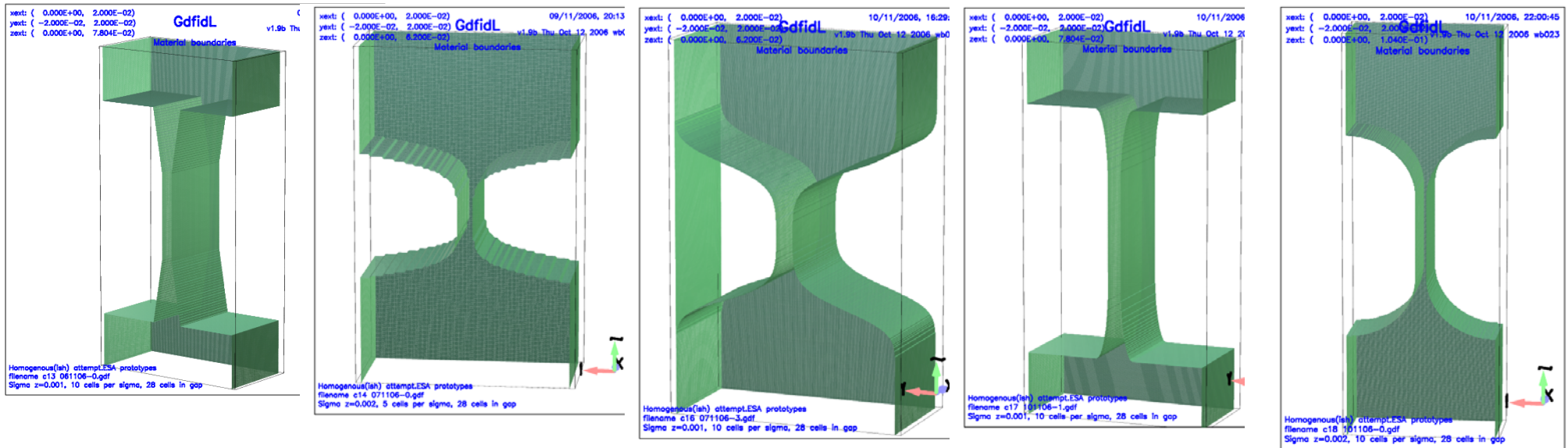7 with flat [13], half exponential[14], 13 with shallower angle[15]
exponential profile[16],
13 with ellipse connecting 4mm and 1.4mm aperture[17]
13 with ellipse connecting beam pipe radius and 1.4mm aperture (also see 9)[18]
half cosine taper [19], raised cosine taper [20], tanh tapers [21]
(set typically to the length of collimator 6)

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Collim.#	Side view	Beam view	Revised 27-Nov-2006
6	~211mm, 1.4mm, α	38 mm, h=38 mm	α=166mrad, r=1.4mm (1/2 gap)
	Exists, from 2006 runs. For reproducibility		
10	α, =21mm		α=166mrad, r =1.4mm
	Roughened surface, compare with 12		
11	α, =21mm		α=166mrad, r =1.4mm
	As 10, in Ti-6Al-4V, polished, cf. 12		
12	α, =21mm		α=166mrad, r=1.4mm
	As 10, in OFE Cu, polished, cf. collim. 6, 13		

Runs 3, 2007

Collim.#	Side view	Beam view	Revised 27-Nov-2006
13	OFE Cu α_2 =21 mm ~52 mm	38 mm h=38 mm	$\alpha_1=\pi/2$ rad α_2=166mrad r_1=4.0mm r_2=1.4mm
	Polished, cf. collim. 7, 12, 13		
14	Ti6Al4V α_2 =21 mm = 0.6χ_0 Ti6Al4V ~52 mm		$\alpha_1=\pi/2$ rad α_2=166mrad r_1=4.0mm r_2=1.4mm
	Polished, cf. collims. 7, 11, 13		
15	α_2 =21 mm ~125 mm		$\alpha_1=\pi/2$ rad α_2=50mrad r_1=4.0mm r_2=1.4mm
	Polished, cf. collim. 13		
16?	OFE Cu =21 mm Form t.b.d.		non-linear taper r=1.4mm
cf. ?			

Runs 3, 2007

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Variation of collimator kick with bunch length

Dependence on col1 kick at 0.5mm with mesh

Dependence on col1 kick at 0.5mm with mesh

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Big gap?

Half-gap = 1.573 mm :: z misalignment = 0.597 mm :: Slope = 157 mrad
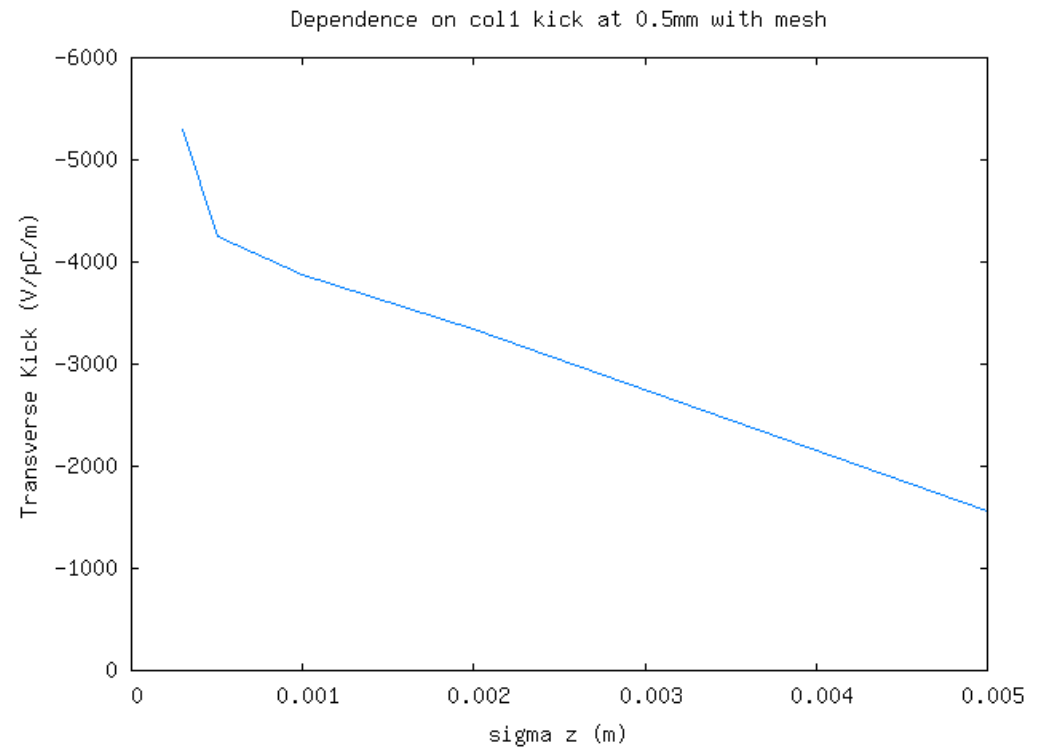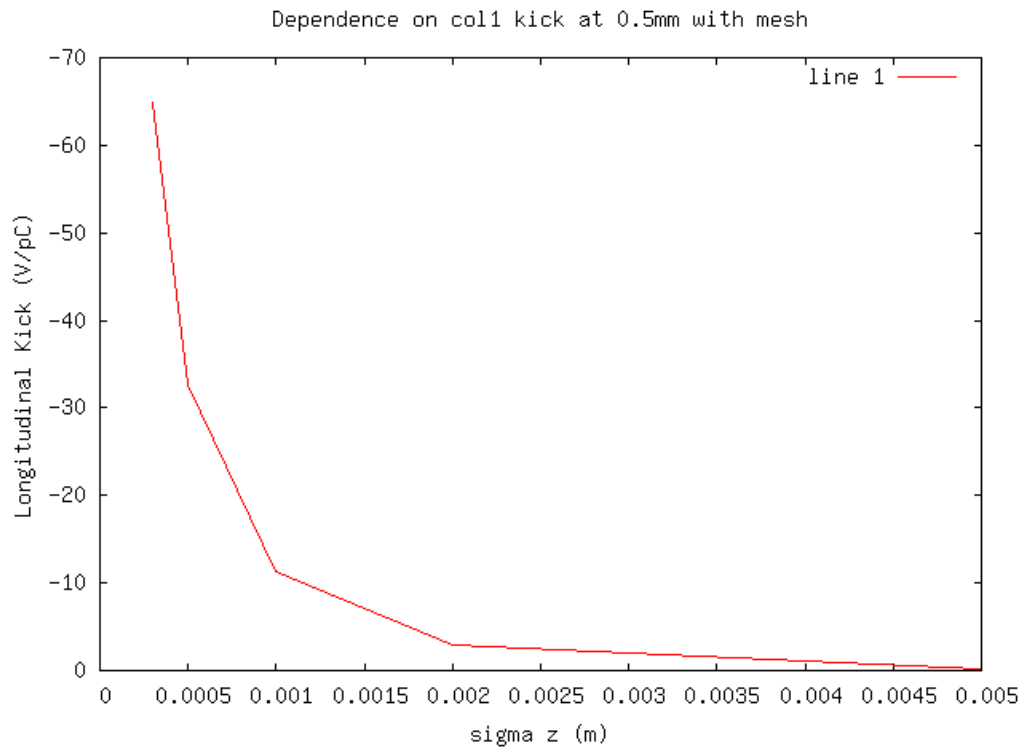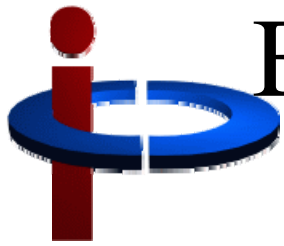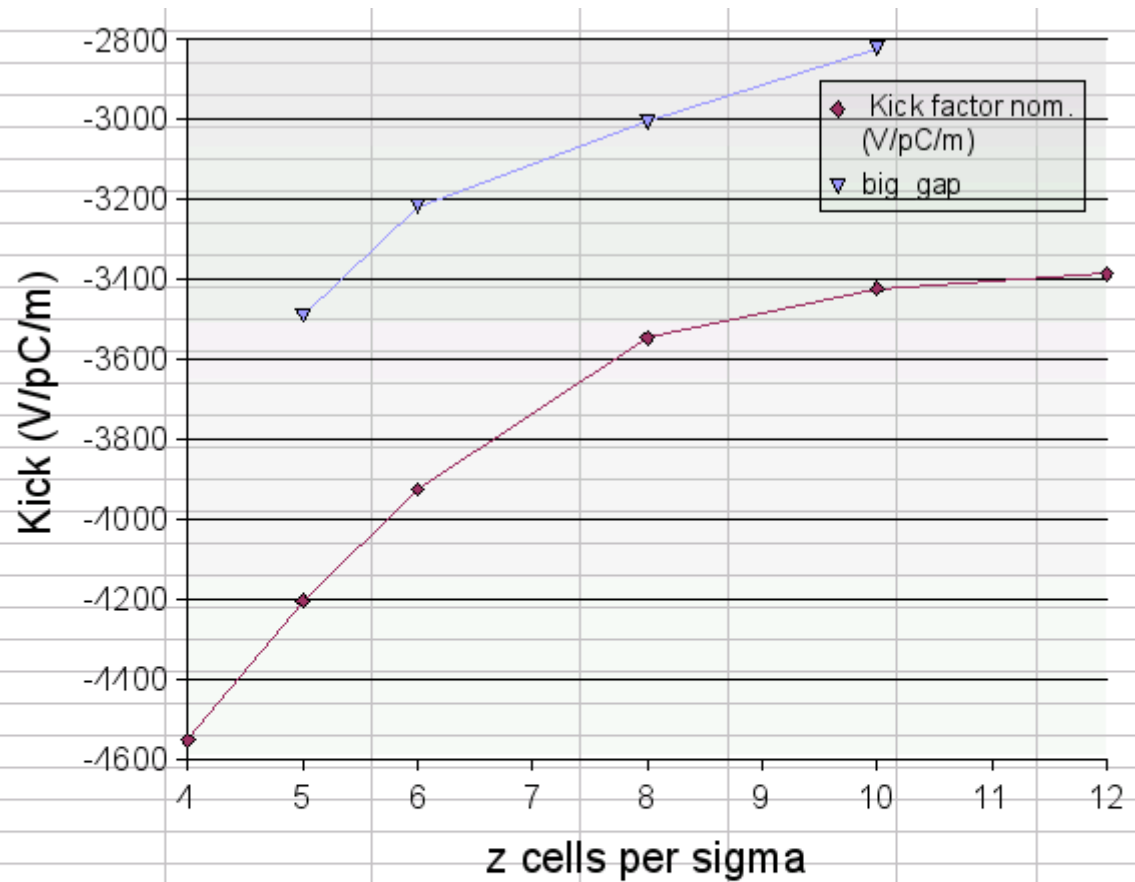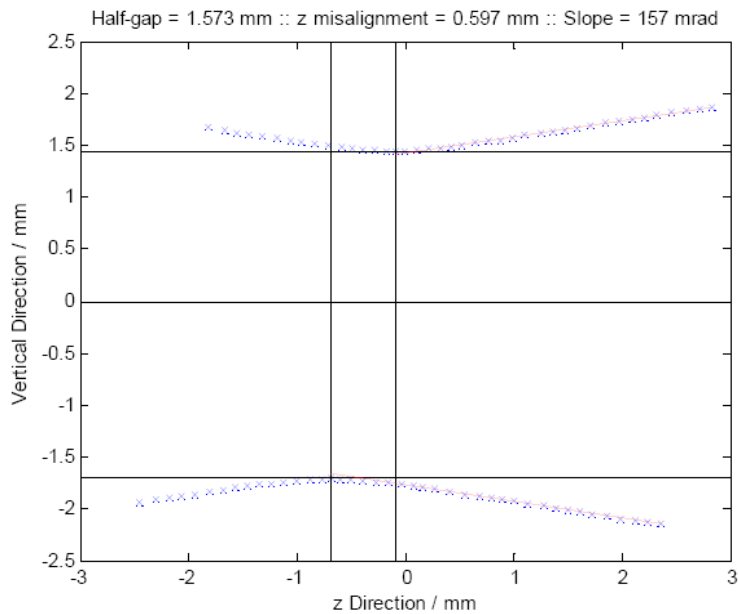
Cells per sigma	Kick factor nom.	big_gap	Reduction
4	-4552.05		
5	-4204.33	-3489.71	0.17
6	-3925.08	-3218.45	0.18
8	-3545.98	-3006.44	0.15
10	-3422.85	-2822.07	0.18
12	-3385.7		
15	-5596825		

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Misallignment

Col 5, 1mm, 10cells/sigma
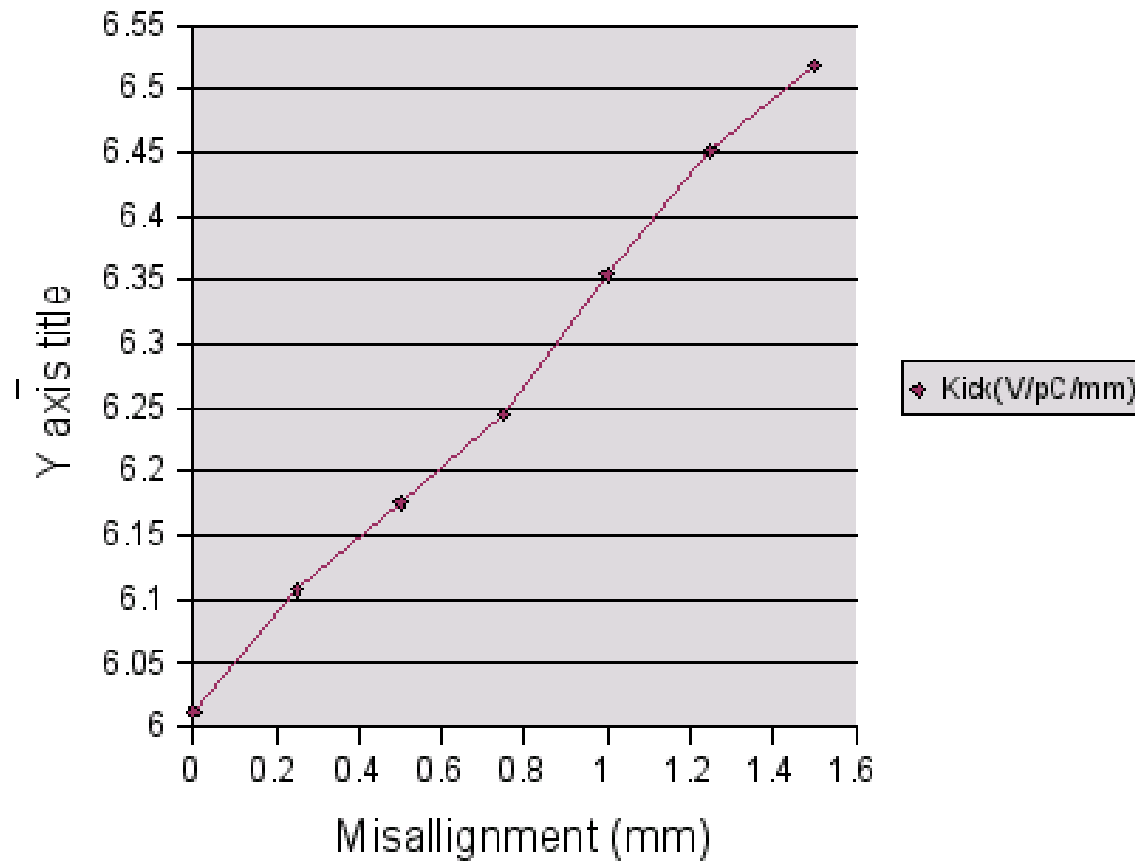
GdfidL & PBCI

- TEMF working on ECHO/PBCI – 3D, moving mesh, conformal, non-dispersive solver

GdfidL

$\sigma/\Delta z=6$

PBCI

$\sigma/\Delta z=5.5$
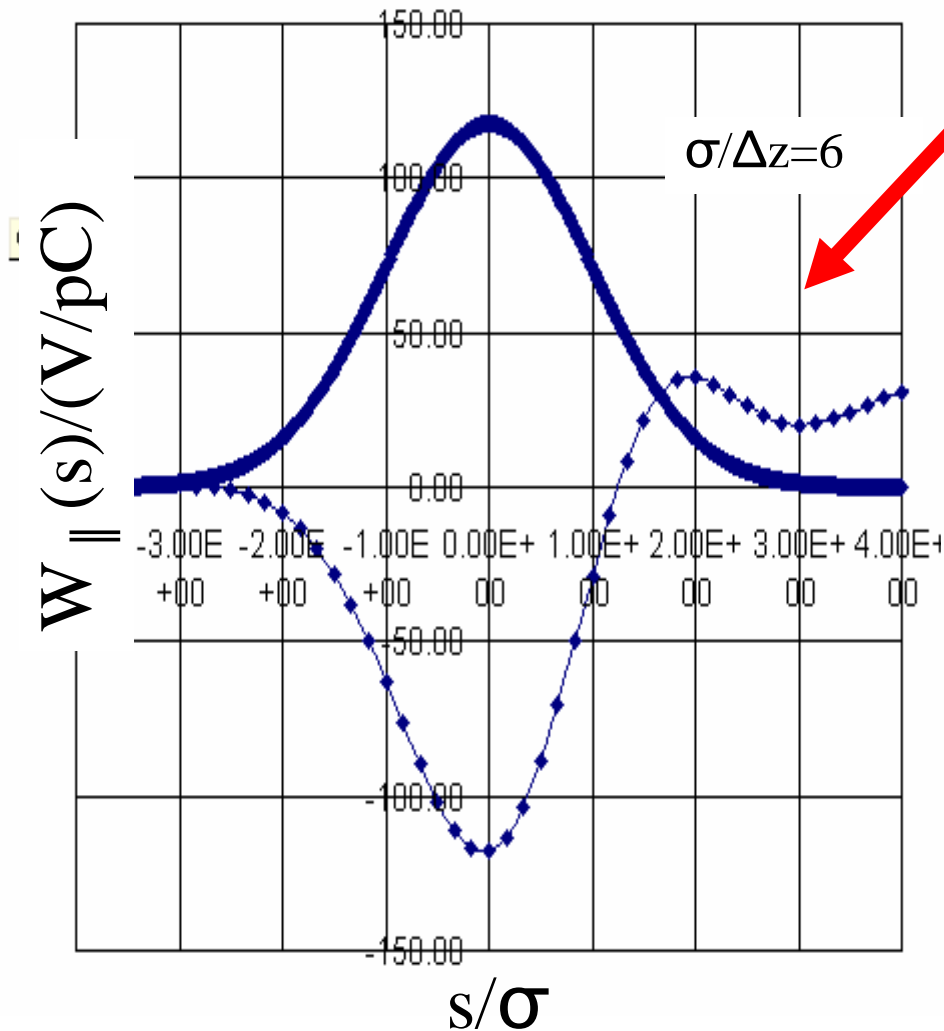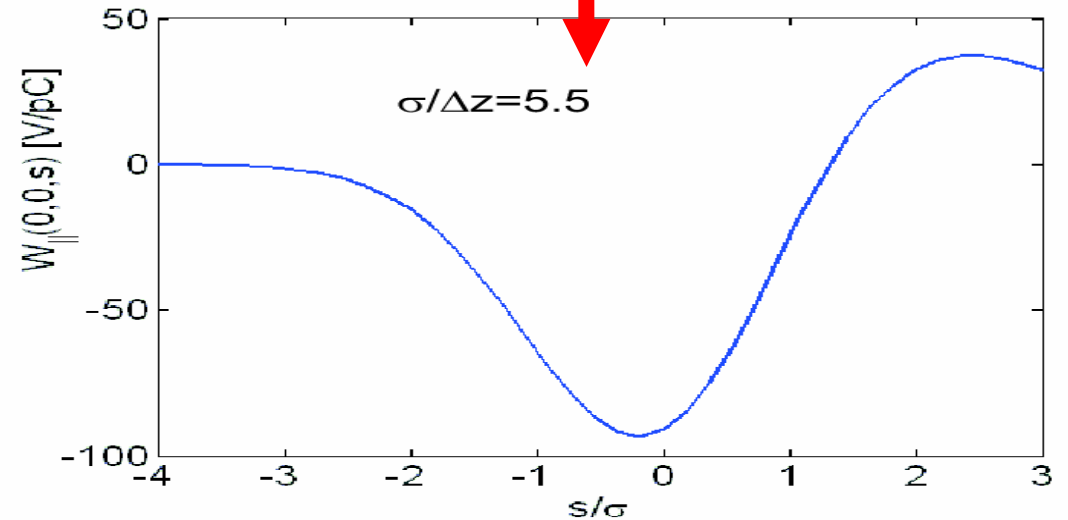
With thanks to Mikko Kärkkäinen

Conclusion

Now starting second iteration…

EM simulations: •MAFIA •GdfidL •ECHO		
Bench Tests (scaling?)	Prediction of effect at IP (MERLIN)	New designs
Beam Tests ESA Damage Studies ?	Prediction of mechanical properties	
Analytical Approach (Lancaster Theory Group)		