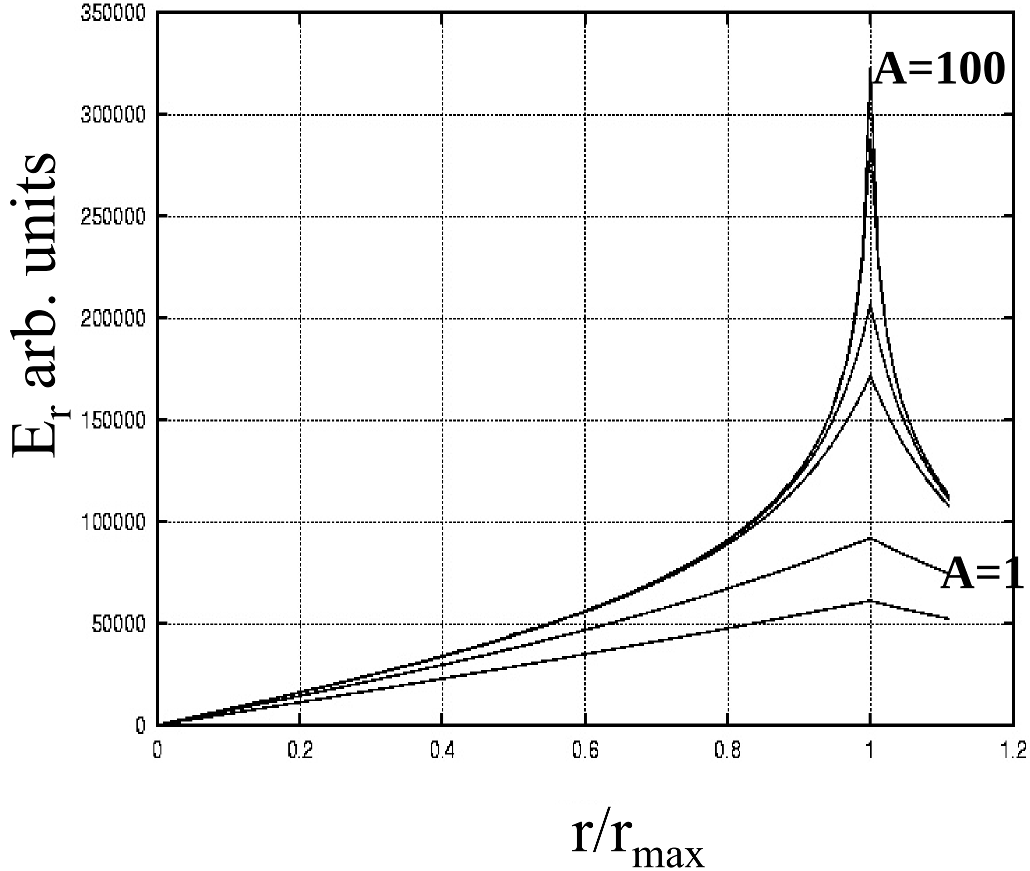
The Uncompleted Low Charge Simulation Study

Multi purpose:

- start with lower charge and compress harder to produce shorter bunches.
- operation at lower beam energy (M. Pedrozzi, PSI, Linac ’04, TUP45).
- Eindhoven proposal for a different particle distribution.
- Eindhoven proposal to generate ‘pan-cake’ like bunches.

Cylindrical particle distribution

E_r vs r for varying aspect ratio of the bunch



$$A = \frac{\sigma_x}{\gamma \sigma_z}$$

Transverse fields are strongly non-linear for the cylindrical particle distribution for 'pan-can' like bunches

Ellipsoidal particle distribution

The non-linearities of the cylindrical distribution are responsible for the emittance growth at the cathode.

A uniformly filled ellipsoid has linear transverse fields for all aspect ratios.

“We should stay in the pan-cake regime as long as possible, i.e. start with short bunches” (M. van der Wiel).

Remarks

- the non-linearities are to some extend self-compensating.
- does the emittance compensation work with the ellipsoidal distribution?
- during the emission process the distribution is not ellipsoidal, i. e. non-linearities will arise.

Boundary Conditions for the Study

Start very academic:

- ignore thermal emittance
- ignore rise time of the laser
- arb. high fields in the booster
- TTF like gun: Gradient 40 MV/m, Solenoid position fixed (~12 cm)
- charge fixed at 100 pC

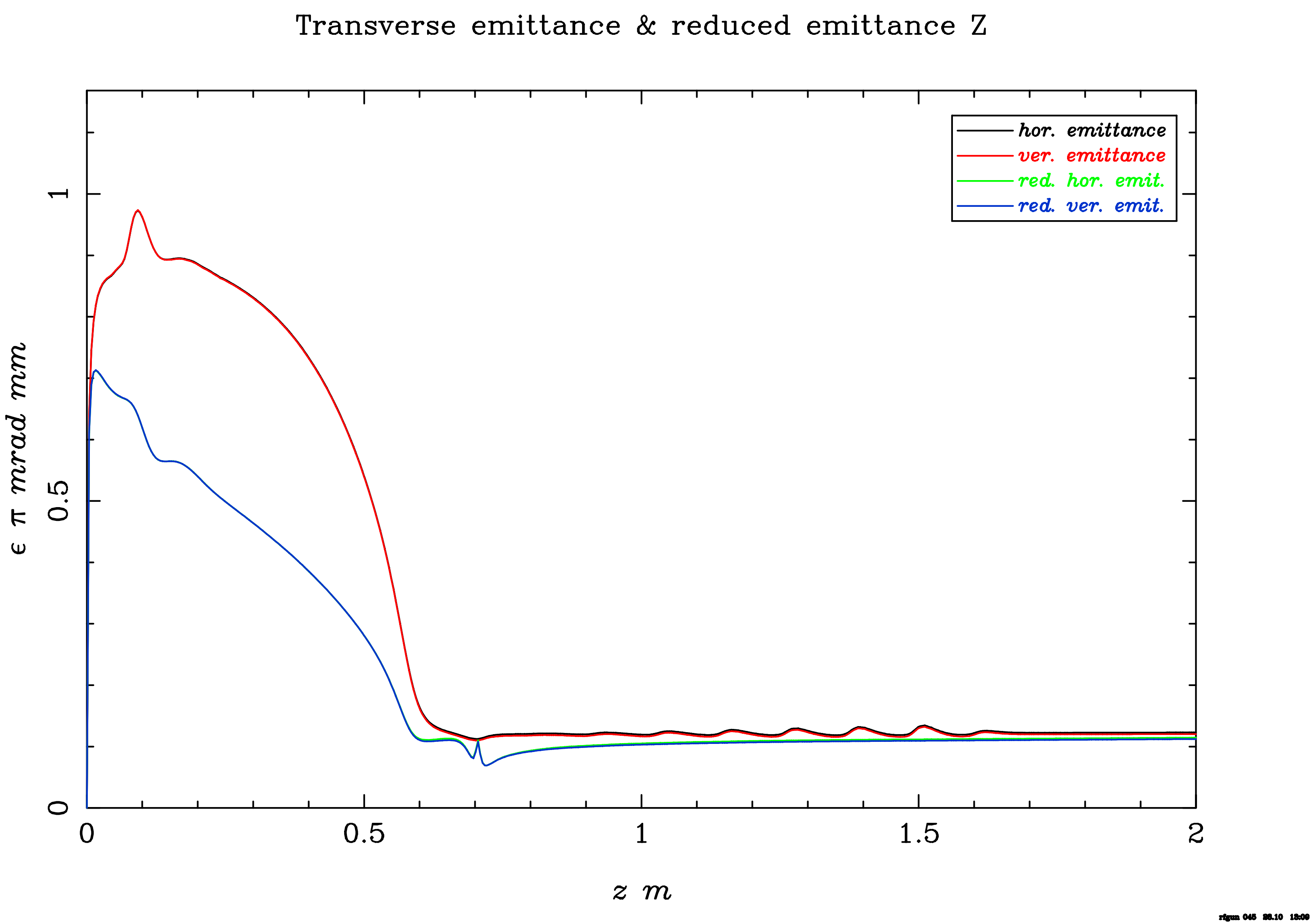
Spot Size and Length

L_{tot}	L_{tot}	I	R	A $\gamma=1$
ps	mm	A	mm	
3.43	1.0	30/40	1.5	~0.8
3.43	1.0	30/40	0.6	~0.3
20.0	6.0	5/6.6	0.3	~0.05

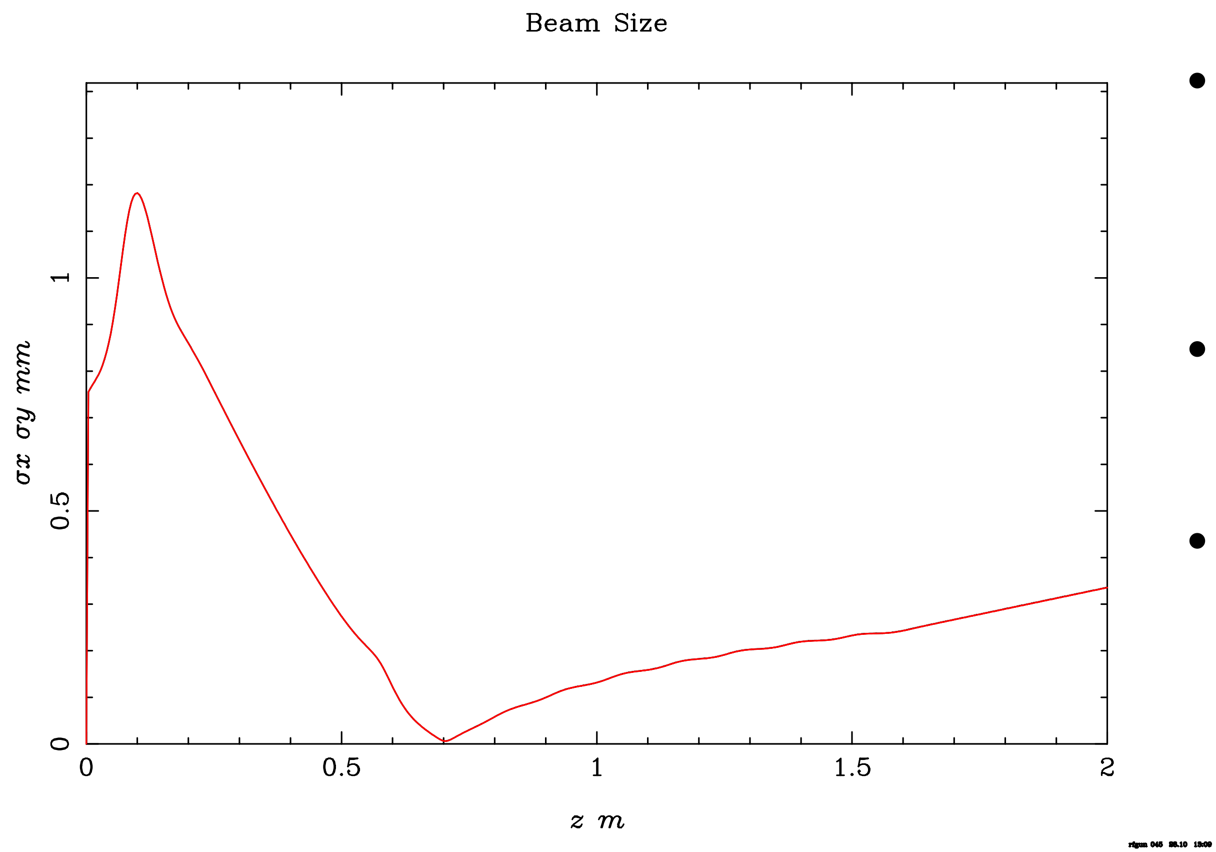
Results: A=0.8

	ε_{proj}	ε_{slice}	I
cylindrical	0.122	0.05	24 A
ellipsoidal	0.06	0.05	24 A

Emittance for Cylindrical Distribution

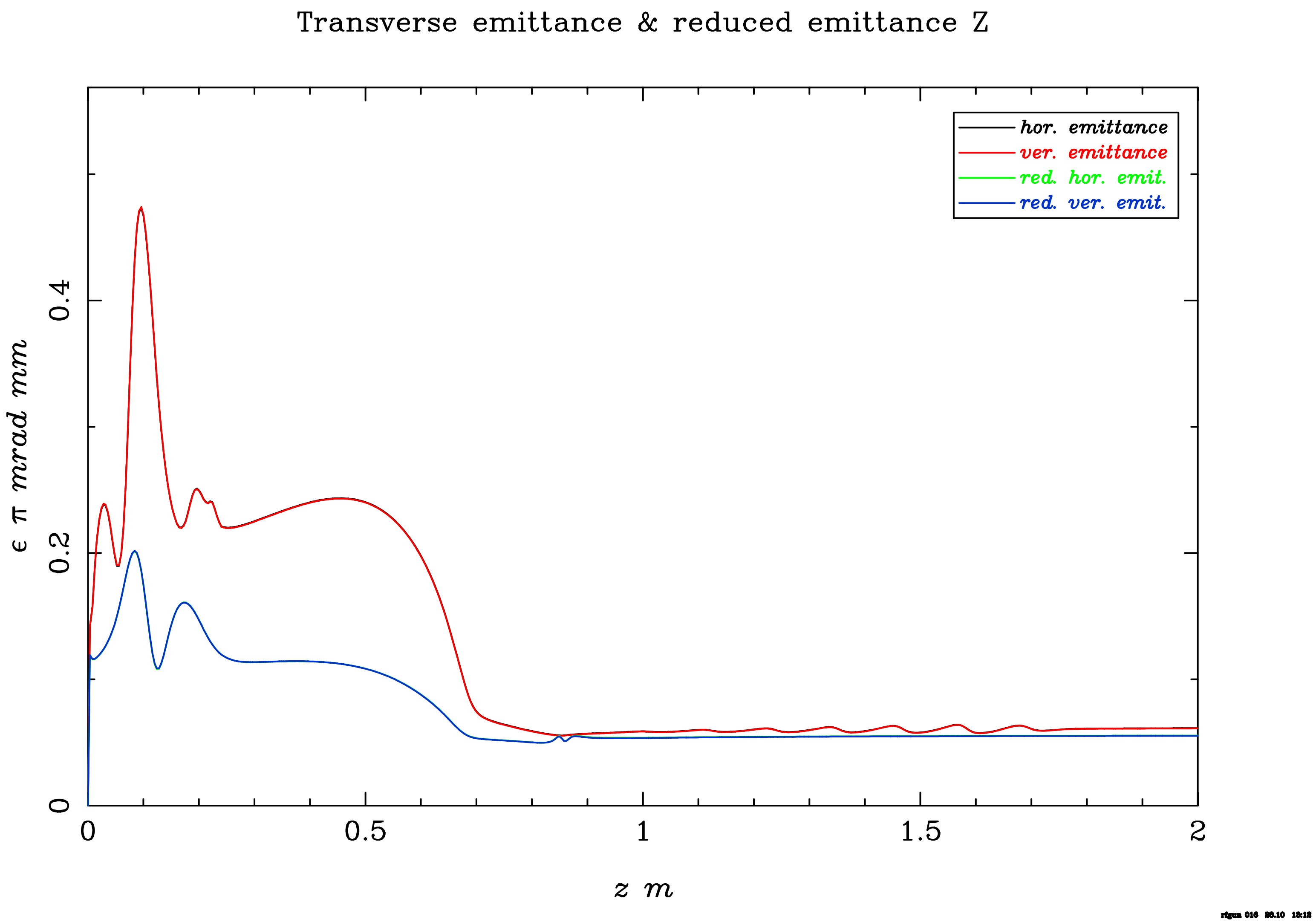


Spot size for Cylindrical Distribution



- very strong focusing
- 141 MV/m peak gradient in the booster
- no double emittance minimum
- invariant envelope?

Emittance for Ellipsoidal Distribution



Results: A=0.3

	ε_{proj}	ε_{slice}	I
cylindrical	0.16		
ellipsoidal	0.12		

booster not yet included!

Results: A=0.05

	ε_{proj}	ε_{slice}	I
cylindrical	0.097	0.08	4.5 A
ellipsoidal			

… to be continued