Assessing target robustness and ignition performance for a direct drive ICF target

A. Schiavi

OLUG, Rochester, 2010

Collaborators in HiPER WP9

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- M. Temporal, GIFI, Univ. Pol. of Madrid
- G. Schurtz, X. Riberye, L. Hallo, CELIA, Bordeaux

POLITÉCNICA
Ingeniamos el futuro

The road ahead...

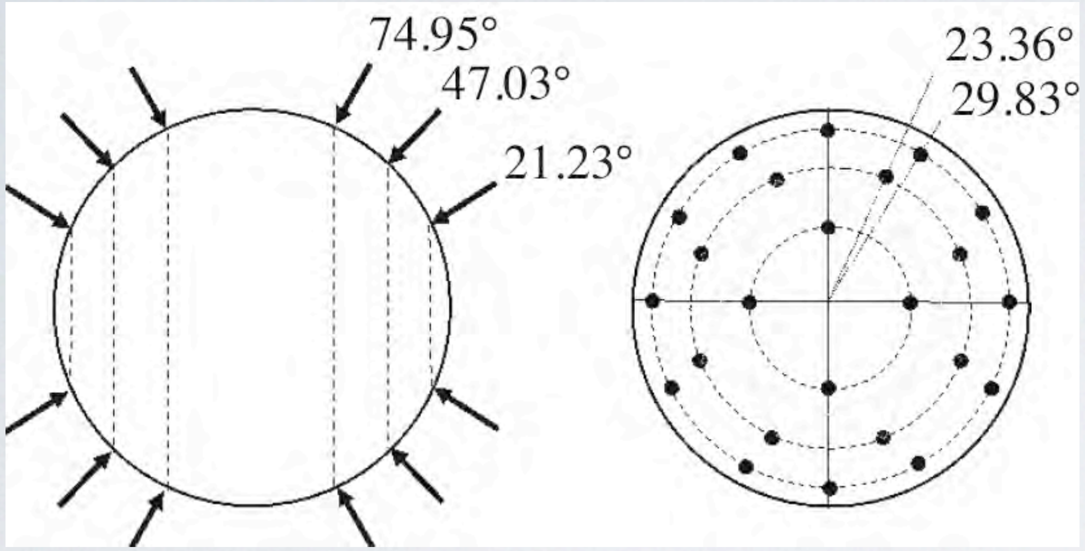
Target positioning

Raytracing 3D

Parametric scan

Target mis-positioning at TCC

Irradiation geometry

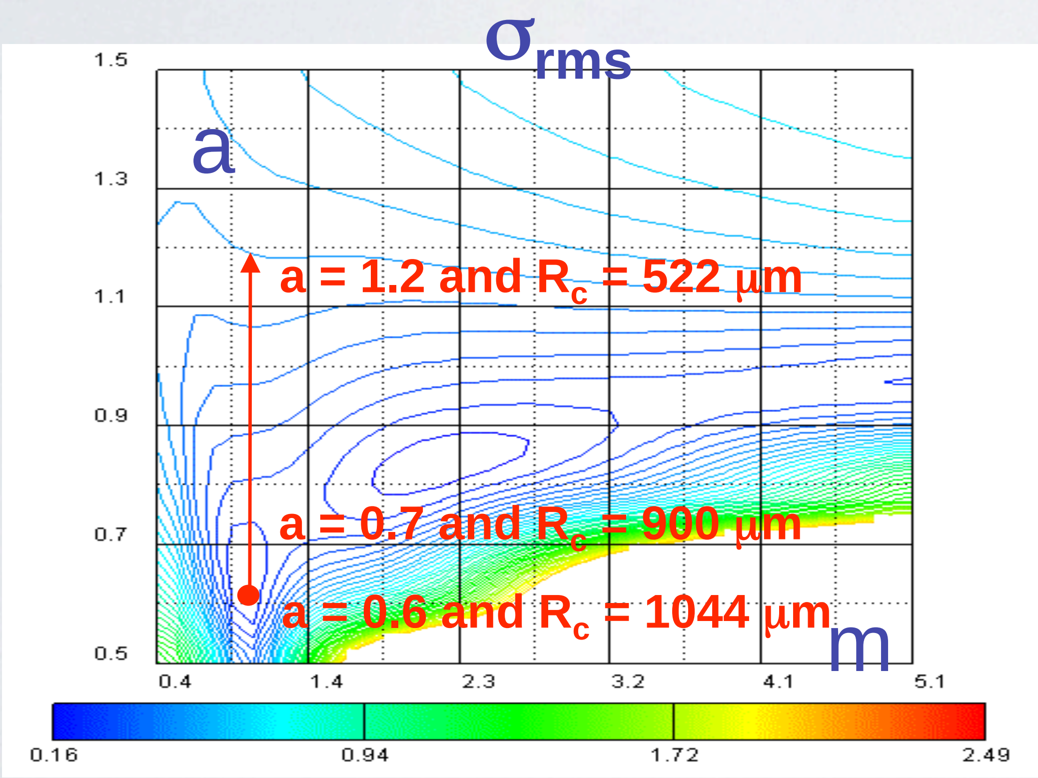


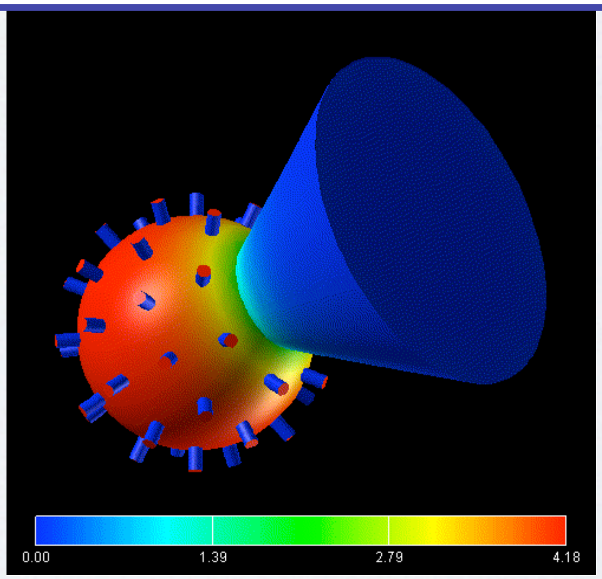
	l-mode
Perfect beam	*12, 8, 10*
Balance (10%)	1, 2, 12, 3
Pointing (5 mrad)	2, 3, 1, 4
centring (2%)	12, 2, 3, 1

Energy balance 94%,

Illumination asymmetry σ_{rms} = 0.15 %

Main low l-modes : 12, 8 and 10 (< 0.004)

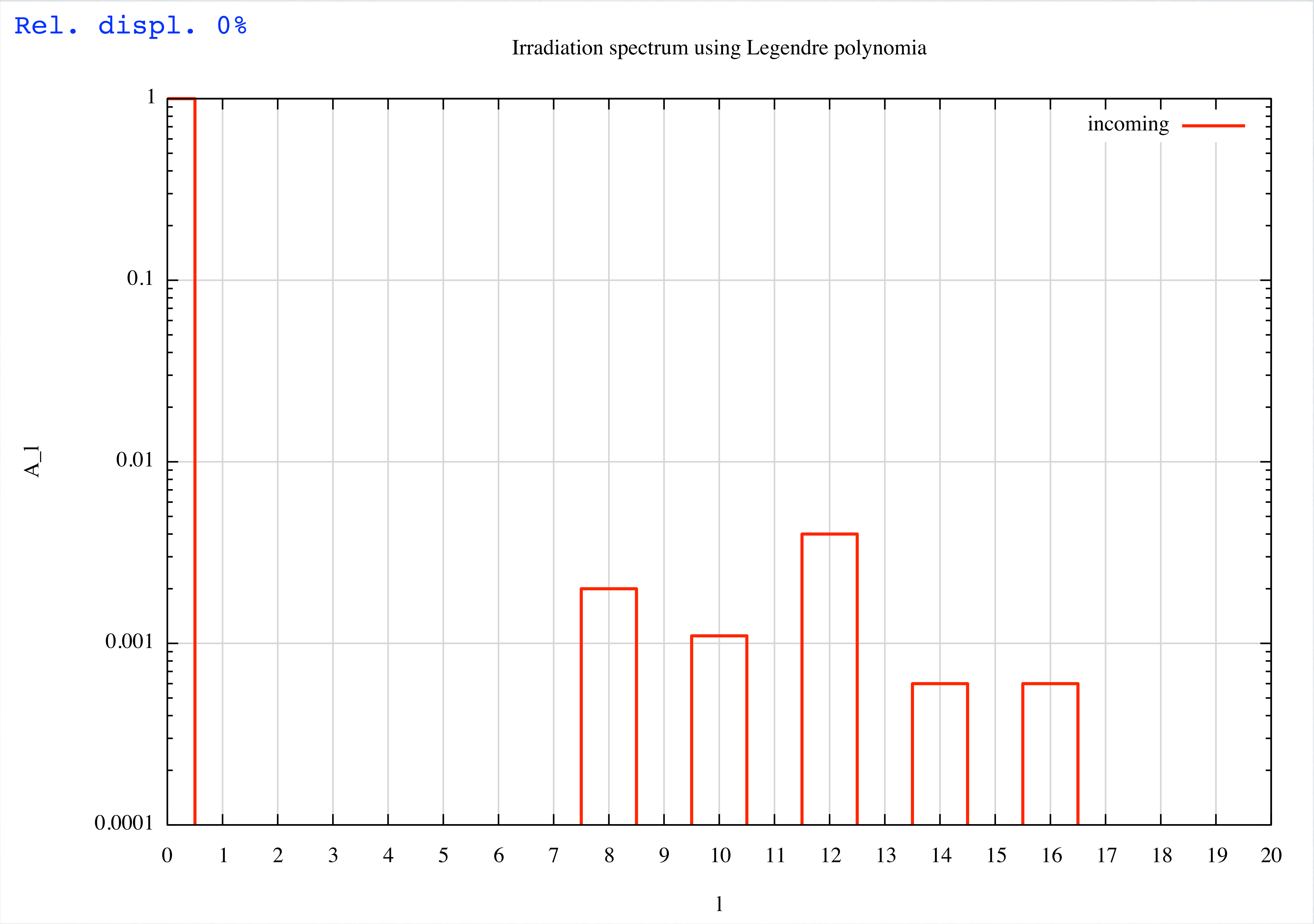




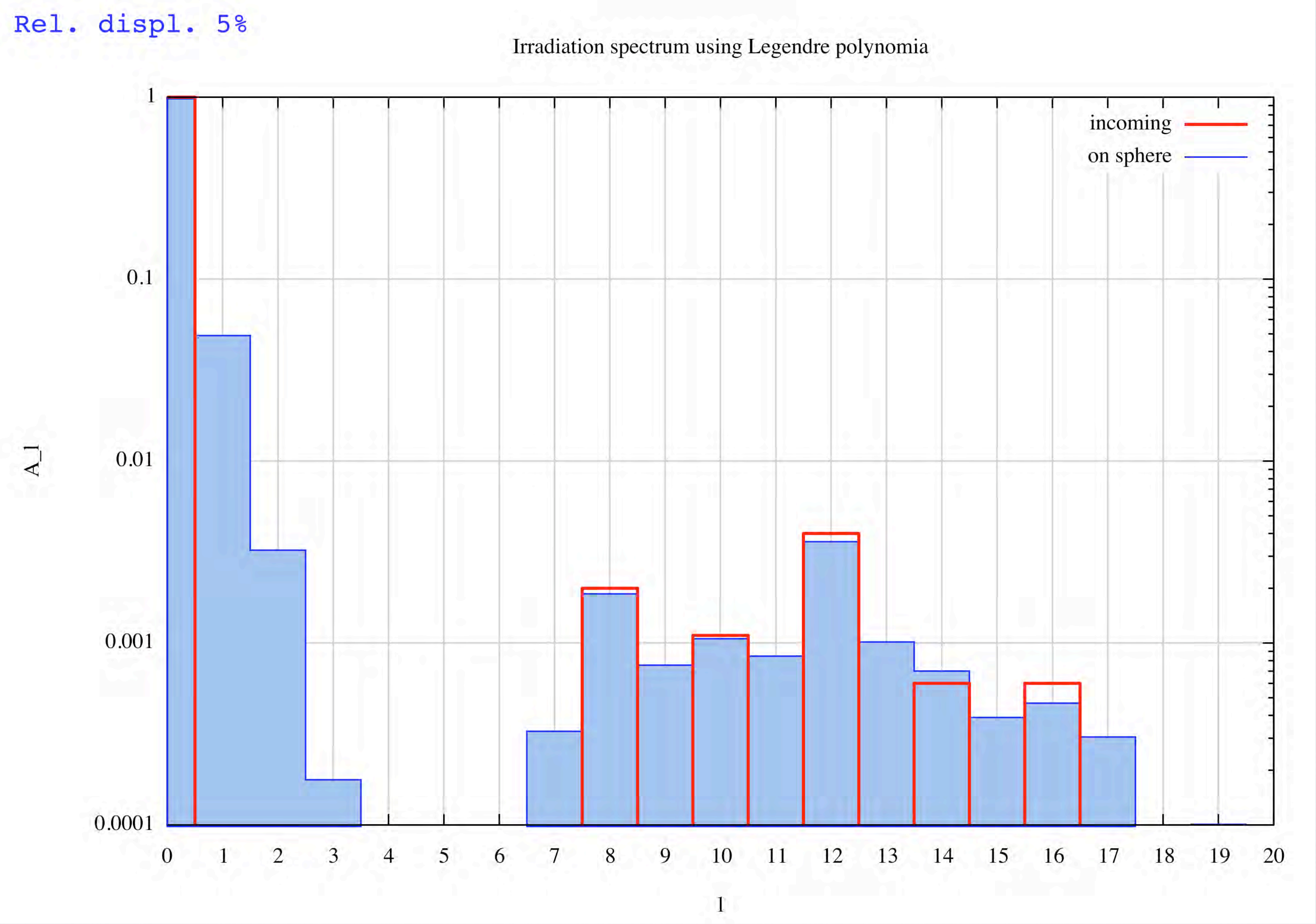
On the cone : 26 % of max intensity
Inside the cone : 2% of max intensity

J.-L. Feugeas and CELIA

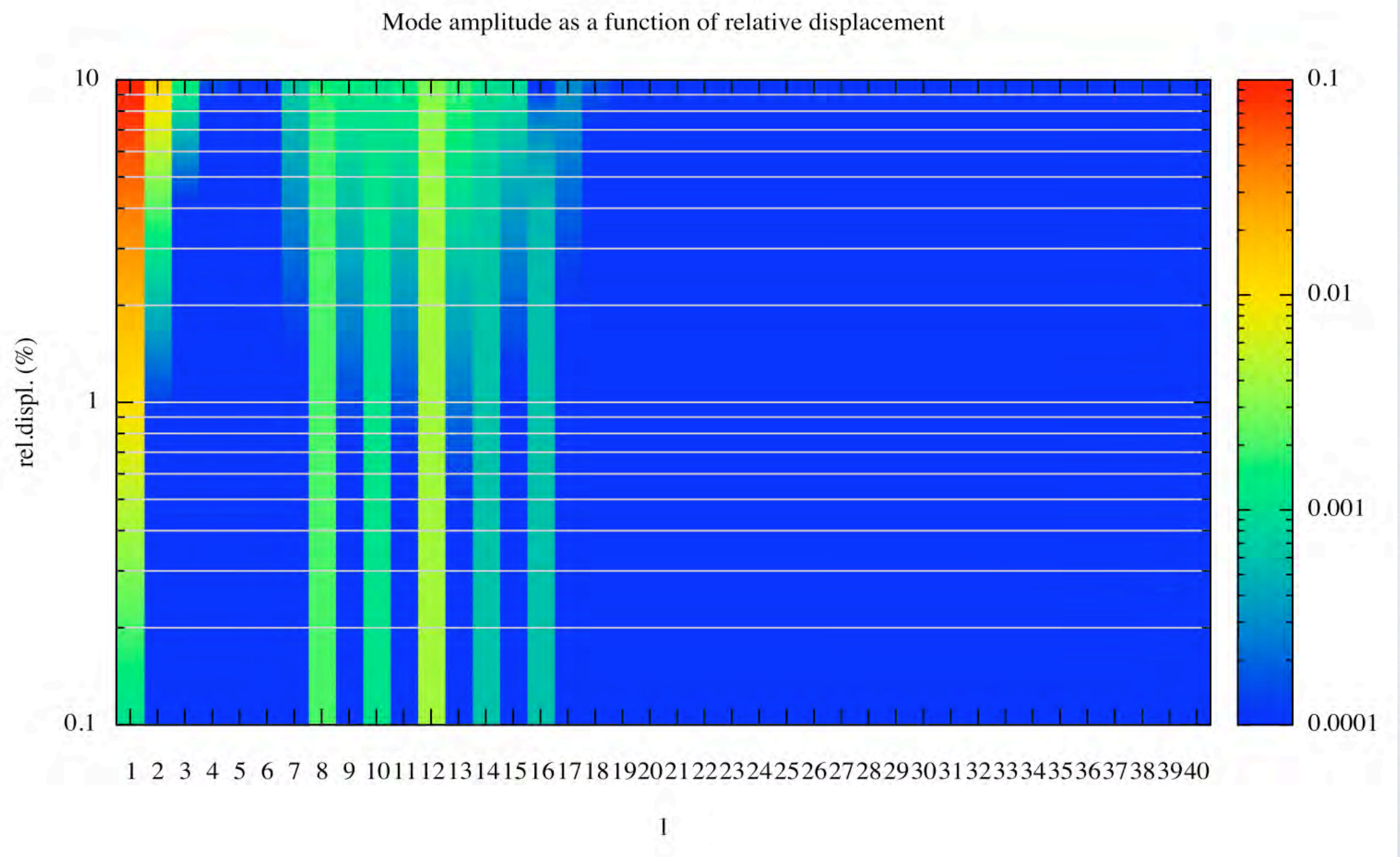
Target irradiation



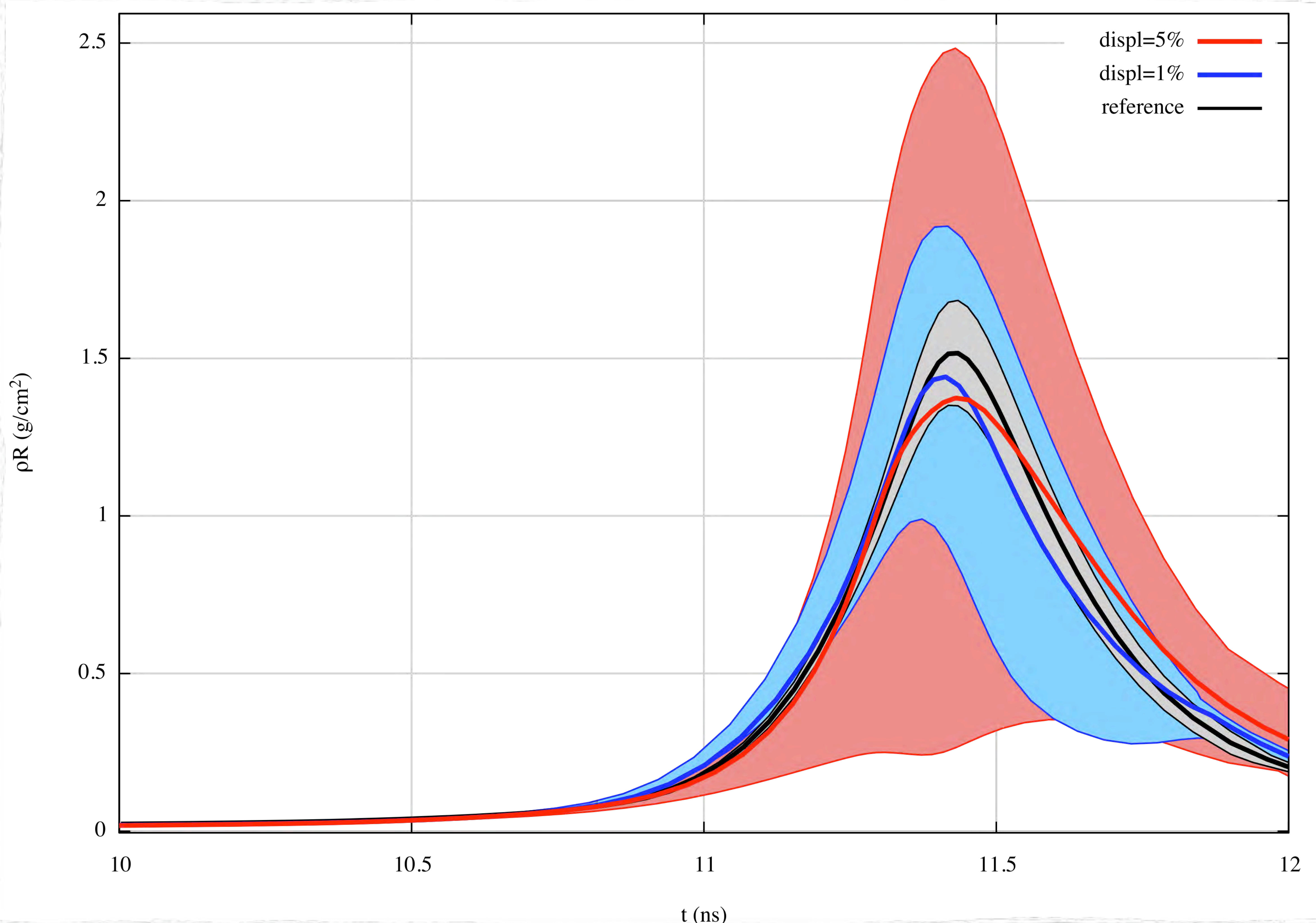
Target irradiation



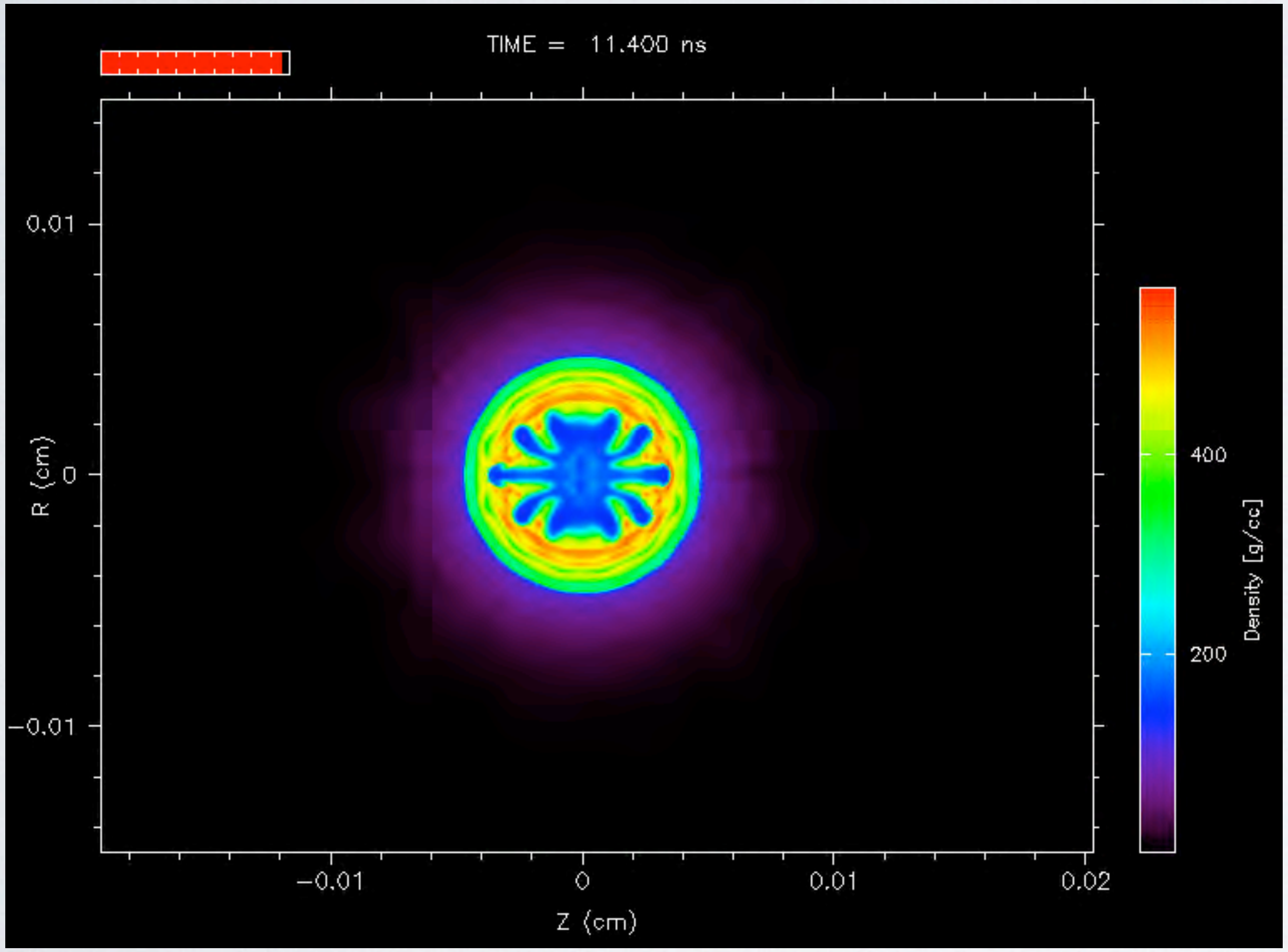
Incoming spectrum modification



Target tolerance to rel. displacement

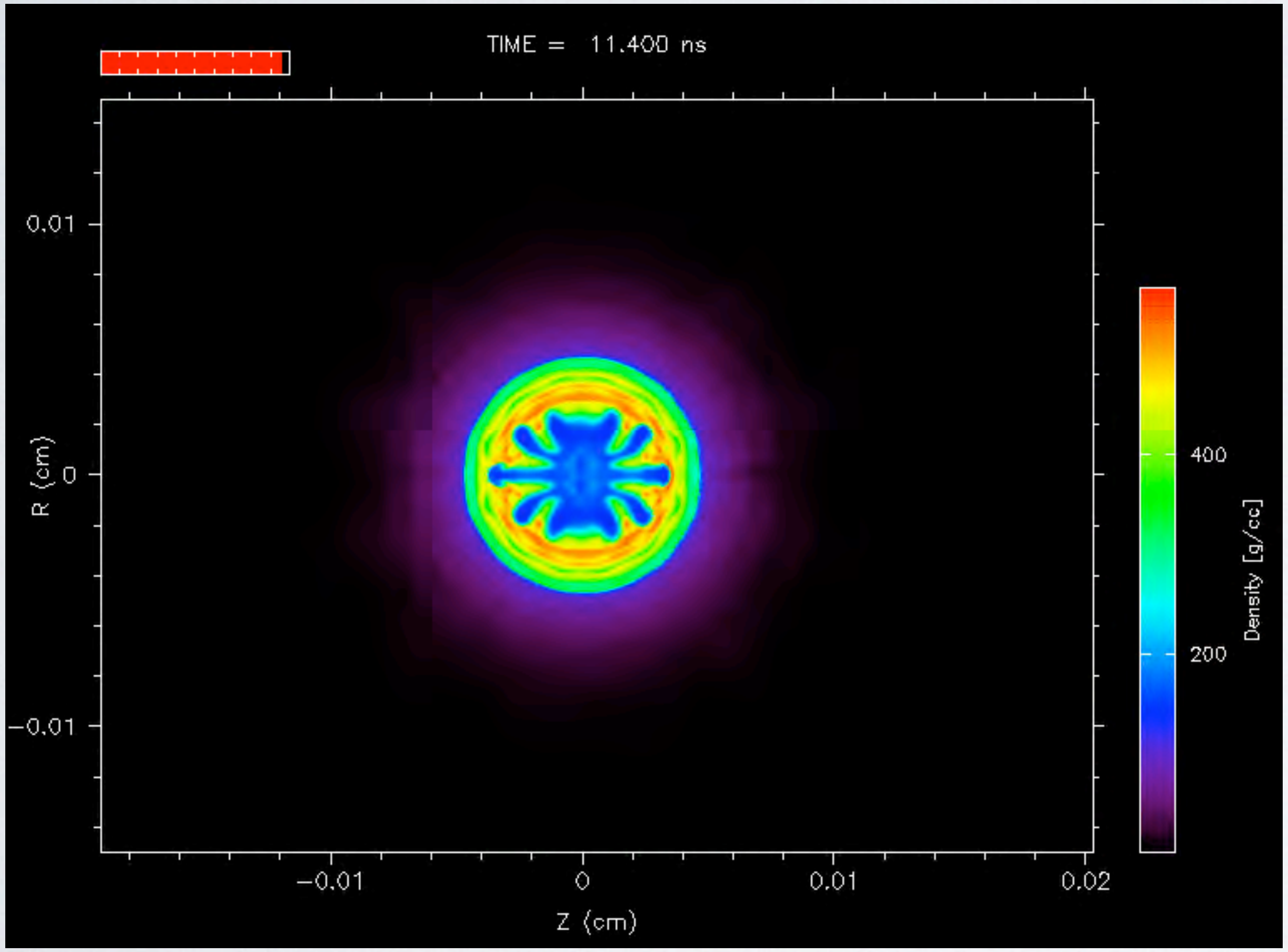


Density map at peak compression

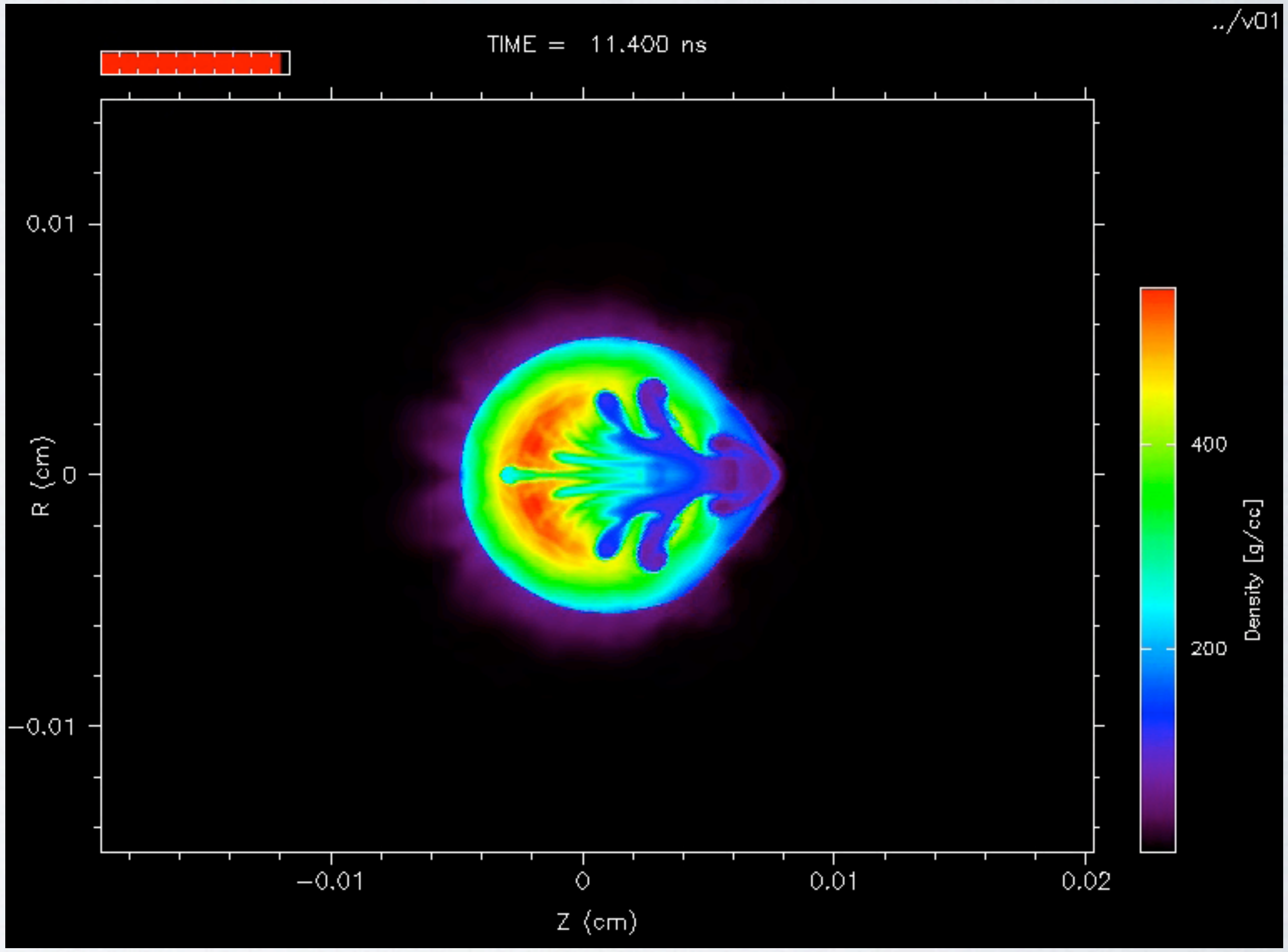


0%

Density map at peak compression



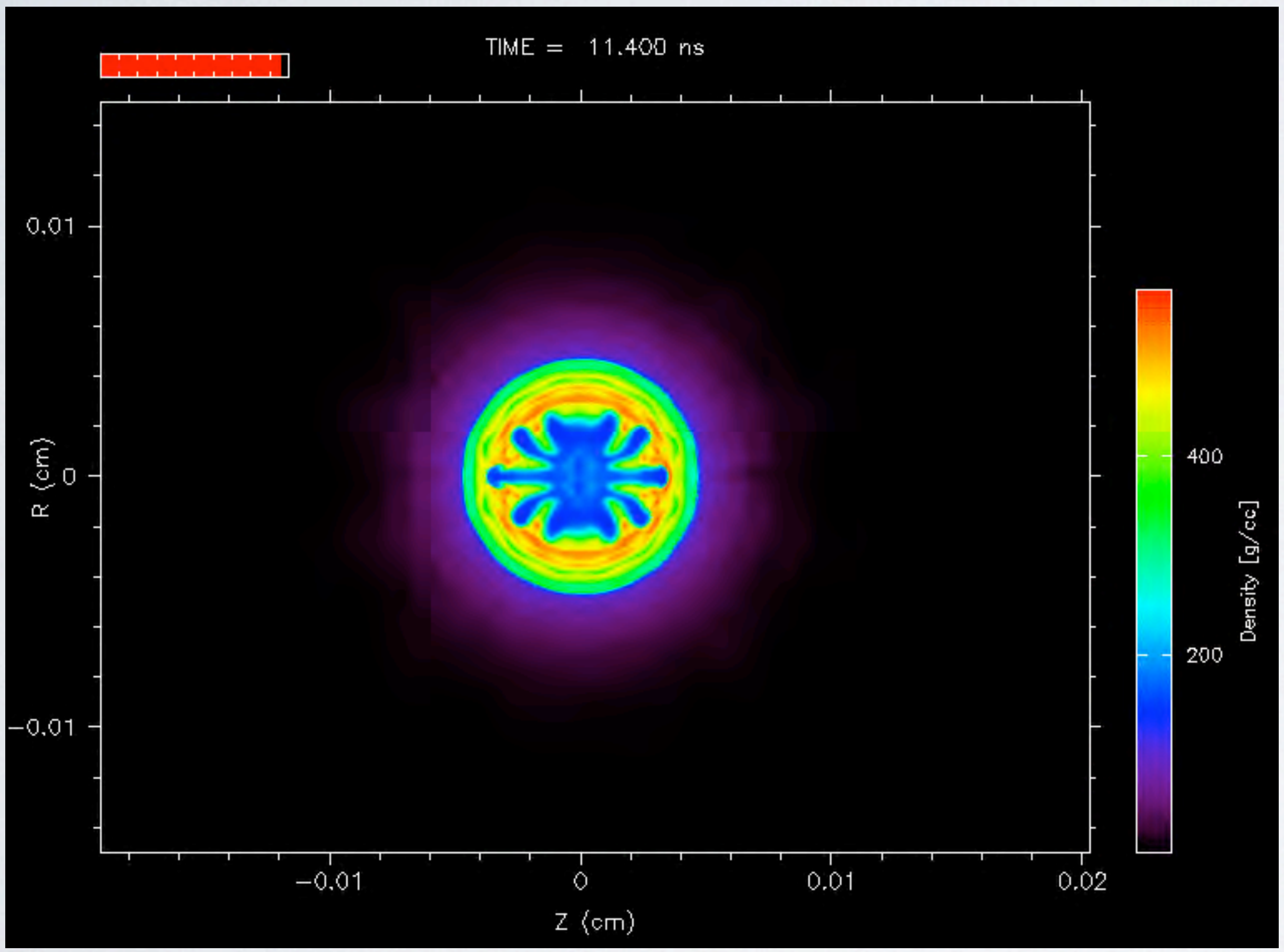
0%



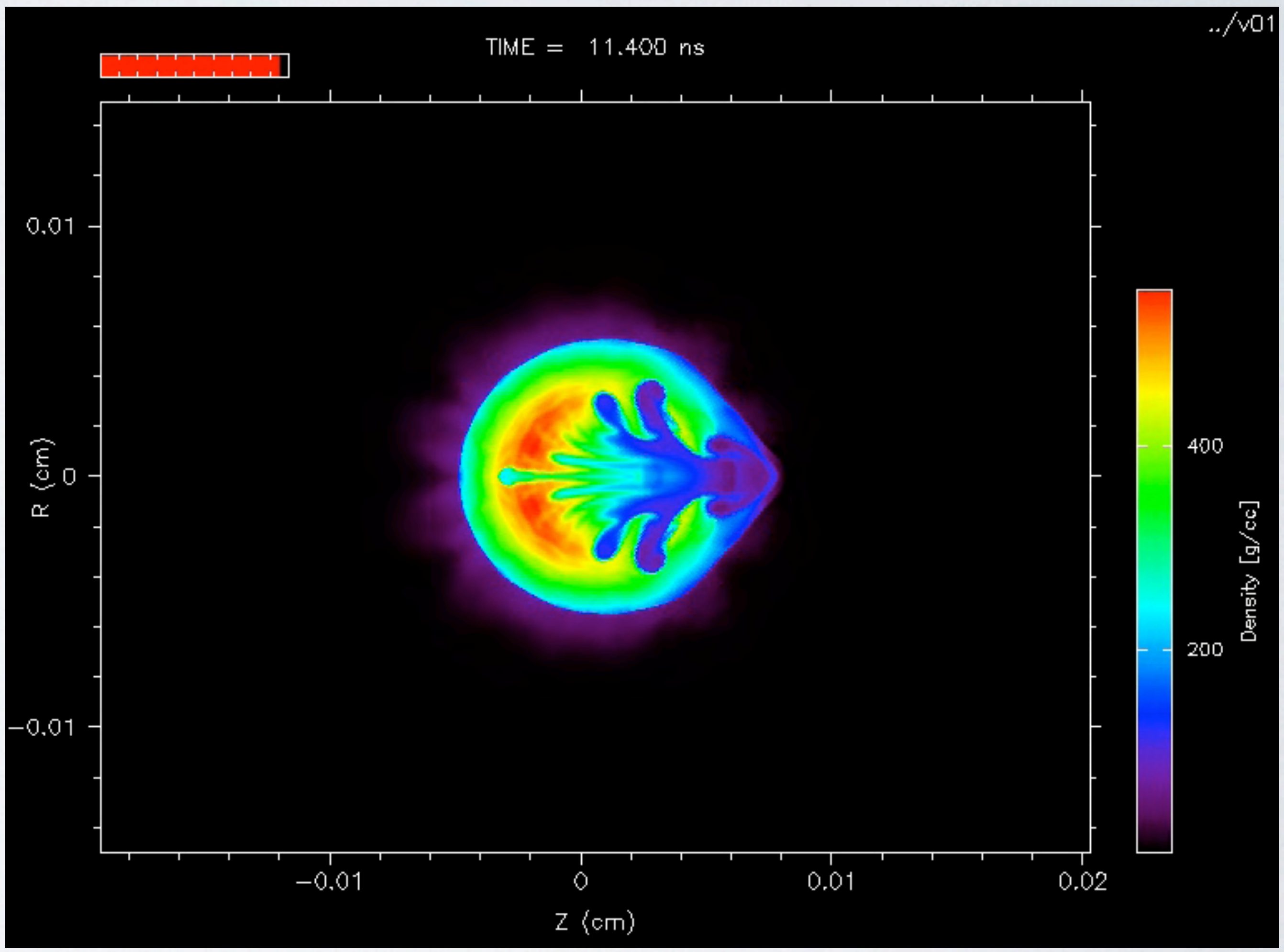
1%

1% displacement = 10 μm !

Density map at peak compression

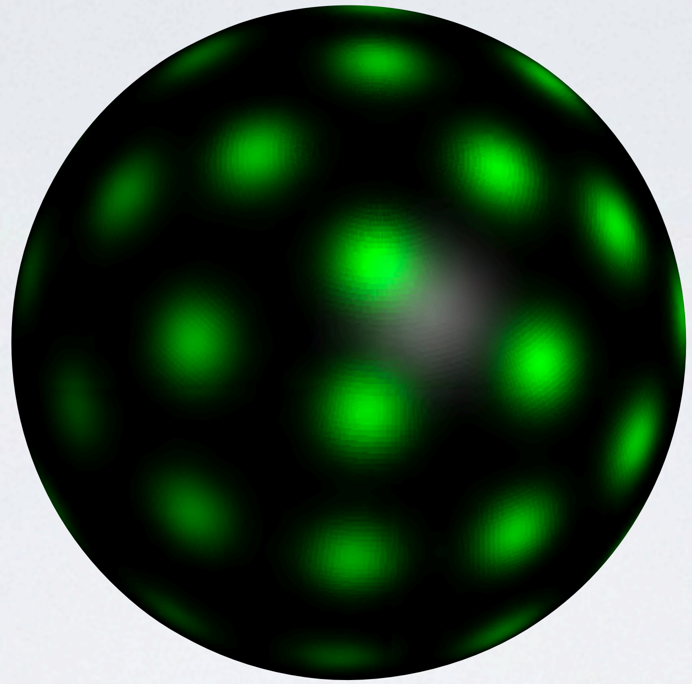


0%

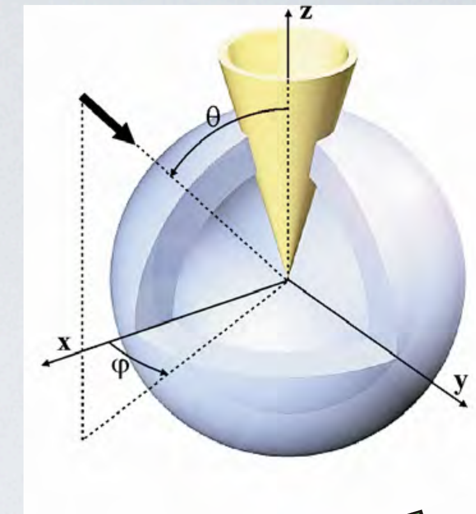


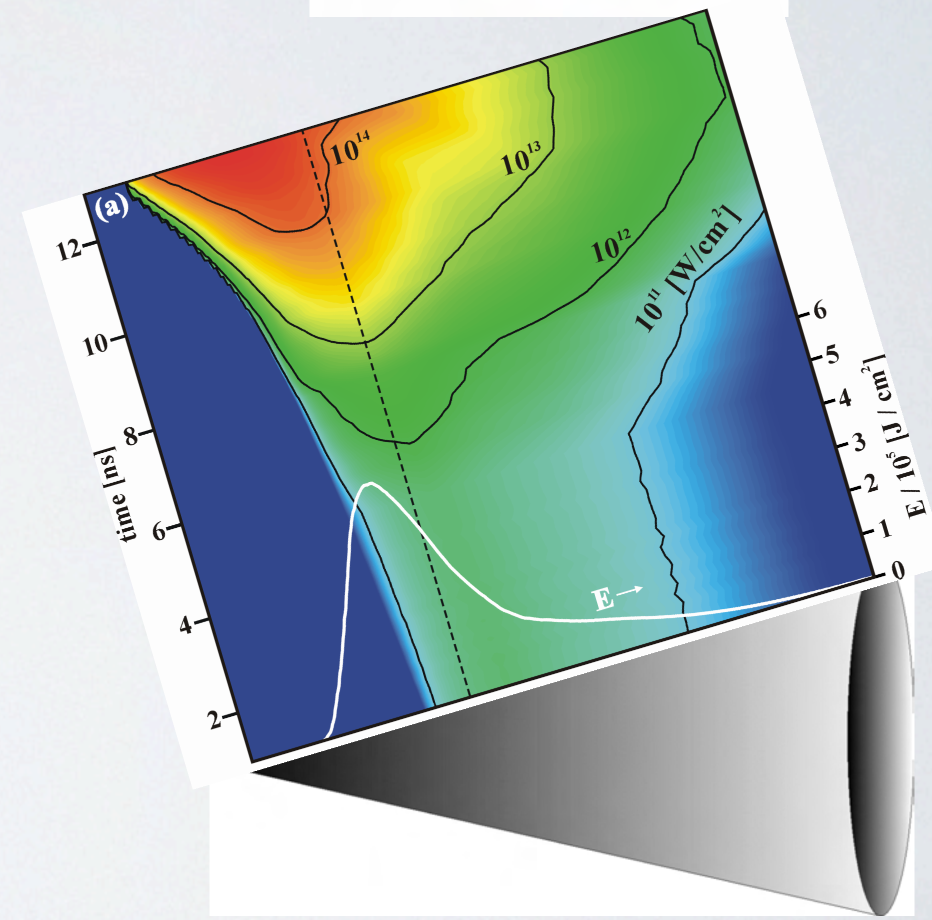
1%

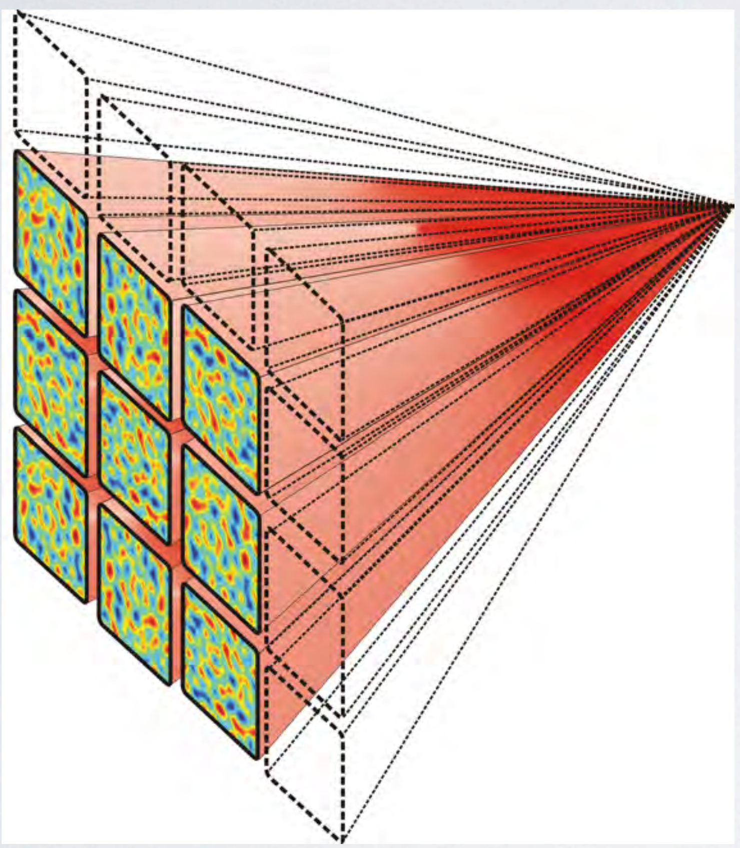
3D raytracing for studying irradiation patterns



HiPER 48 beams







Beamlets splitting

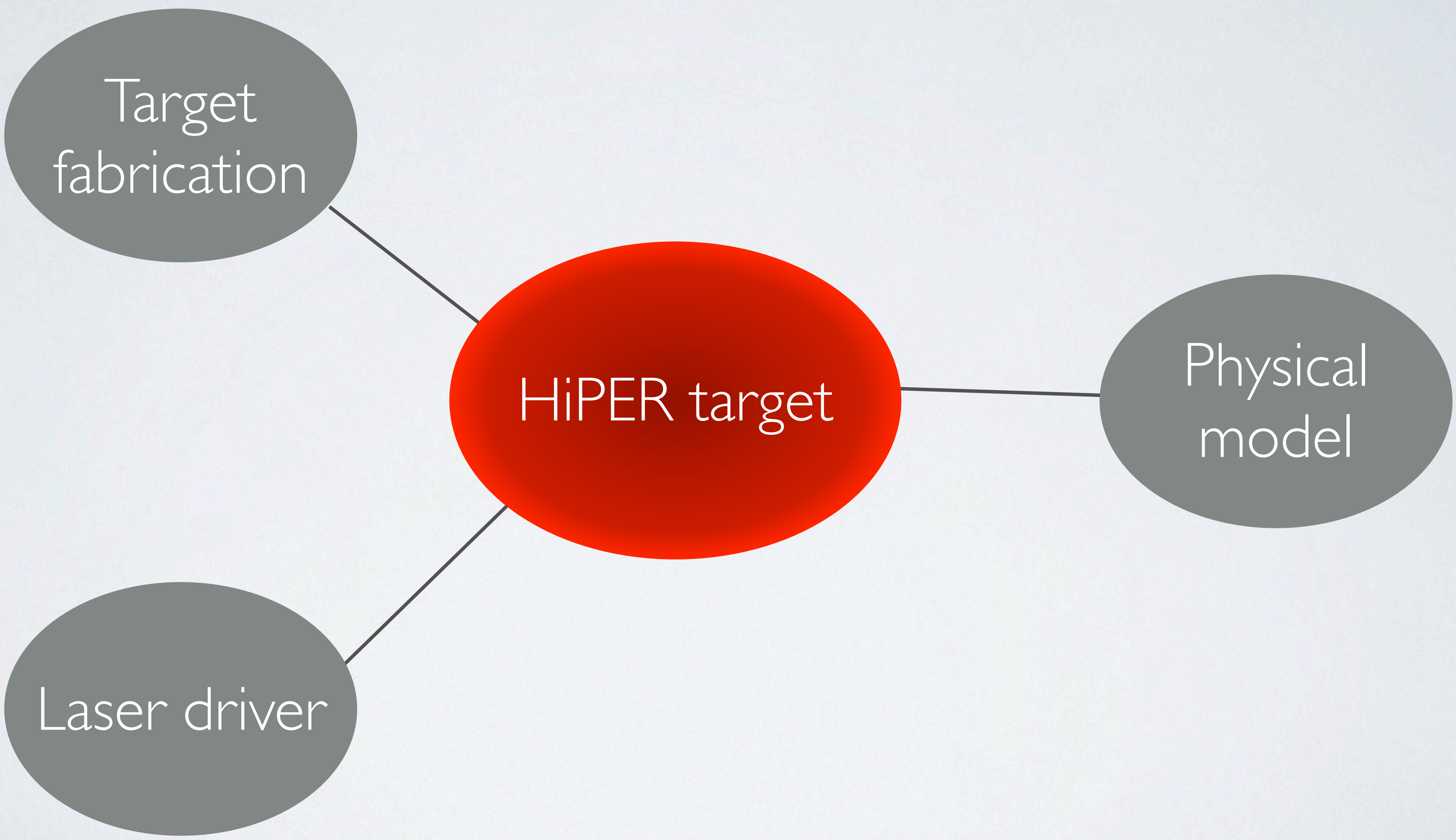
M. Temporal et al, PoP 17 (2010)

Irradiation of the cone

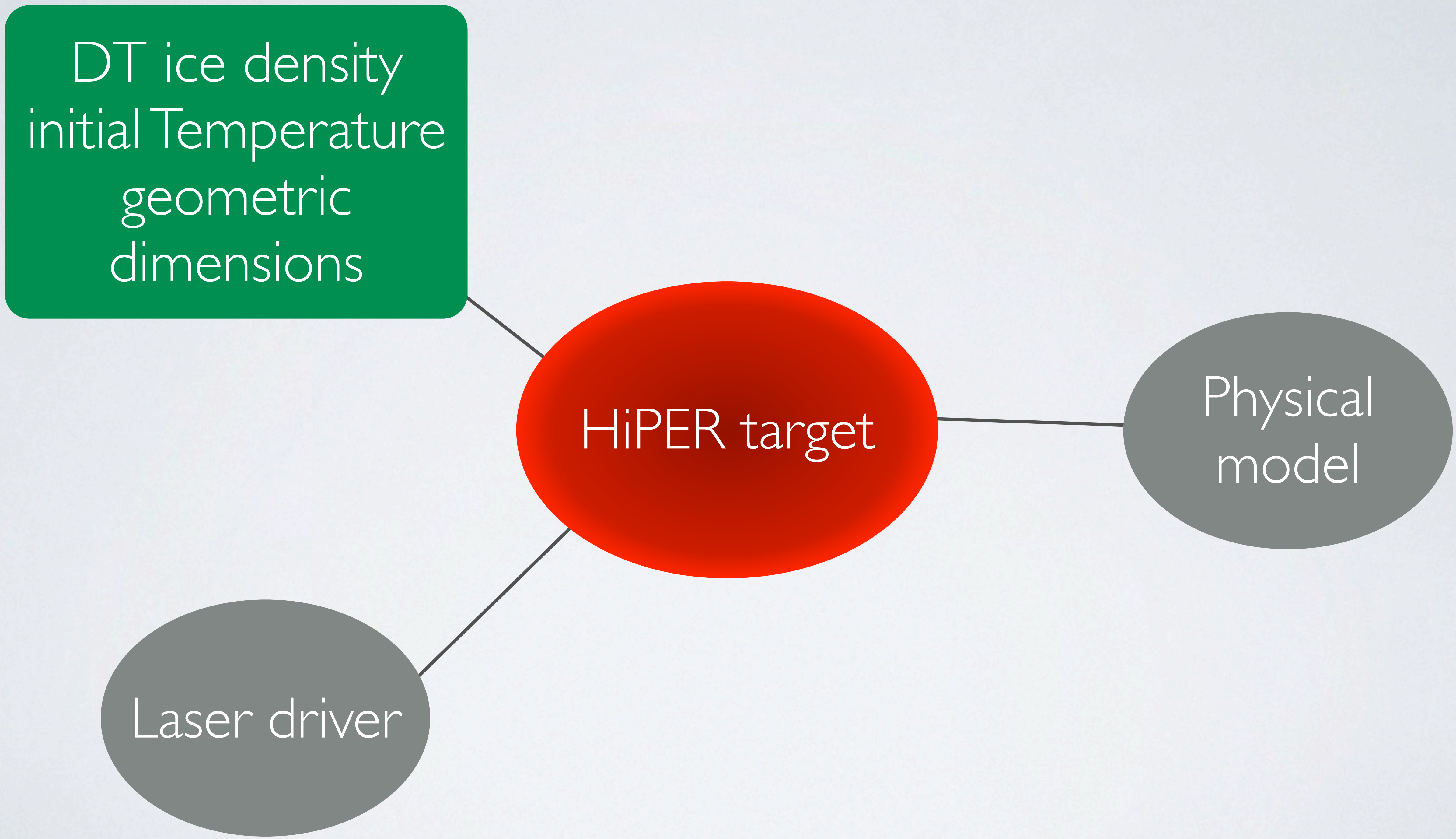
M. Temporal et al, PoP 16 (2009)

1D parametric study of target implosion

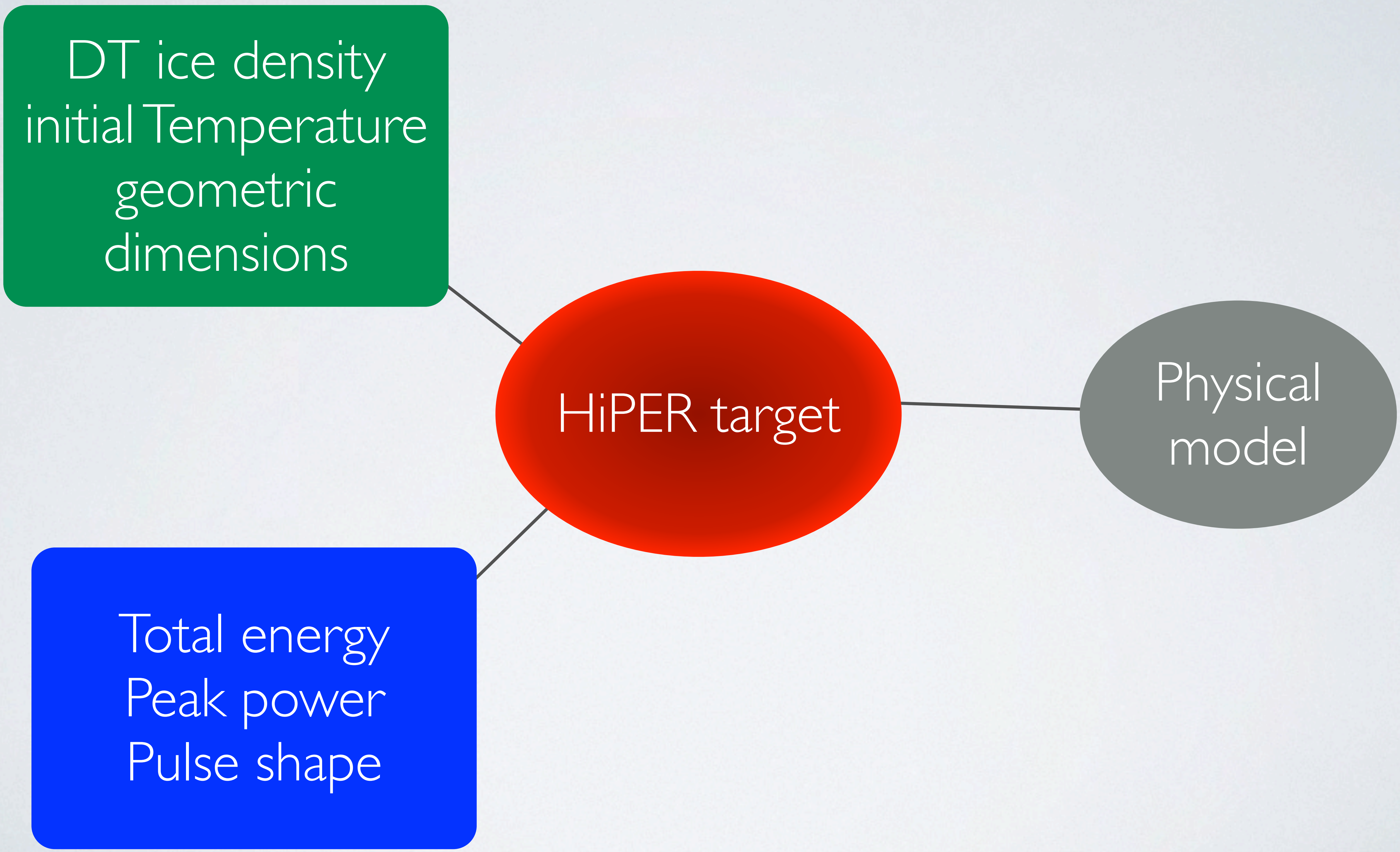
Assessing implosion risk



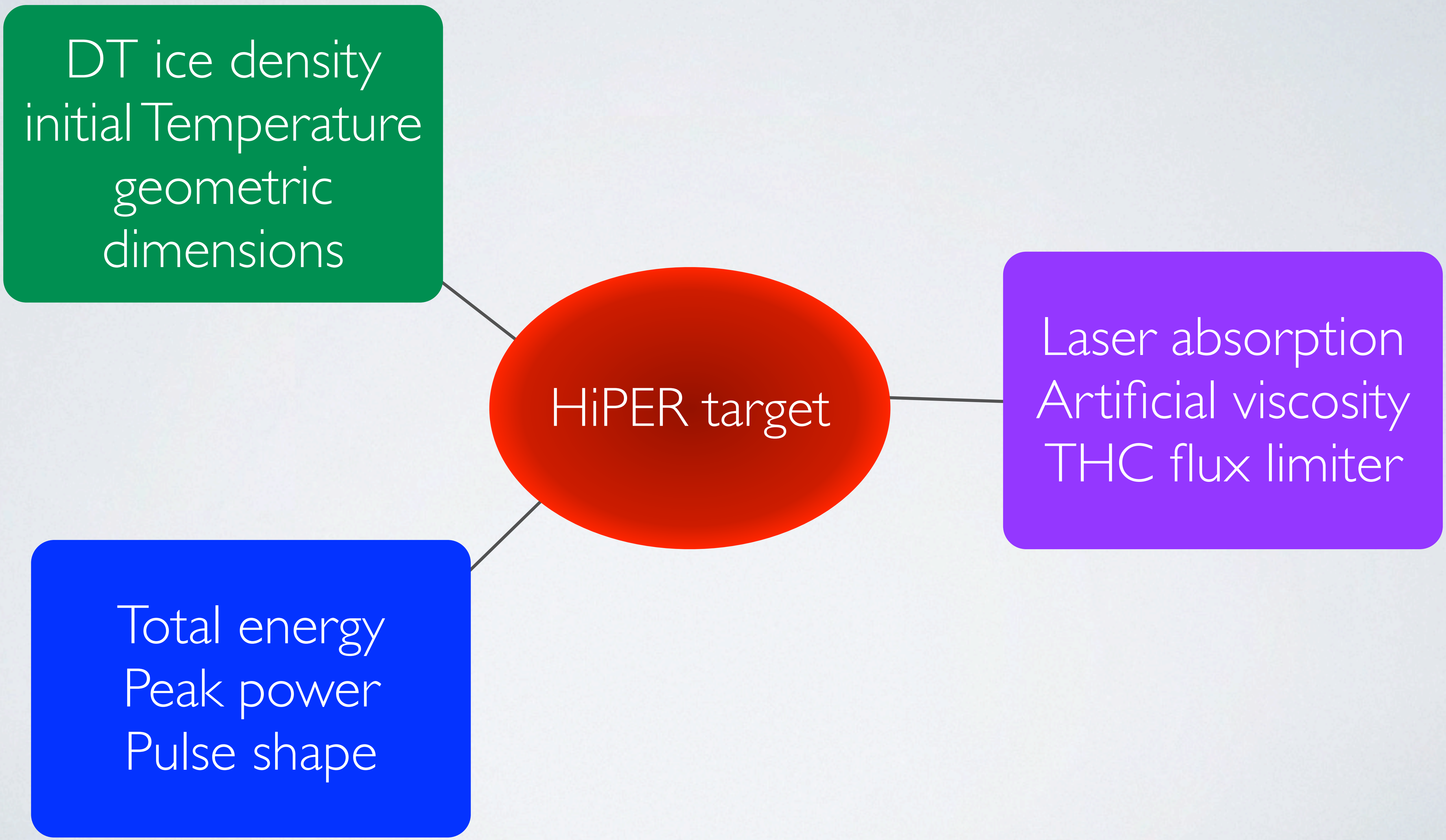
Assessing implosion risk



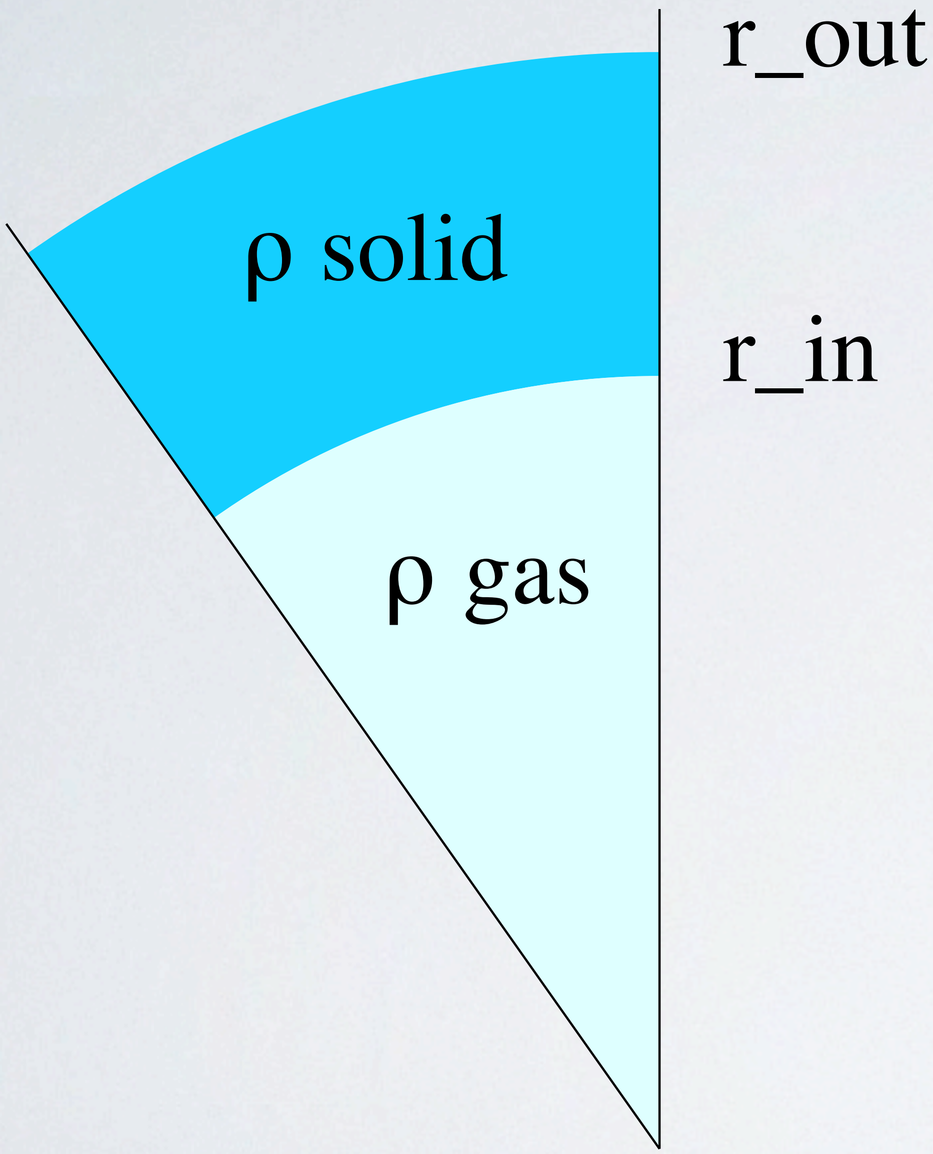
Assessing implosion risk

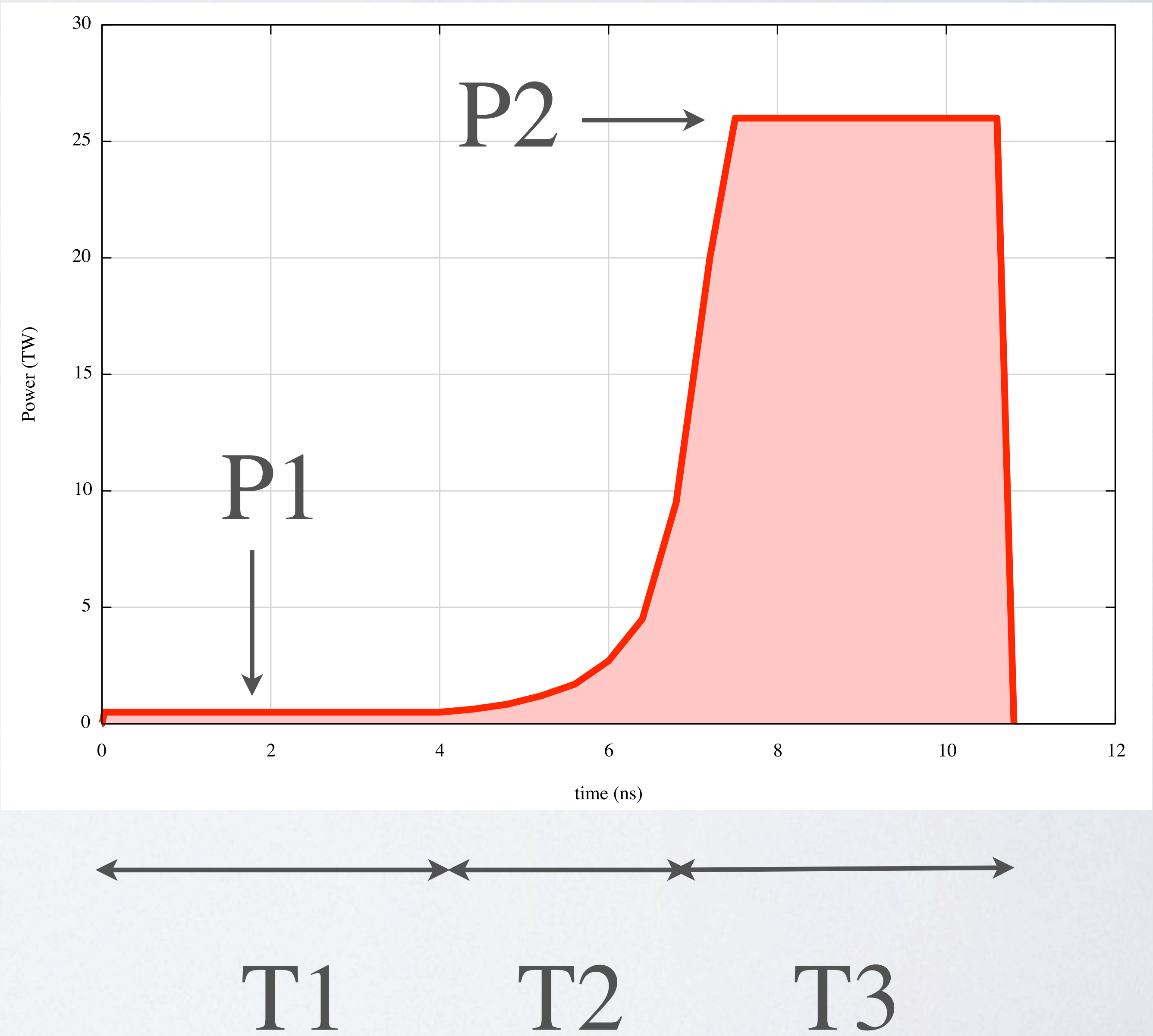


Assessing implosion risk

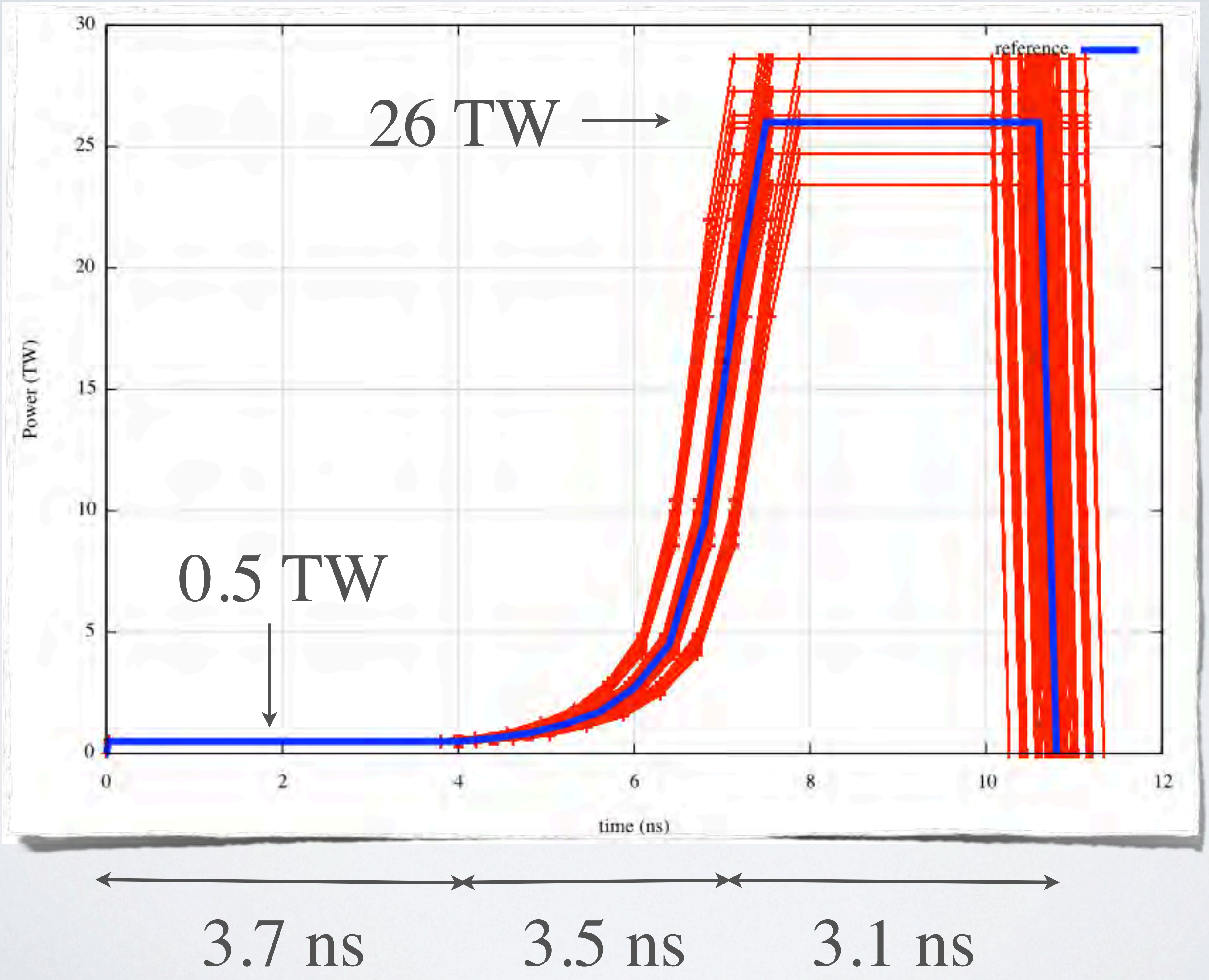


Main experimental parameters

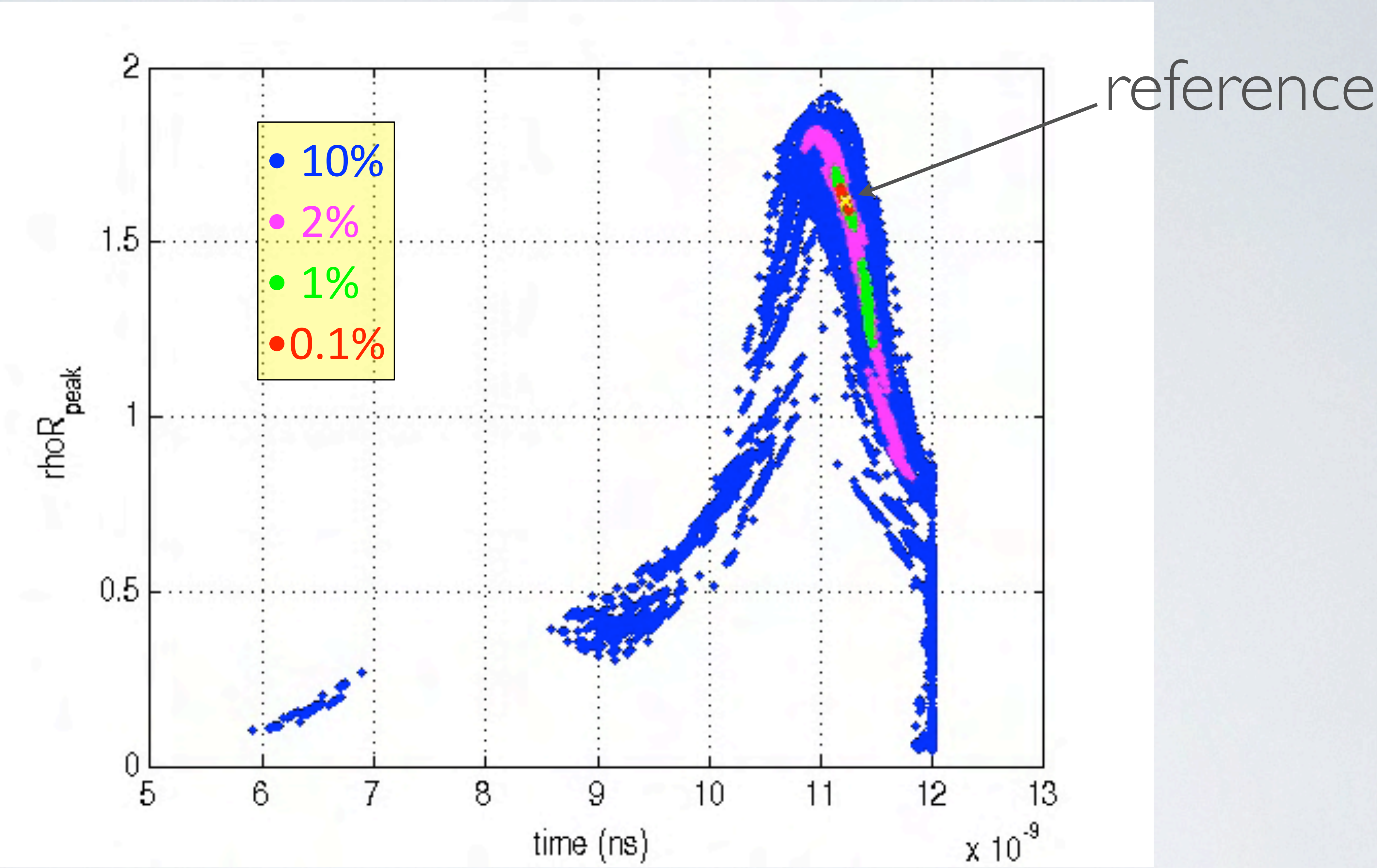




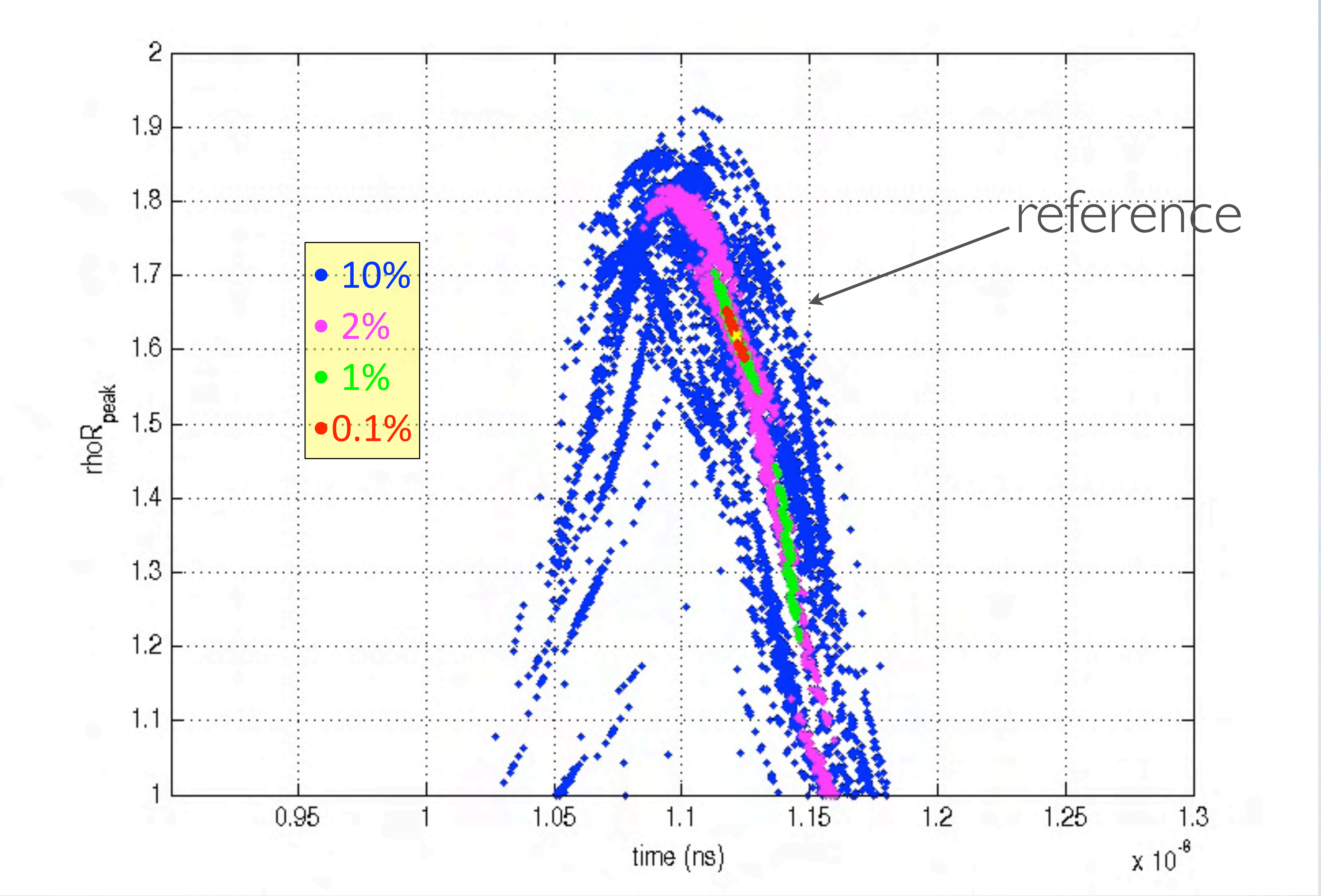
Laser pulse scan



Parametric scan (rin,rout,rho,E)

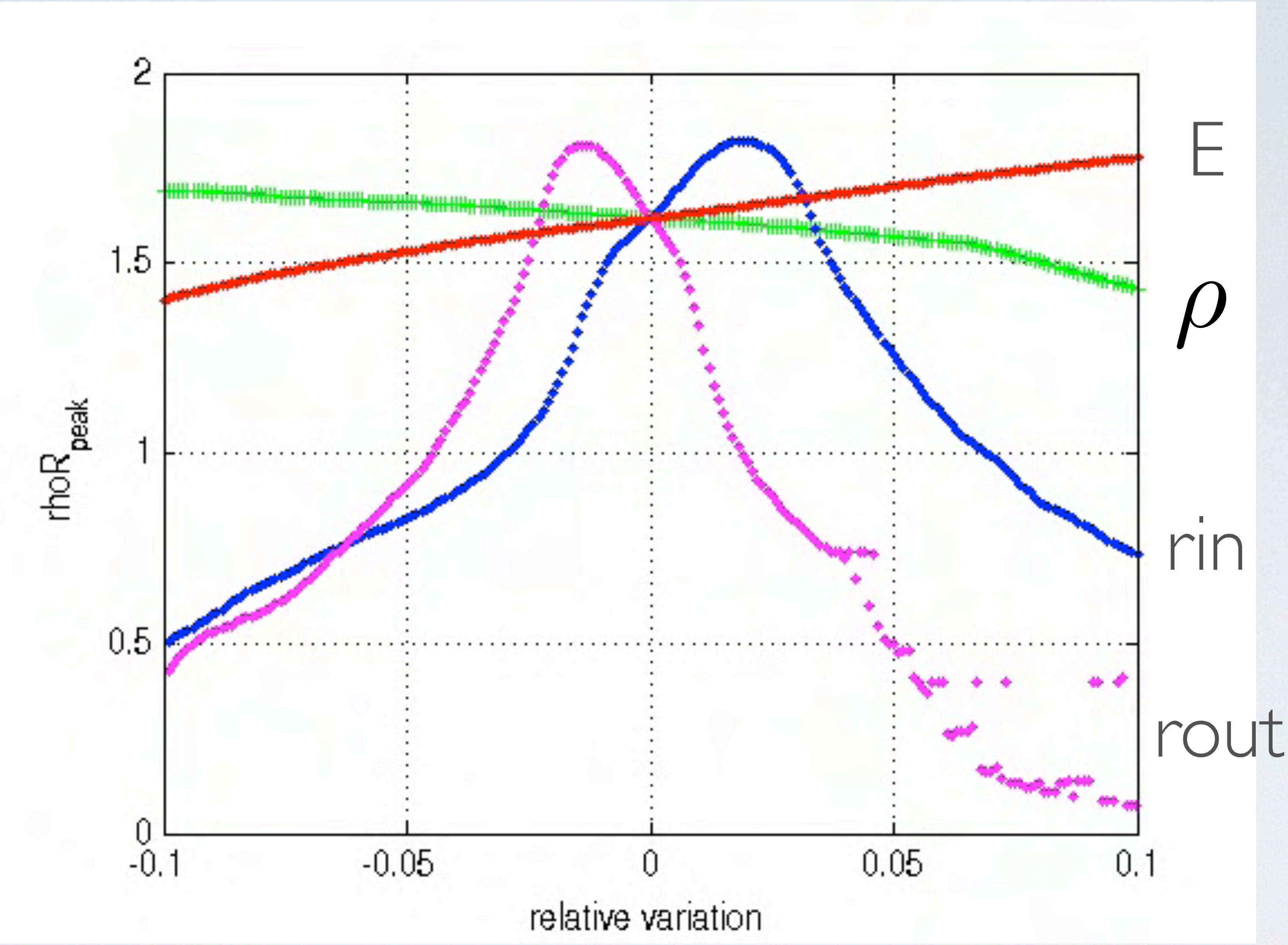


"Dense" scan: $NV^{NP} = 11^4 = 14641$



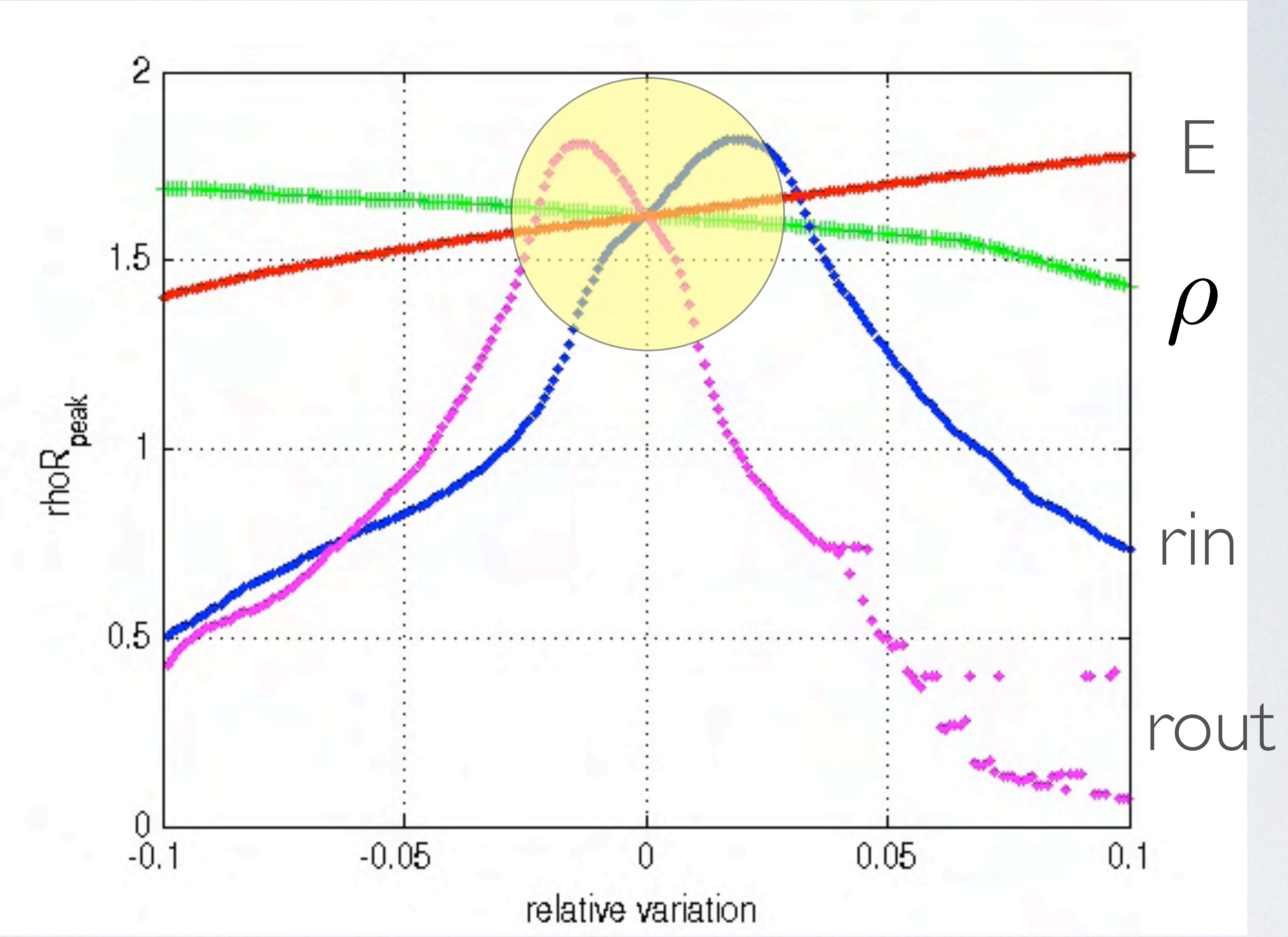
“Dense” scan: $NV^{NP} = 11^4 = 14641$

Geometry, mass and total energy



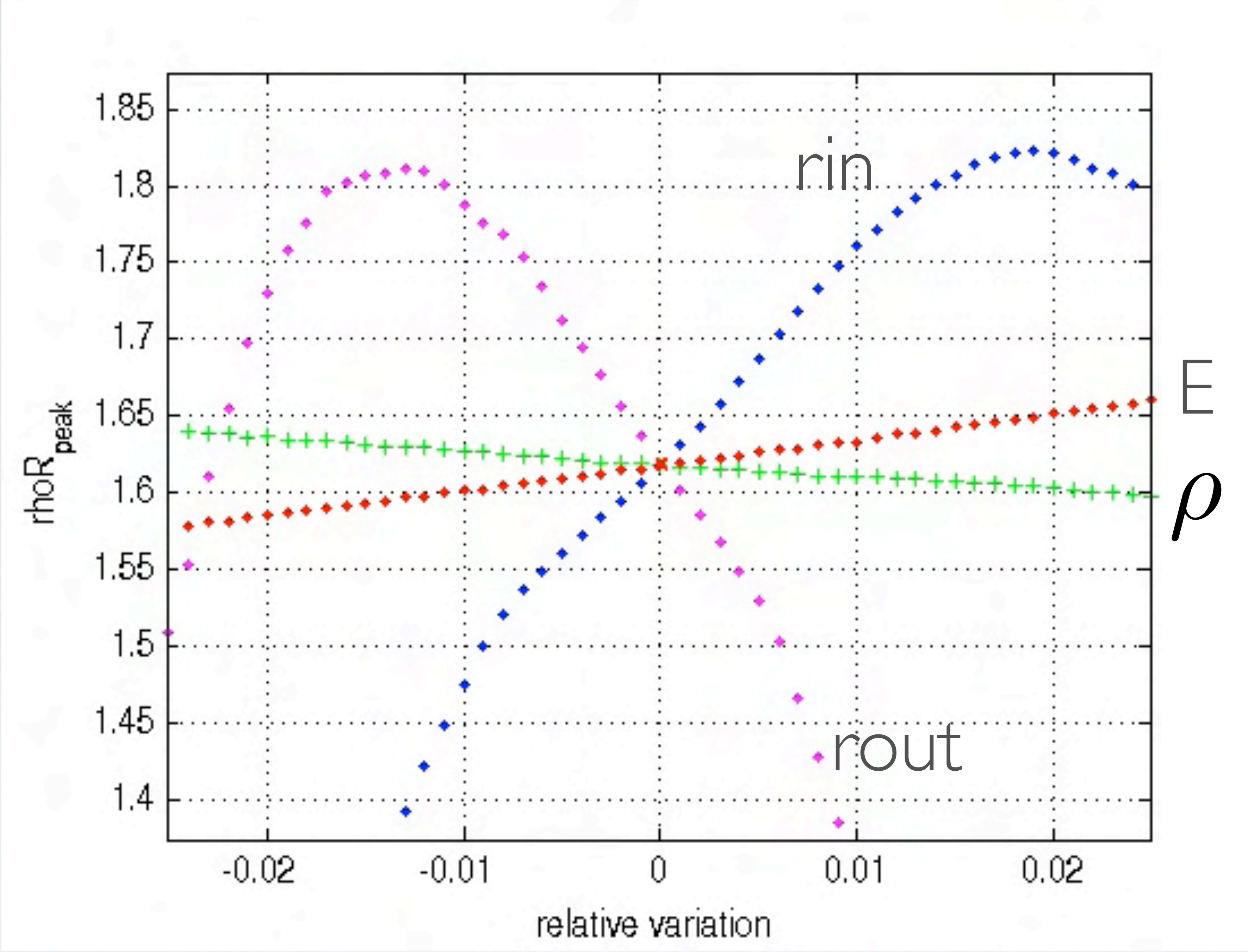
varying just one parameter at a time

Geometry, mass and total energy



varying just one parameter at a time

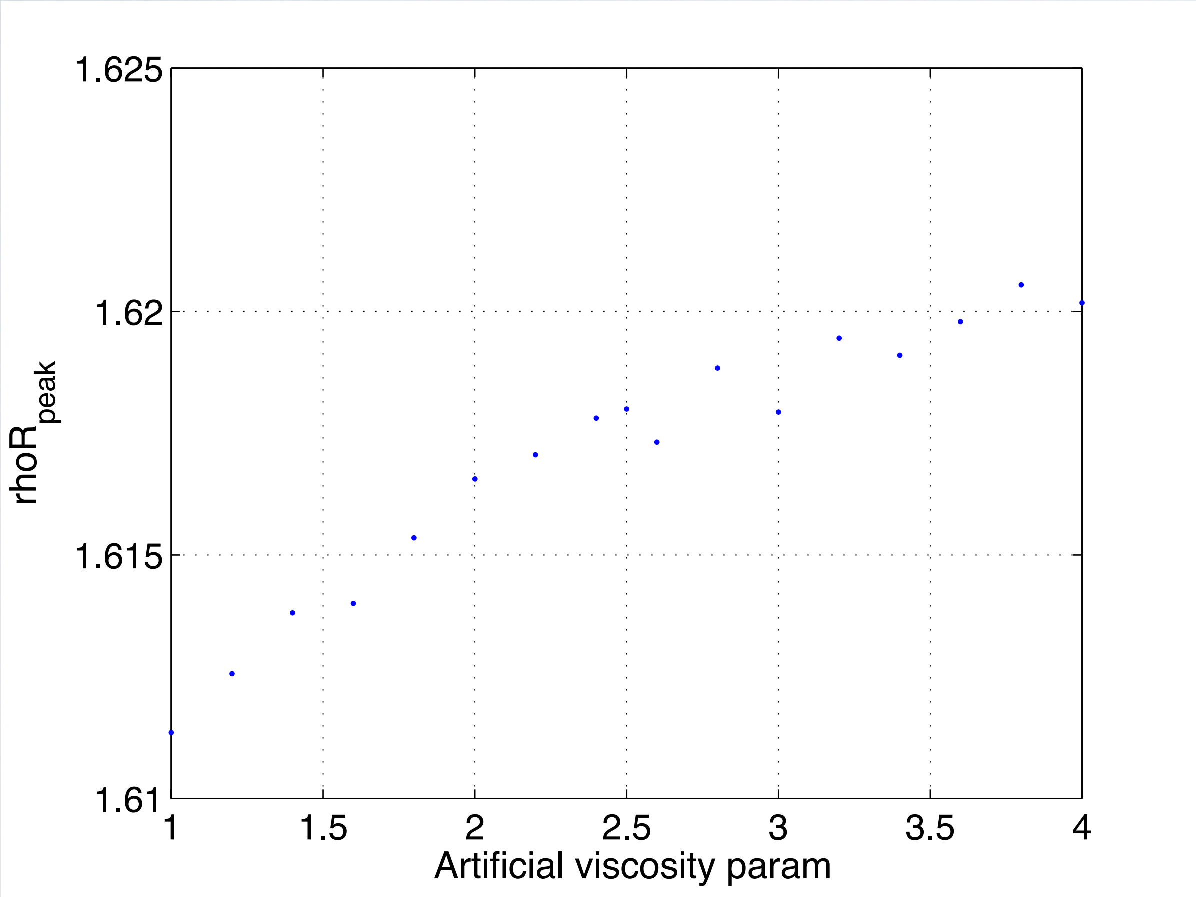
Region of linear dependance

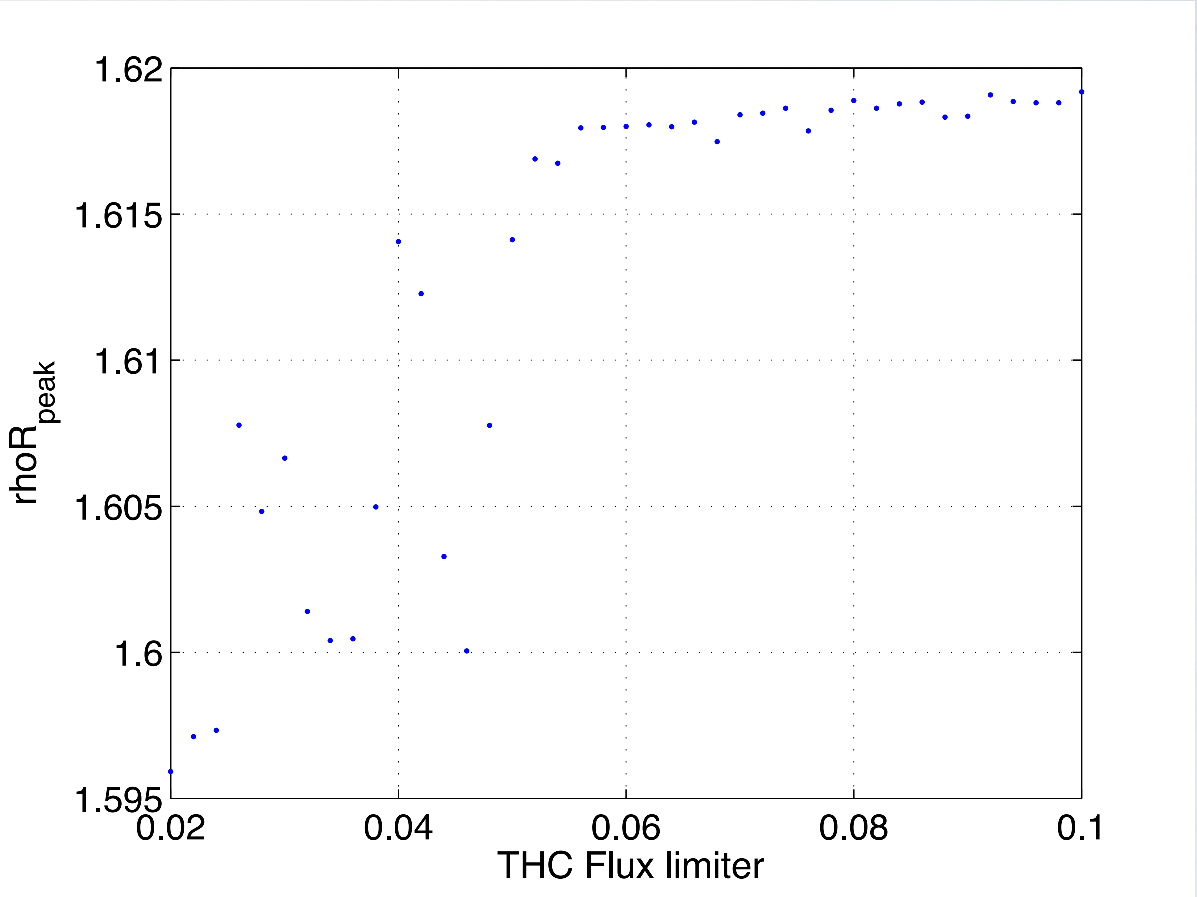


Peak rhoR varies linearly within: 10% for E and rho

1% for rin and rout

Sensitivity to artificial viscosity and THC flux limiter





$$\frac{\sigma_X}{X} \simeq 0.2\%$$

$$\frac{\sigma_X}{X} \simeq 0.5\%$$

Good news: **1D** target implosion is rather insensitive to large variations in these two key numerical parameters

SOME NUMBERS

		Tolerance	
Target injection	lateral displacement at TCC	1-5%	10-50 μm
Target fabrication	DT ice density	10%	
	inner/outer radius	1%	20 μm
Laser drive	Total energy	10%	
	Pulse shape accuracy (time)	1-5%	(30 ps)
	Pulse shape accuracy (power)	5%	

Straighten the path

- Identify key parameters for modeling
- Understand what are the crucial parameters for target fabrication and laser delivery
- Down-selection of parameters (metrics)
- Explore parameter space to assess compression robustness
- Find safety factors for parameters we can control
- Investigate gain sensitivity (ignition metrics for FI or SI)