Imperial College London

Science & Technology Facilities Council
ISIS

Progress in a design of the Radiobiology Facility

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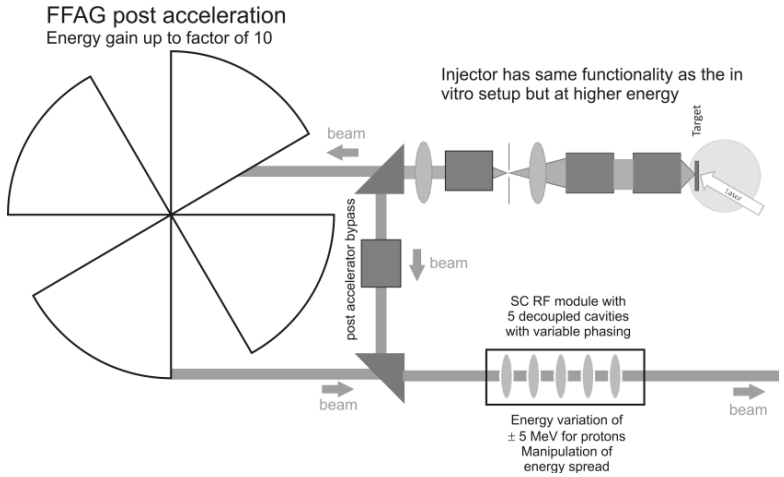
CCAP facility, initial concept

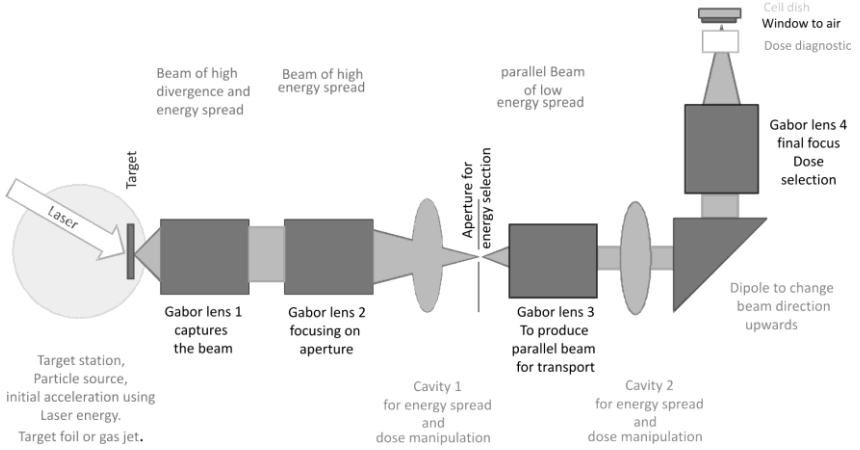
- Aim for in vitro and in vivo facility with:
  - Multiple particle species
  - Flexible energy selection
  - Precise dose control
  - Possibility to adjust bunch length
  - Matching to the irradiation cell
- Initial design:
  - Focusing and energy selection based on Gabor lenses
  - Presence of correlation between beam position and energy (in vitro part) – potential issue
  - For in vivo part FFA (Fixed Field Accelerator) was proposed – in synergy with the work on ISIS upgrade

Centre for the Clinical Application of Particles

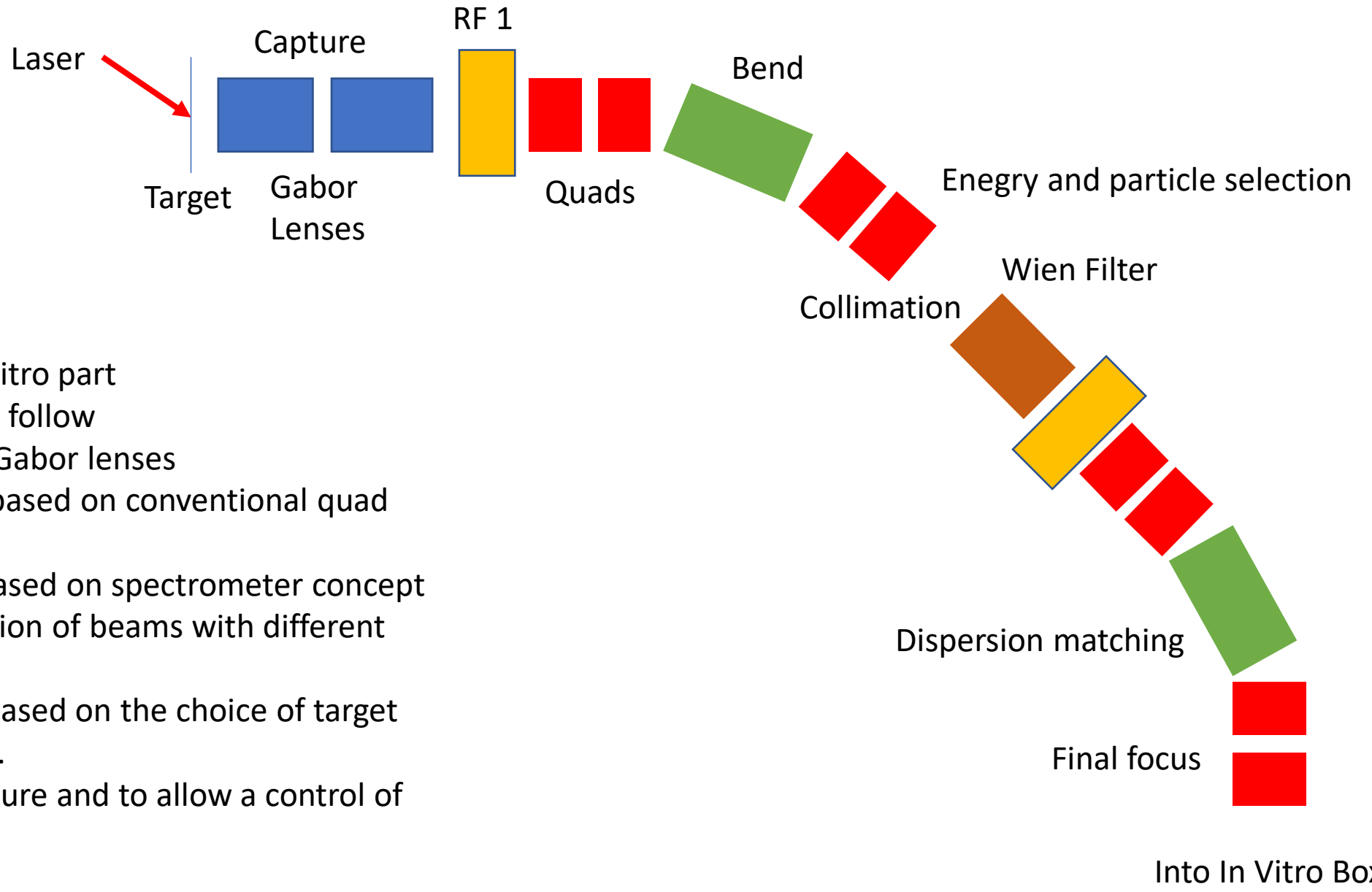
Ambition:



Staging



Updated design (for in vitro)

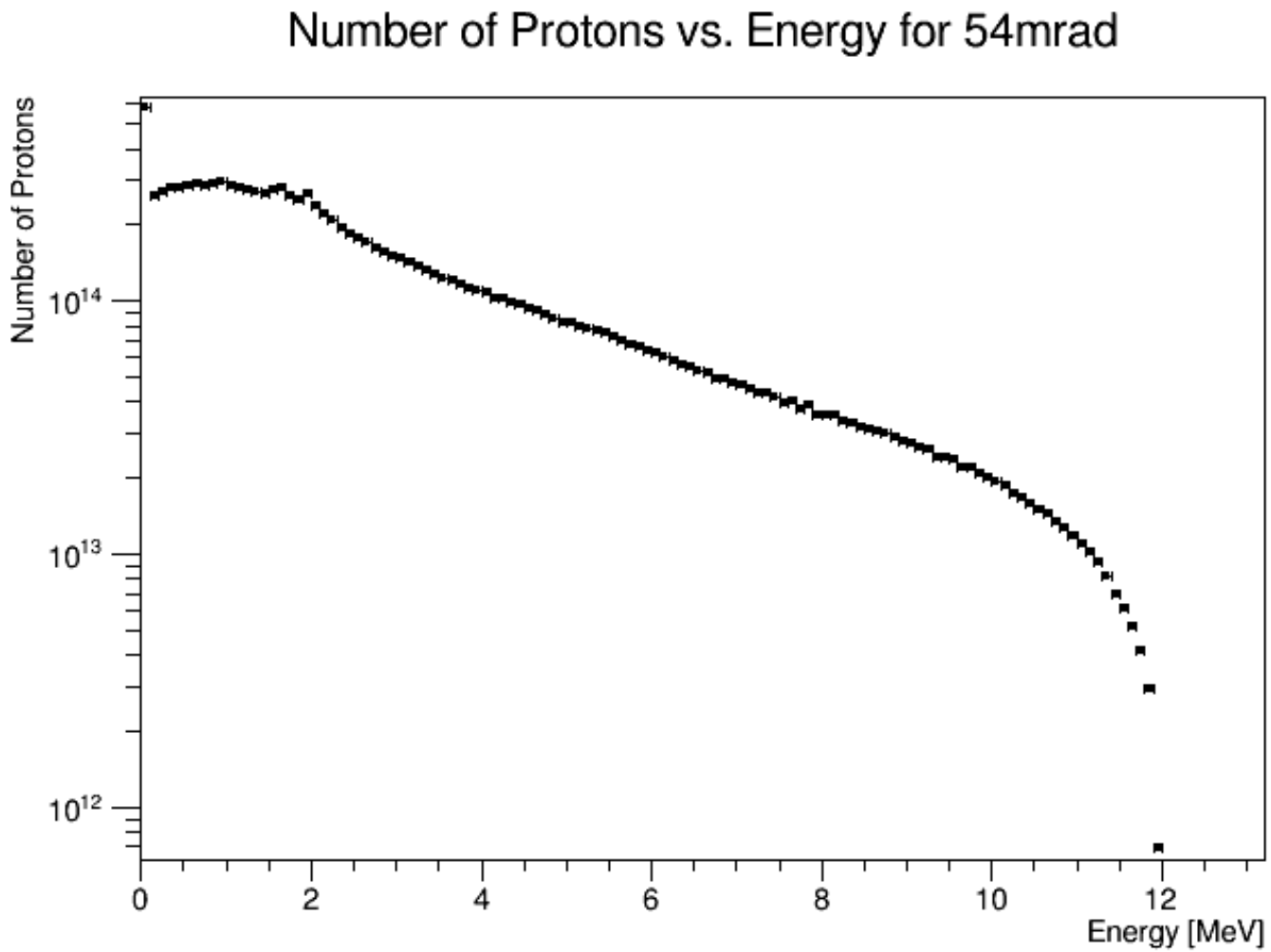


- Considered for in vitro part
  - In vivo part to follow
- Capture based on Gabor lenses
- Further transport based on conventional quad focusing
- Energy selection based on spectrometer concept (dispersive separation of beams with different momenta)
- Particle selection based on the choice of target and the Wien filter.
- RF to increase capture and to allow a control of the bunch length

Some parameters changed …

- Some parameters assumed:
  - Proton beam energy 0.95-11 MeV (from 3 MeV useful for in vitro)
  - Initial beam with 3.4 um in radius and 54mrad max divergence assumed
  - Beam emittance of 0.184 um rad (very small).
- Work focuses on optics in the capture system
  - Short Gabor lenses seem to be preferred.
- Wien filter seems feasible
  - 65 kV (max), 0.6m length, 0.027 T (preliminary)

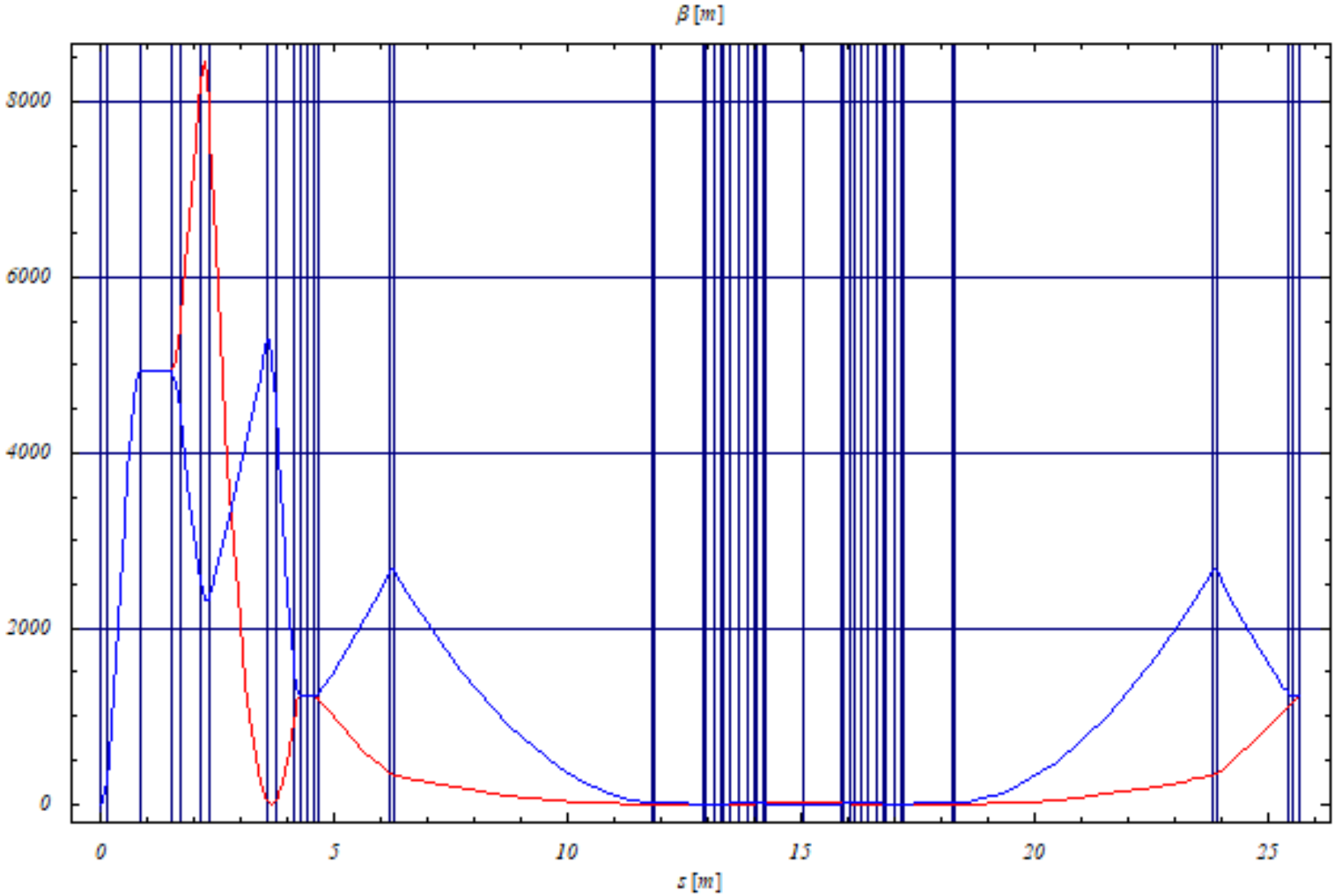
Energy spectrum from target



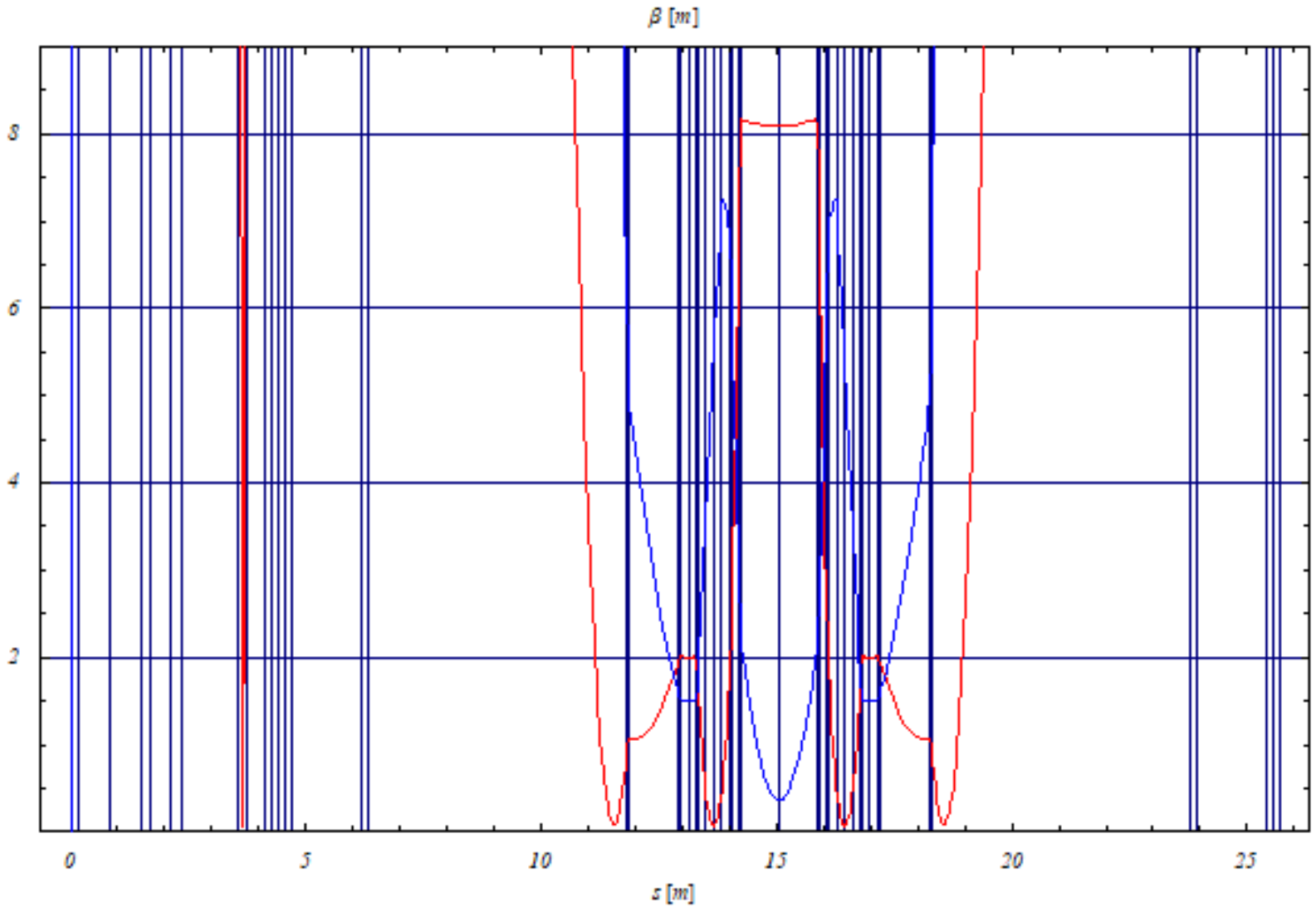
Preliminary proton parameters

Parameter	Unit	Value
Rep. rate	Hz	10
Initial pulse duration (FWHM)	fs	35
Initial spot size (FWHM)	um	4
Max. angular acceptance of capture	mrad	54
Acceptance	Pi.m.rad	0.184*10^-6
RMS physical emittance	Pi.m.rad	0.46*10^-7
Max beam size in the capture (total radius)	cm	3
Gabor Lens space charge filling factor	-	0.5
Max anode voltage in the Gabor Lens	kV	65
Energy range from target	MeV	0-11
Energy range for postaccelerator	MeV	0.95-8.6
Energy for cell irradiation	MeV	?-8 (tbc)
Relative energy spread for cell irradiation	-	±2%
Final spot size (total diameter)	cm	1-3
Dose rate	Gy/min	2
Final bunch intensity	-	~1-3*10^6

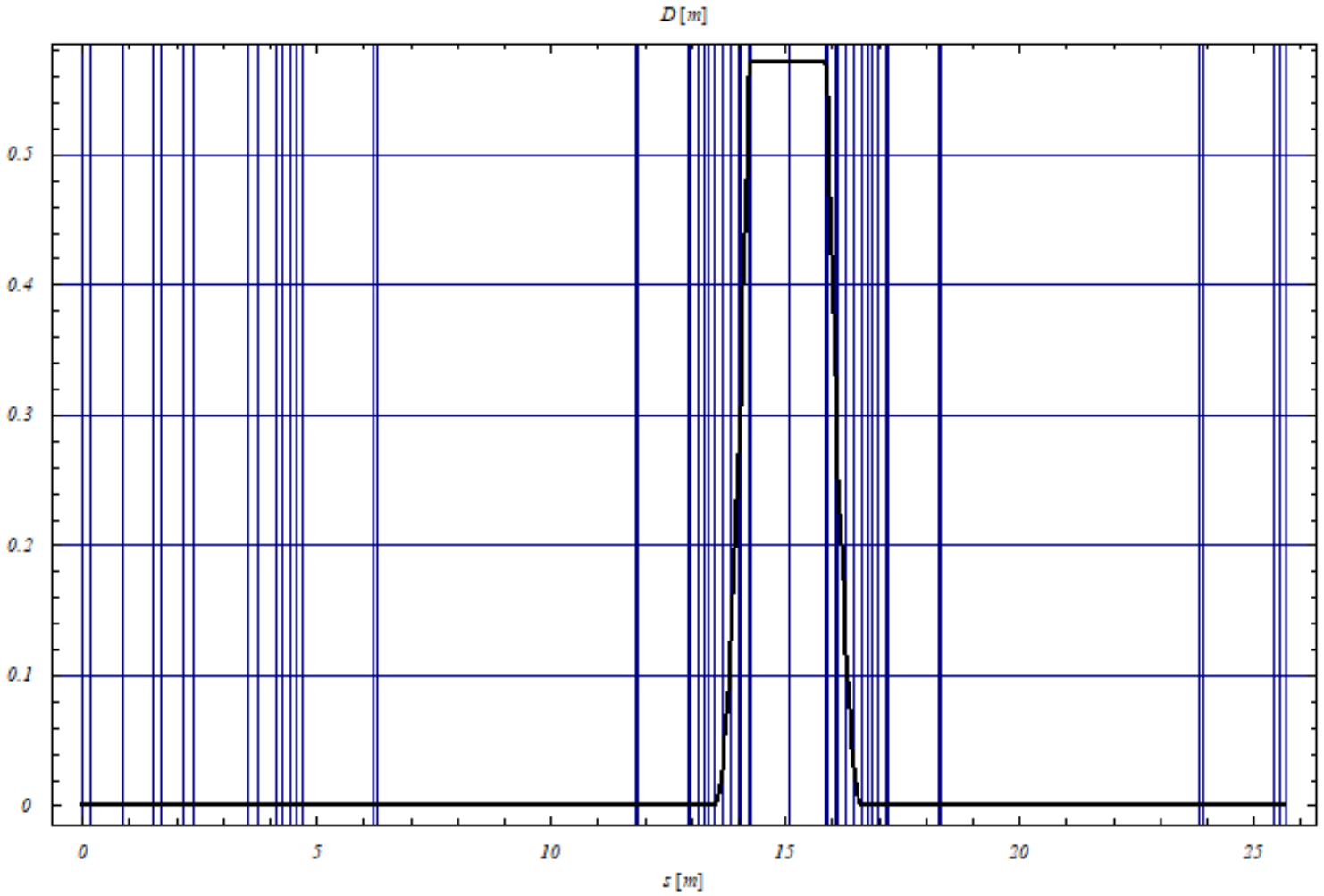
Prelimnary optical solution



Zooming in



…and dispersion



How to make it more compact

- Set max limit on the final spot size (1cm?)
- Use two GLs for the capture system with intermediate focus (subject of space charge simulation check)

Thank you