UNIVERSITY OF MARYLAND, BALTIMORE
RADIATION ONCOLOGY

GPU-accelerated Optimization of Biologically Effective Dose for Inverse-Planned Nonuniform Spatio-Temporal Fractionation (NSTF)

Session Title: *Monte Carlo Sim. and High Performance Comp.*
Date and Time: *08/02/2018 1:00PM — 3:00PM*
Presenting Author: *Arezoo Modiri*

Purpose:

Optimizing treatment plans across fractions in our in-house Eclipse-based GPU-enabled planning system

Method:

•Universal survival curve was used to calculate biologically effective dose (BED) for all structures – organs and tumor, here, non-small-cell lung cancer (NSCLC)

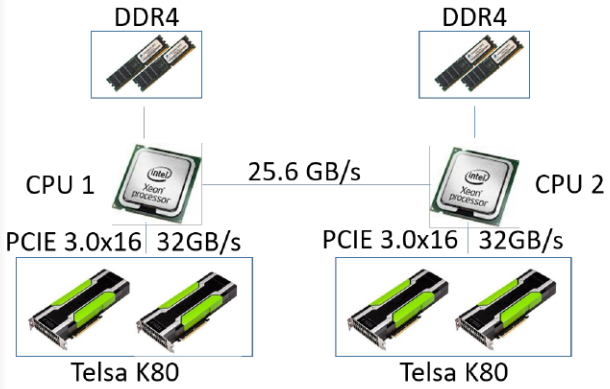
$$BED_i = \sum_{f=1}^{N_{fractions}} D_i^{fx}\{1 + D_i^{fx}/\left(\frac{\alpha_i}{\beta_i}\right)\} \quad D_i^{fx} \le D_{Ti}$$

$$BED_i = \sum_{f=1}^{N_{fractions}} \{(D_i^{fx} - D_{qi})/(\alpha_i D_{0i})\} \quad D_i^{fx} \ge D_{Ti}$$

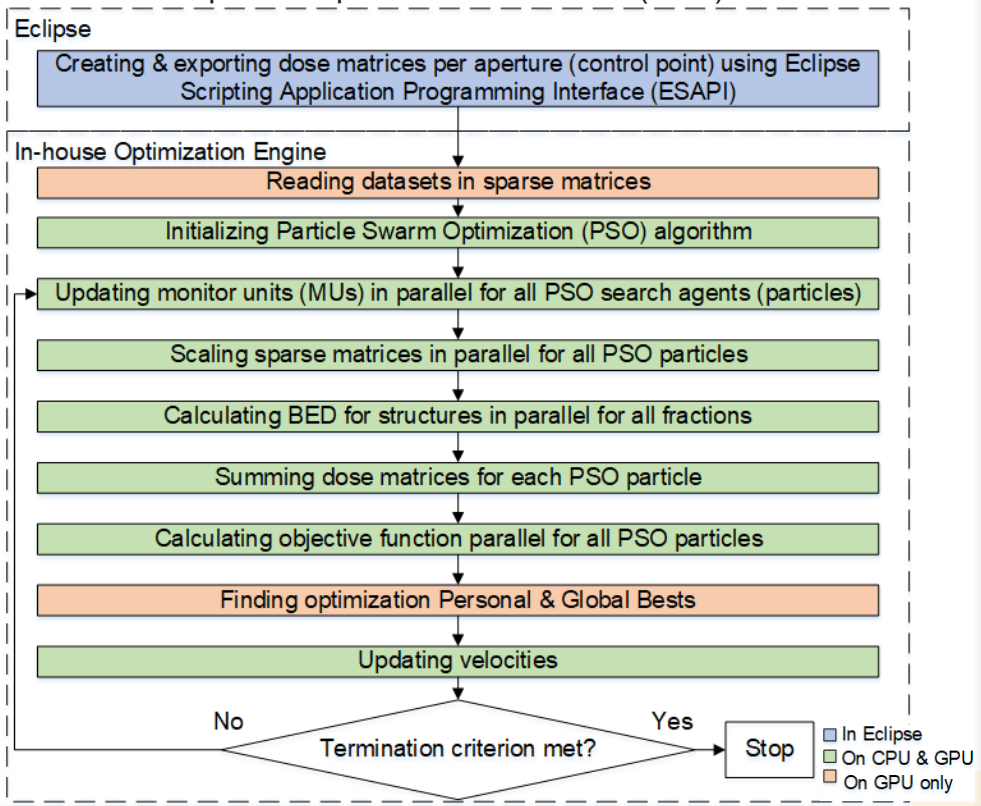
	$\alpha\ (Gy^{-1})$	α/β	D_0 (Gy)	D_q (cGy)	D_T (cGy)
NSCLC	0.33	860	1.25	180	613
Lung	0.133	359	1.30	356	860
Heart	0.333	340	1.46	46	180
Esophagus	0.087	290	1.49	424	974
Spinal cord	0.071	254	1.33	551	1216

•Eclipse was used to create aperture shapes and calculate dose deposition matrices per aperture
•Particle swarm optimization (PSO) algorithm was used to optimize aperture monitor units (MUs)

Our GPU-based processing hardware had
- 4 K80 Tesla NVIDIA cards (2 GPUs per card)
- 12GB memory available per GPU card
- Non-uniform memory access (NUMA) architecture
- 8-core Xeon CPUs , 256GB RAM

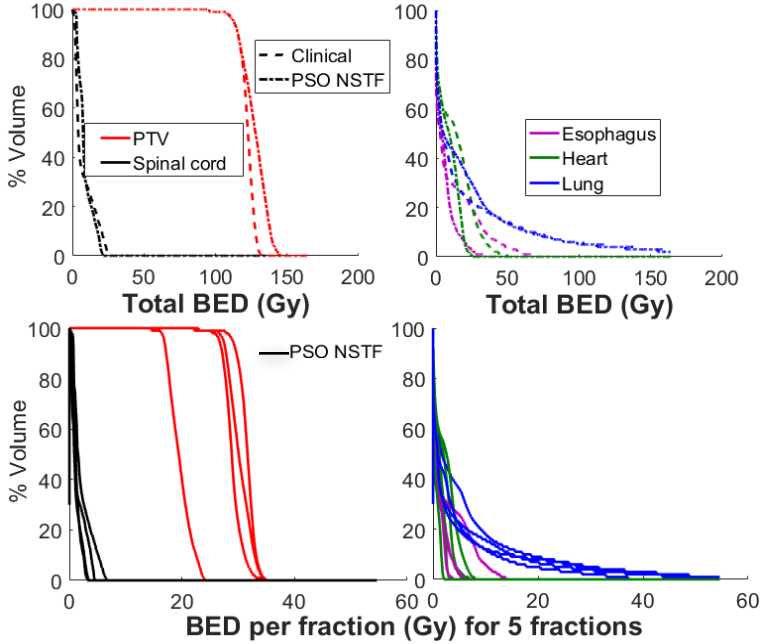


PSO convergence demonstration:



Results:

- Dose volume histograms for a 5-Fx NSTF plan



- Processing time for the GPU-enabled NSTF for different parameter sweeps (k: dose matrix size and P: number of PSO particles)