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PENSSART, A NEW MONTE CARLO SYSTEM FOR QUALITY CONTROL IN RADIOTHERAPY

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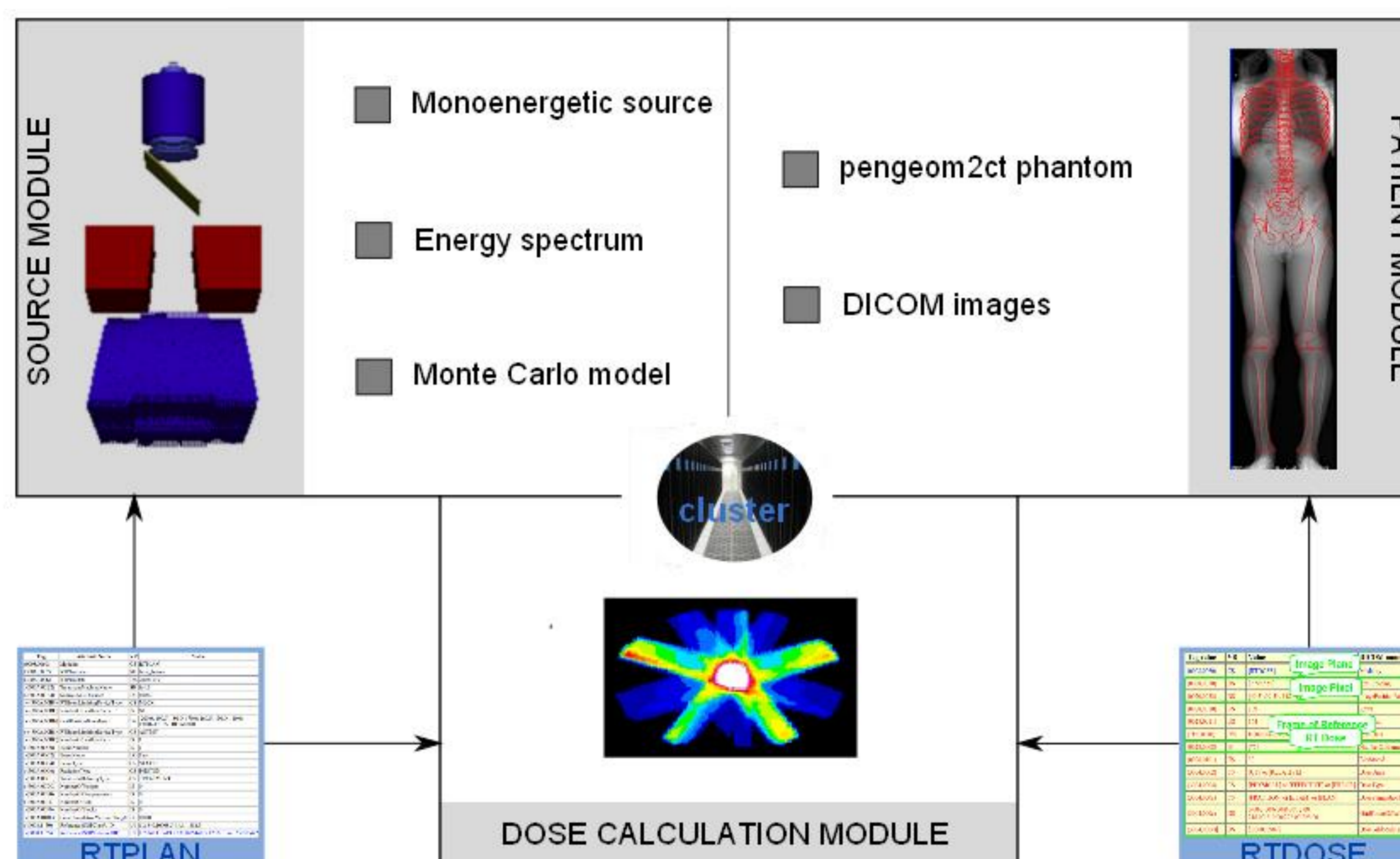
Objectives

Radiotherapy modalities are now more and more complex and accurate dose calculations are essential for treatment planning. However, in presence of small field sizes and light densities, commercial treatment planning systems (TPS) often fail to predict accurate dose distribution. In this aim, we have developed a new Monte Carlo system called **PENSSART** for **PENELOPE Simulation for the Safety in Radiotherapy**.

PENSSART system

The PENSSART system is divided into three modules.

The **dose calculation module** is the core of the PENSSART system as it includes the MC dose computation engine itself which is based on PENELOPE. This module was designed to perform MC dose calculations within voxelized geometries and needs as input data a description of the patient anatomy or phantom geometry as well as a description of the radiation source.



The **patient module** allows the implementation of complex geometries such as phantoms and patients.

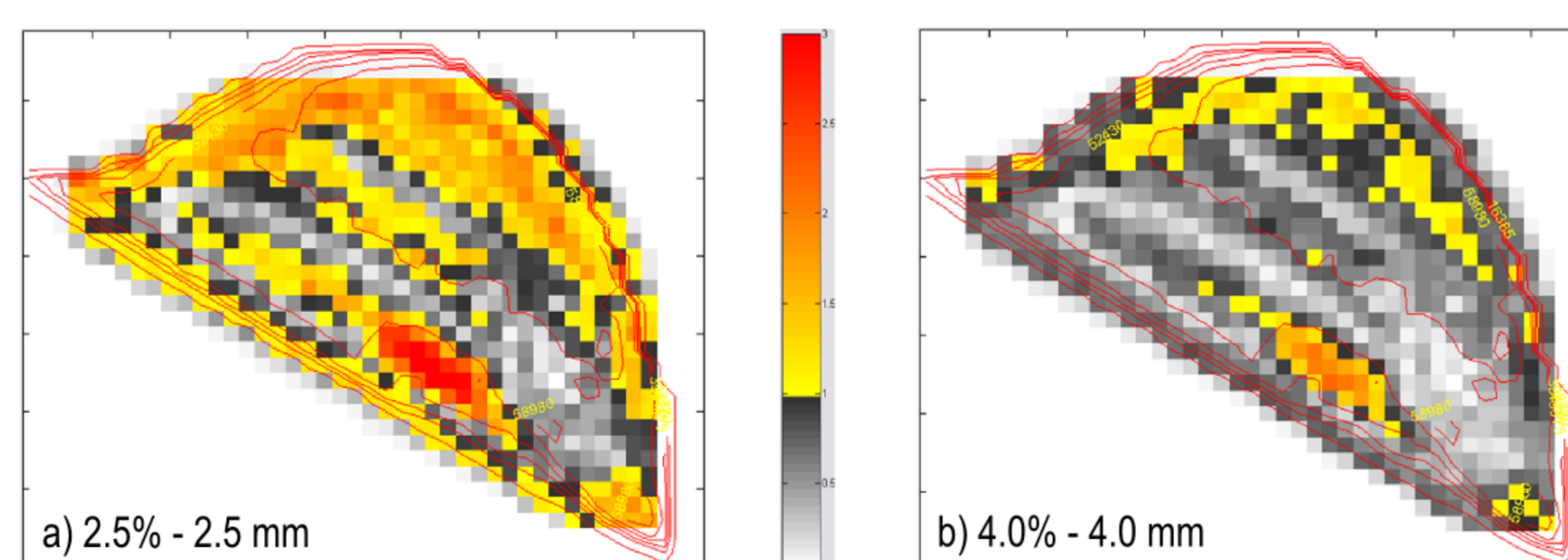
The **radiation source module** is also based on PENELOPE and allows the simulation of different kinds of radiation sources, going from simple sources, such as monoenergetic beams, to more complex sources like the one resulting from the complete modeling of a linac treatment head, including the multileaf collimator (MLC).

TPS evaluation



	Absorbed dose for the plan (Gy)			Deviation (%)		
	OSL	TPS	PENSSART	OSL vs TPS	OSL vs PENSSART	TPS vs PENSSART
Lung	6.89	2.00	6.61 (3.3%)	71.0	4.1	69.7
	3.07	2.00	3.01 (4.4 %)	34.9	2.0	33.6
Bone	43.4	34.3	44.7 (1.3 %)	21.0	3.0	23.3

Differences between OSL measurements and PENSSART estimations are of magnitude similar to that of the statistical uncertainties of the MC simulations (about 3%). **On the contrary deviations of TPS calculations from OSL measurements are larger especially in lung and vary from 21 to 71%.** We also note that the differences between TPS calculations and PENSSART estimations are close to the differences observed between OSL and TPS values.



Gamma test

The reference map is the one obtained with the PENSSART platform. **67.8% and 91.5% of pixels pass the test for the (2.5% - 2.5 mm) and (4% - 4 mm) criteria, respectively.** The main discrepancies between the two distributions are observed at the lung interface.

Conclusions

The results showed that the system did not introduce any bias in the dose calculation due to an error in beam settings or in geometry model. Moreover the system also allows determining the limits of a TPS algorithm in the cases of breast and lung treatments.