UNIVERSITÀ DEGLI STUDI DI MILANO

Particle therapy masterclass LASA and INFN-MI group

Therapy planning of Liver and Prostate

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INTERNATIONAL MASTERCLASSES
hands on particle physics

International Particle Physics Outreach Group

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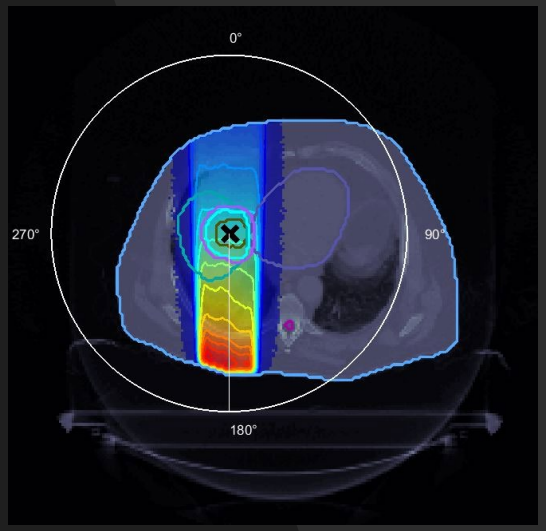
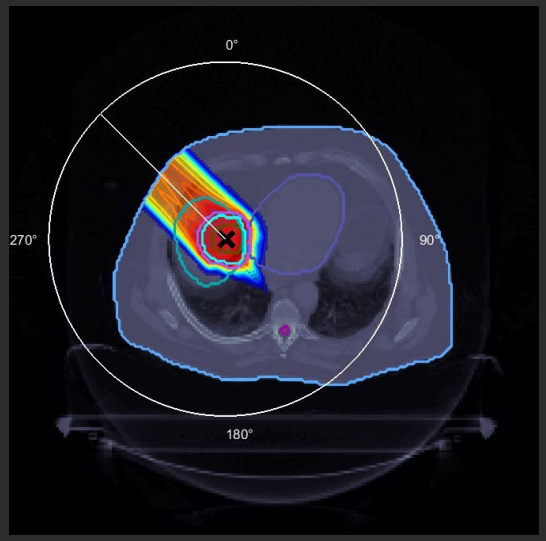
COMPARISON BETWEEN SINGLE PHOTON AND SINGLE PROTON BEAM FOR LIVER

- Photon therapy
  - Best angle for photon therapy (180°), single beam, minimum effects on OARs (heart - spinal cord - skin)
  - More amount of radiation for heart



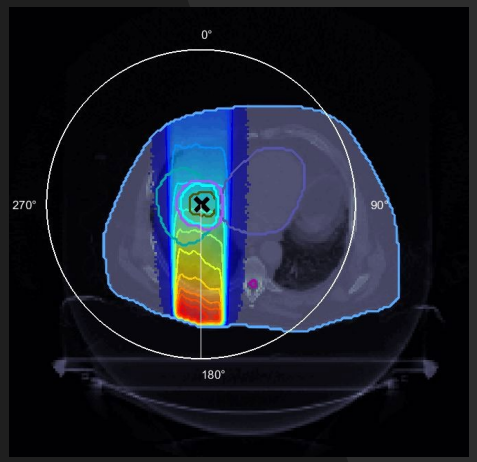
- Proton therapy
  - Best angle for proton therapy (315°), single beam, minimum effects on OARs (heart - spinal cord - skin)
  - Less amount of radiation for heart



COMPARISON BETWEEN SINGLE AND MULTIPLE PHOTON BEAMS

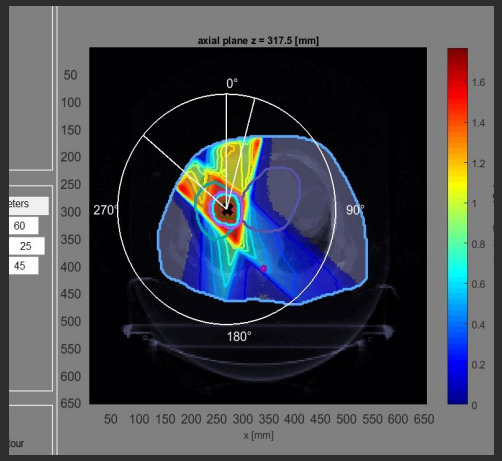
- Single beam

- Ineffective method, radiation dispersion on sensitive tissues although in small dose



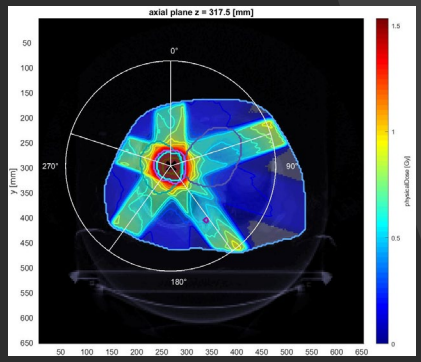
- Three beams

- The best solution that we found with 3 beams is the following one: 0-15-310 degrees.
- In this way the damage reported by the vital organs are minimum, while the tumor is well stricken by the radiations



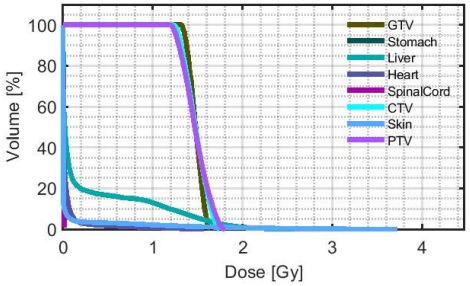
- Five beams

- By using 5 photons the result is way less optimal, the vital organs are damaged by the radiations.
- There is no difference in spreading the beams between 0 and 360 degrees or between 180 and 360 degrees. The result is still better if we use three beams.

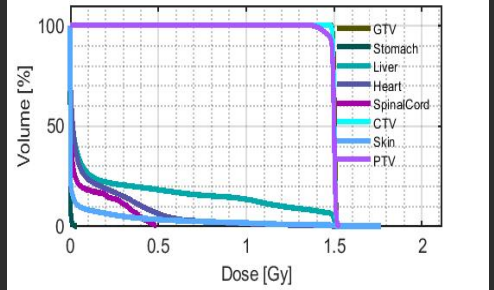


COMPARISON BETWEEN SINGLE AND MULTIPLE PHOTON BEAMS

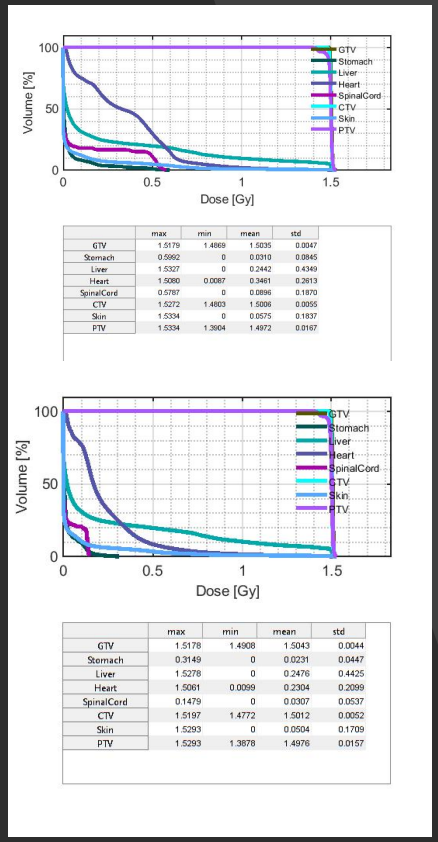
- Single beam
- Three beams
- Five beams



	max	min	mean	std
GTV	1.6435	1.3219	1.4784	0.0745
Stomach	0	0	0	0
Liver	2.5827	0	0.2511	0.5122
Heart	1.5703	0	0.0370	0.1387
SpinalCord	0.0190	0	0.0015	0.0038
CTV	1.7481	1.2307	1.4801	0.1223
Skin	3.7300	0	0.0511	0.2656
PTV	1.8093	1.1918	1.4766	0.1401



	max	min	mean	std
GTV	1.5241	1.4855	1.5029	0.0062
Stomach	0.0410	0	7.3520e-04	0.0027
Liver	1.5683	0	0.2461	0.4708
Heart	1.5170	0	0.1112	0.2166
SpinalCord	0.4898	0	0.0641	0.1298
CTV	1.5260	1.4741	1.5007	0.0065
Skin	1.7672	0	0.0481	0.1926
PTV	1.5357	1.3672	1.4966	0.0178

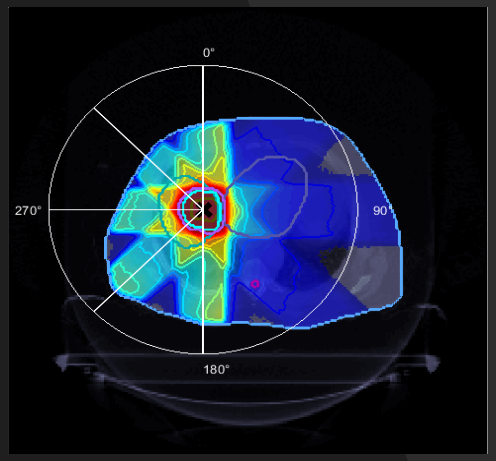


	max	min	mean	std
GTV	1.5179	1.4869	1.5035	0.0047
Stomach	0.5992	0	0.0310	0.0845
Liver	1.5327	0	0.2442	0.4349
Heart	1.5080	0.0087	0.3461	0.2613
SpinalCord	0.5787	0	0.0896	0.1870
CTV	1.5272	1.4803	1.5006	0.0055
Skin	1.5334	0	0.0575	0.1837
PTV	1.5334	1.3904	1.4972	0.0167

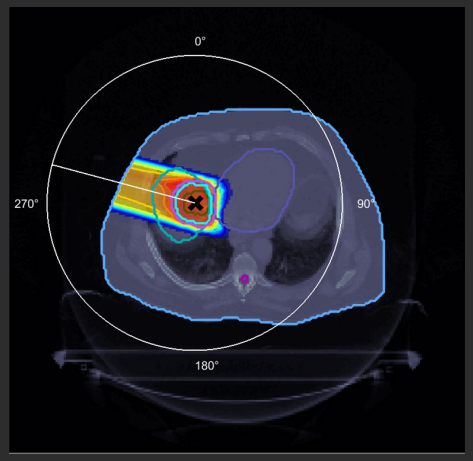
	max	min	mean	std
GTV	1.5178	1.4908	1.5043	0.0044
Stomach	0.3149	0	0.0231	0.0447
Liver	1.5278	0	0.2476	0.4425
Heart	1.5061	0.0099	0.2304	0.2099
SpinalCord	0.1479	0	0.0307	0.0537
CTV	1.5197	1.4772	1.5012	0.0052
Skin	1.5293	0	0.0504	0.1709
PTV	1.5293	1.3878	1.4976	0.0157

COMPARISON FOR PHOTON, PROTON THERAPY AND CARBON ION THERAPY FOR LIVER

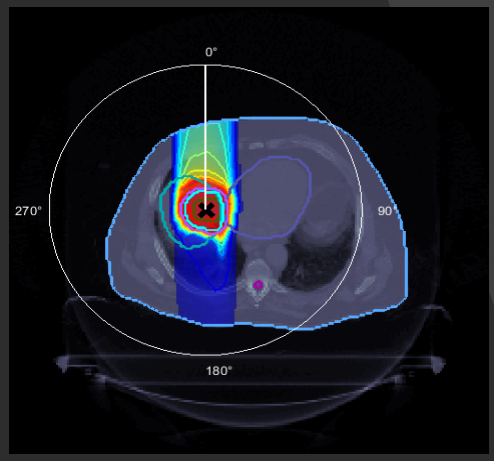
- Photon
  - Liver's irradiation using a 0, 180, 225, 270, 315° angle with 5 photon beams



- Proton
  - Liver's irradiation using a 285° angle with a single proton beam



- Carbon Ion
  - Picture of liver irradiation using a 0° angle with a single carbon beam



COMPARISON FOR PHOTON, PROTON THERAPY AND CARBON ION THERAPY FOR LIVER

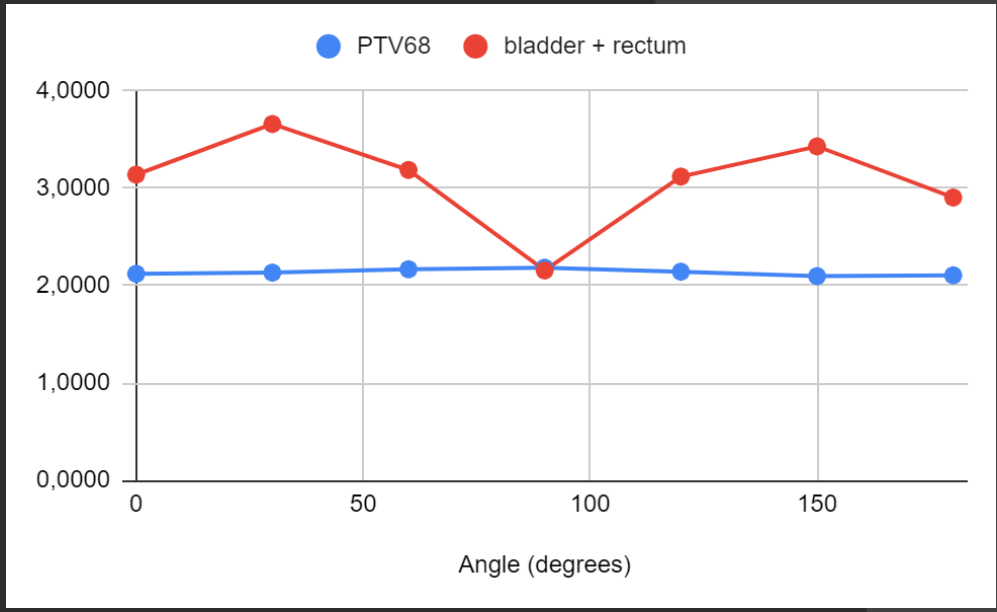
	Max dose	Mean dose	
	Skin	Heart	Stomach
Photons	1,5206	0,2159	0,0232
Protons	1,8349	0,0251	0
Carbon Ions	1,6937	0,0175	0

	PTV		
	Max. dose	Min. dose	Mean dose
Photons	1,5206	1,3903	1,4965
Protons	1,7953	0,8226	1,4915
Carbon Ions	1,6937	1,0604	1,4947

DOSE DELIVERY TO THE OARs AS A FUNCTION OF THE ANGLE FOR A SINGLE PHOTON BEAM FOR PROSTATE

We compared PTV68, bladder and rectum mean doses for various angles (multiples of 30°), and graphed the results. In the graph, we notice that the best angle for the treatment is 90° (minimum dose delivery to the OARs and maximum to the PTV).

	Mean Dose		
Angle (deg)	PTV68	Bladder	Rectum
0	2,1216	1,8692	1,2706
30	2,1338	2,1799	1,4792
60	2,1680	1,7563	1,4315
90	2,1845	0,9996	1,1566
120	2,1433	1,3691	1,7507
150	2,0980	1,4923	1,9375
180	2,1060	1,2659	1,6385



CONCLUSIONS

- Comparing treatments between single photon and proton beams for the liver we found that the second one was better because of the **lower skin dose** and more **uniform PTV dose**.
- A better result is obtained by using **more photon beams** and by choosing angles that permit to avoid OARs.
- We can conclude that the best therapy for liver is the **one with carbon ions**, using a 0 degree angle, because the damages to skin, heart and stomach are the lowest between the ones calculated.
- We found that the entry angle for a single photon beam that minimizes the damage to the OARs in a prostate treatment is of 90°. The mean dose to the PTV is not a function of the angle.


Thank you
for **your** attention!