Superconducting Synchrotron vs LINAC for Hadron Therapy Application

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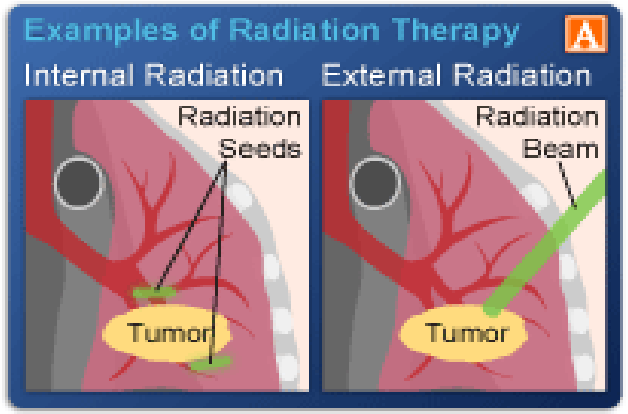
Middle East Technical University (METU)

Most Liked About CERN: Minimalistic Approach and Humble, High Achievers

After CERN: PhD at Imperial College and King‘s College London in Medical Imaging Sciences

Intro



asbestos.net/mesothelioma/treatment/conventional-mesothelioma-treatments-and-therapies/

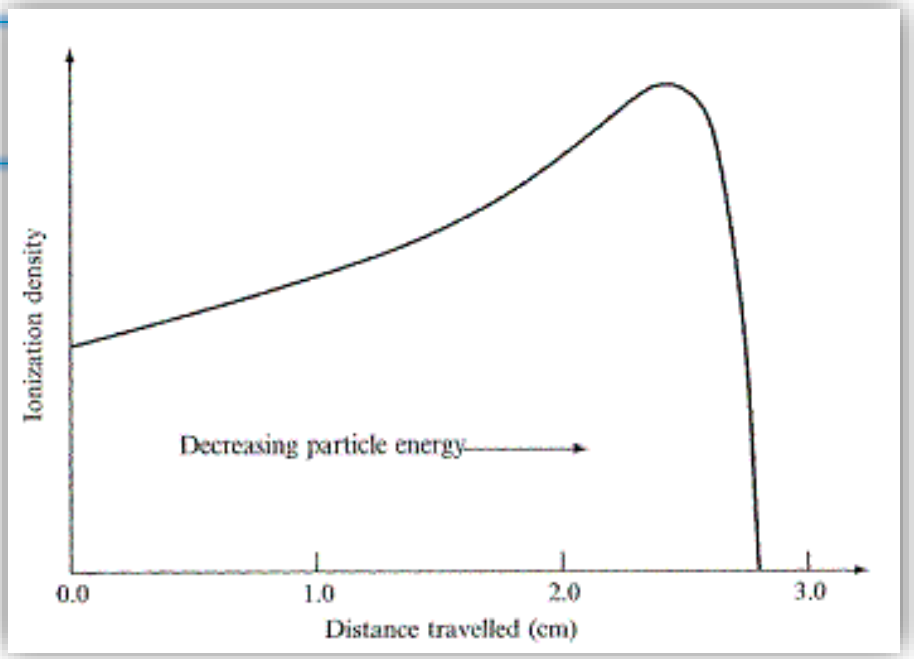
- 1 in 3 people affected by cancer
- Possible treatments
  - Surgery
  - Chemotherapy
  - Radiotherapy
    - Internal Radiation Therapy
    - External Beam Therapy
- Generally performed using
  - Photons
    - High energy X-rays
    - Cobalt unit – gamma rays
    - Lower energy X-rays
  - Charged particles
    - Protons, Heavy Ions

Disadvantages of Non-Hadron Therapies

➢ SURGERY	Patients experiencing pain and disorientation afterwards
➢ CHEMO	Patients experiencing fatigue, pain, nausia, blood disorders, etc.
➢ SEALED AND UNSEALED (INTERNAL) RADIOTHERAPY	Radiation of the very patient (harmful for the healthy people); Intoxication of healthy organs inside the body
➢ X RAYS	Great deal of healthy tissues destroyed
➢ e BEAMS	Rapid diffusion; Inability to reach deeper tissues

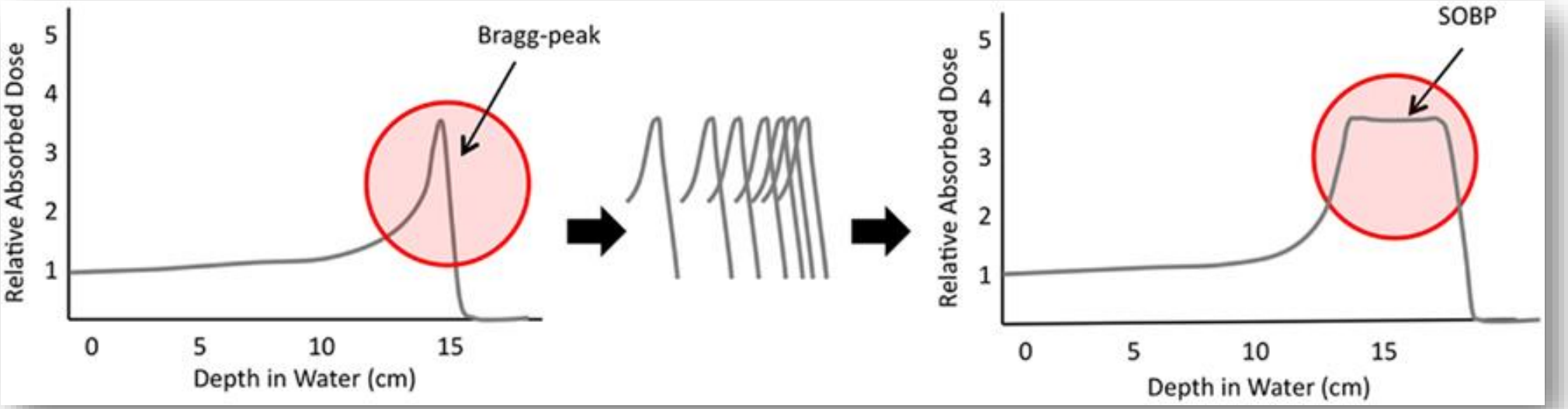
Rescue: Hadron Therapy

- Works by damaging the DNA of cancerous cells mostly by ionization;
- Minimal damage to the healthy tissue surrounding the tumor;
- Energy lost via Coloumbic interactions;
- Slowing down in an almost straight line movement;
- Definite range depends on particle energy, mass, charge and nature of the absorbing medium.

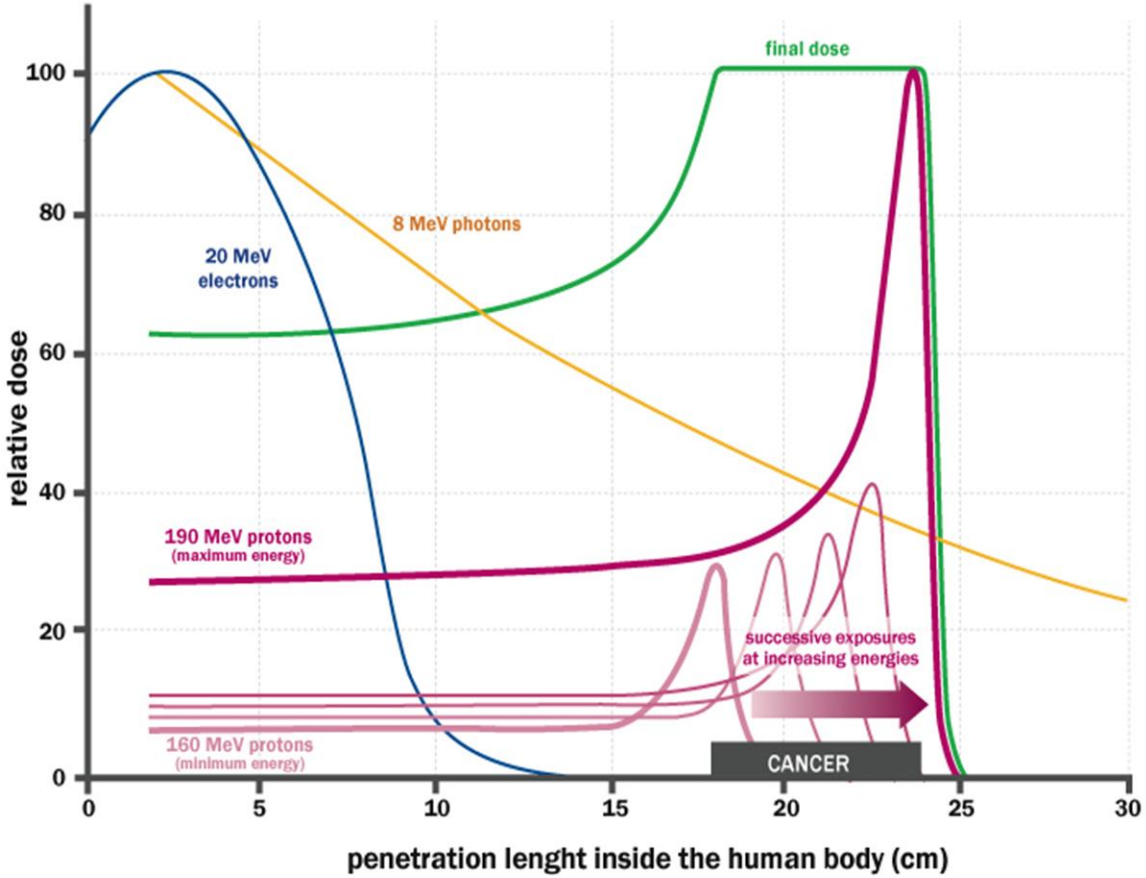


Hadron Therapy for Cancer Using Heavy Ions, C. So, University of Surrey

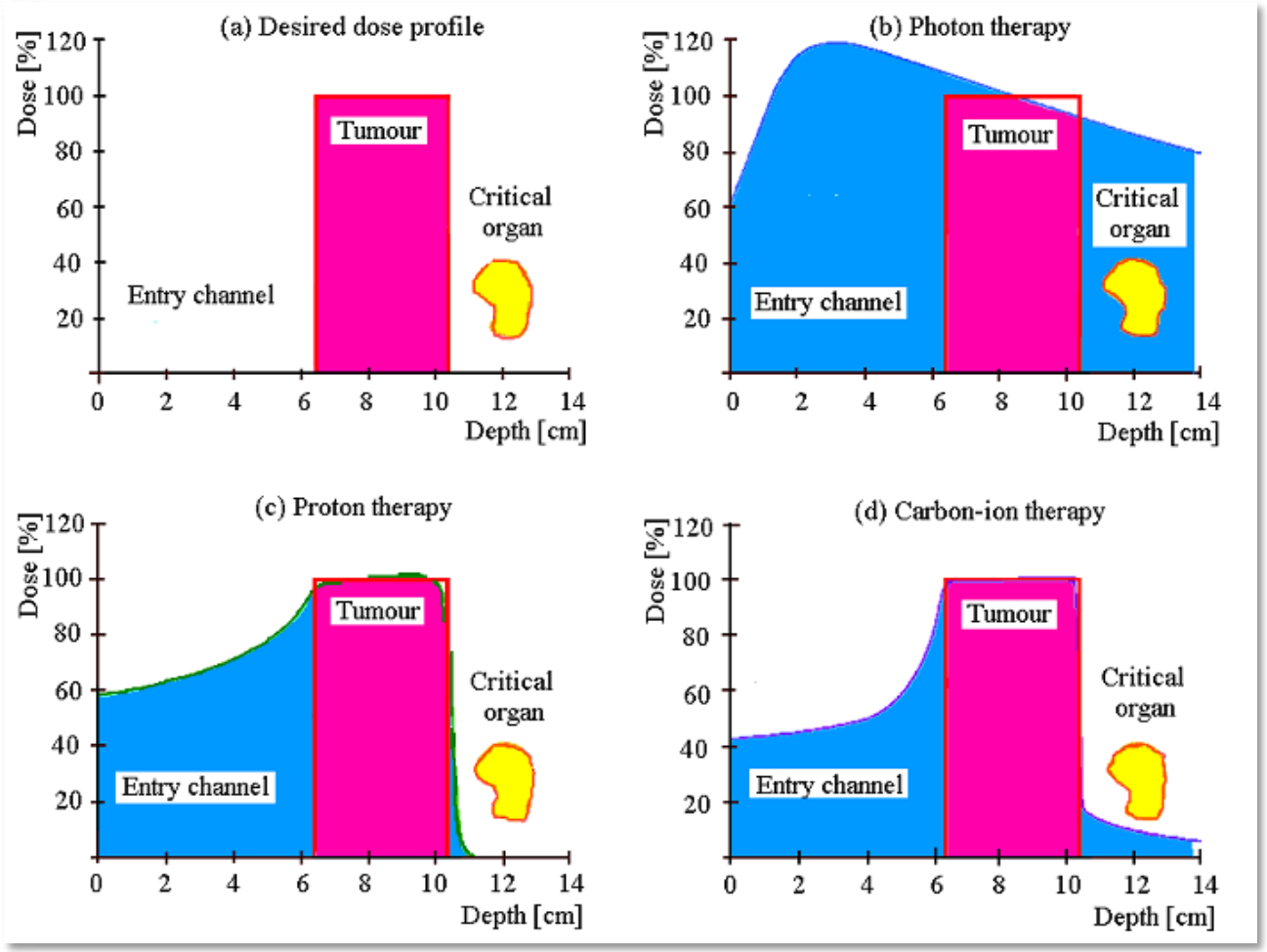
http://journal.frontiersin.org/article/10.3389/fonc.2011.00024/full



Rescue: Heavy Ion Therapy



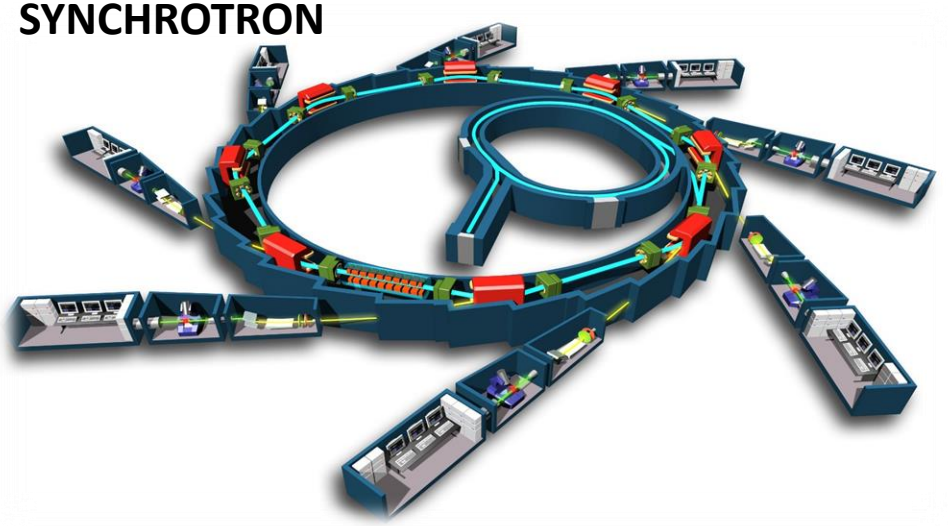
accelerators-for-society.org/health/index.php?id=7



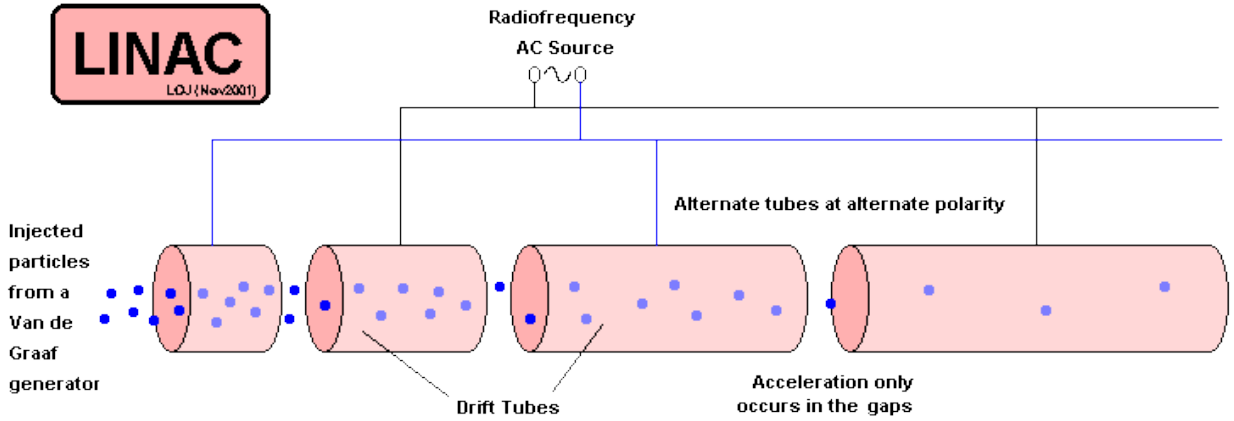
Hadron Therapy for Cancer Using Heavy Ions, C. So, University of Surrey

Accelerators Keeping up with the Hadron Therapy Demands

SYNCHROTRON



en.wikipedia.org/wiki/Synchrotron_light_source



http://barclayphysics.wikia.com/wiki/Linear_accelerators

- Paul Scherrer Institute (PSI), Switzerland
- Heidelberg Ion Therapy (HIT), Germany
- Centro Nazionale di Adroterapia Oncologica (CNAO), Italy
- Gesellschaft für Schwerionenforschung (GSI), Germany
- Heavy Ion Medical Accelerator in Chiba (HIMAC), Japan

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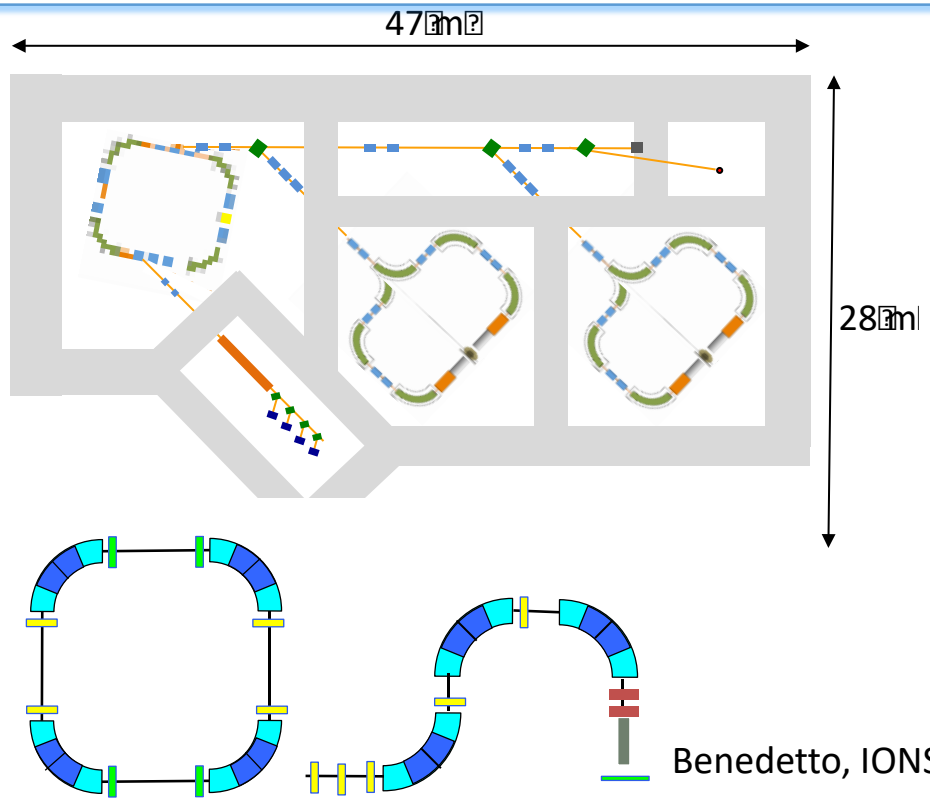
The IONS 2018 Workshop: Leading Ideas

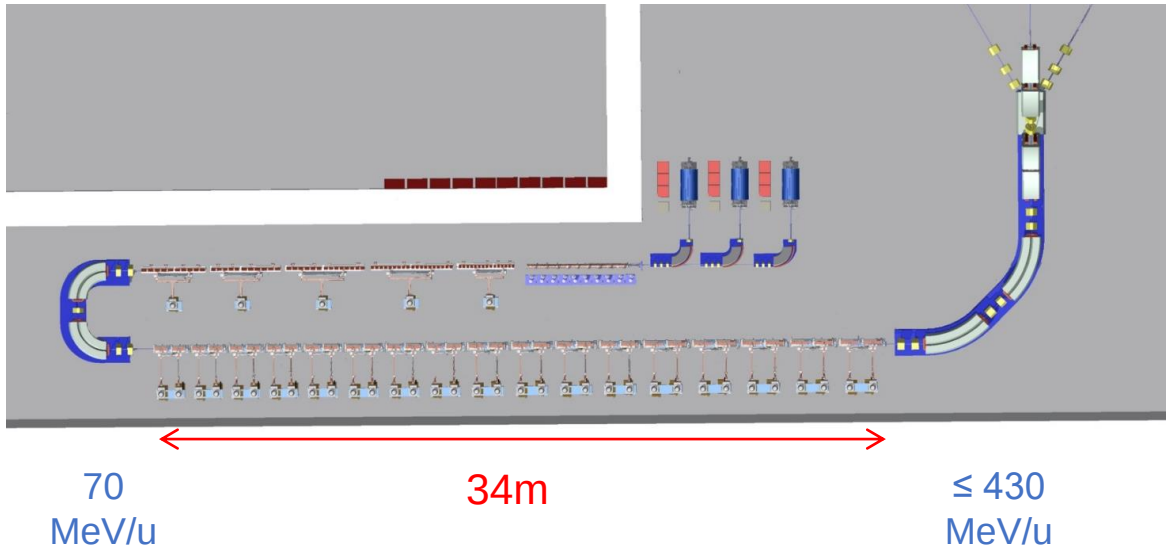
- Leading experts discussed the best new accelerator design options for heavy ion treatment
- 2 designs stand out

Canted Cosine Theta Superconducting Magnet Synchrotron



Benedetto, IONS2018 Conference

CABOTO (CArbon BOoster for Therapy in Oncology) Linac



Degiovanni, IONS2018 Conference

The IONS 2018 Workshop: SS vs LINAC in General

Canted Cosine Theta Superconducting Magnet Synchrotron

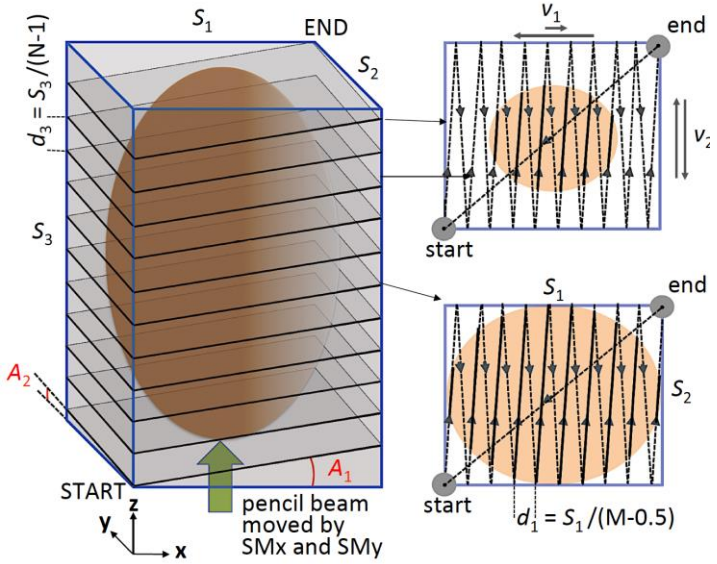
- Compact: Ring 25 m circumference, Gantry 5.3 m tall;
- Less iron used, less expensive, circumference reduced;
- Active Oblique Raster Scanning Method employed;
- Treatment does not require rapid variations of the beam spot energy – less magnet ripples;
- Inductances of the SC coils can be more than 10 times larger than the ones in conventional synchrotrons;
- Variation rates of SC currents are more than 10 times smaller than the ones used in conventional synchrotrons, and the power dumped is reduced;
- 3D Control Feedback employable – needed for moving organs.

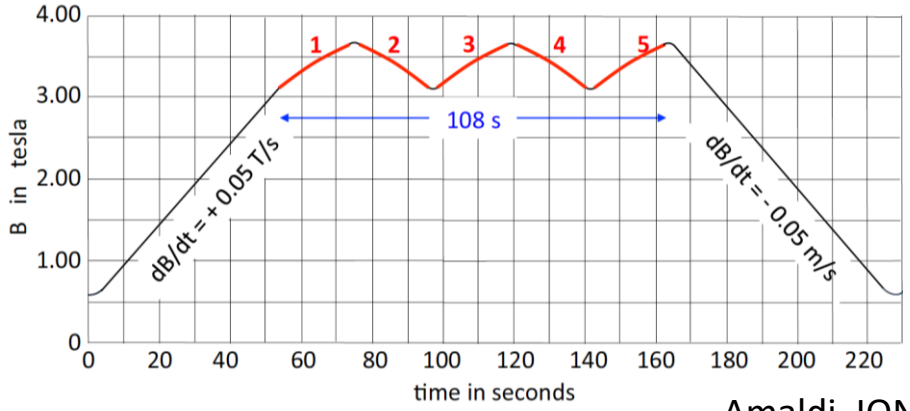
CABOTO (CArbon BOoster for Therapy in Oncology) Linac

- Compact: (22 – 34) m long;
- TE and H mode cavities can be used;
- For larger ion energies, shunt impedance is high;
- Very useful for spot scanning tehnique with multipainting (with various energies);
- High frequency (planned approx. 3 GHz);
- High repetition rate (planned approx. 200-400 Hz);
- Short Hadron pulses (planned approx. 1.5 us);
- Fast (varying energy and intensity in 2ms)!
- Compatible for 3D control Feedback (PET, MRI)!

The IONS 2018 Workshop: SS vs LINAC in Dose Delivery

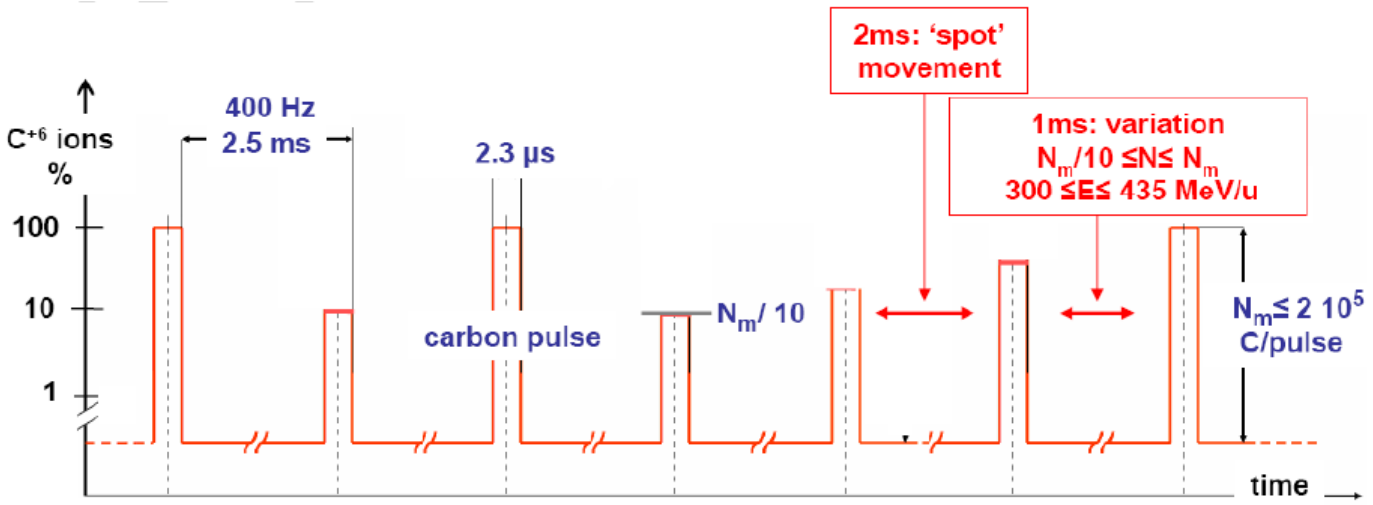
Canted Cosine Theta Superconducting Magnet Synchrotron





Amaldi, IONS2018 Conference

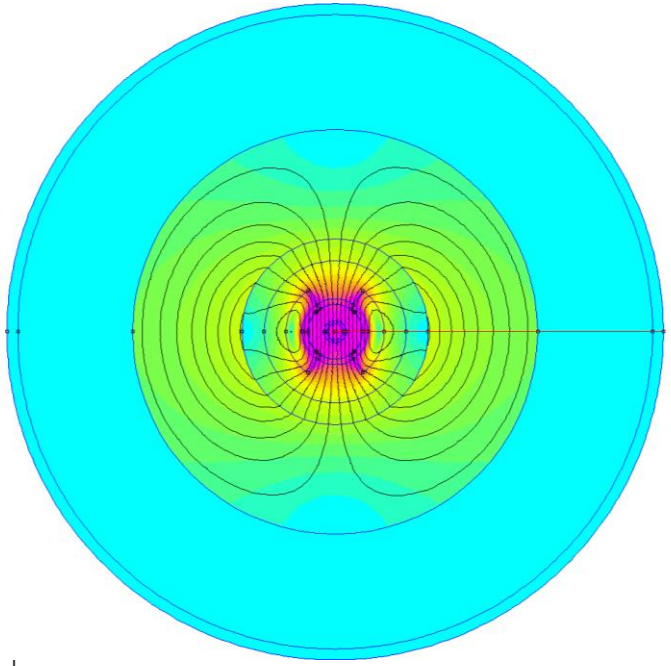
CABOTO (CArbon BOoster for Therapy in Oncology) Linac



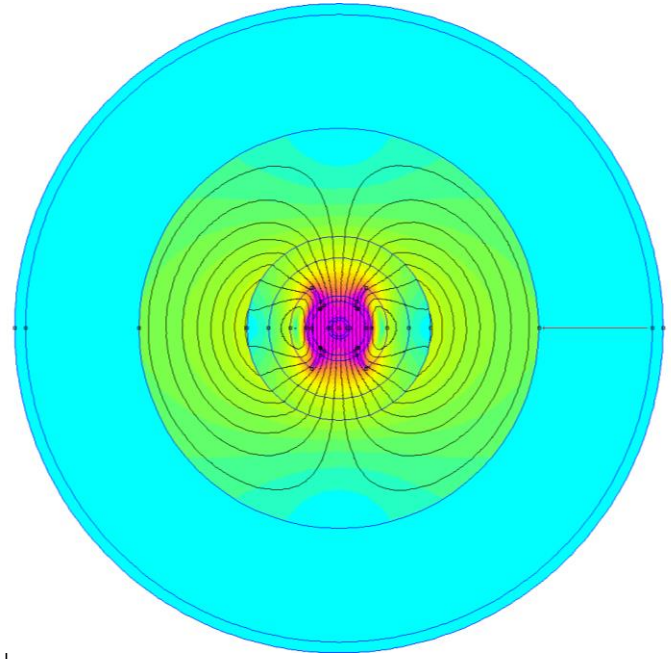
Degiovanni, IONS2018 Conference

At the Moment: Shielding Design Study in CCT SS Gantry – FEMM vs OPERA

Yoke R
17cm-37cm



Plotting line



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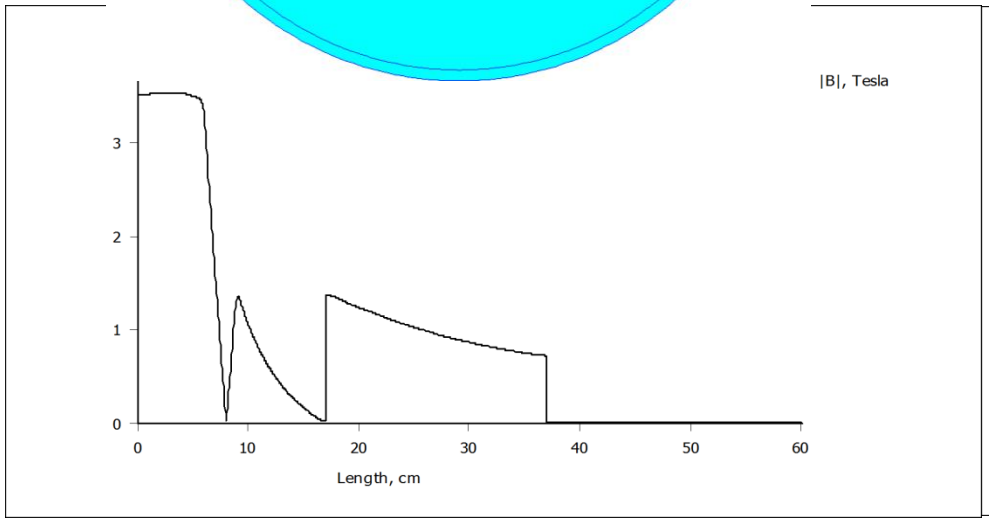

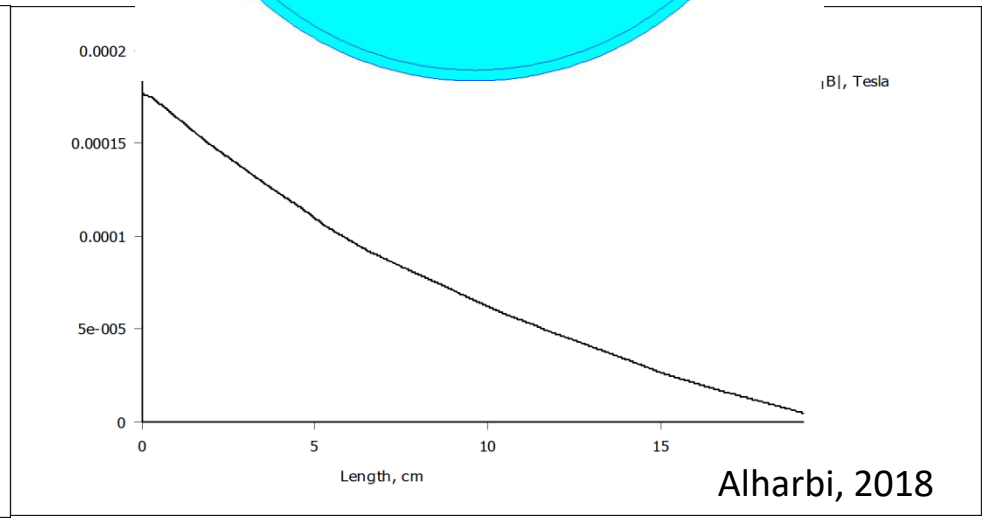

Alharbi, 2018

Acknowledgements: CERN

- Dr. Maurizio Vretenar
- Prof. Ugo Amaldi
- Dr. Yiota Foka
- Dr. Toms Torims
- Dr. Elena Benedetto
- Dr. Adriano Garonna
- Dr. Alberto Degiovanni
- Dr. Nader Alharbi
- Dr. Manjit Dosanjh
- Dr. Sanja Damjanović

Thank you for your attention...

Questions?