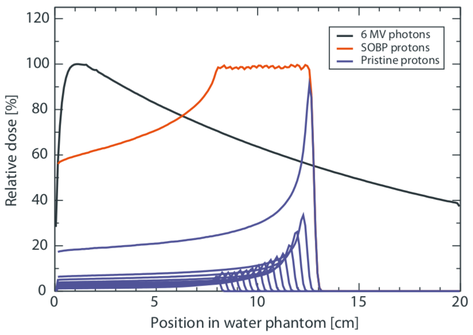
AARHUS UNIVERSITY

PARTICLE THERAPY IN AARHUS

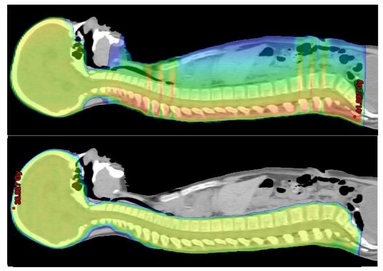


Therapy with protons or heavier ions have advantages over conventional therapy with photons and electrons.

When a beam of protons penetrate tissue, they deliver most of their kinetic energy at the end of their particle trajectory.

This results in a highly localized dose deposition which can be controlled with millimeter precision.

The figure to the left shows a series of proton beams with several energies (**blue lines**) in a water target. Careful energy selection and weighting will produce a uniform dose distribution (**red line**), which is more favorable than conventional therapy (**black line**).

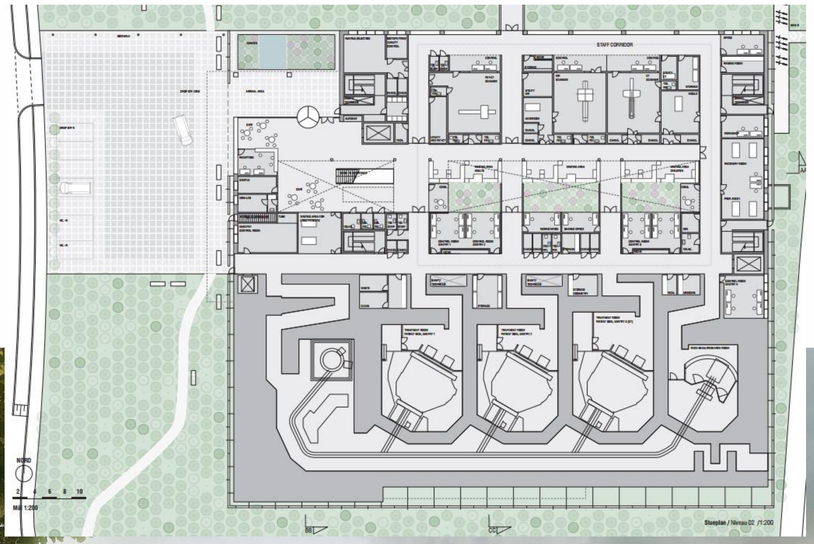


Treatment plan by Jørgen B. B. Petersen, Aarhus University Hospital

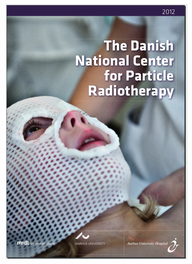
Proton therapy results in a **better localization of dose**. The figure above shows irradiation of the cranio-spinal axis of a child with medulloblastoma. A treatment plan for conventional radiotherapy is shown on the top and protons on the bottom. This study was made at Aarhus University Hospital.

Proton therapy reduces the amount of healthy tissues irradiated, thereby **limiting side effects**.
In other cases, protons can also enable dose escalation, which **increases tumour control**.

As of 2015 there are more than 50 active particle therapy centers world wide, and to date more than 100.000 patients have been treated with protons.



The pictures above show the floor plan and an artist rendering of the new proton therapy facility at Skejby Sygehus, when it will be completed at the end of 2018.



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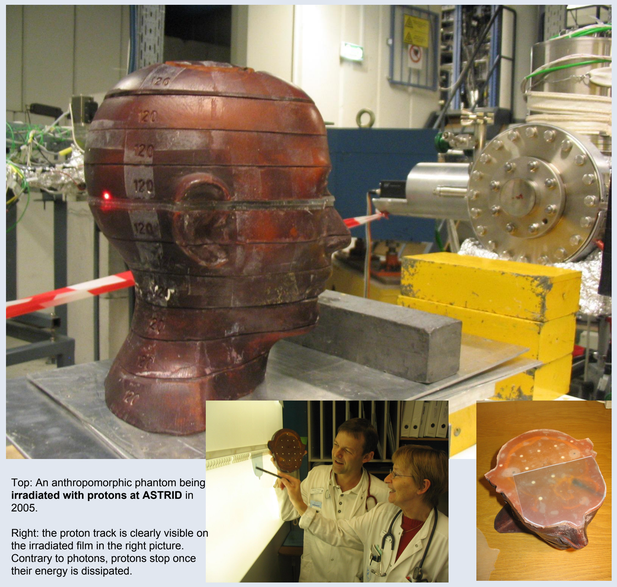
In 2012 Aarhus University and Aarhus University Hospital was selected to host the **Danish Center for Proton Therapy** (DCPT) located at The New University Hospital (DNU) in Skejby just north of Aarhus.

The plan foresees a cyclotron accelerator, delivering the proton beam to **three treatment rooms** and a dedicated **research room**.

This facility will be able to treat up to **1500 patients per year**.

The facility is expected to be ready for patient treatment end of 2018.

RESEARCH



Top: An anthropomorphic phantom being **irradiated with protons at ASTRID** in 2005.

Right: the proton track is clearly visible on the irradiated film in the right picture. Contrary to photons, protons stop once their energy is dissipated.

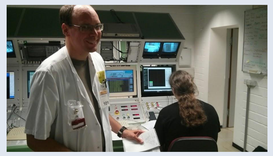
Since 2002, Aarhus University has been active in research in particle therapy in a interdisciplinary effort involving:

- Dept. of Physics and Astronomy
- Dept. of Mathematics
- Dept. of Computer Science

and at the Aarhus University Hospital;

- Dept. of Experimental Clinical Oncology
- Dept. of Medical Physics

along international collaborators and research institutions, such as CERN, GSI Darmstadt or the particle centers in Heidelberg and Marburg.



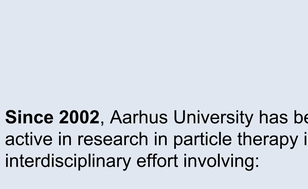
Tumour control studies at GSI, Darmstadt, where tumour bearing mice were irradiated with carbon ions.

Detectors systems and **cell lines** have been investigated at Aarhus University, in beams of photons, protons, carbon ion and antiprotons.

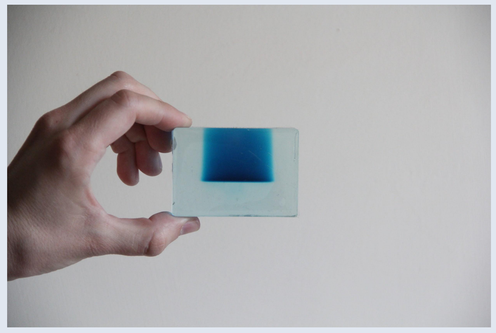
Work is interdisciplinary with medical doctors and radiobiologists from Aarhus University Hospital and abroad.

Example projects at IFA, or with IFA participation:

- Measuring the **relative biological effectiveness** in hamster cells *in vitro* of Antiprotons at CERN.
- Measuring **tumour control probability** and normal tissue complications in CDF mice, *in vivo* at GSI using carbon ion beams
- Simulating medical ionization chambers in medical radiation fields
- Measuring and developing response models for a broad range of solid state detectors in ion beams at CERN and GSI, but also in Finland, Poland and Germany
- Neutron irradiation of Alanine detectors at a nuclear reactor in Mainz, Germany
- Monte Carlo particle transport development SHIELD-HIT12A, which can simulate ion beams in tissues, organs and other targets.



Data acquisition for the Antiproton Cell Experiment (ACE) conducted by Aarhus University at CERN.



Dosimeter material developed at IFA after irradiation with 60 MeV protons (entering from above). The Bragg peak is clearly visible.
Further information from **Ellen Marie Hoye <elhoey@rm.dk>**

We are currently developing a 3D dosimeter - an instrument that can detect radiation, that can be used for quality assurance in radiation therapy of cancer patients, both photons and protons.

Contact persons at IFA for Bachelor and MSc Projects

- Niels Bassler <bassler@phys.au.dk>
- Peter Balling <balling@phys.au.dk>
- Karsten Riisager <kvr@phys.au.dk>

AARHUS PARTICLE THERAPY GROUP