EU Scientific Seminar: Light Ion Beam Therapy

Oliver Jäkel

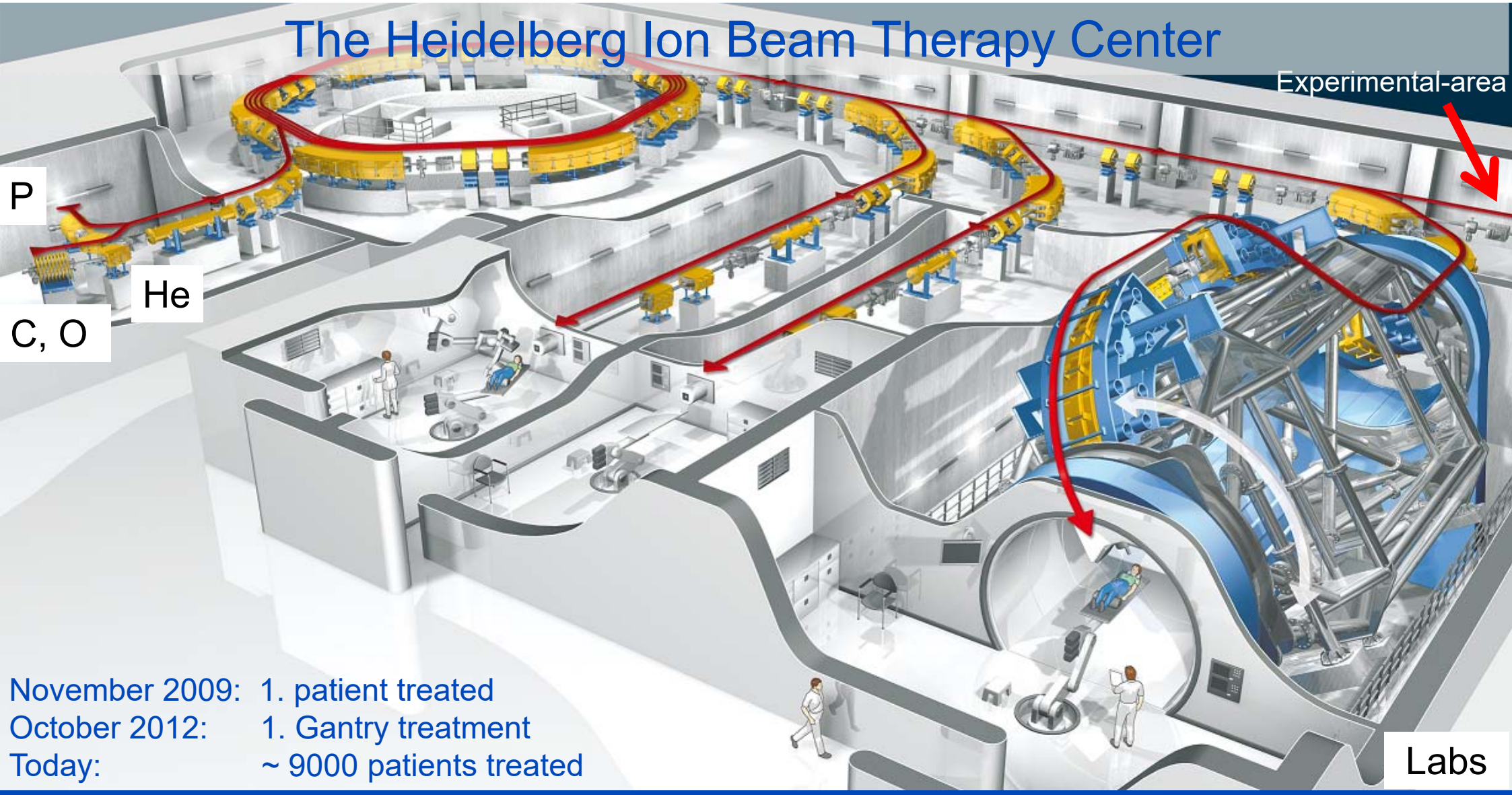
Div. Medical Physics in Radiation Oncology (DKFZ) & Heidelberg Ion Beam Therapy Center (HIT)

HIT Heidelberger Ionenstrahl-Therapiezentrum

dkfz. GERMAN CANCER RESEARCH CENTER IN THE HELMHOLTZ ASSOCIATION

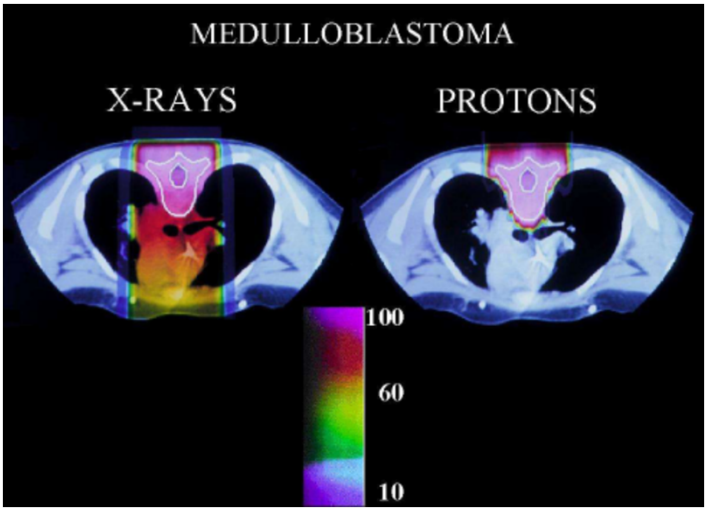
Research for a Life without Cancer

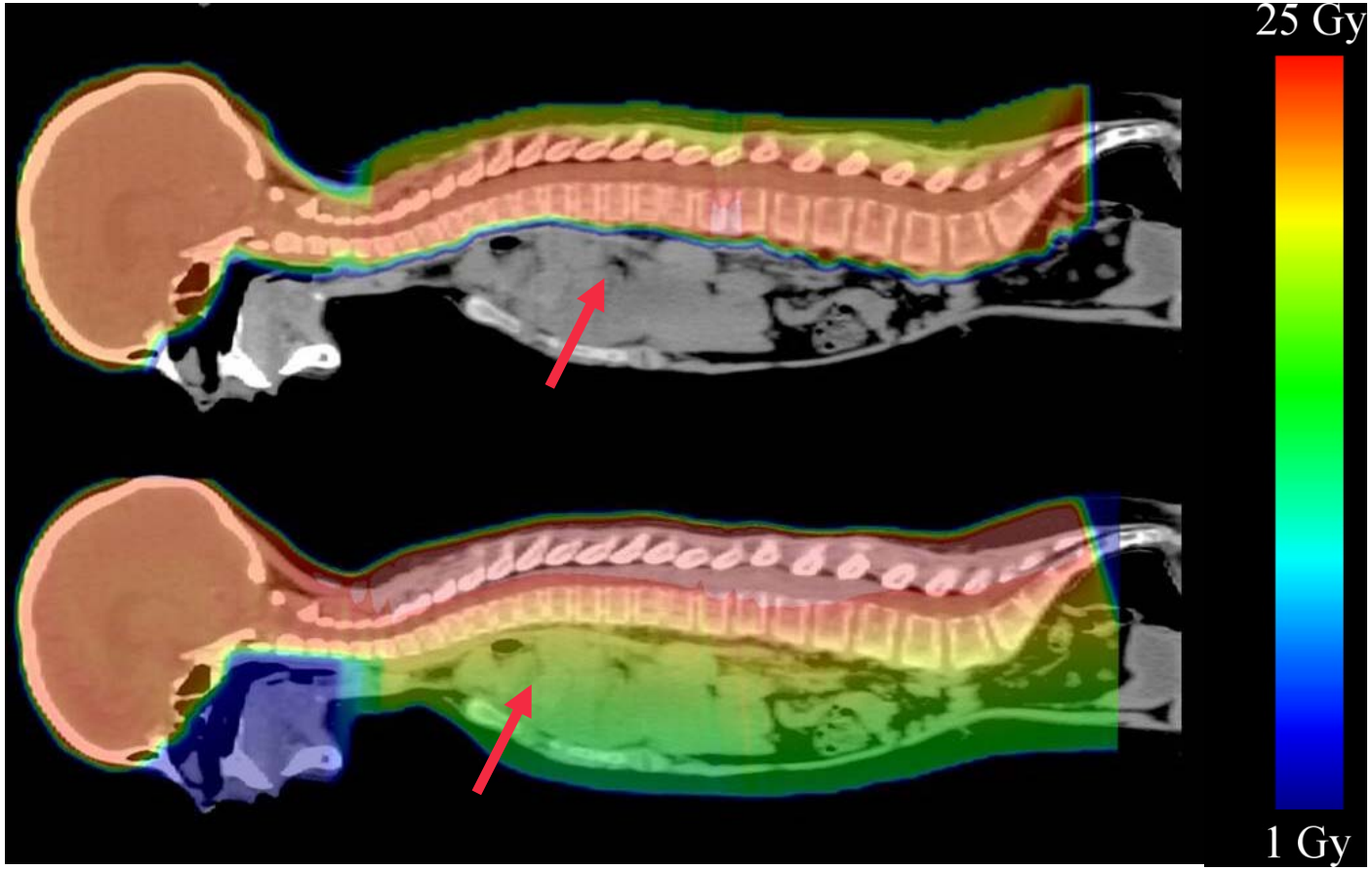
The Heidelberg Ion Beam Therapy Center



November 2009: 1. patient treated
October 2012: 1. Gantry treatment
Today: ~ 9000 patients treated

Proton therapy for Medulloblastoma patients



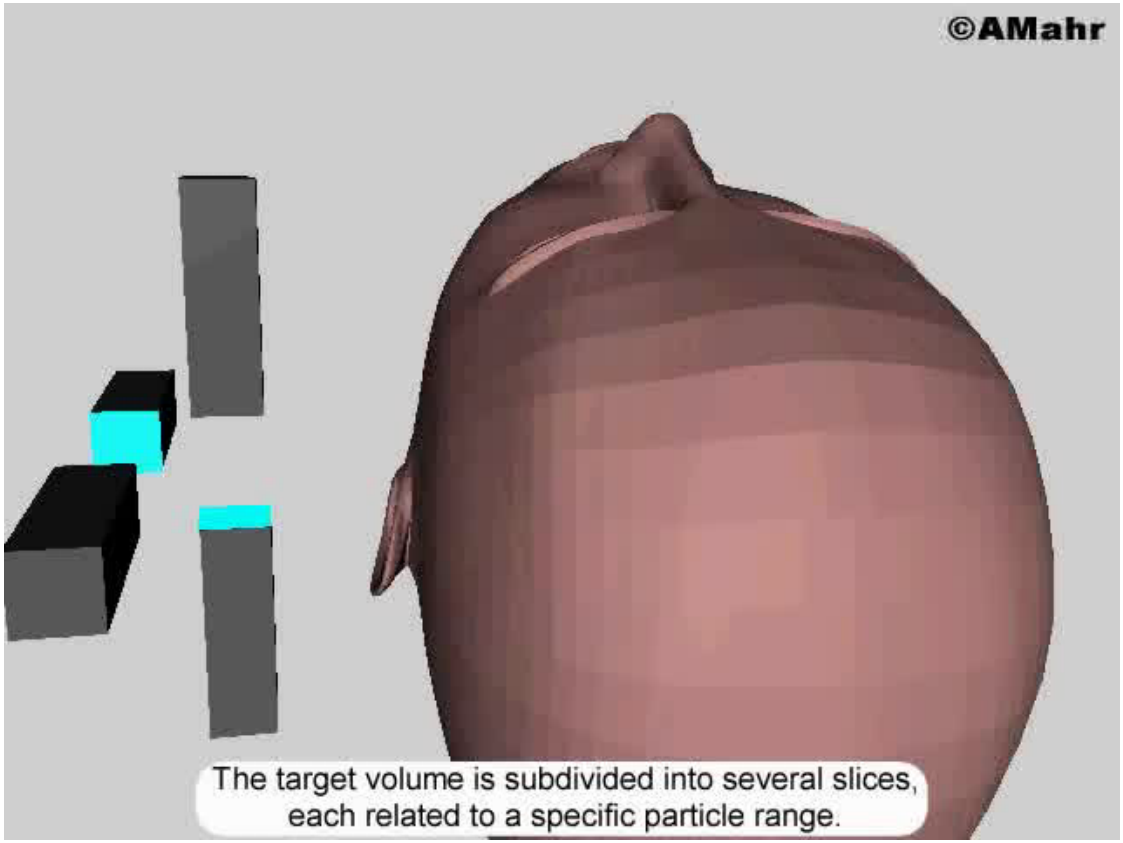


Stokkevåg et al. *Acta Oncol* **2014**

No dose to the heart, lung, mediastium, bowel

Dose delivery by beam scanning

Pointwise delivery with 5mm beam, 1mm resolution in 3D



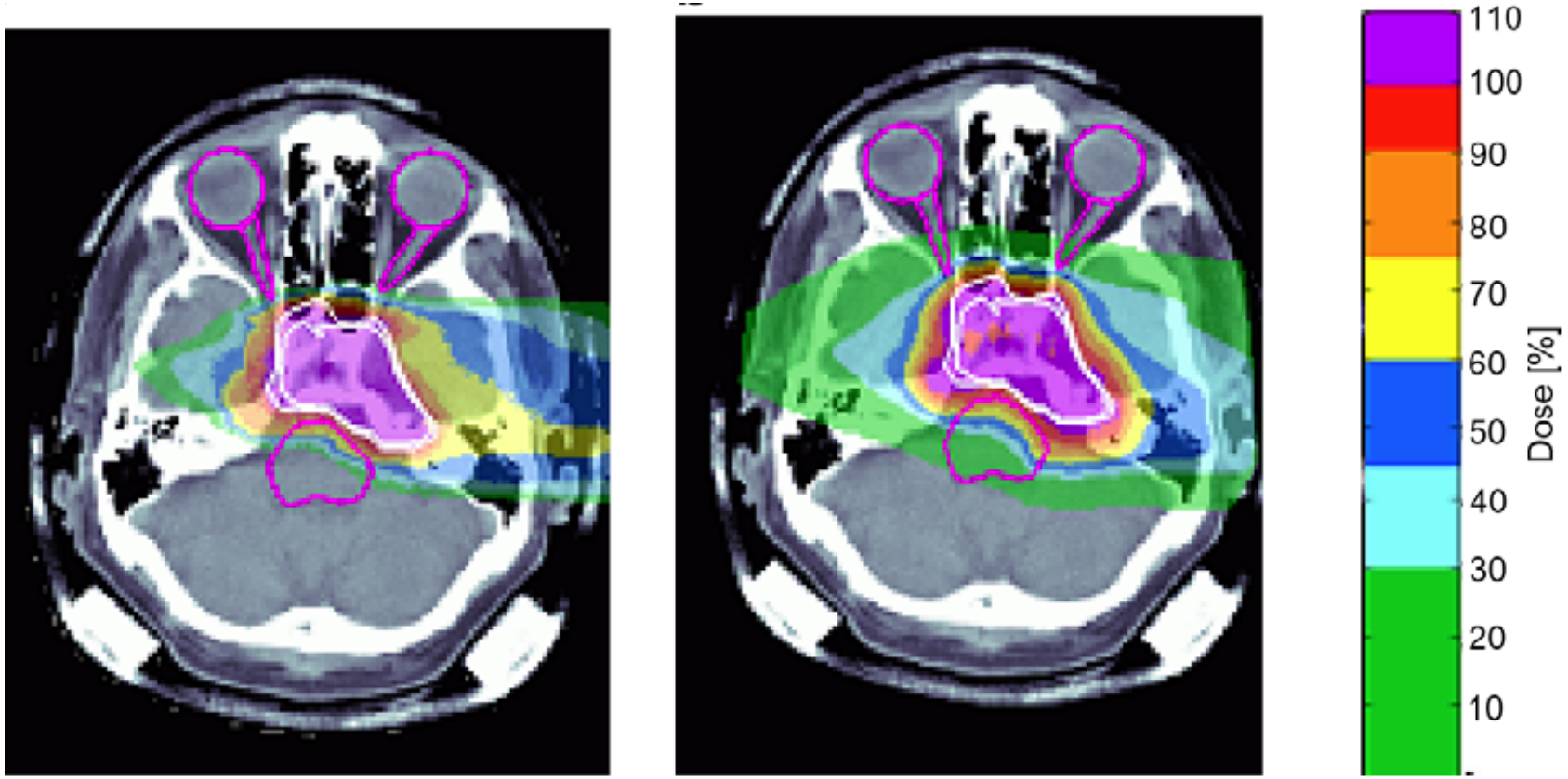
typ. 30-50 energies, 20000 -50000 single beams

Heavier particles have a smaller lateral penumbra

Treatment plan for identical parameters (scanned beams)

Carbon (GSI)

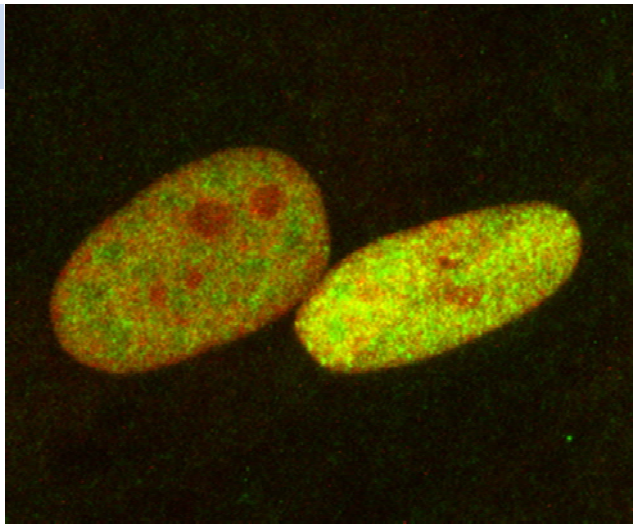
Protons (MGH)

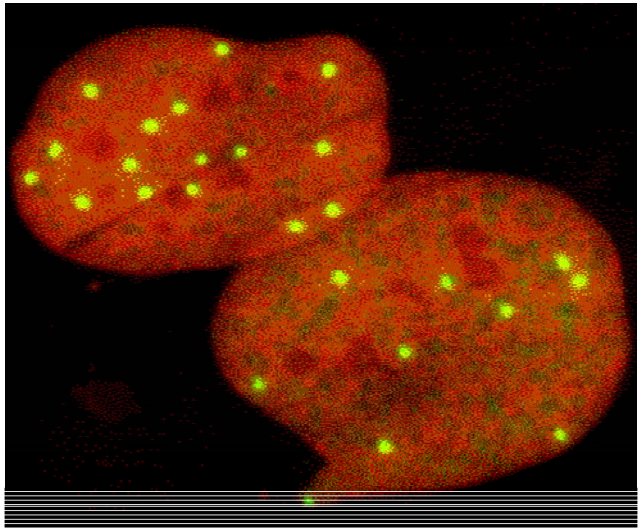


H. Suit et al, Radiat. Oncol. 2010

Low vs. high LET

Low LET



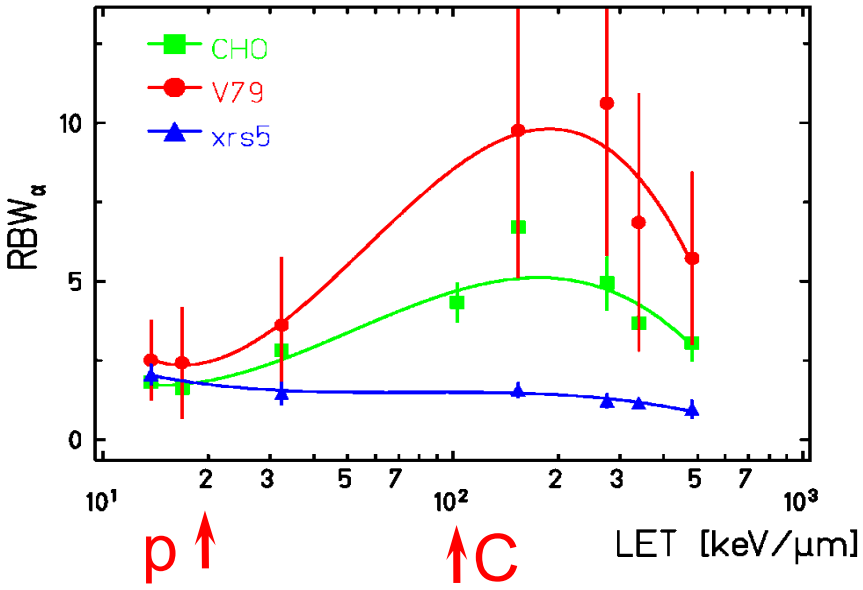


High LET

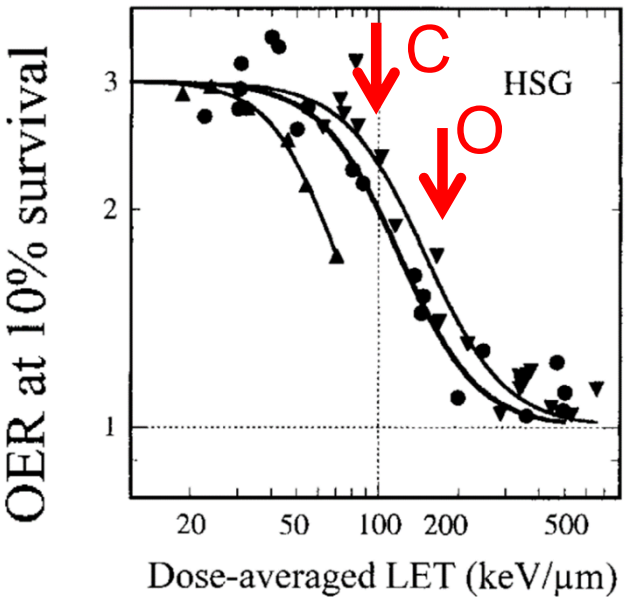
High LET means, that more of the transferred energy is deposited into a smaller volume along the track!

Biological Effectiveness: RBE and OER

Weyrather Int. J. Rad. Biol. (1999),



Furusawa Rad. Res. (2000)



He: ▲,
^{12}C: ●,
^{20}Ne: ▼

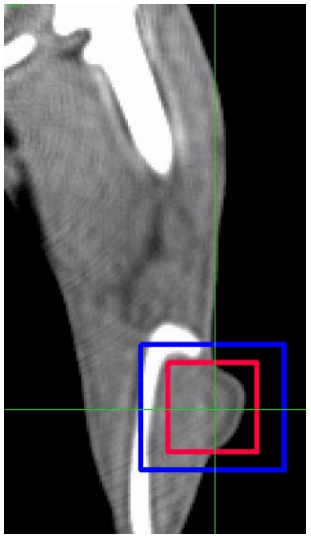
- Increased RBE in resistant tumors.
- Improved outcome in hypoxic tumors.
- Differential RBE for Carbon

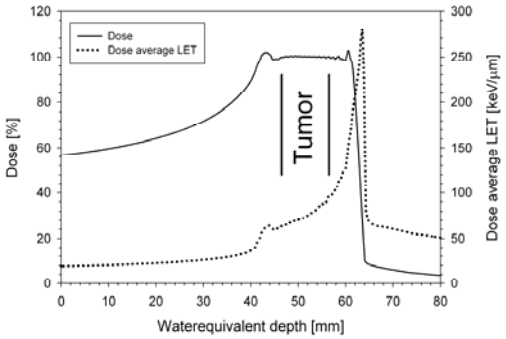
Scanned Oxygen beam @HIT

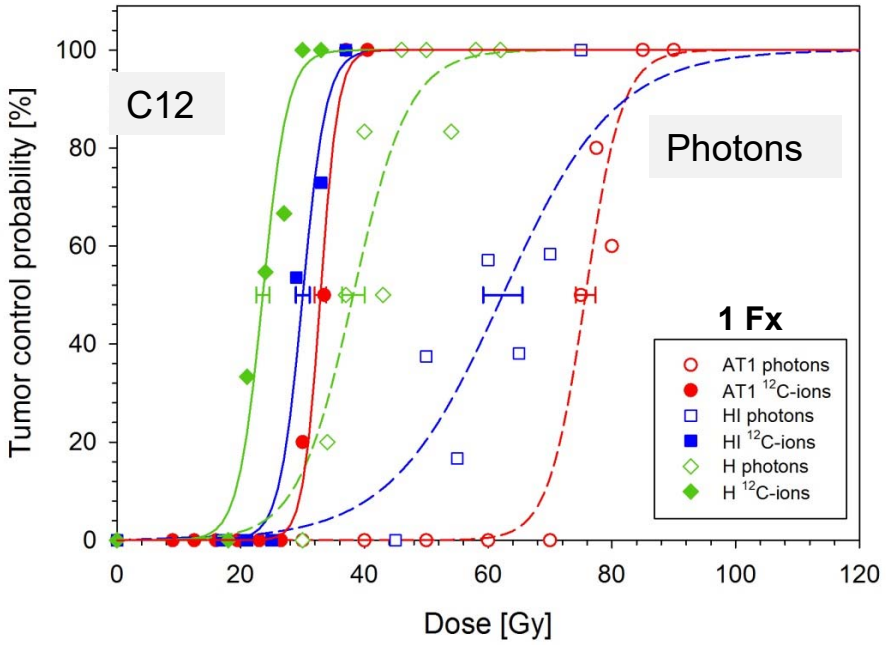
Reduced importance of tumor cell heterogeneity in response to Carbon ion beams

Glowa 2016 (Cancer Lett.)

Xenograft rat tumor model







Tumor*	Progression status	Vol.-doubling time	Hypoxic fraction
AT1	Anaplastic	5 d	High (chronic)
HI	Moderatly differentiated	10 d	Moderate (acute)
H	Well differentiated	20d	low

Long term follow up in skull base chordoma

Uhl M et al., Cancer 2014; 120(10)

Cohort:

- **155 patients (76 m + 79 w)**
- median age 48 years (15y -85y)
- Scanned carbon ions
- median total dose **60 Gy, 3 Gy/Fx (RBE)**
- median boost PTV 70 ml (2-294 ml)
- **median follow-up 72 mo. (12-165**)

Endpoints:

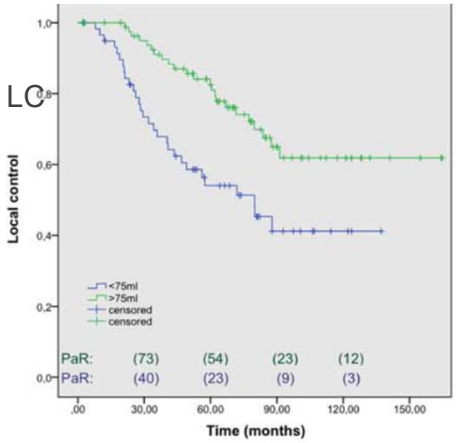
- local control (LC)
- overall survival (OS)
- long-term toxicity

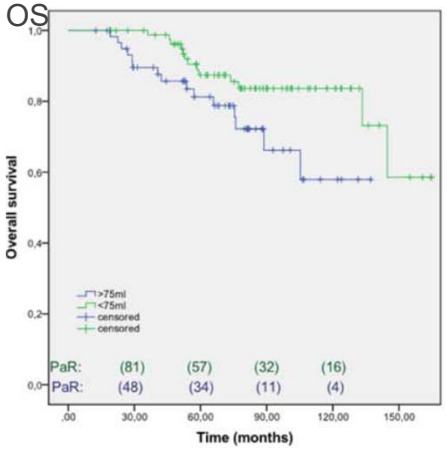
Results:

- **No higher late toxicity** could be detected after 12 Ctreatment.
- **55 local recurrences** (35%) during f/u

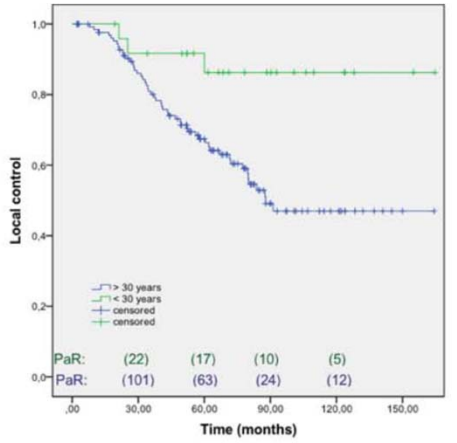
	3 years	5 years	10 years
LC	82%	72%	54%
OS	95%	85%	75%

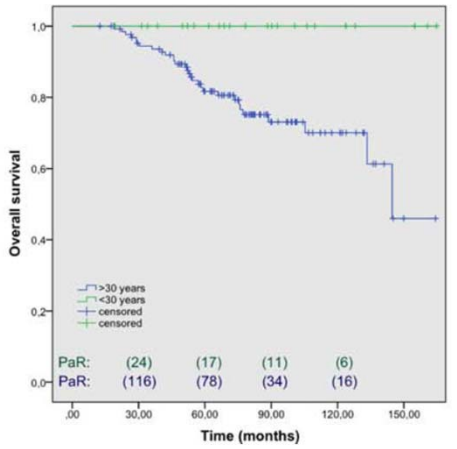
Boost Volume < 75 ml

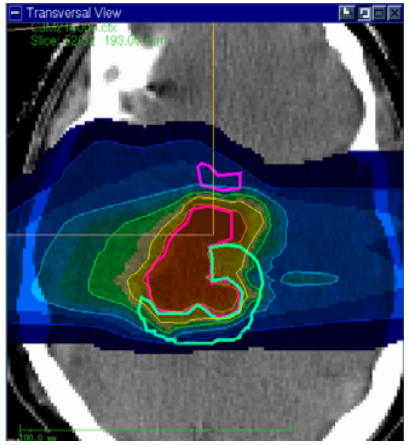


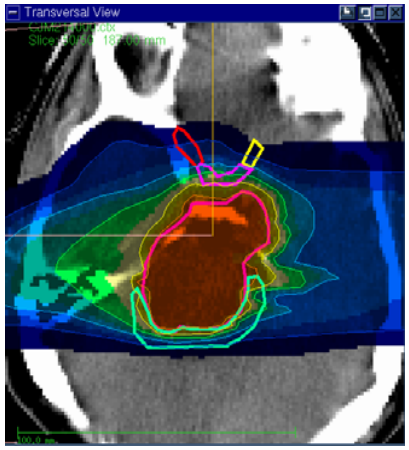


Age < 30 y





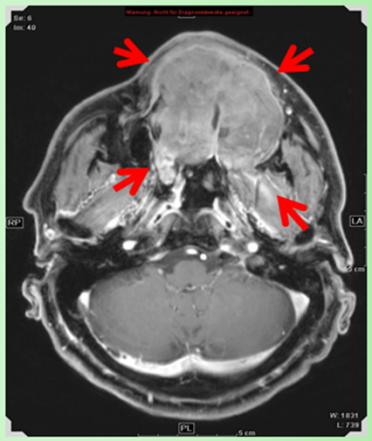




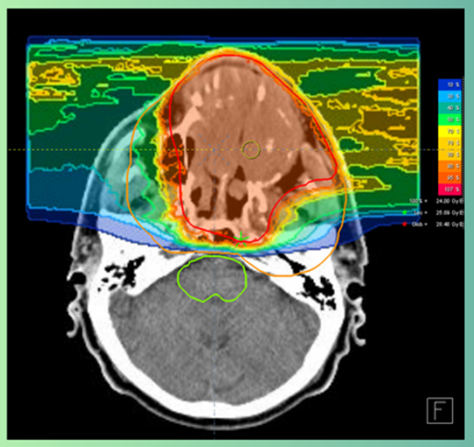
Locally advanced Adenoidcystic Ca.: COSMIC

Combined therapy of malignant **s**alivary gland tu**m**ors with **I**MRT and **c**arbon ions
- Phase II feasibility study

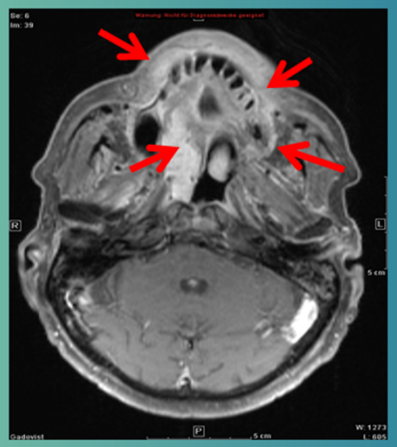
- ➢ No dose limiting acute toxicity
- ➢ Late Toxicity G > CTC grade 2 < 5%



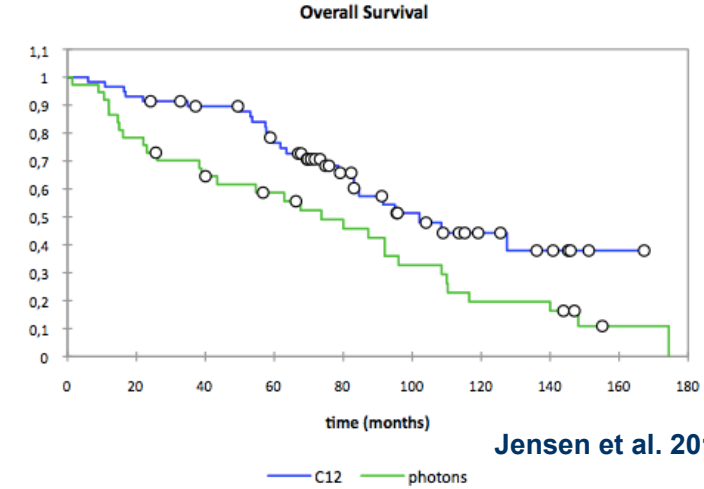
Pre-treatment situation



Treatment planning
C-12 boost



6 weeks post RT



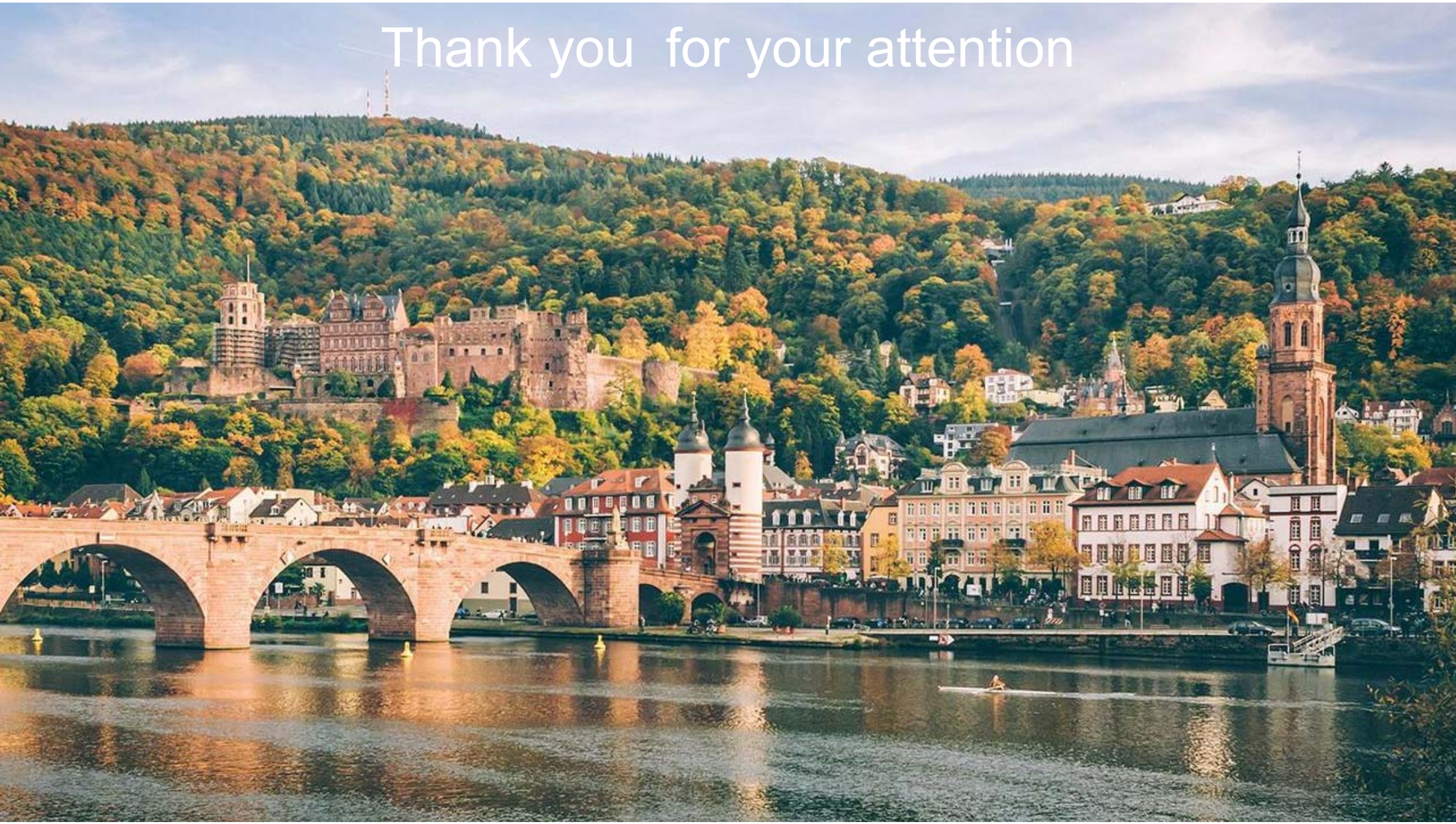
Jensen et al. 2015, Cancer

Cancer

Original Article

Combined intensity-modulated radiotherapy plus raster-scanned carbon ion boost for advanced adenoid cystic carcinoma of the head and neck results in superior locoregional control and overall survival

Better local tumor control by C-12 irradiation leads to better long-term survival of locally advanced adenoid cystic carcinoma


Thank you for your attention