Radiation therapy with proton microchannels: reduced side effects in a human skin model

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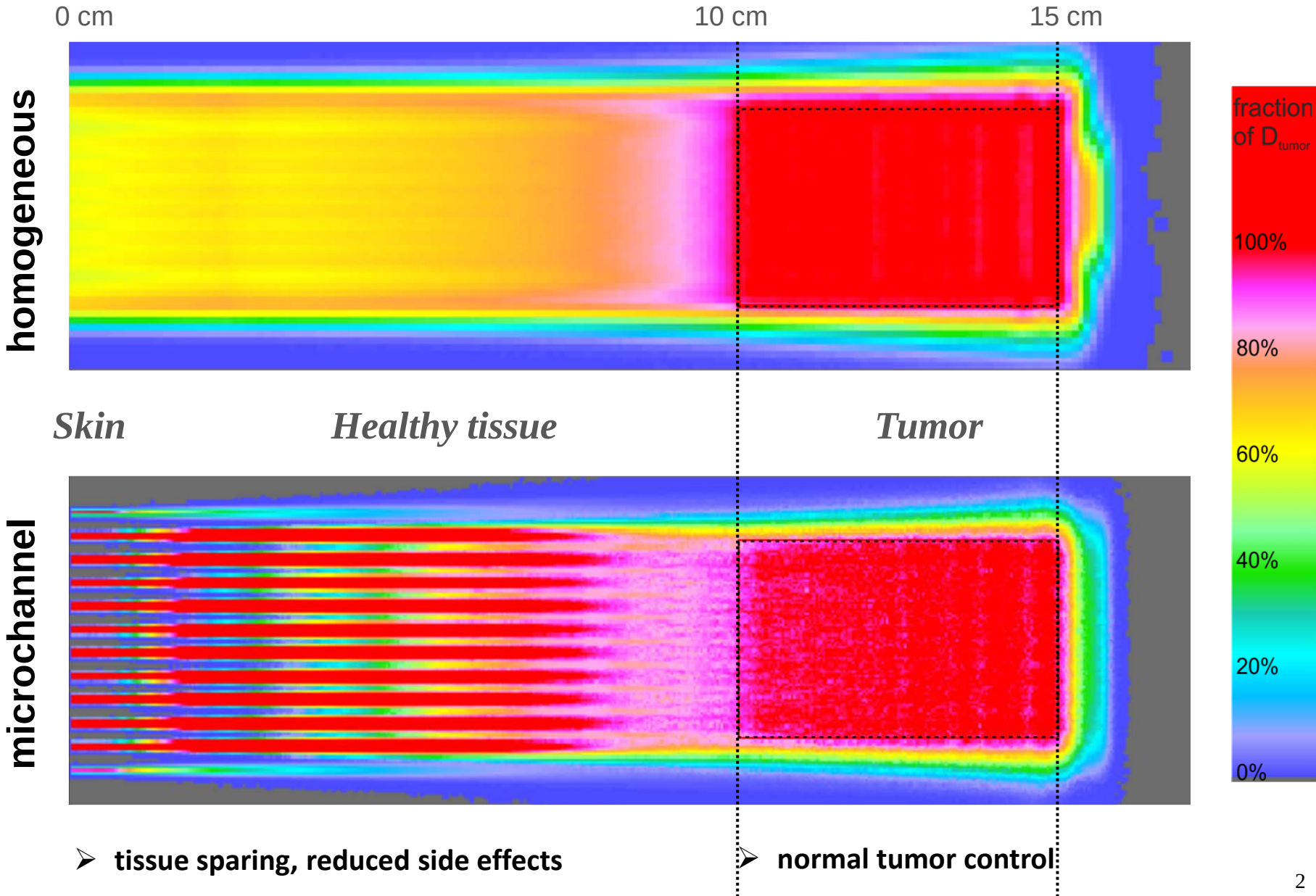
The Idea



- tissue sparing, reduced side effects
- normal tumor control

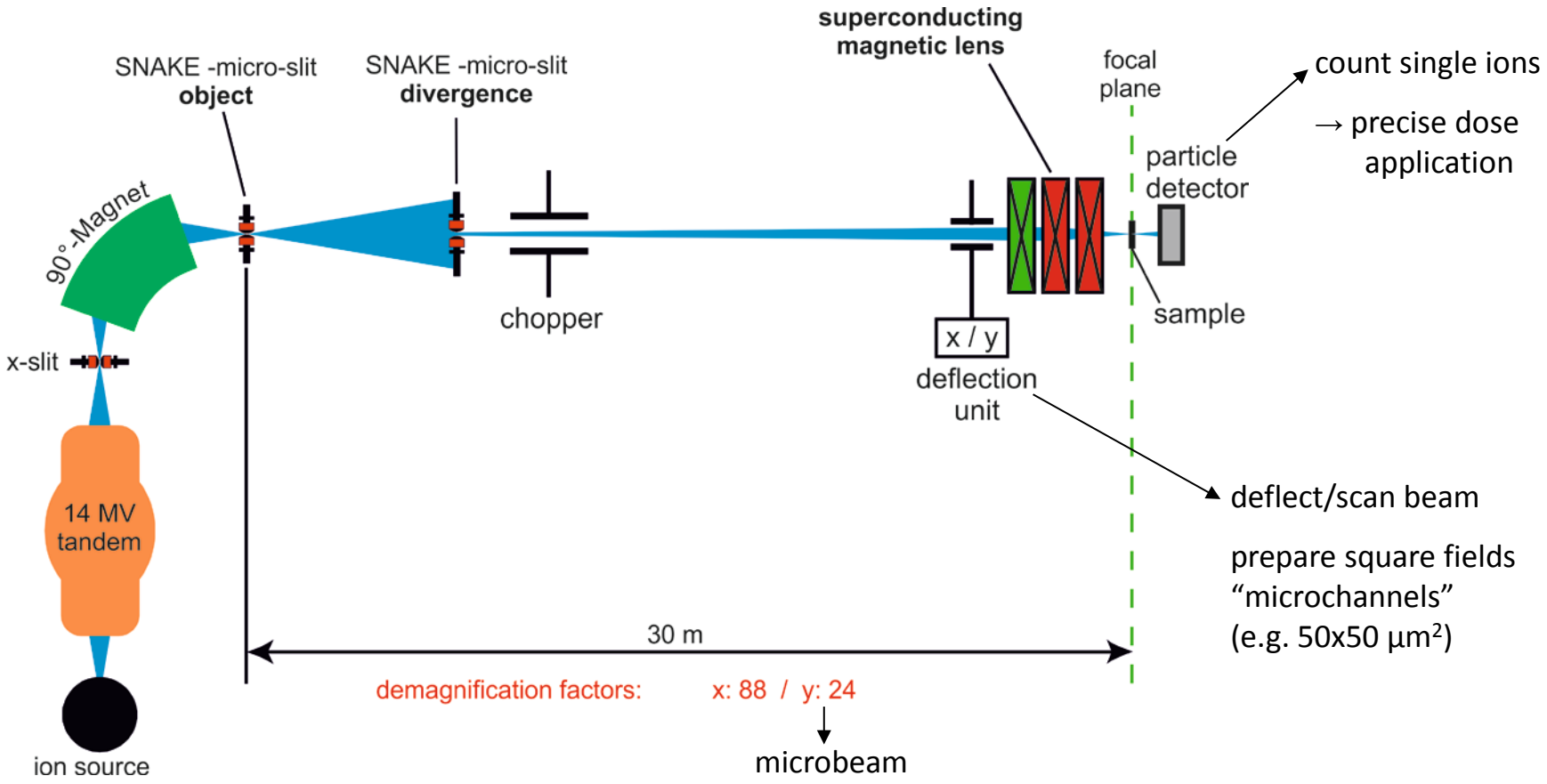
Test experiments at SNAKE with human skin tissue

SNAKE: superconducting nanoprobe for applied nuclear physics experiments

(Supraleitendes Nanoskop für Angewandte Kernphysikalische Experimente)

Irradiation at SNAKE

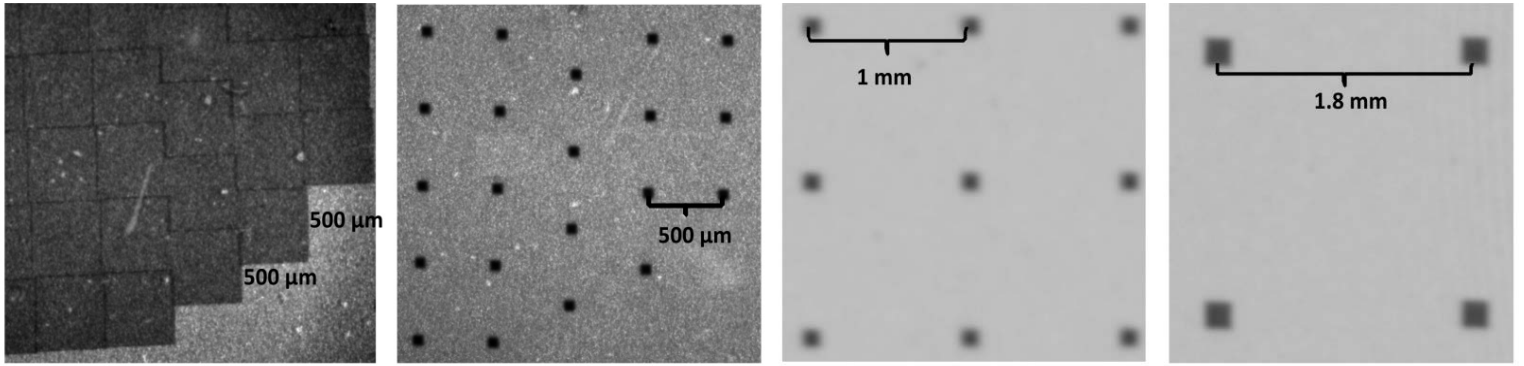
Tandem Accelerator in Garching



Irradiation at SNAKE

microchannels ↔ homogeneous

Irradiation fields visualized with Gafchromic film



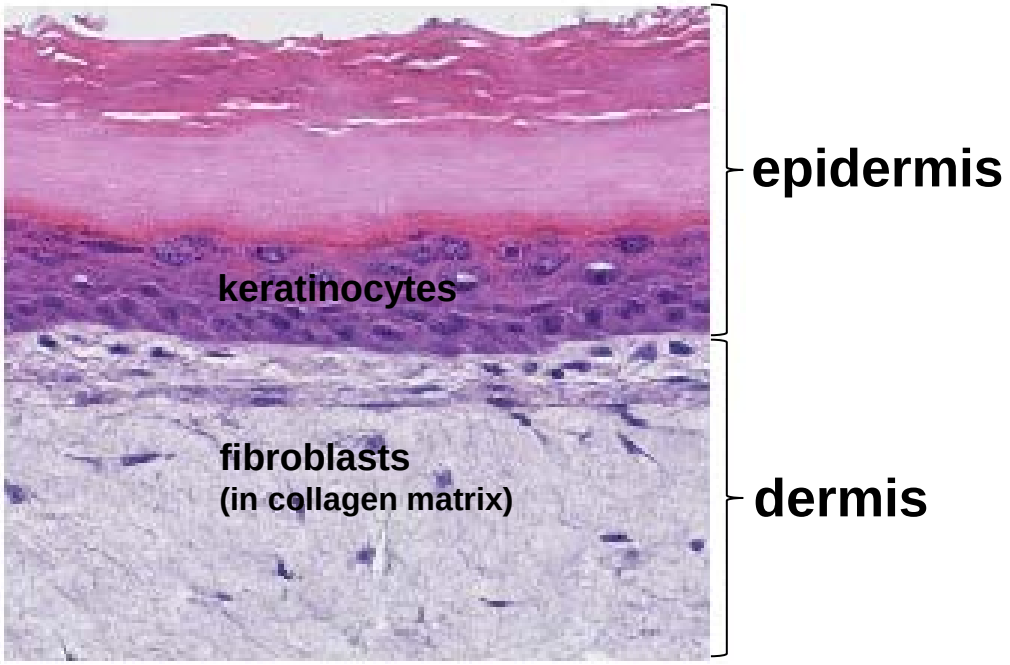
Homogeneous	50 x 50 µm² channels	100 x 100 µm² channels	180 x 180 µm² channels
	500 µm	1 mm	1.8 mm
2 Gy homogeneous	200 Gy per channel		
100%	irradiated area 1%		

average dose 2 Gy

20 MeV protons, LET ~ 2.66 keV/µm

Human skin tissue model

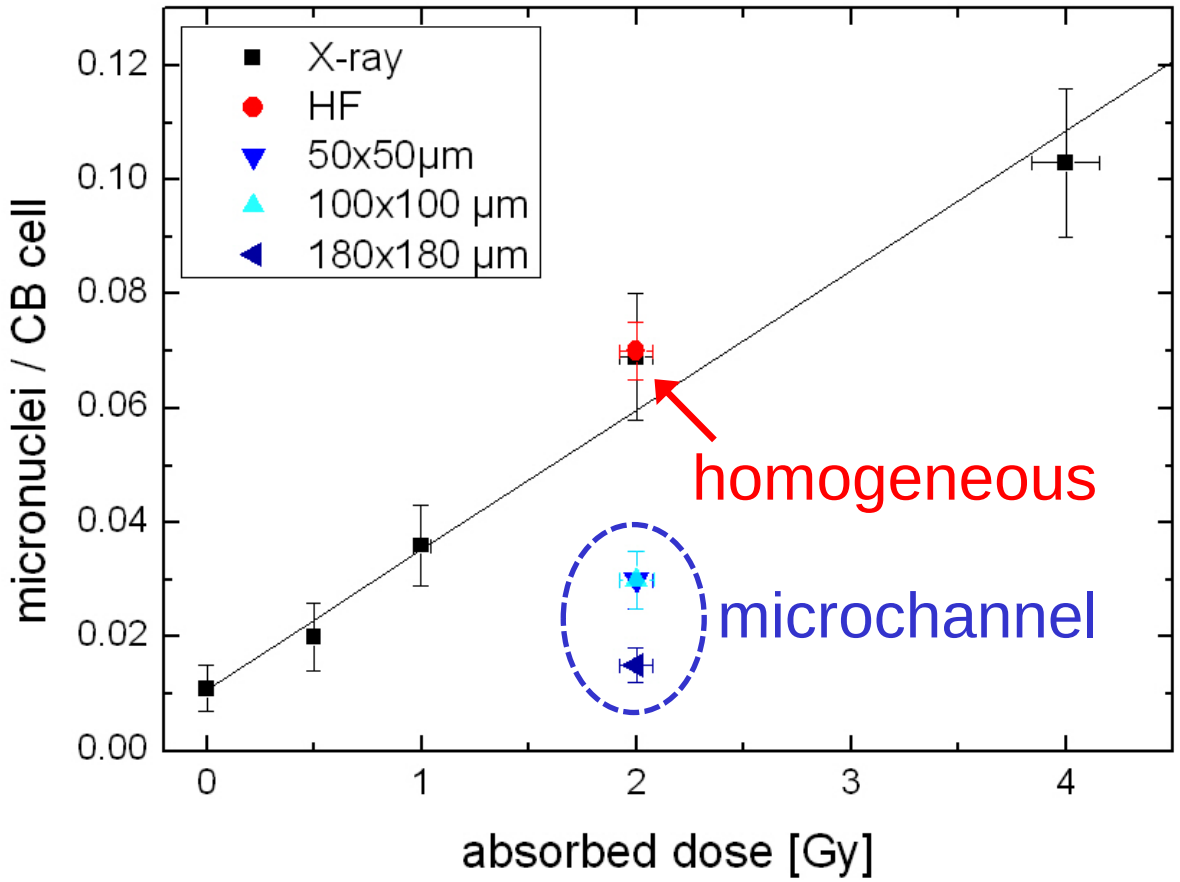
EpidermFT 400 from MatTek:



- no blood vessels
- grown in culture medium (nutrition through diffusion)
- 0.5 - 1 mm thick
- max. 2 weeks in culture

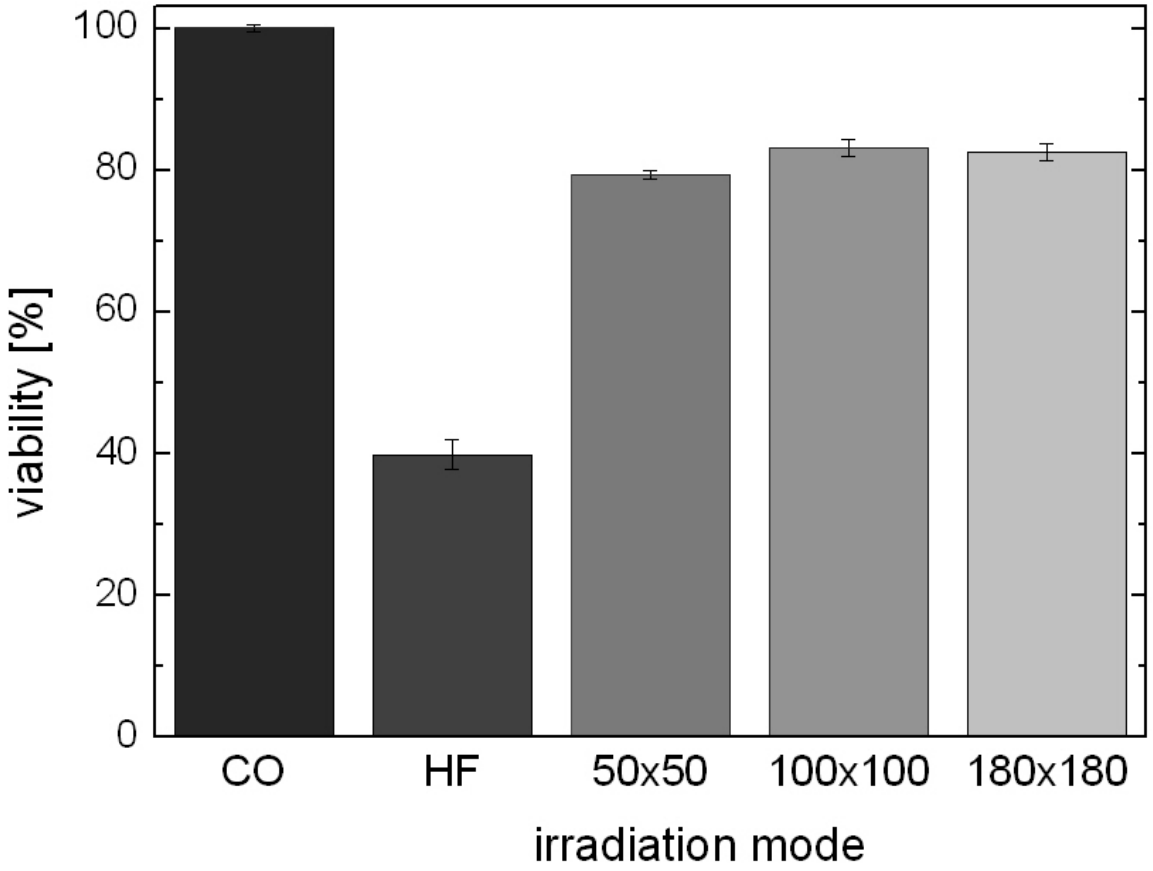
Results: Genetic damage

Micronucleus test



Microchannel irradiation: less genetic damage

Results: Tissue Viability
MTT Test

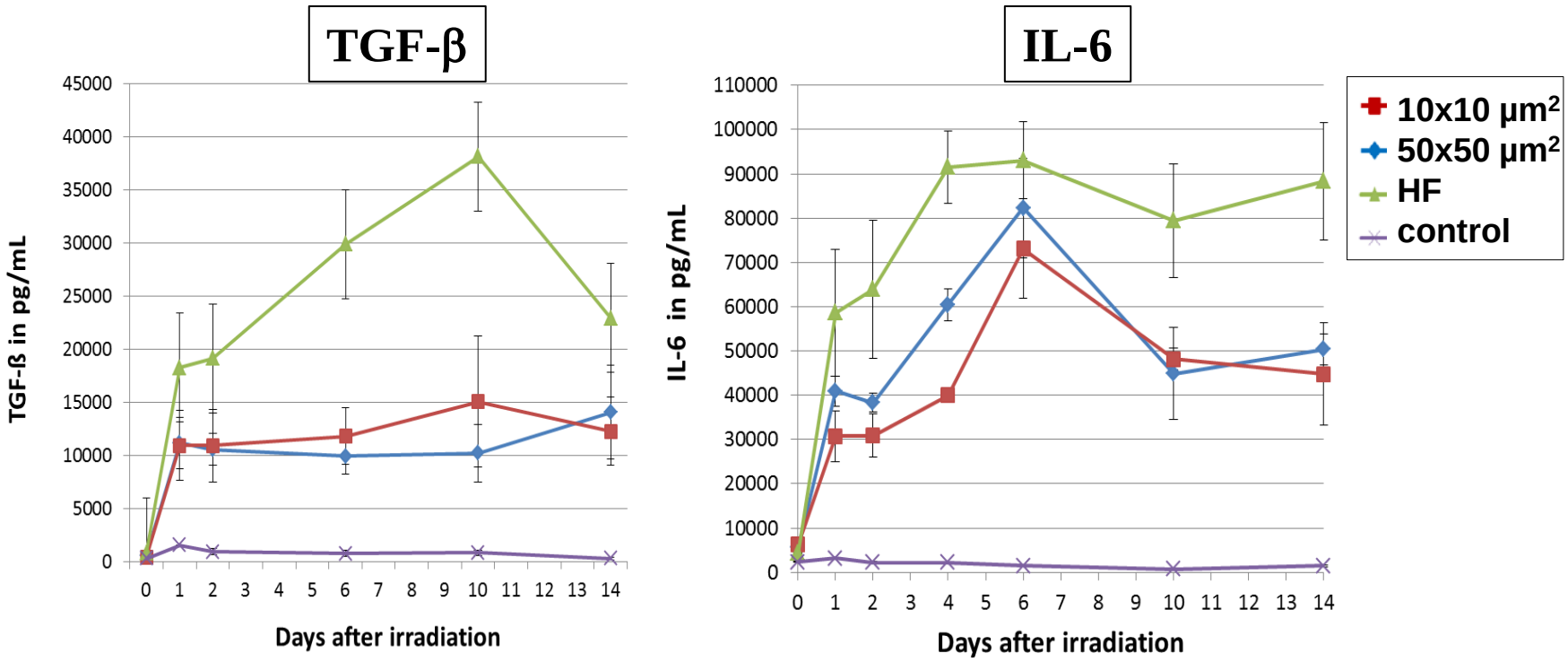


CO: untreated control
HF: homogeneous

Microchannel irradiation: more viable tissue

Results: Inflammatory Response

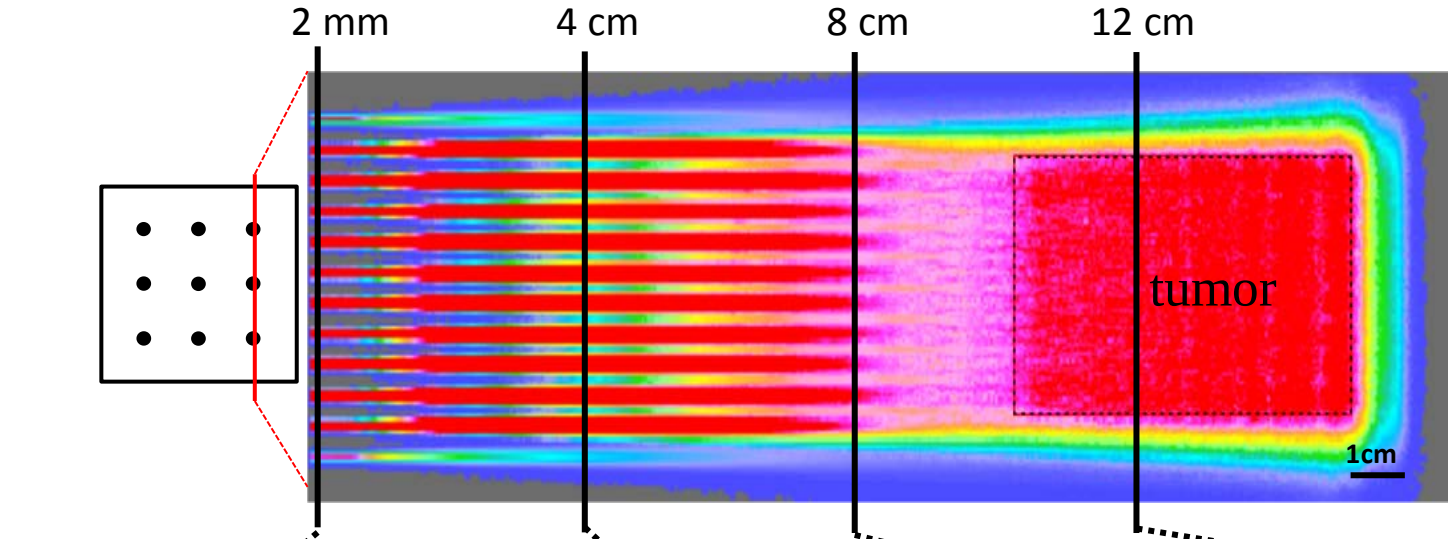
Cytokine release in medium

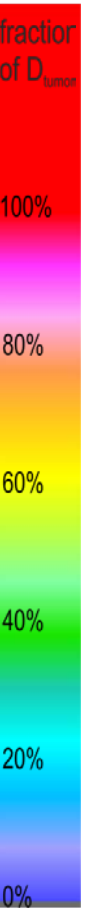


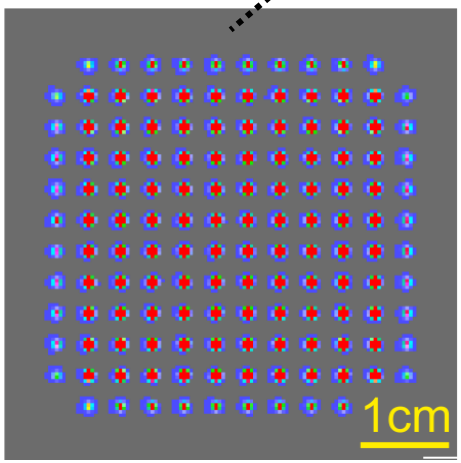
Microchannel irradiation:

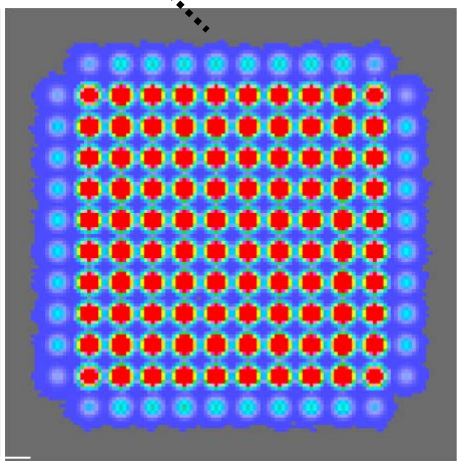
reduced and shorter inflammatory response

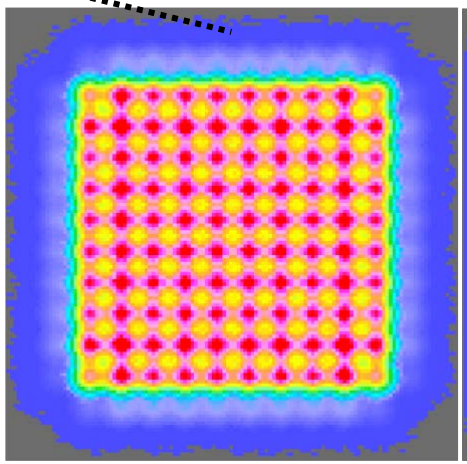
Simulation of widened channels in skin model

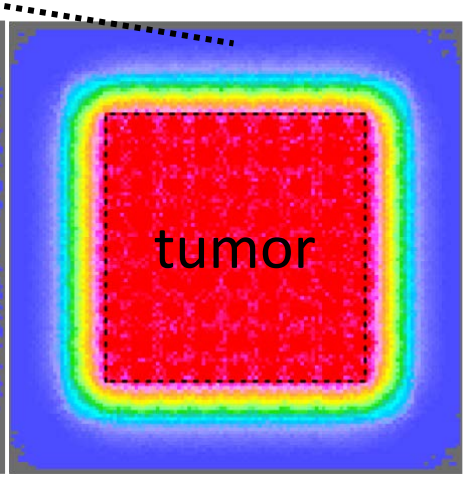












SC WC OC HF

Summary and Outlook

- **Reduced acute** and **long-term adverse effects** for **normal tissue** by microchannel radiation therapy
  (Zlobinskaya, Girst et al. 2013, RadEnvBio)

- **Mouse Ear** experiments:
  - influence of immune system
  - vasculature …

- **Technical Feasibility ?**