Radiobiological measurements for extending carbon-ion therapy to other ions
• Relative Biological Effectiveness (RBE)

• Oxygen Enhancement Ratio (OER)

• Planned experiments
Relative Biological Effectiveness (RBE)

RBE depends on...

- Survival level

\[ \text{RBE} = \frac{D_{\text{X-ray}}}{D_{\text{particle}}} \] (isoeffect)

(W.K. Weyrather)
Relative Biological Effectiveness (RBE)

RBE depended on...

- Survival level
- Energy
- Particle
- Repair capacity of the cell
- Oxygen status

\[
RBE = \frac{D_{\text{X-ray}}}{D_{\text{particle}}} \quad \text{(isoeffect)}
\]

(W.K. Weyrather)
RBE depends on the particle

What we know: Carbon

- **RBE maximum in the Bragg Peak**
- **Low RBE in the entrance**
- **High RBE in the tumor volume**
Oxygen Enhancement Ratio (OER)

\[ \text{OER} = \frac{D_{\text{hypoxic}}}{D_{\text{aerated}}} \] (Isoeffect)

OER = 2.8
Heavy ions reduce the OER effect

\[
\text{OER} = \frac{D_{\text{hypoxic}}}{D_{\text{aerated}}} \quad \text{(Isoeffect)}
\]
OER Carbon

• V79 cells

![Graph showing OER vs. dose averaged LET for V79 cells.](Furusawa et al. 2000)
Planned experiments

- RBE as function of energy for different ions (Lithium, Oxygen)
- Set of survival curves
Planned experiments

• RBE as function of depth
First Results: $^7$ Lithium

LET: 11.3 Kev/μm
residual range: 17.2 mm
Planned experiments

• OER measurements for irradiation with oxygen ions
• Survival curves for different hypoxic condition
• Influence of acute and chronic hypoxia

(C. Schicker, Diploma Thesis GSI 2007)
THANK YOU FOR THE
ATTENTION