

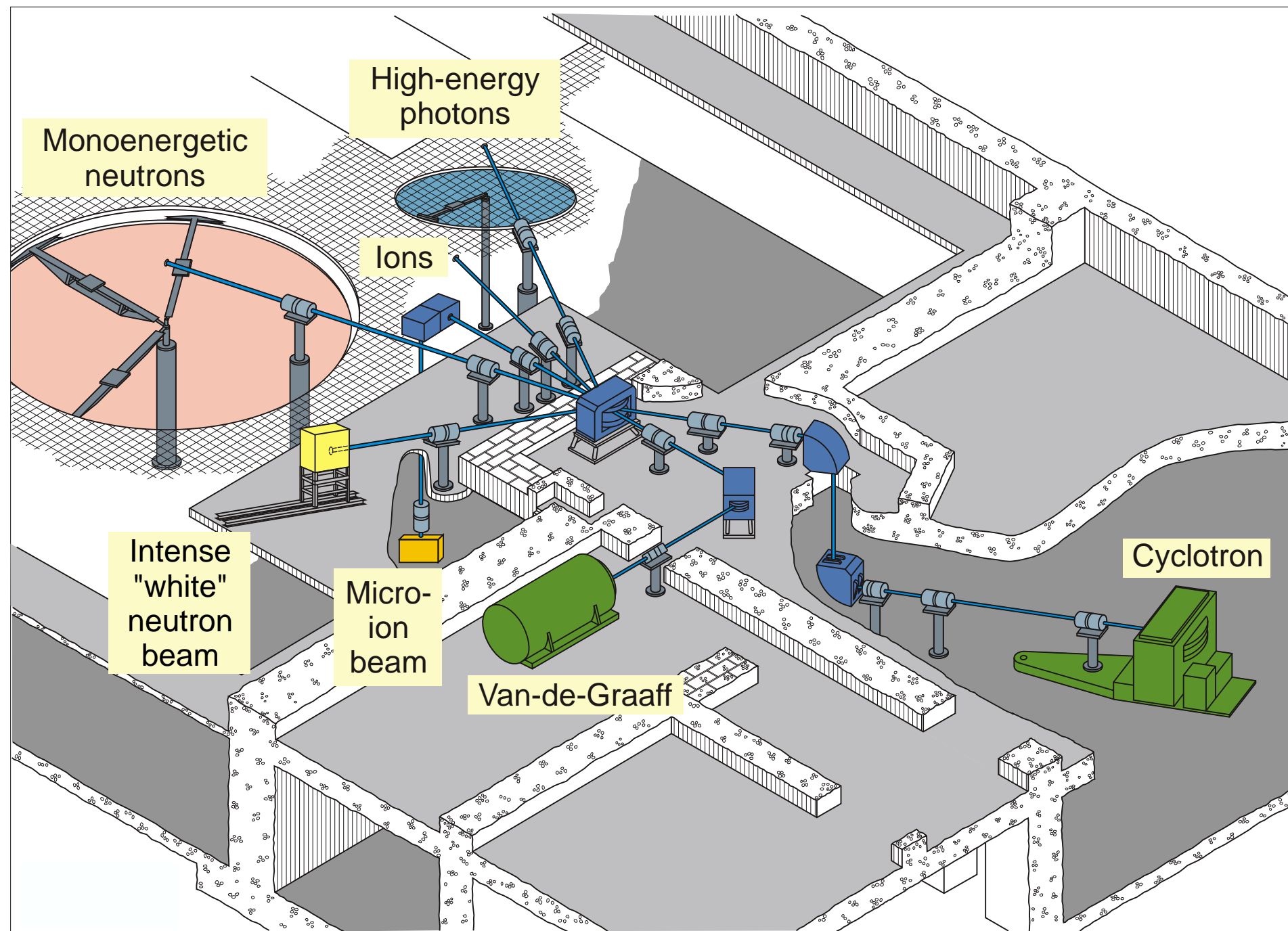
The PTB-Microbeam Facility

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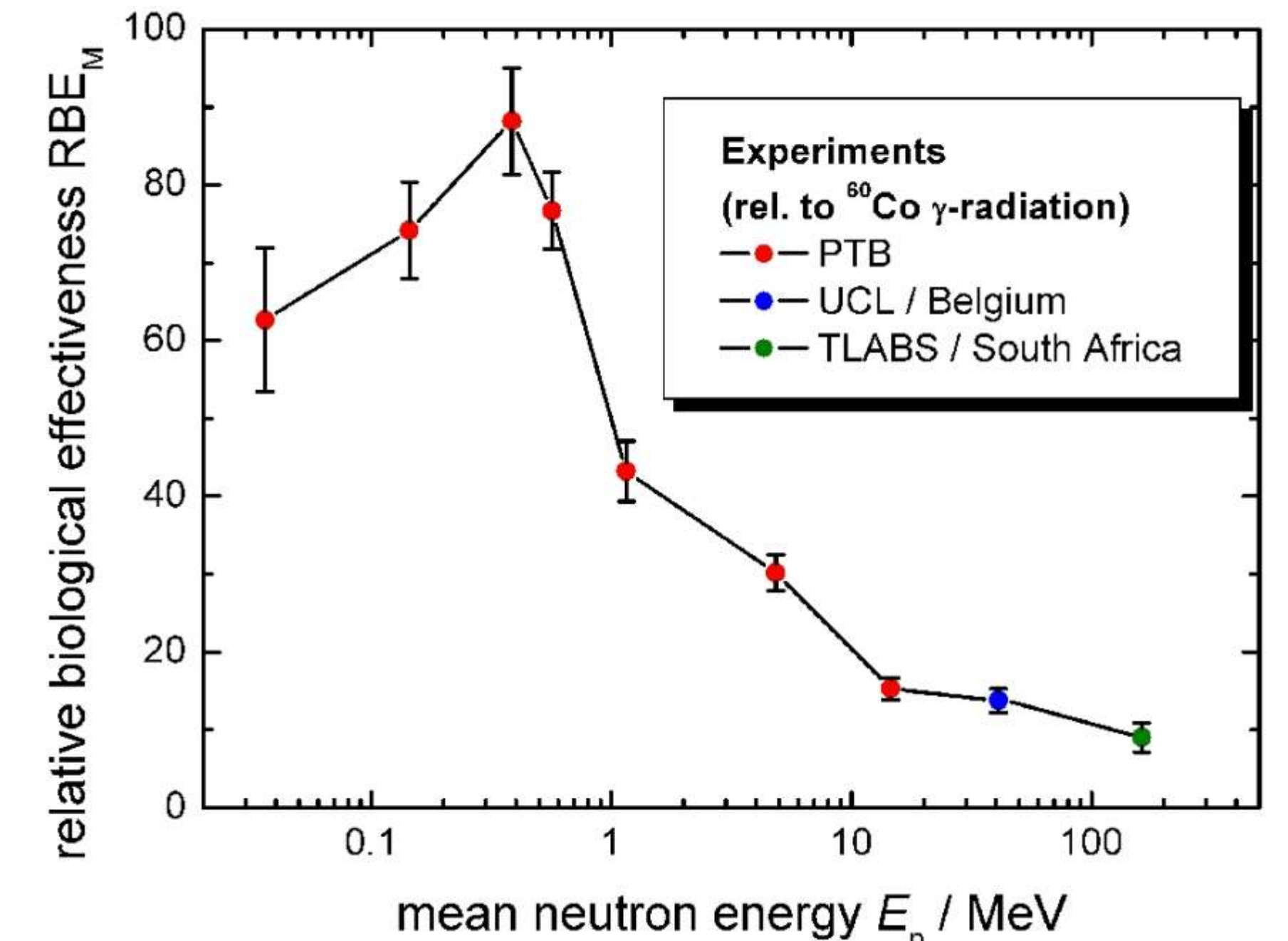
PIAF - PTB Ion Accelerator Facility



For irradiations with ions, neutrons and photons

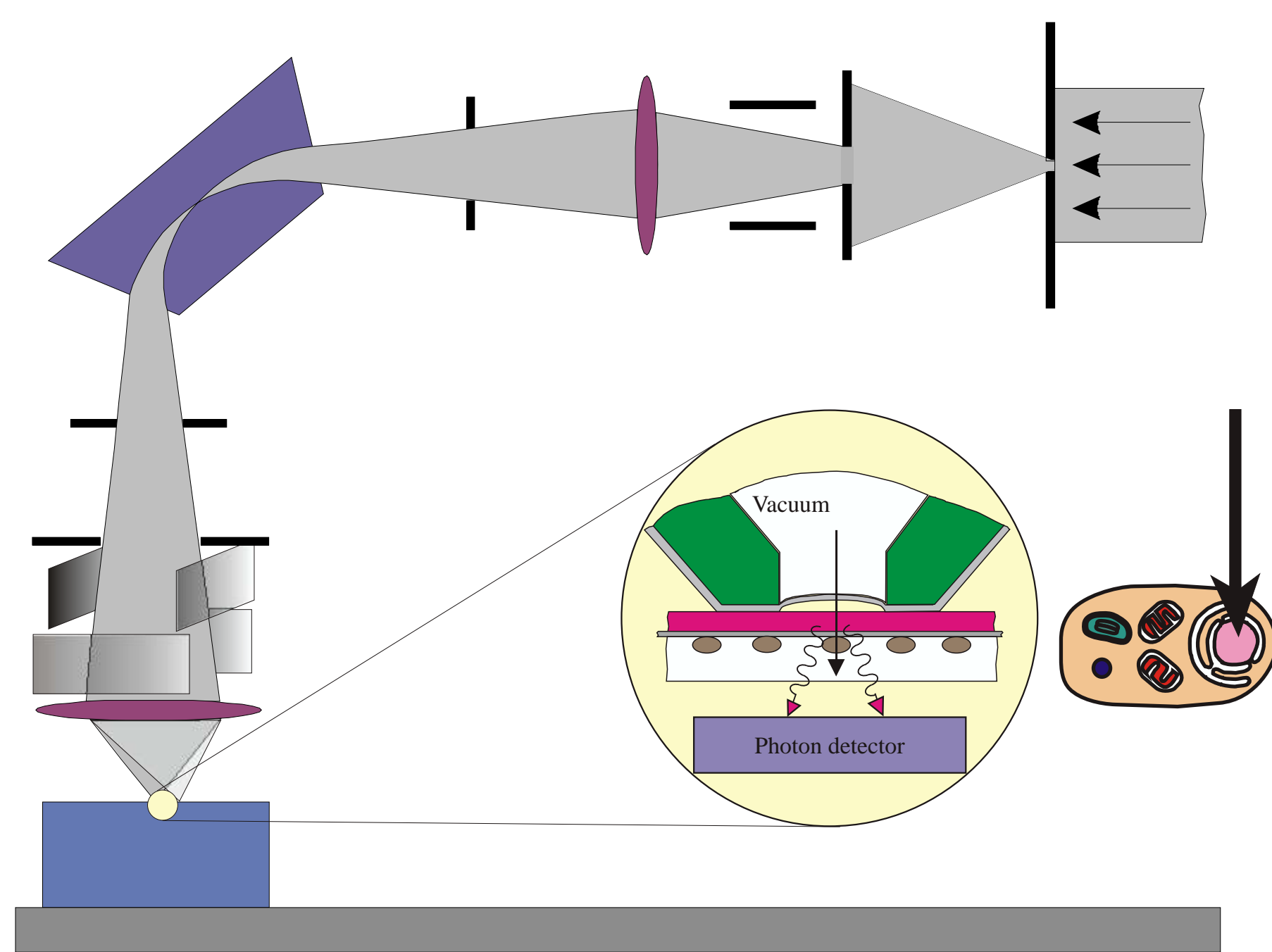
Protons, deuterons and alpha-particles are accelerated by means of a Van de Graaff accelerator with voltages between 0.1 MV and 3.75 MV. An energy-variable cyclotron furnishes ion beams with energies of up to 27 MeV. With the two accelerators, the following beams are made available for experiments and/or irradiations:

- Protons: 0.1 MeV to 19 MeV
- Deuterons: 0.2 MeV to 13.5 MeV
- particles: 0.2 MeV to 27 MeV
- Neutrons: 24 keV to 19 MeV



Example: RBE of neutrons as a function of neutron energy Schmid et al. REB (2003) 42:87, Nolte et al. PoS (FNDA2006) 082

Microbeam Facility

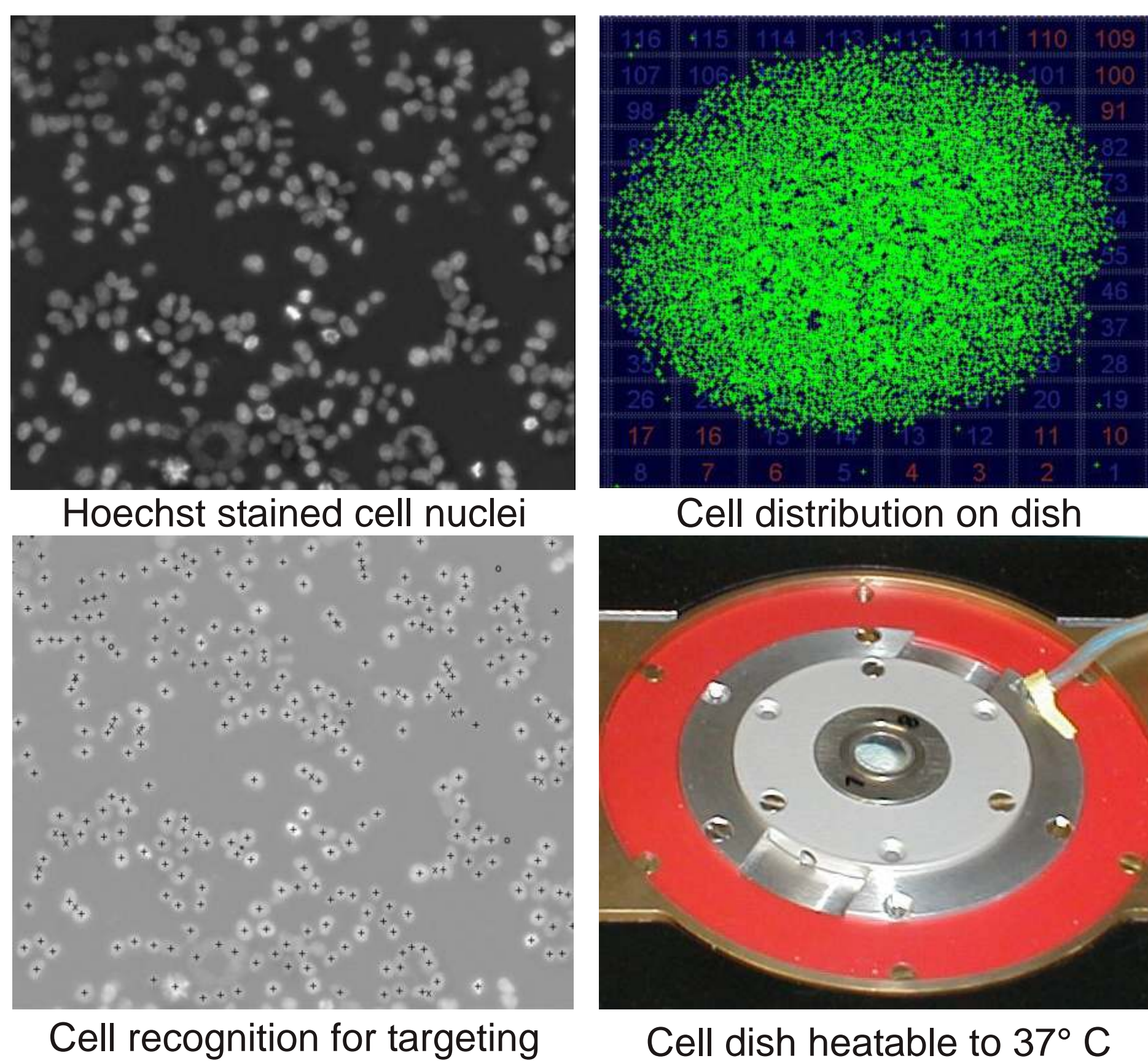


Study of high- and low-LET radiation effects with single ions

- beam size and targeting accuracy of about 2 - 3 μm
- targeting of subcellular structures (nucleus, cytoplasm) or irradiations in patterns (lines etc.)
- every cell is exposed to a selected number of -particles with an LET of 50 - 200 $\text{keV}/\mu\text{m}$ or protons with an LET of 3 - 50 $\text{keV}/\mu\text{m}$
- Overall experimental speed of up to 25000 cells/dish in 1 hour
- ideal experimental set-up for studying
 - bystander effects
 - low-dose radiation effects
 - live cell imaging



Cell Irradiation



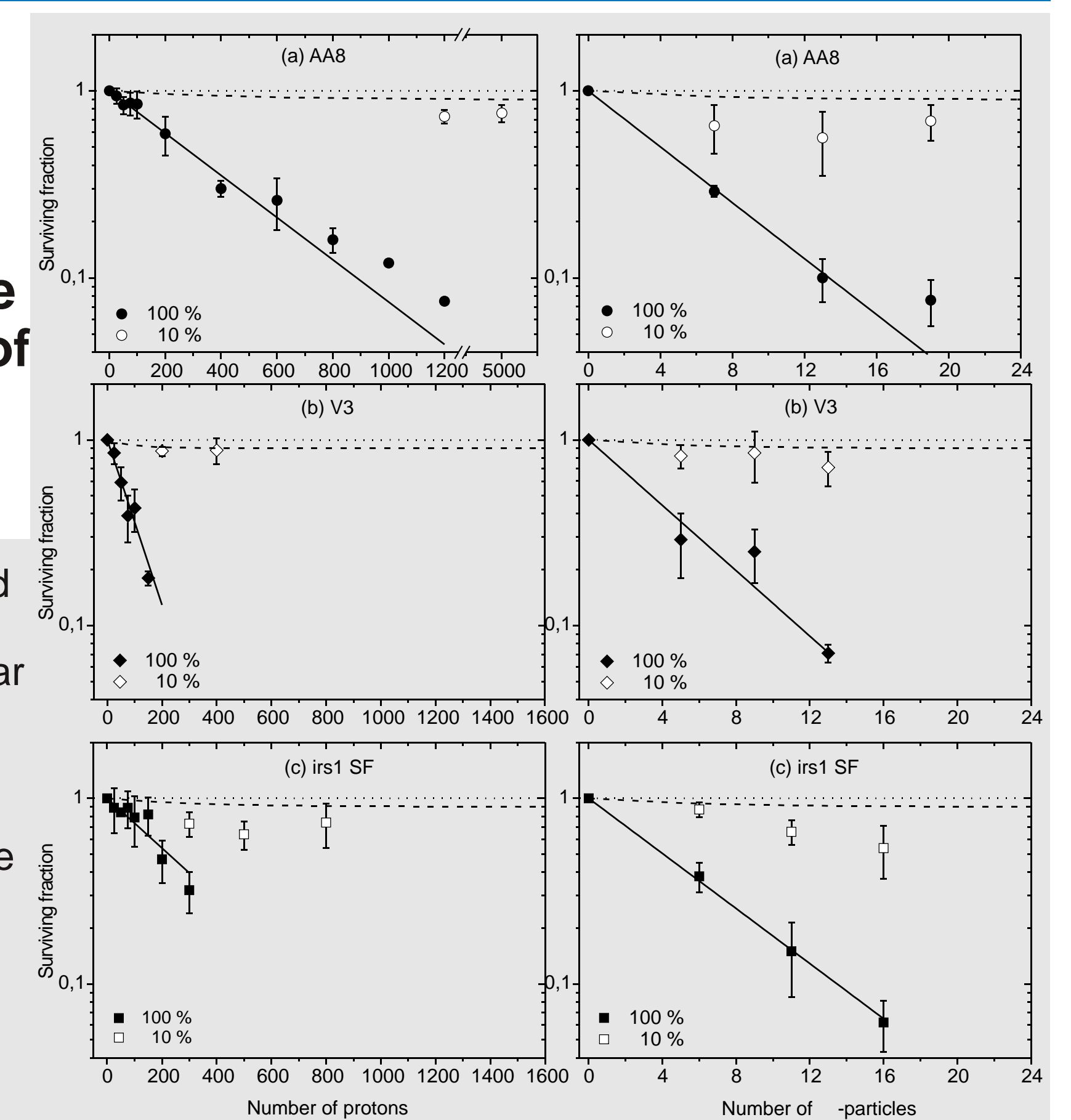
Studies of Bystander Effects

Example: Frankenberg et al. REB (2008) 47:431-438

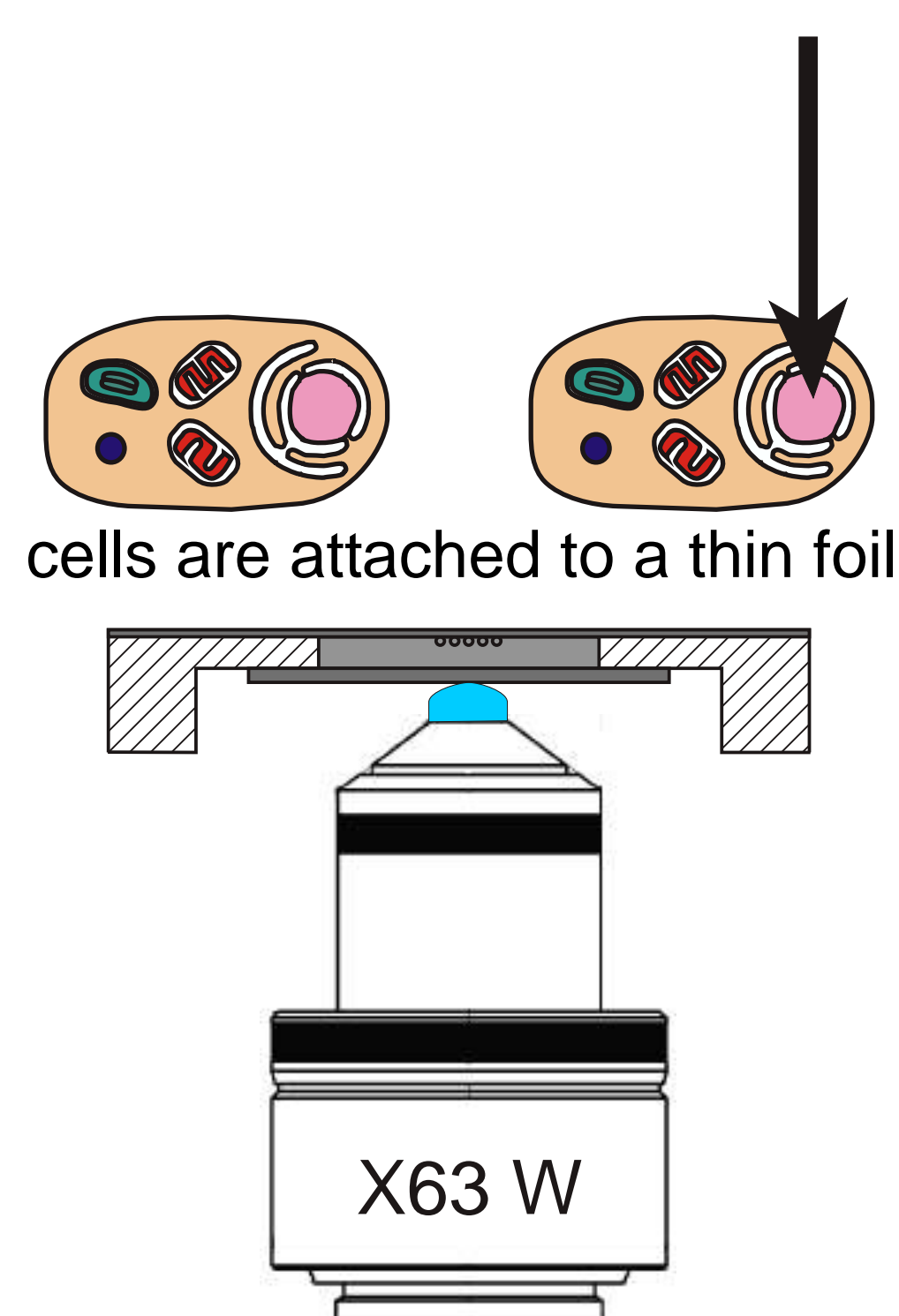
The role of nonhomologous end joining and homologous recombination in the clonogenic bystander effects of mammalian cells after exposure to counted 10 MeV protons and 4.5 MeV -particles of the PTB microbeam

D. Frankenberg, K.-D. Greif, W. Beverung, F. Langner, U. Giesen

Figures on right site: Surviving fraction of closely neighbored CHO AA8 cells (a) and their DSB repair-deficient derivatives v3 (NHEJ-defective) (b) and irs1-SF (HR-defective) (c) after nuclear traversals by 10 MeV protons (LET = 4.7 $\text{keV}/\mu\text{m}$) and 4.5 MeV -particles (LET = 100 $\text{keV}/\mu\text{m}$). The full symbols are the data when all cell nuclei on the dish were exposed. The open circles indicate surviving fractions when only 10% of all cell nuclei were exposed. The broken lines show the percentage of cells that would be expected to survive when only 10% of the cells were targeted and no bystander effects had occurred. The dotted horizontal lines represent the percentage of cells that would be expected when no cell killing occurs



Online Live Cell Imaging



Goal: Measurements of kinetics of foci formation for the study of DNA damage recognition and repair processes

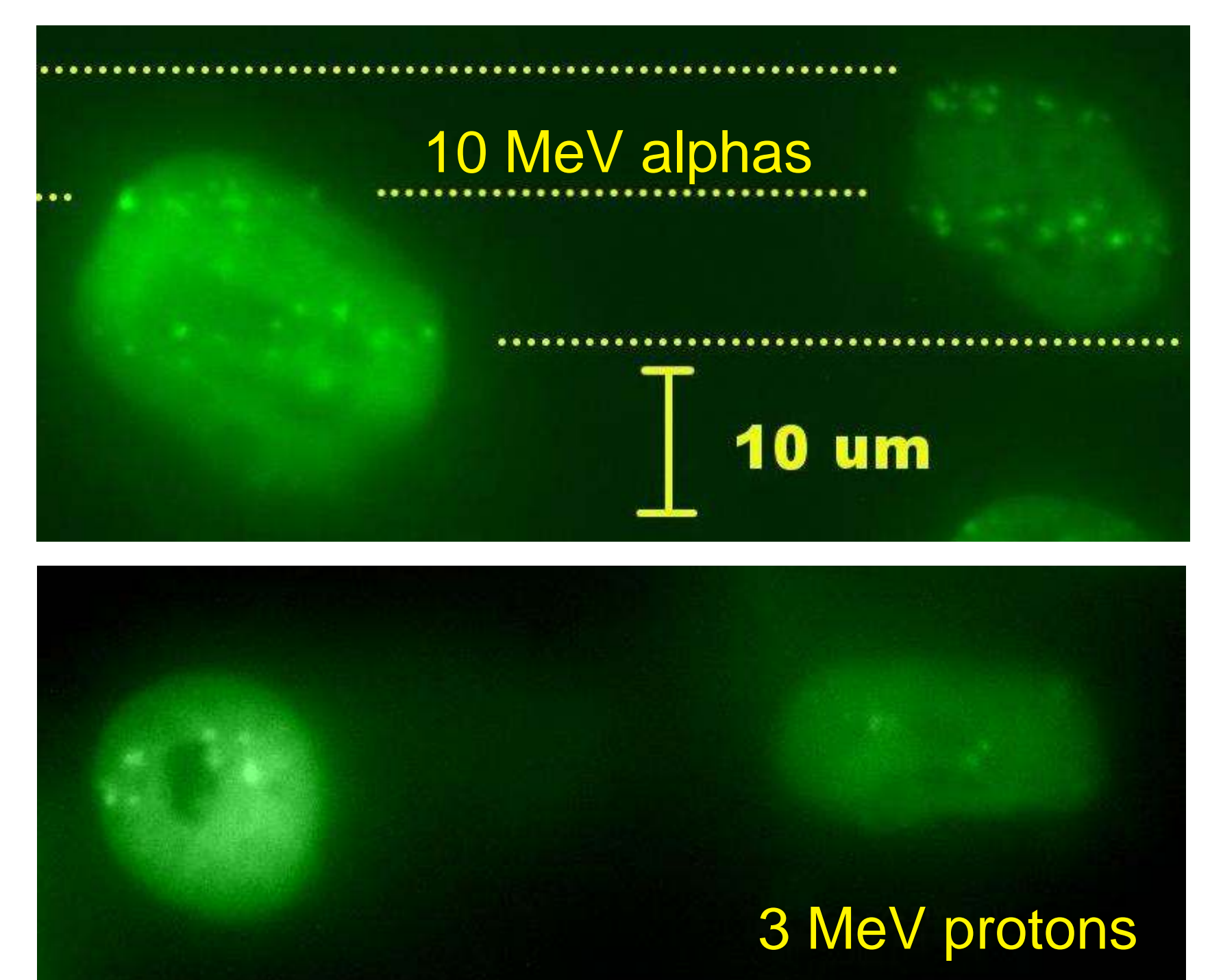
Experimental Procedure:

- 10 MeV -particles (LET = 75 $\text{keV}/\mu\text{m}$)
- 3 MeV protons (LET = 15 $\text{keV}/\mu\text{m}$)
- lines with ~ 1 particle/ μm and 10 μm spacing
- detection of red and green fluorescence in HT-1080 cells, stably transfected with 53BP1 and/or MDC1-GFP (-RRP)
- pictures taken every 5 s or 15 s

In cooperation with C. Mielke¹ and W. Dirks²

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Mosconi et al. REB (2011) 50:345-352



Accumulation of 53BP1 in fluorescent foci after irradiation with 10 MeV alphas or 3 MeV protons