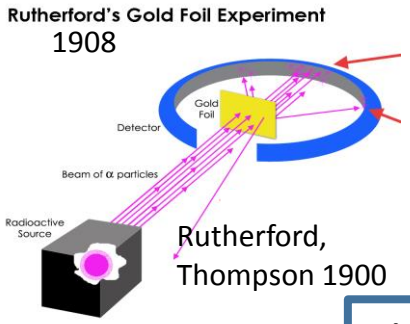
Session II Particle Accelerators and Their Applications

Julia Herzen and Daniela Leitner

Speakers: Matt Johnson, Helene Felice, Christina Krywka, Joerg Schreiber

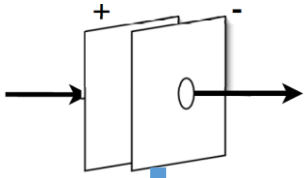
Particle Accelerators Have Been Developed For More Than 100 Years

Beginning of accelerators



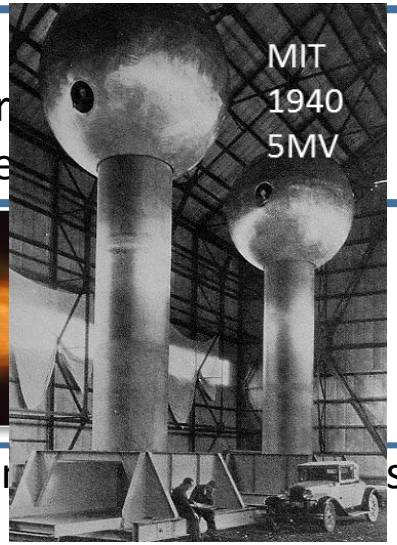
Rutherford, Thompson 1900

Electrons, ions –Acceleration through an electrical potential



Electrostatic –final energy reach limited

New
Laser
Wake



Time varying fields - Electromagnetic

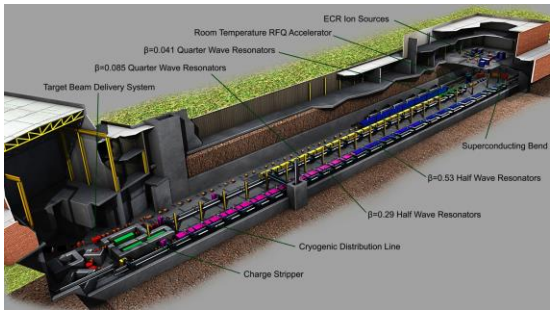
Non Resonant
Betatrons, Induction

Resonant
Synchronized Bunches

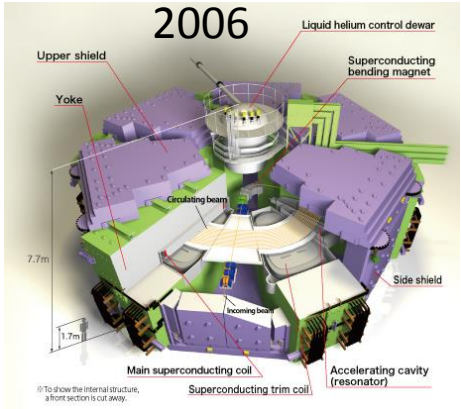
Linear Accelerator: Linacs

Circular Accelerators: Cyclotrons, Sy s

First Cyclotron RIKEN SC Ring Cyclotron RHIC, LHC



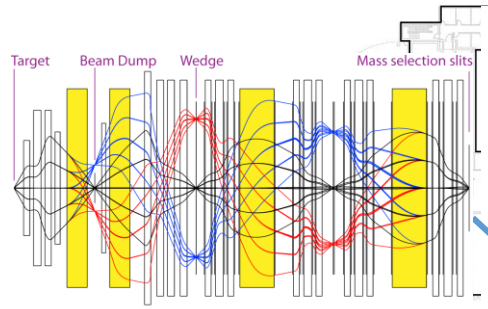
FRIB: Superconducting Heavy Ion Linac 2020

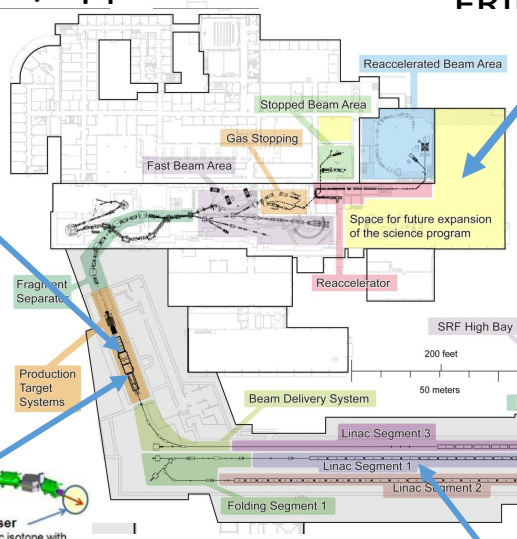


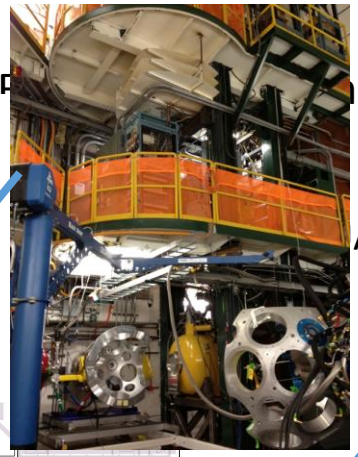
Applications Of Accelerators: Worldwide An Estimated 26000 Are In Operations, > 90% Applications

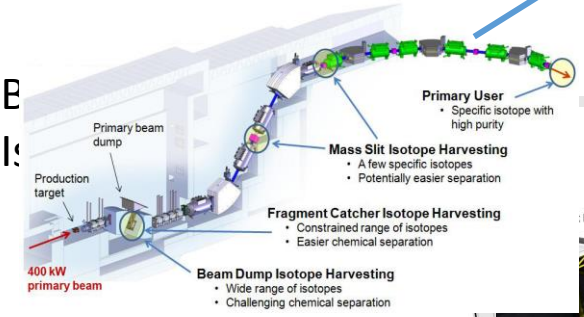
Detectors, Data Acquisition, Electronics, Data Analysis, Controls, Superconducting Magnets, High Power RF, Power Supplies, Safety, Operations, Systems Engineering, Beam Optics, Manufacturing, QA, Cryogenics, Vacuum Engineering, Mechanical Engineering, Electrical Engineering, Machine Protection, Data Security

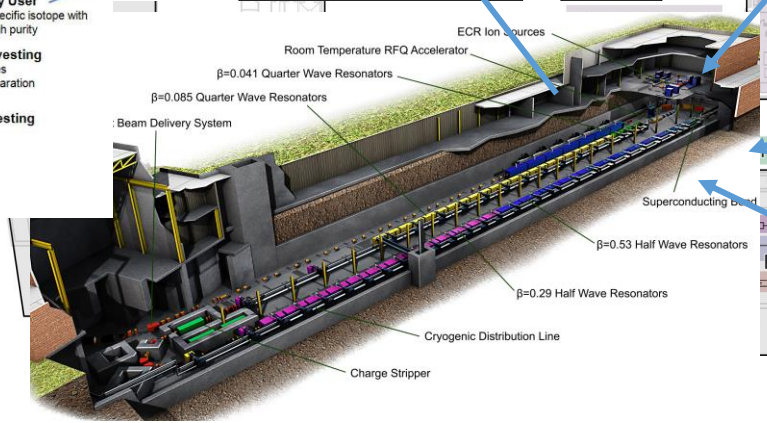
User Area/Application

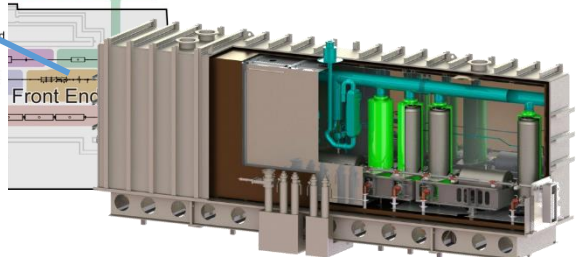




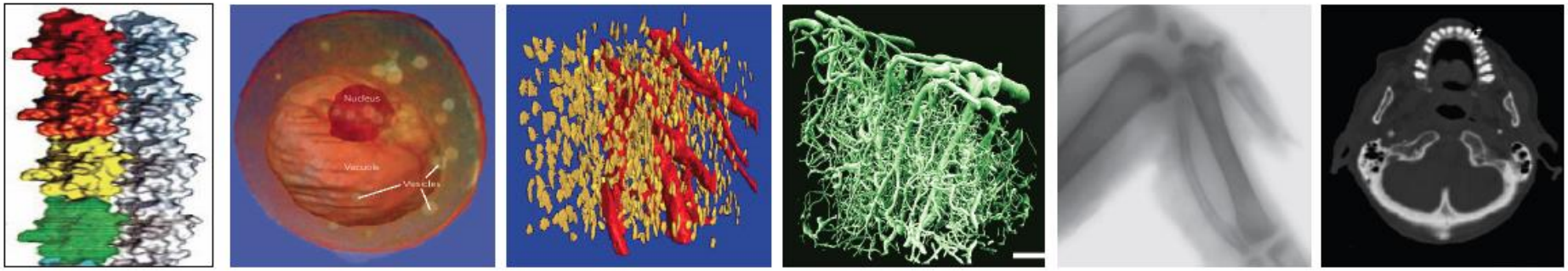








X-ray Generation



X-ray radiography

crystallography

X-ray optics

X-ray coherent diffractive imaging

---

electron microscopy

MRI

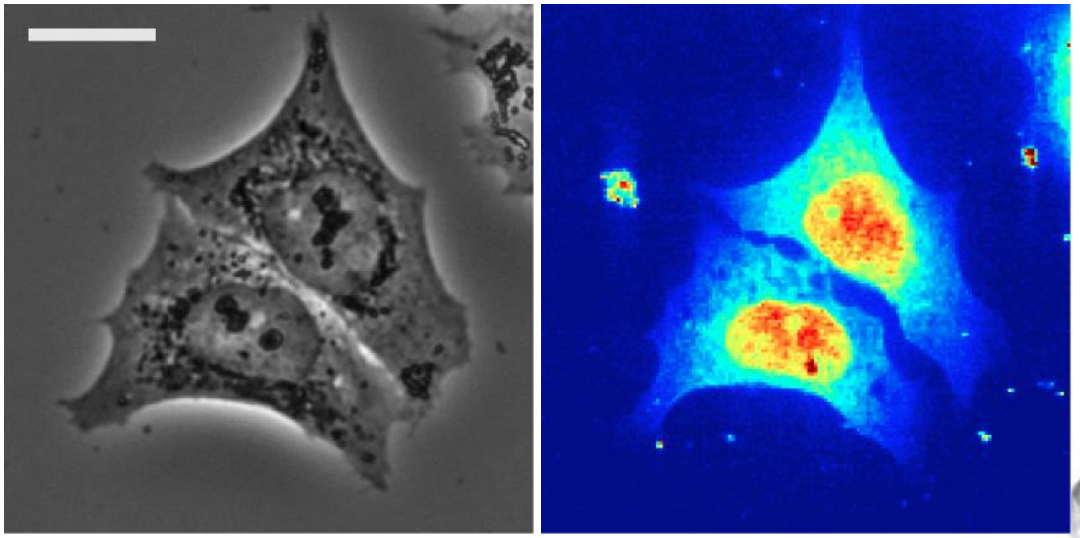
light microscopy

scanning probe microscopy

ultrasound

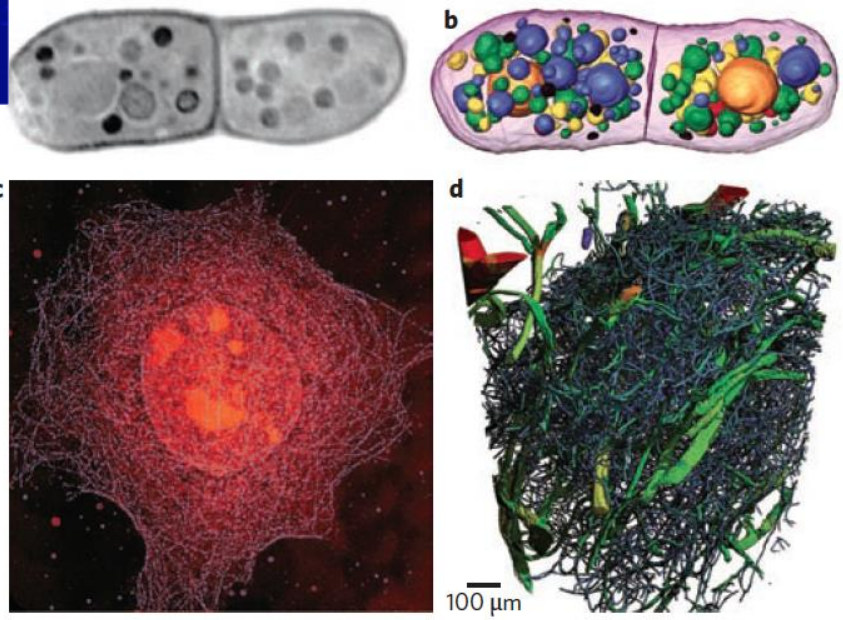
Biomedical X-ray Nano-Diffraction and Imaging

Scanning X-Ray Nanodiffraction
on Living Cells



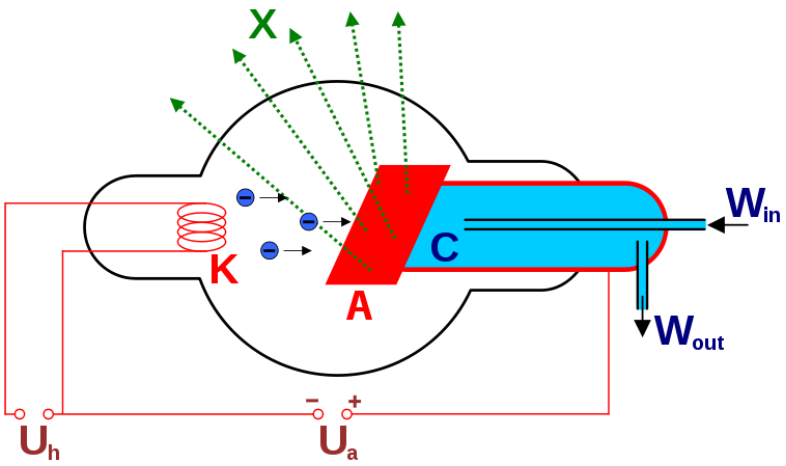
Weinhausen et al., Phys.
Rev. Lett. 112, 2014

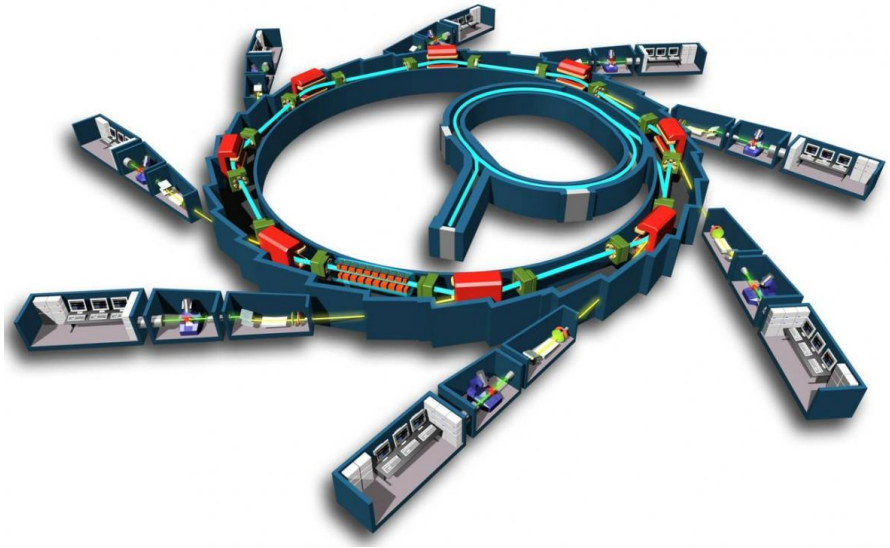
Biological applications of nanoscale
X-ray imaging



Sakdinawat &Attwood et al.,
Nature Photonics 4, 2010

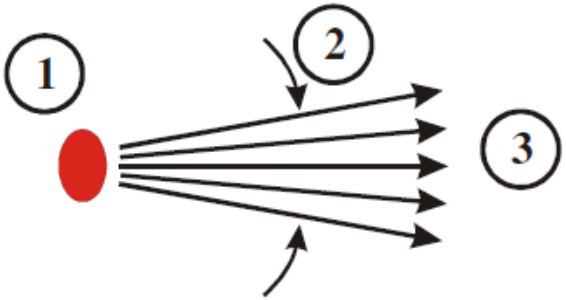
X-ray Tube vs Synchrotron





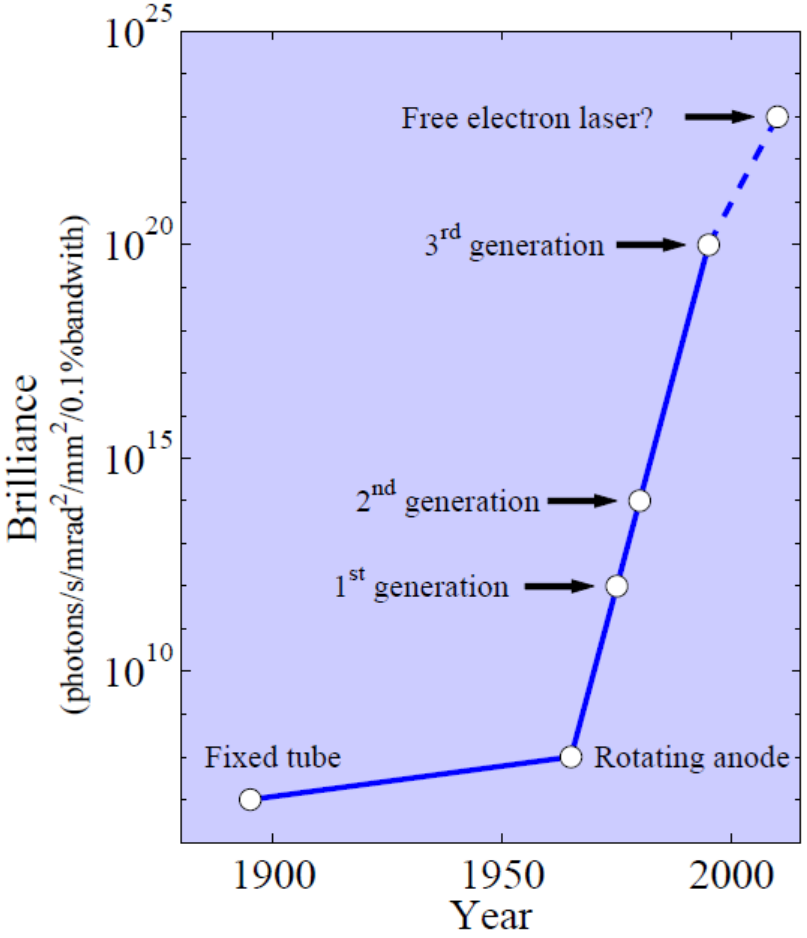
Spectral Brightness (Brilliance)

Brilliance of an X-ray Source:



$$\text{Brilliance} \sim \frac{3}{1 \quad 2}$$

[ph / (sec mm^2 mrad^2 0.1 % BW)]



Synchrotrons Worldwide

Diamond, Oxford UK

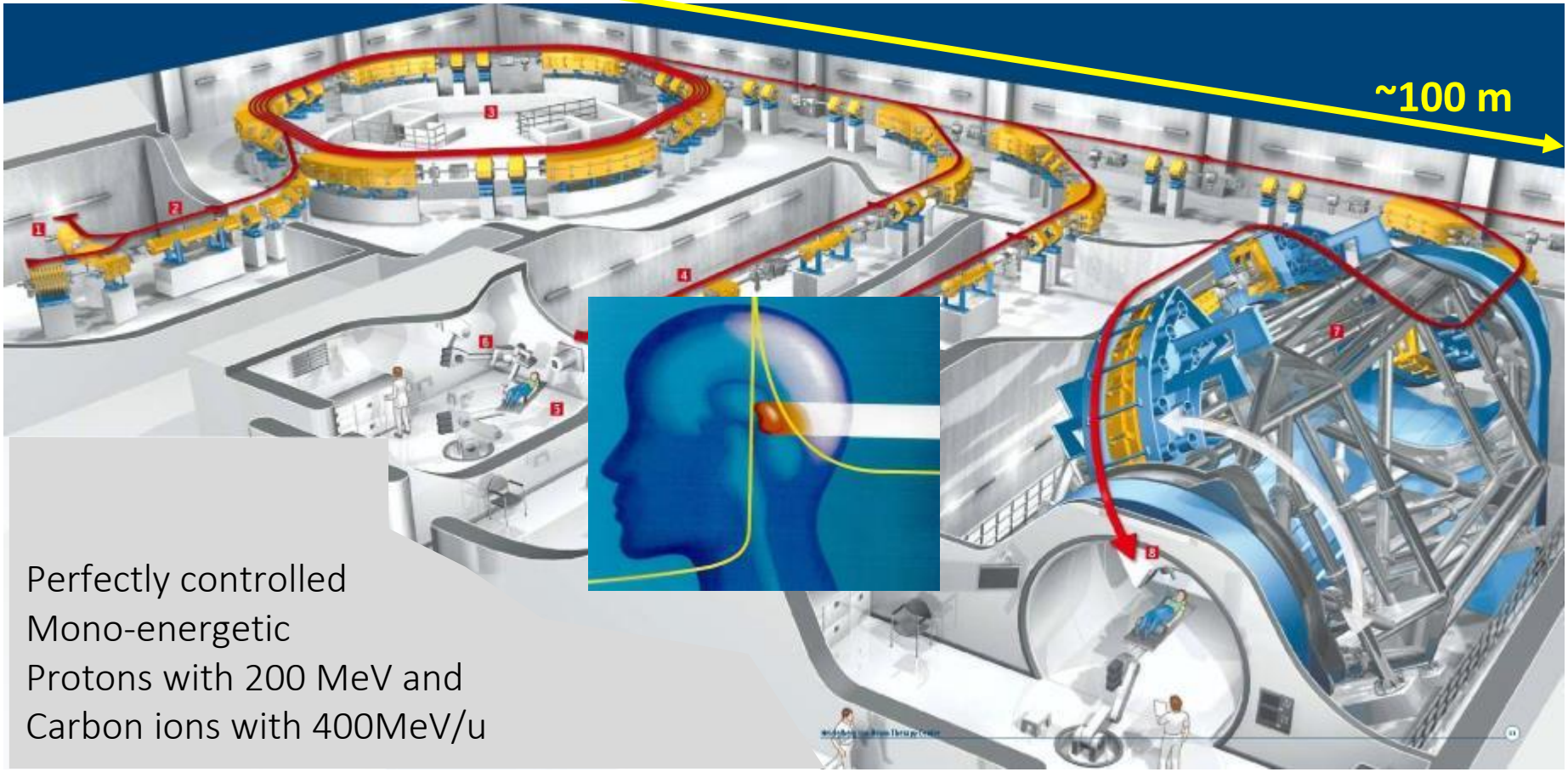
Spring-8, Hyoto Japan

Advanced Photon Source (APS), Chicago USA

Soleil, Paris France

Ion Beam Therapy – Cancer Treatment

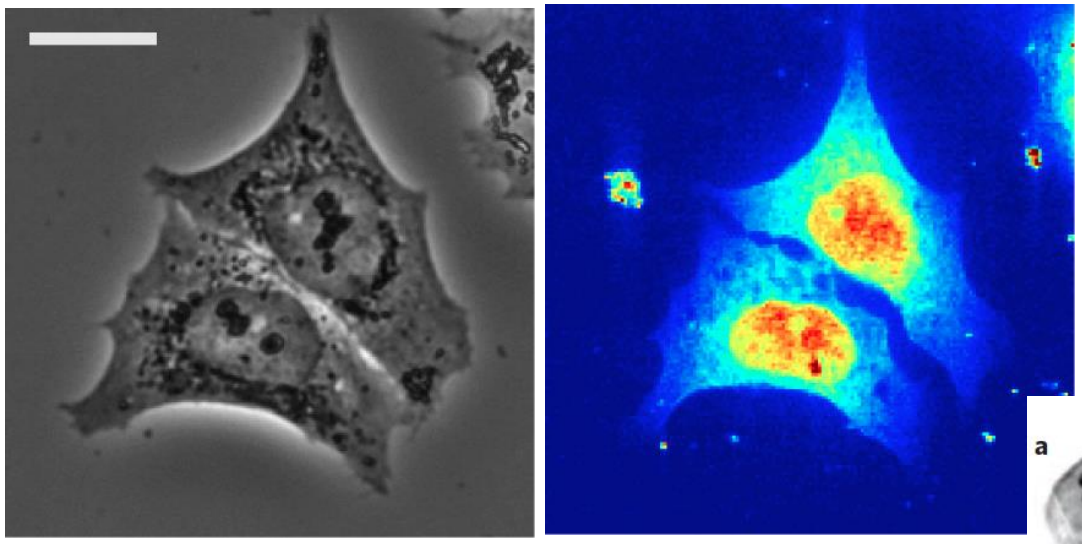
Heidelberg Ion Therapy Centre



Perfectly controlled
Mono-energetic
Protons with 200 MeV and
Carbon ions with 400MeV/u

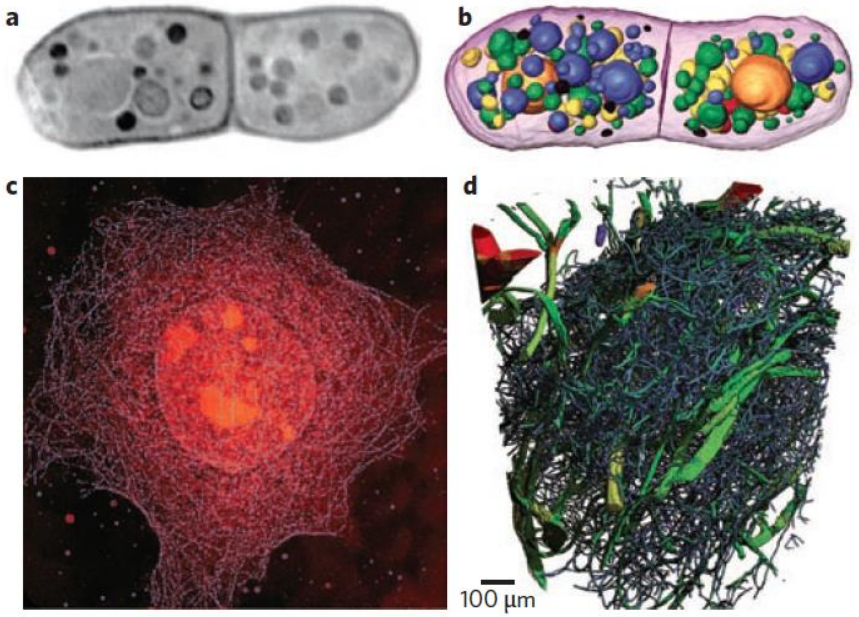
Applications Using Synchrotron Radiation Sources

Scanning X-Ray Nanodiffraction
on Living Cells



Weinhausen et al., Phys.
Rev. Lett. 112, 2014

Biological applications of nanoscale
X-ray imaging



Sakdinawat &Attwood et al.,
Nature Photonics 4, 2010

Speaker of the Session

Applications

Christina Krywka
Helmholtz Zentrum Geesthacht

Accelerator Development

Helene Felice
(Lawrence Berkeley National Laboratory)

Matt Johnson
(Lawrence Berkeley National Laboratory)

Novel Accelerator Concept

Jörg Schreiber
Ludwig-Maximilians-University Munich,
Max-Planck-Institute Garching