Research Activities at IBA

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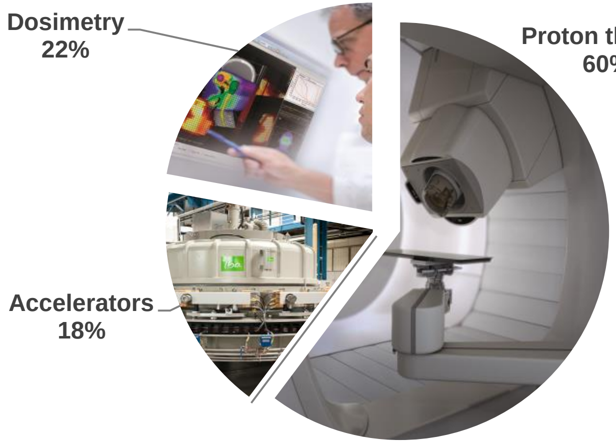
Outline

- **IBA Activities in short:**
  - RadioPharma solutions
  - Industrial accelerators
  - Dosimetry products
  - Proton therapy
- **Current research activities:**
  - Health Physics
  - Accelerator Physics
  - Medical Physics

IBA in short

- Company formed in 1986 as spin-off of UCL and based in Louvain-La-Neuve (LLN), Belgium
- Employs ~ 1,000 people worldwide, ~500 based at LLN headquarters.
- Number one provider of integrated proton therapy solutions
  - More compact and targeted radiotherapy applications
- Synergistic businesses in dosimetry, medical and industrial accelerators



Quality Assurance & GMP

$^{18}F^{-}$

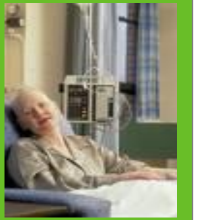
+ other radioisotopes

^{18}FDG

+ other compounds

Quality control & sterility tests

MRI/PET or PET/CT



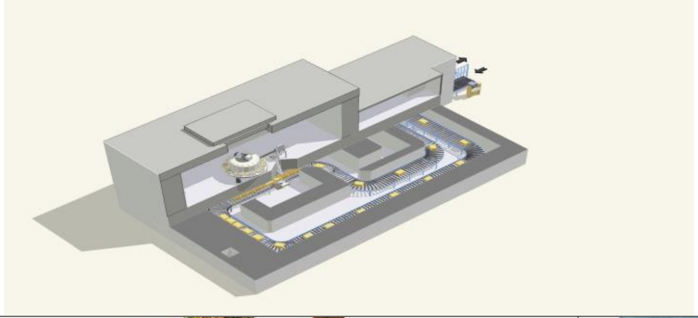
Injection & Diagnostic

IBA CYCLOTRONS FAMILY : GLOBAL COVERAGE

3 MeV 11 MeV 18MeV 30MeV 70MeV

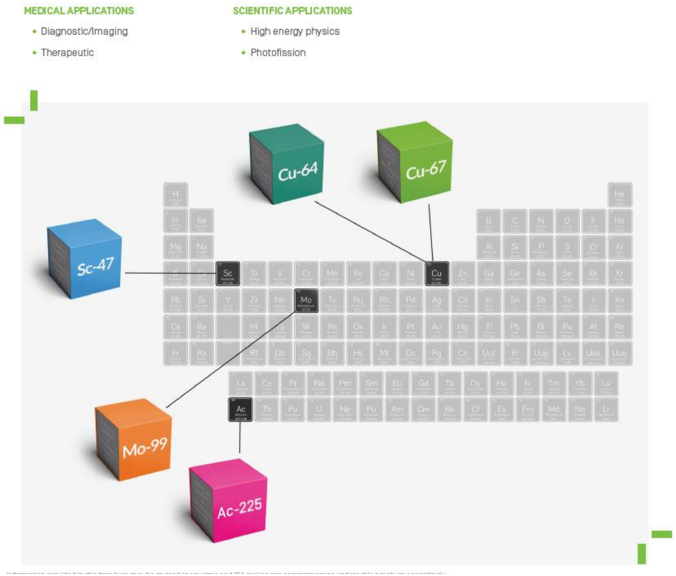
IBA Industrial Accelerators (1)

- Electron beams 3 to 10 MeV
- Beam power 35 kW to 700 kW (7 MeV/100 mA)
- E-beam or X-ray treatment modes
- Applications:
  - Medical device sterilization
  - Food pasteurization
  - Advanced material manufacturing (cables, tires, …)
- Installed base > 200 units



IBA Industrial Accelerators (2)

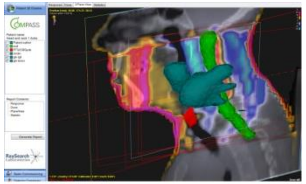
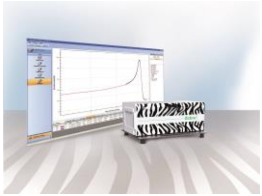
- New Rhodotron able to deliver 40 MeV/125 kW electrons beams.
- Production of medical isotopes via photonuclear reactions such as $^{100}Mo(\gamma,n)^{99}Mo \rightarrow {}^{99m}Tc$ production.



IBA DOSIMETRY PRODUCTS

Radiation Therapy

Linac commissioning and quality assurance of machine and patient plan, for safer patient treatments.

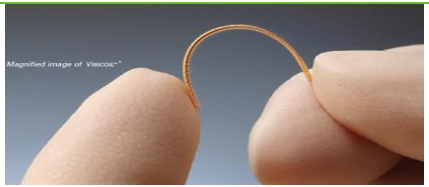



Medical Imaging

Full solution provider in quality control in diagnostics imaging, for better diagnosis.


Image Markers

Clear tumor localization, for higher targeting accuracy.

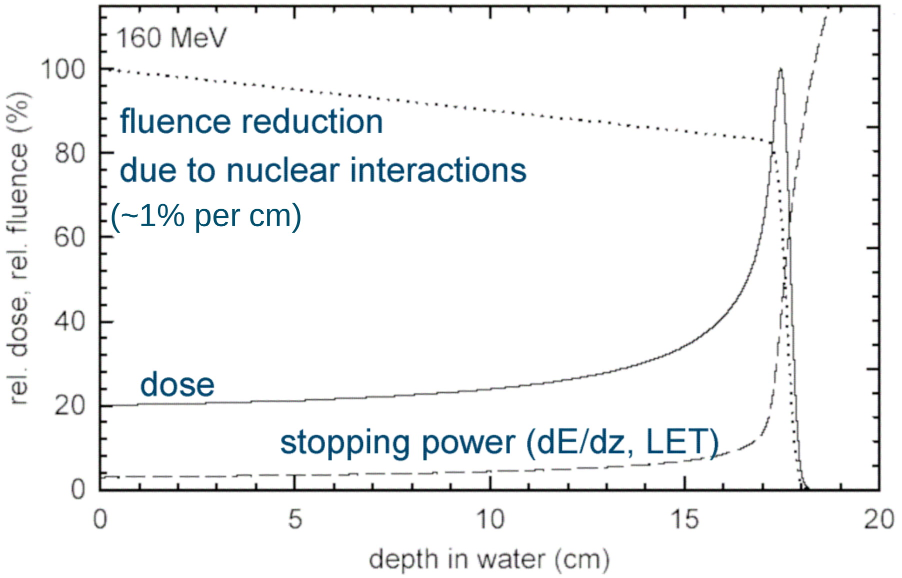



Proton Therapy
Next generation in targeted cancer treatment

Proton Depth-Dose Curve

Bragg peak:
stopping power

$$\frac{dE}{dz} = -4\pi n \frac{Z_{eff}^2 e^4}{m_e v^2} \left\{ \ln \frac{2 m_e v^2}{I(1-(v/c)^2)} - (v/c)^2 \right\}$$



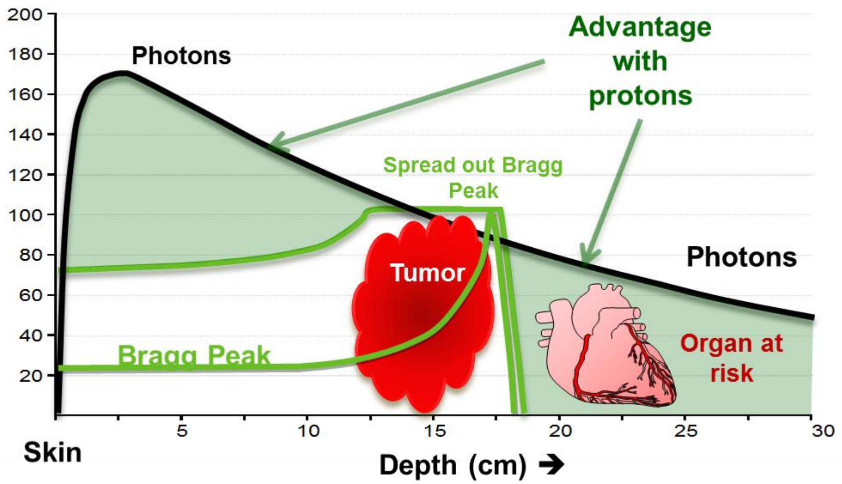
Proton therapy vs. conventional radiotherapy

Case studies for efficacy and toxicity

Protons have a superior dose distribution

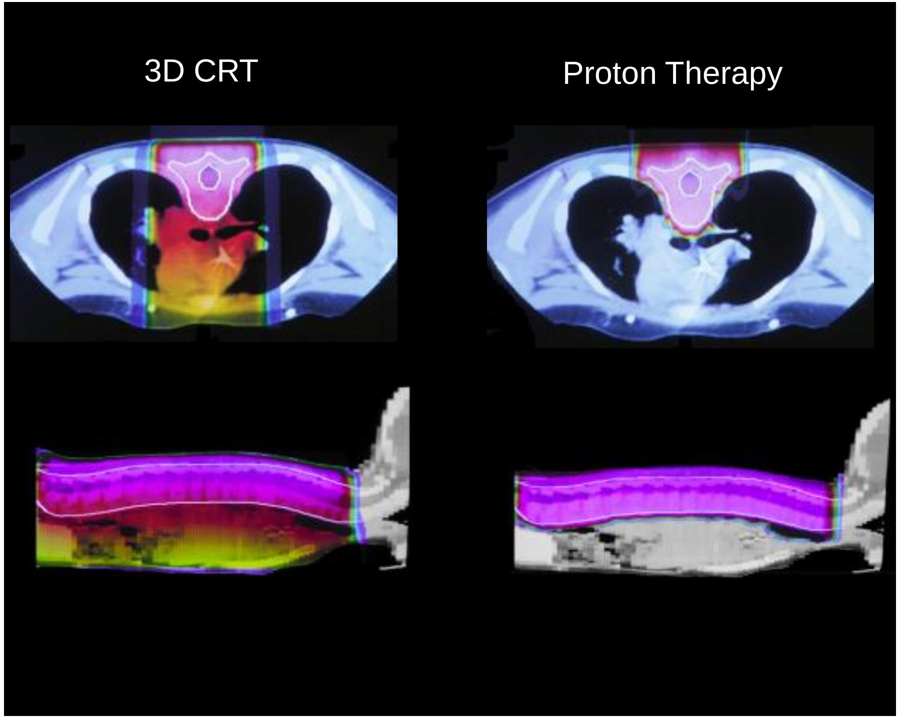
- Protons:
  - Deliver their maximum energy within a precisely controlled range
  - Deposit a high and conformal dose
  - Deposit very little entry dose
  - Deposit no exit dose

  - Up to 50% reduced risk of radiation-induced secondary cancer
  - Much lower risks of adverse effects (toxicity, side effects, abnormal growth)



➔ Better quality of life during and after treatment

Clinical examples : pediatric medulloblastoma



Side Effects	Photons	Protons
Restrictive Lung Disease	60%	0%
Reduced exercise capability	75%	0%
Abnormal EKGs	31%	0%
Growth abnormality	100%	20%
IQ drop of 10 points at 6 yrs	28.5%	1.6%
Risk of IQ score < 90	25%	15%

"Proton beam therapy has become a standard of care for pediatric cancers… " (*)

(*) Presentation Dr. Jay S. Loeffler, NPTC/MGH, ASTRO 2001

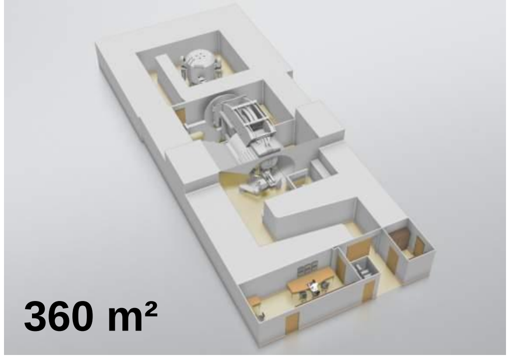
Clinical outcome and affordable

Multi-room to single-room solutions

Proteus® ***PLUS***

1800 m²

Proteus® ***ONE****

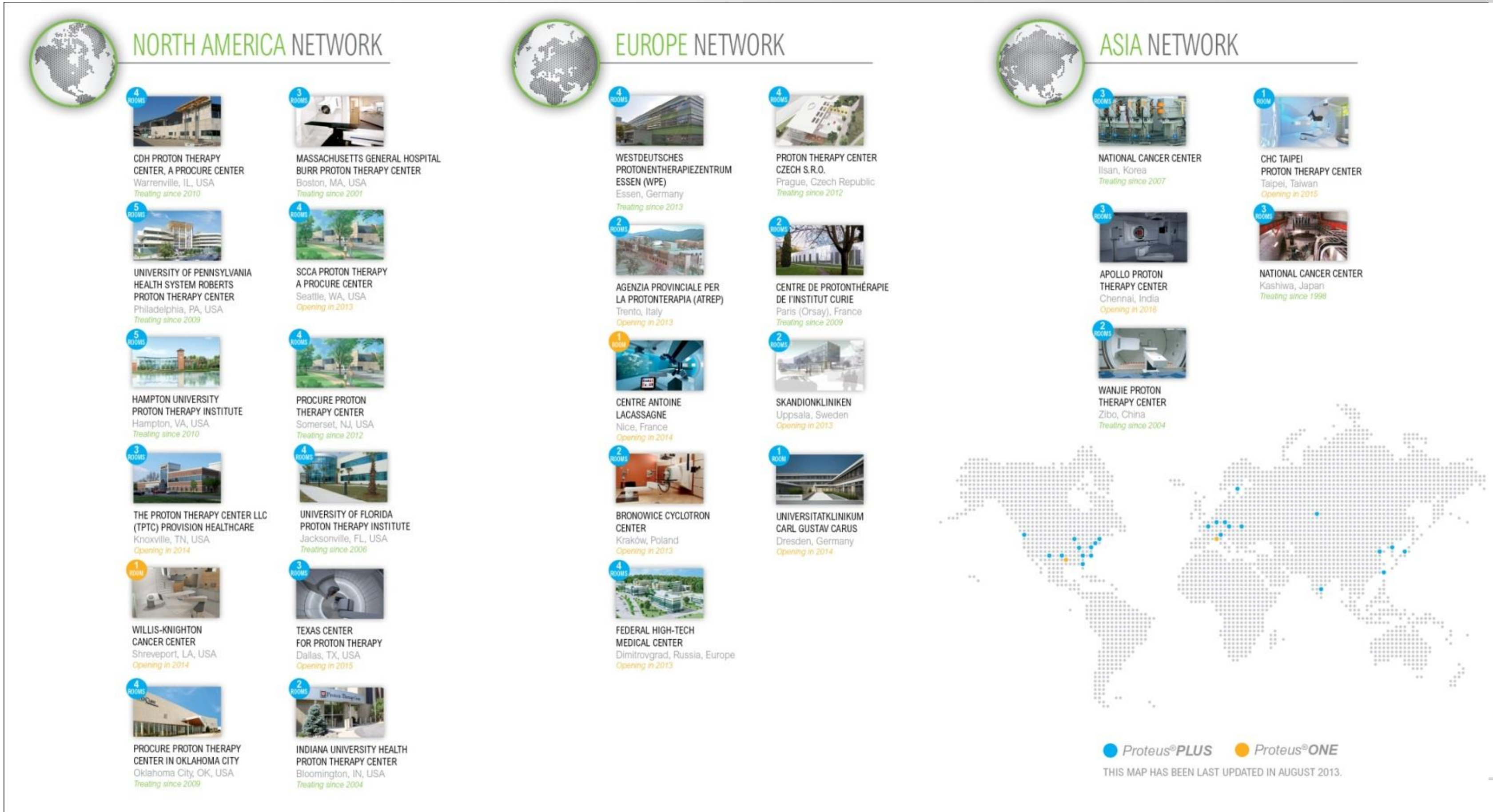


***Proteus®ONE features PBS, Cone Beam CT and Compact gantry.**

**Subject to review by Competent Authorities (FDA, European Notified Bodies, et al.) before being put on the market.*

Global adoption of IBA Proton Therapy

26 IBA reference centers - 25,000 patients treated



Monte Carlo Simulations at IBA (1)

- **IBA core business deals with the use of particle accelerators for medical and industrial applications ➔ MC transport codes are essential tools in many activities**
  - Radiation protection studies:
    - Shielding design around accelerators and patients/targets;
    - Activation studies for the equipment and the environment (concrete, ground, air, cooling water);
    - Code benchmarking and experimental validations using neutron detectors.
  - Accelerator physics (beam losses, beam transport line modeling);
  - Evaluation of radiation damages to electronic devices;
  - Medical physics:
    - On-line monitoring of proton beam range inside patient (Prompt gamma, PET emission)
    - Study of secondary neutron doses delivered to patient during treatment

Monte Carlo Simulations at IBA (2)

- **Major used codes:**
  - **<u>MCNPX (Monte Carlo N-Particle eXtended) / MCNP6</u>**
    - Developed by Los Alamos National Lab. for Nuclear Physics
    - Transport of e^-,γ, n, h, light ions, heavy ions, μ, baryons, mesons (π, K, D).
  - **<u>PHITS (Particle and Heay Ion Transport code System)</u>**
    - Developed by JAEA, RIKEN for accelerator design, medical physics and cosmic-ray research
    - Transport of e^-,γ, neutrons, protons, light ions, heavy ions
  - **<u>GEANT4 (TOPAS)</u>**
    - Developed by CERN, SLAC and other HEP Labs.
    - Transport of particles for energies from 250 eV to 1 TeV.

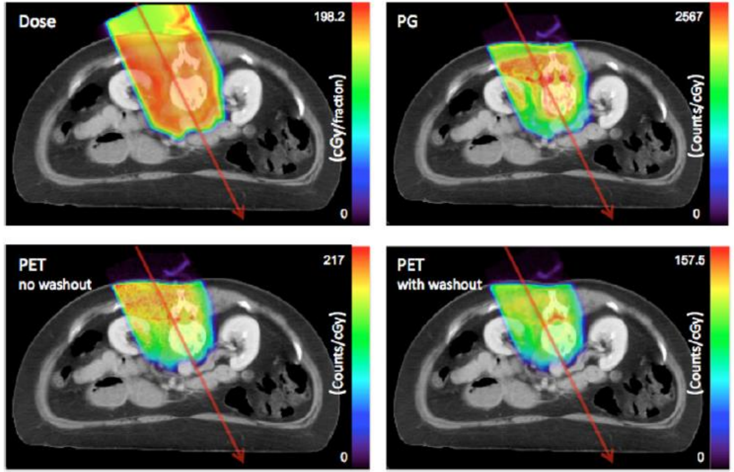
Example Project (1)

- **Radioprotection studies around the newly developed Rhodotron High-Energy (40 MeV electrons):**
  - Benchmarking of photonuclear physics implemented in MC codes MCNPX and PHITS;
  - Characterization of radiation fields produced by 40 MeV electrons on various targets (^{100}Mo, steel, copper, …)

    ➔ X-rays and neutrons produced by photonuclear reactions;
  - Design of a suitable shielding around the accelerator and the targets;
  - Study of equipment/target activation due to secondary X-ray and neutron fields.
  - Optimization of a ^{100}Mo target station for high-yield uniform ^{99}Mo production.

Example Project (2)

- **Study of secondary radiation fields produced by PET isotopes generated during patient treatment with proton beams**
- **Production of PET isotopes in patient:**
  - ^{11}C ($T_{1/2}$ = 20.39 min)
  - ^{15}O ($T_{1/2}$ = 2.03 min)
  - ^{13}N ($T_{1/2}$ = 9.97 min)
  - ^{30}P ($T_{1/2}$ = 2.50 min)
  - ^{38}K($T_{1/2}$ = 7.63 min)
- **These PET isotopes will decay into 511 keV g rays some time after treatment**



→ **Evaluation of total doses delivered to surrounding organs and evaluation of the risk of secondary cancers induced by those doses.**

→ **Simulation of the external dose rates produced by the patient after treatment.**

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Thank You

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