Medical Applications at CERN

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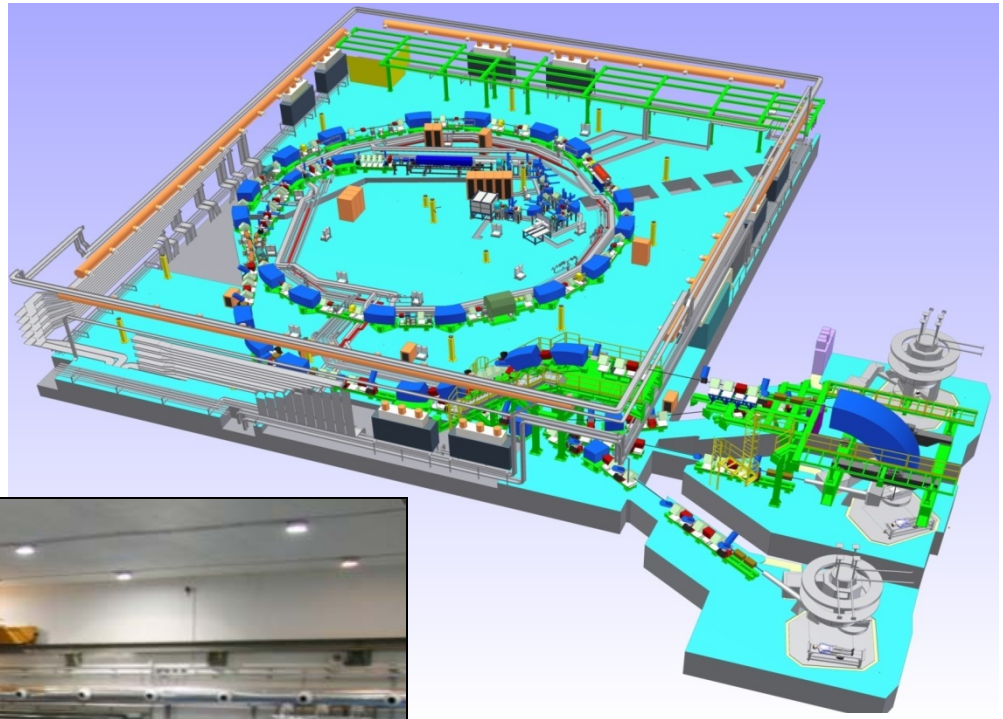
History and Reminders

Initiative: Accelerator reminder PIMMS

"In 1996, CERN initiated the Proton Ion Medical Machine Study (PIMMS), which aimed at designing a synchrotron optimized for the treatment of moving organs with carbon ions (and protons). Together with CERN part-time staff, the study participants were the TERA Foundation (Italy), the MedAustron project (Austria) and Oncology 2000 (Czech Republic). The design was summarized in two reports issued in 2000. The project was adapted by TERA and used as a basis for the CNAO centre, which has just been completed in Pavia by the CNAO Foundation and INFN. The MedAustron facility utilises the same synchrotron design, and is currently being built in Wiener Neustadt (Austria)."

CNAO (Pavia) is treating patients



CNAO in Pavia

MedAustron is building a centre in Wiener Neustadt

MedAustron Status – Wiener Neustadt

PIMMS1 design has been a big service to the community

- **2 source branches installed**
- **Beam commissioning**
- **Synchrotron hall installation**

Medical Applications at CERN (2014-2018)

Some budget and manpower in the MTP for the next 5 years

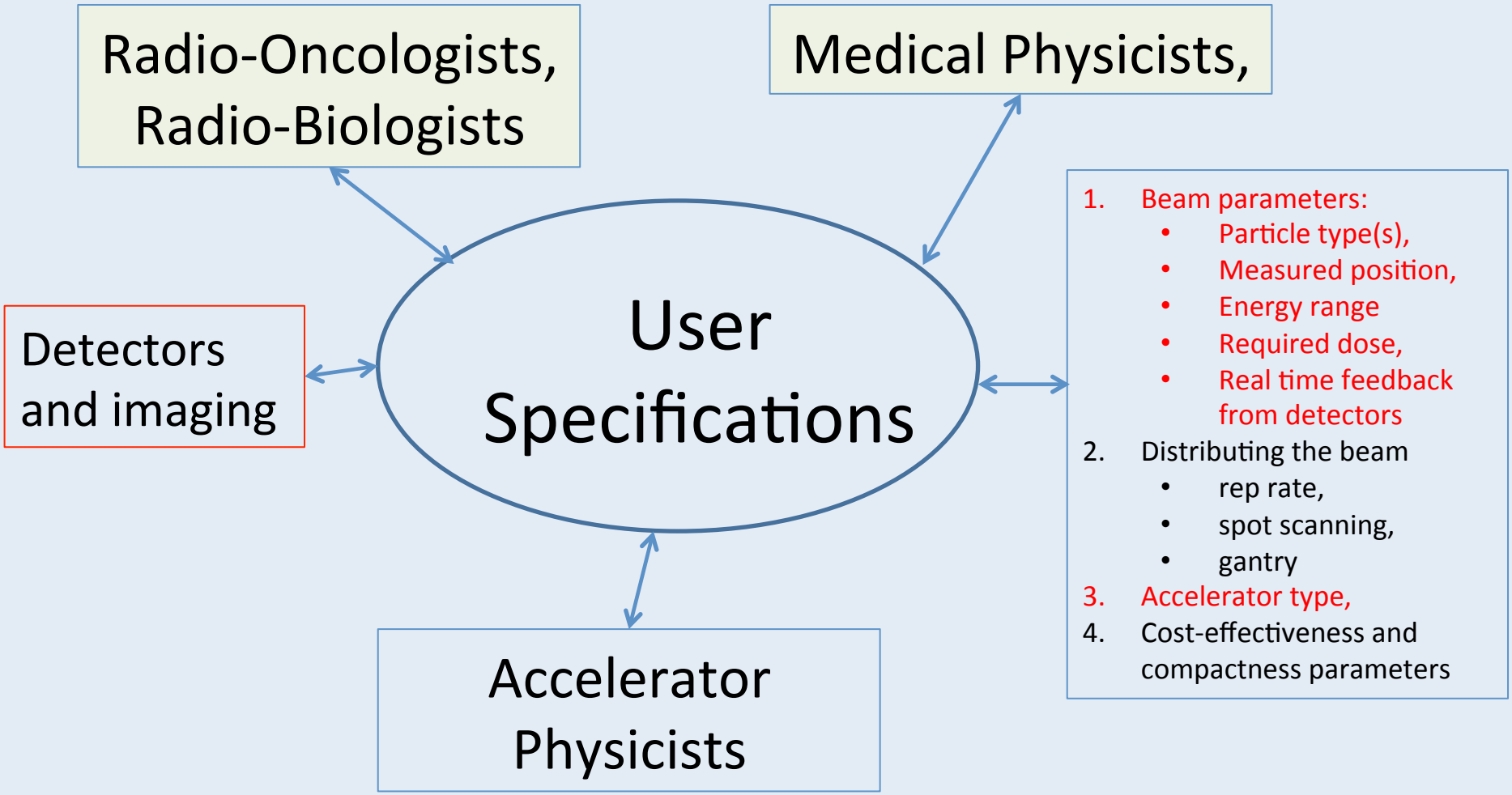
- In 2013, the Director General proposed a new medical initiative plan to CERN's governing body, the Council. This proposal was unanimously approved and a budget line now exists in the CERN Medium Term (five year) to resource this plan. (2.5 - 3 MCHF pa)
- The over-riding goal of this plan is to contribute to the technologies needed for a global system for the treatment of cancer tumours with particle beams.
- Accelerators:
- Detectors:
- Technologies such as superconductivity
- IT (the grid)

The New CERN Initiatives

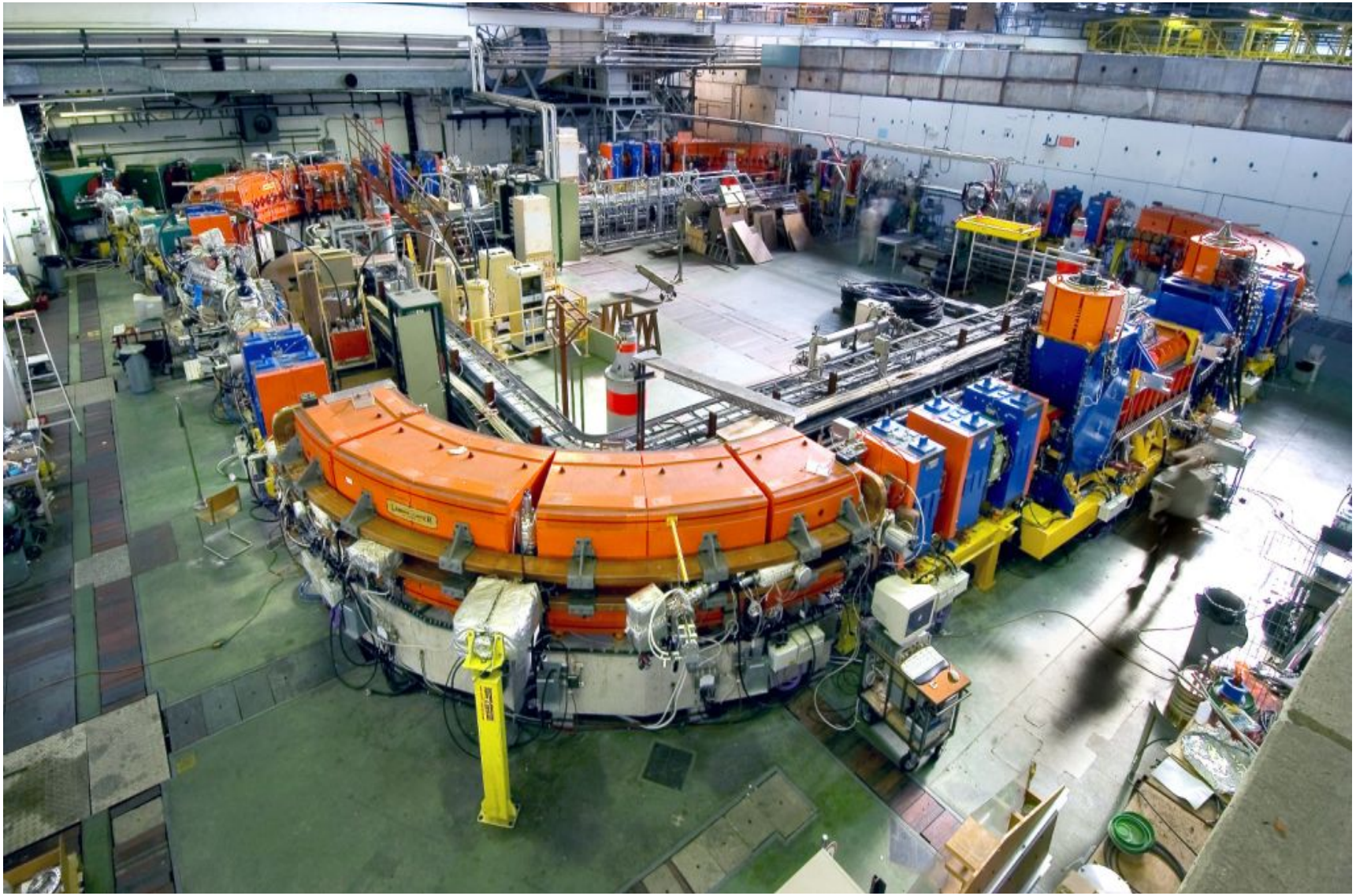
1. Medical Accelerator Design
   - coordinate an international collaboration to design a [illegible]mpact, cost-effective accelerator facility, using the most adva[illegible]chnologies
2. Biomedical Facility
   - creation of a facility at CERN that provi[illegible]cle beams of different types and energies to external users for ra[illegible]gy and detector development
   - Iterative experimental verificati[illegible]ulation results
3. Detectors for beam c[illegible] and medical imaging
4. Diagnostics and D[illegible]etry for control of radiation
5. Radio-Isotop[illegible]aging)
6. Large Sca[illegible]nputing (treatment planning)
7. Appli[illegible]s other than cancer therapy

Will be carried out in a global collaboration

User Specs for Hadron Therapy



Biomedical Research Facility at LEIR

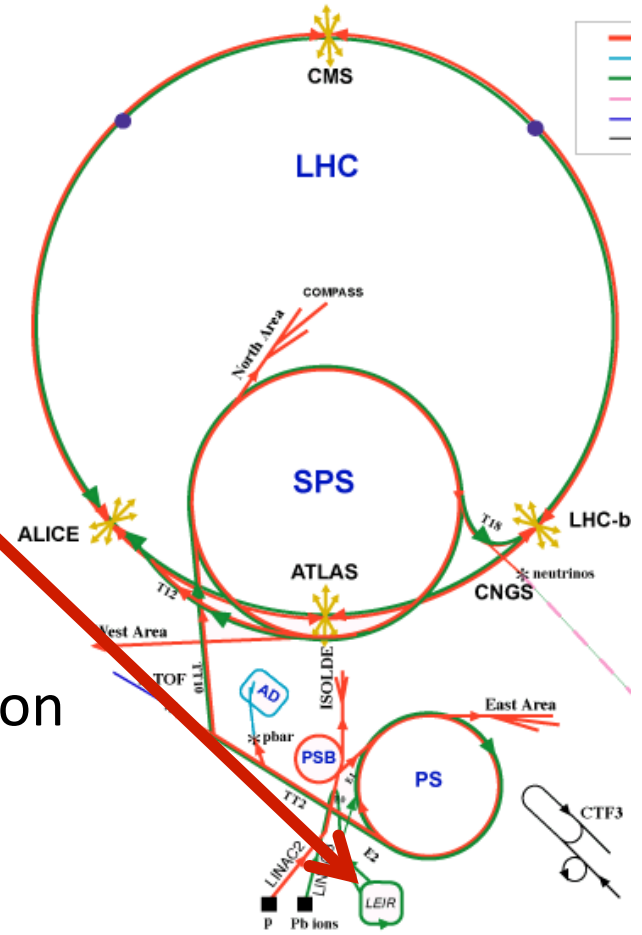


Radiobiological Facility @ CERN

LEIR (Low Energy Ion Ring)

- part of LHC injection chain
- accumulator for LHC ion programme (lead ions)
  - only used for several weeks / year

- Planned to **establish facility** for
  - **radiobiology**
  - basic physics studies such as fragmentation of ion beams
  - dosimetry
  - tests of instrumentation



3) Detectors

- Continuous development on particle physics detectors at CERN
- Scintillating crystals
- Medipix
- Diamond detectors

5) Radio-Isotopes

input from Thierry Stora

Key Points : Radio-Isotopes

- Securing an adequate supply of radioisotopes is a big challenge, not only for $^{99}Mo/^{99m}Tc$ but even more for promising "new" radioisotopes such as alpha emitters for radio-immunotherapy.
- A European user facility to be created to supply innovative radioisotopes (produced at ISOLDE-CERN, ILL, PSI, Arronax,...) for R&D in life sciences (preclinical and clinical studies).

Civil Engineering has started

September 4th 2013

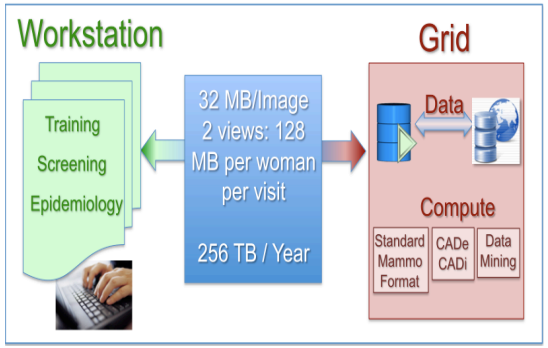
Planning proposal*

**subject to modification…*

	Construction	2013-2015
PHASE I	Commissioning : No beam	end 2015
PHASE II	Commissioning with beam and light targets to gain operational experience	2016
PHASE II B	Isotope production with light targets	mid 2016
PHASE III	Extending to heavy targets up to Tantalum	end 2016
PHASE IV	Collection of short lived alpha emitters (e.g. 149Tb)	2017
PHASE IVB	Operation with Lasers	
PHASE V	Operation with Uranium targets/possible proton beam upgrade	2018

Sciences using the CERN Grid (EGEE)

- Archeology
- Astronomy & Astrophysics
- Civil Protection
- Computational Chemistry
- Computational Fluid Dynamics
- Computer Science/Tools
- Condensed Matter Physics
- Earth Sciences
- Finance (through the Industry Task Force)
- Fusion
- Geophysics
- High-Energy Physics
- Life Sciences
- Multimedia
- Material Sciences
- ... Further applications under evaluation



Grid computing for medical data management and analysis

Where are we?

Starting Point

- "CERN Medical Applications Workshop" following this ICTR-PHE (15-16 February)
- Attracted ~80 top experts from all over the globe (you!!)

Programme: 9 sessions and summary

1. Clinical Results and Perspectives
2. Accelerators
3. Dose delivery and gantries
4. Biomedical facility at CERN
5. Radioisotopes production and Use
6. Detectors for in-beam monitoring and imaging
7. Hadron Beam Dosimetry
8. Large Scale Computing and Simulations

Perspectives from the 8 Conveners

9. Collaboration Structure and Funding Sources

Organization and Structure

- The funding from CERN is meant to be “seed” funding. It is anticipated that the commmunity will find/provide funding from other sources
- I will organise an internal CERN structure
- This internal structure should fit in and be part of a wider collaboration structure involving the medical community

Some Questions on how to proceed

There seems to be a lack of collaboration coordination and overall strategy

Q1: Do we need/want better collaboration, coordination and fixing of overall strategies?

If yes

Q2: How could we bring this about?...New Entity

What entities already exist?

Q3: What should this entity strive to do? …

- prioritize, coordinate work and set strategies for medical/technical work in the medical applications field

Some Questions on how to proceed (2)

Q4: What responsibility should this entity have?

- Develop overall medical/technical strategy
- lobby for funding?
- Coordinate demands for funding or distribute funding received

Q5: Who should constitute the members of this entity

- Medical research institutes?
- Representatives from countries?
- …

Q6: What form should this entity take?

- Governing board,
- Coordination board
- Advisory board,
- European (world) institute
- European (world) network (EU)

How will the CERN internal organization fit in with this "form"

- In order to progress, we need consensus on the answers to these questions

My Notes from the sessions

Clinical Results and Perspectives

Equipment

- Smaller, cheaper
- Image guidance
- Motion control
- Beam position control
- Ultra fast ADAPTIVE treatment

Biology

- RBE for different beams
- Interaction with other anticancer therapy
- Image and non image biomarkers for selection
- Biological adaption

My Notes from the sessions (2)

- "No convincing evidence that protons ate better than photons"
- Speed up GEANT4 (FLUKA)
- Certification of FLUKA (GEANT4) for treatment planning
- PET scan is very valuable
- Fast scanning of moving organs
- Adaptive radiotherapy
- Biology needs improvement
- Biology of protons and carbon ions is essential
- Results from Japan are very impressive
- Specs for the "3rd generation machines"
- Prompt gammas
- Repainting
- Anders Brahme many new ideas

My Notes from the sessions (3)

- Different ions should be a biological decision
- Movement of patient
- Bio-LEIR could pay for itself
- Prompt gammas + secondary protons
- > 15T magnets for high resolution MRI
- Visit Dresden
- Tumour modeling
- Certification of FLUKA/Geant4
- Japanese language data in NIRS

- Standard protocol for imaging data
- Tool-kit solution for CERN
- Conventional Very cheap RT for poor countries
- CERN as standards lab for dossinetry
- Approach ESS radio-isotopes
- CERN training “school” for medical physics
- Overview group (systems)

My Requests to Participants

- Mail to me your crucial convictions

Thanks

- Manuela, Helen, Sparsh (Manjit's team)
- Ugo and Manjit
- Conveners, and rapporteurs
- Participants
- 'till the next time: SAFE HOME!!!

Discussion