
CERN

The PIMMS2 Study at CERN

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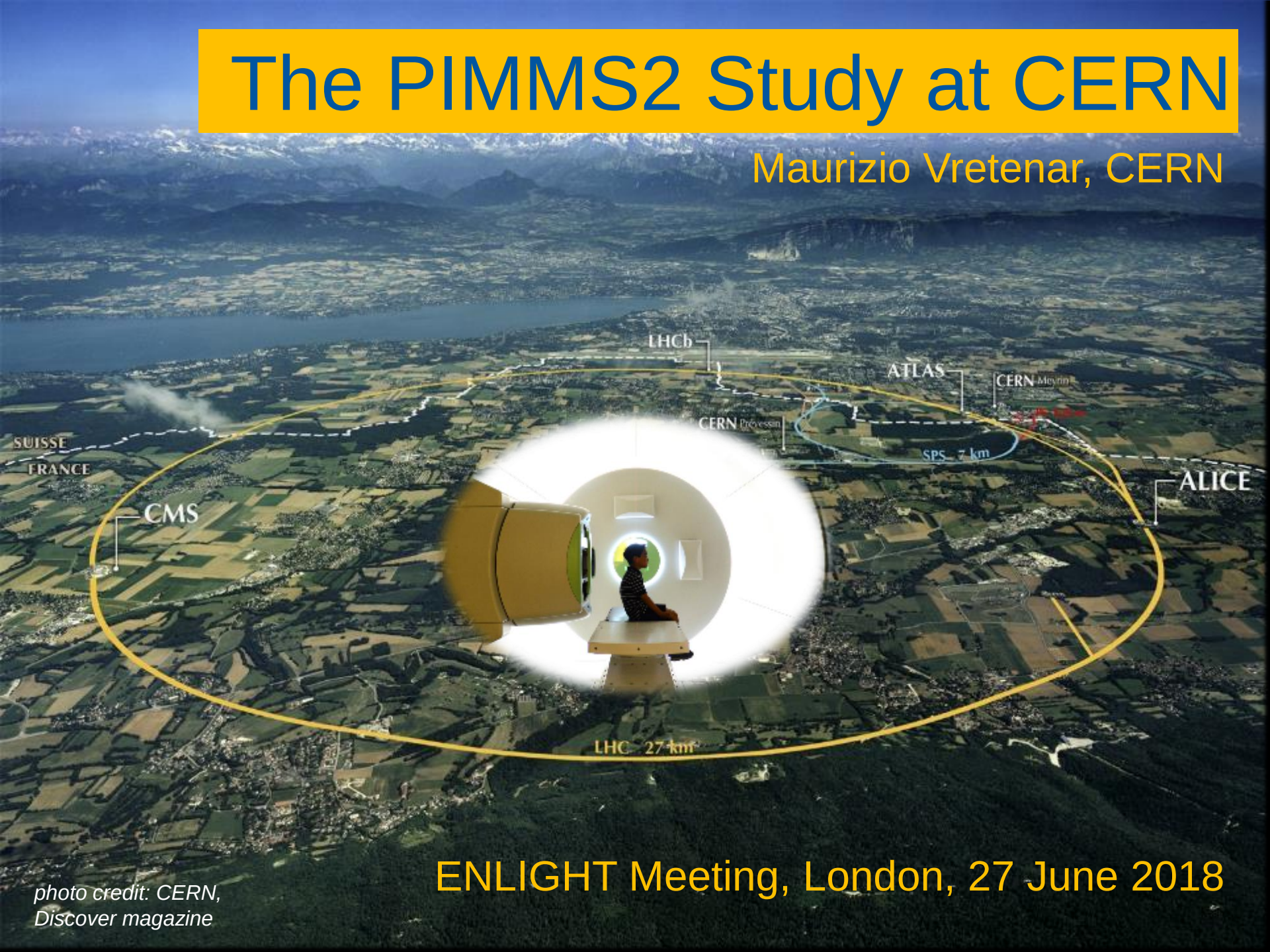
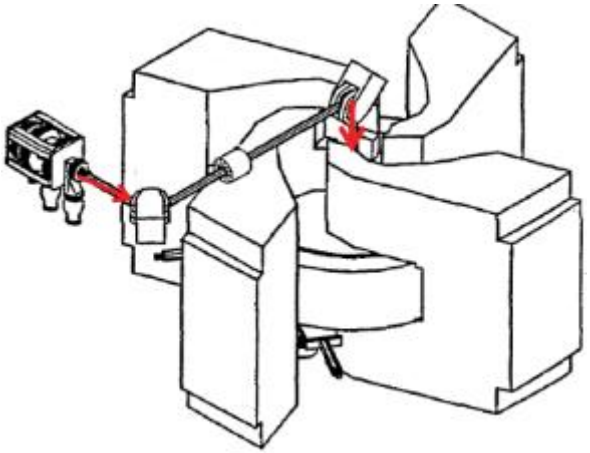


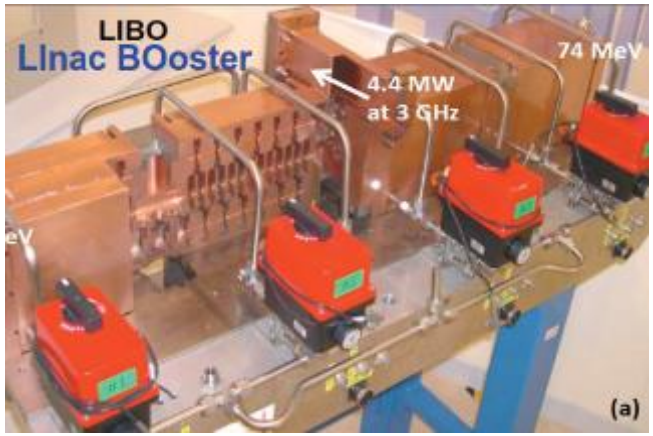
ENLIGHT Meeting, London, 27 June 2018

photo credit: CERN, Discover magazine

Medical accelerators at CERN

- CERN has accumulated a huge competence in particle accelerators and has an old tradition of being a meeting place where people from different countries and laboratories collaborate freely.
- Since the early 80's, CERN scientists have contributed to projects to adapt CERN technologies to the development of medical accelerators.
- Similar organization: a study group at CERN that develops designs and prototypes for facilities built outside of CERN:
  - **Medicyc** 1982-1990 and **Eulima** 1985-1989 → Cyclotrons at Centre Lacassagne, Nice.
  - **LIBO** (Linac Booster) 1998-2001 → LIGHT linac being built by ADAM/AVO.
  - **PIMMS** (Proton Ion Medical Machine Study) 1996-2000 → CNAO and MedAustron proton&ion synchrotrons.
- The concentration of resources on LHC construction from 2002 has interrupted this long tradition.
- 16 years later, there is interest from CERN and some support from the management to restart a medical accelerator activity.
- But where should we go? Particle therapy has made an enormous progress in the last 20 years and the situation is very different from the initial pioneering years.



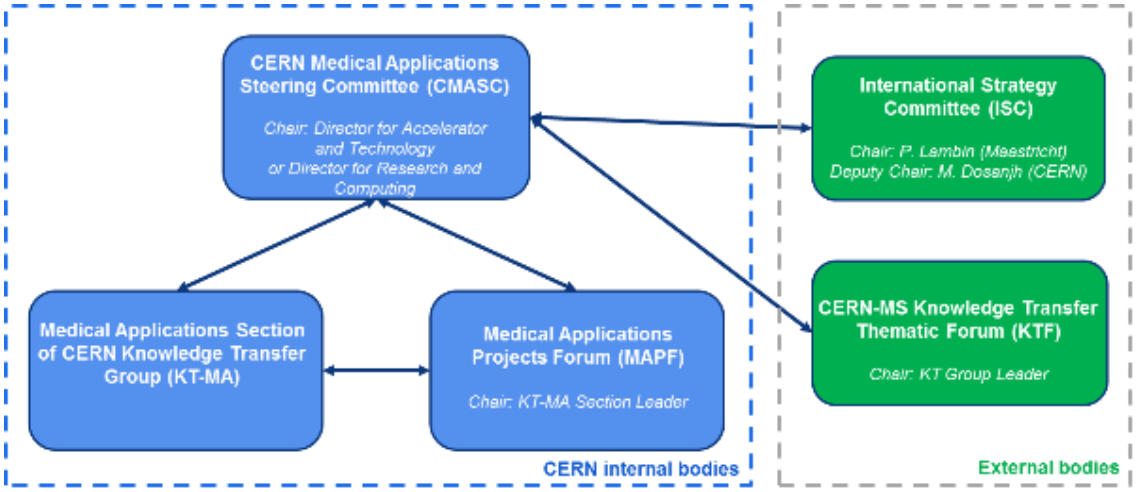


New CERN Medical Applications

- The limits to the CERN engagement are defined in a Medical Strategy document approved by Council in March 2017.
- While CERN core mission is particle physics, maximising the societal impact of its research is an integral part of this mission. The goal is knowledge transfer (to society), not the development of a specific instruments or projects.
- A (limited) personnel and material budget is foreseen as seed funding for collaborative R&D projects (receiving additional support from EU or other sources), using technologies and infrastructures that are uniquely available at CERN.
- The selected projects must not overlap with activities in Member States or be in competion with industry, and must be driven by the requirements of the medical research community.

Funding and Organisational Structure

Medical accelerator programmes:
~ 0.1% of the CERN budget (Material and Personnel), administered and controlled by 5 Committees.



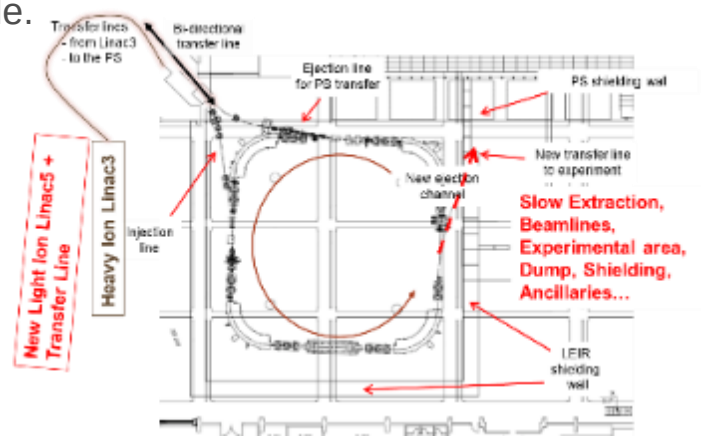
Background: PIMMS(1) and BioLEIR

PIMMS = Proton-Ion Medical Machine Study

- Started in 1996 as a study group at CERN (CERN, TERA Foundation, Med-Austron, initial collaboration with GSI.
- Goal: design of a cancer therapy synchrotron, development of the main technical components of the facility.
- In 2000 resulted in the publication of a Technical Design Report, with a CD-ROM of data and technical drawings.
- The PIMMS study was the basis for the construction of CNAO (Pavia, Italy) and MedAustron (Wiener Neustadt, Austria).

BioLEIR

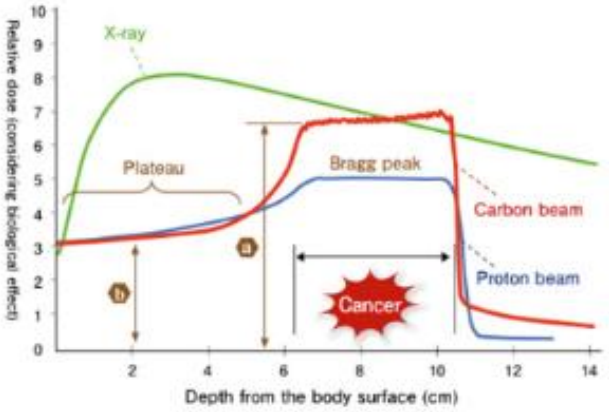
- Proposal to add light ions to the CERN ion accumulator ring LEIR to provide beams for biomedical research when not operating for LHC.
- Goal: compare different ions (RBE, cancer effectiveness, H, He, Li, Be, B, C, N, O), measure particle range, ballistics, fragmentation. No tests on animals or patient treatment.
- Strong support from the biomedical community.
- Working group, Feasibility Study published in 2017, estimate 29 MCHF + 119 FTE.
- Project stopped because funding not available (nor from CERN, nor from external international sources) to start in time with CERN long-term schedule.

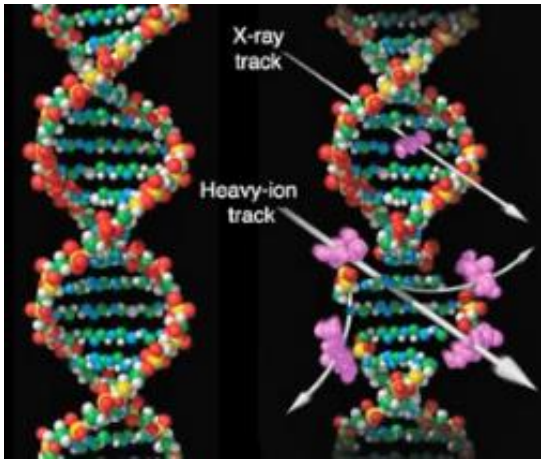


How could CERN contribute

A quick overview of the situation in 2018:

- Proton therapy is rapidly progressing, thanks to the commercial availability of turn-key facilities. Research is oriented towards delivery systems and optimizing treatment; nobody questions the accelerator and we should not interfere with commercial companies.
- Instead, there is clear indication that **ion therapy has a strong potential** (higher RBE, effective with radio-resistant tumours) but to make it accessible to a larger fraction of the population some action is needed along three axis:
  - Collect more data from biomedical research with different types of ions *(the BioLEIR line, extended to tests on animals and possibly clinical trials)*.
  - Try to reduce size and cost of the facility, using some new accelerator design *(for carbon or lighter ions?).*
  - Further optimise the delivery system, including the gantry.





A common objective

The conclusion of our investigation is that to further advance ion therapy, we should aim for:

- A multiple-ion research and therapy facility – *built in Europe, possibly with support from the European Commission.*
- Based on innovative accelerator technologies - *to become the test bench for a new standardised treatment facility*.
- Structured as a multi-national centre, addressing the entire European and worldwide community – *no European country can afford building this facility alone*.

In this programme, CERN can:

1. within a PIMMS2 initiative, contribute to identifying and developing new accelerator technologies
2. offer a multinational environment to grow the multi-national collaboration.

The Archamps Workshop

“Ideas and technologies for a next generation facility for medical research and therapy with ions”, ESI Archamps (France, Geneva area), June 19-21.

Co-organized by CERN, ESI, GSI - 63 participants

Objectives:

1. Highlight the potential of ion therapy for cancer.
2. Share the current experience: advantages and disadvantages of present implementations, ideas for future facilities, directions for improvement.
3. Explore the options for the design for a next generation medical research and therapy facility with ions in Europe, identify and motivate a community that could contribute.
4. Identify basic parameters, a set of technical options, and outline a possible basic R&D programme.

Key outcomes

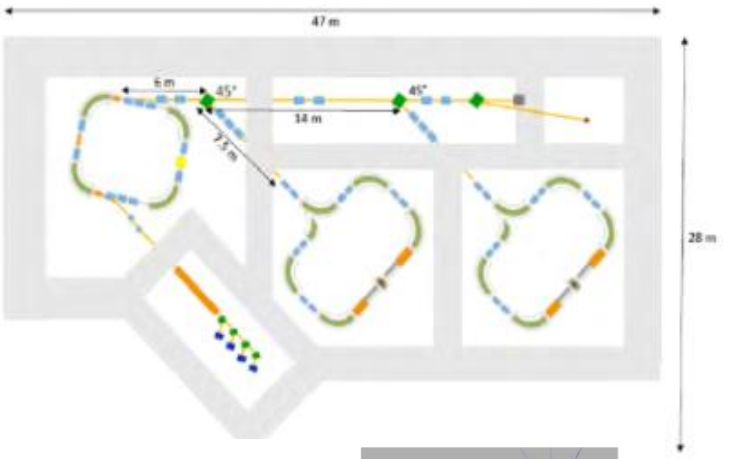
Take away words:

- Small and cheap
- Fast delivery
- Real time imaging
- Low consumption
- Higher intensity
- Possibly with MRI
- “Start from the patient”

Two technical options

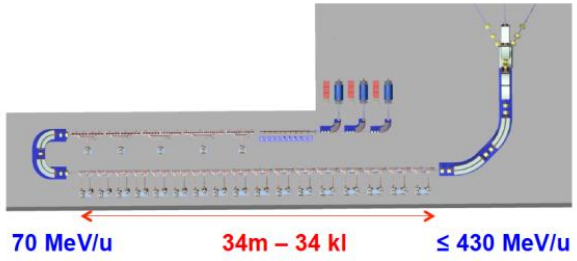
Superconducting synchrotron

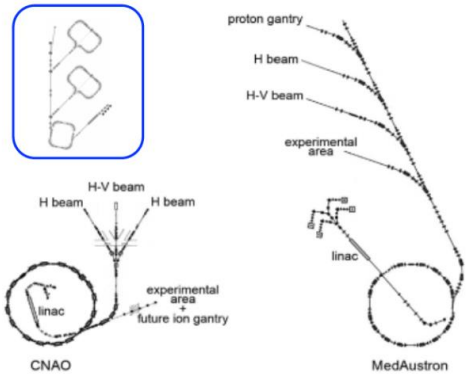
Four 90deg canted cosine theta magnets, Bmax 3.5T, ring 27m, gantry r=5.3m



Linear accelerator

Folded linac, 34m length, high rep. frequency and intensity, low emittance





Both options require development!

SC synchrotron compared to CNAO and Medaustron

Development Options

The main avenue: from Health to RI

Submit in a proposal for a **Design study** to be supported by the EC (Research Infrastructures) for the **design of a next-generation ion research (and therapy) facility**.

Deadline: December 2019, duration 2-3 years. EC contribution 3 M€, partners' matching funds ~3 M€ (total 6 M€).

~10 beneficiaries, 10-20 collaborating partners

Coordination with the SEEIIST

The design Study must be coordinated with the SEEIIST (South East Europe International Institute for Sustainable technologies) that is seeking EU support for the construction of a medical accelerator centre in the SE Europe.

Depending on the time scale, SEEIIST can be a first user of the new facility design.

Thank you for your attention

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