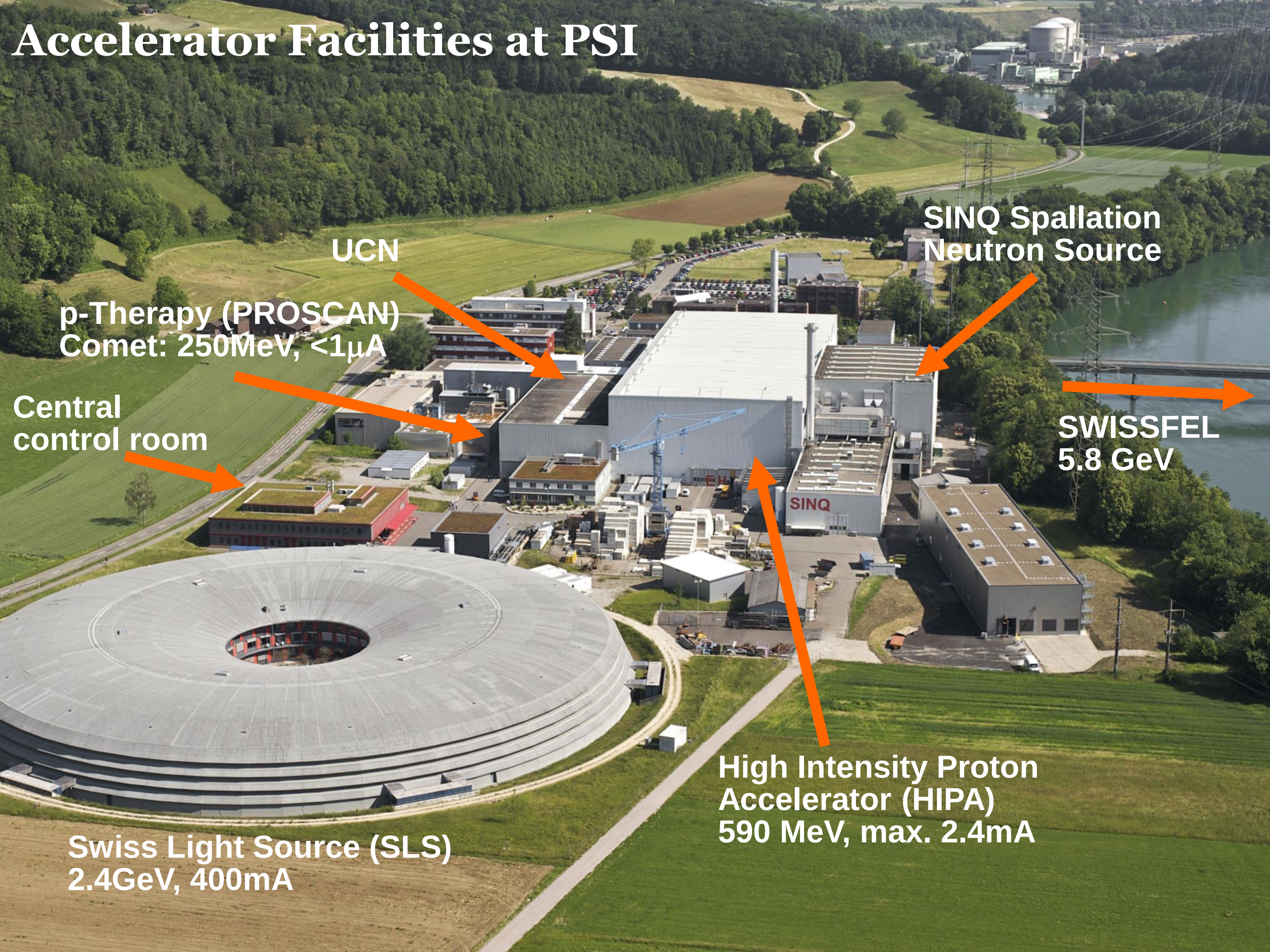
PAUL SCHERRER INSTITUT PSI

Daniela Kiselev :: 8100 :: Paul Scherrer Institut

IMPACT – Quo vadis?

IMPACT Informationsveranstaltung, Auditorium, PSI, 31.1.2023

Accelerator Facilities at PSI



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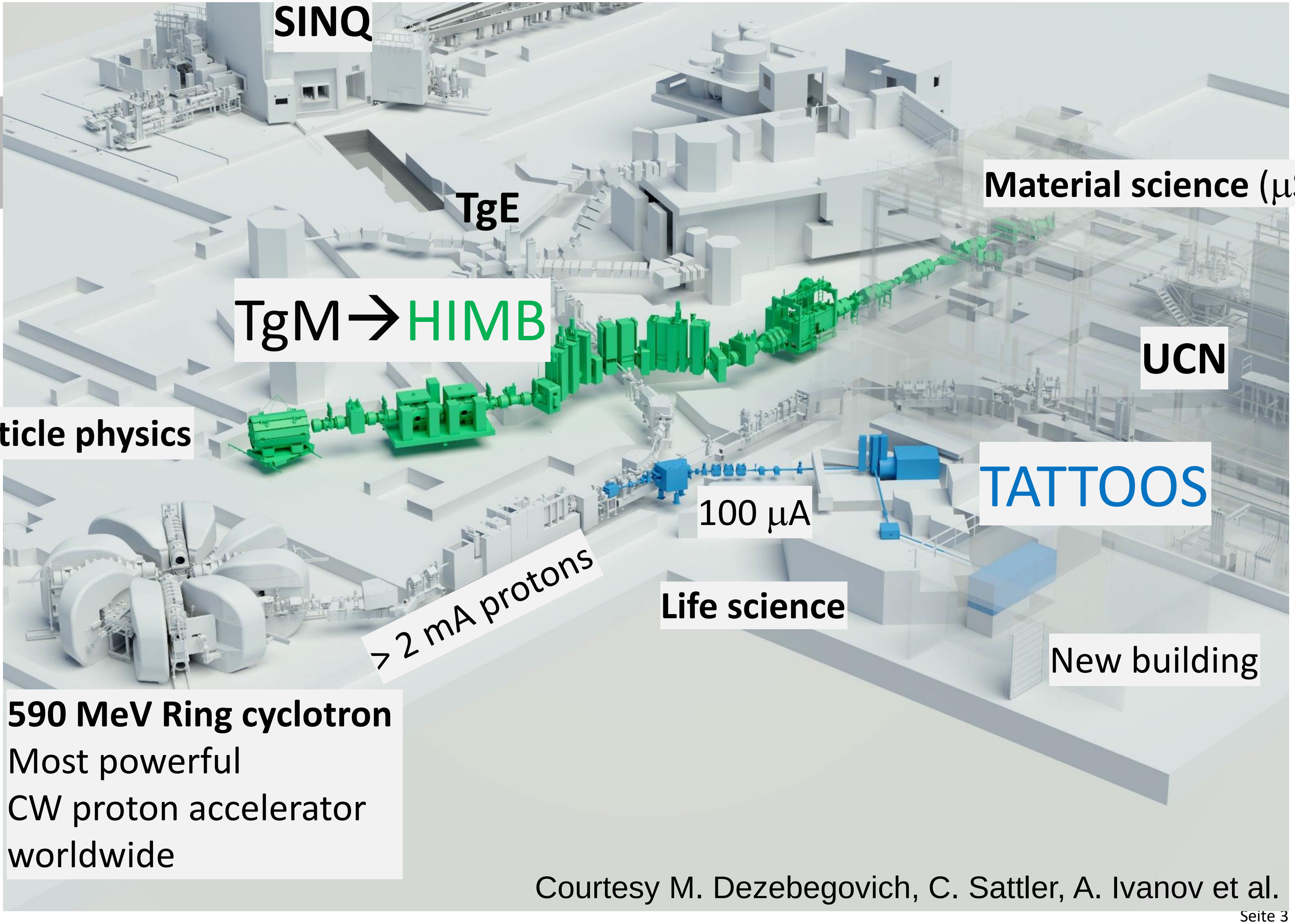
HIPA with IMPACT (= HIMB & TATTOOS)



IMPACT = HIMB + TATTOOS

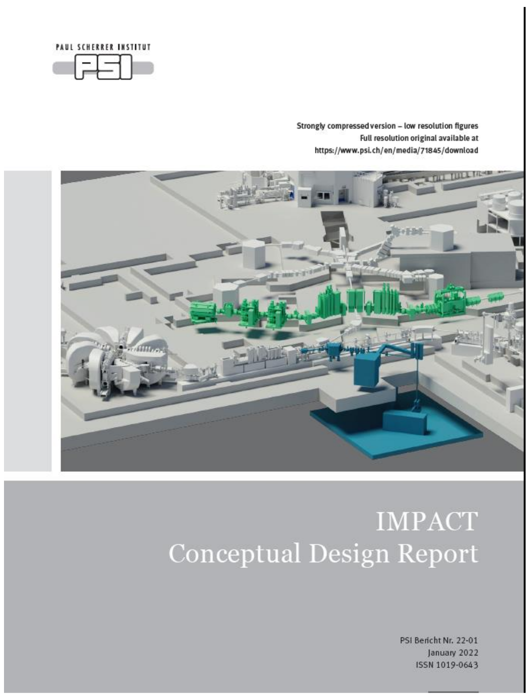
Isotope and Muon Production with advanced cyclotron and target technology

HIMB (High Intensity Muon Beams)

Upgrade of target station M to target station H for 100 x more surface muons

TATTOOS (Targeted Alpha Tumour Therapy and Other Oncological Solutions)

New target station for producing radioisotopes for research in cancer therapy



~ 100 people are involved

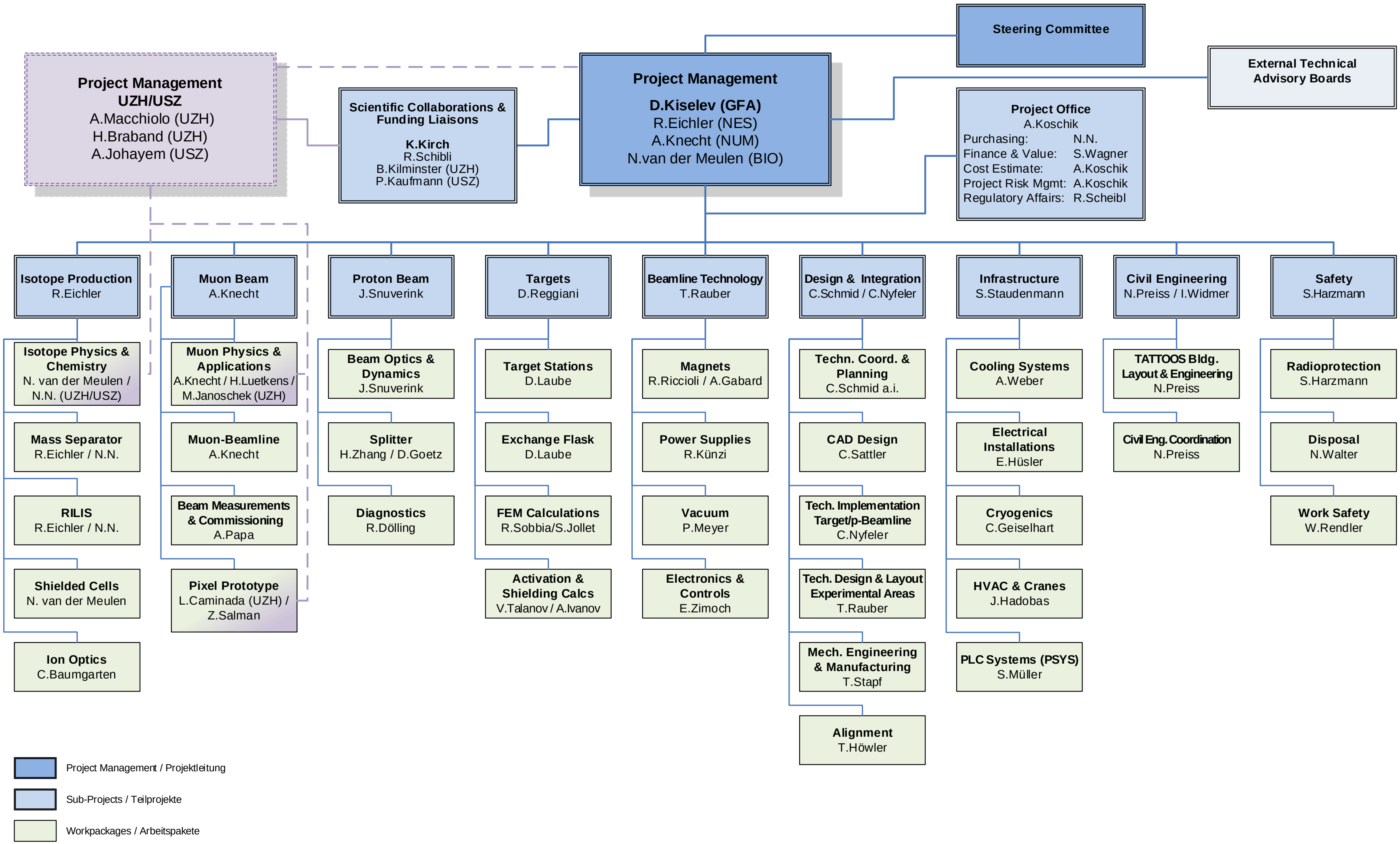
from BIO, GFA, LOG, NES, NUM

9 subprojects and 35 working groups

Conceptual Design Report (Jan. 2022)

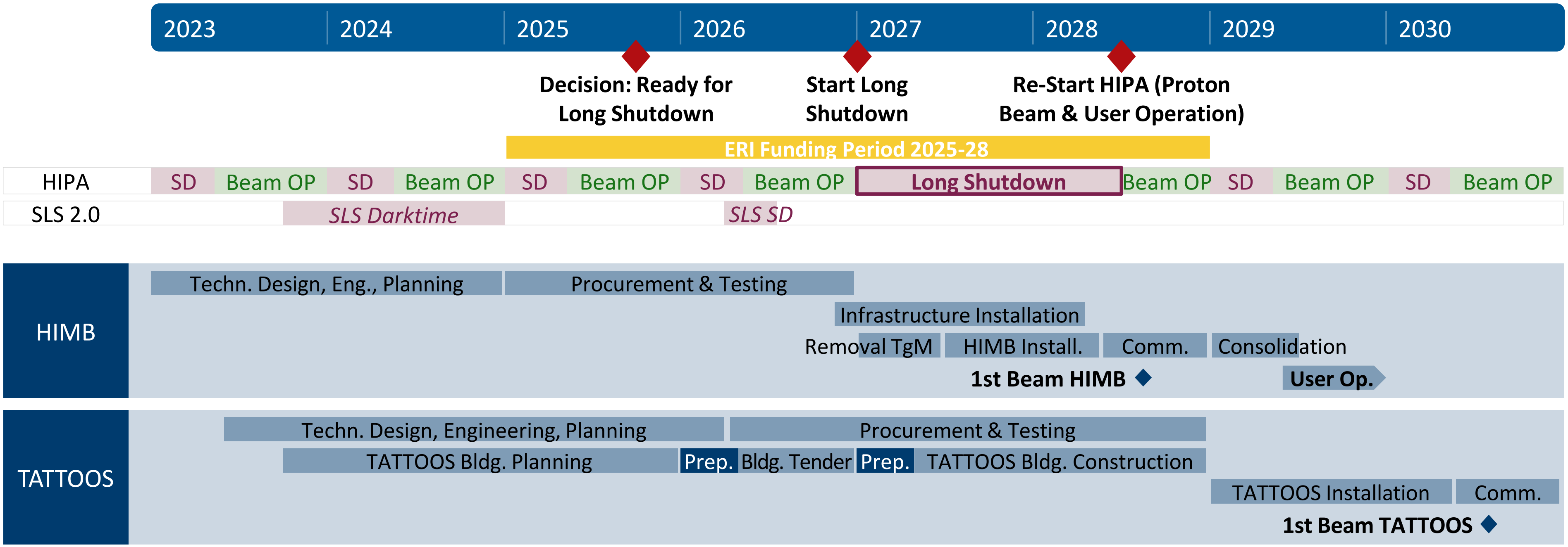
https://www.dora.lib4ri.ch/psi/islandora/object/psi%3A41209

Project Organisation



IMPACT-PM-KA80-2109201_Projektstruktur_v1.7.vsdx

IMPACT schedule



HIPA: 2027 no beam

→ Installation of HIMB

→ 2028 first beam with new target station H

TATTOOS: New building necessary → Beam 2 years after HIMB (2030)

<u>Advantages:</u>

- Target station installations for HIMB and TATTOOS not at the same time

→ more PSI resources available, less temporary hired staff

→ less shortage on storage place for new components, shielding

Swiss Roadmap for Research Infrastructures

1st Phase

April 21 2-page proposal: «Motivation & Intention» 1. cost estimate

revised version in June 21

Aug. 21 Support from ETH Board

Dez. 21 SNF-Proposal: in-depth description of the research infrastructure

- **Quality of the infrastructure and research**
- **National and international scientific relevance and future potential**
- **Users and access**
- **Scientific feasibility**

PI: Klaus Kirch, 1. Co-PI: Roger Schibli,
2. Co-PI: Ben Kilminster (UZH), 3. Co-PI: Philipp Kaufmann (USZ)

+

Planning, governance and management, and finances (2. cost estimate)
Project team: Daniela Kiselev, Robert Eichler, Andreas Knecht,
Alexander Koschik, Nick van der Meulen

+

Jan. 22 Conceptual Design Report (CDR) IMPACT
(2 chapters on UZH & USZ installations)

Roadmap process

2nd Phase

15.7.22: 1. Evaluation of scientific part by SNF

A-rating in all categories!
- Scientific quality & relevance
- Access & user groups
- Scientific feasibility

3rd Phase

Nov.22 2-page Report: Revised Time plan & budget
Dec.22: 2. Evaluation of technical feasibility + finances by ETH Board

→ ETH Board recommends IMPACT for the admission on the Swiss Roadmap

Next steps:

1. half 23: Publication of Swiss Roadmap for research infrastructures by SERI

↓

Dec. 24: Funding after decision of parliament for 2025-2028

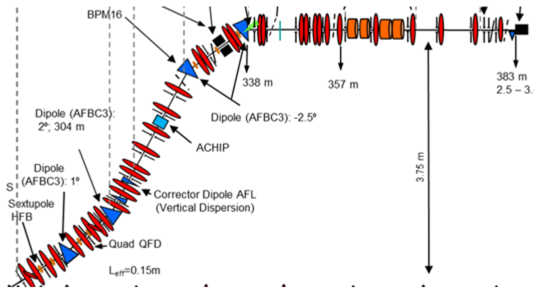
Former PSI projects on the Swiss Roadmap

<u>ERI period</u>

SwissFEL/Aramis

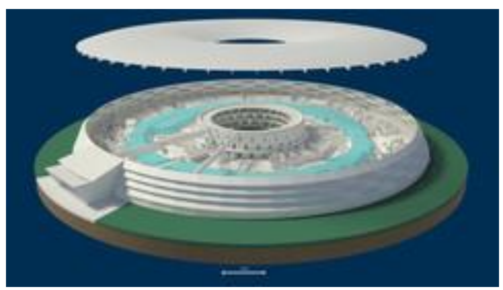
2013 - 2016

SwissFEL/Athos



2017 - 2020

SLS1 → SLS2



2021 - 2024

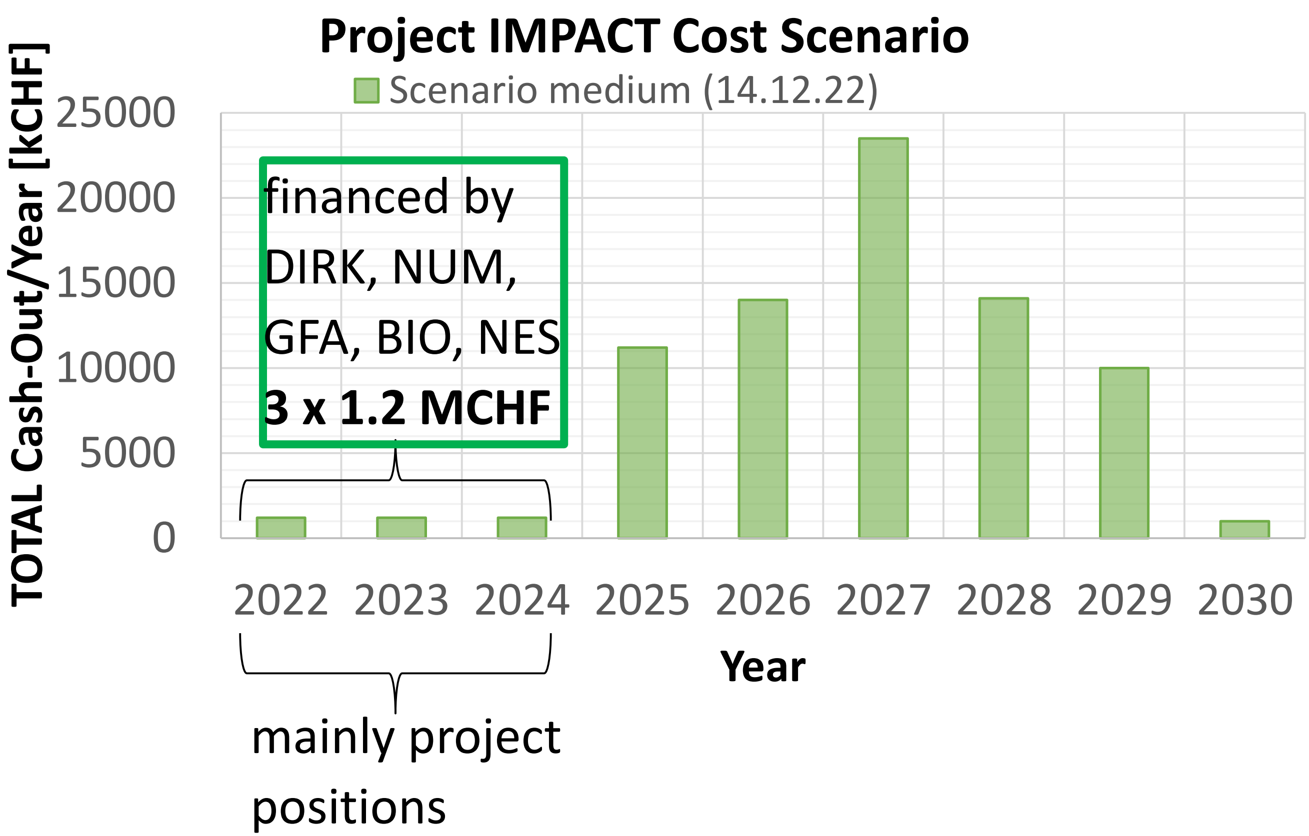
IMPACT

2025 – 2028 - 2030

Priority at PSI in ERI period

Financing IMPACT

Source	MCHF
Swiss Roadmap	60
PSI (DIRK, NUM, GFA, BIO, NES)	10
Third-party funds	7
Total costs	77



Challenging: Current inflation & delivery times

Established committees

- **Steering Committee (SteCo):** 2. SteCo: next April
  Chair: Christian Rüegg
  Directorate Staff/ Scientific Affairs Michèle Erat
  division heads of BIO, GFA, LOG, NES, NUM
  + heads of finances (F. Behner), civil construction (L. Jacob)
  Radiation protection & safety (S. Mayer)
  Particle physics (Klaus Kirch),
  Radiopharmaceutical Sciences (Roger Schibli)
  Protocol: Alex Koschik (Project office IMPACT)

- **External Advisory Board (EAB)**
  international experts with different expertise important for project
  for HIMB: 6th 2-day meeting in May
  Chair: Robert Zwaska (Fermilab)
  Johannes Bernhard (CERN), Stephen Blundell (U. Oxford),
  Yasushiro Miyake (KEK), Michele Weber (Uni Bern)
  for TATTOOS: coming soon

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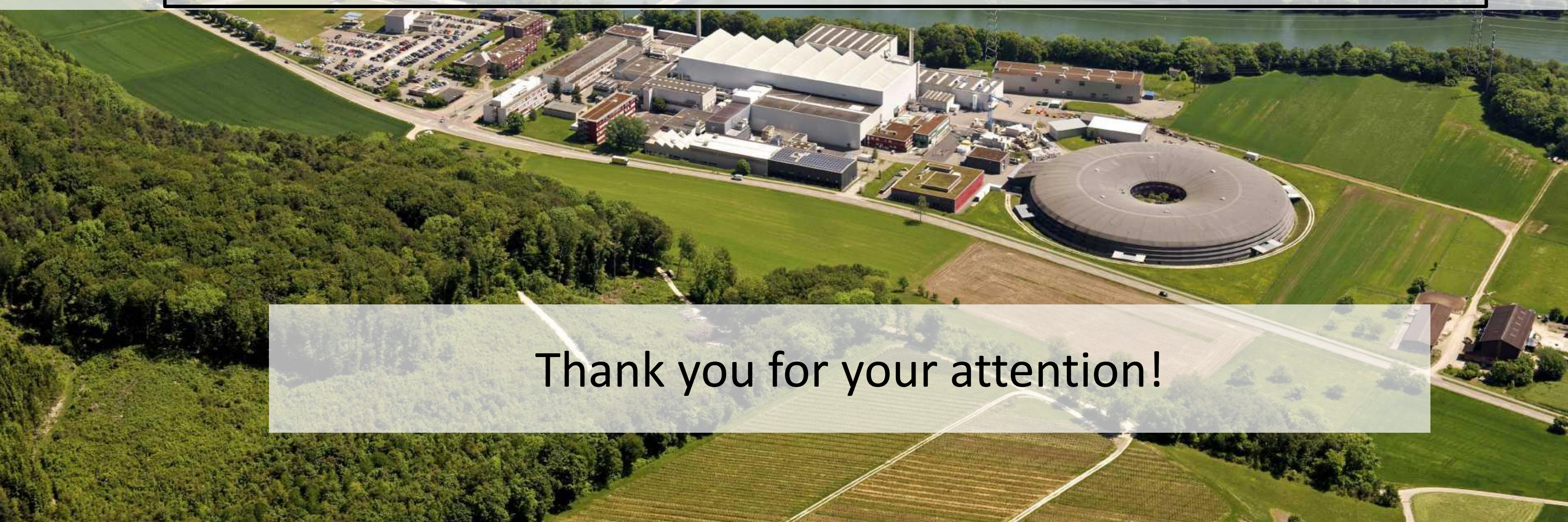
Summary

IMPACT: a 77 MCHF project to upgrade the existing meson production station M
& a new target station to produce radioisotopes with 590 MeV protons

- covers a broad field of applications: particle, solid state physics, life science ......
- CDR finished Jan. 2022
- Installation 2027 to 2030: 2028 HIMB beam, 2030 TATTOOS beam on target
- Next big milestone: TDR in 2024

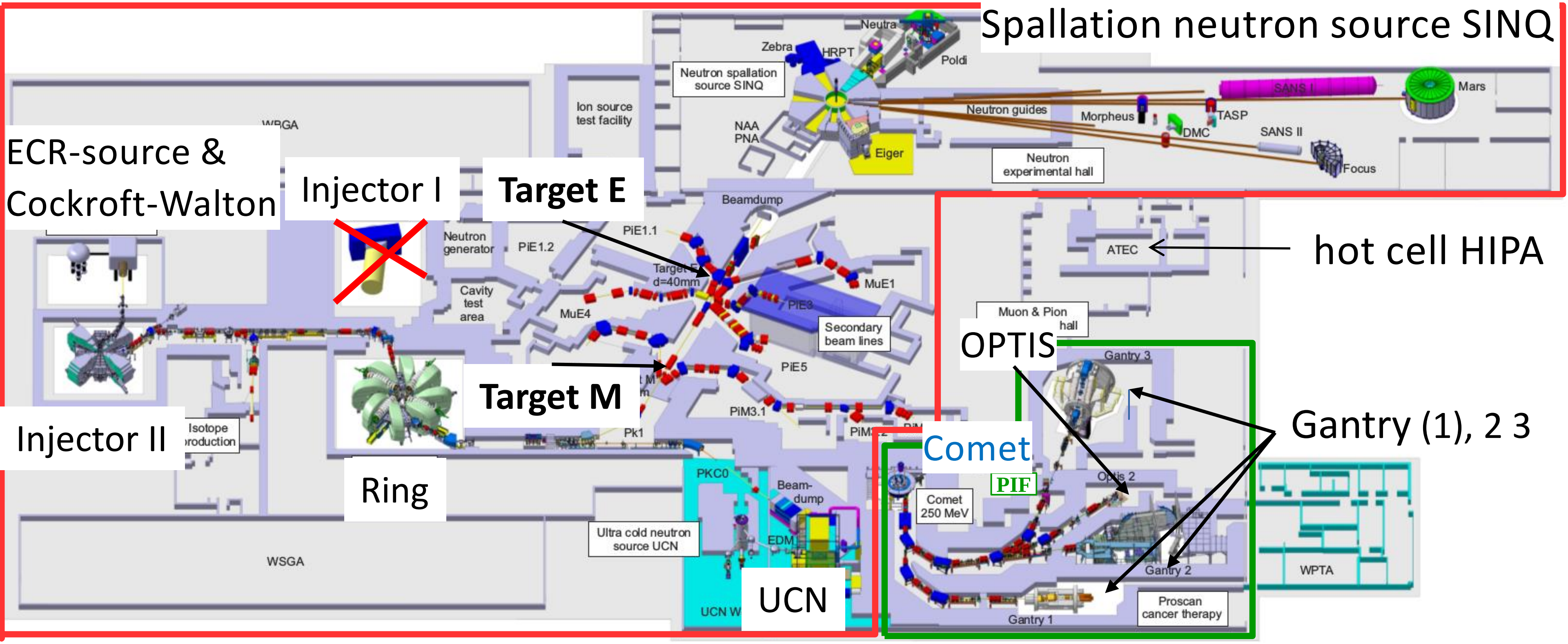
Thanks to all IMPACT project members for their contributions & ideas and the support from the divisions BIO, GFA, LOG, NES, NUM & DIRK



Thank you for your attention!

Christian Rüegg	director PSI
Michèle Erat	head director's staff
Frank Behner	head finances
Gebhard Schertler	head BIO division
Mike Seidel	head GFA division
Peter Allenspach	head LOG division
Andreas Pautz	head NES division
Alex Amato	head NUM division
Lilian Jakob	head civil construction
Sabine Mayer	head radiation protection & safety
Klaus Kirch	head particle physics
Roger Schibli	head Radiopharmaceutical Sciences

The PSI Proton Accelerator Facilities



HIPA (High Intensity Proton Accelerator)

- CW (50.63 MHz), 590 MeV,
- up to 2.4 mA(1.44 MW)
- **2 meson production targets**
- 7 secondary beam lines
- SINQ and UCN spallation source

PROSCAN (Proton therapy): since 2007

Comet: superconducting cyclotron

CW, 250 MeV, up to 1 µA protons

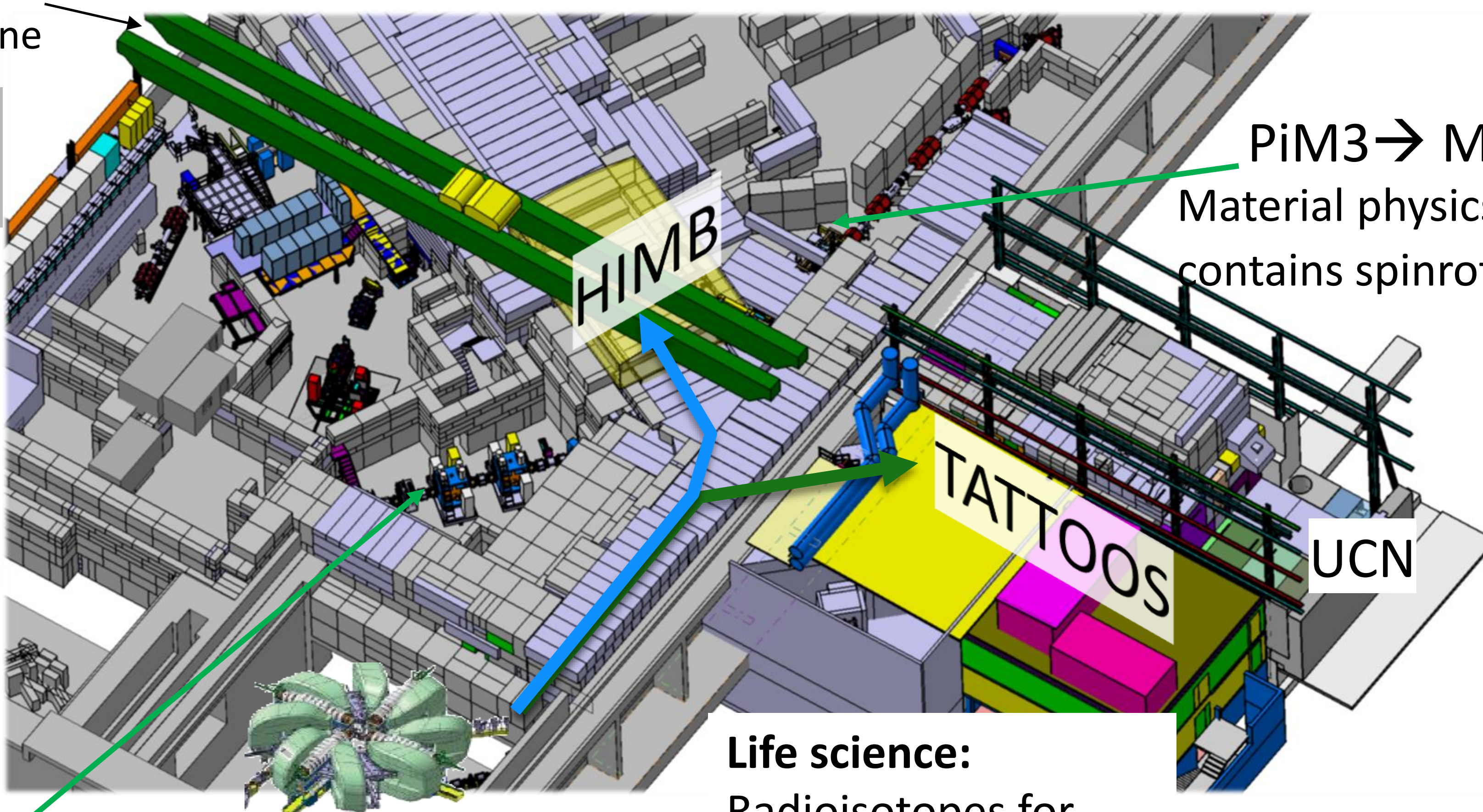
medical treatment:

3 Gantries, 1 Eye Cancer Treatment Station

Irradiation Station: PIF

HIPA with IMPACT (= HIMB & TATTOOS)

This is the
60 t crane



PiM3→ MuH3
Material physics (μSR):
contains spinrotator

PiM1→ MuH2

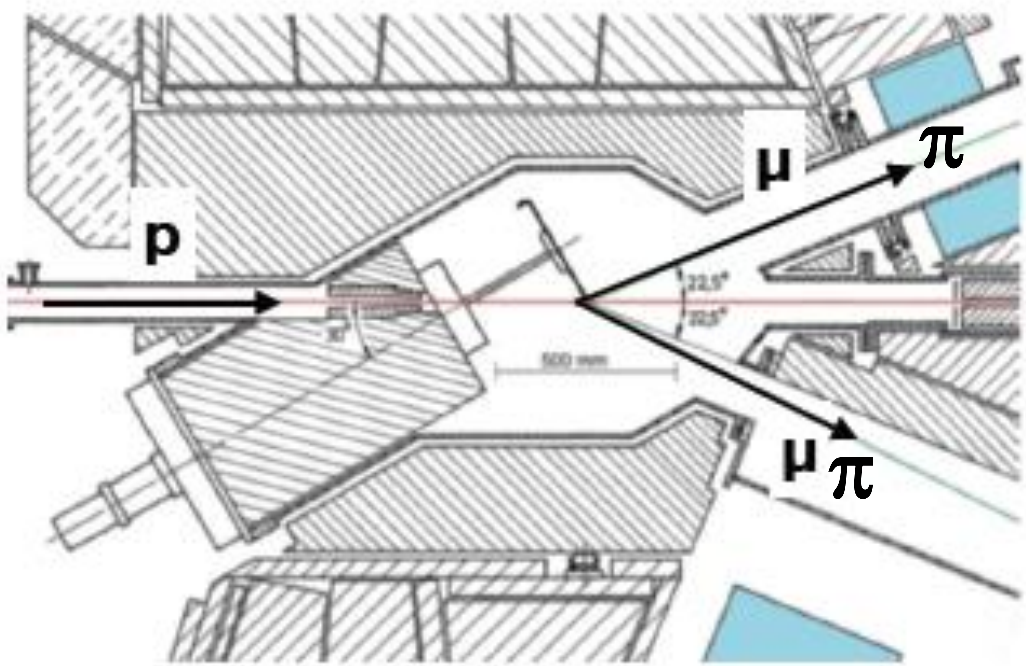
Particle physics:
Physics beyond the standard model

590 MeV
Ring cyclotron

Life science:
Radioisotopes for
clinical studies
in cancer therapy

Both secondary beamlines are optimized for
low energy «surface» muons (~28MeV/c)

Present TgM station (built 1985)



PiM1

particle physics

PiM3

μSR (GPS, FLAME)

$10^7\ \mu^+/s$

nowadays surface muons needed

Beamlines under 22.5°

→ optimized for high-momentum π > 100 MeV/c,

@ 350 MeV/c: π+: $2x10^8$ /(s mA)

Target: graphite

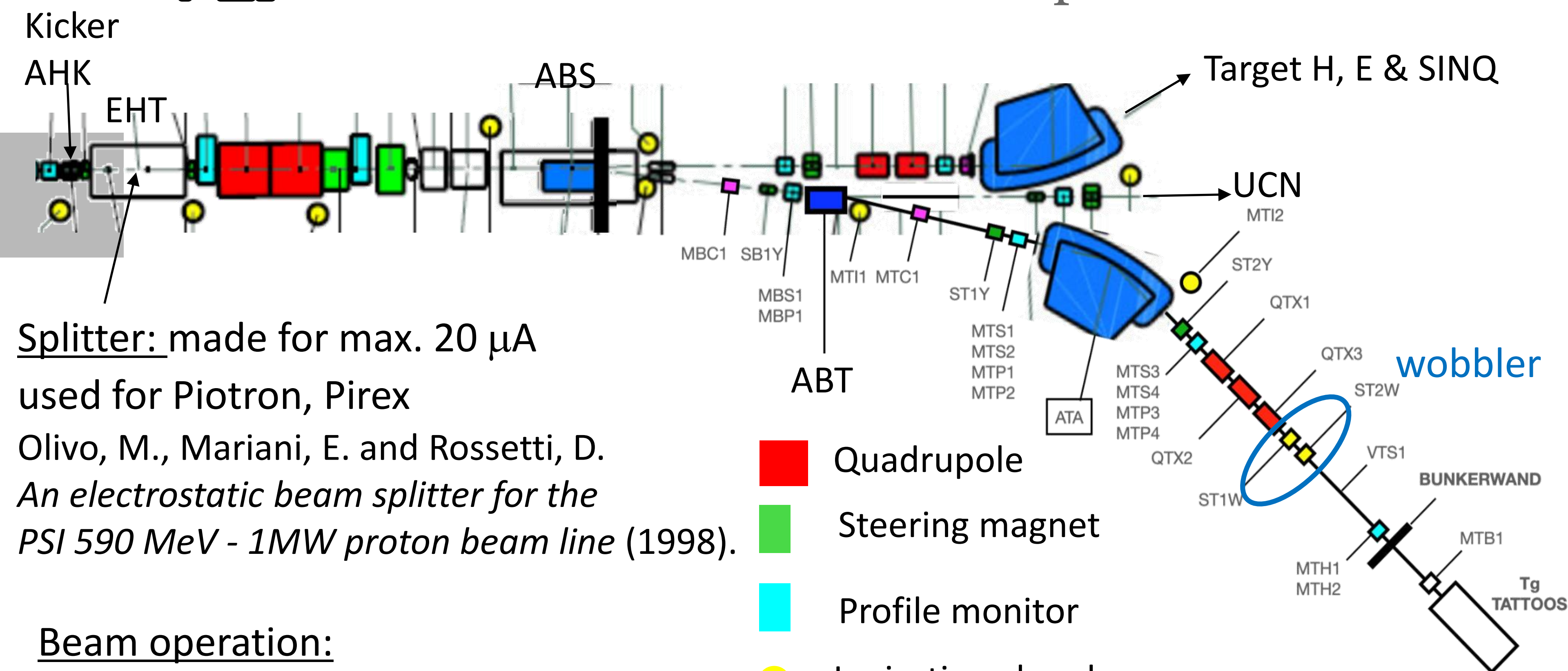
2 mm thick rim

→ effective 5 mm (due to angle),

cooled by thermal conduction

no problems with bearings, since well shielded!

Beamline to TATTOOS and operation modes



Splitter: made for max. 20 μA

used for Piotron, Pirex

Olivo, M., Mariani, E. and Rossetti, D.
An electrostatic beam splitter for the PSI 590 MeV - 1MW proton beam line (1998).

- Quadrupole
- Steering magnet
- Profile monitor
- Ionization chamber

TATTOOS Target:
10 cm Ta (Phase 1),
later U or Th

Beam operation:

- mode 1: SINQ & TATTOOS
  → 100 μA split from main beam to TATTOOS (ABT on -)
- mode 2: UCN
  full beam (~ 2 mA) swept to UCN by fast kicker magnet (ABT on +)

Quasi-parallel beam operation, i.e. no beam to TATTOOS, if pulse to UCN
→ ~ 15 % beam time loss for TATTOOS (acceptable)

HIMB: High Intensity Muon Beams

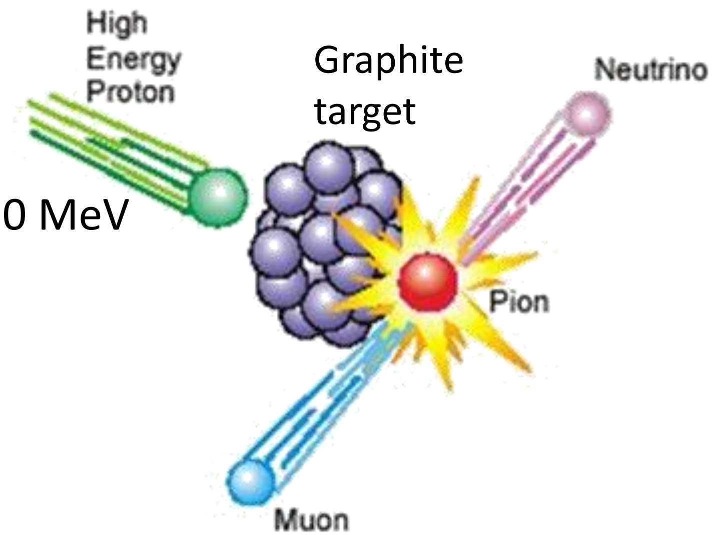
Particle & material physics (μSR)

Surface muons (~ 28 MeV/c) rates of 10^{10}/s for

- Increasing the sensitivity for the detection of rare/forbidden muon decay
  → Physics beyond the standard model
- Study of magnetic properties below surface with more sensitivity

Production of muons:

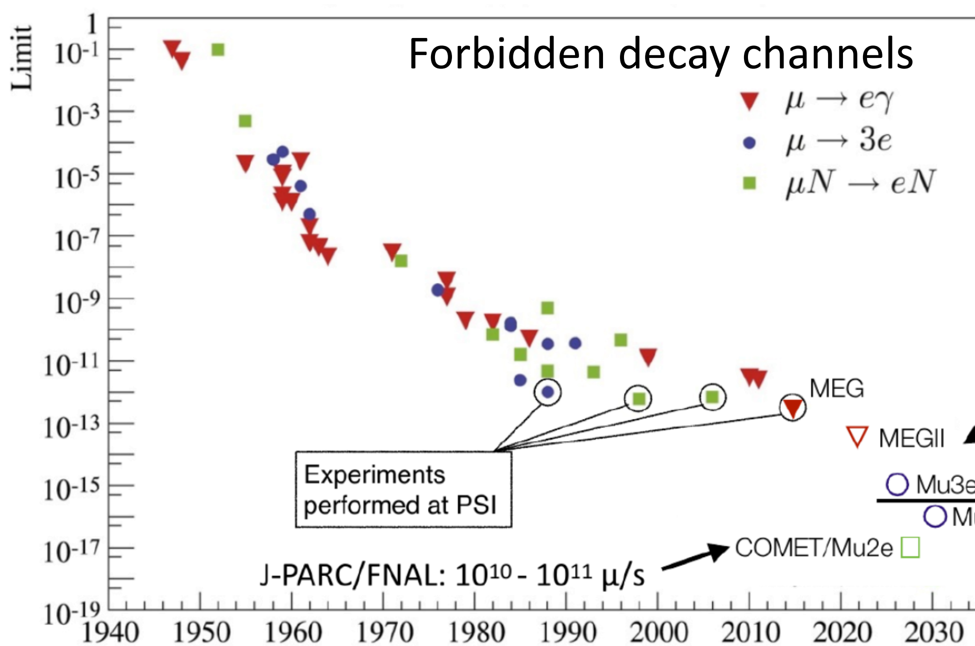
590 MeV



28 – 120 MeV/c

Keep the competiveness for future experiments & attractiveness for users

→ HIMB



in piE5: ~10^8 μ/s

>10^9 μ/s needed

[Plot courtesy of A.Papa/A.Knecht] A. Signer

TATTOOS: Targeted Alpha Tumour Therapy and Other Oncological Solutions

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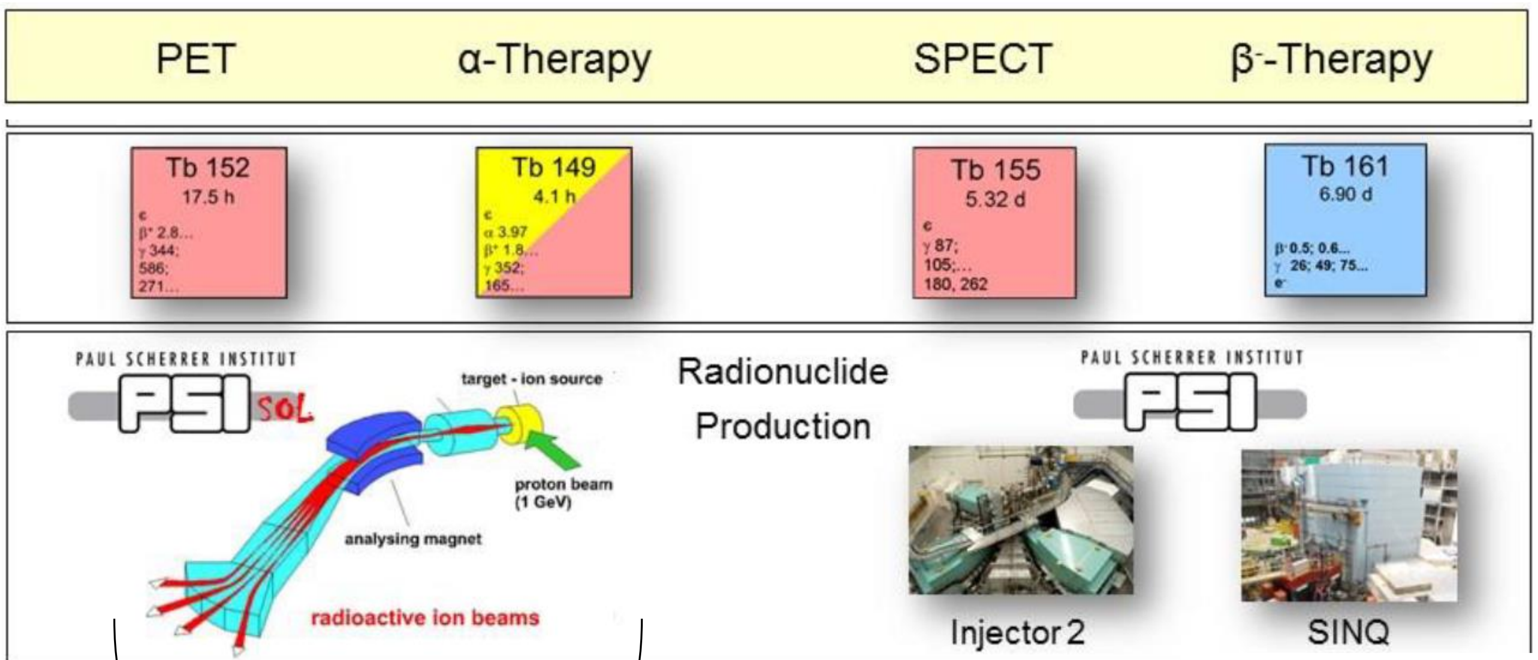
Life science:

Producing enough radioisotopes with 590 MeV p (100 μA)

- for cancer treatment & diagnostics (theranostics) in quantities needed for clinical studies on human beings
- research only, no commercial production planned.

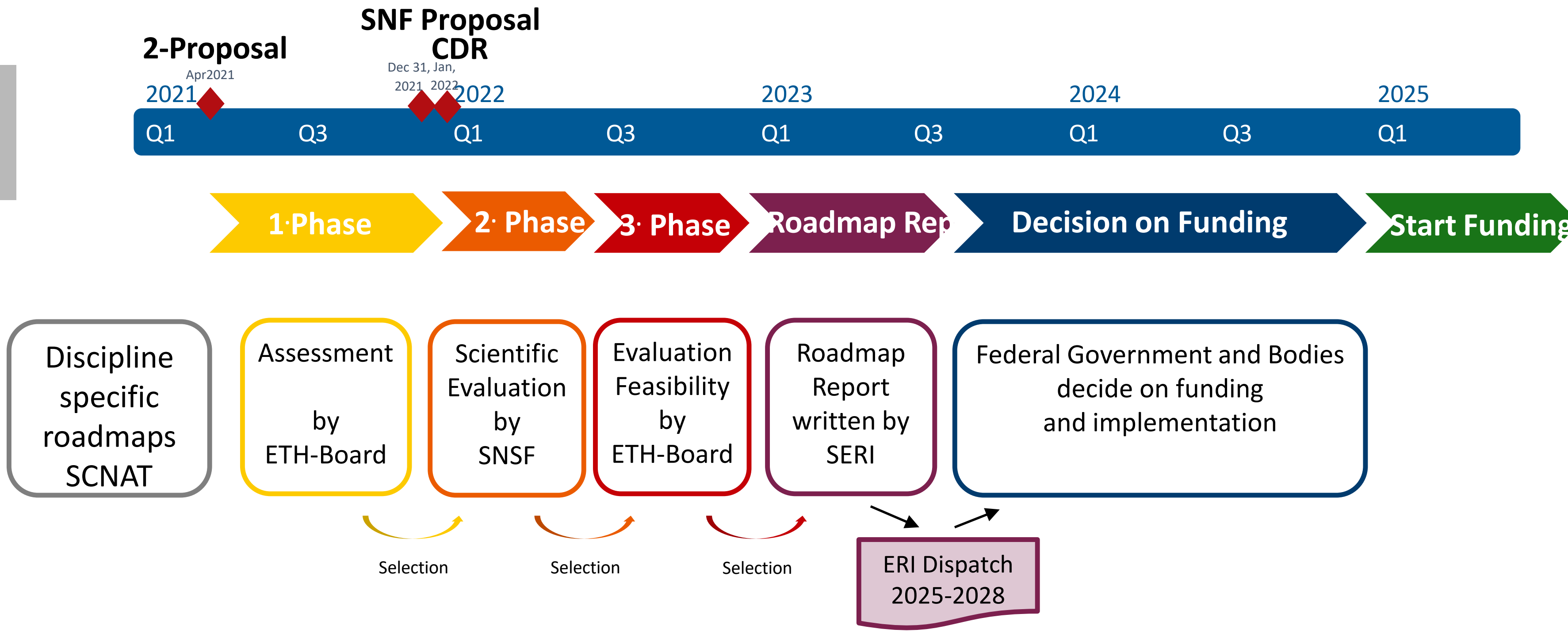


TATTOOS
590 MeV protons on Ta

IP2 (72 MeV)
^{155}Gd target

$^{160}Gd(n,\gamma)^{161}Gd \rightarrow {}^{161}Tb$

Funding Procedure: Swiss Roadmap for RI’s



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What is IMPACT? → IMPACT = HIMB + TATTOOS

Isotope and Muon Production with advanced cyclotron and target technology

Particle & Material physics (μSR)

HIMB: High Intensity Muon Beams

Surface muons (~ 28 MeV/c) rates increase by a factor 100 ($10^{10}\mu$/s) for

- Increasing the sensitivity for the detection of rare muon decay
- Study of magnetic properties within shorter times and over a broader range

Keep the competiveness for future experiments

→ talk by Andreas Knecht

Life science:

TATTOOS: Targeted Alpha Tumour Therapy and Other Oncological Solutions

Producing radioisotopes with 590 MeV p (100 μA)

- for cancer treatment & diagnostics in quantities needed for clinical studies at human beings
- just research, no commercial production.

→ talk by Robert Eichler

Wesentliche Unterschiede zu SLS2 oder SwissFEL

- sehr viele Prototypen geringer Stückzahl
  → starker konstruktueller Aufwand
  → besondere Herausforderung ist die starke Strahlenbelastung
  → benötigt Erfahrung, teils nicht mehr vorhanden

- sehr viele Randbedingungen durch bestehende Anlage

- sehr alte Anlage → grosser Erneuerungsbedarf

- Abbau von hoch aktiviertem Material
  → Abbau Manipulator unterstützt
  → dauert sehr lange
  → eventuell Zwei-Schichtbetrieb notwendig

- benötigt sehr viel Abschirmmaterial (Stahl)
  → starke Abbhängigkeit von Rohstoffpreisen