Particle Physics at PSI

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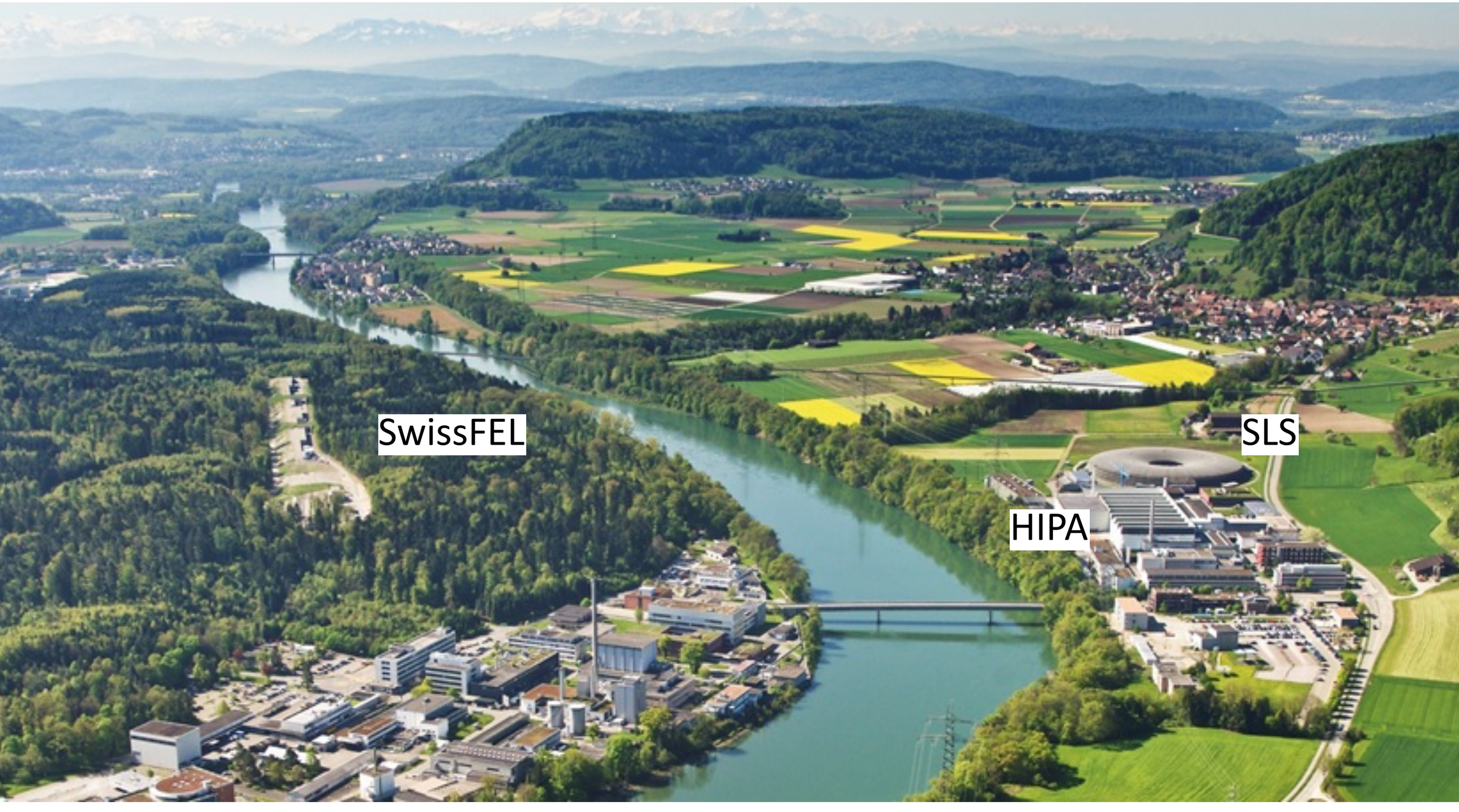
CHIPP Plenary 2021
11. 6. 2021

Large-scale facilities at PSI



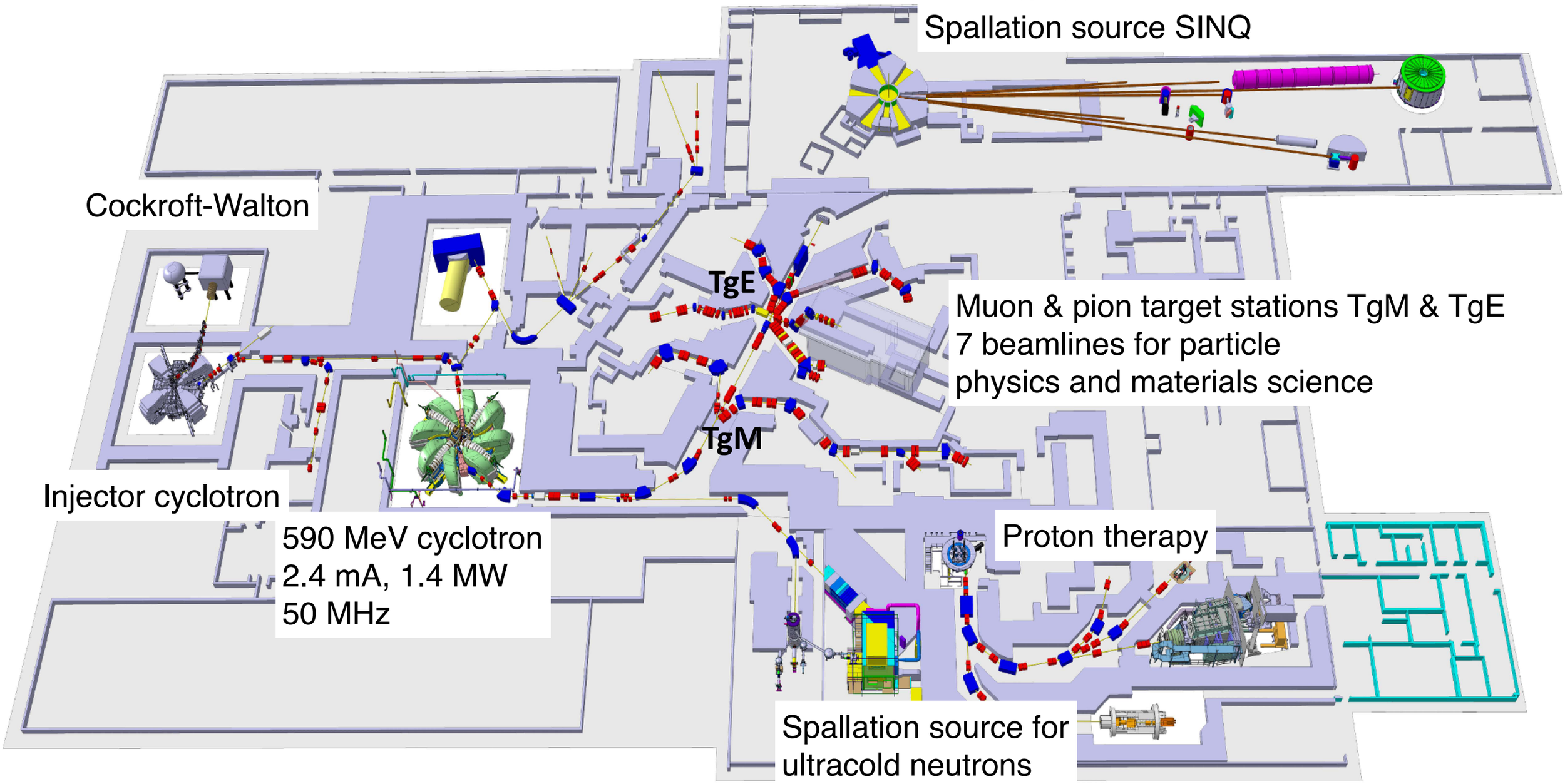
HIPA accelerator: Driving the in-house particle physics

Ring cyclotron at PSI

590 MeV energy with 1.4 MW beam power

→ Most powerful accelerator in the world

PSI Proton Accelerator HIPA



PSI Laboratory for Particle Physics

LTP-Groups

- **Theory**
- **High Energy Physics**
- **Muon Physics**
- **Ultracold Neutron Physics**
- **Electronics for Measuring Systems**
- **Detectors, Irradiations and Applied Particle Physics**

Academic links to universities:

Professorships at ETHZ, UZH, Pisa and more teaching activities

Discovery Physics at high and low energies

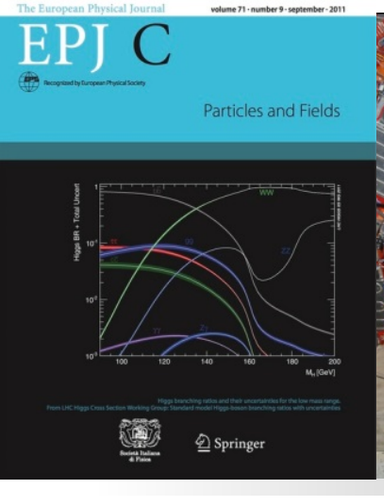
- **At PSI:**
  Precision measurements (MuLan, CREMA, MuCap, MuSun, MUSE ..) **and searches for new physics** (MEG II, Mu3e, n2EDM, ...)
- **At LHC:**
  Participation and key contributions to CMS (Si-pixel R&D and data analysis, e.g. B-μμ, H-cc)
- **Particle phenomenology**

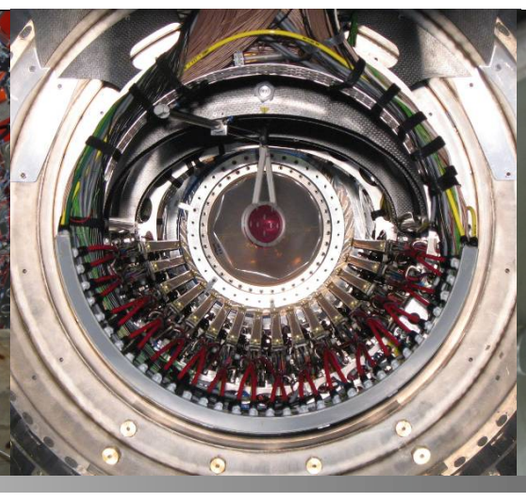
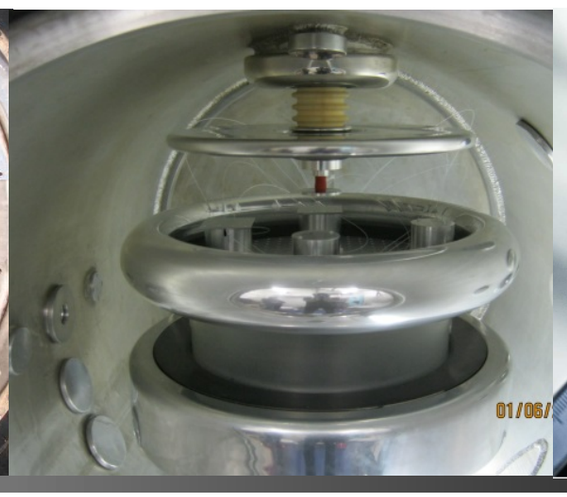
Collaborations with

- **all Swiss universities**
- **many universities and institutions world-wide**

Outreach and Spin-off

- **Detectors (pixel, gas and scintillation) for particle physics; n, μSR, x-rays**
- **Chip design, electronics and software for PSI and world-wide, e.g. DRS-4, elog, Midas, ...**
- **Irradiation using p, π, μ, e**
- **Zuoz schools (2022: 25th!)**
- **PSI20xy workshop: PSI2022**




PSI Laboratory for Particle Physics

- Personnel, approximate numbers, head count
  (independent of funding source and degree of employment):

  - 24 Scientists (Profs., Senior Scientists, TT-Scientists)
  - 18 Engineers/Technicians/Admin
  - 10 Postdocs
  - 20 PhD students
  - 2 Instructors & 16 Electronics apprentices

Particle physics with muons and UCN at PSI

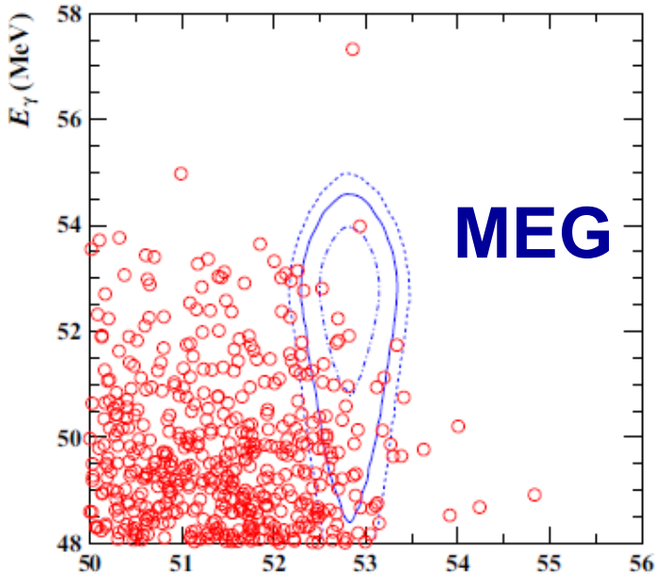
PAUL SCHERRER INSTITUT PSI

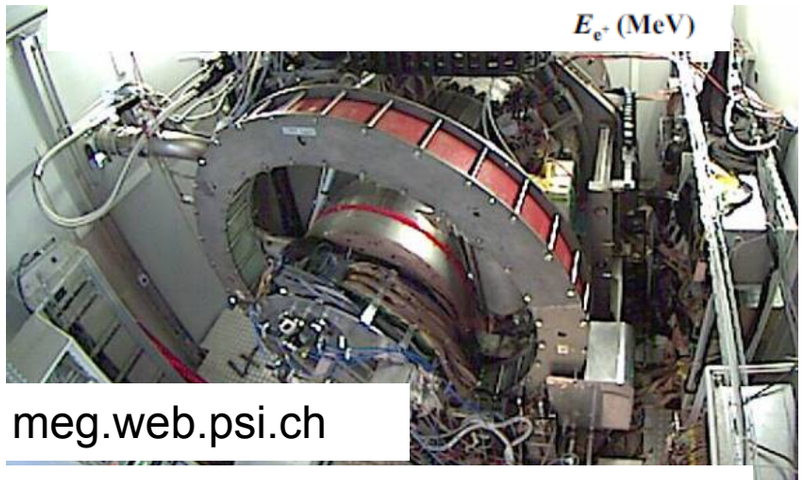
Search for
charged lepton flavor violation

The best limit on any rare decay:

The **branching ratio $\mu \to e\gamma$** is

less than 4.2×10^{-13} (90%CL)





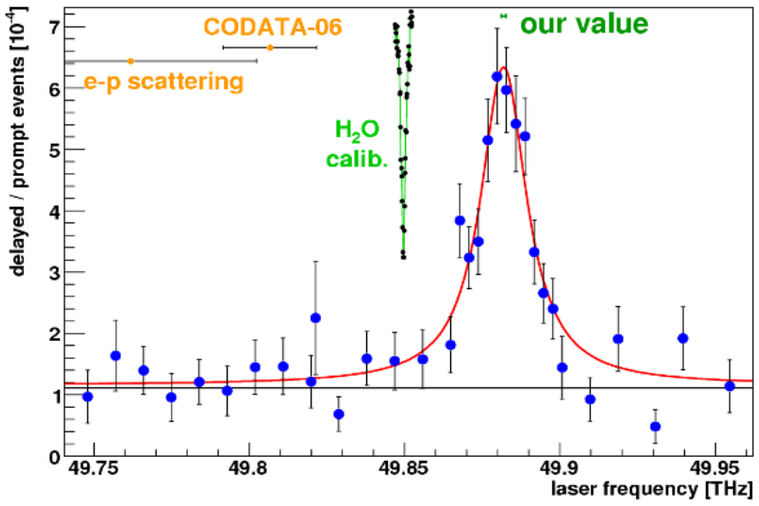
meg.web.psi.ch

EPJC76(2016)108, EPJC76(2016)434, EPJC80(2020)858

Next: MEG II, Mu3e

Laser spectroscopy
of light muonic atoms

The most precise determination of **charge radii** of proton, deuteron, ^{3,4}He from the muonic 2S-2P Lambshift



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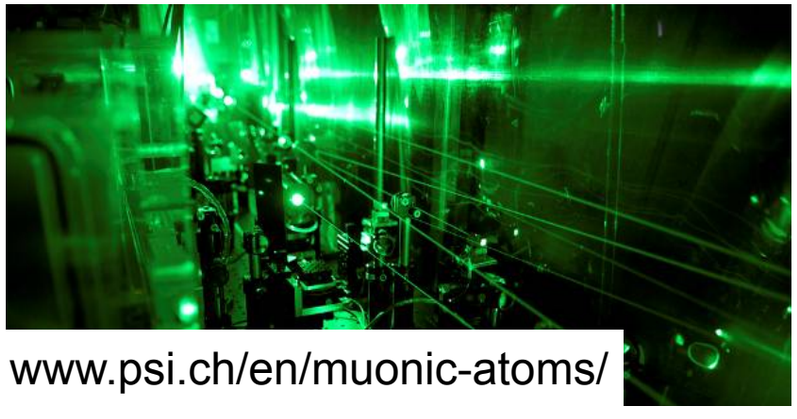


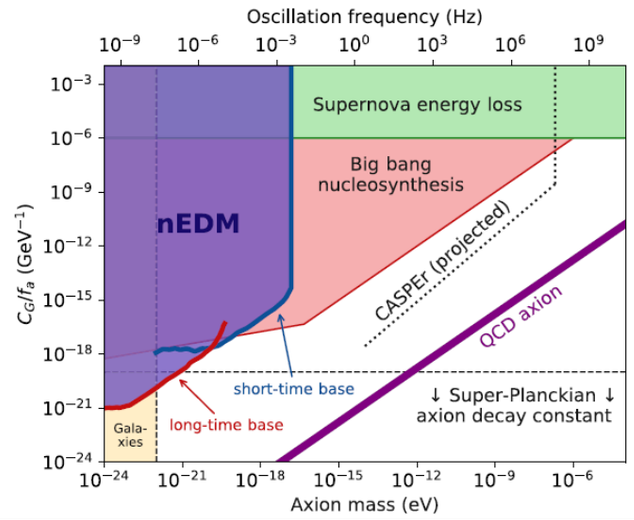
www.psi.ch/en/muonic-atoms/

Nature 466(2010)213, Science 339(2013)417, Science 353(2016)669, Nature589(2021)527

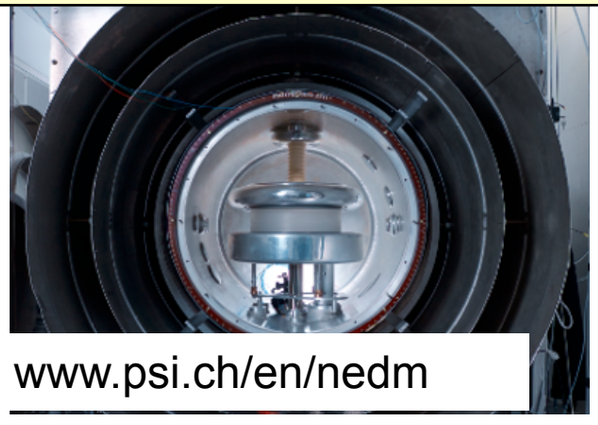
Next: HyperMu

Search for
time reversal and CP violation

The most stringent limits on a permanent **neutron electric dipole moment** and various candidate particles of dark matter



$d_n < 1.8 \times 10^{-26}$ e cm (90%CL)



www.psi.ch/en/nedm

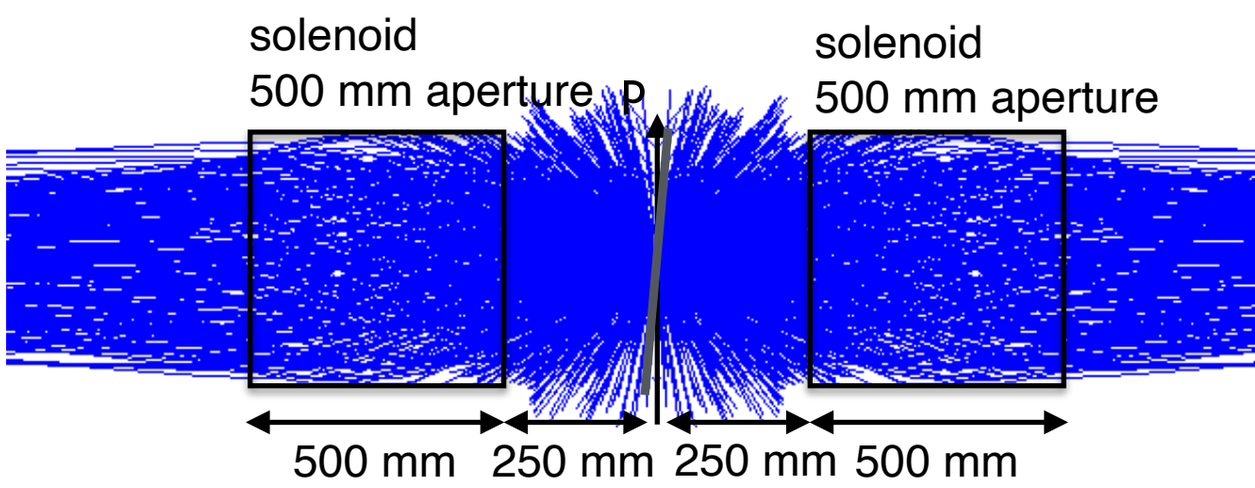
PRX7(2017)041034, PRL124(2020)081803, PLB812(2021)135993

Next: n2EDM

Future of muons at PSI: HIMB

HIMB Project:

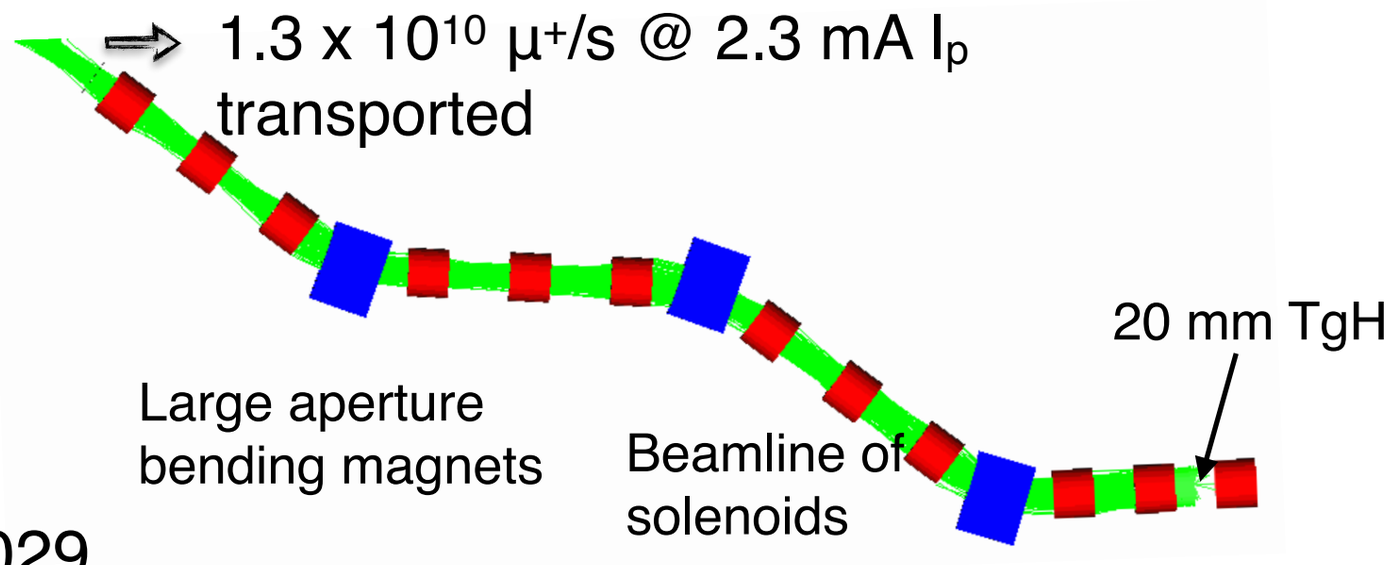
- Construction of new target station TgH at the place of the existing TgM
- Construction of two new solenoid-based beamlines for μSR and particle physics delivering 10^{10} surface muons per second



Science case:

- Improved measurements of Mu3e, MEG
- Precision measurements with muonium
- High-brightness muon beams with muCool
- Muon EDM, muon g-2
- High-rate μSR measurements
- μSR measurements at extreme pressures
- …

⇒ 1.3 x 10^{10} μ^+/s @ 2.3 mA I_p transported



⇨ Expected start of operation in 2029