

The Role of Accelerators in Universities

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THE GUTENBERG SPIRIT:
Moving Minds –
Crossing Boundaries

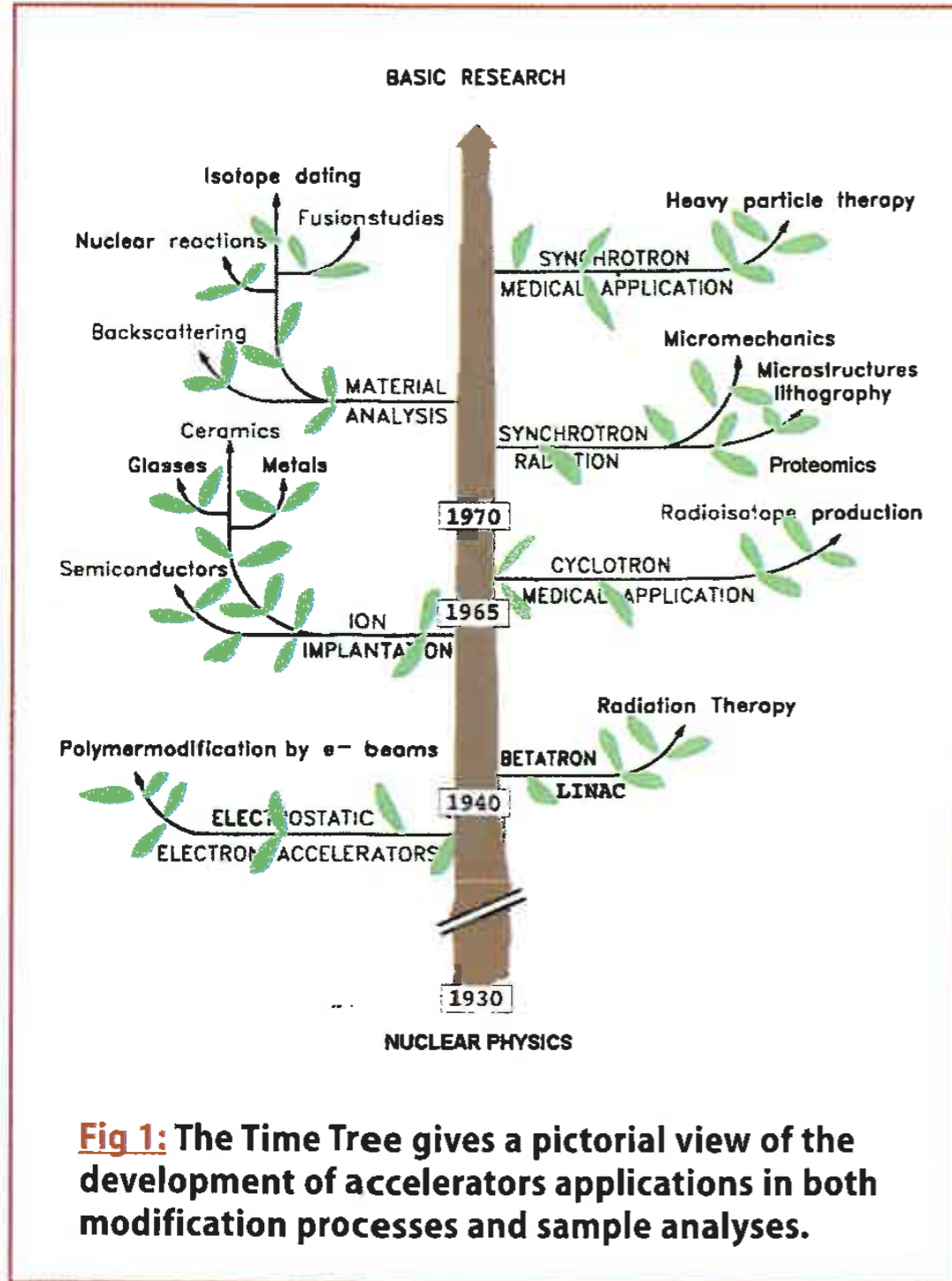
“Ut omnes unum sint”



THE LOW-ENERGY FRONTIER
OF THE STANDARD MODEL

Accelerators are Ubiquitous but unsung

Ugo Amaldi, University of Milano Bicocca and TERA Foundation, Italy



Accelerators serve:

👉 discovery science

👉 medicine, industry, energy, environment, national security

...

Accelerators are Ubiquitous but unsung

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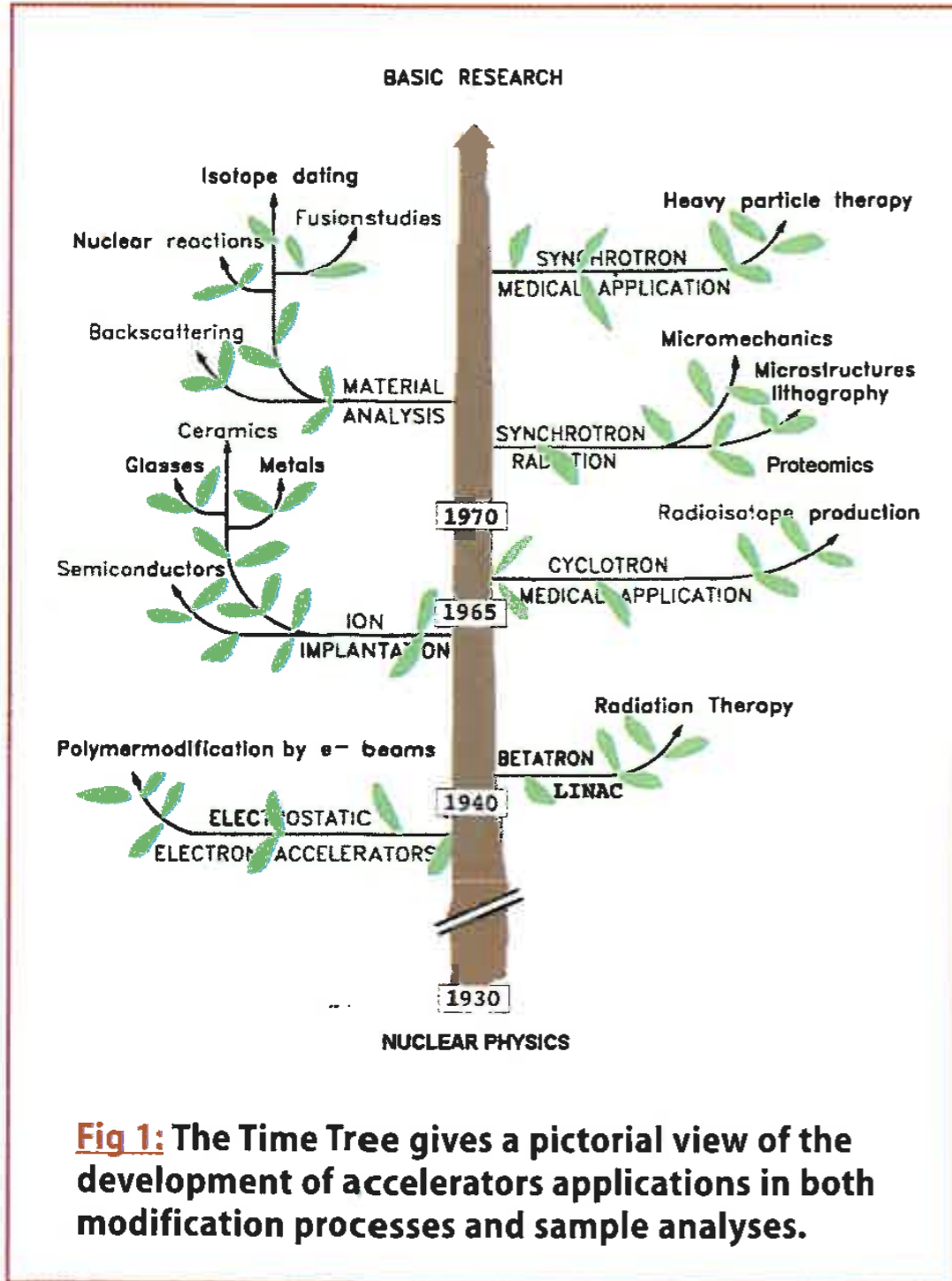
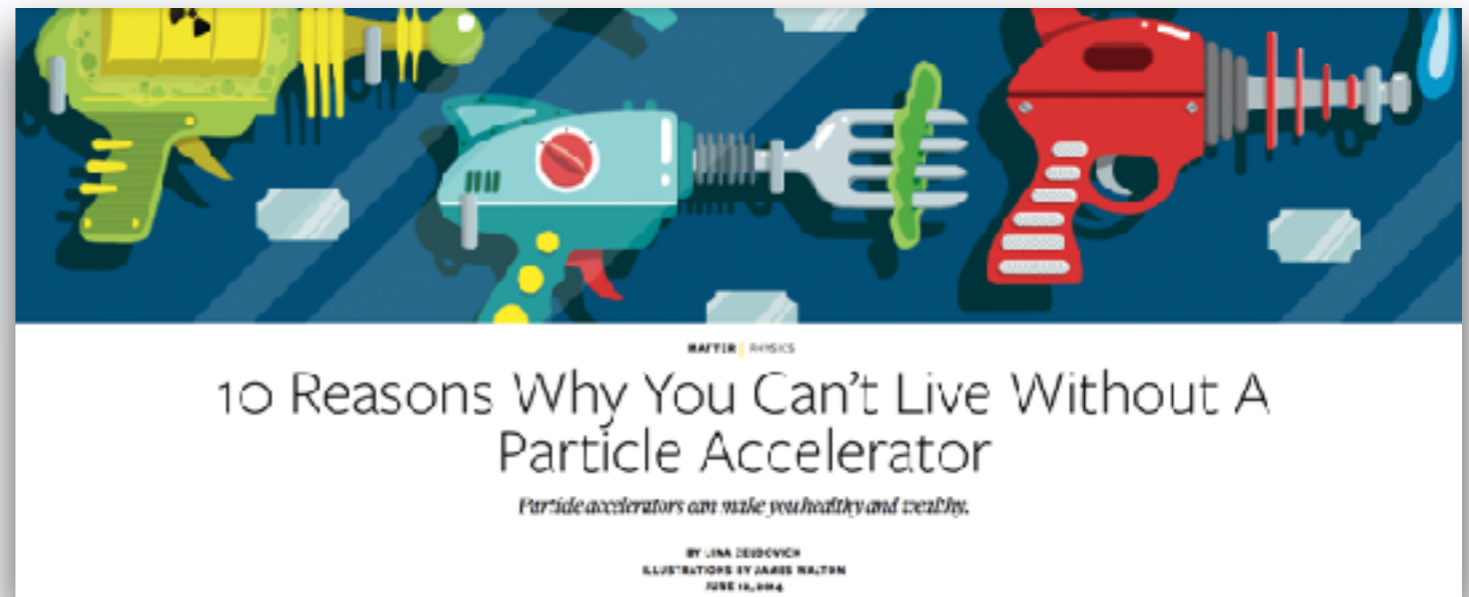


Fig 1: The Time Tree gives a pictorial view of the development of accelerators applications in both modification processes and sample analyses.

Accelerators serve:

- 👉 discovery science
- 👉 medicine, industry, energy, environment, national security
- ...

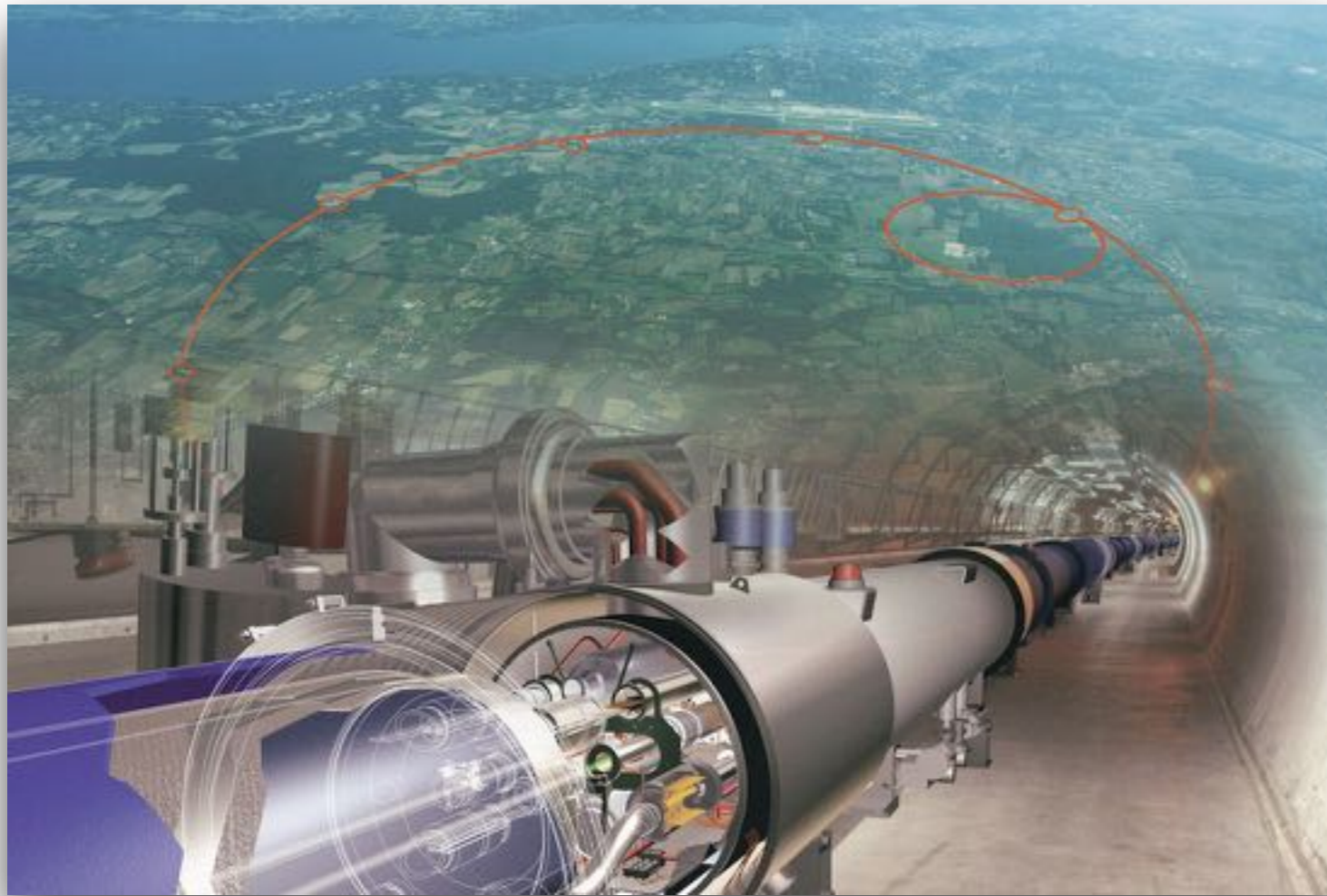


Accelerators are Ubiquitous but **unsung**

More than **30,000** particle accelerators in operation around the world

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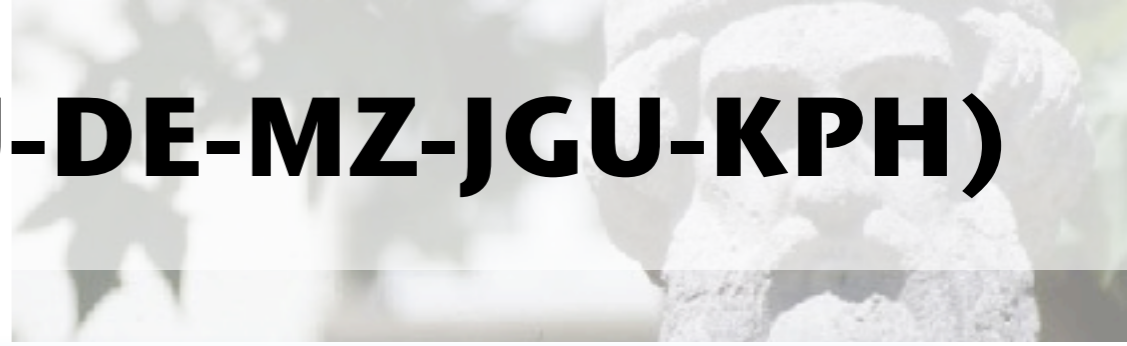


- Total budget (2016)
1127.2 million CHF
- Employed members 3197
- Associated members 13128

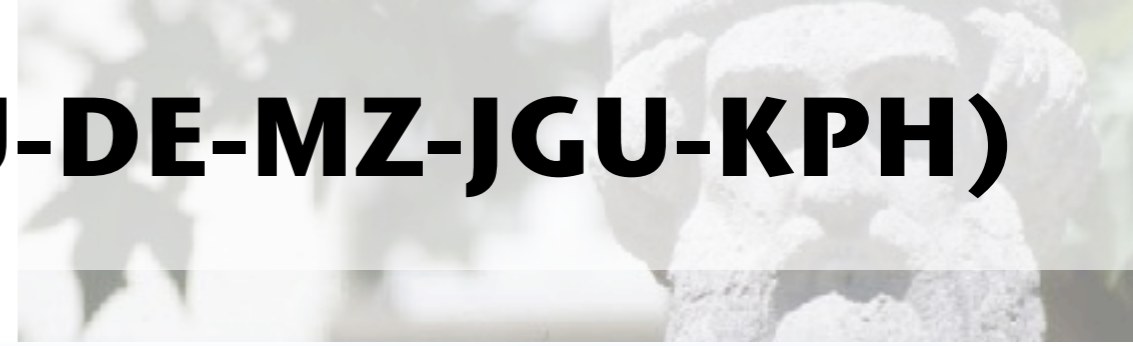
Mission:

“Seeking and finding answers to questions about the universe”

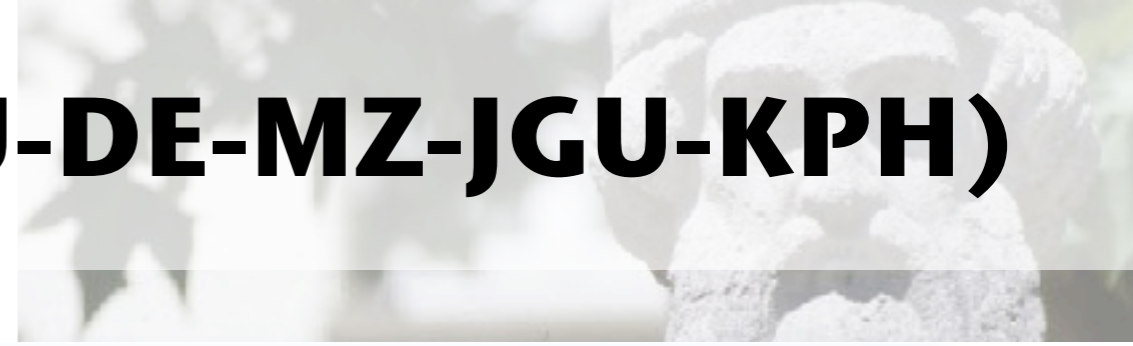
MUCH smaller ... (EU-DE-MZ-JGU-KPH)



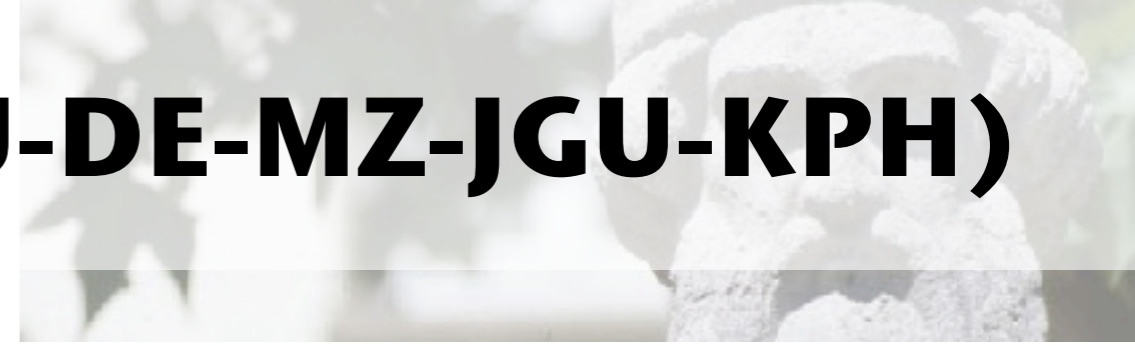
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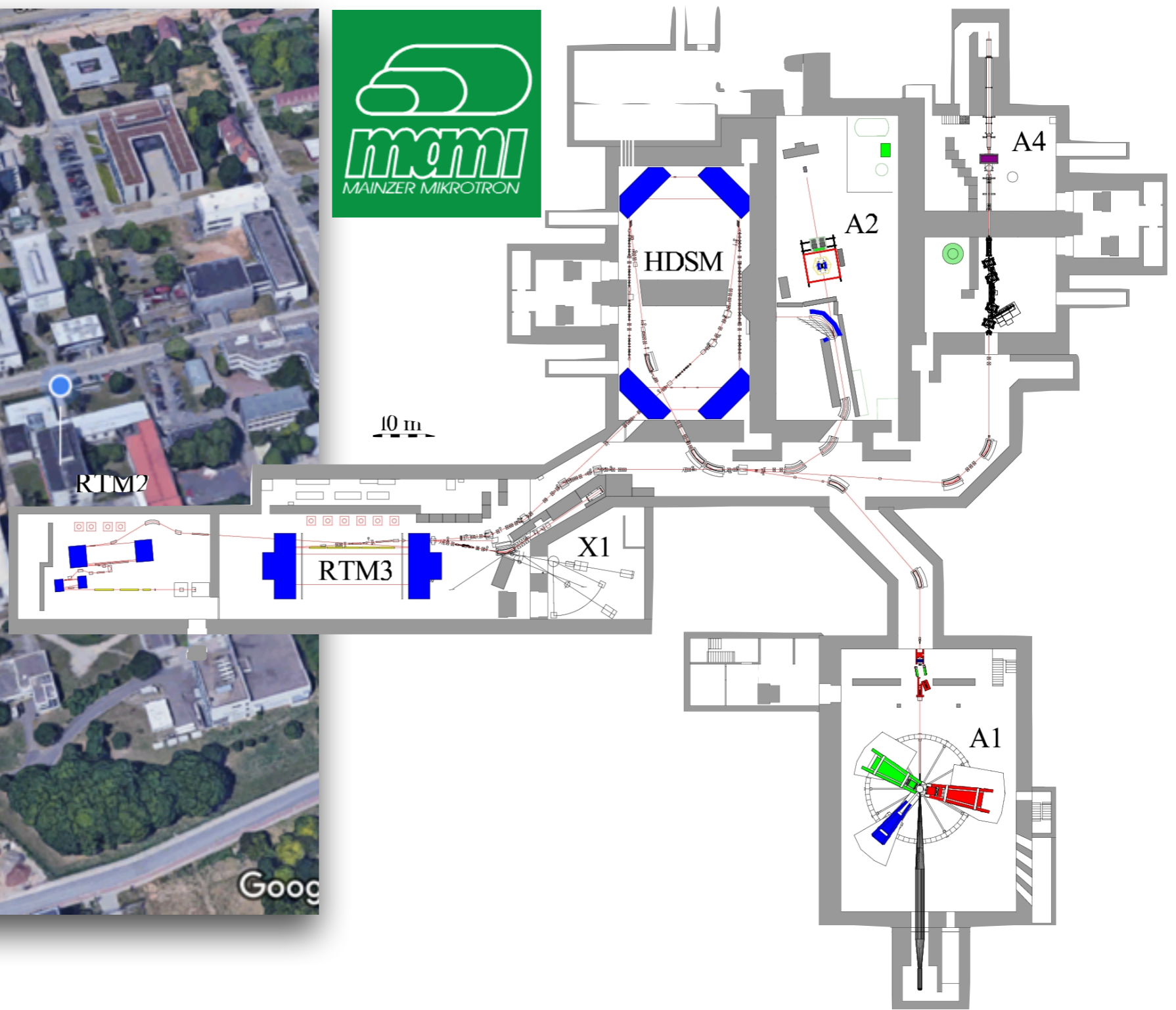
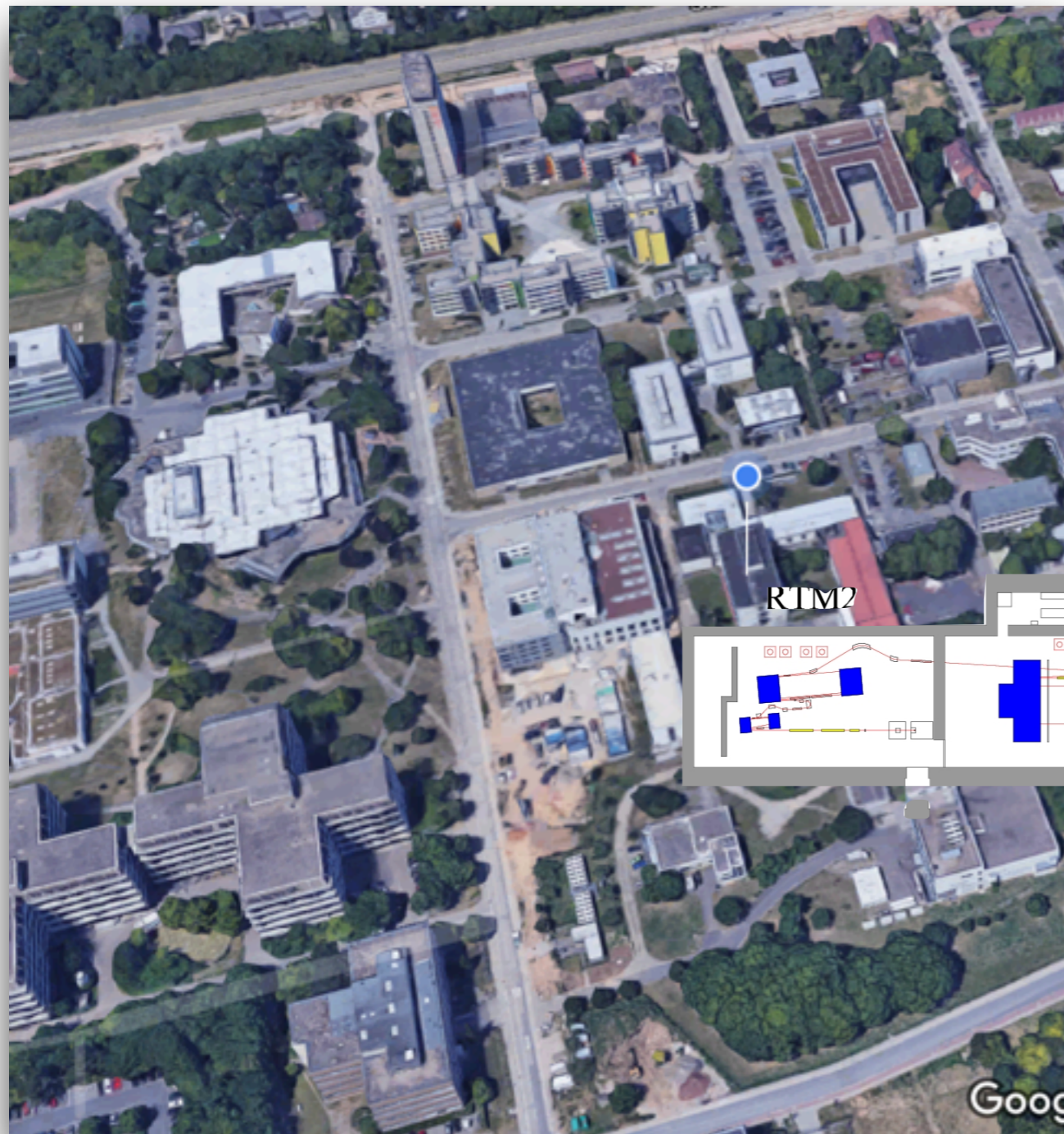
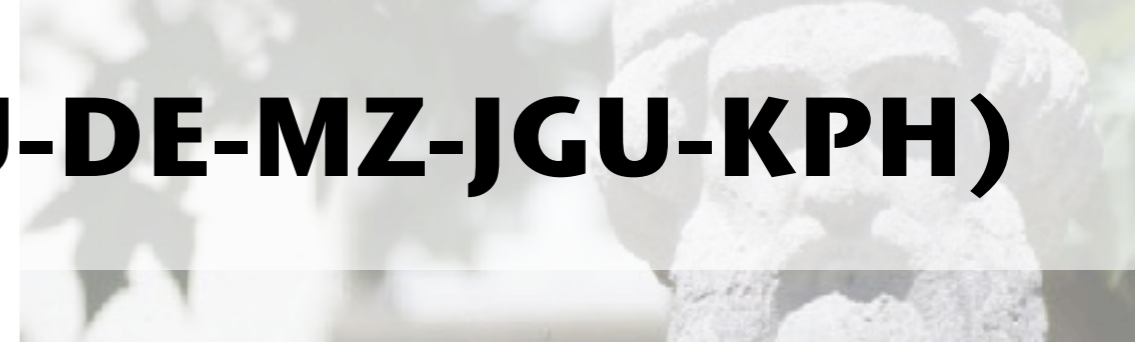
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The MAMI Legacy

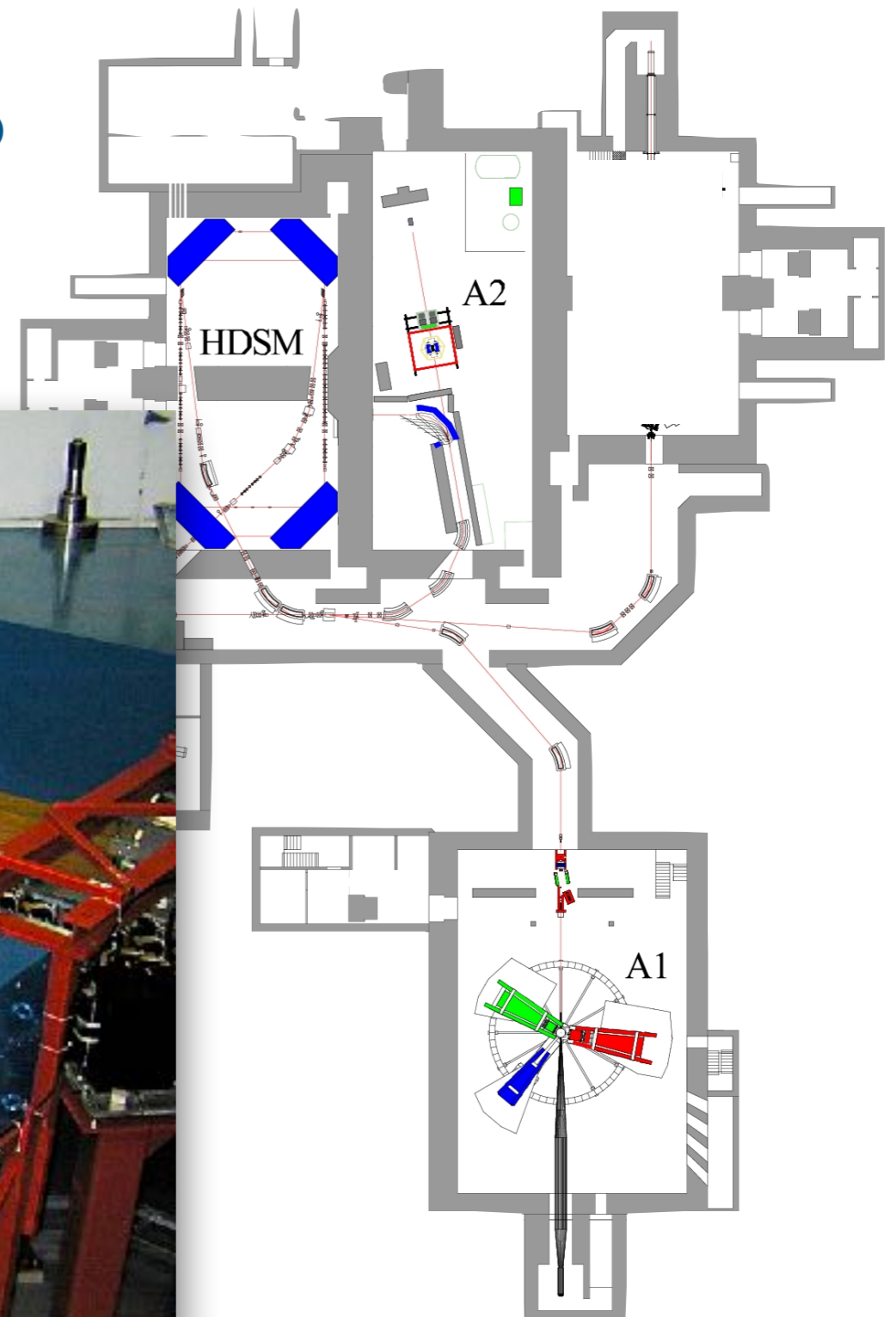
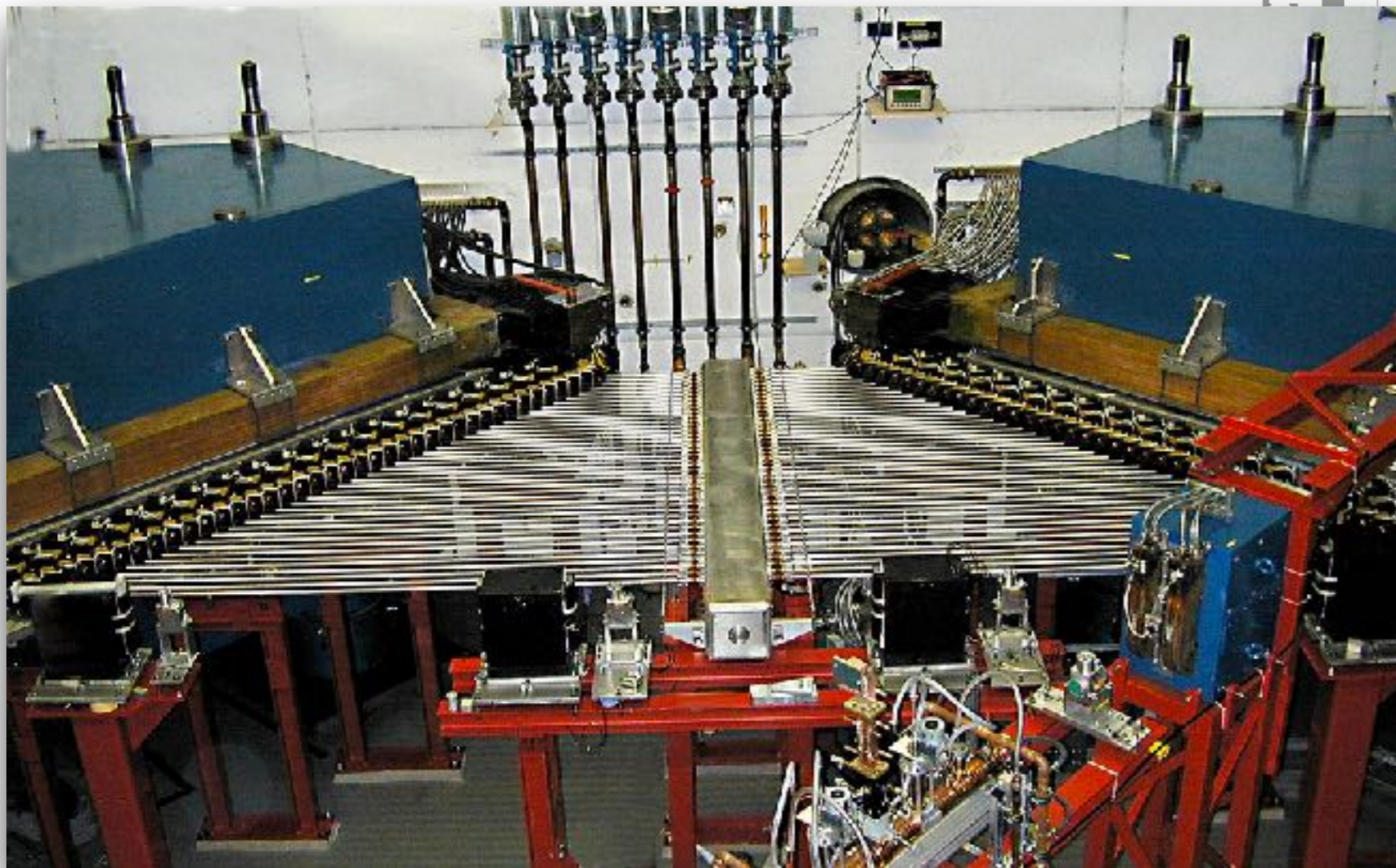


Upgrade to ...

MAMI-C

Harmonic Double Sided Microtron (2007)

up to $E = 1.6 \text{ GeV}$



The MAMI Legacy



Upgrade to ...

MAMI-C

Harmonic Double Sided Microtron (2007)

up to $E = 1.6 \text{ GeV}$

HIGH

Intensity

up to $100 \mu\text{A}$

Resolution

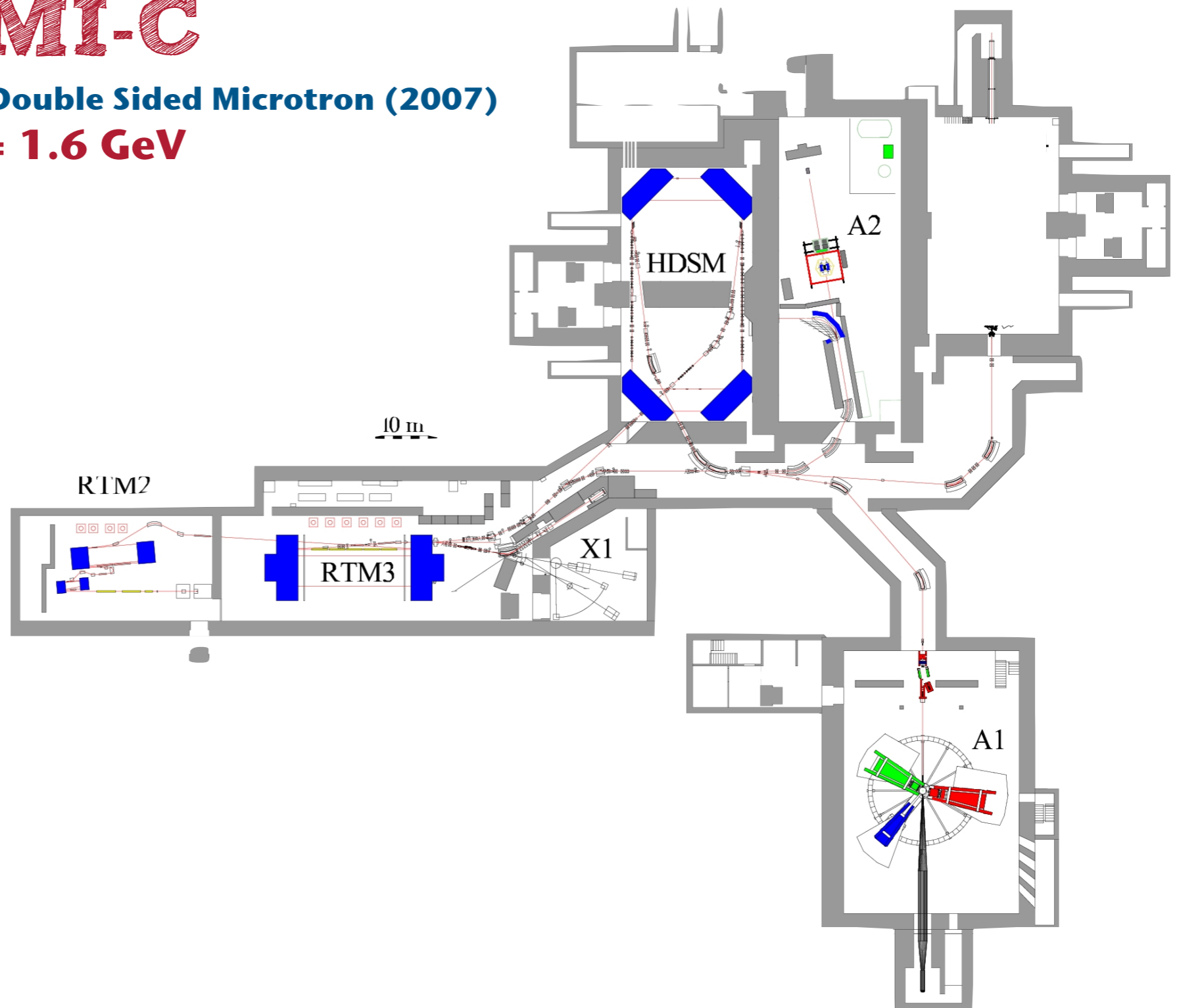
$\sigma_E < 0.100 \text{ MeV}$

Polarization

up to 80% @ $40 \mu\text{A}$

Reliability

85% (7000 h/y)



The MAMI Legacy



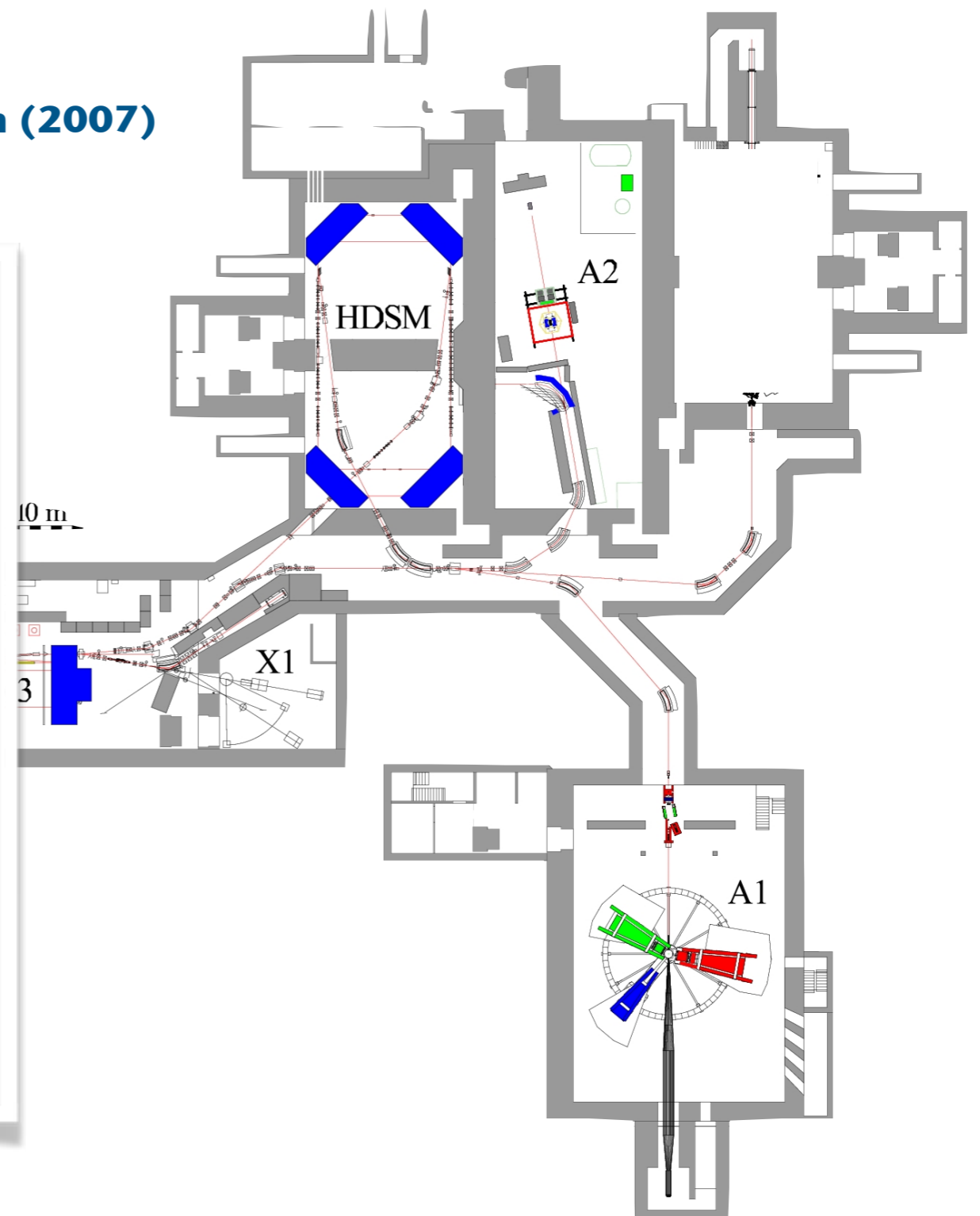
Upgrade to ...

MAMI-C

Harmonic Double Sided Microtron (2007)

up to $E = 1.6 \text{ GeV}$

Year	Activity
1975	Proposal for a Race-Track Microtron (design by H. Herminghaus <i>et al.</i>)
1979	14 MeV beam from MAMI A1
1982	Preliminary Sonderforschungsbereich (SFB) established
1983	183 MeV beam from MAMI A2
1983 - 87	MAMI A operation with a total of 18,700 h
1983 - 90	Development of the 855 MeV MAMI B
1984	SFB 201 established
1990	First 855 MeV beam from MAMI B (first experiment by A2 Collaboration)
1990 - 2005	MAMI B operation with a total of 82,843 h
1999	Sonderforschungsbereich 443 established
2000	Approval of 1.5 GeV HDSM (Harmonic Double-Sided Microtron, design by K.-H. Kaiser <i>et al.</i>)
2001 - 03	Installation of the four HDSM magnets
2006	Commissioning and begin of physics

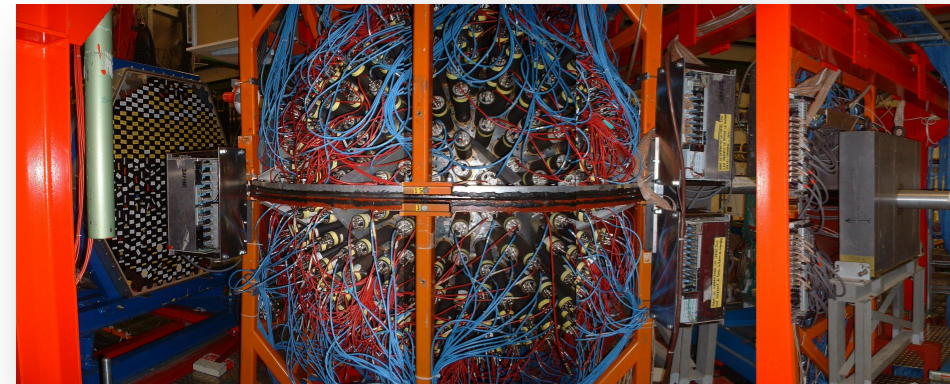


The Wheelers

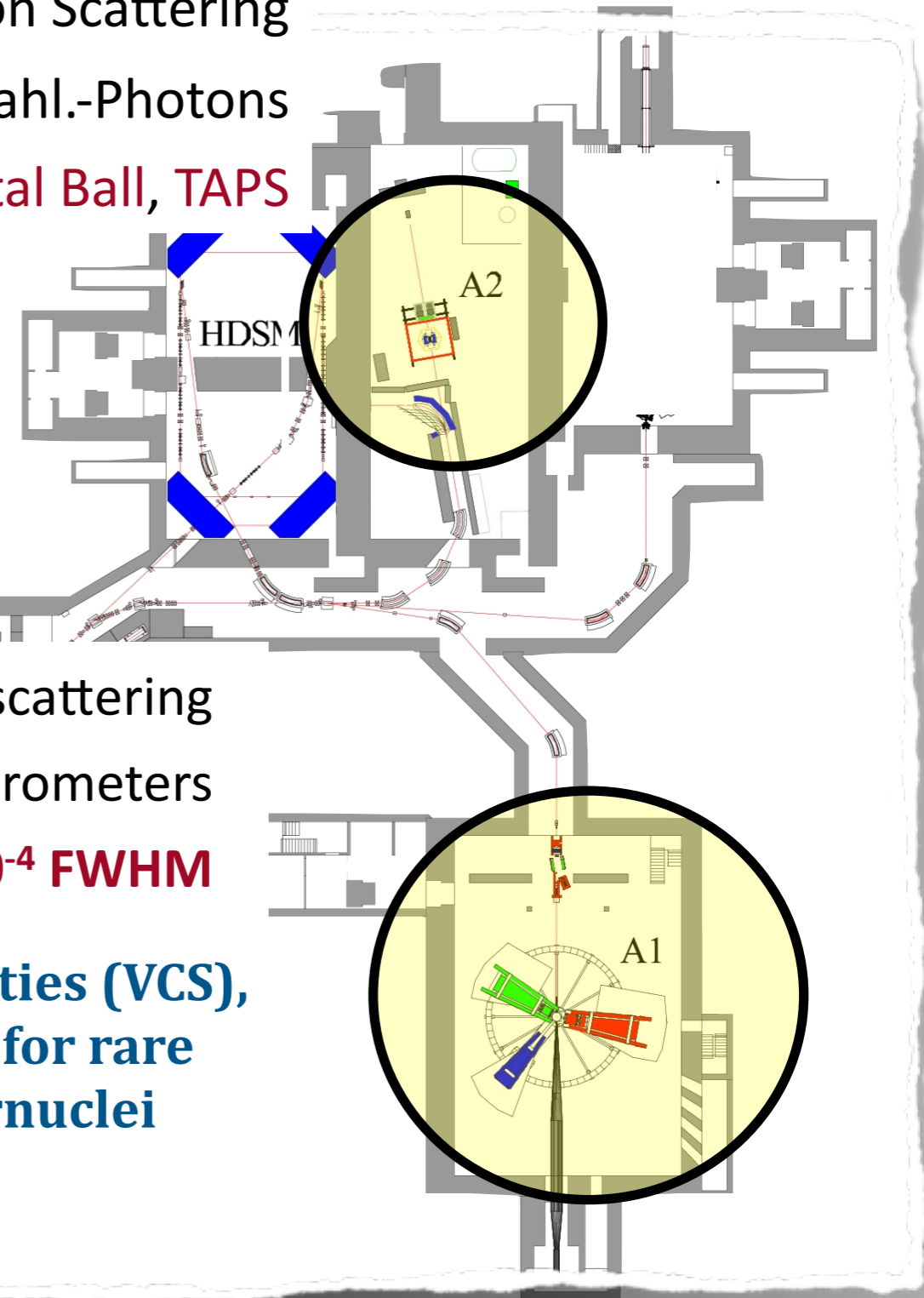
A2: Real Photon Scattering

✧ *Tagged* Bremsstrahl.-Photons

✧ 4π -Setup: Crystal Ball, TAPS



Polarizabilities (RCS), Low Energy Excitation of light hadrons, Neutron Skin, Light Mesons dynamics



RTM2

A1: Electron scattering

Three High Resolution Spectrometers

$\Delta p/p < 10^{-4}$ FWHM

Form Factors, Polarizabilities (VCS), Few-Body Physics, Search for rare events, EW Physics, Hypernuclei



The MAMI Legacy (A.D. 2010)



Upgrade to ...

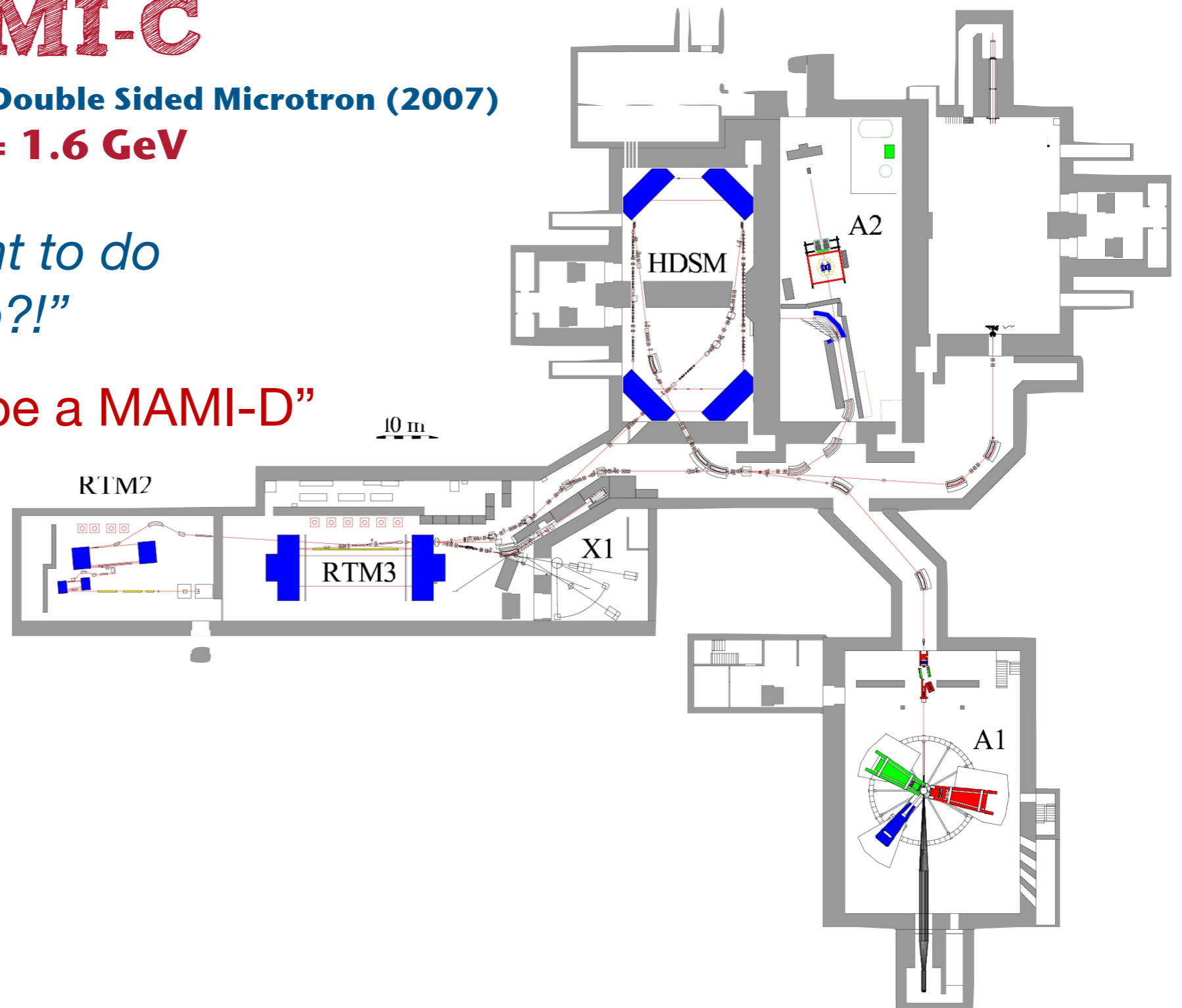
MAMI-C

Harmonic Double Sided Microtron (2007)

up to **E = 1.6 GeV**

“What do you want to do with this old scrap?!”

“There will never be a MAMI-D”



The MAMI Legacy (A.D. 2010)



Upgrade to ...

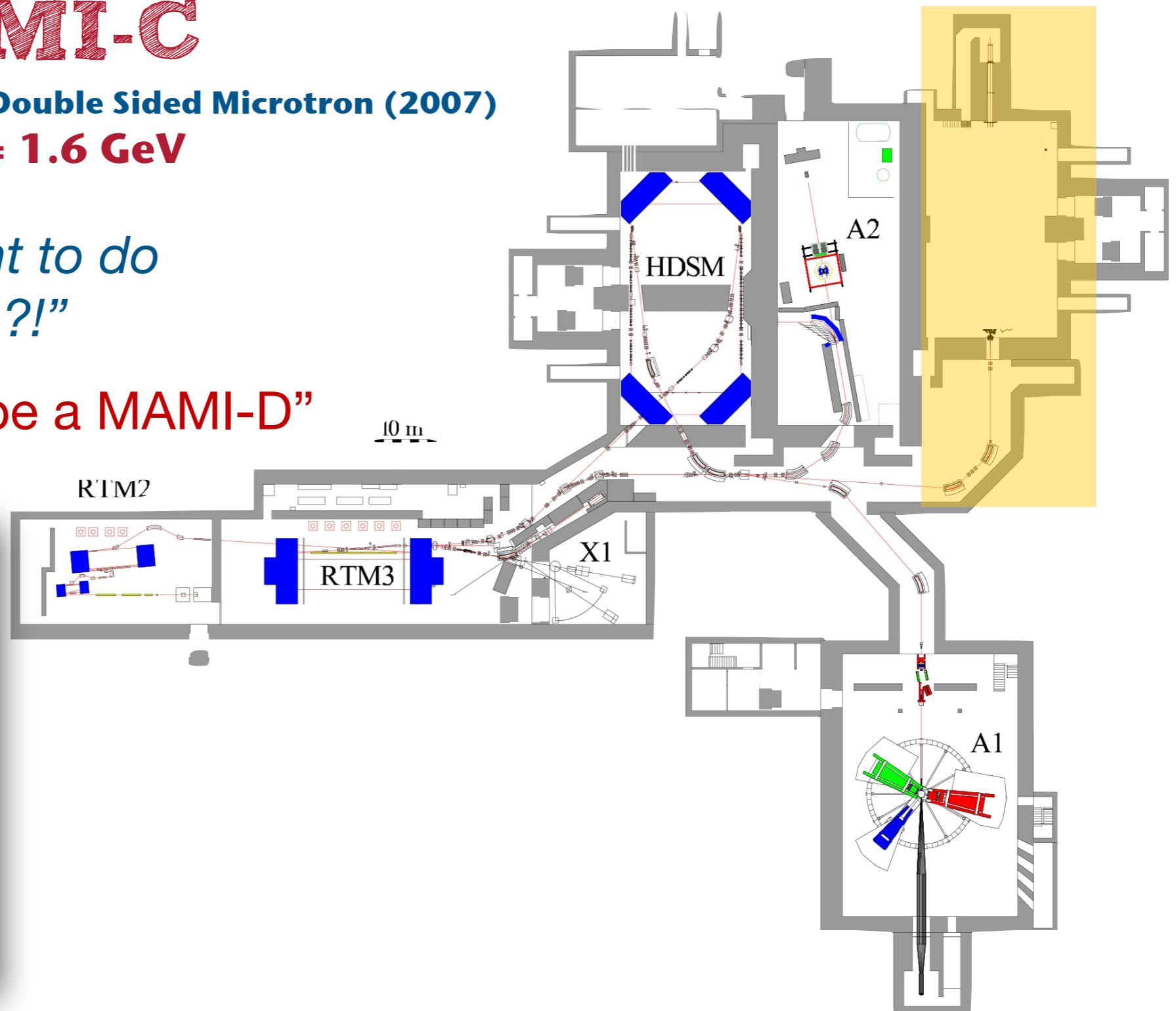
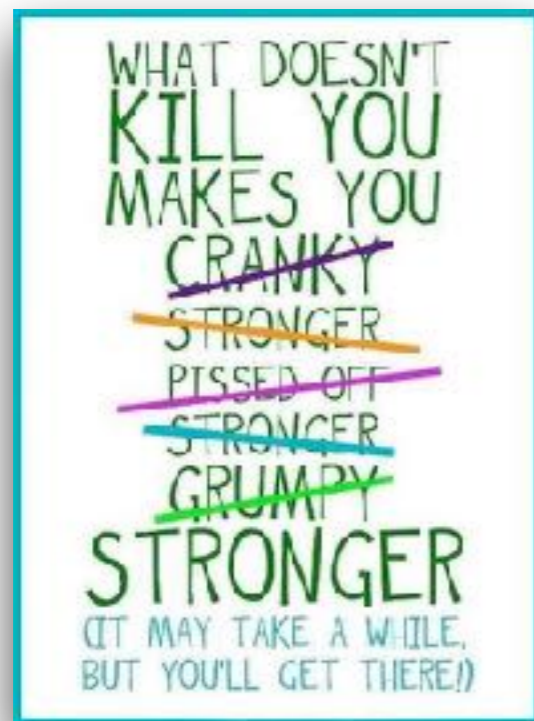
MAMI-C

Harmonic Double Sided Microtron (2007)

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The Mainz Energy recovery Superconducting Accelerator

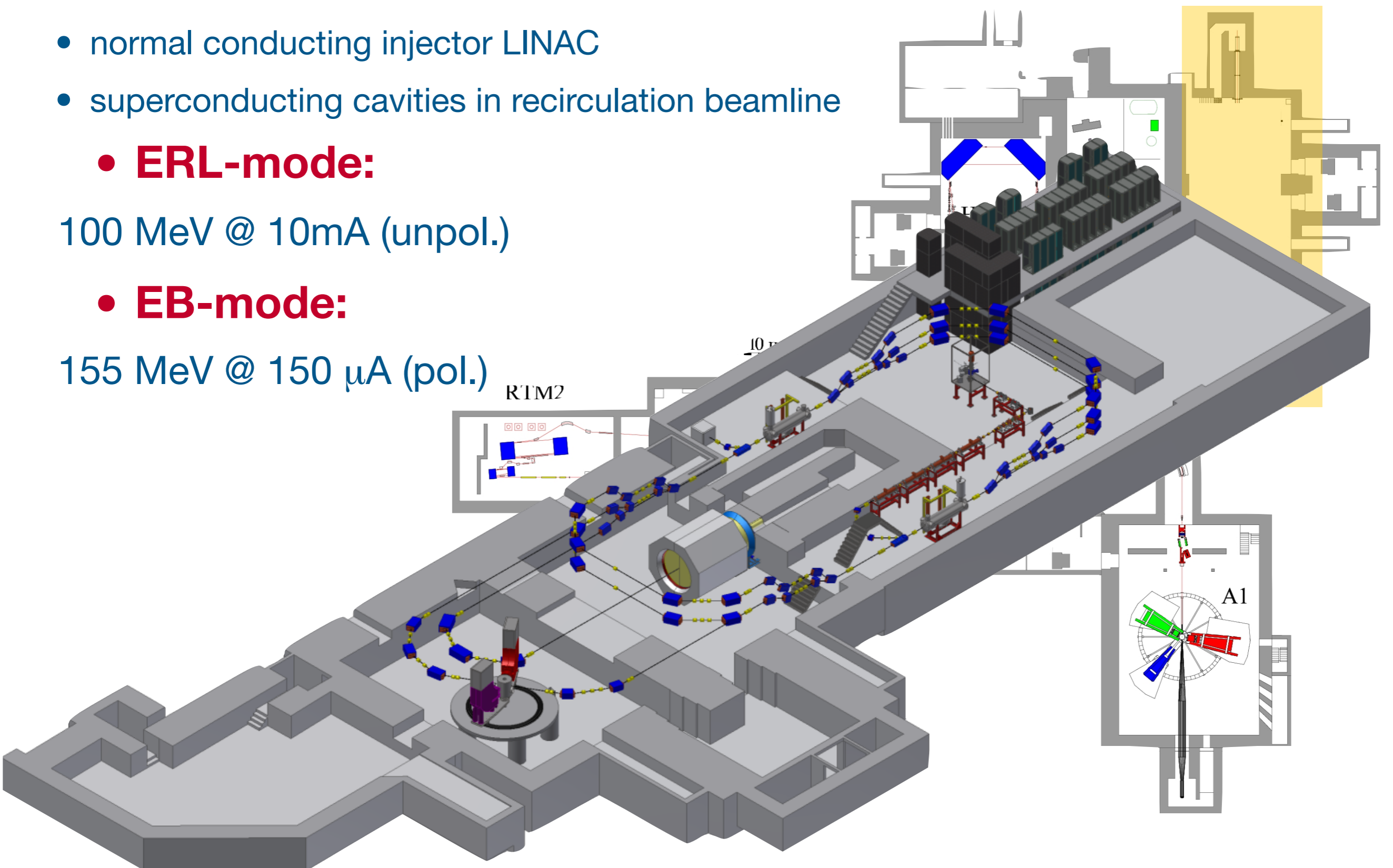
- 1.3 GHz c.w. beam
- normal conducting injector LINAC
- superconducting cavities in recirculation beamline

- **ERL-mode:**

100 MeV @ 10mA (unpol.)

- **EB-mode:**

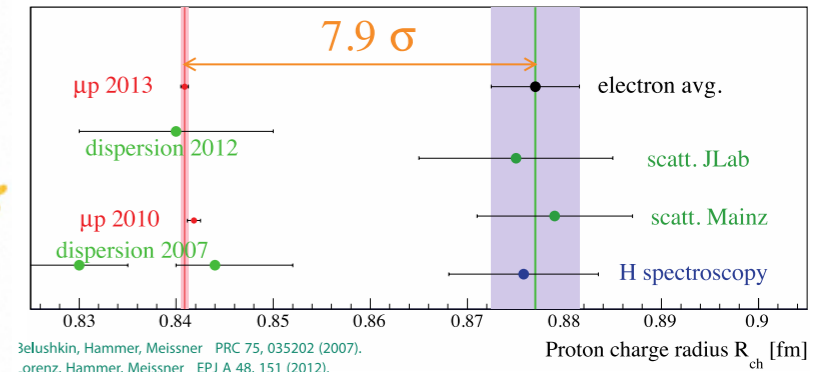
155 MeV @ 150 μ A (pol.)



The physics cases@MAMI and MESA

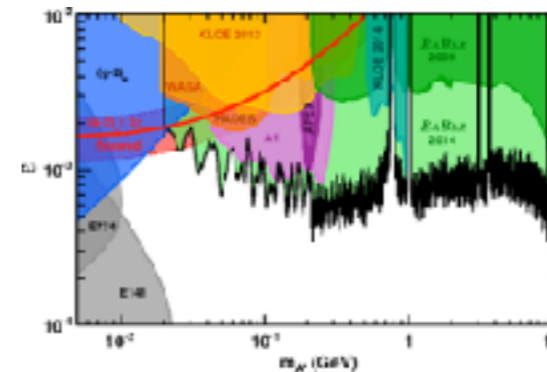
Low energy nuclear physics

High luminosity + high resolution + polarized beam and target



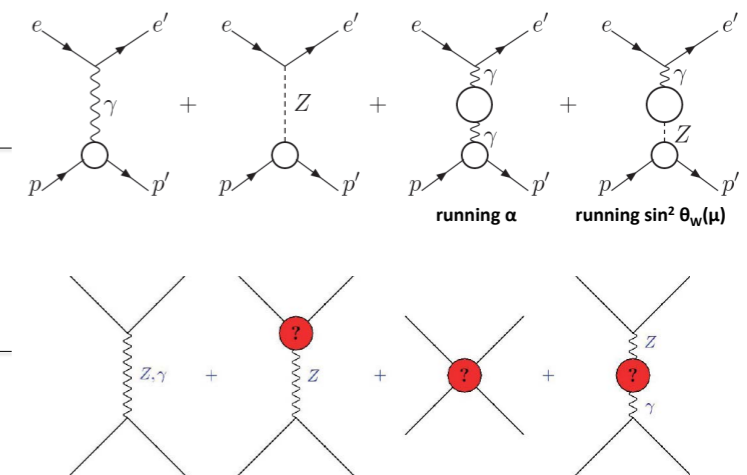
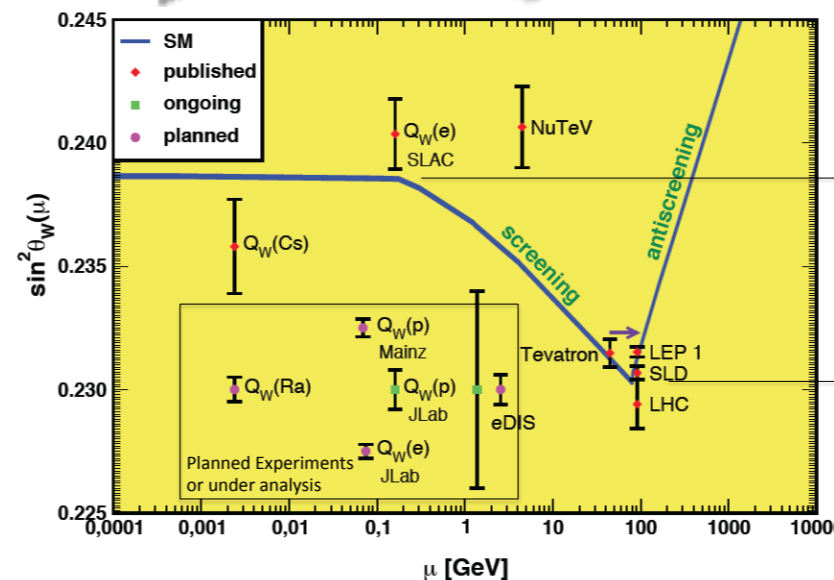
Search for rare events

High luminosity + high resolution



Precision EW physics

High luminosity + polarized beam



The role of accelerators at Universities

MAMI is the flagship of the Johannes-Gutenberg University

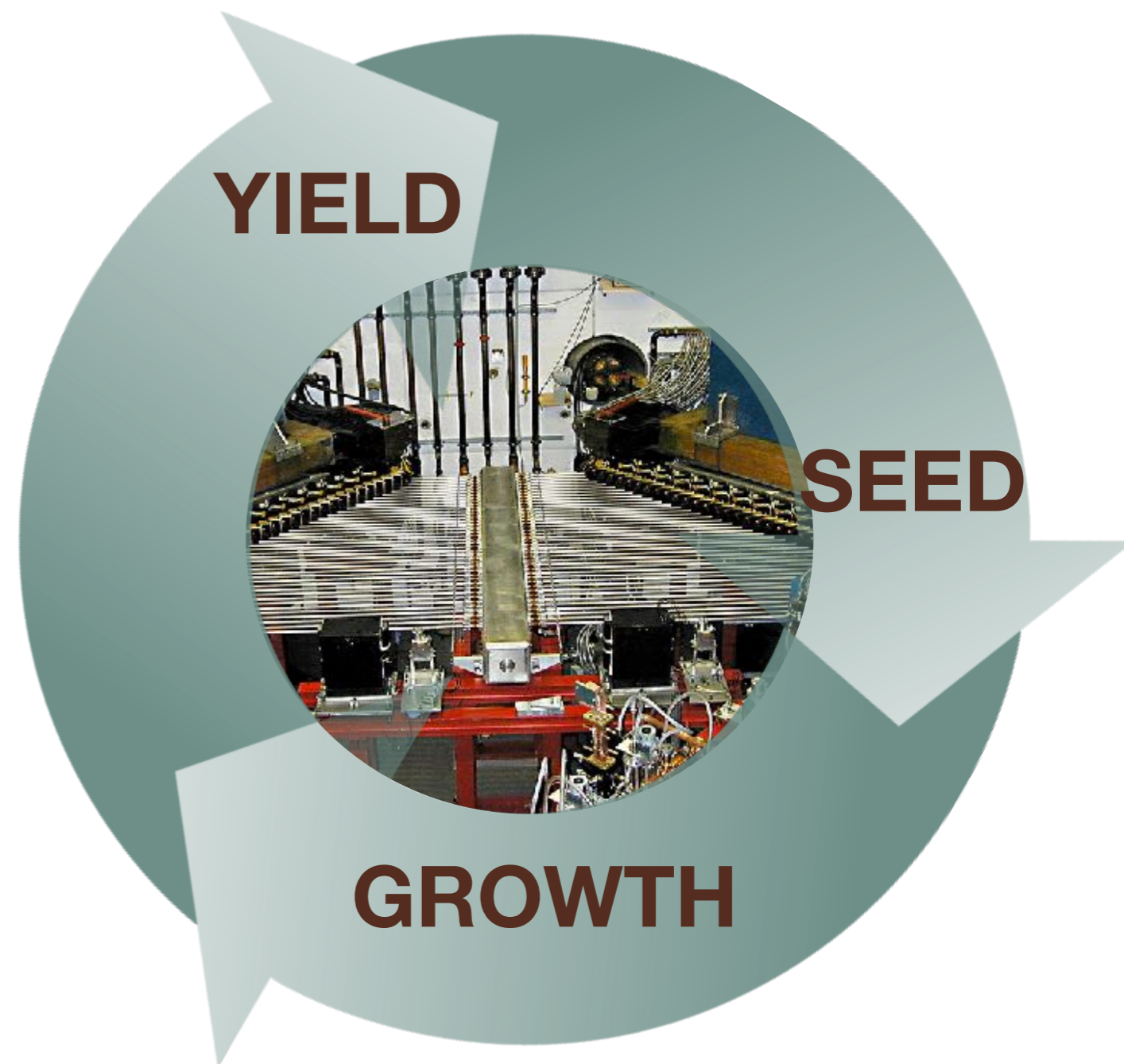
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The role of accelerators at Universities

MAMI is the **flagship** of the Johannes-Gutenberg University

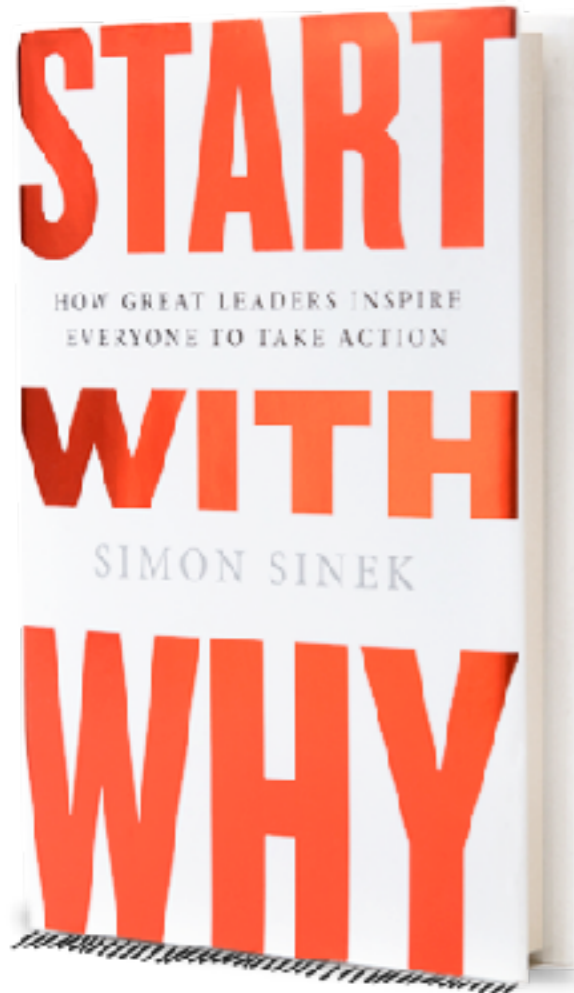




The MAMI recipe for small accelerators

Basic and applied research

- Scientific development
- Society benefit



- “The low energy frontier of the SM”
- Accelerator science for medicine (ERL)
- Radiation damage studies
- Crystal properties for new materials
- (coming) Biophysics



The MAMI recipe for small accelerators

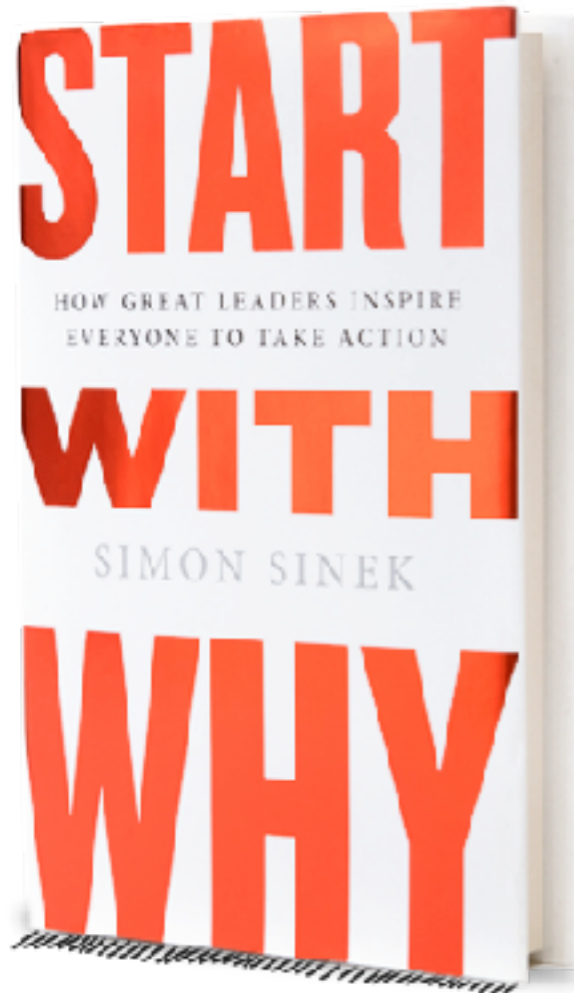
Basic and applied research

- Scientific development
- Society benefit

SEED

“Intellectual satisfaction we obtain only from a connection of the whole”
(Hermann von Helmholtz)

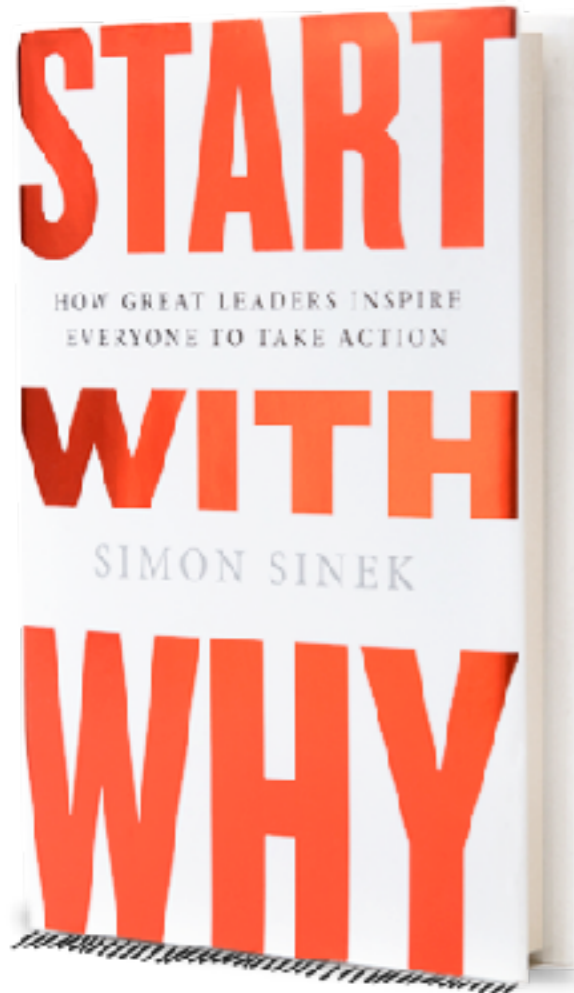
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The role of accelerators at Universities

Basic and applied
research

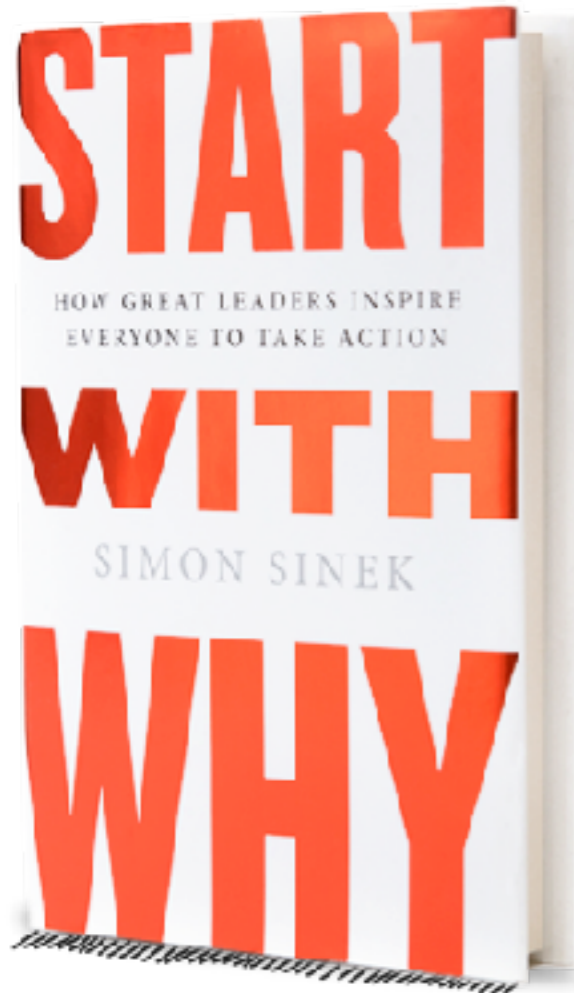


“Any simple problem can be made insoluble if enough meetings are held to discuss it”
(Mitchell’s law of committees)



The role of accelerators at Universities

Basic and applied research



SEED



- PAC
- Science Advisory Board

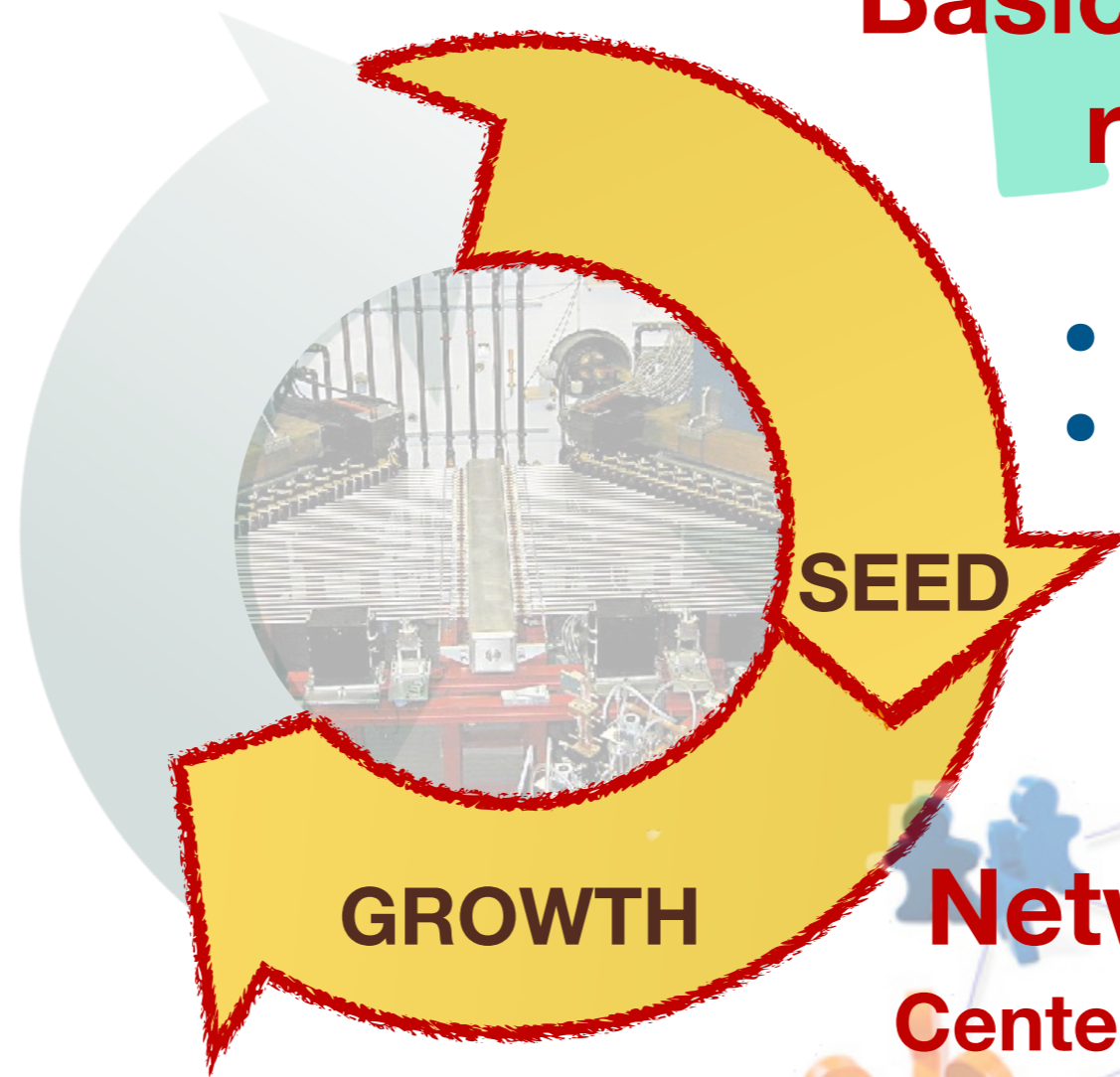
- Unbound to specific funding initiative and agendas
- Applied research as benchmark for comprehensive universities



The MAMI recipe for small accelerators

Basic and applied research

- Scientific development
- Society benefit



Network (Research Center, Universities and Industries, Press)

- Jefferson Laboratory
- HGF (FAIR) and MP (Material science)
- Cooperation with Danfysik
- (coming) Journalism internships





The MAMI recipe for small accelerators

Basic and applied research

- PAC
- Scientific Council
- ...

- Scientific development
- Society benefit

SEED

GROWTH

Network (Research Center, Universities and Industries, Press)

- Jefferson Laboratory
- HGF (FAIR) and MP (Material science)
- Cooperation with Danfysik
- (coming) Journalism internships





The role of accelerators at Universities

- National (and International) collaborations with Research Centers
- National and regional cooperations

➤ Increase internationalisation and visibility of the University



Basic and applied research



Network (Research Center, Universities and Industries, Press)





The MAMI recipe for small accelerators

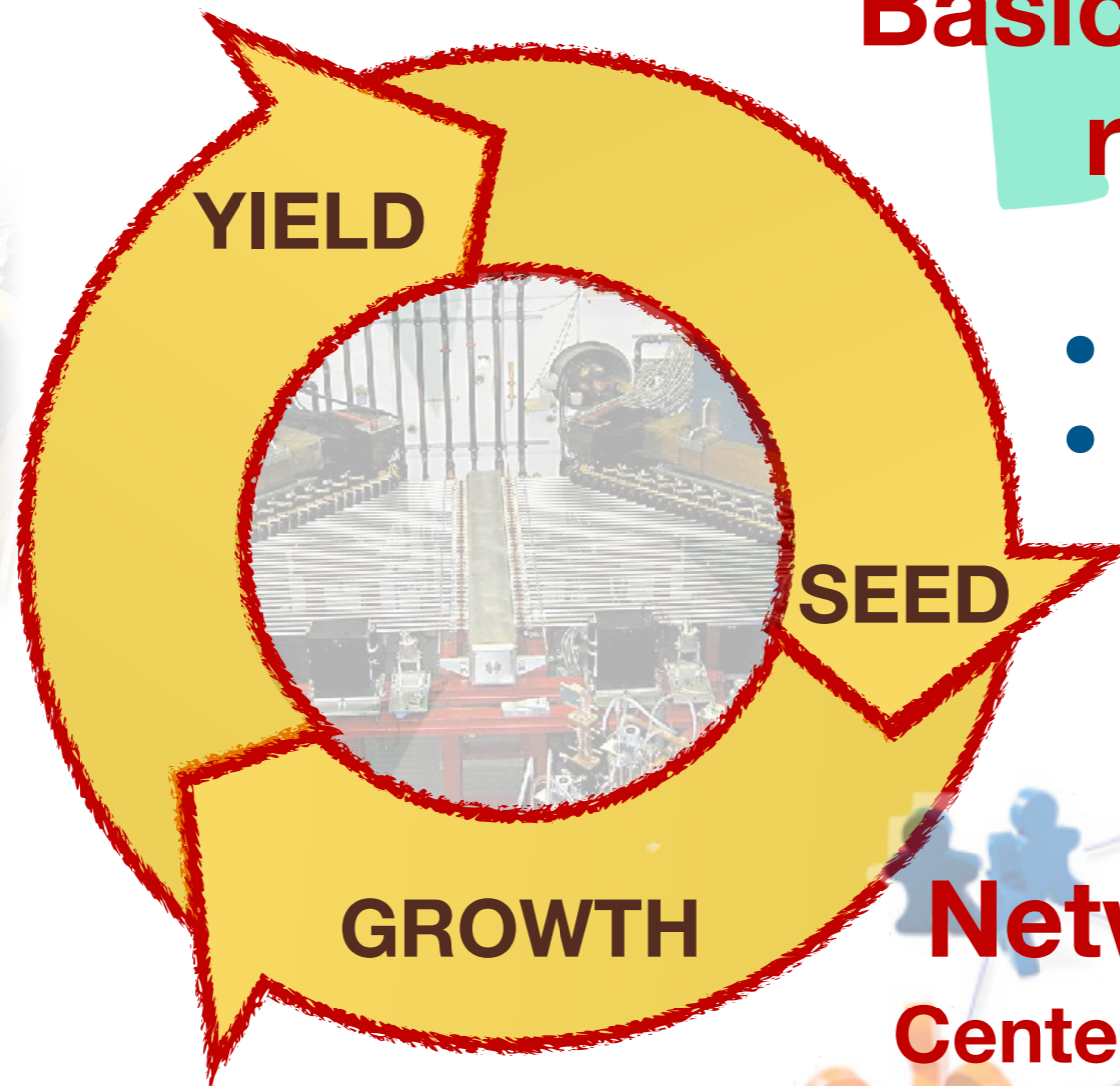
Basic and applied research

- Scientific development
- Society benefit

Education

- Research-oriented teaching
- Service and Outreach

- Beam times as part of curriculum
- Particle Physics Academy
- Open days, Sat. Morning Phys.



Network (Research Center, Universities and Industries, Press)





The MAMI recipe for small accelerators

Sustainability of future research programs



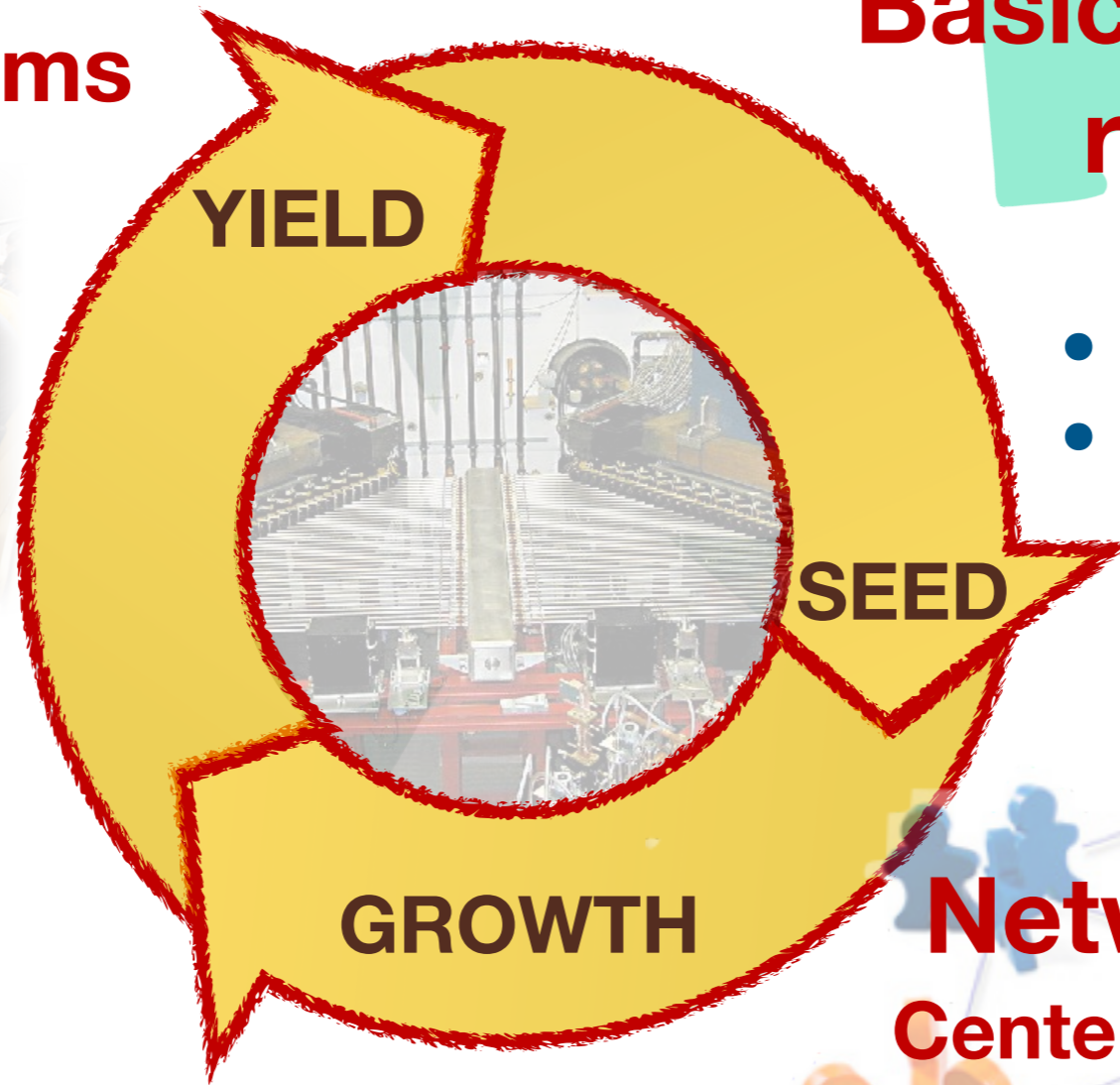
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The role of accelerators at Universities

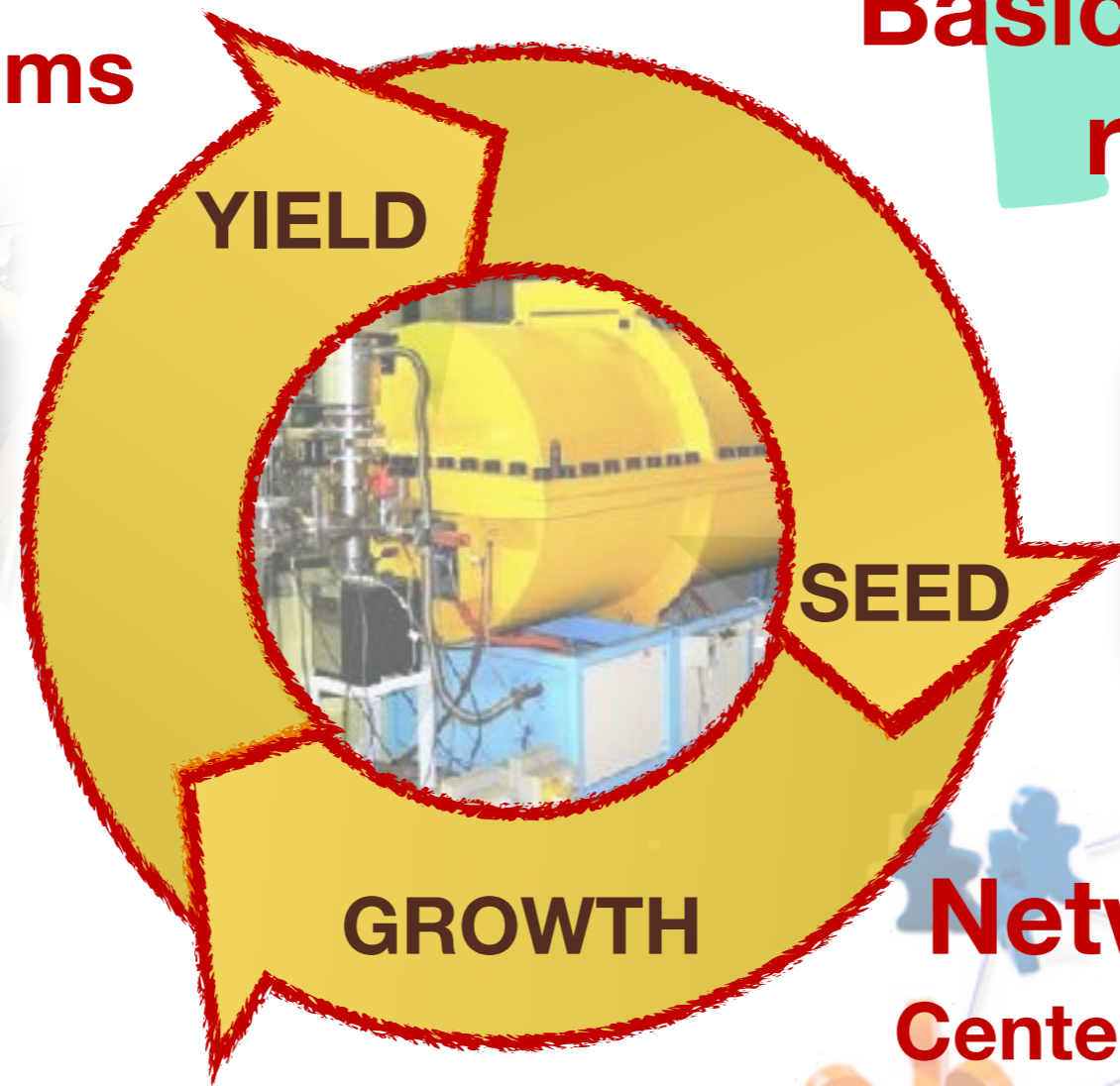
**Excellence of
future research
programs**

**Basic and applied
research**



Education

- Beam times as integral part of BSc.
- Extend to other disciplines
- International PhD Summer schools
- Teachers internship

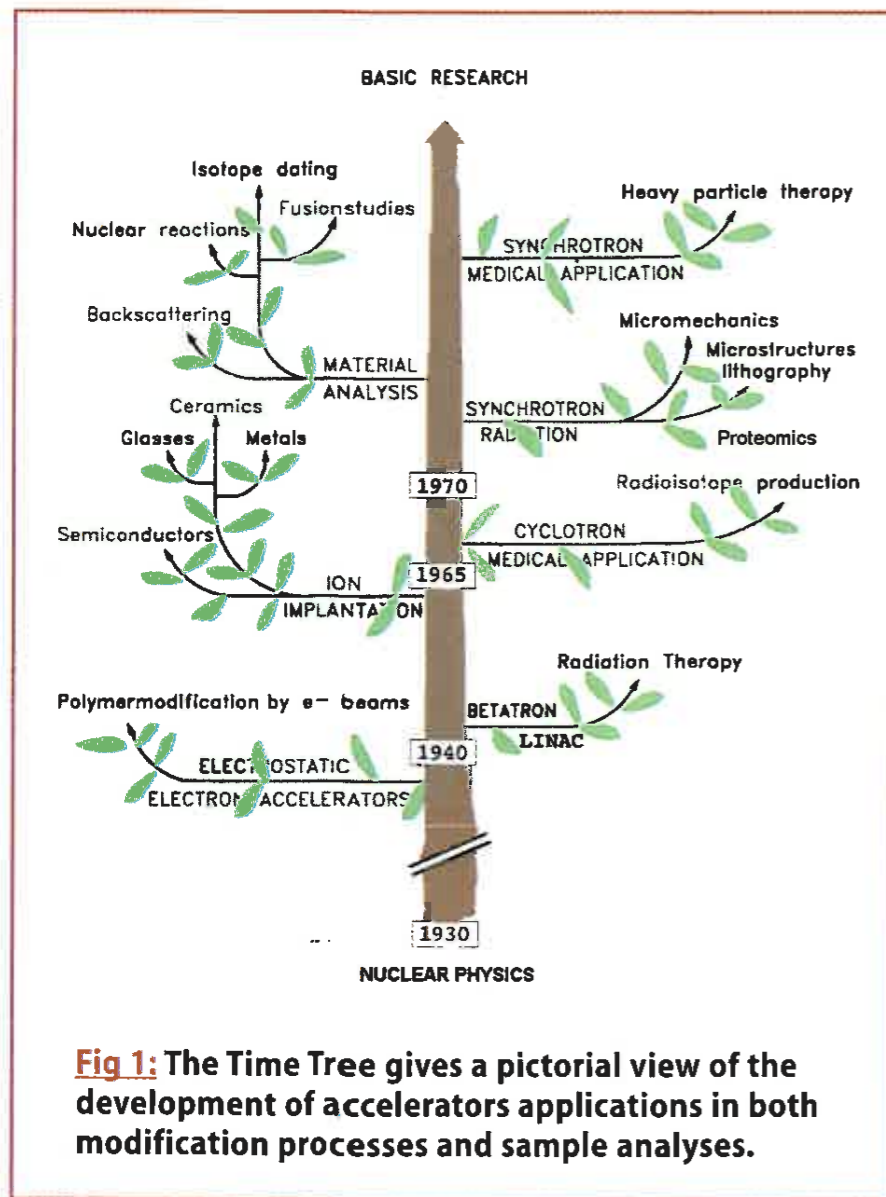


**Network (Research
Center, Universities and
Industries, Press)**



Accelerators are Ubiquitous but Unsung

More than **30,000** particle accelerators in operation around the world



Accelerators serve:

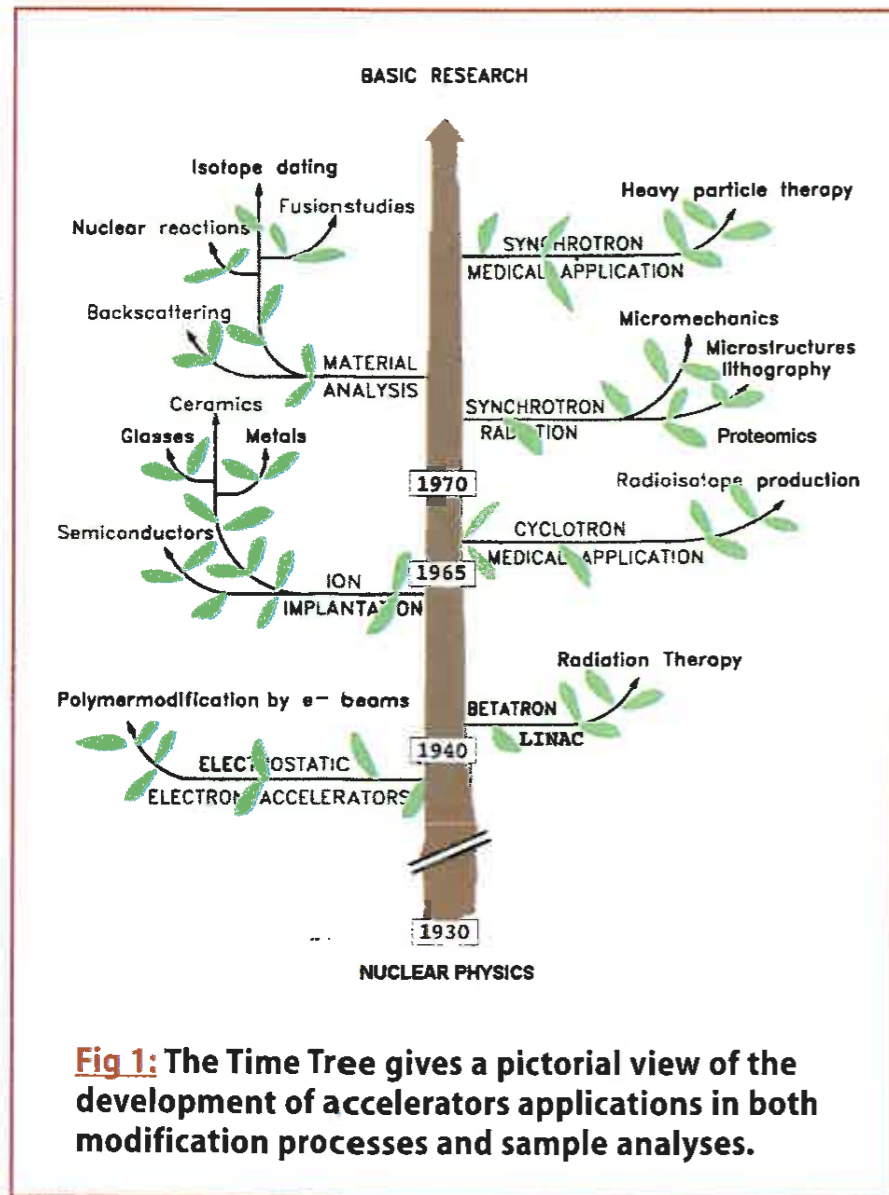
- 👉 discovery science
- 👉 medicine, industry, energy, environment, national security ...

Accelerators drive:

- 👉 excellence
- 👉 internationalisation
- 👉 innovation → economic growth

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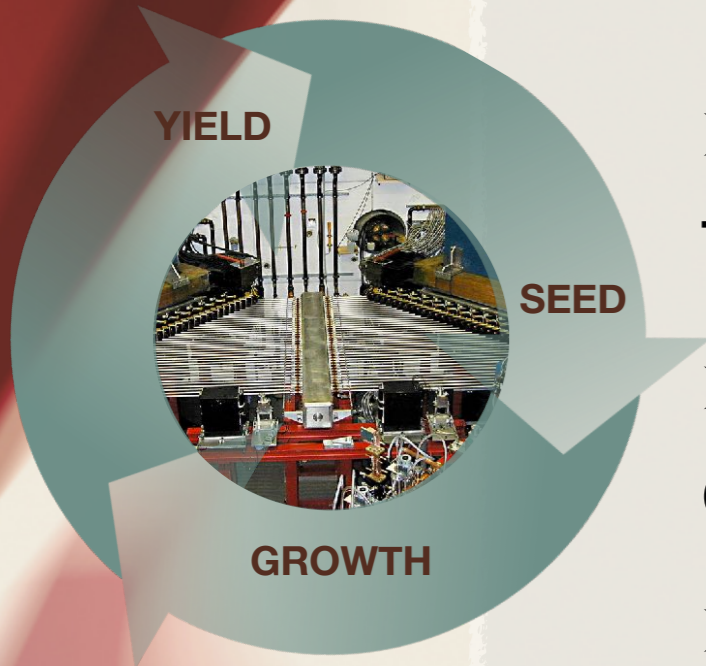
Accelerators drive:

- ☞ excellence
- ☞ internationalisation
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Generators of knowledge

The Role of Accelerators at Universities

- Accelerators are the flagships of Research Universities
- They are generators of knowledge unbound to specific funding initiative and agendas
- They allow for research-oriented teaching: driver of excellence
- They are hearth and crash test for comprehensive universities



“Challenge is nothing more than the seed of opportunity”

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Moving Minds –
Crossing Boundaries

“Ut omnes unum sint”

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