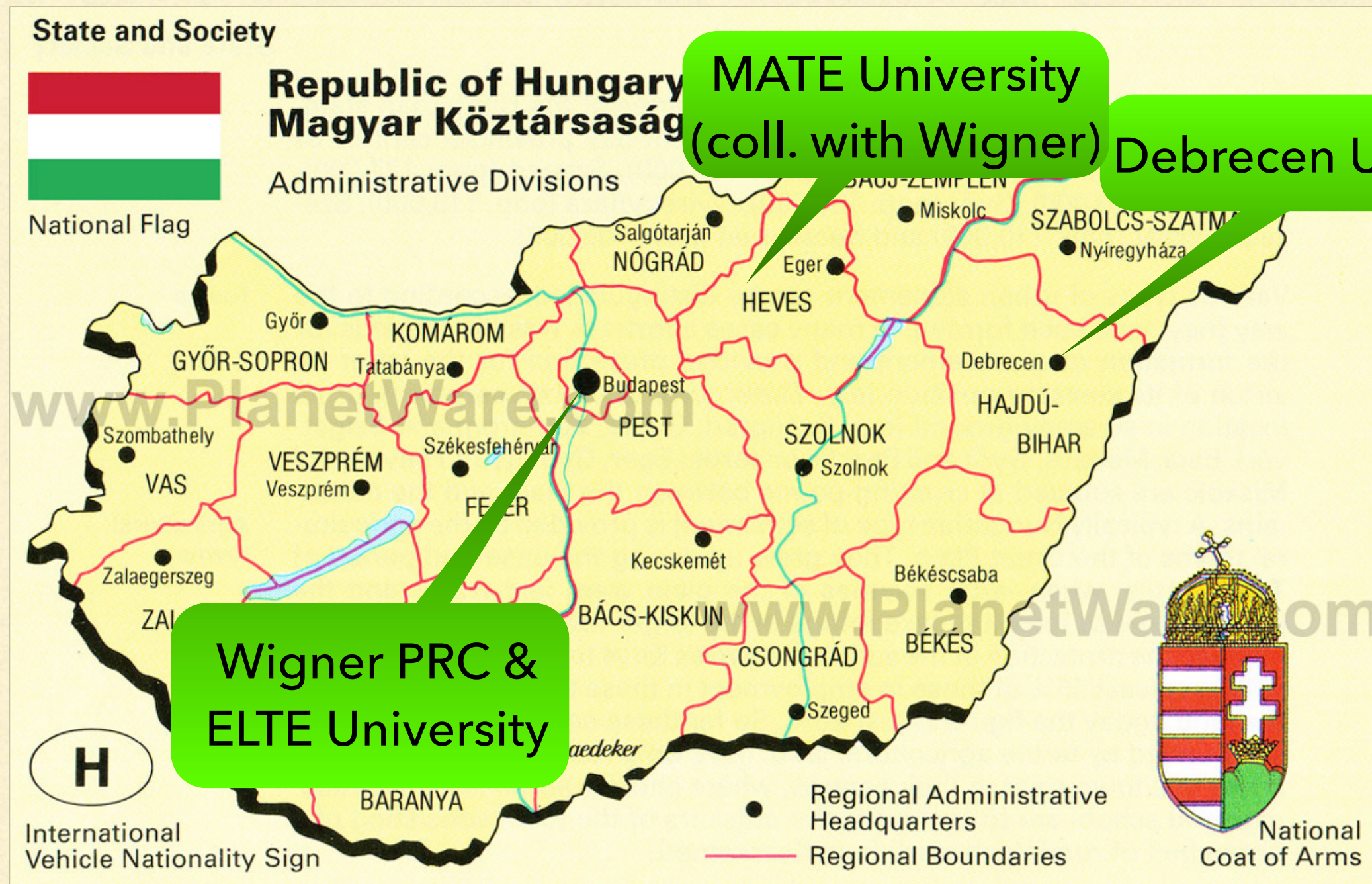


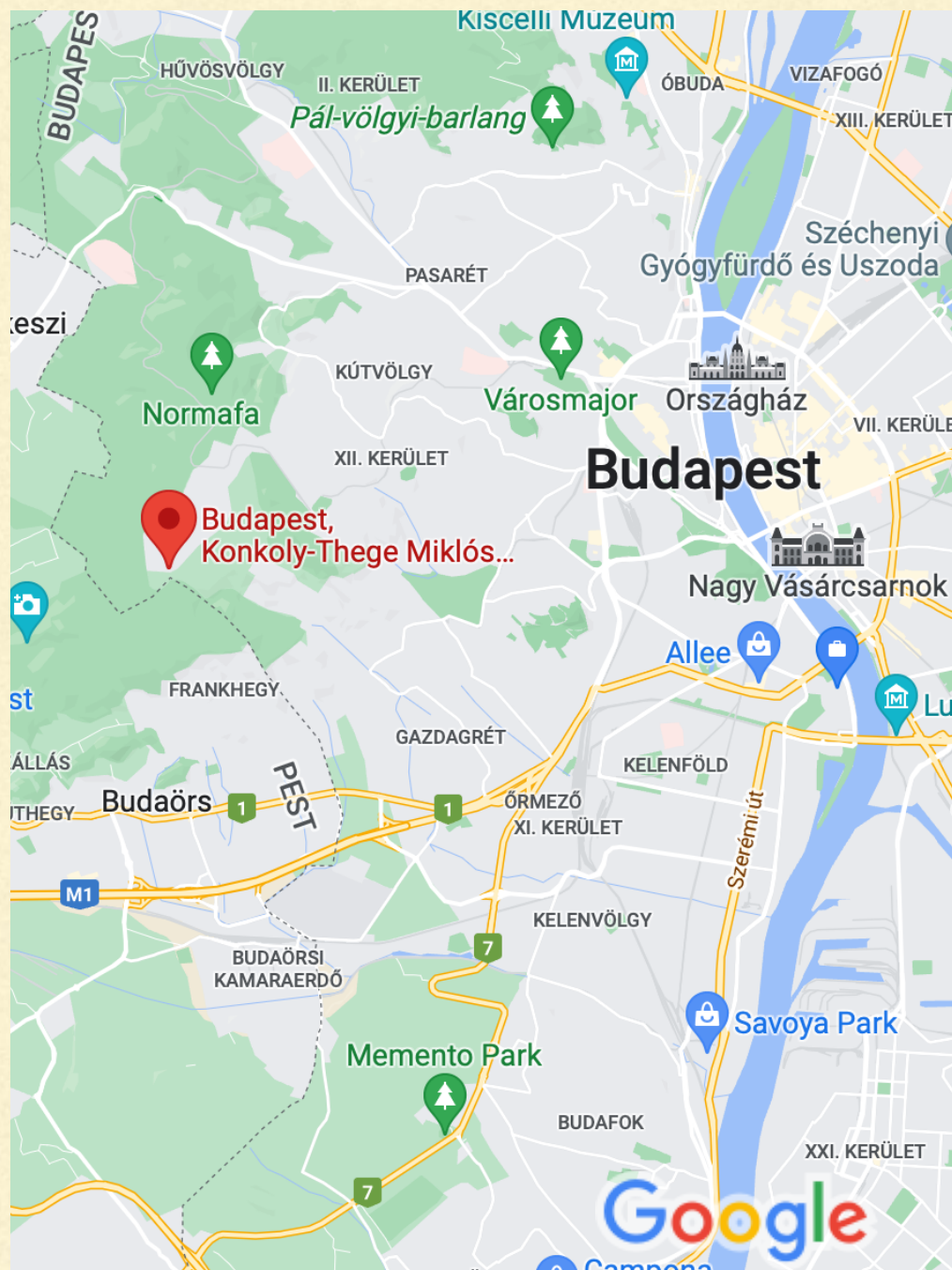
HEPP THEORY IN HUNGARY

RECFA visit
Budapest, 23 September, 2022

Three centres of theoretical research in HEPP



Wigner PRC Budapest



Wigner PRC Budapest

- **Personnel:** 25 FTEs
 - **5 scientific advisors** (equivalent of university professor at research institutes)
 - **14 research associates** (researchers with PhDs)
 - **6 students**
- **Activities:**
 - **Theoretical research:** QFT, QCD & HIC phenomenology
 - **Coordination of contributions to large-scale experimental research:** CERN LHC **ALICE**, **CMS**, GSI **FAIR**, GPU & cloud **computing**, big data science, **hardware & software development**
 - **Representation** of the Hungarian community in **NuPECC**, **ApPEC** and **ECFA**

Wigner PRC Budapest

Strengths:

excellent research acclaimed internationally, highly qualified scientists, good international relations

Weakness:

majority close to retirement, few young colleagues stay after PhD (low salary)

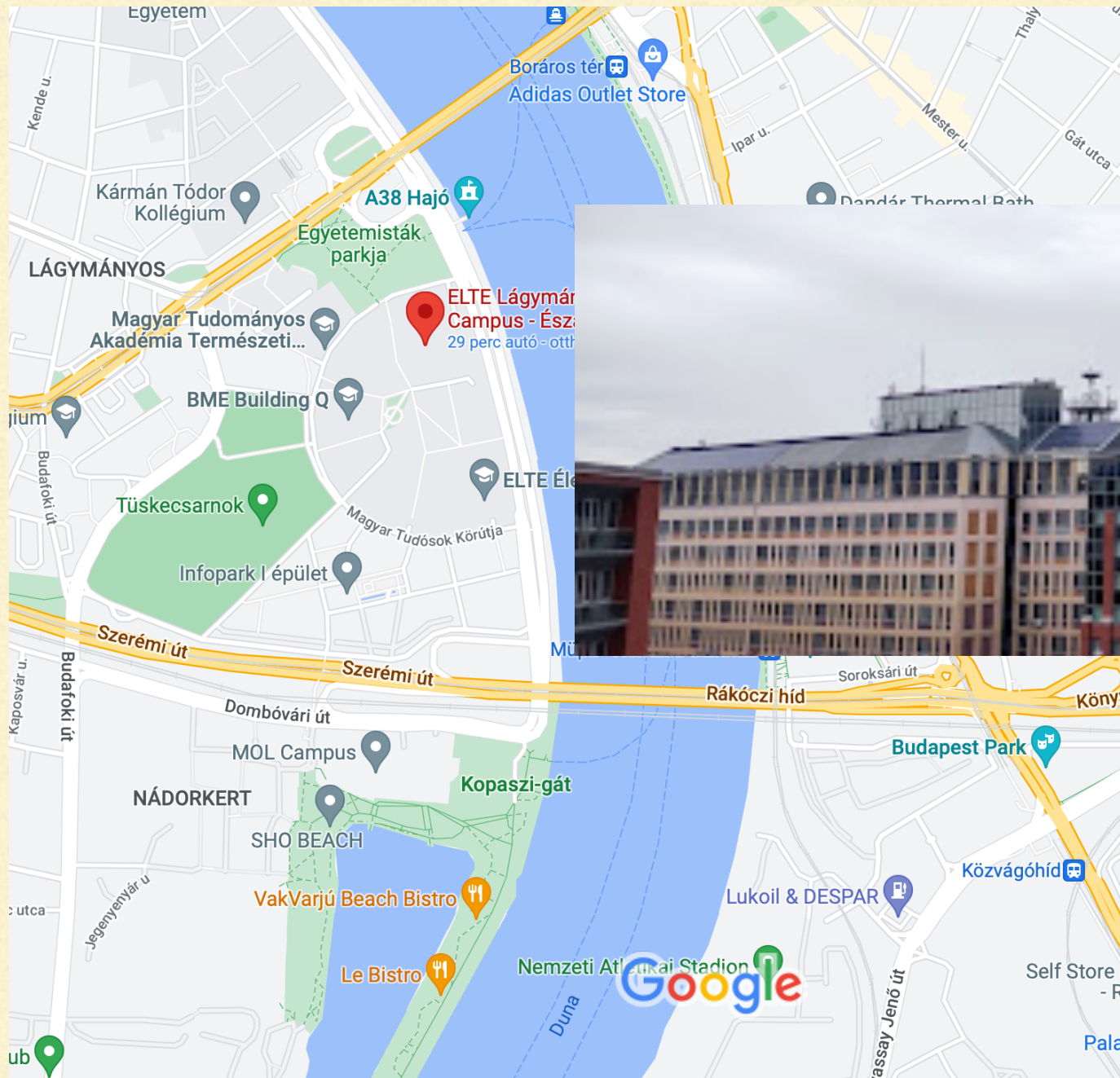
Opportunities:

national, bilateral, COST grants

Threats:

young colleagues leave for abroad, or for significantly better paid jobs (e.g. in finance), uncertain international environment

ELTE Eötvös Loránd University Budapest



ELTE Eötvös Loránd University

Budapest

- **Personnel:** 28 FTEs
 - 6 professors (+ 1 on long term leave)
 - 14 research associates (researchers with PhDs)
 - 8 students
- **Activities:**
 - University teaching
 - **Theoretical research:** BSM phenomenology, GR, heavy ion phenomenology, lattice QCD, QFT, string theory
 - **Coordination of contributions to large-scale experimental research:** Hungarian CERN Committee
 - **Representation:** liaison of HU in IUPAP

ELTE Eötvös Loránd University

Budapest

Strengths:

excellent research acclaimed internationally, highly qualified scientists, good international relations, leading position among central European university physics institutes

Weakness:

sluggish university administration, relatively few international young researchers

Opportunities:

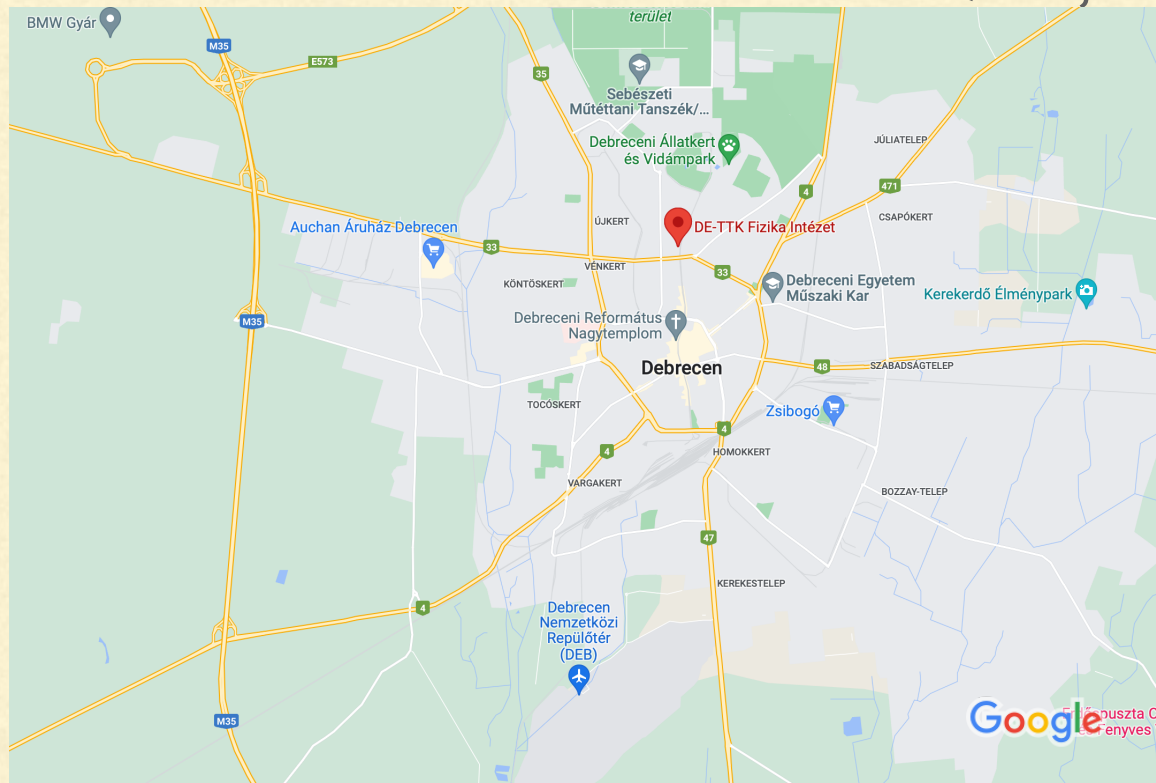
national, international, bilateral, grants

Threats:

uncertain international environment

University of Debrecen

- **Personnel: 5 FTEs**
 - 3 research associates (researchers with PhDs)
 - 2 students
- **Activities:**
 - University teaching
 - **Theoretical research: QFT, QCD phenomenology**



University of Debrecen

Strengths:

excellent research, well qualified scientists

Weakness:

very small group with diverse interest, very few students

Opportunities:

presence of international students

Threats:

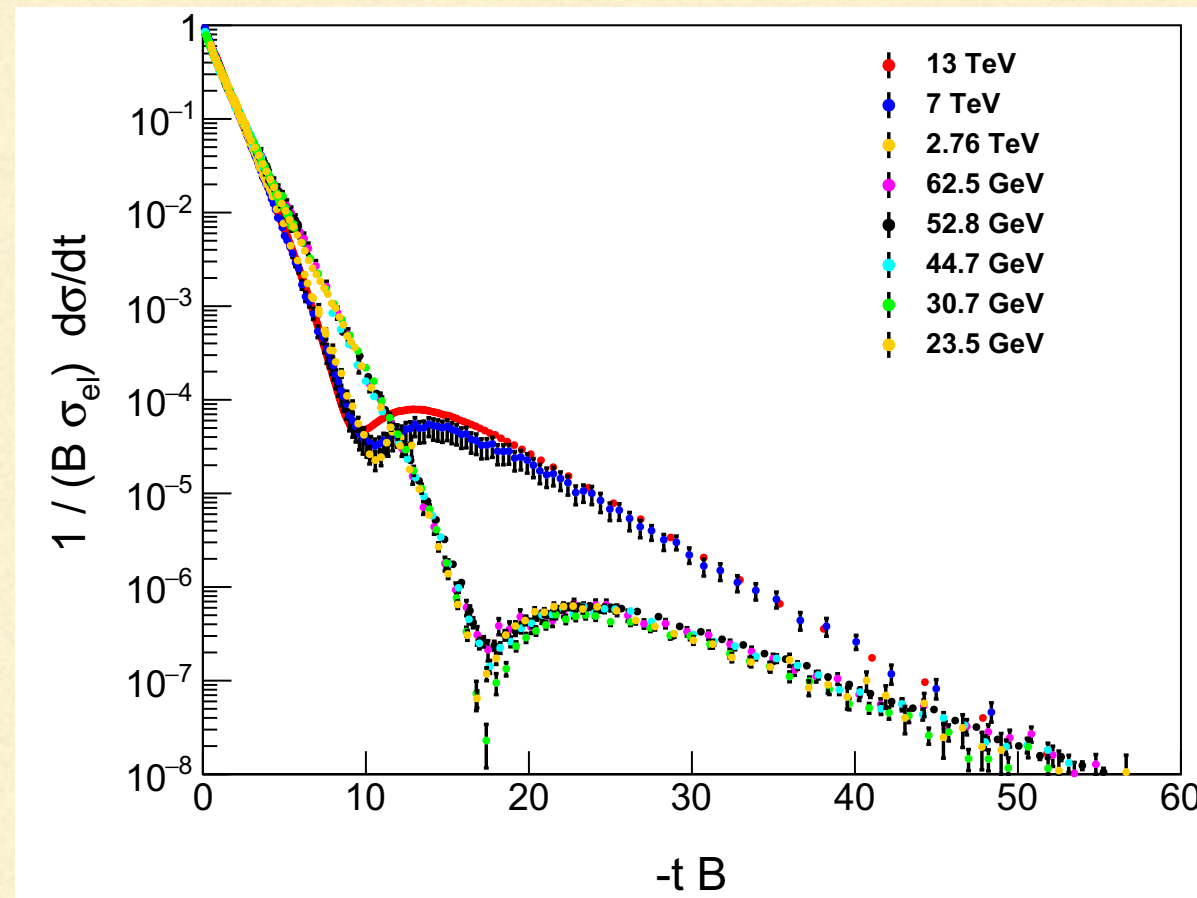
university strategic plan lacks this field of research

Topics and outstanding results (in alphabetical order)

Femtoscscopy, heavy ion phenomenology and theory (ELTE and Wigner)

- Demonstration of >5 sigma statistical significance for odderon exchange

[Csörgő et al, Eur. Phys. J. C (2021) 81:180]



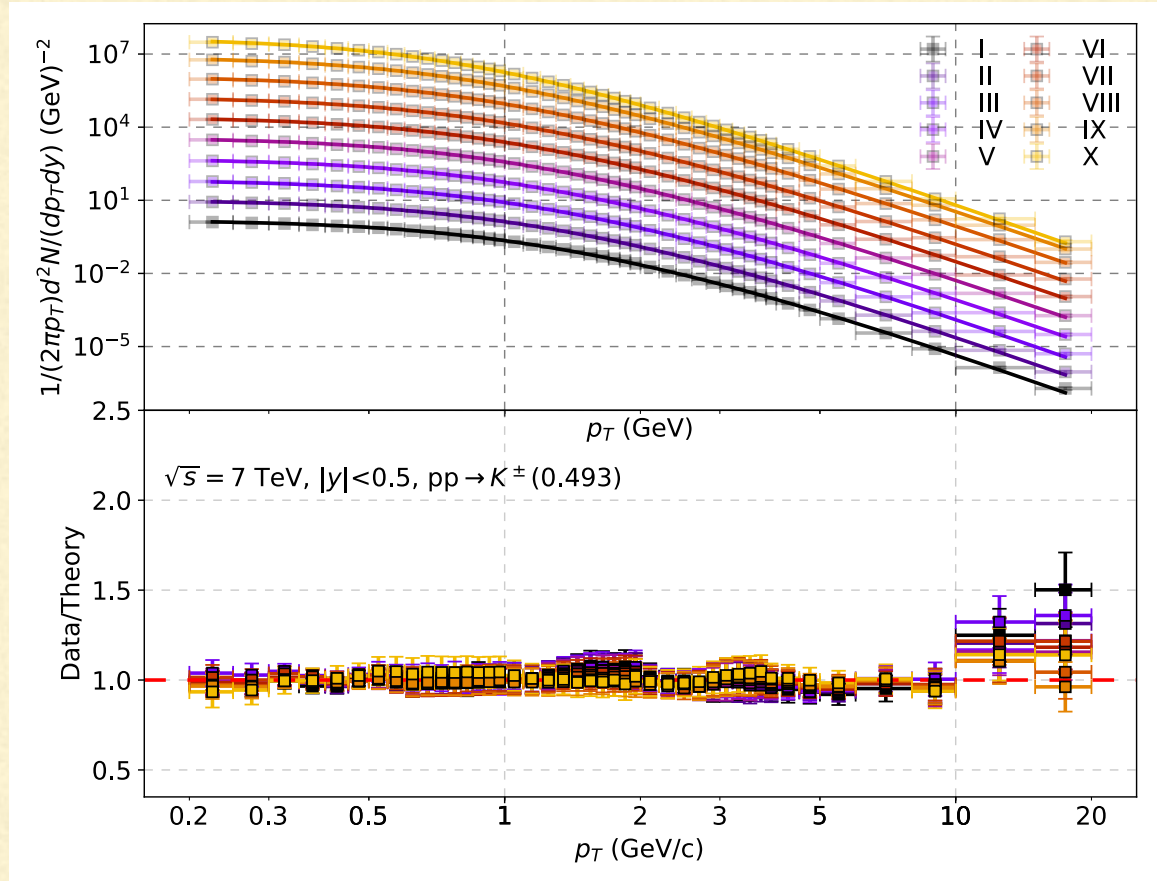
Scaling behaviour of the differential cross section $d\sigma/dt$ of elastic pp collisions from ISR to LHC energies.

Femtoscscopy, heavy ion phenomenology and theory (ELTE and Wigner)

- Demonstration of >5 sigma statistical significance for odderon exchange [Csörgő et al, *Eur. Phys. J. C* (2021) 81:180]
- HIJING++ software [Barnaföldi et al, *Nucl.Part.Phys.Proc.* 289-290 (2017) 373-376]

Femtoscopy, heavy ion phenomenology and theory (ELTE and Wigner)

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- HIJING++ software [Barnaföldi et al, *Nucl.Part.Phys.Proc.* 289-290 (2017) 373-376]
- Hadronization with Tsallis-Pareto-like fragmentation



[Bíró et al, *J.Phys.G* 47 (2020) 10, 105002]

Yields of charged kaons in
different multiplicity classes

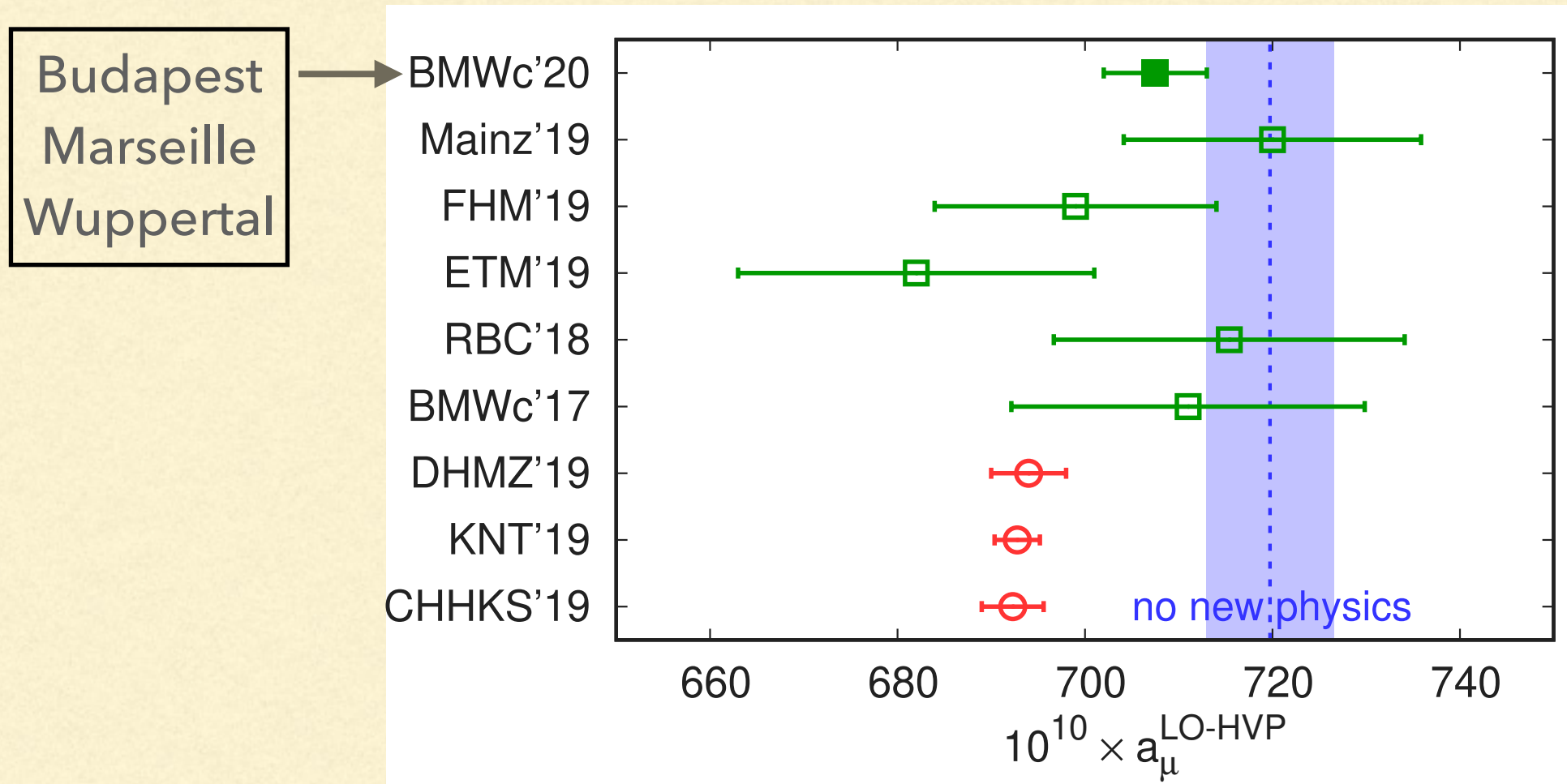
Femtoscscopy, heavy ion phenomenology and theory (ELTE and Wigner)

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- HIJING++ software [Barnaföldi et al, *Nucl.Part.Phys.Proc.* 289-290 (2017) 373-376]
- Hadronization with Tsallis-Pareto-like fragmentation
[Bíró et al, *J.Phys.G* 47 (2020) 10, 105002]
- Construction of models for HICs at RHIC/LHC/FCC-energies

Lattice QCD highlights (ELTE)

■ Computation of the HVP contribution to the muon ($g-2$)

[Borsányi et al., Nature 593 (2021) 7857]



Lattice QCD highlights (ELTE)

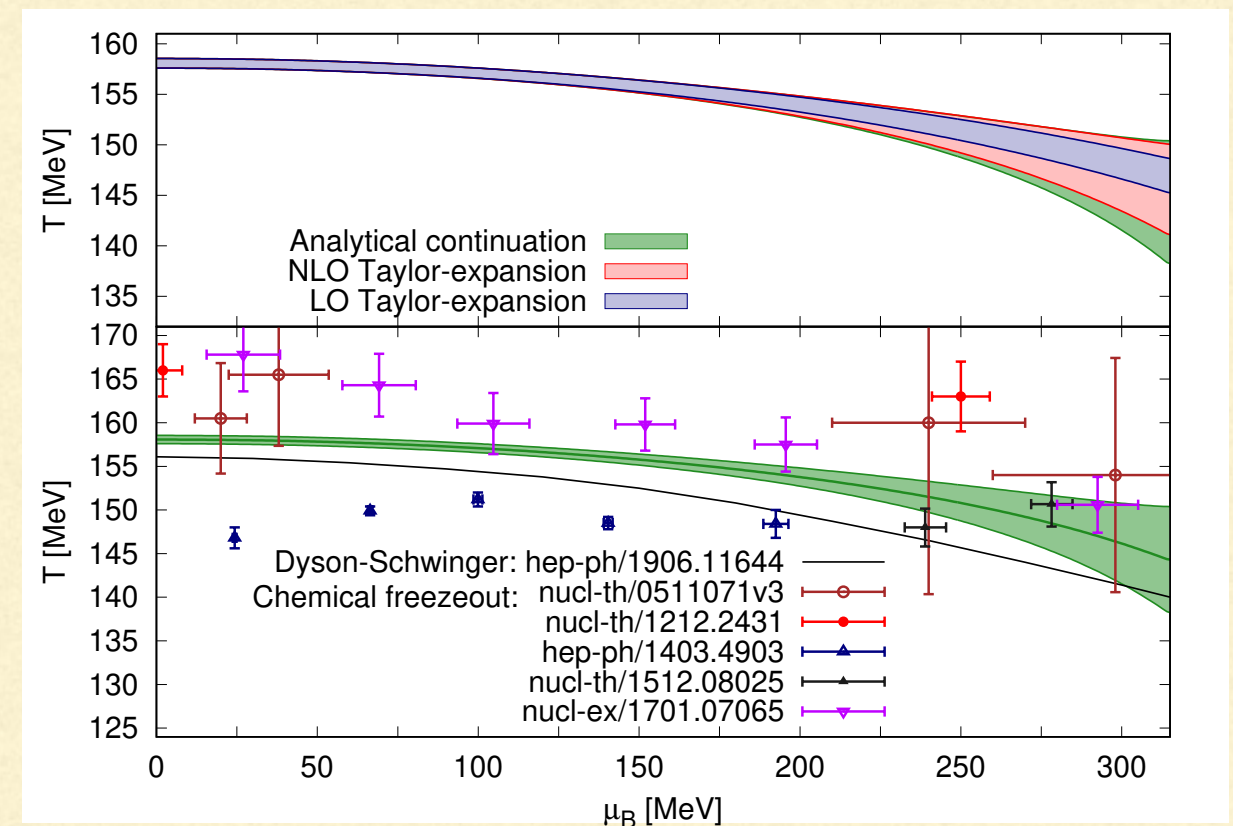
- Computation of the HVP contribution to the muon ($g-2$)

[Borsányi et al., Nature 593 (2021) 7857]

- Finite temperature QCD crossover line has been determined using continuum extrapolated lattice QCD calculations.

[Borsányi et al., Phys.Rev.Lett. 125 (2020) 5, 052001]

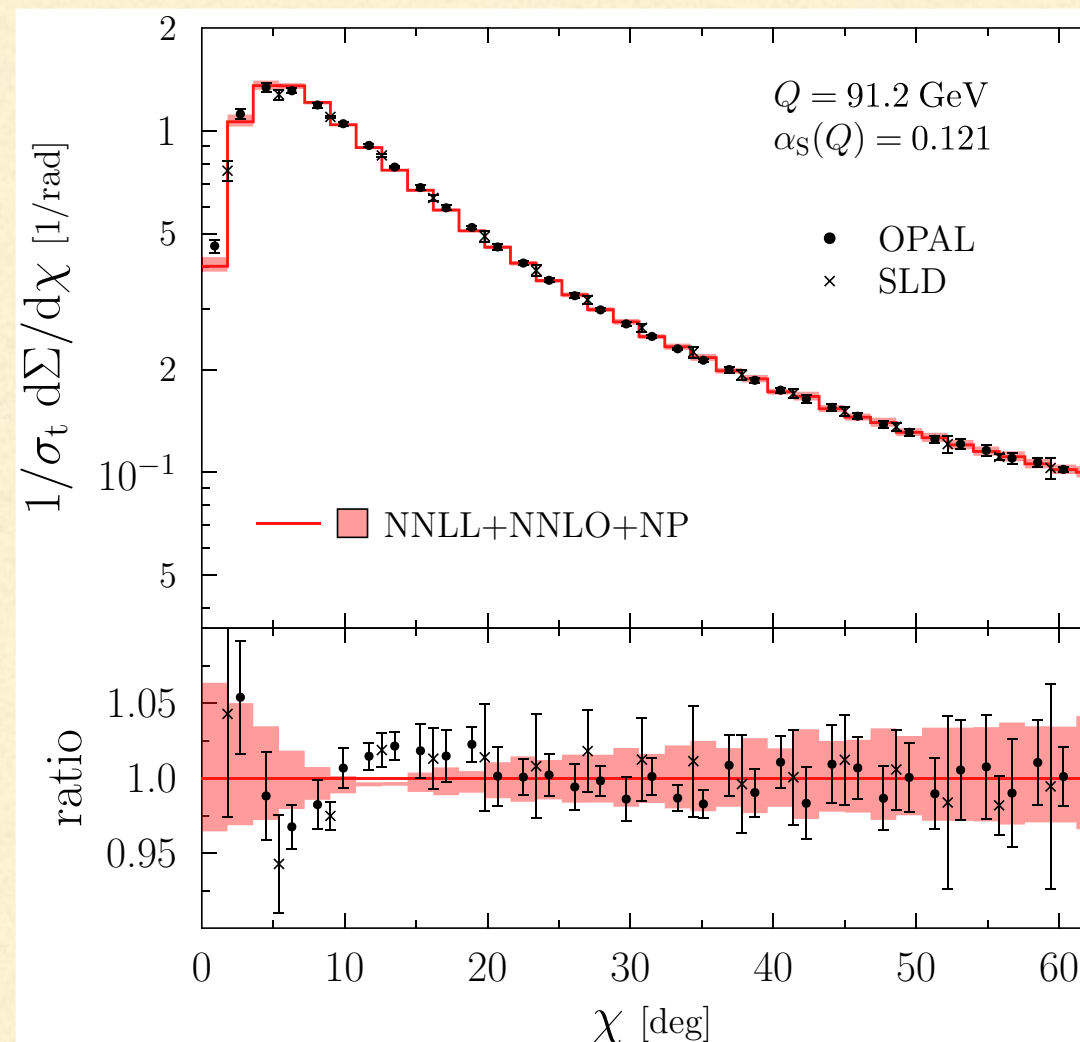
Results compared to
chemical freeze-out points
obtained from experiments



Particle phenomenology (DE, ELTE, Wigner)

- QCD corrections at NLO, NNLO and matched to resummation or parton shower

[Zoltán Tulipánt et al., *Energy-energy correlation...*, Eur.Phys.J.C 77 (2017) 11, 749]



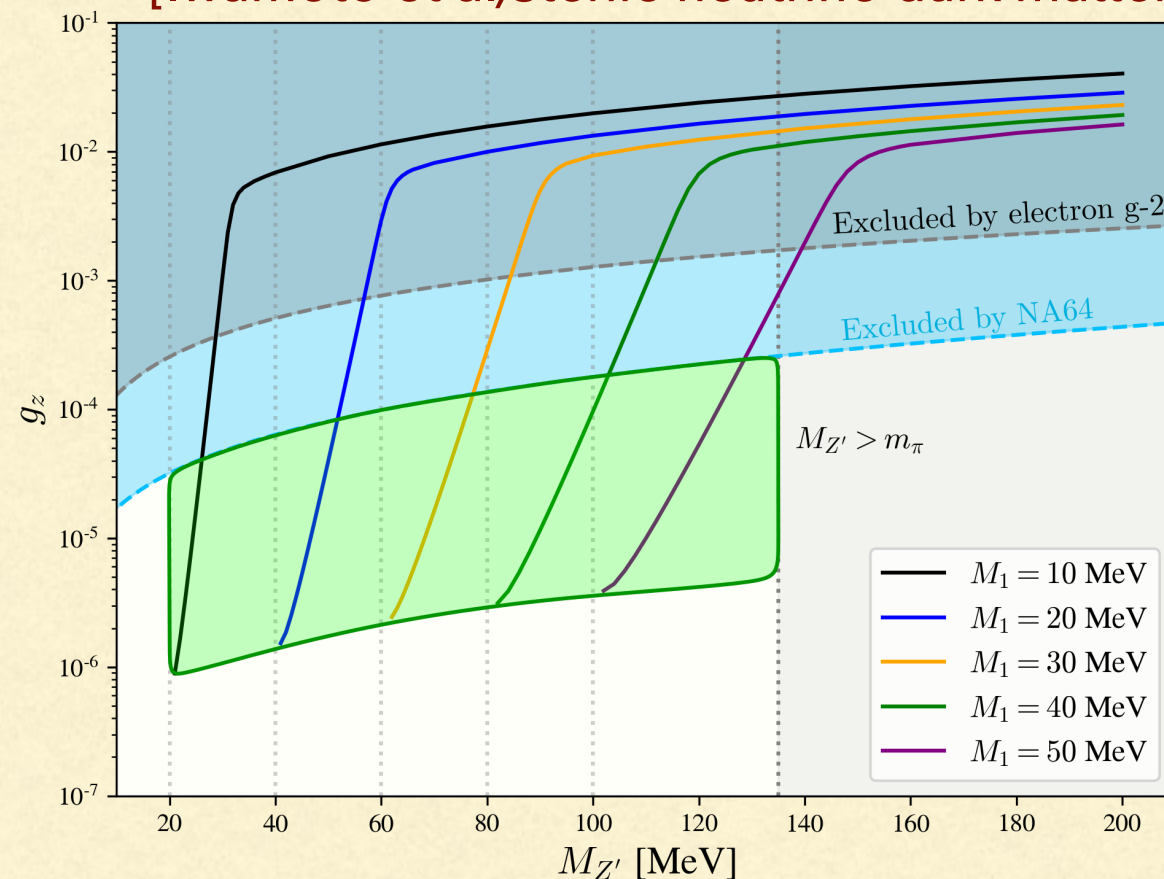
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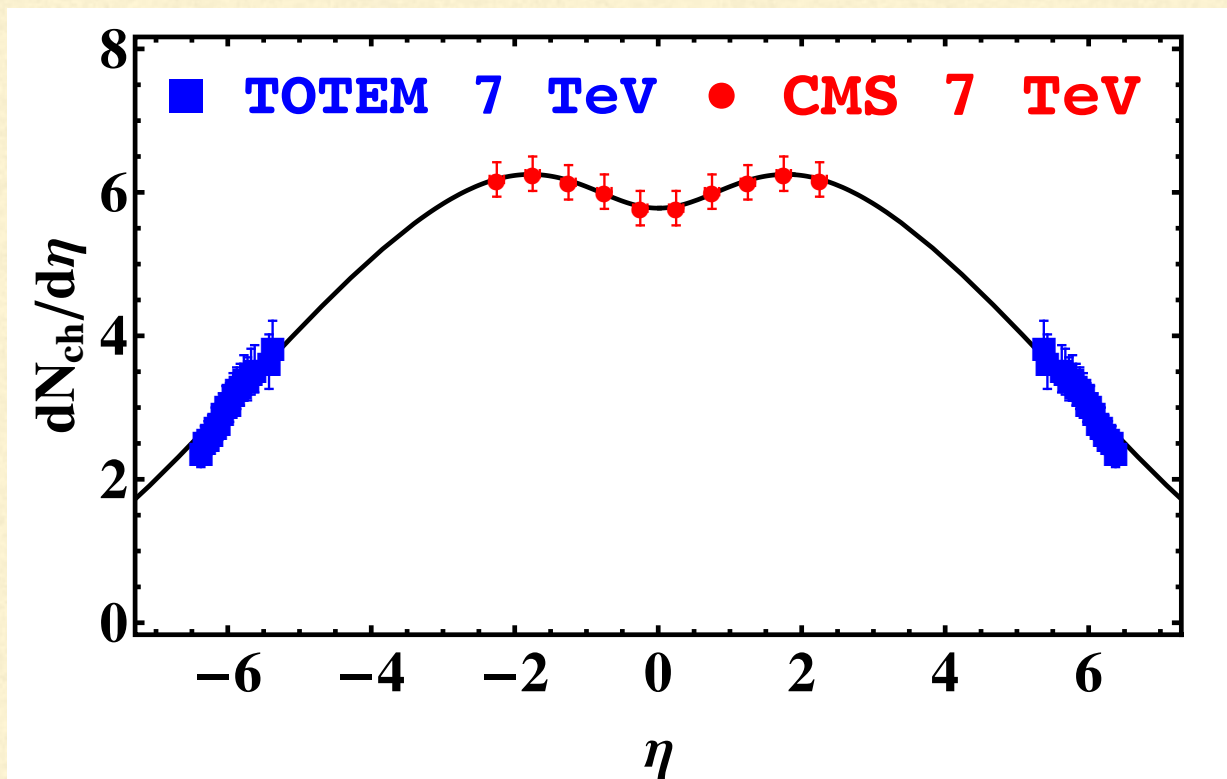
- BSM phenomenology of the Superweak extension of SM

[Iwamoto et al, Sterile neutrino dark matter..., JCAP 01 (2022) 01, 035]



Relativistic hydrodynamics (ELTE and Wigner)

- Accelerating hydrodynamic description of pseudorapidity density and the initial energy density in p+p, Cu + Cu, Au + Au, and Pb + Pb collisions at energies available at the BNL Relativistic Heavy Ion Collider and the CERN Large Hadron Collider



[Csanad et al, Phys.Rev.C 97 (2018) 6, 064906]

Quantum field theory highlights

- Studies of **localized and weakly localized states** (breathers, oscillons, oscillatons) and Q-balls in field theories **coupled to gravitation**, e.g. Anti-de Sitter geon families
[Fodor et al., *Phys.Rev.D* 96 (2017) 8, 084027]
 - **Proof of a** conjectured expression for the currents of the conserved charges in local equilibrium, for interacting lattice models, leading to a **generalized Euler-type hydrodynamic equation**
[Borsi et al., *Phys.Rev.X* 10 (2020) 1, 011054]
 - **Quantification of GR effects in muon g-2, EDM and other spin precession experiments** in connection with CERN's planned Charged Particle Electric Dipole Moment experiment
[László, Zimborás, *Classical and Quantum Gravity*, 35 (2018) 175003]
-

In summary: pro's and con's

Pro's:

- strong tradition in HEPP theory
- excellent research results
- many opportunities for short term support

Con's:

- career future looks uncertain
- young colleagues leave the field or the country

Great thanks

to the Hungarian HEPP community
for helping me collecting data
to this presentation

The end