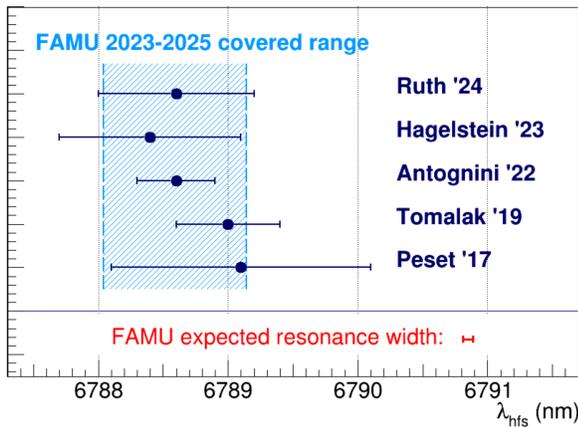


Muonic atom spectroscopy for particle and applied physics: **FAMU**, CHNet-MAXI, and more

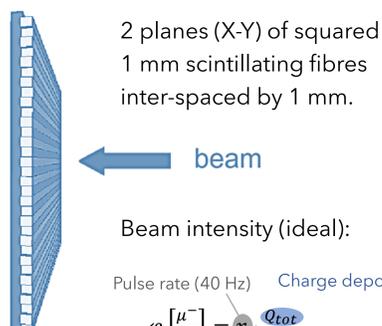
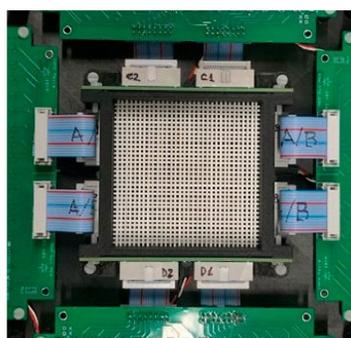
R. Rossini for the FAMU Pavia group

FAMU is a nuclear physics experiment with the objective of measuring the ground-state hyperfine splitting ($1S$ -hfs) of the muonic hydrogen atom (μH), in order to extract the proton Zemach radius with accuracy lower than 1%:

$$r_Z = \int r d^3r \int d^3r' \rho_E(\vec{r} - \vec{r}') \rho_M(\vec{r}')$$



FAMU@Pavia: the muon beam monitor



2 planes (X-Y) of squared 1 mm scintillating fibres inter-spaced by 1 mm.

Beam intensity (ideal):

$$\varphi \left[\frac{\mu^-}{s} \right] = r \cdot \frac{Q_{tot}}{Q_{\mu}}$$

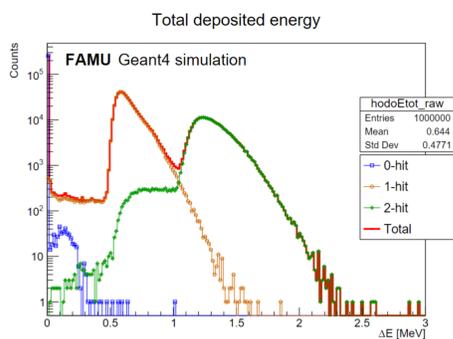
Pulse rate (40 Hz) Charge deposit

Charge deposit for a single muon

Beam intensity (real case) calculated as:

$$\varphi \left[\frac{\mu^-}{s} \right] = \frac{\text{Pulse rate (40 Hz) - fixed} \cdot \text{Total charge deposit during a beam pulse}}{\text{Constant} \cdot \text{Charge deposit of a single muon, measured with a low-intensity run}}$$

Simulated correction factors:
 W_j = fraction of muons interacting with j fibres
 η = fraction of Q_{μ} deposited by muons interacting with only 1 fibre

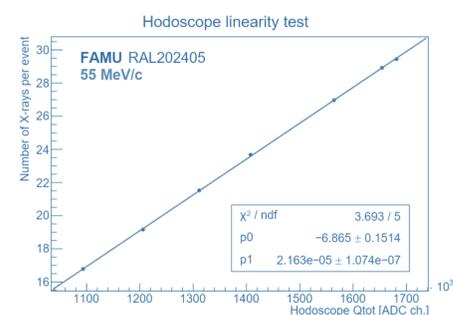


- Performance:
- Great stability
 - Good linearity between Q_{tot} e φ
 - φ resolution < 2%.

It is allowing both beamline diagnostic and correction during the FAMU data acquisition, and off-line data normalisation.

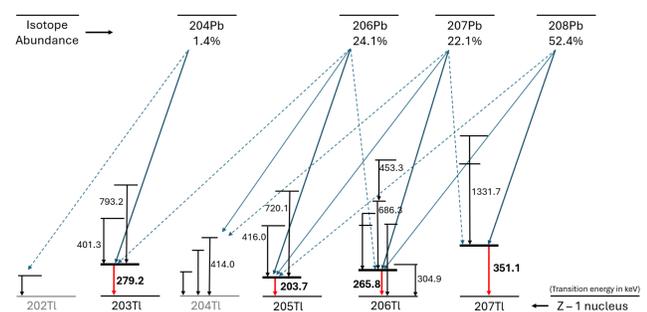
our latest paper on The FAMU beam monitor

R. Rossini et al. (the FAMU Collab.). The Muon beam monitor for the FAMU experiment: design, simulation, test and operation. Front. Detect. Sci. Technol., Vol. 2, 2024.



Spin-off for cultural heritage: CHNet-MAXI

Isotopic analysis in Pb studying the X and γ emission of muonic lead atoms obtained from sample irradiation with negative muons.



Similar beam monitor implemented, data acquisition in December 2025 with standard Pb samples of different isotopes. Results on their way!

Spin-off for beamline diagnostics

Collaboration UNIPV-ISIS to develop low-momentum beam monitors based on thin scintillator. Funded through a grant by the Royal Society.

