# High performance DAQ for muon spectroscopy experiments

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## BEAM MONITORING HODOSCOPES

- one with 64 1x1mm$^2$ squared fibers with EMA & SiPM-based readout - AdvanSiD with side 3mm (cell side40μm)
- 2 with 64 3x3mm$^2$ squared fibers with Al wrap & SiPM-based readout - Hamamatsu S12752 with side 3mm (cell side 25μm)

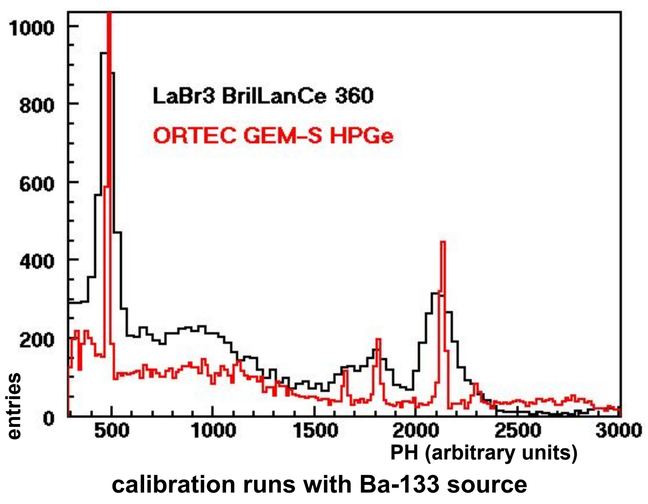
## FAST SPECTROSCOPY

- many $LaBr_3$(Ce) crystals - decay time 16ns
  - ↘ PMT-read with Hamamatsu R11265-200
  - ↘ SiPM-read with various sensors
- one standard cylindrical 1''×1'' BrilLanCe 380

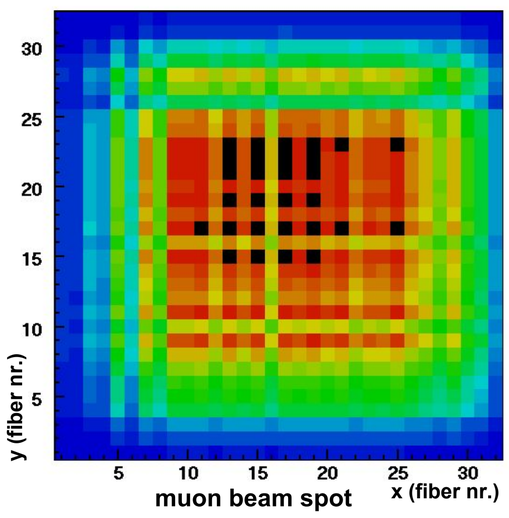
## HI-RES SPECTROSCOPY

ORTEC HPGe: one GLP and one GEM-S from INFN Milano Bicocca, one GEM-S and one GMX from RIKEN-RAL Muon Facility

- ↘ FWHM < 1keV @ 122keV for all the detectors



calibration runs with Ba-133 source



muon beam spot

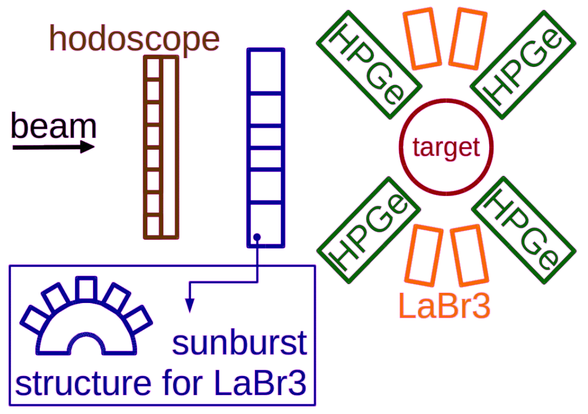
## Beam from the RIKEN-RAL Muon Facility @ ISIS Neutron and Muon Source

- extracted from ISIS proton synchrotron
- (20,120)MeV/*c* muons
- momentum tuning with a sensitivity of 1MeV/*c*
- 2 successive spills (~100ns wide) at ~37.5Hz
- $10^4$ muons per spill (with $\mu^-$ @ ~50MeV/*c*)

## FAMU — Fisica degli Atomi MUonici

high time resolution spectroscopy: study of out-of-spill X-ray emission resulting from muon transfer between muonic hydrogen and higher-*Z* elements in gaseous mixtures, with the aim of measuring the hyperfine splitting in the ground state of muonic hydrogen

## CHNET_TANDEM — Cultural Heritage NETwork Tecniche Analitiche Non Distruttive per l'archEoMetria

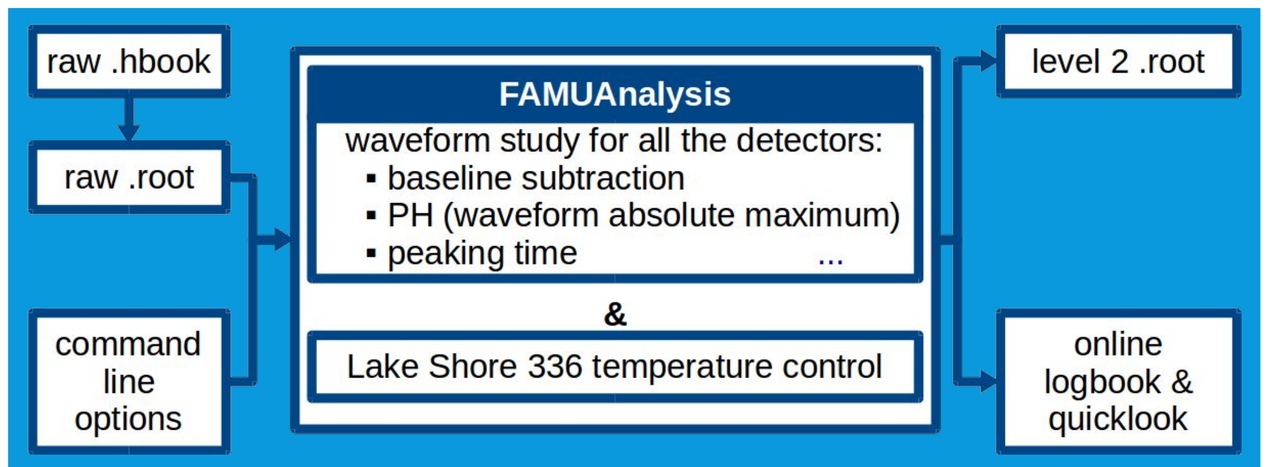


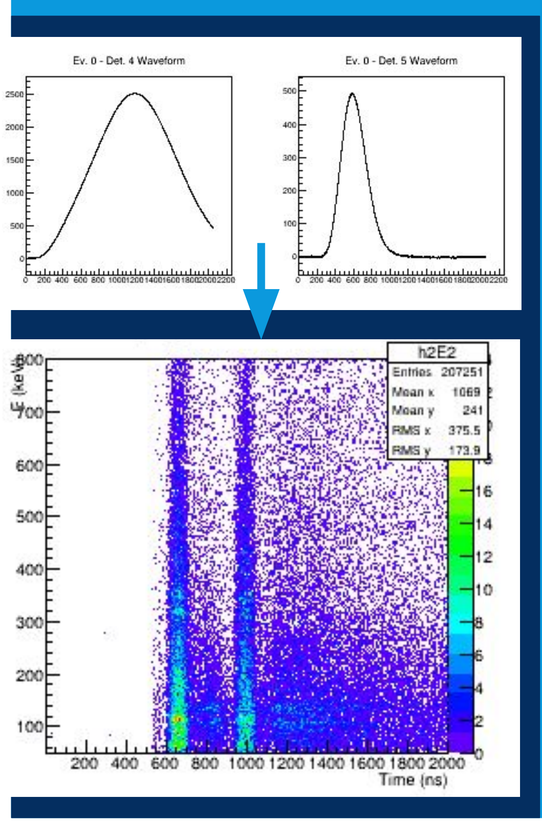

high energy resolution spectroscopy: study of X-ray emission of decaying muonic atoms in metallic artifacts - internal composition analysis with good depth resolution via beam momentum tuning

digitizers-based readout in order to meet many different needs...

| | CAEN V1724 | CAEN V1730C | CAEN V1742 |
|---|---|---|---|
| **nr. of channels** | 8 | 8 | 32+2 |
| **resolution** | 14 bit | 14 bit | 12 bit |
| **input range [Vpp]** | 10 (custom version) | 0.5 or 2 (selectable for each channel) | 1 |
| **sampling rate (simultaneously on each channel) [MS/s]** | 100 | 500 | 750 to 5k (selectable) |
| **memory depth** | 512 kS/ch | 640 kS/ch | 128 ev/ch 1kS/ev |
| **single channel settings** | yes | yes | no |
| **comments** | wide range needed for HPGe preamplified signals | high speed good for fast spectroscopy setup | large nr. of channels needed for hodoscopes (3 in beam focus search config.) |

Electronics for HPGe: ORTEC preamp & ORTEC 672 amplifier (shaping in 500ns) for GLP; GALILEO preamp & ORTEC 579 fast-filter amplifier (shaping in 250ns) for GEM-S




C++ and ROOT-based tool for real time automatic raw data conditioning, first level analysis and results display: every few seconds bash scripts search in raw data directory for new files for

- backup at CNAF;
- level 1 analysis for each detector (from raw waveforms to PH, peaking time, etcetera);
- online logbook pages and quicklook plots filling.

**Full-run automatic analysis in a few tens of seconds!**