# Upgrade of the flash beam monitoring system at ARRONAX cyclotron

Quentin Mouchard, Noël Servagent, Charbel Koumeir, Guillaume Blain, A. Bongrand, Sophie Chiavassa, Sylvain Deffet, Grégory Delpon, Manon Evin, Arnaud Guertin, et al.

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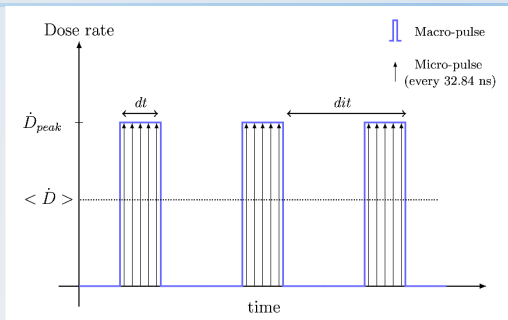
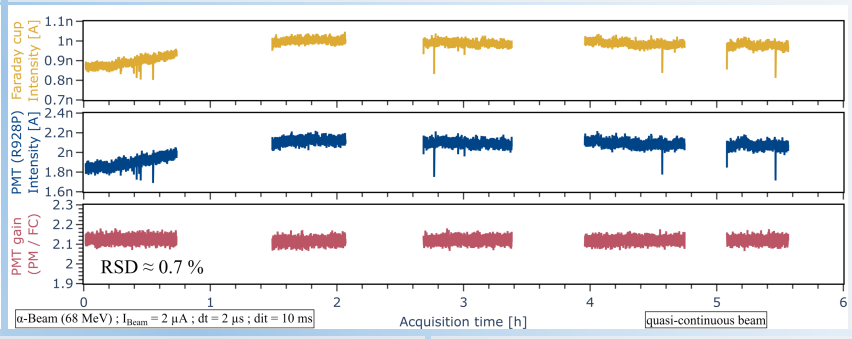
## Previous results

The **radiobiological platform at ARRONAX** offers different types of particles (**protons**, deuterons, **alpha**) in an energy range of **up to 68 MeV**, with two delivery modes: **continuous** and **pulsed beams**. In addition, beam monitoring (intensity and profile), based on the detection of air fluorescence, with a PMT is in progress for an **ultra-high pulsed dose rate up to an order of magnitude** $(\mathcal{O})$ **of 100 kGy/s**.

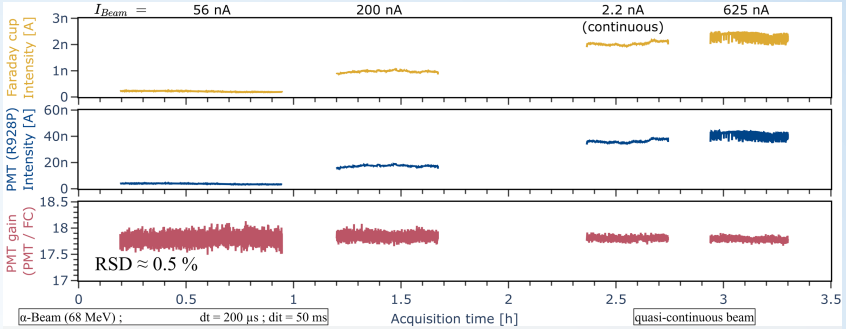



## PMT gain stability as a function of time



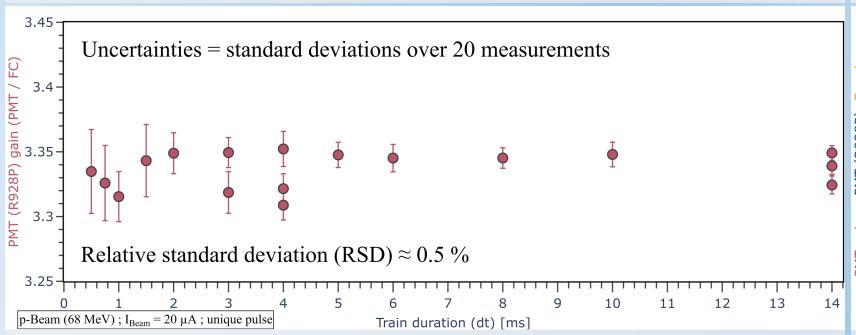

- ✓ Correlation of the PMT intensity: $I_{PM} \propto I_{FC}$
- ✓ PMT gain constant over time for continuous beam

## PMT gain stability as a function of beam intensity



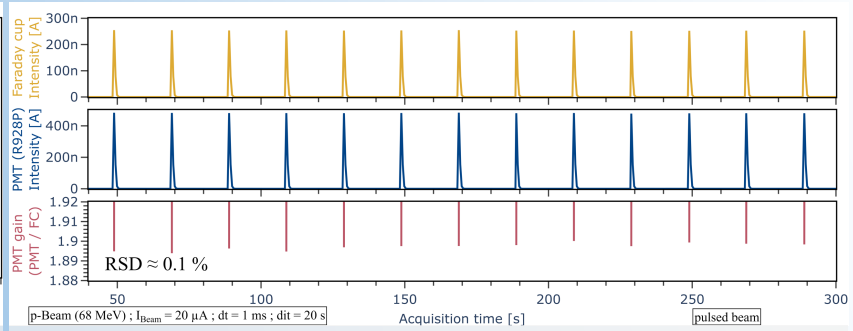

✓PMT gain constant over beam intensity $I_{Beam}$ $\mathcal{O}(10)$ nA to $\mathcal{O}(1)$ µA

## PMT gain stability as a function of pulse width



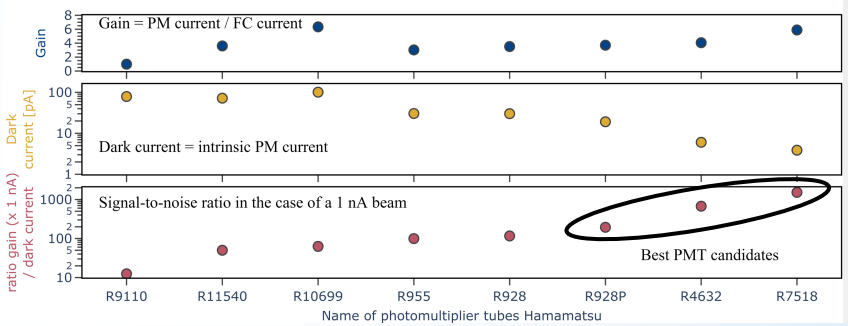

✓ PMT gain constant over width pulse

## PMT gain stability with a pulsed beam




✓ PMT gain constant over time for pulsed beam

## Selection of photomultiplier tubes (PMT)




**To increase the sensitivity** of the device for the **beam profile** (low light intensities), we made a selection of PMTs offering the **best signal-to-noise ratio, low dark current, high gain** and **reasonable cost**.

## Conclusions / Outlook

- ✓ **Stable gain** over time, in the case of a **quasi-continuous** and **pulsed beam** ➔ **robustness** of PMT
- ✓ **Stable gain** for different **pulse widths (dt)** and **beam intensity** ➔ **adaptability** of PMT
  - ➢ The **PMT** allows **continuous and pulsed beam monitoring** at **conventional** and **ultra-high dose rates**. The **same dosimetric protocol** can be used regardless of the beam structure and dose rate.
- ❑ The development of a new beam profiler based on PMTs is in progress, thanks to the choice and characterisation of a suitable PMT (best gain/dark current ratio).

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