

Time-dependent instrumental effects in IXPE: pressure variation and GEM charging inside GPDs

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We present the results of analyses conducted on two of the long-term effects of a Gas Pixel Detectors (GPD), central point of the X-ray detection, imaging and spectroscopy of the IXPE mission: the charge build-up in the dielectric layer of the Gas Electron Multiplier (GEM), amplification stage of the detector and the pressure decrease inside the gas cell, due to gas absorption in the sealed volume. For the latter effect, we have performed quantitative measurements of gas absorption by the epoxy glue bonding the detector layers.

The Gas Pixel Detector

Is a multi-purpose X-ray gas detector in the energy band 2–8 keV based on photoelectric effect, capable of providing imaging, spectroscopy and polarimetry of the incoming radiation. Its active gas is the Dymethyl Ether (DME) and the amplification stage of signal current is a GEM layer (specifics?).

Charging effects

Per Alberto (Chiara): le cose che ho scritto di verde sono da modificare, volevo giusto avere un'idea del layout del poster :)

Pressure variations inside control GPDs

The pressure inside GPDs is assumed to decrease exponentially, monitored indirectly measuring three proxies:

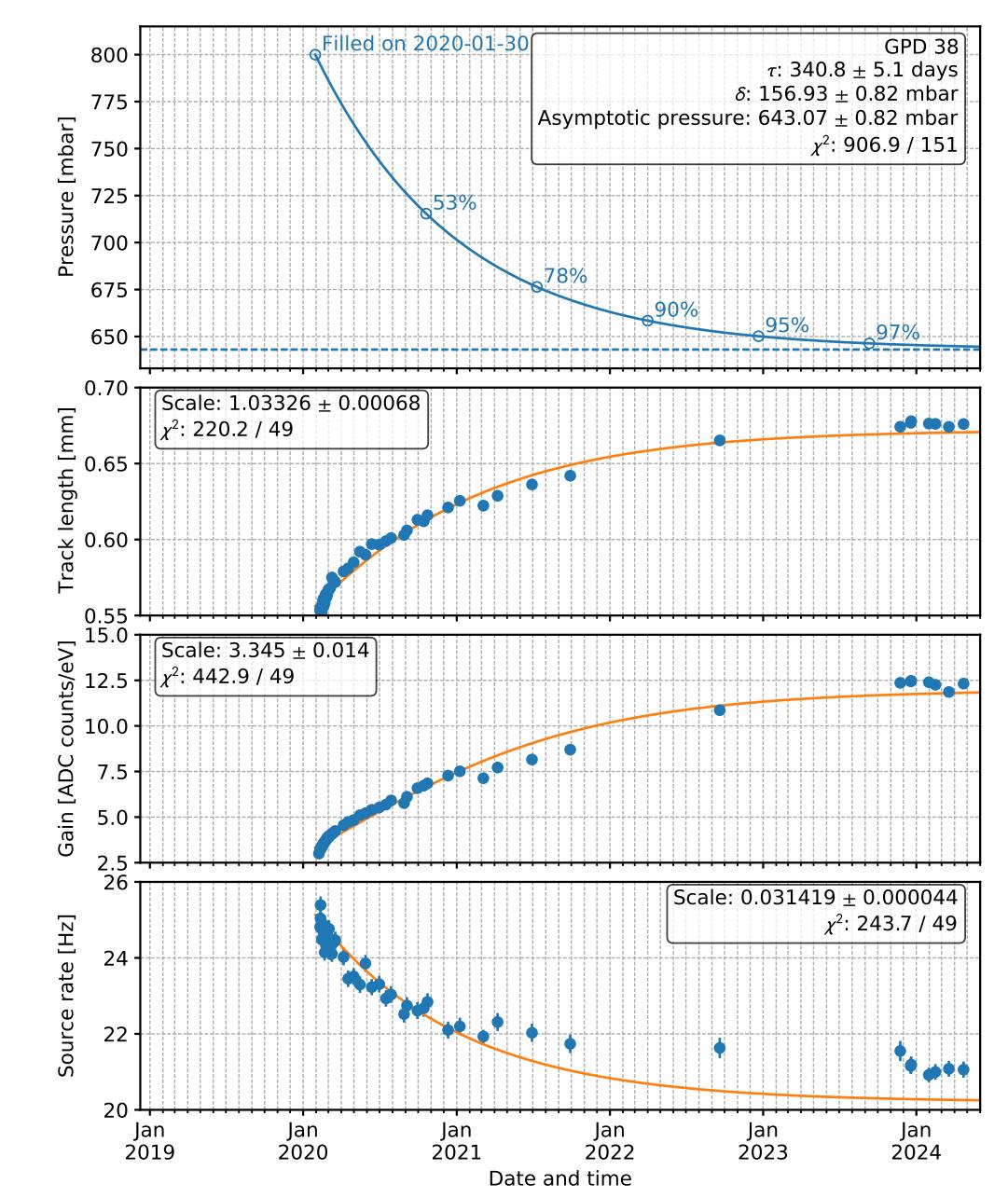
► **detector gain:**

$$G(p) = G(p_0) \cdot \exp \left\{ -\frac{p_0 - p}{p_{scale}} \right\}$$

► **track lenght:**

$$L(p) = L_0 \cdot \left(\frac{p}{p_0} \right)^{\alpha_L}$$

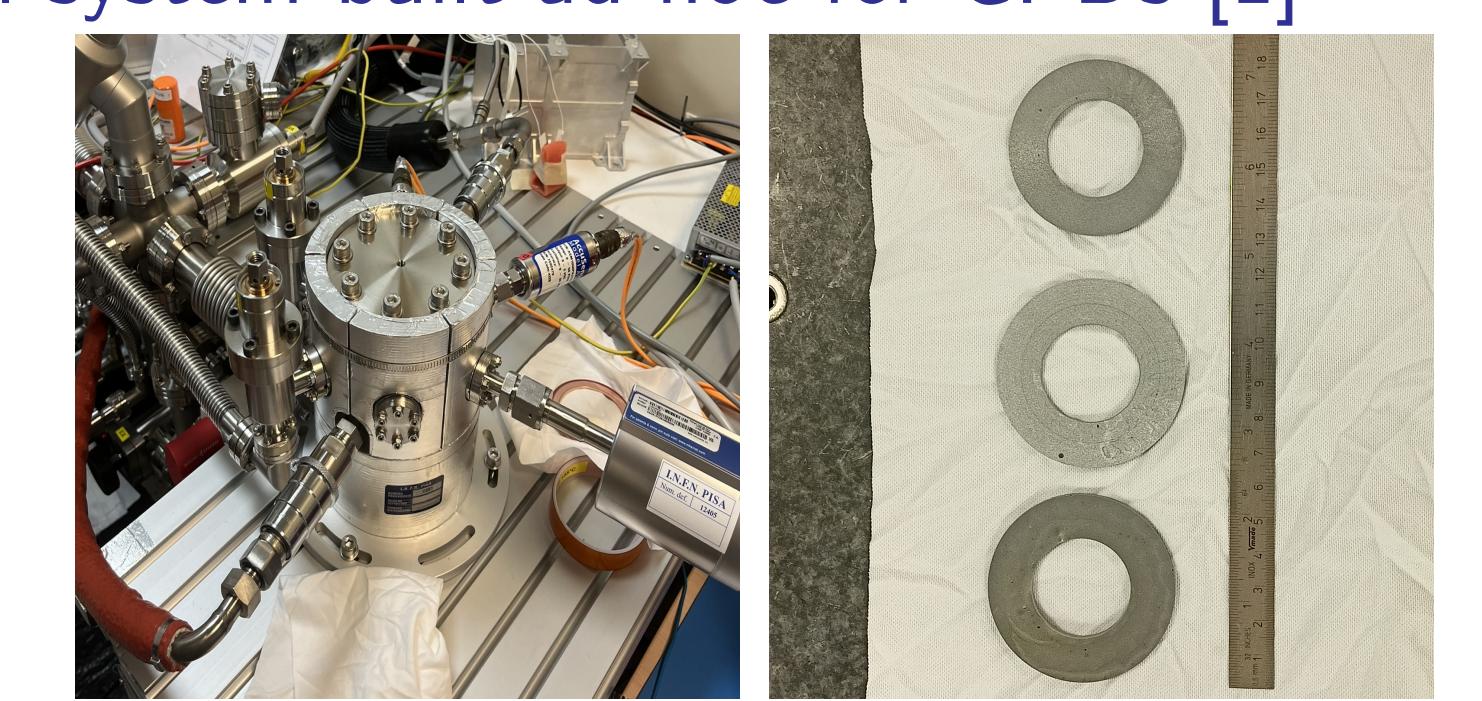
► **relative event rate** in a controlled setup: $R(p) \propto p(t)$



The Absorption Chamber

We have performed the gas absorption measurements inside a dedicated chamber, part of a bake-and-fill system built ad hoc for GPDs [1]

- externally filled with gas Ar or DME and thermally controlled;
- equipped with pressure sensors.

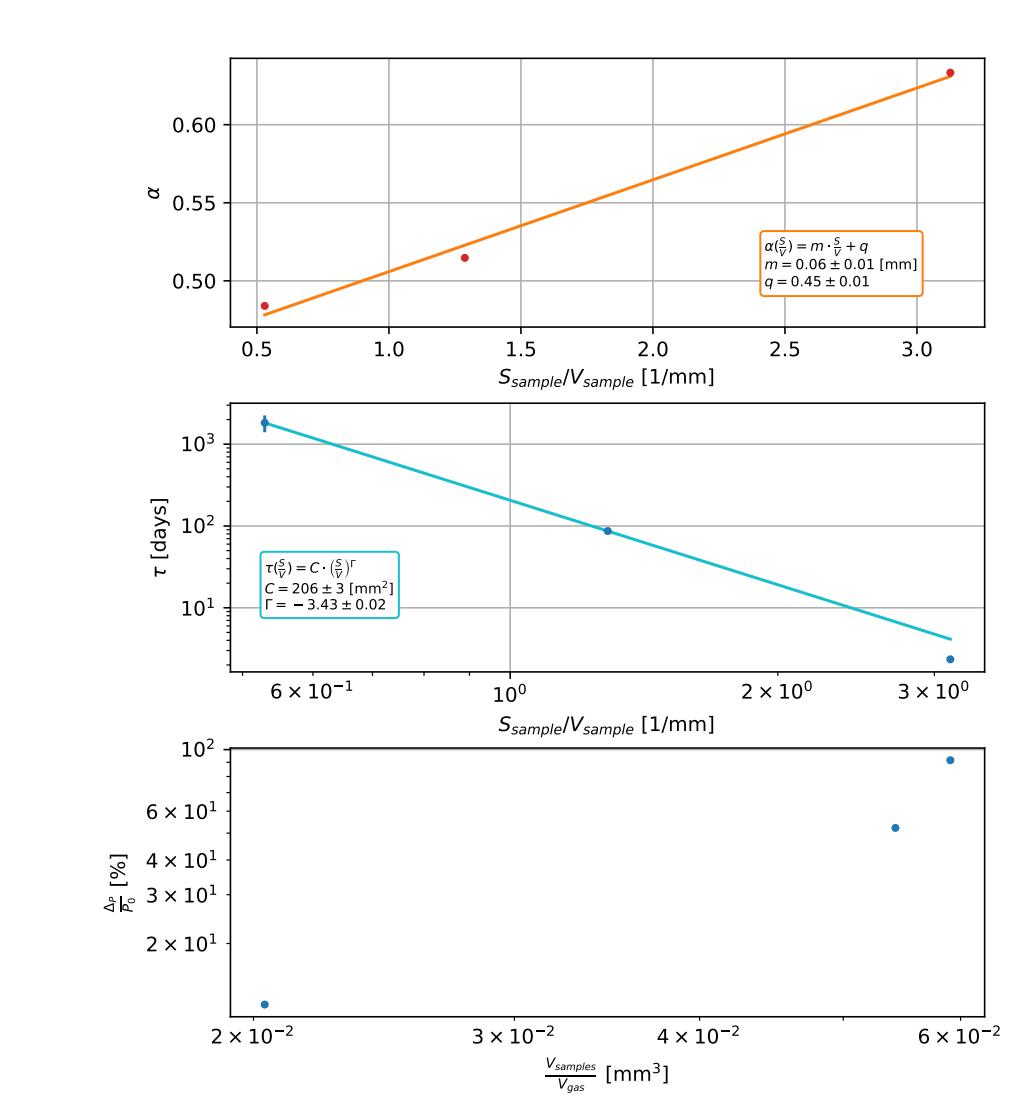
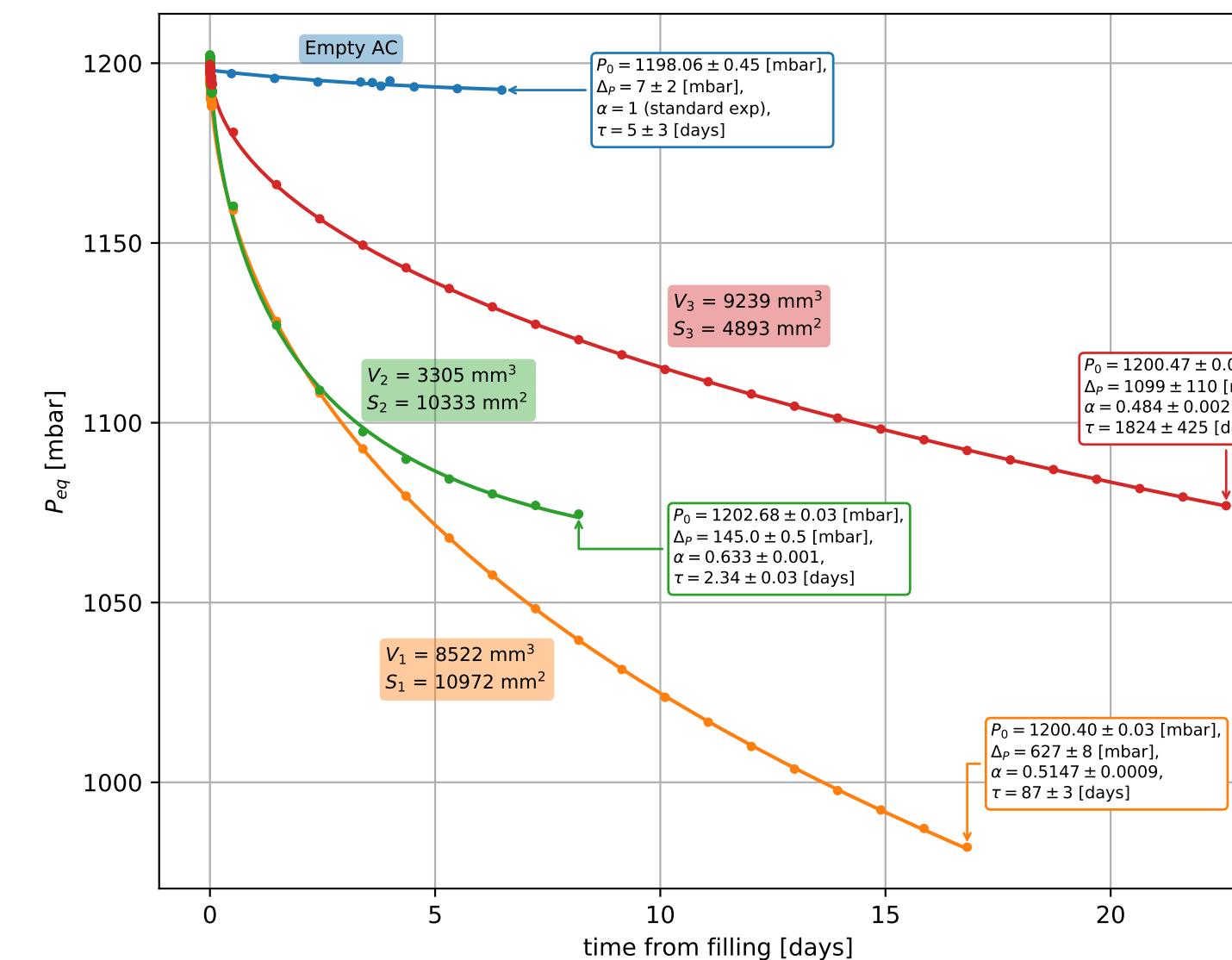


Results

The epoxy glue absorption can be modeled with a stretched exponential:

$$P_{gas}(t; P_0, \Delta_P, \alpha, \tau) = P_0 - \Delta_P \cdot (1 - \exp^{-\left(\frac{t}{\tau}\right)^\alpha}) \quad (1)$$

with $\alpha < 1$, specifying an anomalous **subdiffusive** process.



Conclusions

- Gas absorption by glue is responsible for the pressure decrease, the process is subdiffusive, modeled by a stretched exponential;
- α and τ depend on $\frac{S}{V}$, Δ_P depends on V .

References

[1] Proceedings Volume 12678, UV, X-Ray, and Gamma-Ray Space Instrumentation for Astronomy XXIII; 126781A (2023)