

# HRPPD AfterPulses

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## AfterPulses: time of arrival

- assuming uniform electric field  $E=200 \text{ V}/1.1 \text{ mm}$ , and zero initial velocity of ion at the entry MCP face we obtain:

$$t = \sqrt{\frac{2LM}{qE}} = \sqrt{\frac{2 \times 1.1\text{mm} \times 0.94\text{AGeV}/c^2}{Z_{eff} \times 200\text{V}/1.1\text{mm}}} = 11.23\text{ns} \sqrt{\frac{A}{Z_{eff}}}$$

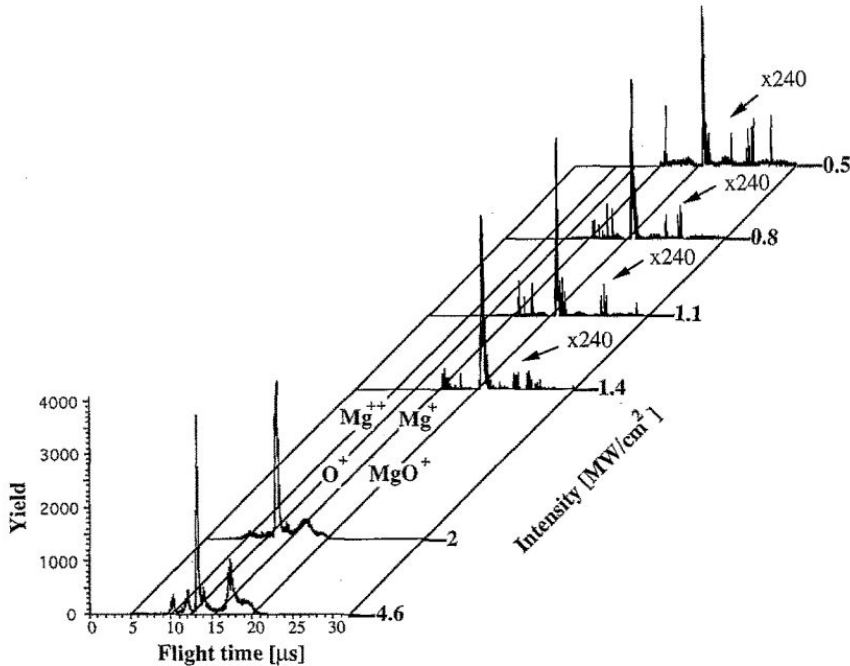
- p.e. drift** adds another **0.262 ns** delay to the above estimate;
- thus, for major ions in the MCP (MgO layer,  $\text{SiO}_2$ ):

$$\begin{aligned} t_{H^+} &= 11.49\text{ns} & t_{O^+} &= 45.18\text{ns} & t_{Al^+} &= 58.61\text{ns} \\ t_{Mg^+} &= 55.28\text{ns} & t_{Mg^{2+}} &= 39.16\text{ns} & t_{MgO^+} &= 71.29\text{ns} \end{aligned}$$

- no ion feedback at  $t < 11 \text{ ns}$ , having 200 eV kinetic energy we expect ion impact to produce signals with many photo-electrons.

# Expected ions in HRPPD

- laser ablation data of MgO (secondary emission layer in HRPPD) show that at low energy most probable is emission of  $\text{MgO}^+$ , while at higher energy  $\text{Mg}^{++}$ ,  $\text{Mg}^+$  and  $\text{O}^+$  become dominant.

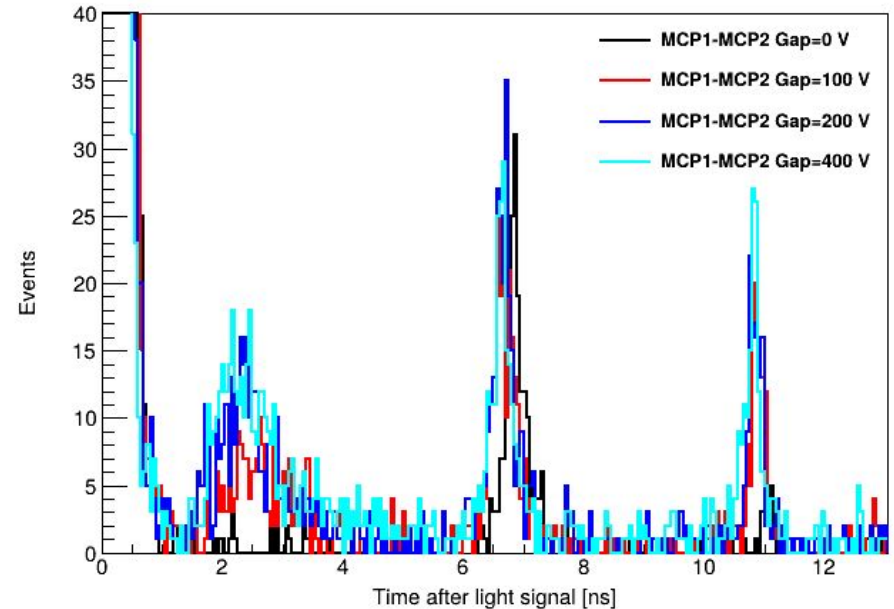
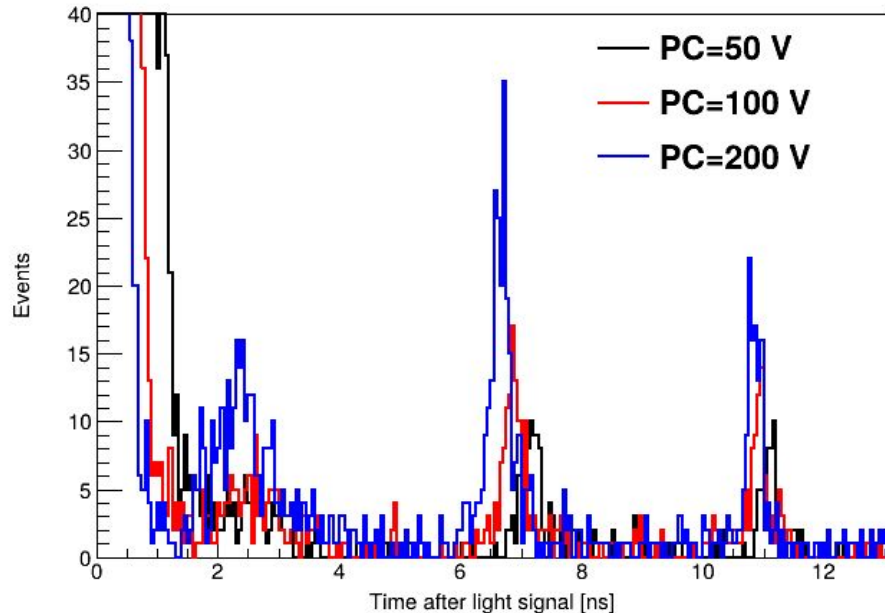


O. Kreitschitz, W. Husinsky, G. Betz, N.H. Tolk, "Laser induced desorption of ions from insulators near the ablation threshold", NIM B78, (1993) 327-332

Fig. 1. Time-of-flight spectra of MgO are shown as a function of laser intensity at 193 nm.

# AfterPulses with $\geq 1$ p.e. amplitude

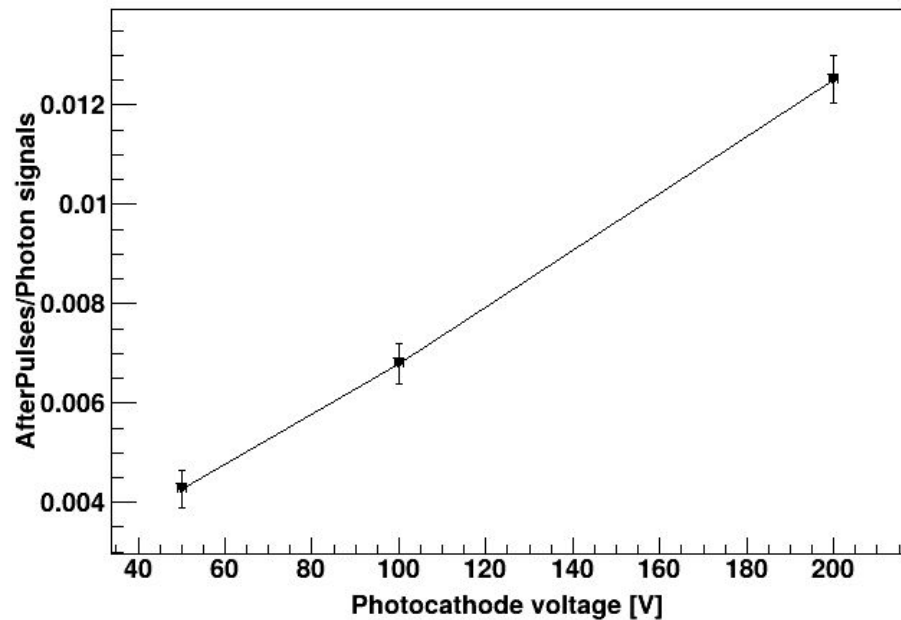
- PC bias increase by factor 2 gives peak time reduction on 0.1-0.3 ns - expected factor 1.4 reduction, or for  $H^+$  ions -5 ns, while for p.e. it should be -0.1 ns;
- peak at 2.5 ns almost disappears at  $PC < 200$  V;
- at zero voltage in MCP1-MCP2 gap peaks at 2.5 and 11 ns almost disappear.



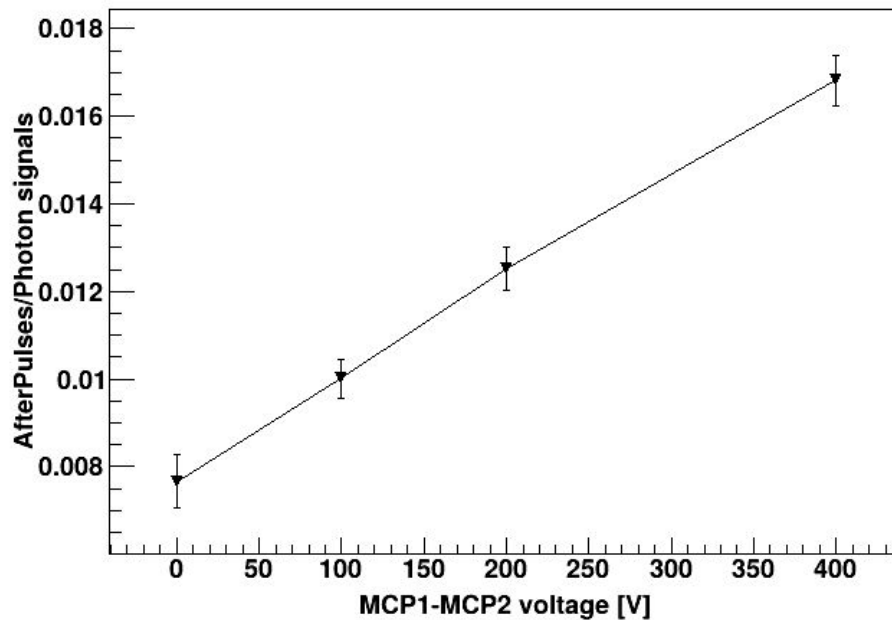
# Relative rate of AfterPulses with $t > 10$ ns

- rate of AfterPulses increases linearly with PC and MCP1-MCP2 gap voltages;
- we reached integrated precision of 0.05%, but still don't see ion feedback peaks;
- each run of  $10^5$  pulses had about  $5 \cdot 10^4$  PE signals - still insufficient?

Relative Rate



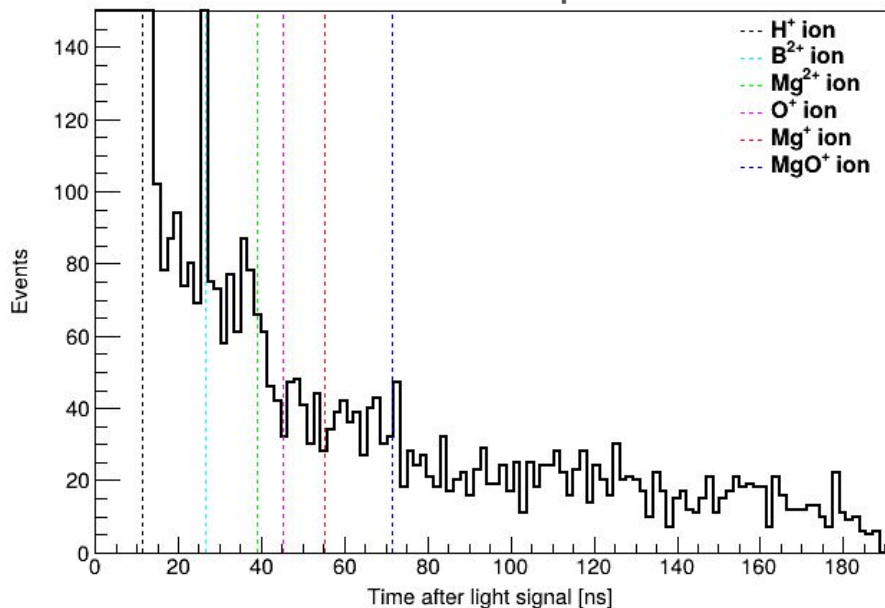
Relative Rate



# AfterPulses combined data at PC=200 V

- summed up 9 runs for about  $4 \cdot 10^5$  signals;
- limits:  $\text{Mg}^{2+} < 10^{-4}$ ,  $\text{O}^+ < 10^{-5}$ ,  $\text{Mg}^+ < 10^{-5}$ ,  $\text{MgO}^+ < 4 \cdot 10^{-5}$ ;
- datasheets quote AfterPulse contribution  $< 4\%$ .

threshold  $\geq 1$  p.e.



threshold  $\geq 2$  p.e.

