Gas-filled Wire Electron Multipliers of high spatial resolution for high rates (simulation)

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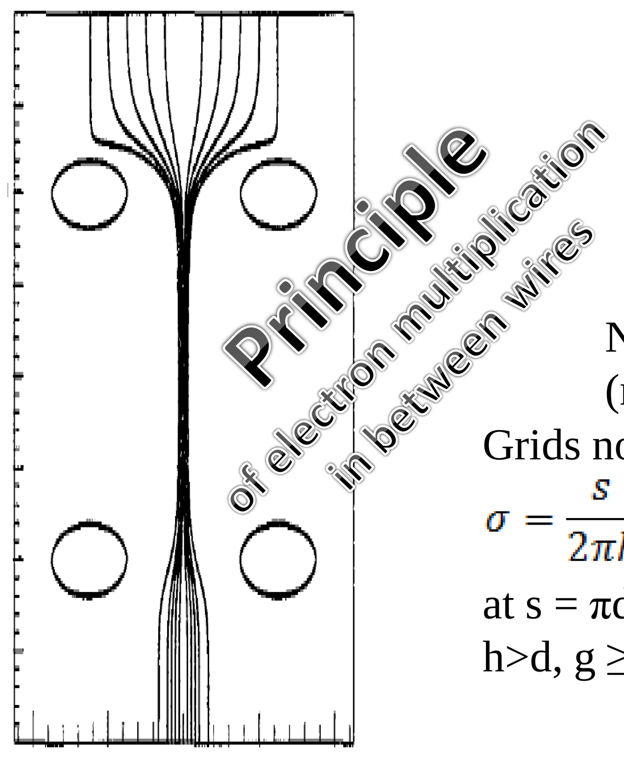
M.Shafranov, T.Topuria (2001) [1]



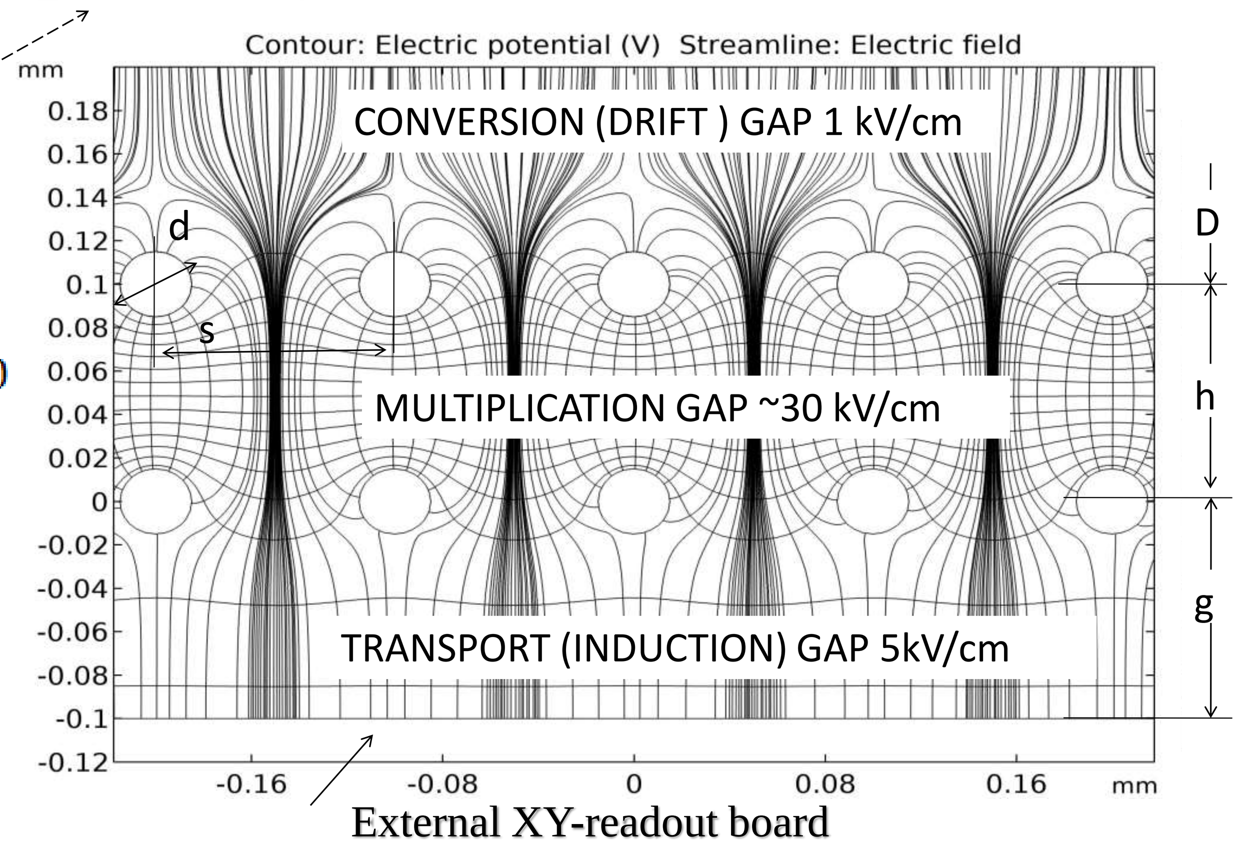
Numbers (microns)
Grids nontransparency

$$\sigma = \frac{s}{2\pi h} \cdot log\left(\frac{s}{\pi d}\right) = 0$$

at s = πd [2]
h>d, g ≥ h

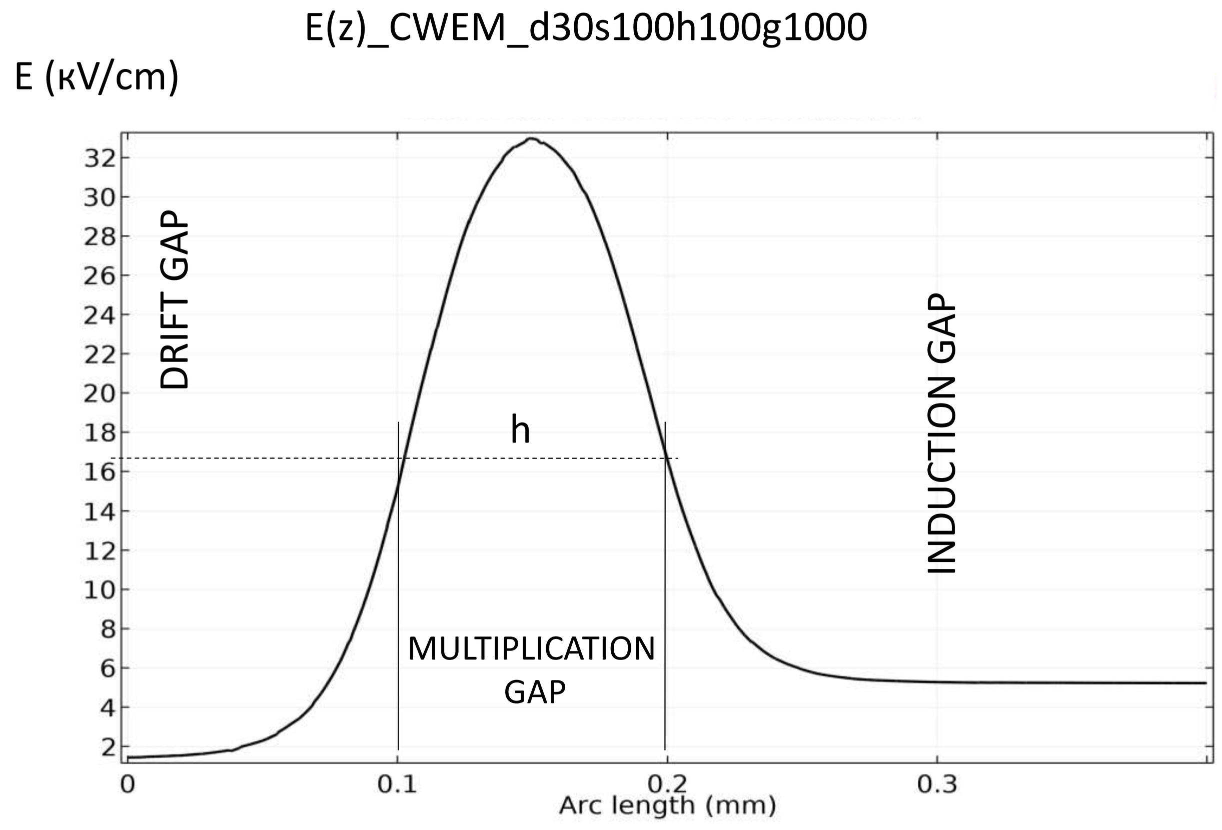
2 Parallel wires PWEM without multiplication in induction gap at g=0.1-1 mm with DLC readout anode

PWEM_d30s100h100g100; -100/0/+350/+400V Field created with COMSOL [3]

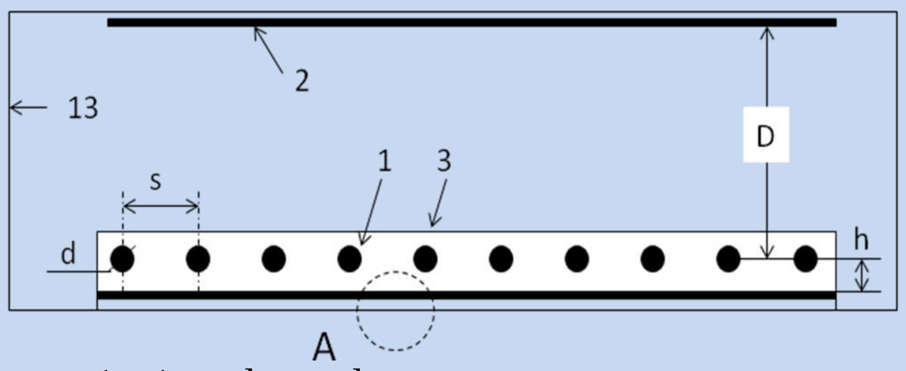


External XY-readout board

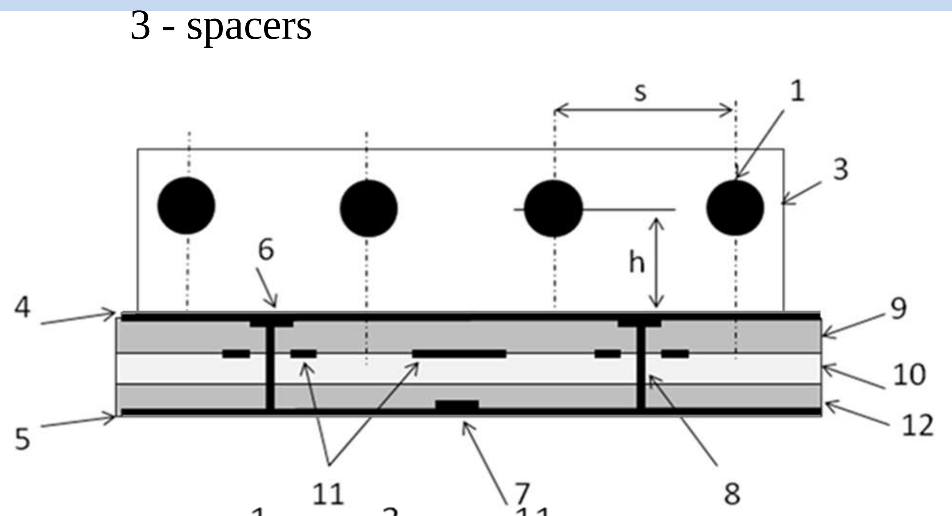
E(z)_CWEM_d30s100h100g1000

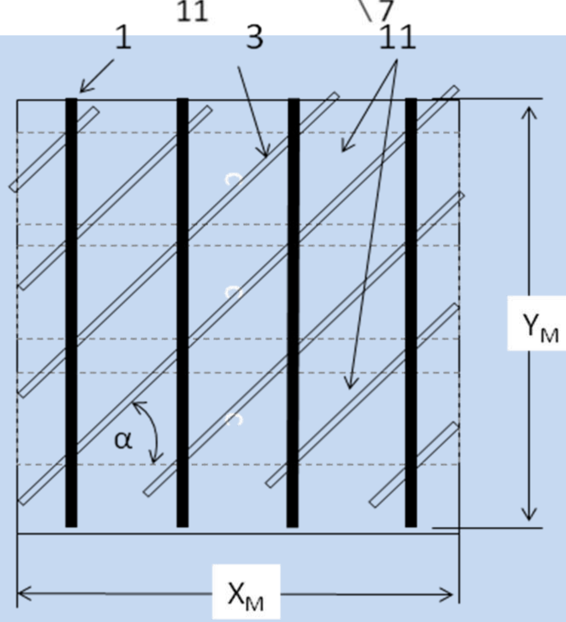


1 The simple μRWEM at g=0 μRWELL-like detector with DLC anode and XY-readout board

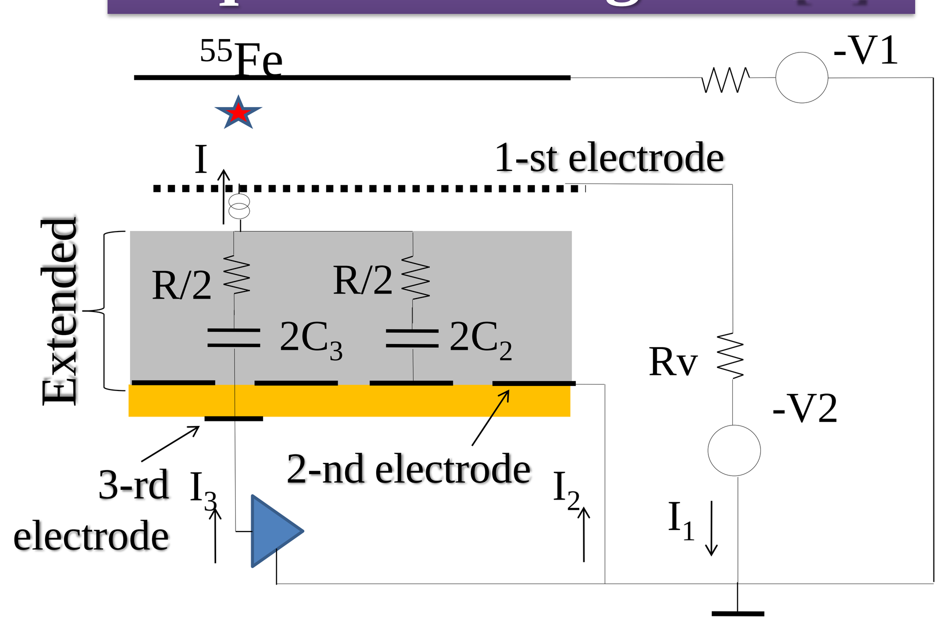


1 - 1-st electrode
4,5,6,7,8 - 2-nd electrode
11 - 3-rd electrode (readout, e.g. zig-zag strips)
3 - spacers

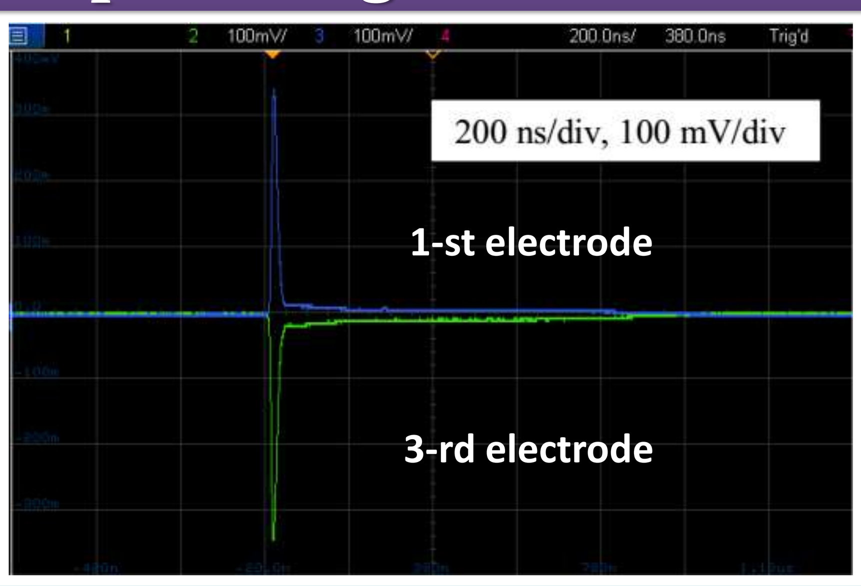




Equivalent diagram [4]

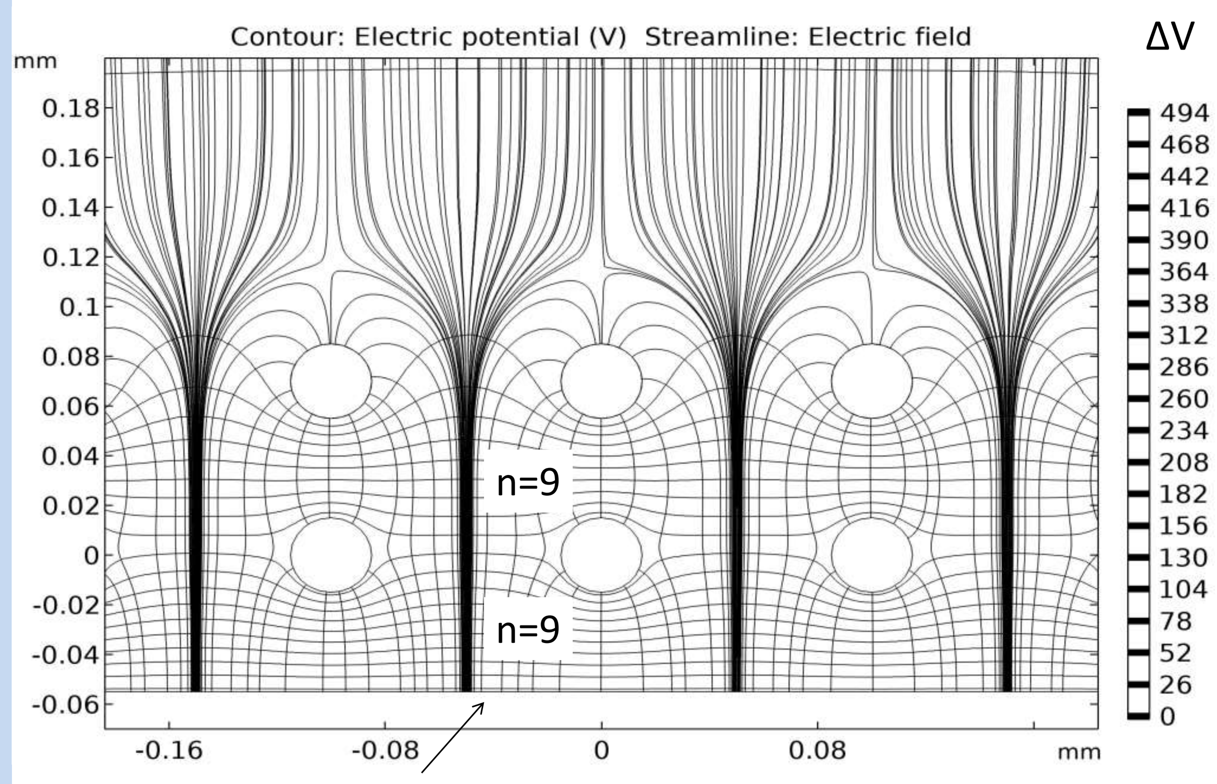


Expected signals at G=2000 [4]



3 PWEM with multiplication in induction gap at g=h=40 μm with DLC anode and external XY-readout board

PWEM_d30s100h40g40; -100/0/+250/+500V

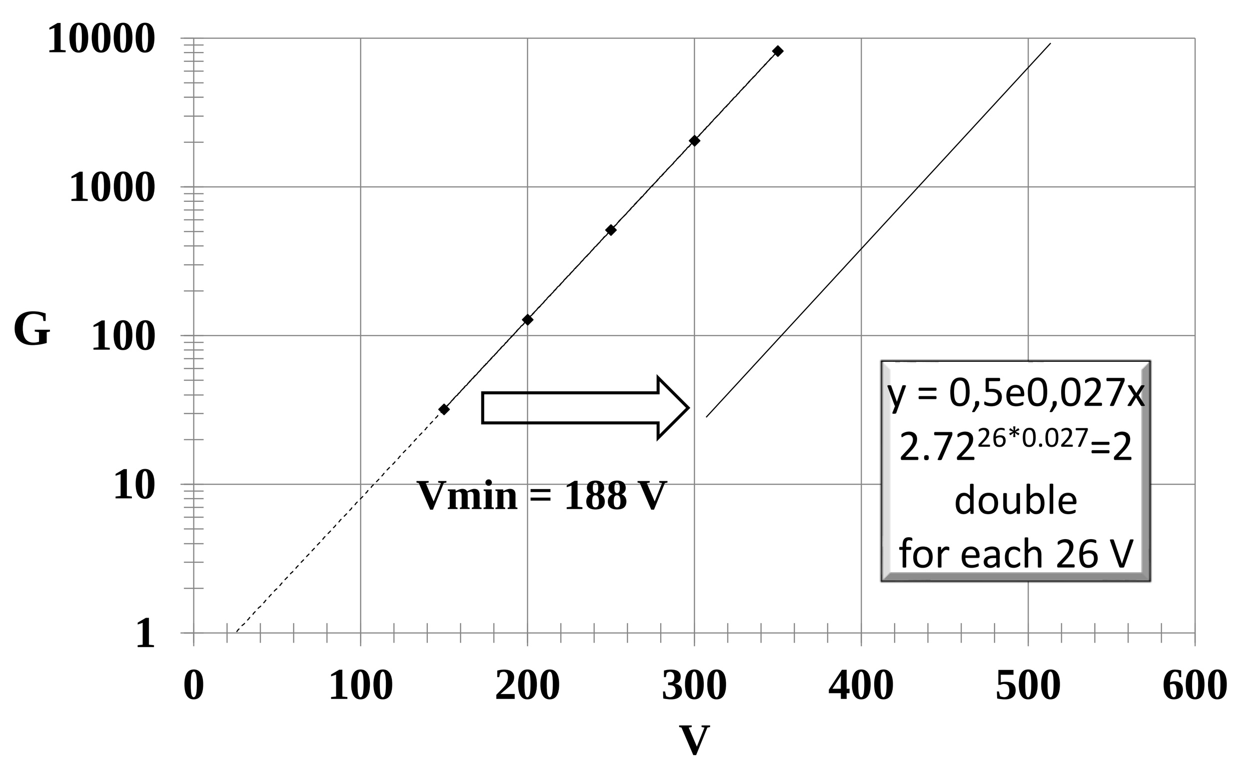


External XY-readout board

Gas Gain parameterization

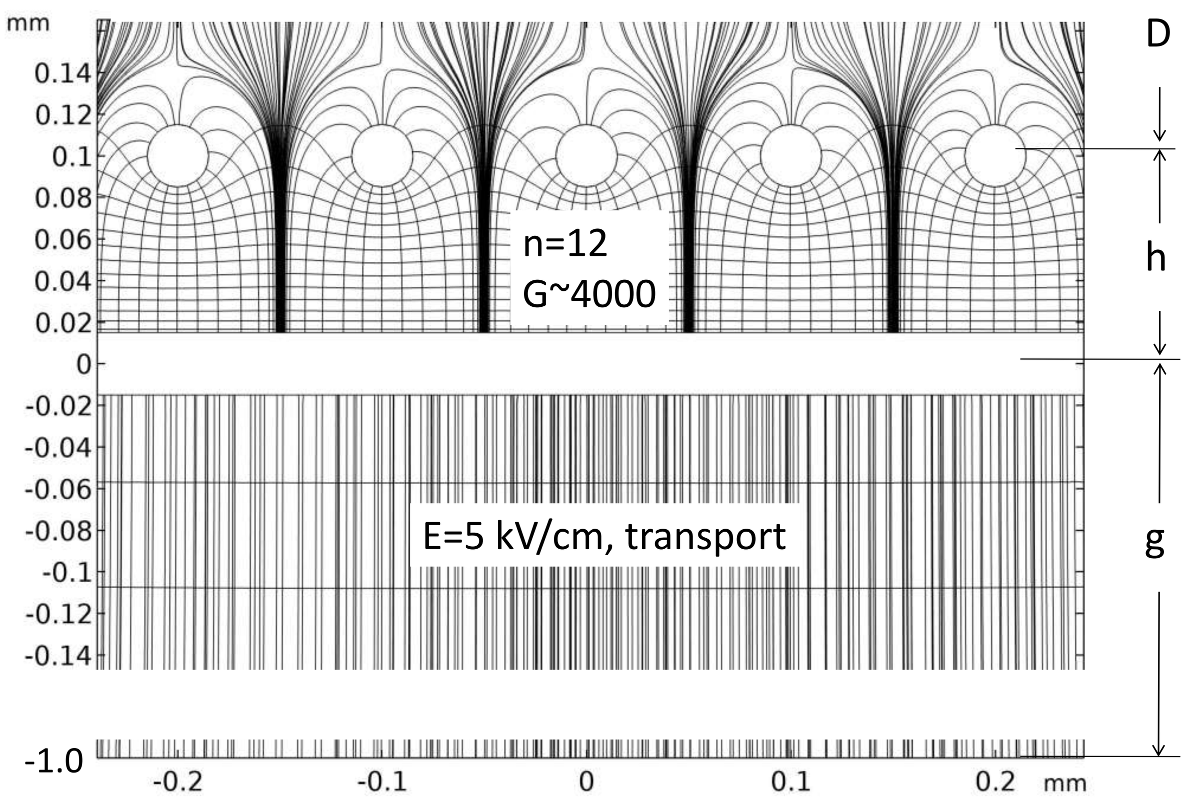
$G=2^{(V-Vmin)/\Delta V}=2^n$

where Vmin corresponds to Emin,
at which multiplication starts
(to be measured, Vmin ≈188 V in our case)
ΔV=26 V - corresponds to average energy,
at which electon-ion pair is created:
in Ar ~15 eV ionization, ~11 eV exitation
n – number of equipotentials obtained
with COMSOL



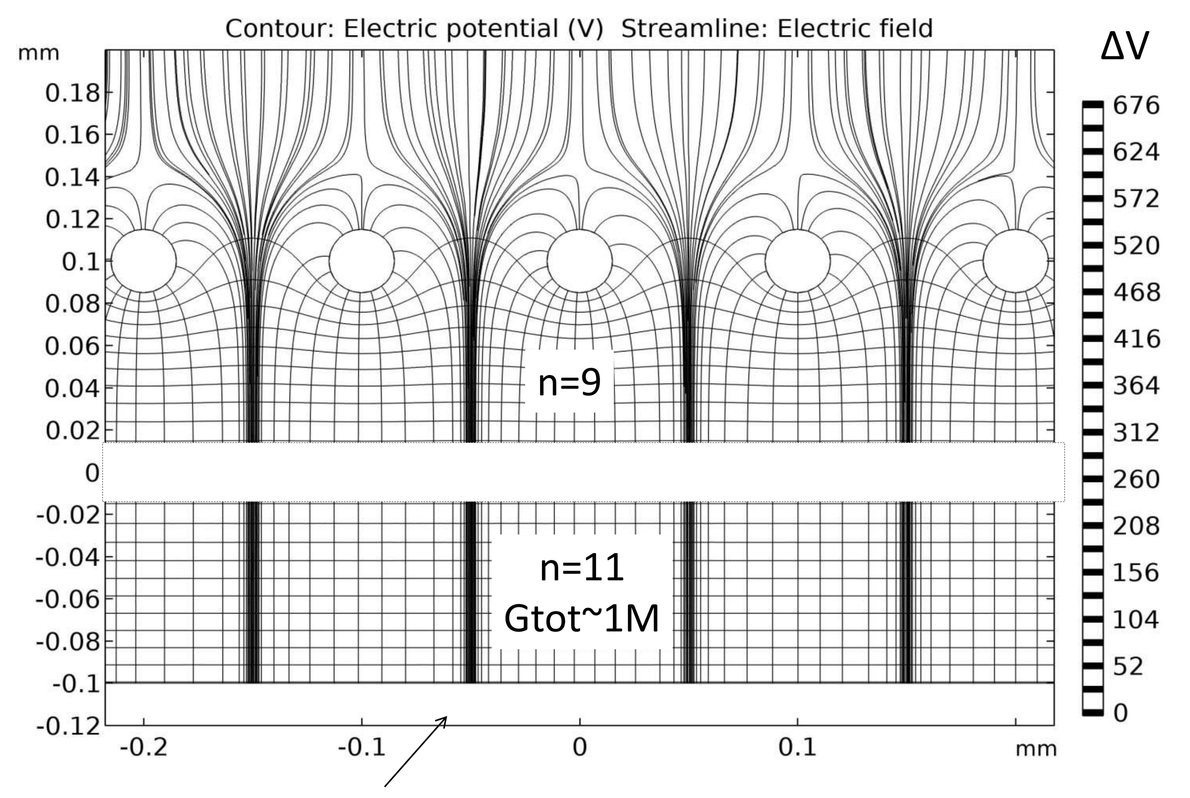
4 Crossing wires CWEM without multiplication in induction gap with direct XY-readout from wires at low X/X0~0.02%

CWEM_d30s100h100g100; -100/0/+350/+400V



5 CWEM with multiplication in induction gap at g=0.1 mm with DLC anode and external readout board

CWEM_d30s100h100g100; -100/0/+300/+600V



External XY-readout board

For the same geometry (d,s,h) one can obtain the gas gain in rather wide range for various applications optimized by changing D, g and Voltage, e.g. G~10 for thermal and cold neutrons, G~10⁶ for single photons, and G=(5-10)·10³ for X-Rays and MIPs

References
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3. https://www.comsol.ru/comsol-multiphysics
4. A.Kashchuk, V.Akulich, K.Afanaciev, V.Bayev, …, S.Movchan, et al. 2020 JINST 15 C09018.

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