Some thoughts about DESY testbeam puzzle “Low ToT values”

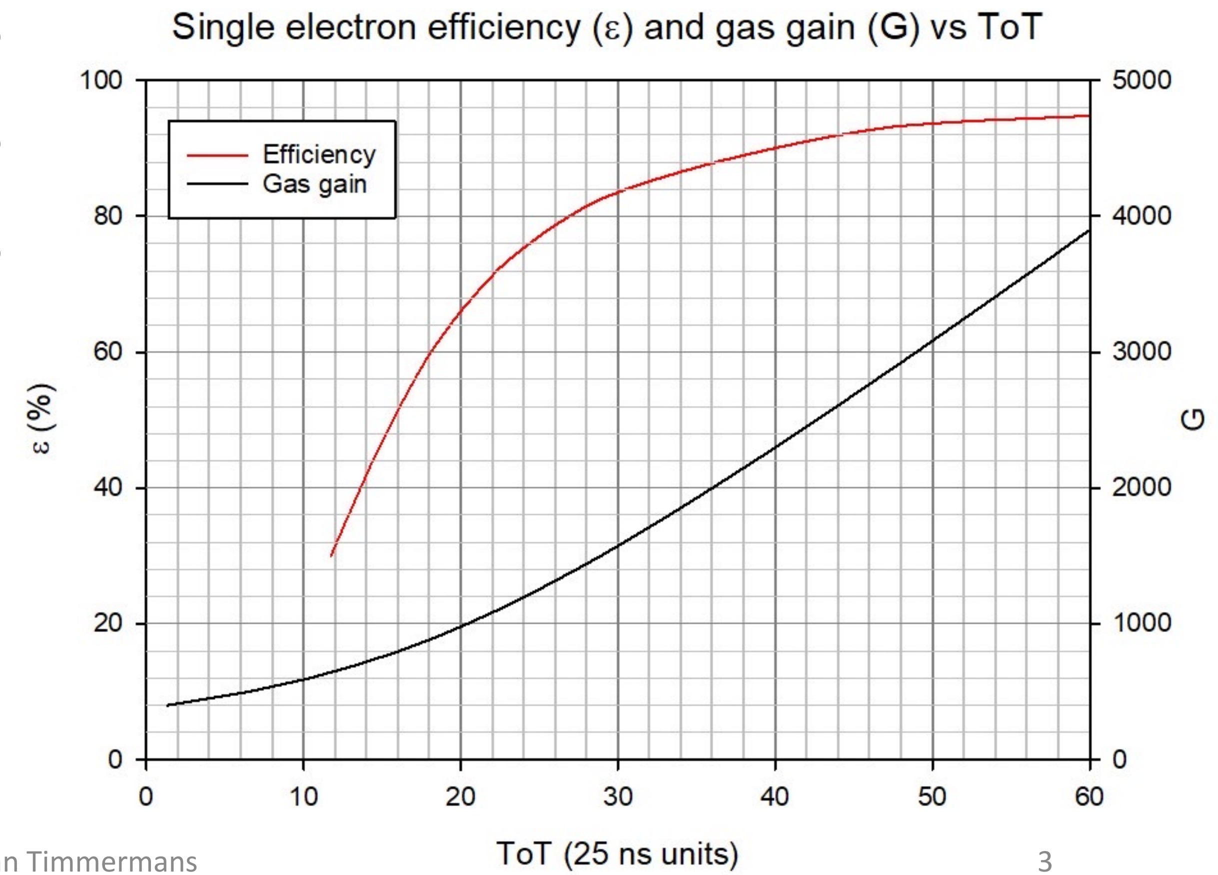
From thesis Kees:

- Fig. 4.6: mean ToT as function of –Vgrid
    - ToT = 20 <--> ToT =0.500 us
    - For T2K gas reached at Vgrid = 310 V (with quite some spread for 4 chips)
- Fig. 4.5: ToT as function of input charge for ONE chip
    - This should be measured/compared also for the (32) chips on the 8Quad system (maybe done already?)

From Fred's plot of efficiency and gain as function of ToT (but measured for Ar/iC4H10 82/18)

- ToT = 20: gain = 1000 eff. ~ 66%
- ToT = 30: gain = 1600 eff. ~ 84%
- ToT = 40: gain = 2300 eff. ~ 90%

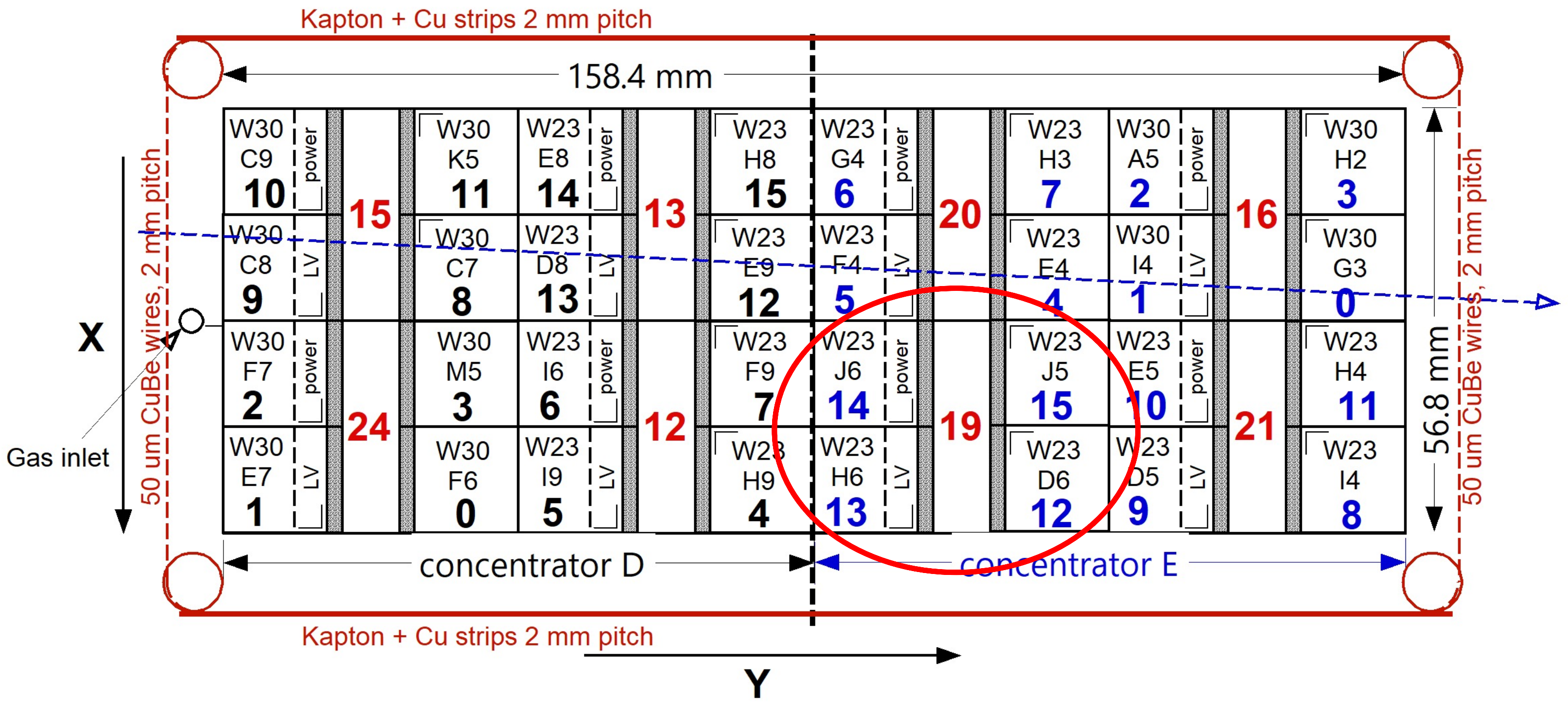
Values measured with TPX3 chip at Th = 550 e-
Efficiency curce measured in Ar/iC4H10 82/18
Gain curve measured with test pulses (Kees Ligtenberg)
8-5-2021



Chip layout and wafer map of TPX3 chips in 8Quad system

Orientation of TPX3 chips in Lepcol 8-quad testbox

View from drift region



Low ToT values for chips 28-31 (chips 12-15 of Wafer 23

23-3-2021
Fred Hartjes
Nikhef

Blue: wafer 23
Green: wafer 30

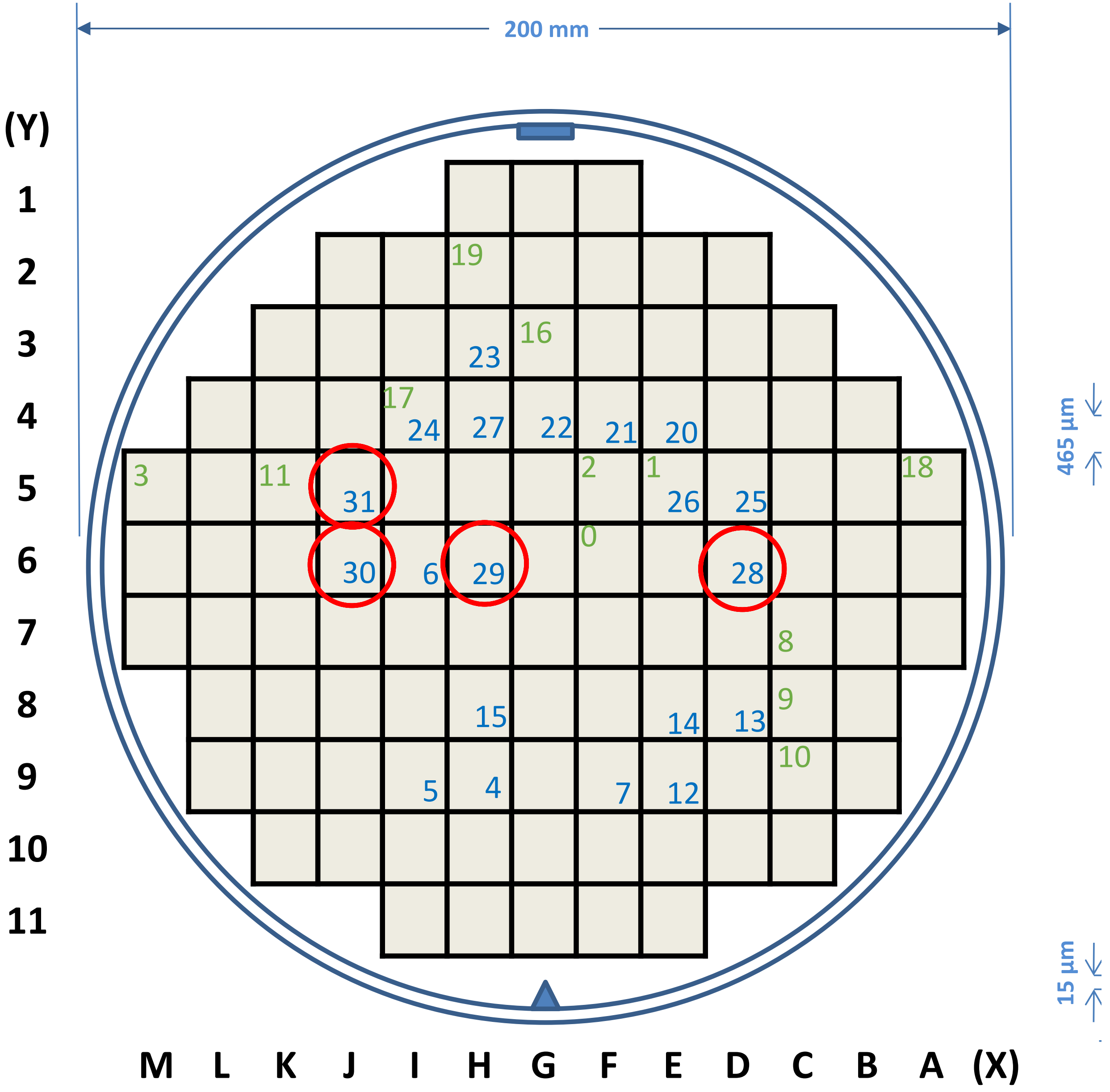


Figure 57. Timepix3 wafer step plan

Chip layout and wafer map of TPX3 chips in 8Quad system

- Only 2 chips at border of wafer: chip 3 and chip 18 (both wafer 30)
- Chips 10 and 19 (also wafer 30) are rather close to border
- All other chips of both wafers are located quite centrally on wafers 23 and 30
- My conclusion: lower ToT for chips 28-31 (wafer 23) not due to higher GridPix pillars

- To do (if not done yet):
    1. ToT calibration for all 32 chips
    2. ToA calibration (as also described in Kees' thesis, section 6.4.2)

From Y.Giomataris, NIM A419 (1998)239

$$M = \mathrm{e}^{\alpha d}, \tag{1}$$

where d is the gap of the two parallel electrodes and a is the Townsend coefficient, which represents the mean free path of the electron between two ionizations. A good approximation of this coefficient is given by Rose and Korff formula

$$\alpha = pA\mathrm{e}^{-Bp/E}, \tag{2}$$

where E is the electric field and A,B are parameters depending on the gas mixture. At high electric field values the Townsend coefficient saturates because

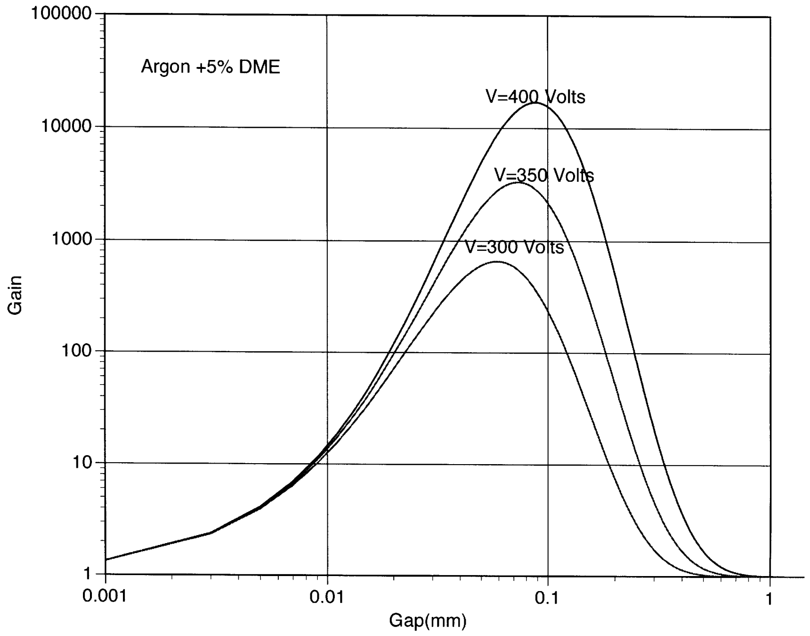


Fig. 2. Expected gain as a function of the amplification gap at various potentials.

Max Chefdeville's thesis, page 116

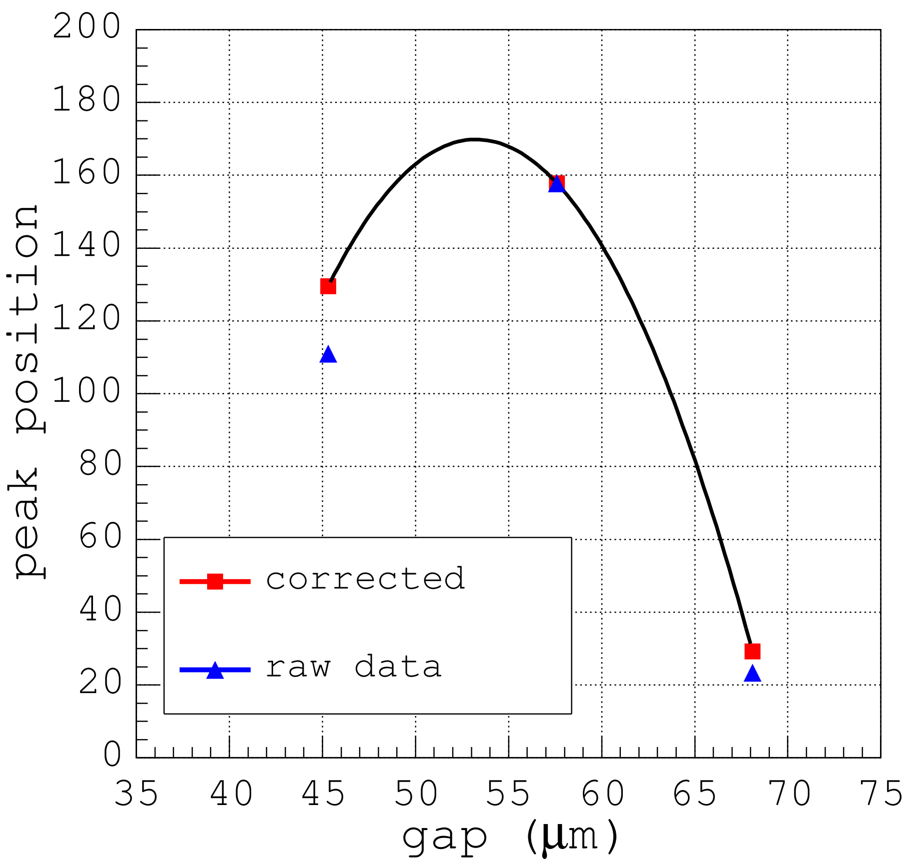


Figure 6.12: *Peak position, corrected for hole diameter variations, at a grid voltage of -390 V for three gap sizes. The data point at 57 μm is used as reference and is not corrected for diameter variations.*

$$\mathbf{v}_{\text{drift}} = \frac{q}{m}\frac{\tau}{1+\omega^2\tau^2}\left(\mathbf{E} + \frac{\omega\tau}{B}(\mathbf{E}\times\mathbf{B}) + \frac{\omega^2\tau^2}{B^2}(\mathbf{E}\cdot\mathbf{B})\mathbf{B}\right), \tag{3.5}$$

$$v_{\text{drift}} = \mu E = \frac{qE}{m}\tau, \tag{3.6}$$

$D_T(B)/D_T(B=0) = 1/\sqrt{1+\omega^2\tau^2}$

$D_T(B=1T)/D_T(B=0) \sim 70/300 \sim 1/4.3$

$\omega\tau \sim 4.2$

At B = 4T, $\omega\tau \sim 10$