# Implementing GridPix in a Darwin detector

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Atoms 4.6%

Dark Energy 72%

Dark Matter 23%
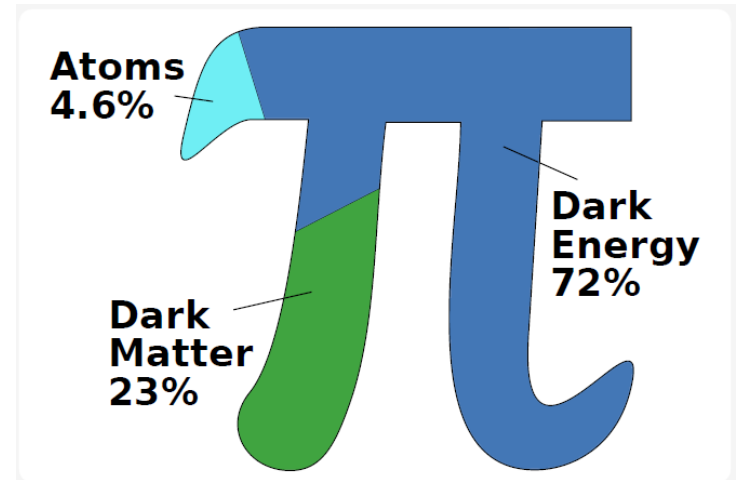
Principle of Darwin detector (baseline)

- **Aim: search for WIMPs => Weakly Interacting Massive Particles**

- Container with dual phase noble gas: liquid/gas
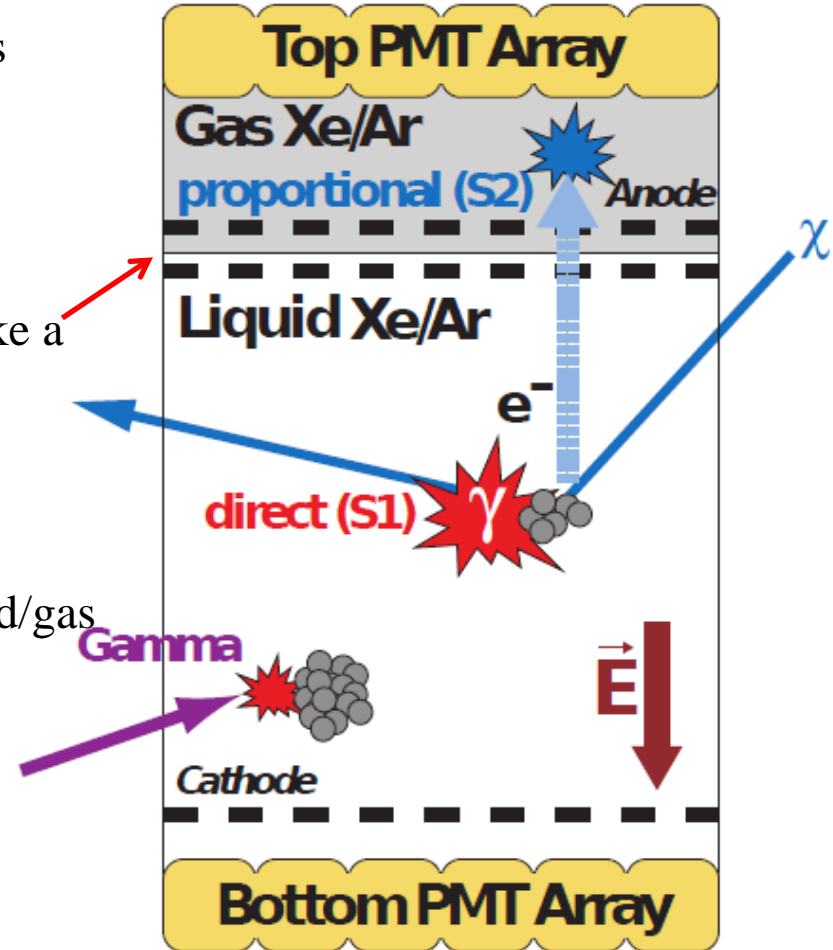
  - Argon or Xenon

- **Drift field E** across liquid

- **Double grid** across liquid/gas boundary to make a high field here

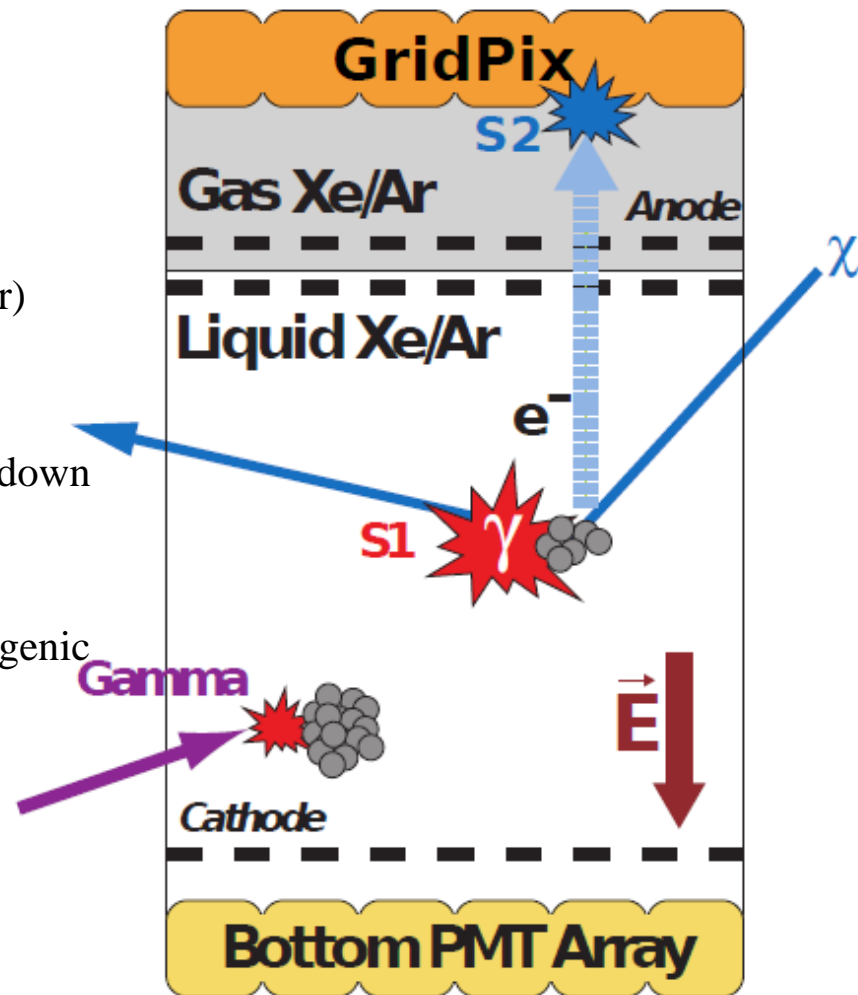- Scintillation light at impact **(S1)**

- Scintillation light when electrons traverse liquid/gas boundary **(S2)**

- Final outcome is **S2/S1** ratio

Replacing upper PMTs by GridPixs

- Direct **electron counting**

- Measuring **recoil path**
    - Getting **direction** of recoil path

- Several problems to be solved
    - **Gas gain** in very pure noble gas (NO quencher)
        - Getting it >10??

    - **Thermal stress** on grid of GridPix at cooling down to 165K (Xe) or 87K (Ar)

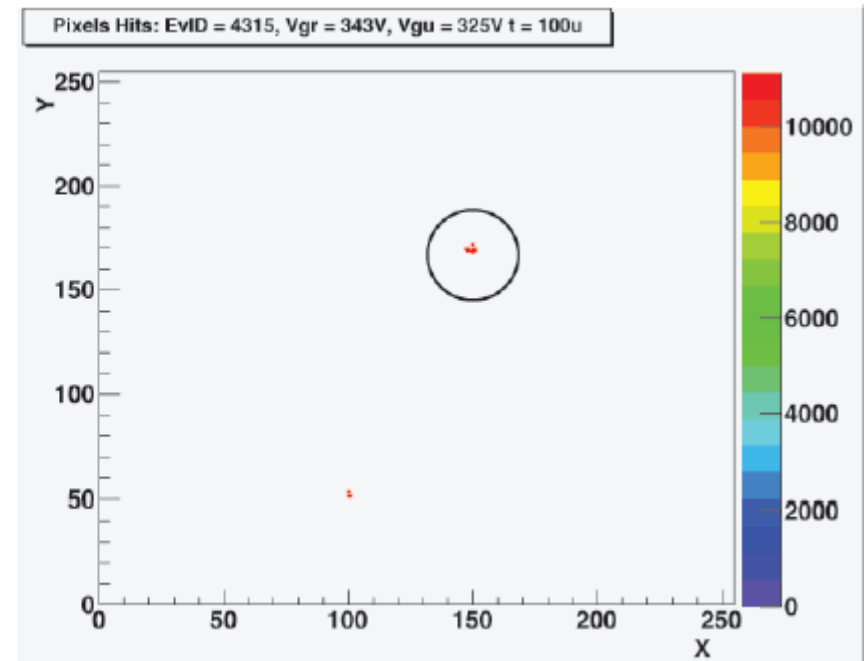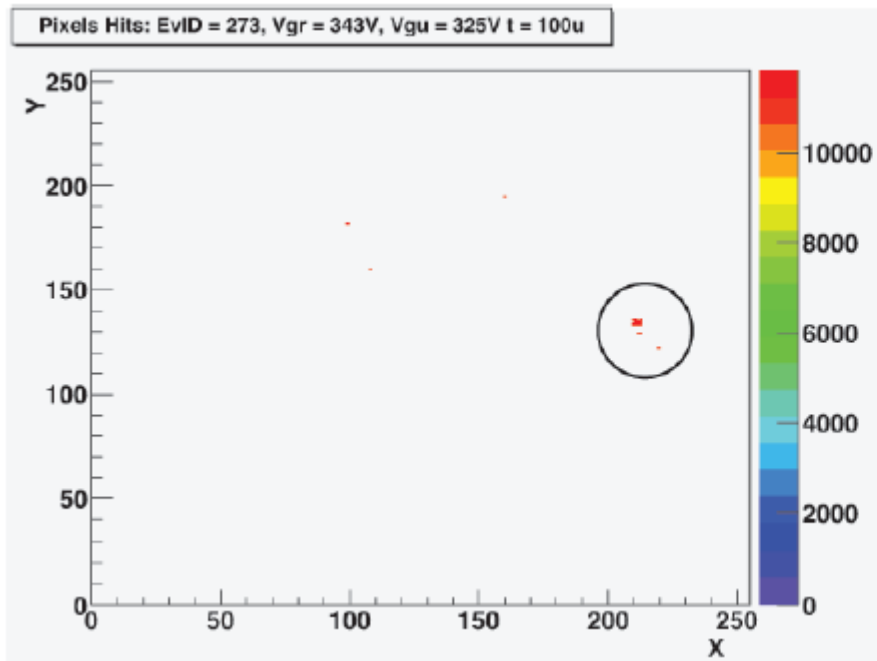   - **Electronic operation** of TimePix chip at cryogenic temperature

Setup of the test detector at Nikhef

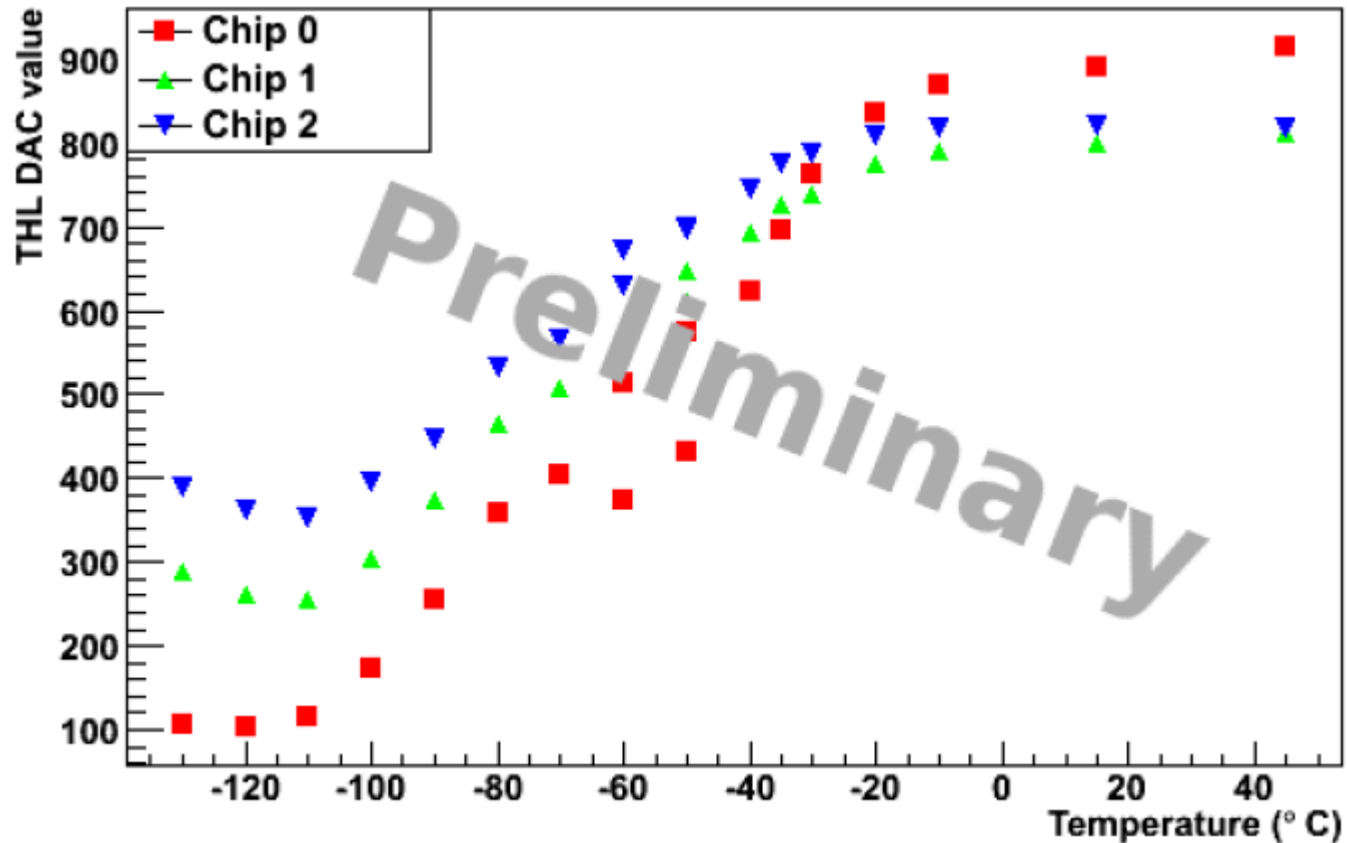■ Field cage with powered GridPix and PMT
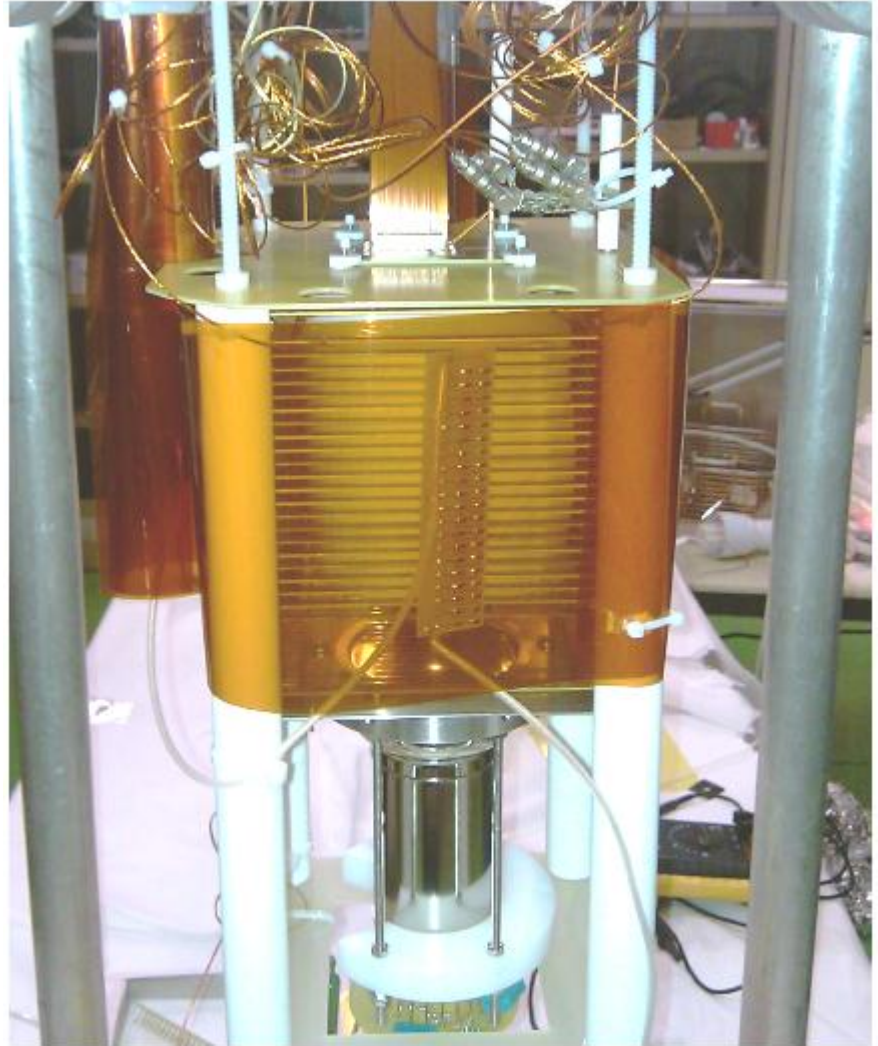
Test in gaseous phase at room temperature

- Using pure Argon (6.0)
- Irradiation with ^{55}Fe gammas
- **TimePix readout** triggered by scintillation light at PMT

Timepix noise level at cryogenic temperatures

❑ Plotted at best threshold level

Scintillation signal in gas phase at 87K

- Using ^{55}Fe gammas
- From **PMT only**
- **GridPix** powered but **not used** (showed only discharges)
  - **Grid at -150V** => no gas gain
- 1st peak (S1) appearing immediately
- 2nd peak (S2) after 60 µs (scintillation light from double grid)

α interaction; V_{grid} = 150 V; v_D = 1.2 mm/µs
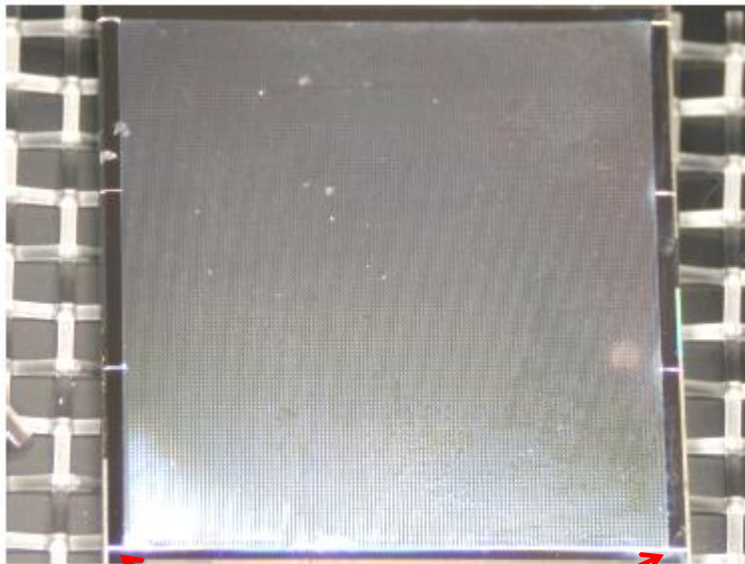
PMT signal in gaseous phase at 87K

- Using different grid voltages
- Shoulder on peak S2 appears as in indication of gas gain at the GridPix
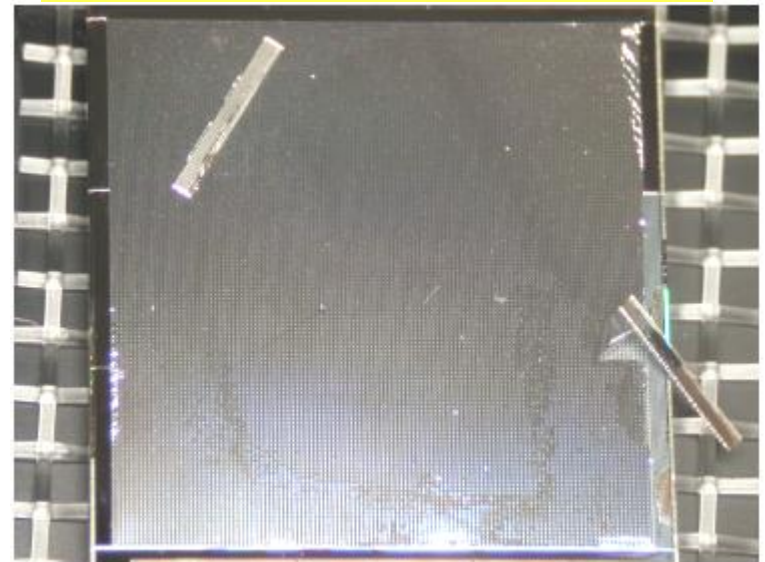 - **Indication of gas gain**
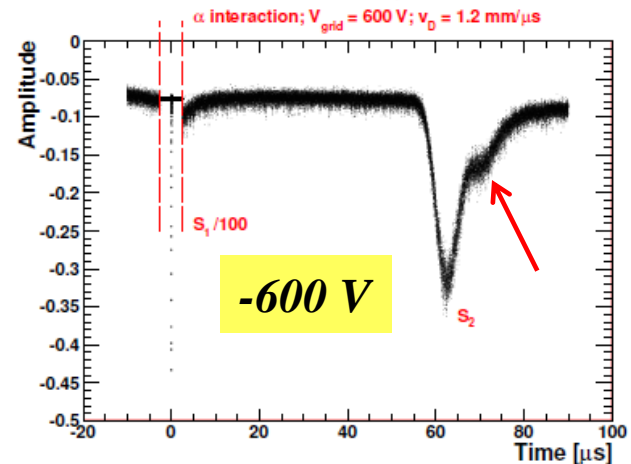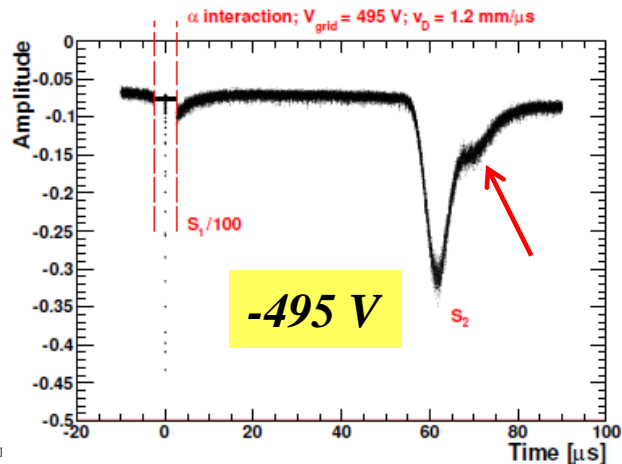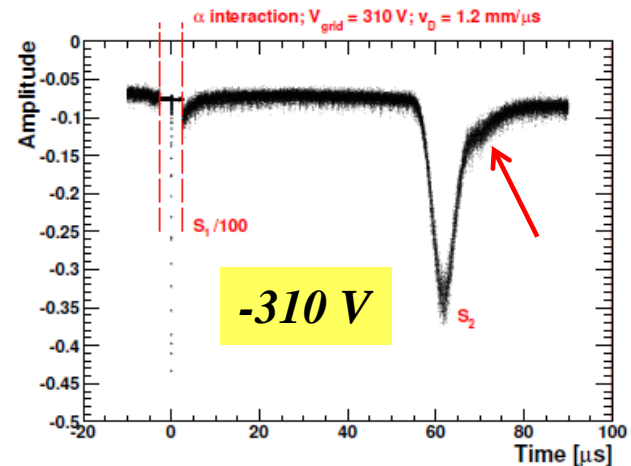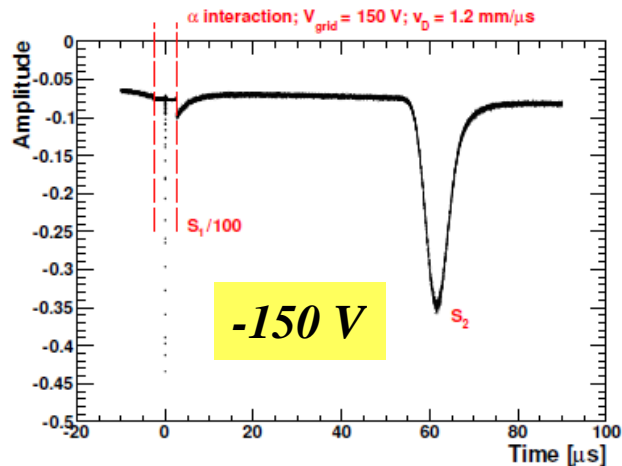
Thermal behaviour

- Often damage on grid of GridPix when cooling down
- Rim structure (**dyke**) around grid for proper **mechanical and electrostatic termination**
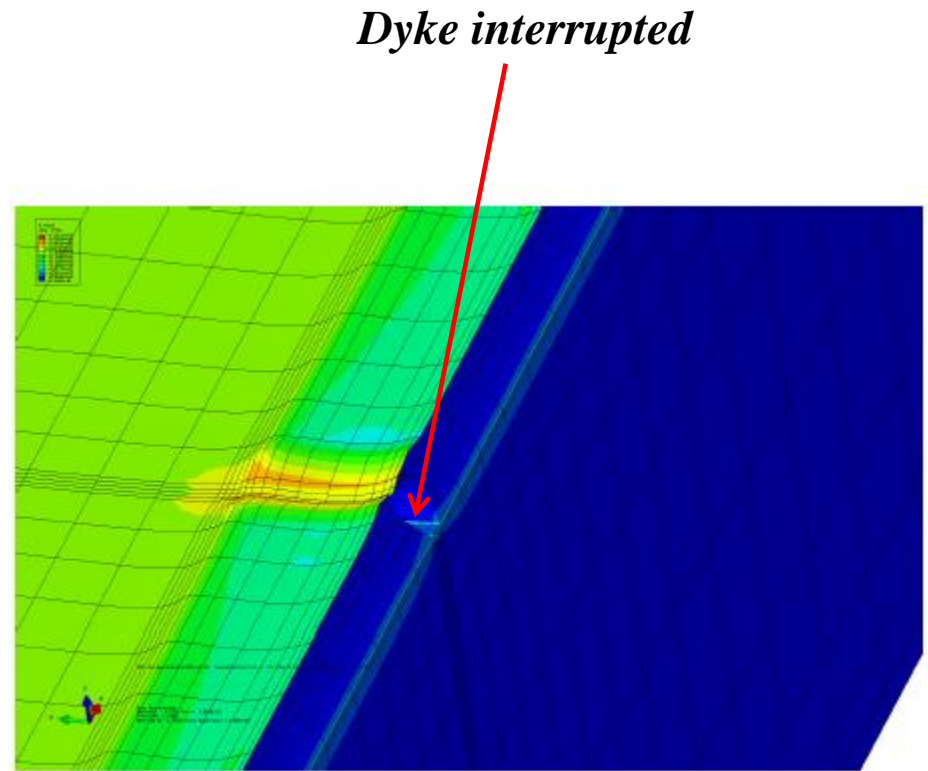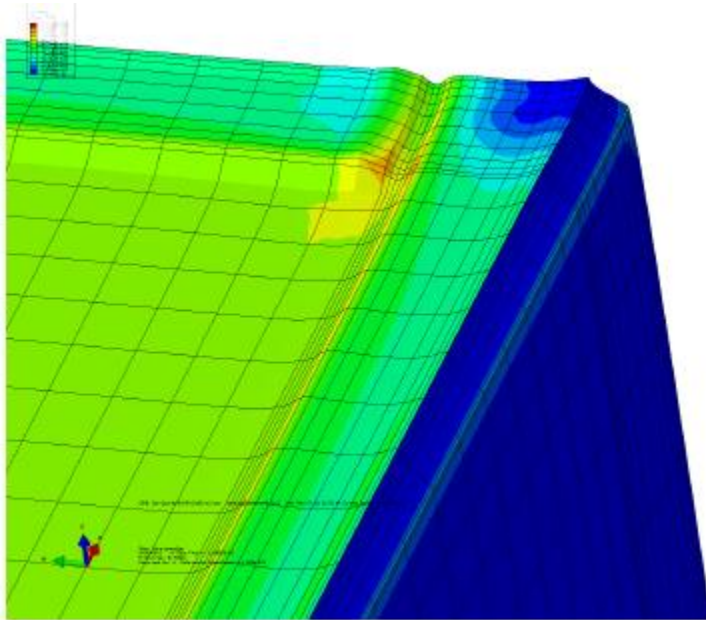
Grid survived cool down

Grid damaged by thermal stress

Dykes surrounding the grid

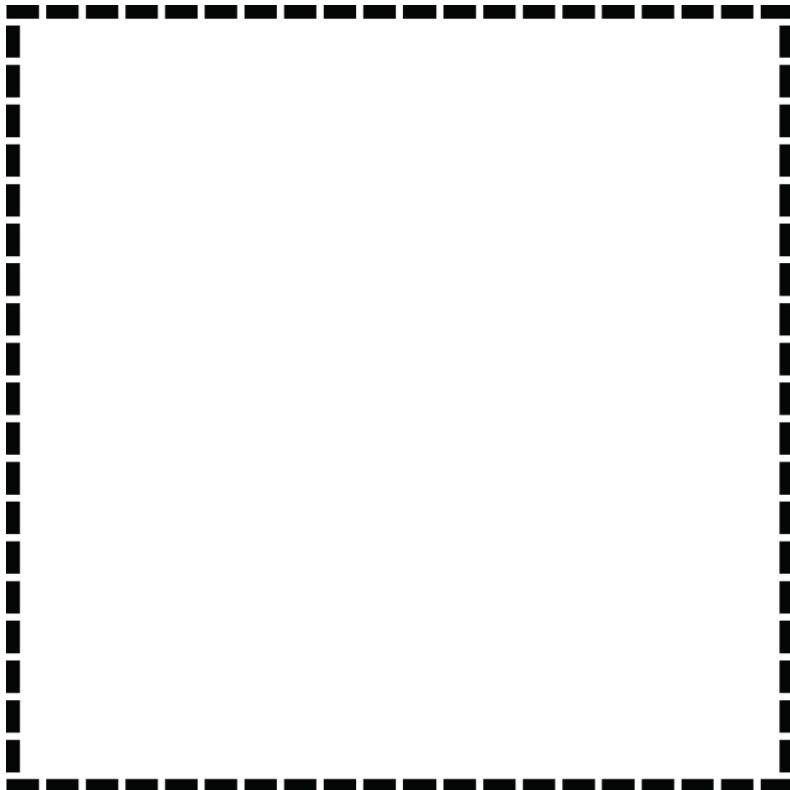# Engineering studies to avoid excessive local stress

■ Segmenting the dyke may help
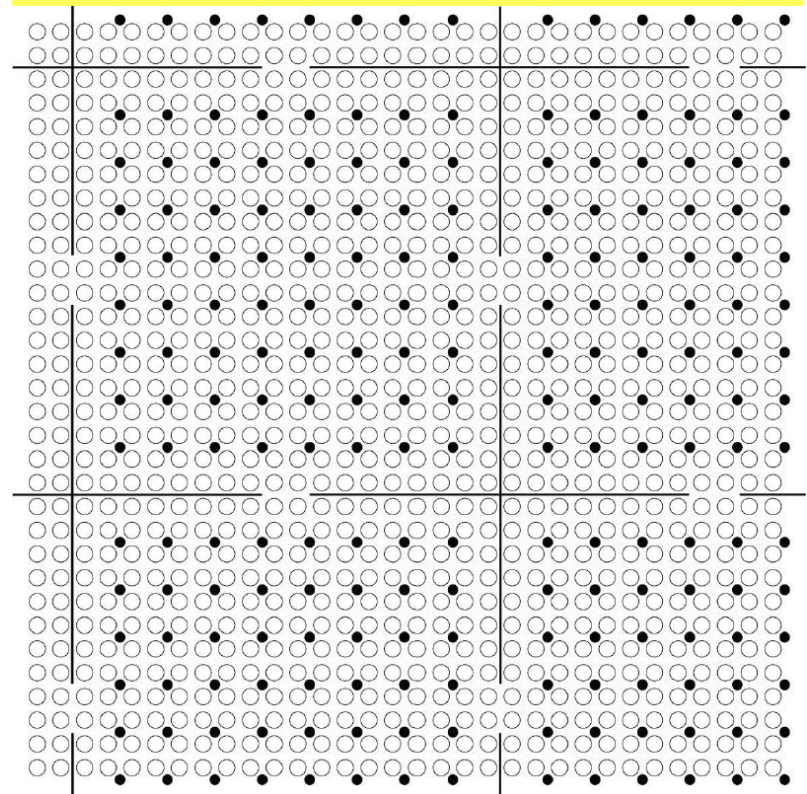
Dyke interrupted

Alternative studies on dyke segmentation

- Greatly increasing the segmentation
- Adding long and thin dykes to stabilize the grid

Full grid with segmented dyke

Grid (detail) with thin dyke structures

Conclusions on applying GridPix in Darwin

- **Gas gain** in pure argon at room temperature
    - But bit doubts about the purity
- **TimePix** operates at liquid Xe temperature 165 K)
    - Reduced noise level
- **Scintillation signal** at LAr temperature (87K) both from impact and from two grid gap
    - Gaseous phase only
    - No operation yet in dual phase
- Indication of **gas gain** (from scintillation light) at **87 K** in pure Ar gas
    - But no clear GridPix signal yet, only some discharges
- Mechanical stress on grid after cooling down still critical
    - Engineering effort for better structuring the grid support

So still much to quantify, define and investigate