

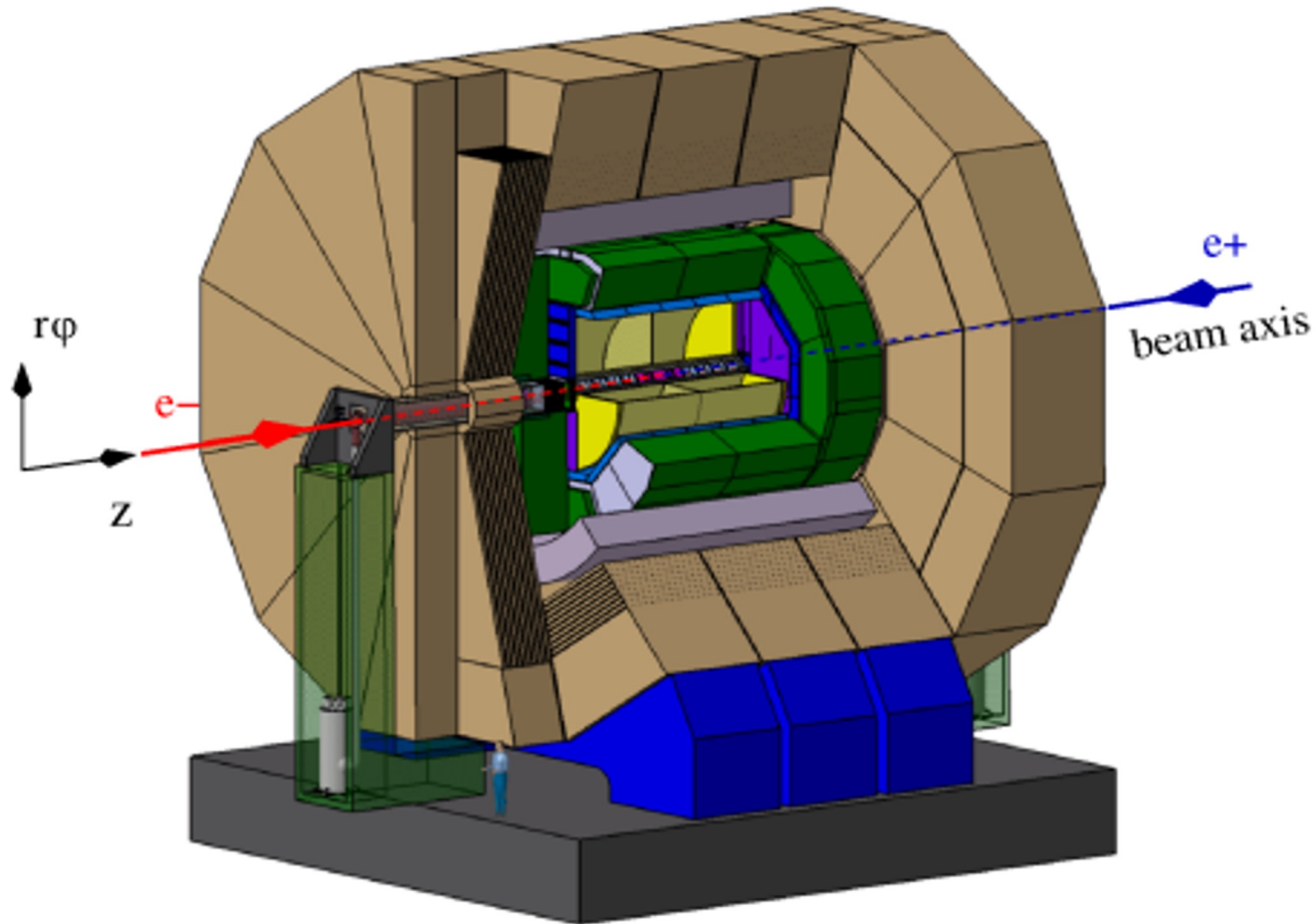
Ideas for detectors at future e^+e^- colliders
but also for
many other tracking applications

It calls for generic R&D at our
National Laboratory
in partnership with
university members

CAP Congress
June 9, 2022

International Linear Collider

An example of a generic detector for future e+e- collider



ILD

- **Momentum resolution:**
 $\delta(1/p_T) < 2 \times 10^{-5} \text{ GeV}^{-1}$
- **Impact parameters:**
 $\sigma(r\phi) < 5 \mu\text{m}$
- **Jet energy resolution:**
 $\sigma_E/E \sim 3\text{-}4\%$

Micro Pattern Gas Detector (MPGD)

Technology choice for TPC readout: Micro Pattern Gas Detector

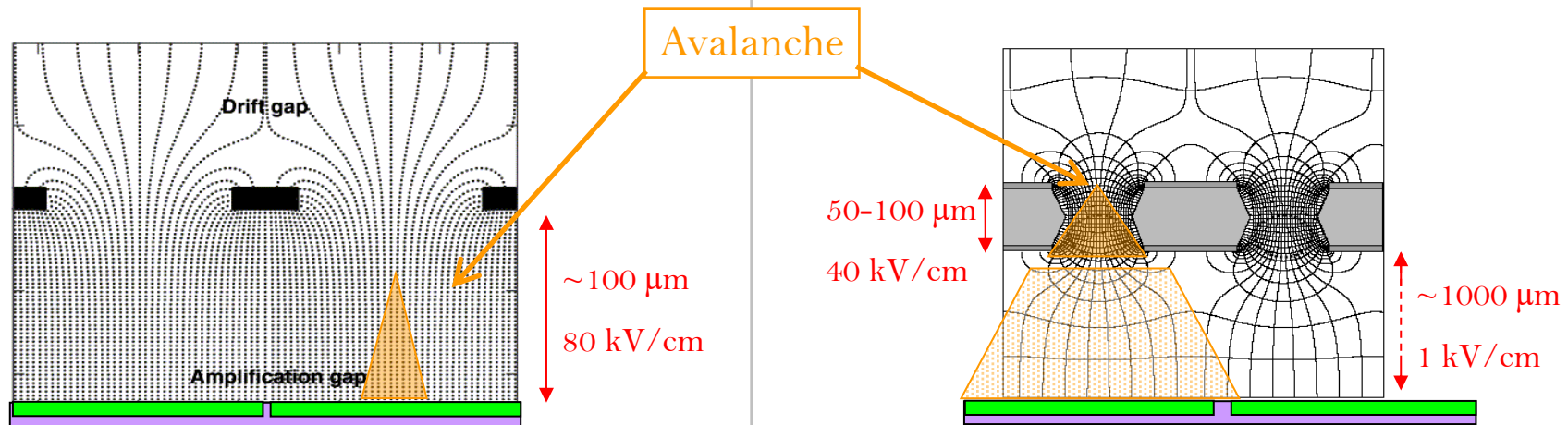
- no preference in track direction
- fast signal & high gain
- better ageing properties
- no $E \times B$ effect
- low ion backdrift
- easier to manufacture

Micromegas (MM)

- MICROMesh Gaseous Structure
- metallic micromesh (typical pitch $50\mu\text{m}$)
- supported by $50\mu\text{m}$ pillars, multiplication between anode and mesh, high gain

GEM

- Gas Electron Multiplier
- 2 copper foils separated by kapton
- multiplication takes place in holes, with 2-3 layers needed



Discharge probability and consequences can be mastered (use of resistive coatings, several step amplification, segmentation) – MPGD more robust mechanically than wires

Time Projection Chamber (TPC) for ILD



Carleton
UNIVERSITY

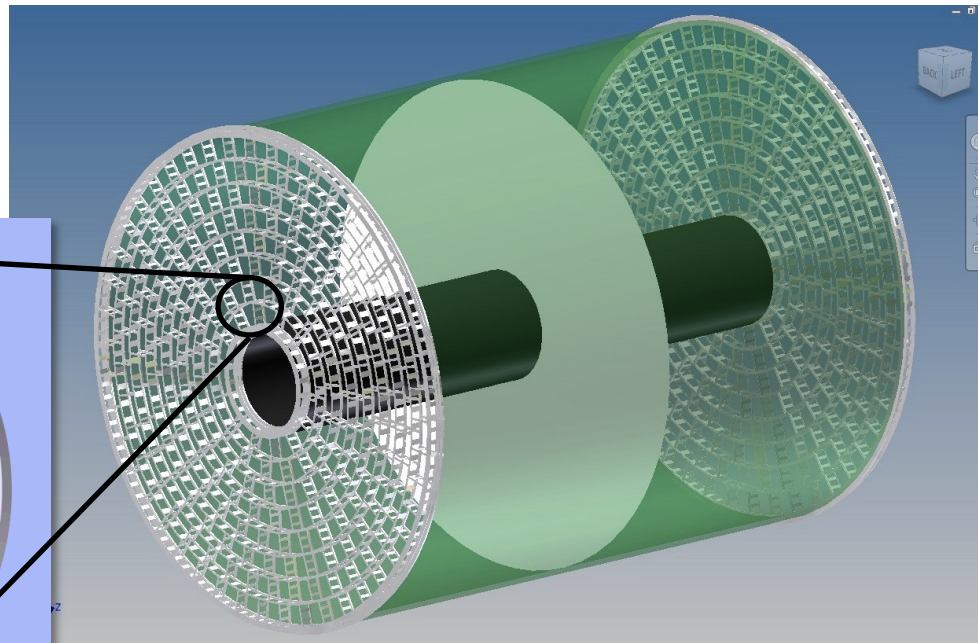
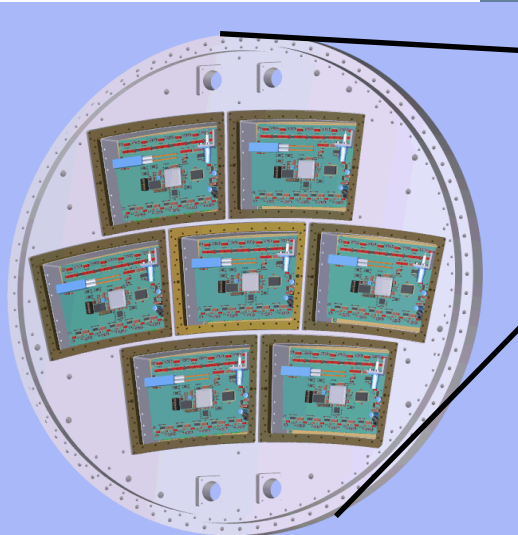


Main activities on micropattern gas detector (MPGD & RD51)
Funding since early-2000 – Carleton University

- Two options with similar resolution for endplate readout with **pads**:
 - **GEM**: $1.2 \times 5.8 \text{ mm}^2$ pads (**smaller pad – more electronics**)
 - **Resistive Micromegas**: $3 \times 7 \text{ mm}^2$ pads (**larger pads – less electronics**)
- Alternative: **pixel** readout with pixel size $\sim 55 \times 55 \mu\text{m}^2$

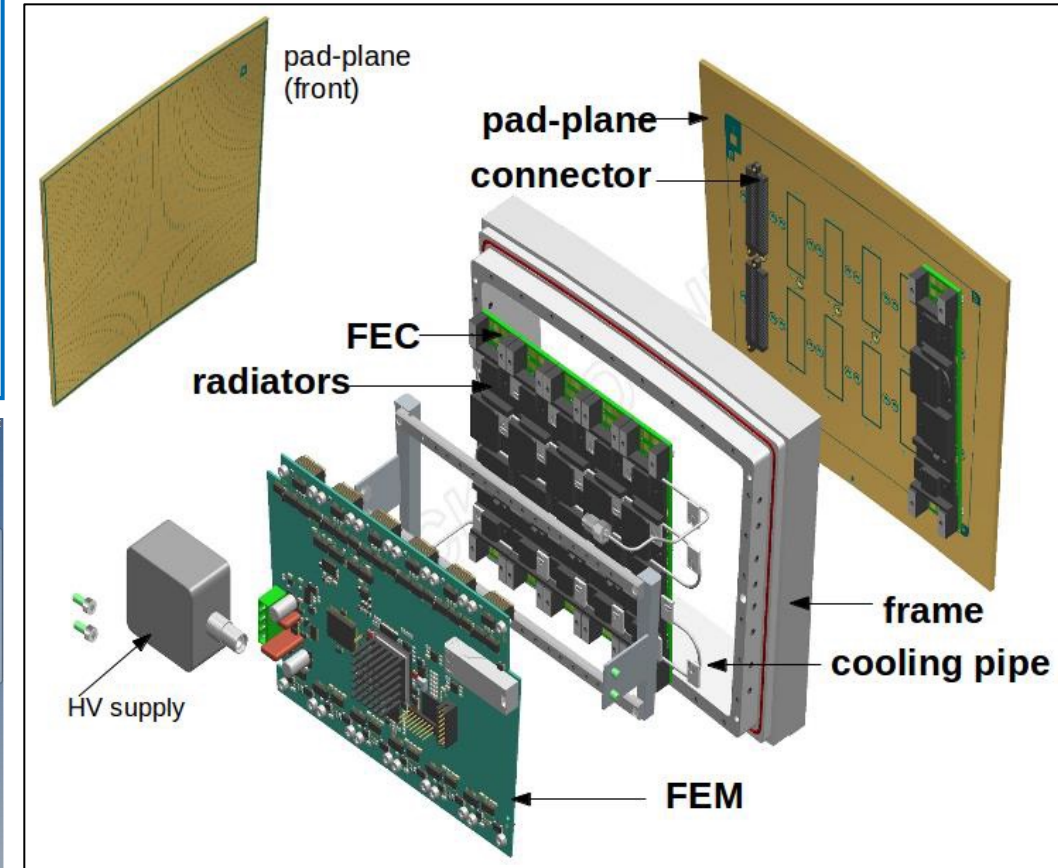
Large Prototype TPC

Endplate of 7 panels, $\phi = 80 \text{ cm}$



ILD TPC

Micromegas module



LCTPC Collaboration for ILD:

3 regions (America, Asia, Europe), 25 member institutions, 22 observer institutions
A. Bellerive co-spokeperson until August 2022

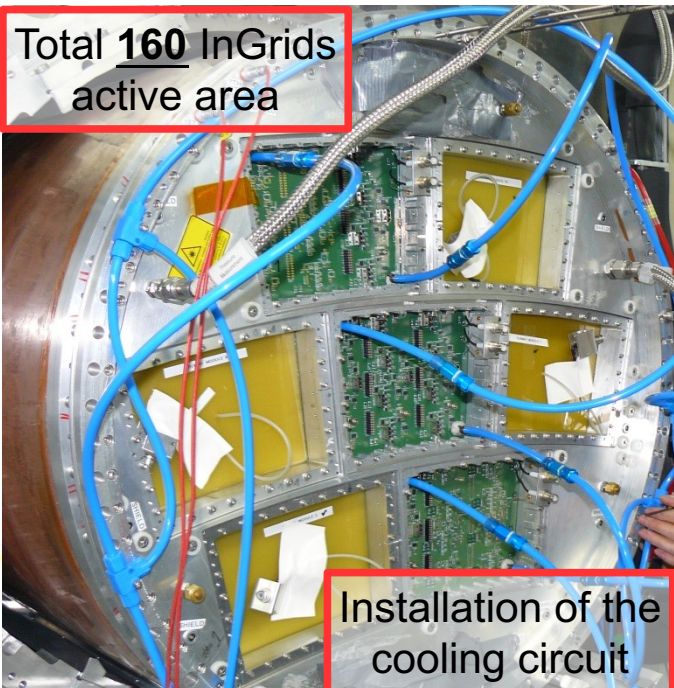
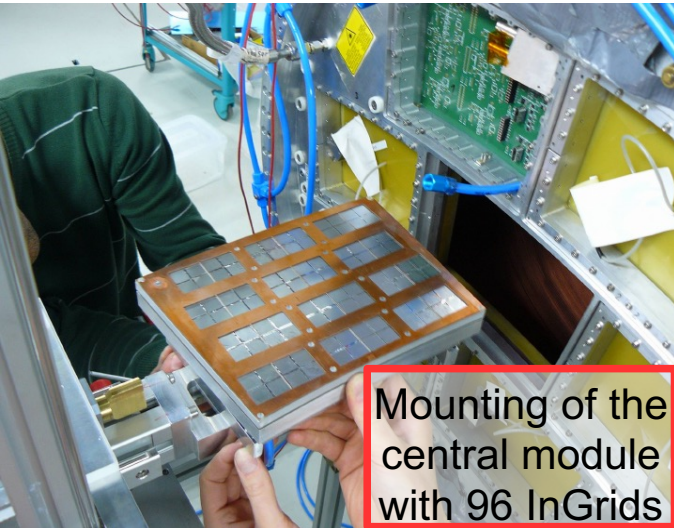
GridPix

Build on expertise of ILC TPC and ATLAS sTGC

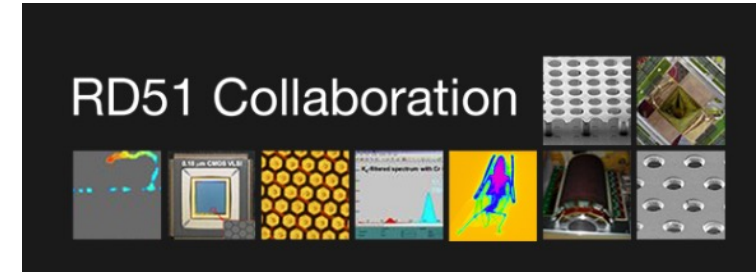
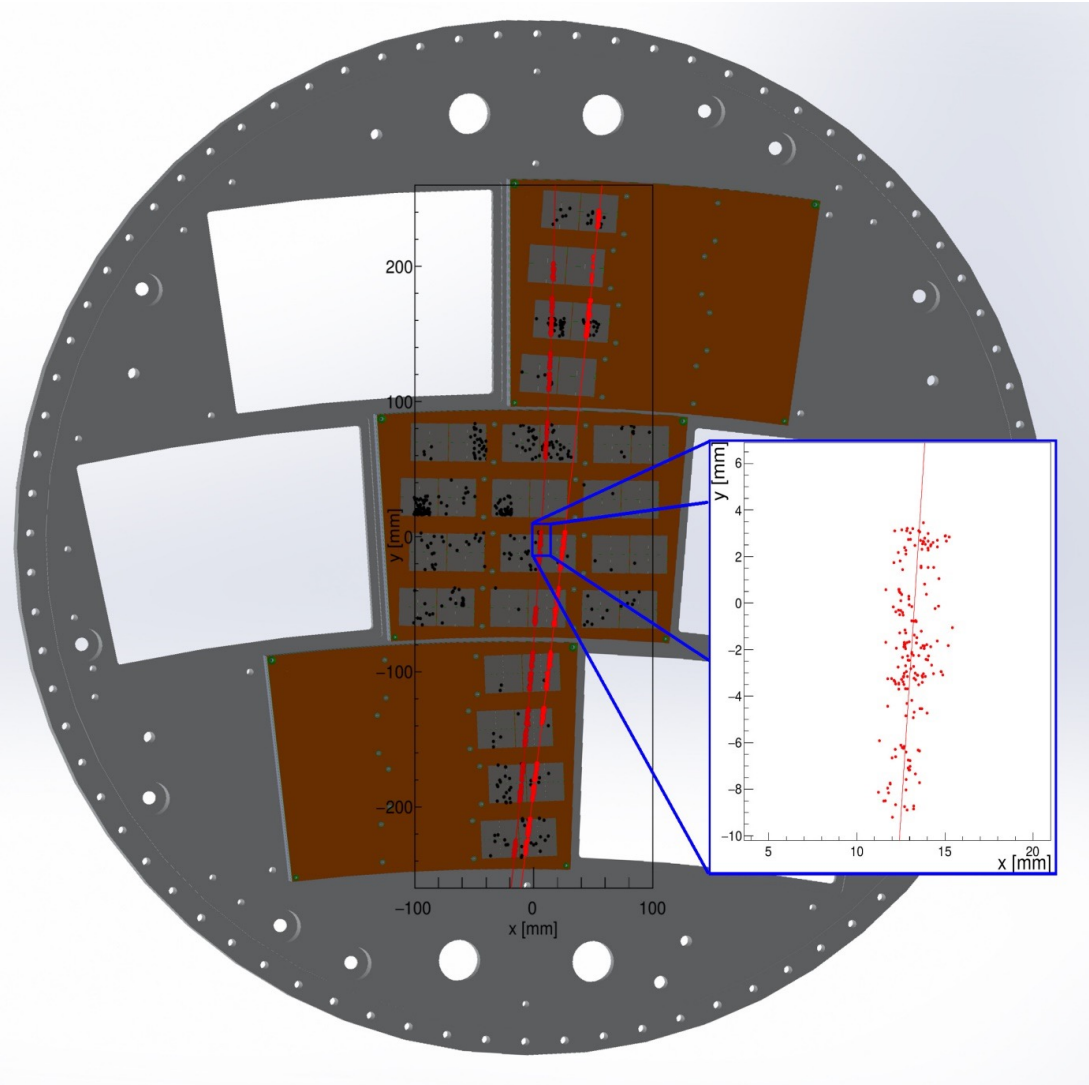
GridPix = future most precise tracking
gaseous detector

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GridPix for Ultimate TPC (ILC, CEPC, Belle3, ...)



Large scale application / Large active area

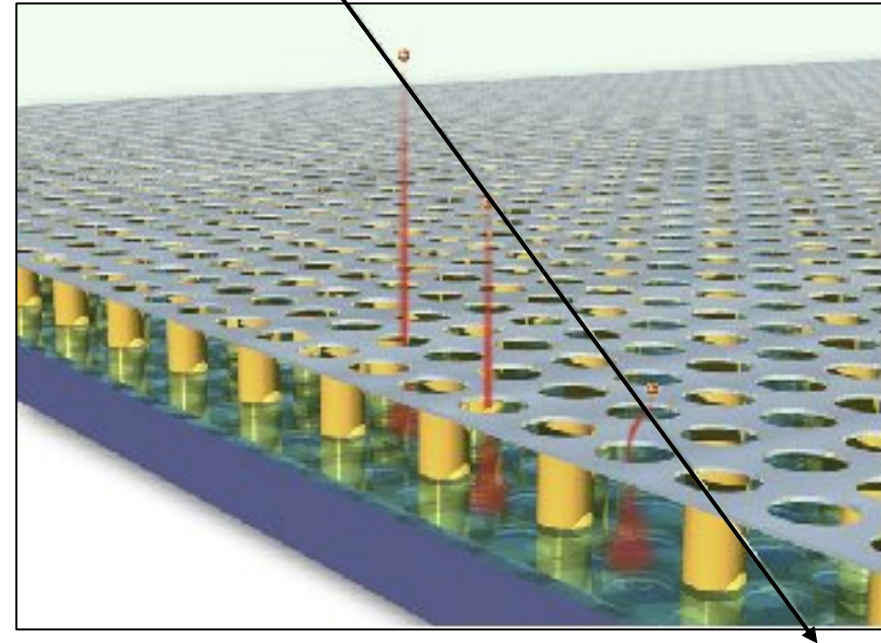
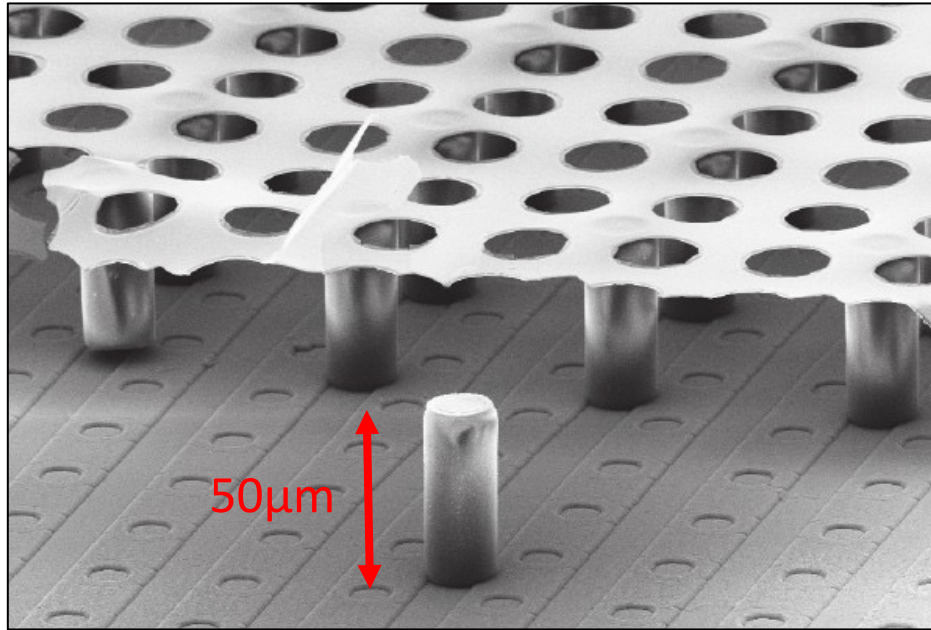


Part CERN
R&D framework
and
EU Detector
development

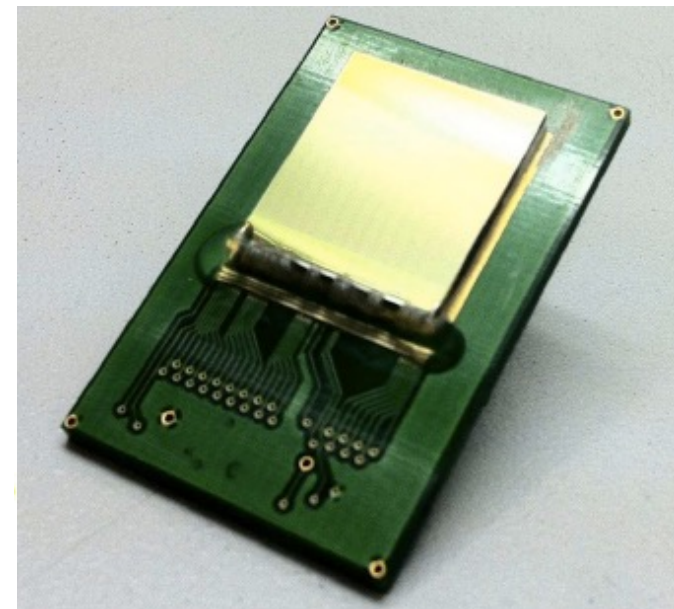
Whitepaper submitted
to SNOWMASS

Contact: Alain Bellerive

Highly Pixelated Readout (GridPix)



- Micromegas on a pixelchip (**Timepix+Micromegas = GridPix**)
- Resistive protection layer (4-8 μm) on top of chip
- Insulating pillars between grid & pixelchip
- **One hole above each pixel / see each ionization electron**
- Amplification directly above the pixelchip
- **Very high single point resolution, 2% dE/dx resolution**
- Why not R&D in Canada?



Timepix: 256 x 256 pixels of size 55 x 55 μm²

➤ Low threshold level ~500 e⁻ (90 e⁻ ENC)

Potential GridPix R&D at TRIUMF



- Interest and experience at Carleton & TRIUMF
- Timepix expertise at Université de Montréal and TRIUMF
- Application in HEP, also medical physics (e.g. proton therapy tracking)
- Top technology for applications with the need of no multiple scattering
- Use for TPC (~1m drift) but any tracking with drift region size (1-100 mm)
- Can match any shape (e.g. cylindrical) and can cover large areas
- **Lots of synergy with 4D SiPM**
- **Share technology challenge for:**
 - **'molecular' bounding, electronics**
 - **sensor layer integration, testing bench**
- Innovative replacement of GEM and Micromegas MPGD's readout
- Gauge the Canadian community for ideas and interest (today!)