

# January 2022 report Snowmass White paper about

## MPGDs for TPCs at future lepton colliders

Alain Bellerive



Part of IF5 on Instrumentation Frontier  
Topical group on Micro-Pattern Gaseous  
Detectors (MPGDs)

Conveners: Bernd Surrow, Maxim Titov, Sven Vahsen

<https://snowmass21.org/instrumentation/mpgd>

# Snowmass effort on MPGD White Paper #4

## *“MPGDs for TPCs at future lepton colliders”*

*Editor / Author: Alain Bellerive, Carleton University*

The paper should cover the following Letters Of Intent (LOIs), with contact persons listed in parentheses:

1. Belle II TPC: Peter Lewis ([lewis@physik.uni-bonn.de](mailto:lewis@physik.uni-bonn.de))
2. Time projection chamber R&D for CEPC detector ([qihr@ihep.ac.cn](mailto:qihr@ihep.ac.cn))
3. A time projection chamber using advanced technology for the International Large Detector at the International Linear Collider ([kaminski@physik.uni-bonn.de](mailto:kaminski@physik.uni-bonn.de) and [alainb@physics.carleton.ca](mailto:alainb@physics.carleton.ca))
4. A high-gain, low ion-backflow double micro-mesh gaseous structure ([zhzhy@ustc.edu.cn](mailto:zhzhy@ustc.edu.cn))

People contacted.

Here are links to the LOIs:

1. [https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF2\\_IF7\\_IF3\\_IF4\\_IF5\\_IF6-056.pdf](https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF2_IF7_IF3_IF4_IF5_IF6-056.pdf)
2. [https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF3\\_IF5-EF1\\_EF4-183.pdf](https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF3_IF5-EF1_EF4-183.pdf)
3. [https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF5\\_IF3-015.pdf](https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF5_IF3-015.pdf)
4. [https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF5\\_IF0-184.pdf](https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF5_IF0-184.pdf)

# Timeline

## *“MPGDs for TPCs at future lepton colliders”*

- November 15 – December 15, 2021:  
Putting together the material and working on skeleton of the White Paper
- December 21, 2021:  
First version of the executive summary of 1.5 pages (A.Bellerive, input Peter Lewis)
- January 15, 2022:  
Provide the first draft (including the 1.5 pages Executive Summary) to the TG conveners
- **January 15 – January 30, 2022:**  
**Iterate with authors, circulate to collaborators & contacts and TG conveners**  
**Note OVERLEAF but latex!**
- February 1, 2022: second drafts of WP and executive summary
- February 15, 2022: final draft submitted
- March 1, 2022:  
Conclude the activity of the MPGD topical working for inputs to Snowmass long range planning<sup>3</sup>

# Structure of the White Paper for “MPGDs for TPCs at future lepton colliders”

1.5 page executive summary: advantages of MPGD, technologies, synergy (USA), TPC's at lepton colliders

LCTPC at ILD

Belle2 TPC

TPC for a CEPC detector and other applications

R&D and other applications

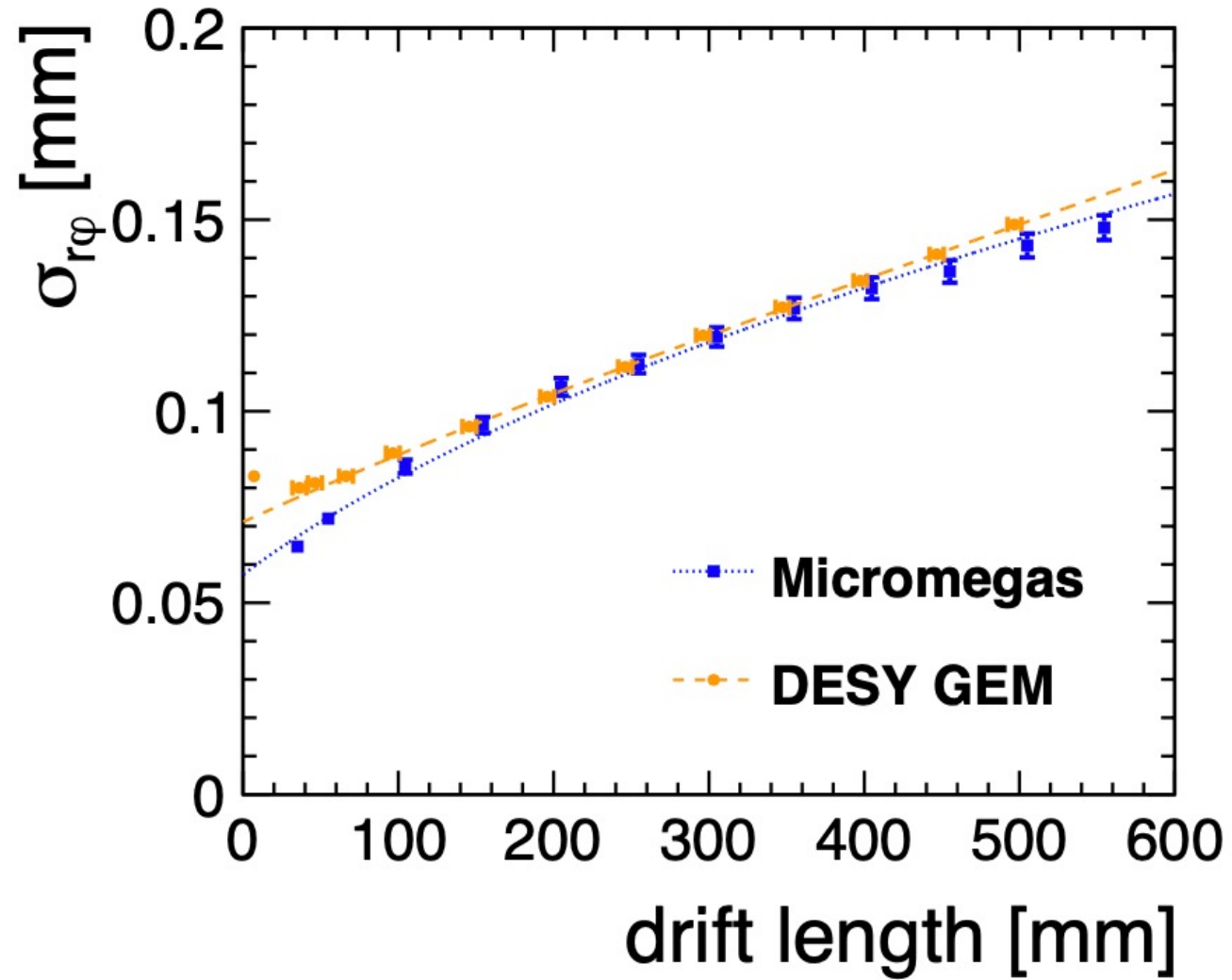
# Structure and content of the LCTPC section

1. Introduction (institute members and scope of the LCTPC collaboration)
2. Design parameters
3. MPGD (from ILC Detector R&D - <https://doi.org/10.5281/zenodo.3749461>)
  - a) GEM
  - b) Micromegas
  - c) GridPix
4. Ongoing study and future plan

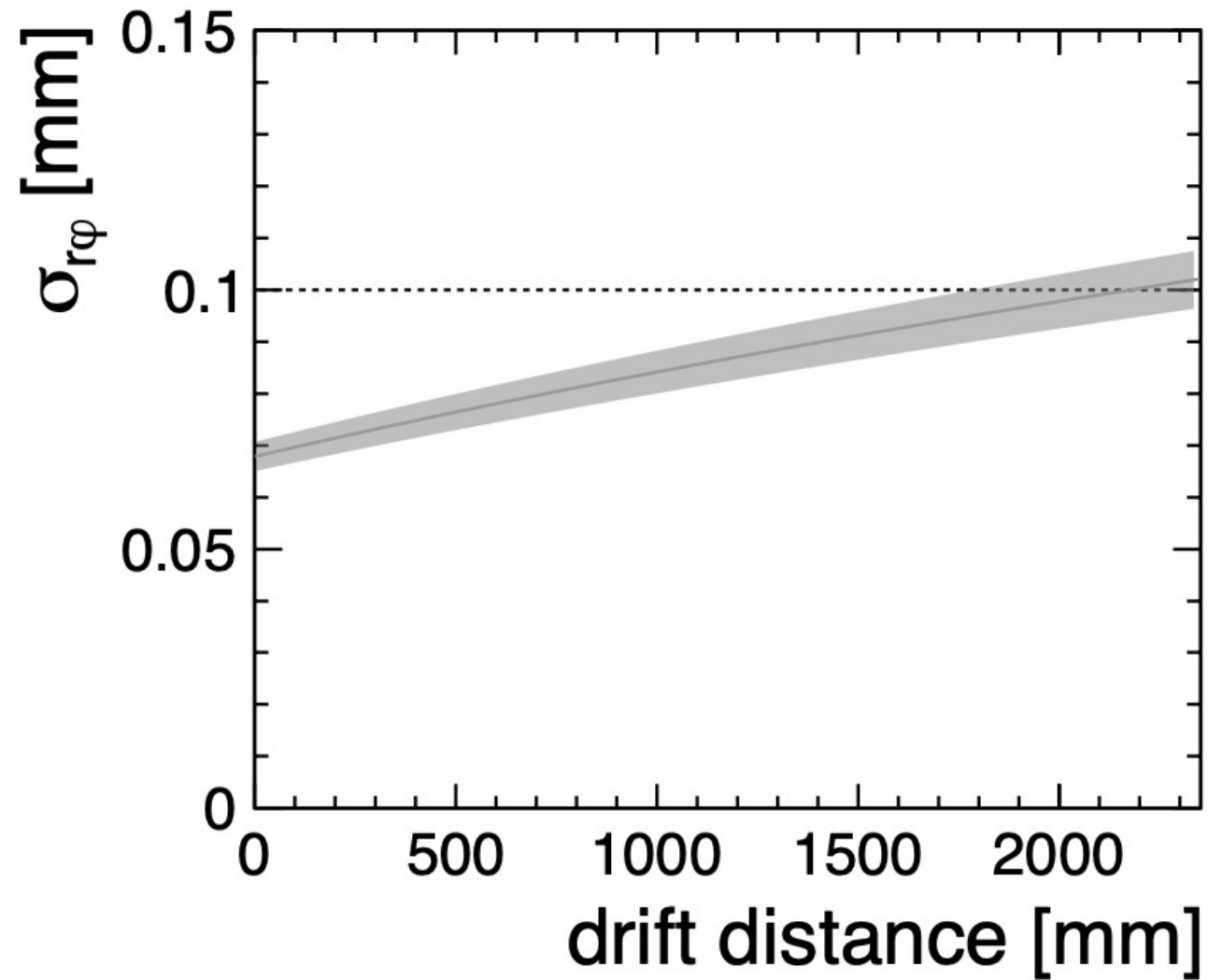
# Design parameters (LCTPC example)

Parameter			
Geometrical parameters	$r_{\text{in}}$	$r_{\text{out}}$	$z$
	329 mm	1808 mm	$\pm 2350$ mm
Solid angle coverage	up to $\cos \theta \simeq 0.98$ (10 pad rows)		
TPC material budget	$\simeq 0.05 X_0$ including outer fieldcage in $r$ $< 0.25 X_0$ for readout endcaps in $z$		
Number of pads/timebuckets	$\simeq 1\text{-}2 \times 10^6/1000$ per endcap		
Pad pitch/ no.padrows	$\simeq 1 \times 6 \text{ mm}^2$ for 220 padrows		
$\sigma_{\text{point}}$ in $r\phi$	$\simeq 60 \mu\text{m}$ for zero drift, $< 100 \mu\text{m}$ overall		
$\sigma_{\text{point}}$ in $rz$	$\simeq 0.4 - 1.4$ mm (for zero – full drift)		
2-hit resolution in $r\phi$	$\simeq 2$ mm		
2-hit resolution in $rz$	$\simeq 6$ mm		
dE/dx resolution	$\simeq 5 \%$		
Momentum resolution at B=3.5 T	$\delta(1/p_t) \simeq 10^{-4}/\text{GeV}/c$ (TPC only)		

**Figure 1 (GEM + MM - LCTPC)**

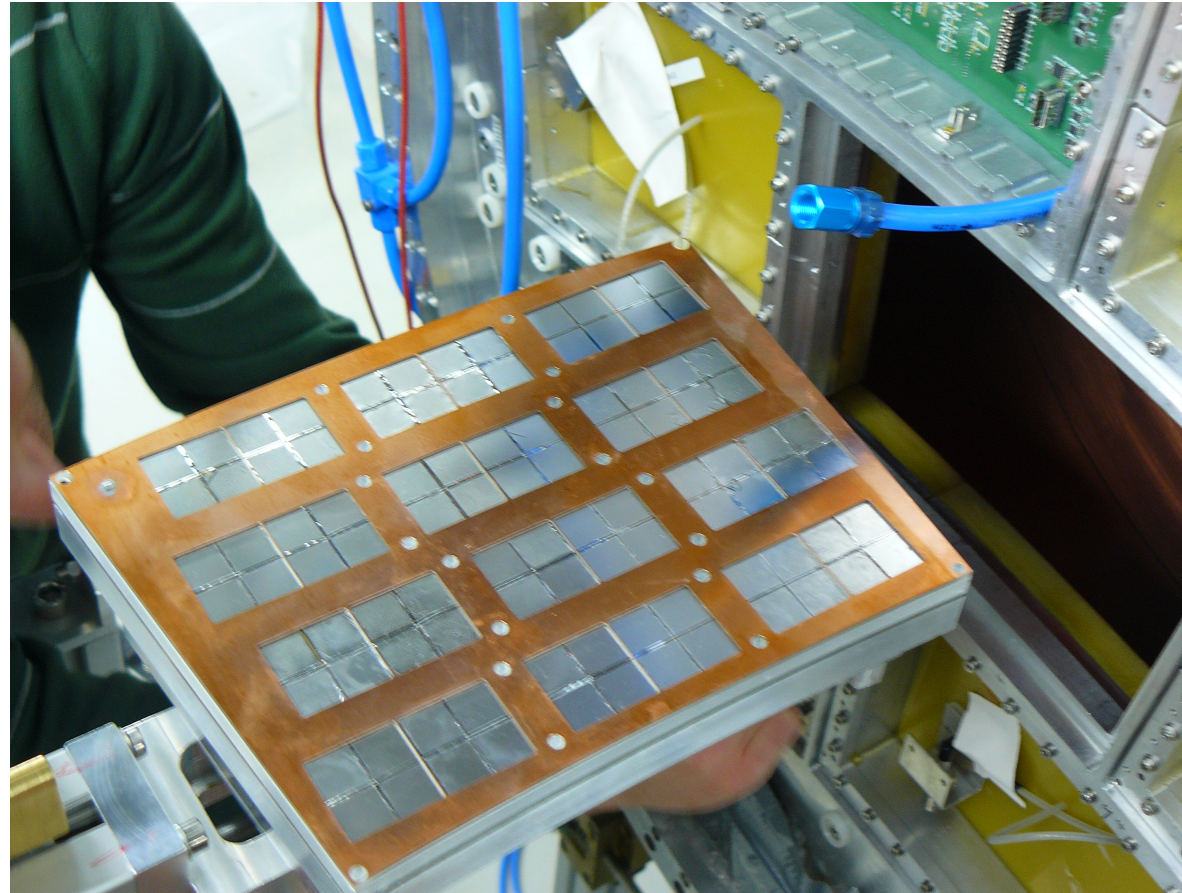


**Figure 2 (Extrapolation 3.5 T LCTPC)**

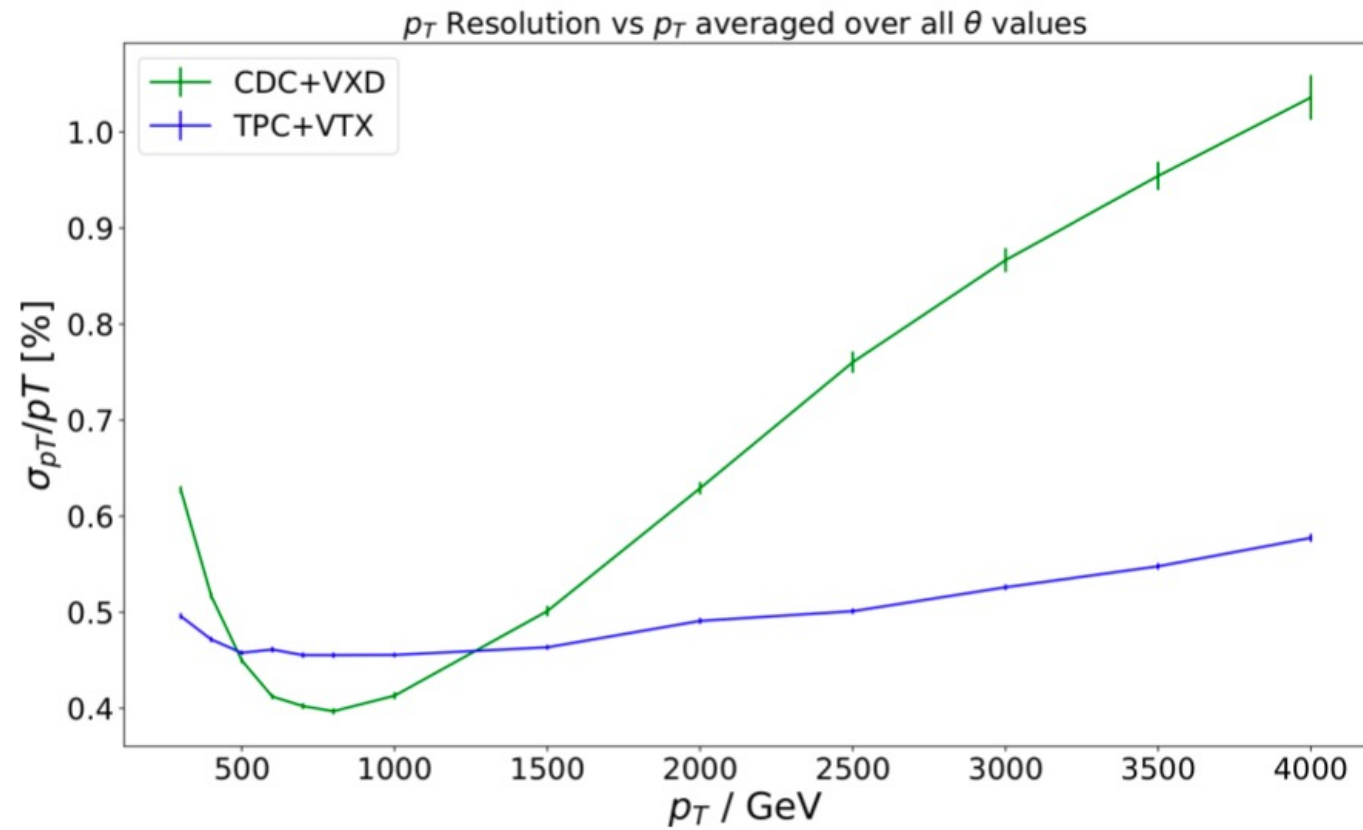




# Figure 3 (GridPix)



# Figure 4 (Belle3)



# Summary & Discussion

First draft completed (see latex). Reference missing. Need to tell a *story* with vision and synergy!

- Received feedback from Huirong Qi (minor complementary about CEPC), I suggested figure a double MPGD structure (pending)
- Suggestion by Peter Lewis (minor)
- LCTPC
  - Suggestion typos, grammar etc
  - comment from Paul Colas and Peter Luit (minor)
  - Suggestion to add  $dE/dx$  figure (tbd)
  - Other meeting dedicated to this White Paper January 27, 2022

**MPGD TPC: conceptually ready, meet design specifications and engineeringly possible**

**Today: (i) info and (ii) feedback**

**Circulated the LCTPC section and other**

**Next Feb 1-15 almost final**

**Submit WP by March 1 (submit to archive March 15)**

# Input & Suggestion

**Question 1:** Is the tone correct? Generic, inform & engaged Americans. I used non technical, more informative. Are figure with lots of technical detail needed?

**Question 2:** Should list institution inclusively? I tried to depict the fact that there are interest and an potential committee for MPGD development. Inluded TRILAB company.

**Question 3:** 1.5 page generic, but also there is many overlap with other MPGD as summarized in last section (see draft). Connection with Alice, T2K, ALTAS/CMS and Homeland security.

**Question 4:** Level of technical detail adequate? What needed for main document?

**Question 5:** Any specific request? People from USA? No R&D on MPGD. I propose we push for GridPix R&D. Where? Synergy? Overlap? MPGD facility: structure \*and\* cathode board production?