An e^+e^- tracker for the reconstruction of converted photons

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Pair tracker requirements

- High efficiency on e^+e^- pairs down to a few MeV/c for the lowest momentum track and up to O(50 MeV/c) for the highest momentum track

  - efficiency loss ~ 20% if $E_{min} > 5$ MeV

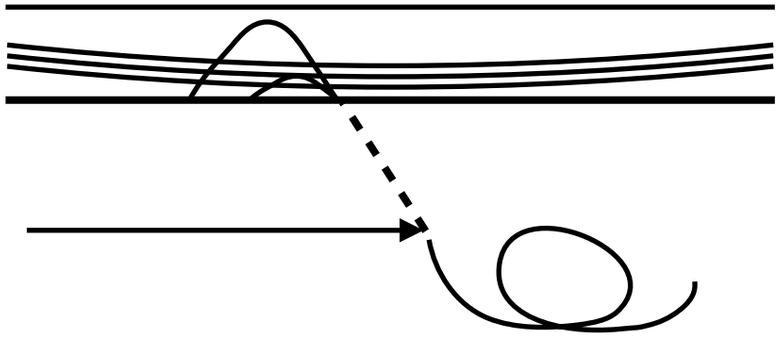
- Large angular acceptance

- Sum energy resolution O(100 keV)

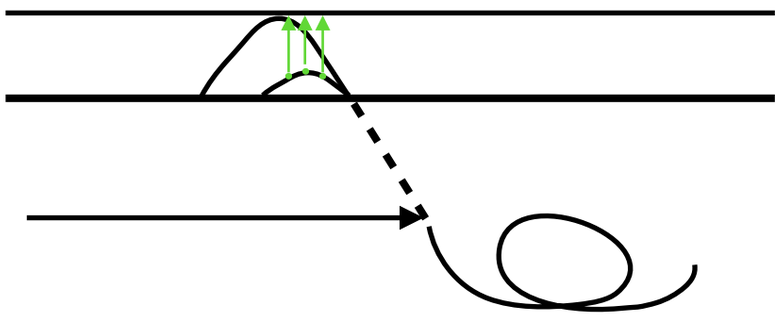
- Scalability to multiple layers at a reasonable cost

Possible technologies

- Silicon tracker:
  - surely satisfies the performance requirements ✔
  - ~ O(10 m2/conv. layer) —> can be very expensive and complex ✗
- Drift chamber:
  - stereo geometry needed —> acceptance limitations at large angles ✗
  - granularity limited by cell size —> difficult to reconstruct very asymmetric pairs (i.e. one track with very low momentum) ✗

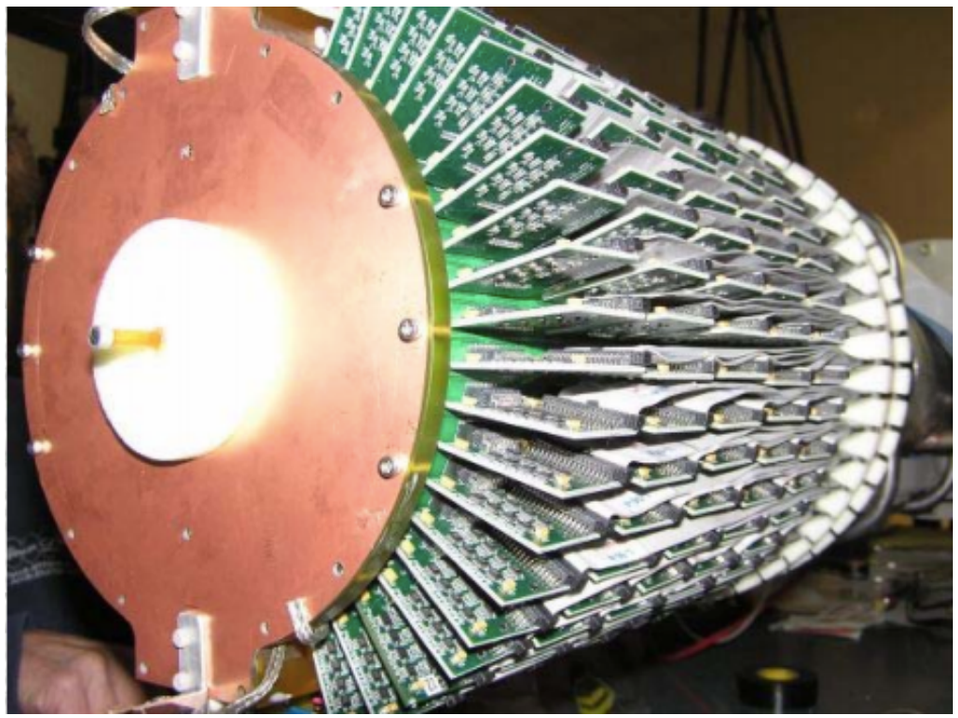


- Time projection chamber:
  - overcomes the limitations of a drift chamber ✔
  - requires a light gas mixture —> resolution limited by diffusion —> drift cannot be along the beam axis —> **radial TPC** ✔?
  - limited space on the cylindrical surface to host the readout electronics ✔?



Radial TPC

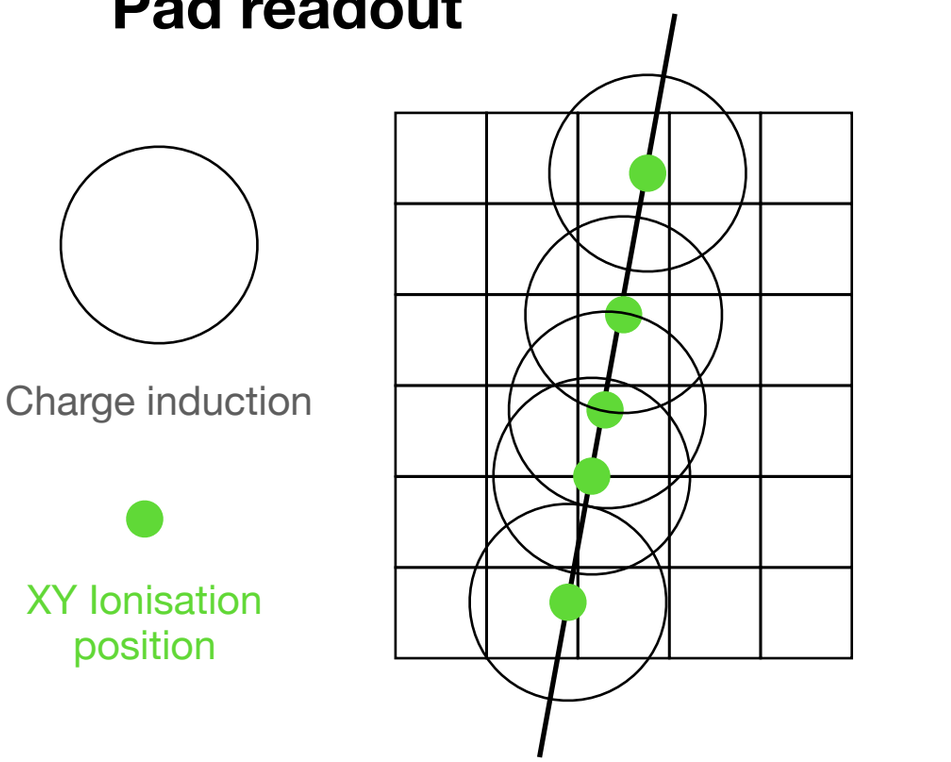
- Some radial TPCs have been operated in the past
  - significant improvements with the availability of cylindrical micro-pattern gaseous detectors (GEM, μRWELL)
- Track reconstruction difficulties connected with the drift orthogonal to the magnetic field, but no first-principle showstopper
- For a multi-layer application, a compact readout is needed
  - standard electronics for a pad readout on the outer surface would be too bulky
  - strips with readout at the endcaps—> would it work?

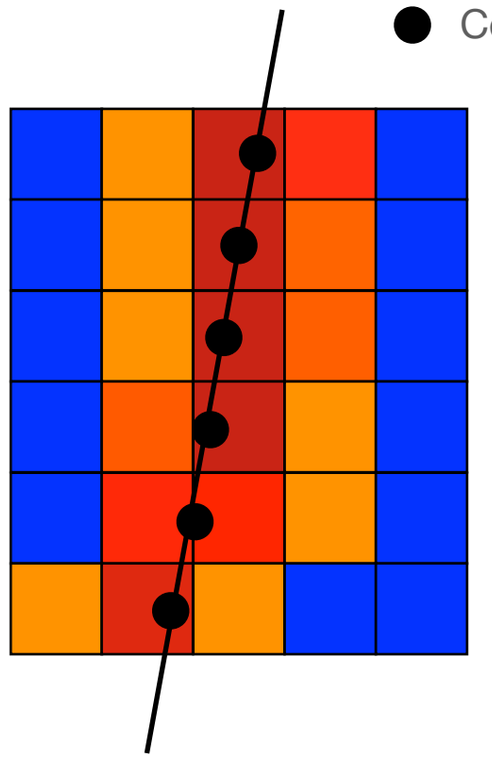


BONuS radial TPC @ J-LAB

Strip vs. Pad Readout

Pad readout





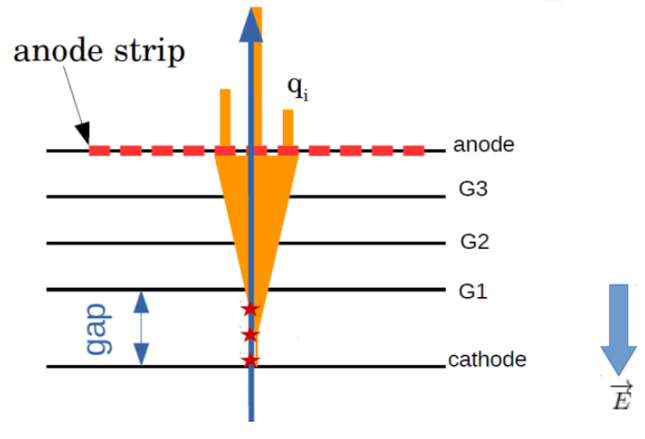
Center of Gravity (CoG)

+ Z position from drift time

Very challenging in a radial TPC, unless a lot of space for the electronics is reserved in the outer cylindrical surface

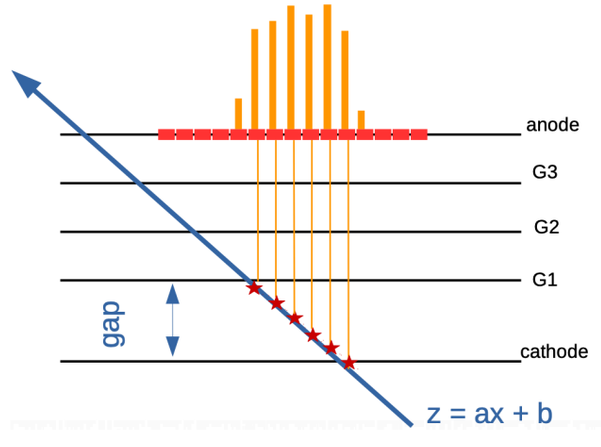
Stereo strip readout of thin-gap chambers

CoG



Doesn't work in a TPC due to track angle (several strips are on within the typical charge integration time of the electronics)

µTPC



phi resolution limited by the strip granularity
Is it good enough? Can be improved with some electronics & analysis trick?

Discussion & plans

- We are considering a radial TPC with strip readout for the reconstruction of the e^+e^- pairs from photon conversion

- The current R&D effort is concentrating on the possibility of reading out the TPC with strips

  - overcoming the difficulty of having bulky electronics between conversion layers

  - possible reconstruction difficulties and resolution limitations

- **We are currently testing a TPC with 3 cm drift and a strip readout, to identify and quantify these issues experimentally**

  - see Susanna Scarpellini's talk

- Some simulations are also in preparation and will be tuned based on the experimental results