

Considerations for tracking and the UT

Matthew Rudolph

Marina Artuso, Steve Blusk, Tomasz Skwarnicki, Sheldon Stone

Syracuse University

December 15, 2020

Introduction

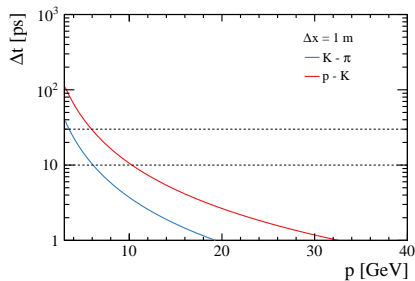
- Busy with Upgrade 1, but are thinking about tracking in U2, focused on UT here
- In view of FTDR, should focus primarily on the requirements for tracking and how detector impacts them:
 - Momentum range
 - Resolution on final parameters
 - Ghost rate and inefficiency
 - **Processing time** in seeding and fitting for HLT
- Is 4D tracking possible and beneficial?
- Also important is data rate and infrastructure to support it: how much segmentation can we handle?

Effect of detector timing

- Precision timing in hits is a **trade-off** with position resolution
- Need to consider occupancy both in terms of channel fraction, and also confusion in the track finding
 - At low momentum, search windows dominated by multiple scattering (and some bending contribution)
 - Naïve extrapolation from U1 indicates it's likely to have many possible UT hits for each VELO track
- y -segmentation will help over strip sensors, but maybe timing can bridge the gap?

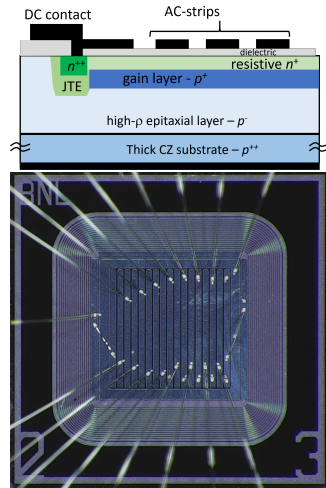
Timing in tracking

- Expect separation between collisions on order 10 ps
- Timing complicated by time of flight differences at low momentum
- Build local segments with timing constraints?
- Need a better idea **what algorithm** will need to run to keep HLT1 and HLT2 performant



A mockup with timing

- Could achieve good spatial segmentation with timing using AC-LGADs (<https://arxiv.org/pdf/2006.01999.pdf>)
- “Pixels” of strips AC-coupled to LGADs: 100 μm in x , 2 mm in y
- DC-coupling only on border gives close to 100% fill factor
- Time resolution 30 ps to 50 ps per hit
- Should be rad-hard enough unless worse than standard LGAD



Segmentation and readout

- Spatial segmentation of course helps with occupancy and position resolution
- Need to think also of readout:
 - Locally on the detector
 - Total data flow and its impact
- Challenging because environment near beam pipe is much, much busier than outer edges

Going forward

- Tracking with timing is potentially powerful, but complicated and will need detailed studies
 - The low momentum part is the hardest: staged approach starting from high p ?
 - Use of calorimeter timing in downstream segments?
- Timing may also be used for low momentum PID
- Need to base choices on physics goals and consider effects on detector readout and processing in HLT