TPC Fast Simulations

Alan Dion, Klaus Dehmelt, Axel Drees (SBU)

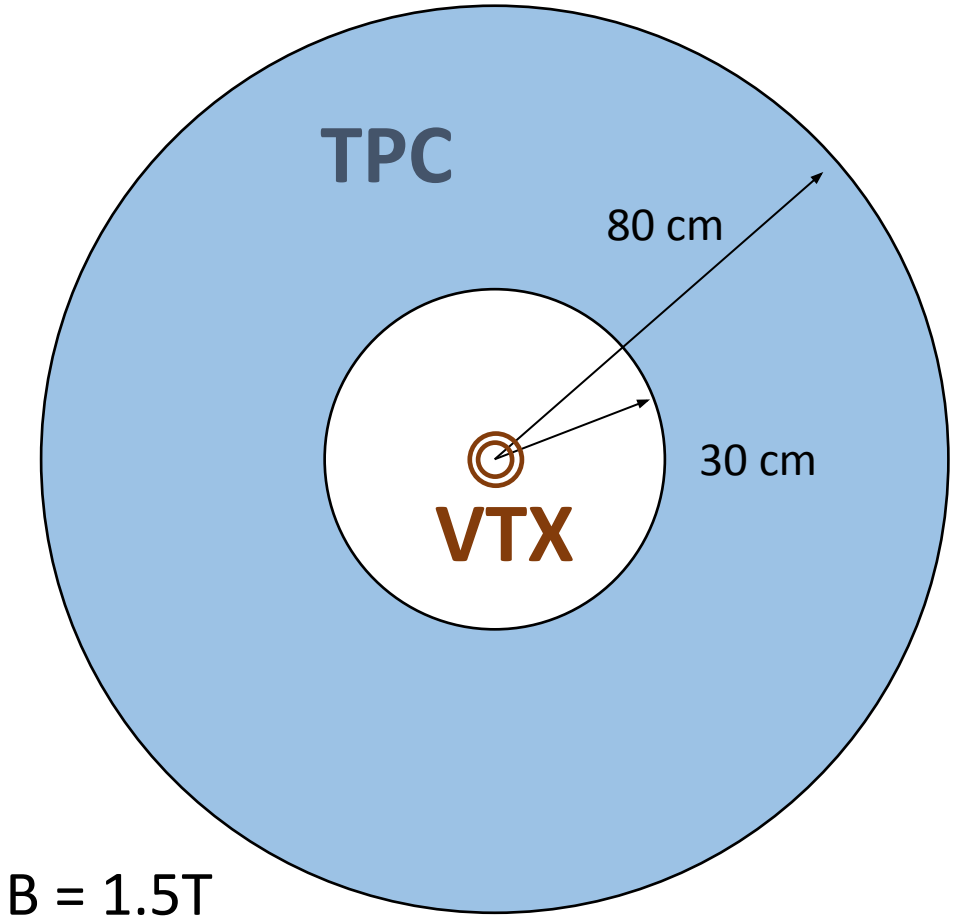
Ron Soltz (LLNL)

Takao Sakaguchi (BNL)

- The purpose of this talk is to get ideas from you about “fast” TPC simulations
- I will show the direction we are going so far
- How have issues like ion-feedback been dealt with in TPC Monte Carlo at STAR?
- What are the main issues that forced a particular simulation framework design?

A sPHENIX Tracking Solution: TPC & 2 Pixel Layers

Design parameters and performance consistent with ILC TPC prototypes



TPC

- T2K gas volume from 30cm to 80cm
- $|y| < 1 \rightarrow z_{max} \sim \pm 80$cm
- 60 radial readout layer with $\Delta r \sim 8$mm
- Readout plane with 1.2mm pads in $r\varphi$
  - approximately 350,000 readout channel
- Assume 40 MHz FADC $\rightarrow$ $\Delta z \sim 2$mm
  - approximately 400 samples per readout channel

VTX layers 1 & 2

- Silicon tracker design

T2K Gas and Response of Readout Plane

Gas properties (Ar(95%) CF_4(3%) Isob(2%)), based on ILC prototype measurements and verified with Magboltz, ionization from PDG:

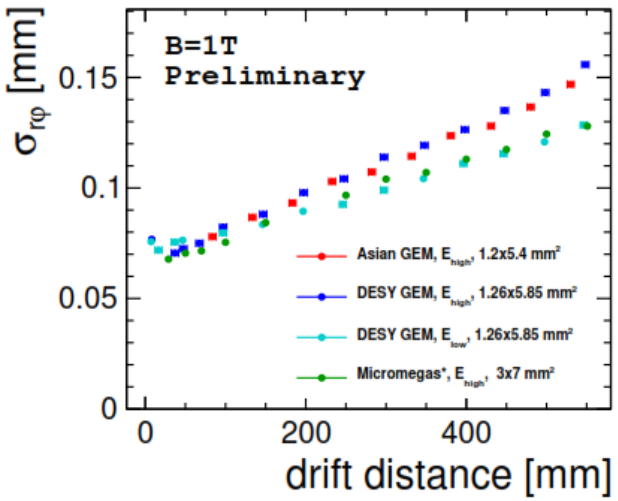
- N_t = 38 electrons/keV
- $v_{drift} \approx$ 6 cm/μs at ~ 150 V/cm
- $D_t \approx$ 57 μm/√cm in 1.45 T field
- $w_t \approx$ 2.2
- $X_0 \approx$ 11633 cm

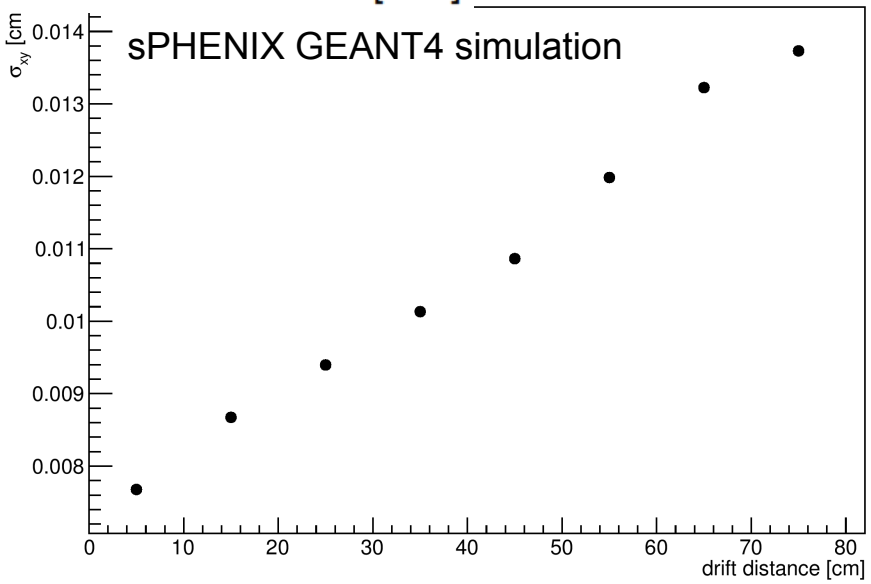
$$\sigma_{r\varphi}^2 = \frac{D_t^2 z}{N_t} + \sigma_0^2$$

$$\sigma_z^2 = (1 + w_t^2)\frac{D_t^2 z}{N_t}$$

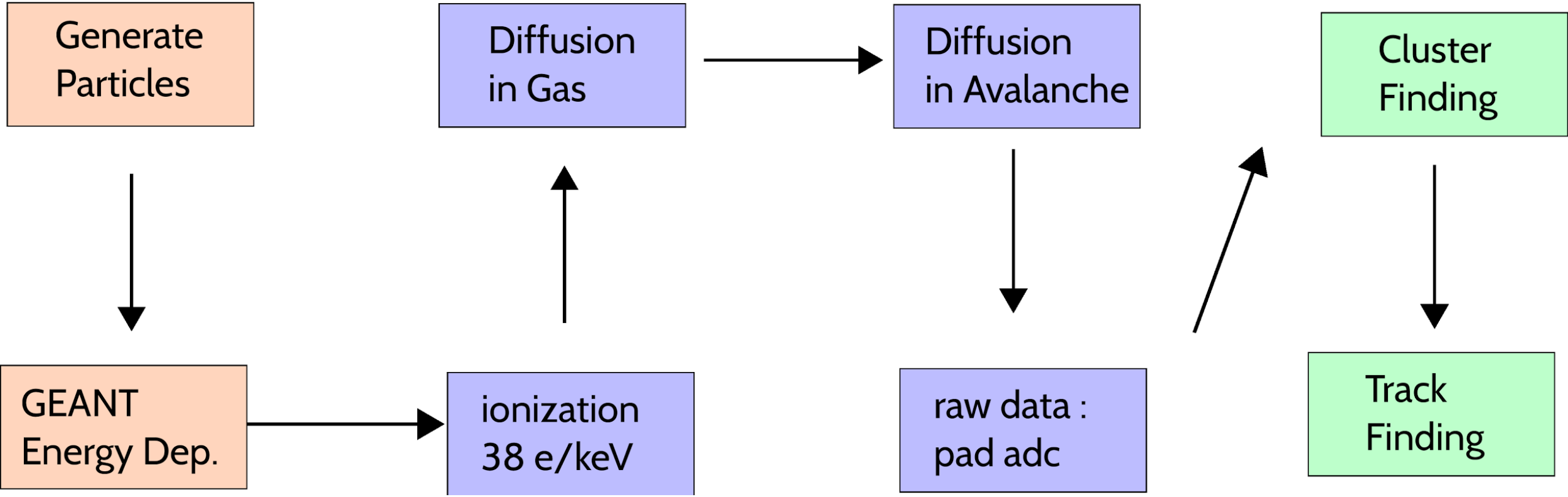
Charge sharing between 2-3 pads of 1.2mm, based on ILC prototype measurements:

- σ_{charge} = 300 μm in triple GEM
- σ_0 = 70-80 μm

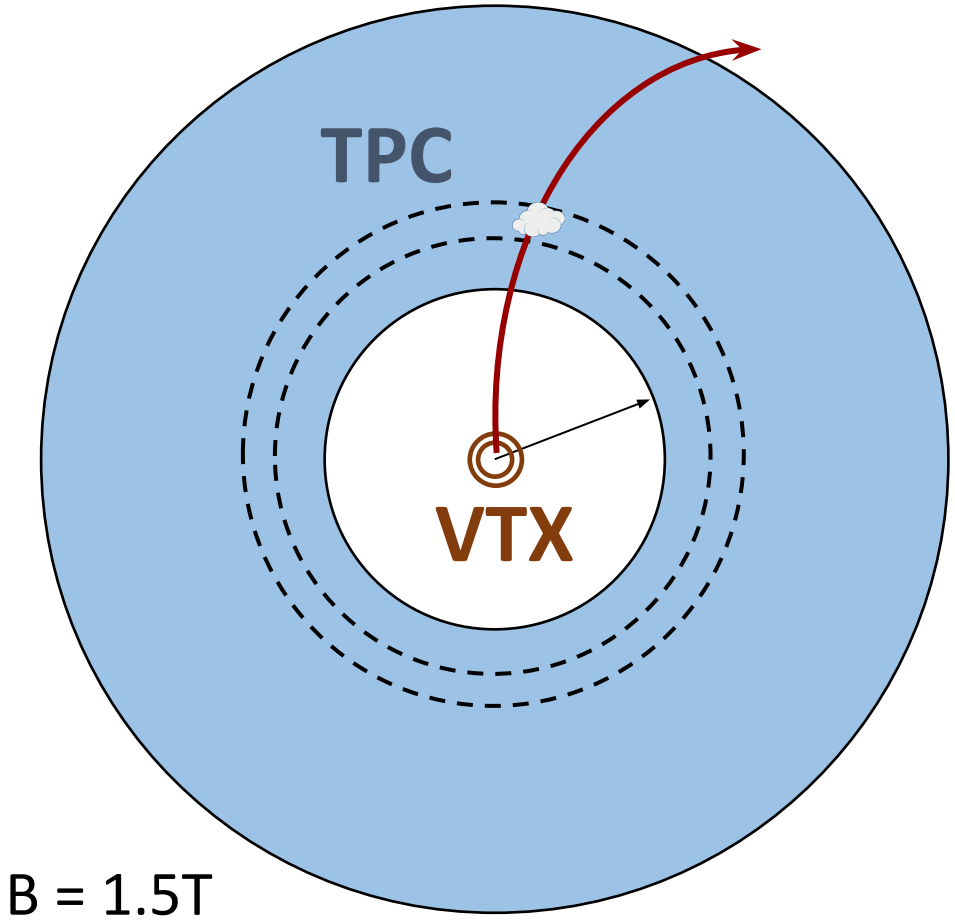




Flow Chart of GEANT Simulation & Analysis



TPC Charge Cloud Generation & Diffusion

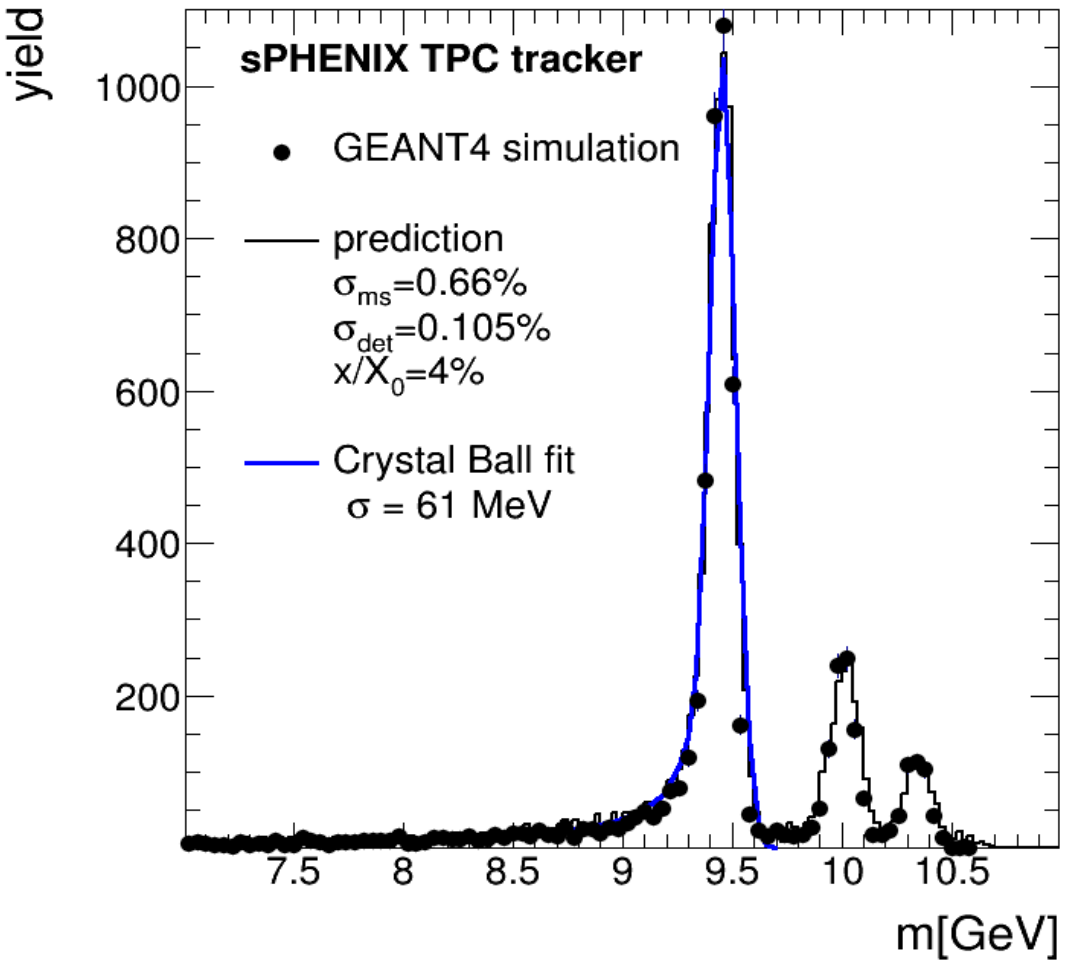


TPC in GEANT

- Record ΔE in radial drift cylinder slice
- Convert to charge cloud along track segment
- Diffuse charge cloud along z for T2K gas in 1.5 T B-field with 220 V/cm E-field
- Distribute Cloud along pads, fit with cluster-finder

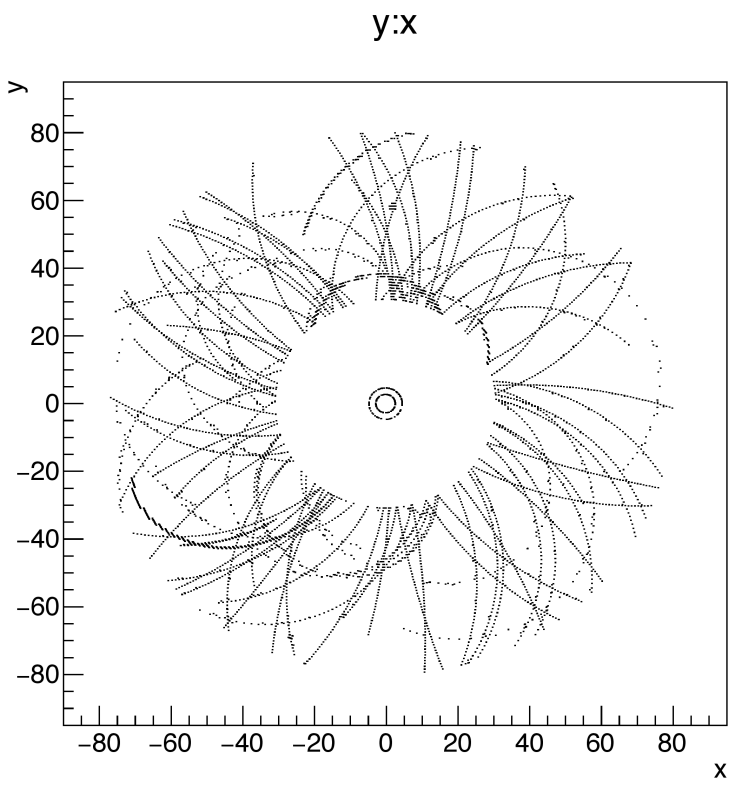
GEANT4 Simulation of Upsilon Measurement

Reconstructed Upsilon mass agrees with analytic calculation



High-multiplicity metrics

- We are at the point of running HIJING events through the framework
- What are the most useful metrics to quantify occupancy effects, e.g. double-hit resolution?
- Does STAR deal with ion feedback in a parameterized way? Can you give insights into general techniques to do so?



Thanks for your input!