Coincidences versus luminosity

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basic notation:

- P_A *probability that track is detected on side A* $\Longrightarrow$ $P_A+P_C=1$
- r_{TR} *track rate (average number of detected tracks in proton-proton collision)*
- R *coincidence rate*

taken into account:

- probability for N proton-proton collisions at certain luminosity
- probability for x tracks in event, given the number of proton-proton collisions
- probability that track is detected on a desired side (A or C)

goal:

- determine **coincidence rate**
- **P_A and r_{TR}** must be determined from simulation
- everything is expected to be **vertex position sensitive**

Calculation-simulation comparison

- **analiticaly:**

$$R(L) = \sum_{N=0}^{\infty} P\left(N, \frac{L}{L_0}\right)\left[\left(1 - e^{-P_A N r_{TR}}\right)\left(1 - e^{-(1-P_A) N r_{TR}}\right)\right]$$

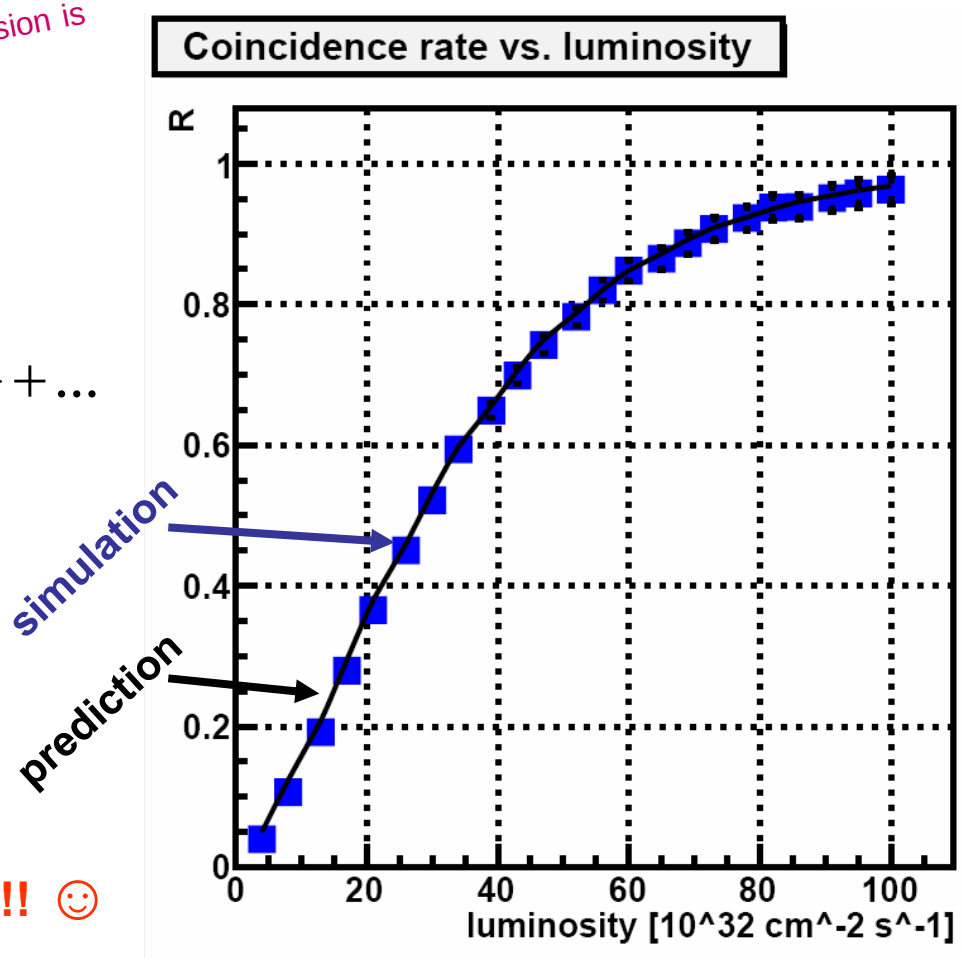
Poissonian distribution

luminosity where on average one proton-proton collision is expected

$$R(L) \approx \left(1 - e^{-P_A r_{TR}}\right)\left(1 - e^{-(1-P_A) r_{TR}}\right)\frac{L}{L_0} + \ldots$$

linear at low luminosity...

- **simulation:**
  - 53k proton-proton collisions
  - vertex at **z=0**



good agreement !! ☺

Vertex position sensitivity

- **parameters P_A** and **r_{TR}** change so R changes
- **analytical estimate** can be given for primary particles (constraint: origin in vertex)
- **basic idea:**

$$\frac{dN}{dz} = \frac{dj}{dz}\Omega + j\frac{d\Omega}{dz}$$

particle flux change

diamond solid angle

- **detail mathematics** given at: http://www-f9.ijs.si/~macek/coincidences.pdf
- **terms of final expression:**
  - effective area of diamond decreases with moving vertex closer
  - solid angle increases when moving vertex closer
  - particle flux changes because of different η of diamond with respect to displaced vertex

- form dN/dz one can predict in the **lowest order**:

$$\frac{dr_{TR}}{dz} = \frac{dN_A}{dz} + \frac{dN_C}{dz} = 0$$

$$\frac{dP_A}{dz} = \frac{1}{r_{TR}}\frac{dN_C}{dz} \approx (0.04 - 0.06)\frac{1}{m}$$

uncertainty of input data

Simulation results

- **original position:**
  - 53k proton-proton collisions
  - vertex at **z=0**
- **results:**
  - P_A^{tot} = 0.4961±0.0034
  - P_A^{prim} = 0.4909±0.0049
  - r_{TR}^{tot} = 0.3959 ±0.0027
  - r_{TR}^{prim} = 0.1937 ±0.0019

- **vertex moved:**
  - 41k proton-proton collisions
  - vertex at **z=10cm**
- **results:**
  - P_A^{tot} = 0.4850±0.0039
  - P_A^{prim} = 0.5033±0.0056
  - r_{TR}^{tot} = 0.3968 ±0.0031
  - r_{TR}^{prim} = 0.1966 ±0.0022

opposite sign as for primary particles !!!

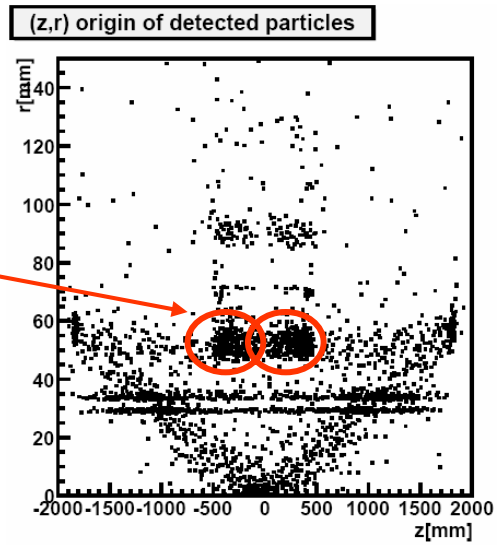
biggest contribution in P_A changes come from secondary particles

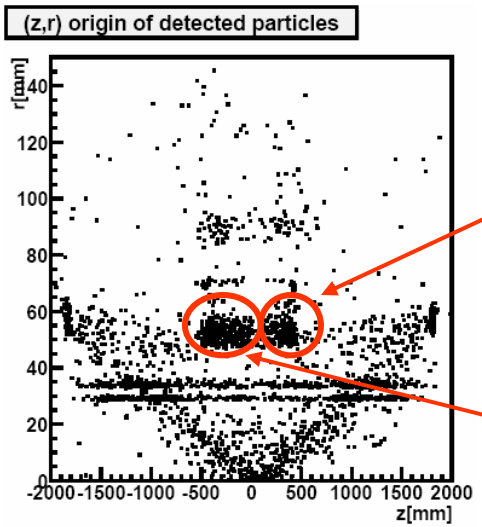
dP_A^{tot}/dz = (-0.111±0.052)/m

dP_A^{prim}/dz = (0.124 ±0.062)/m ← prediction (0.4-0.6)/m

dr_{TR}^{tot}/dz = (0.009 ±0.042)/m ← consistent with zero

dr_{TR}^{prim}/dz = (0.029 ±0.030)/m ← consistent with zero





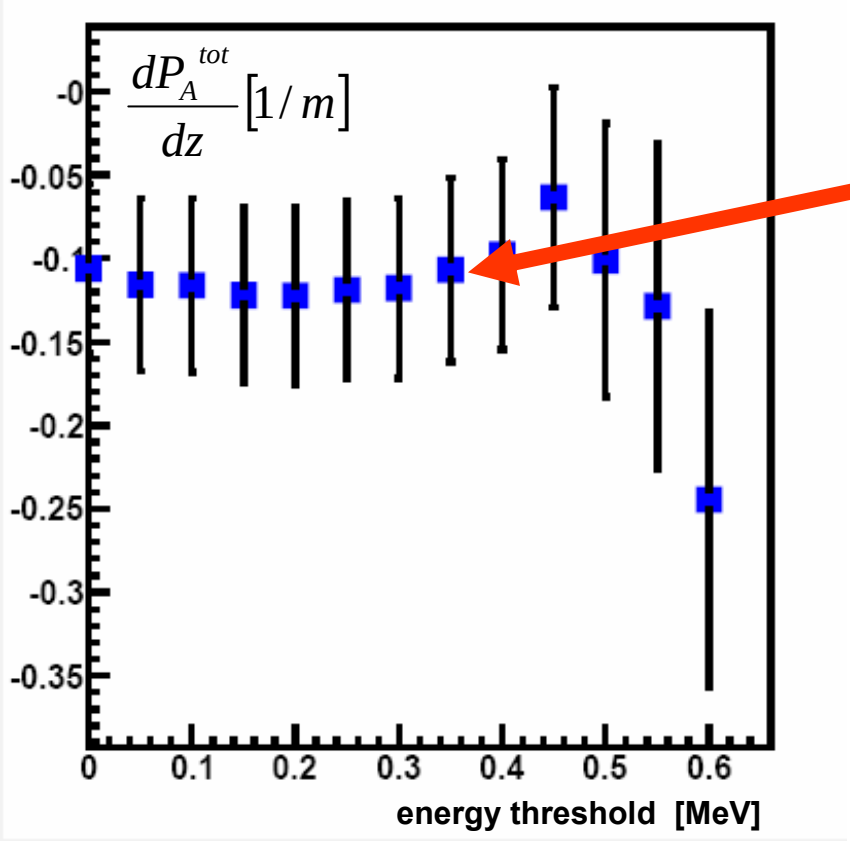
equal contribution form Pixel to both sides

Pixels move out of vertex-diamond way and their contribution decreases significantly

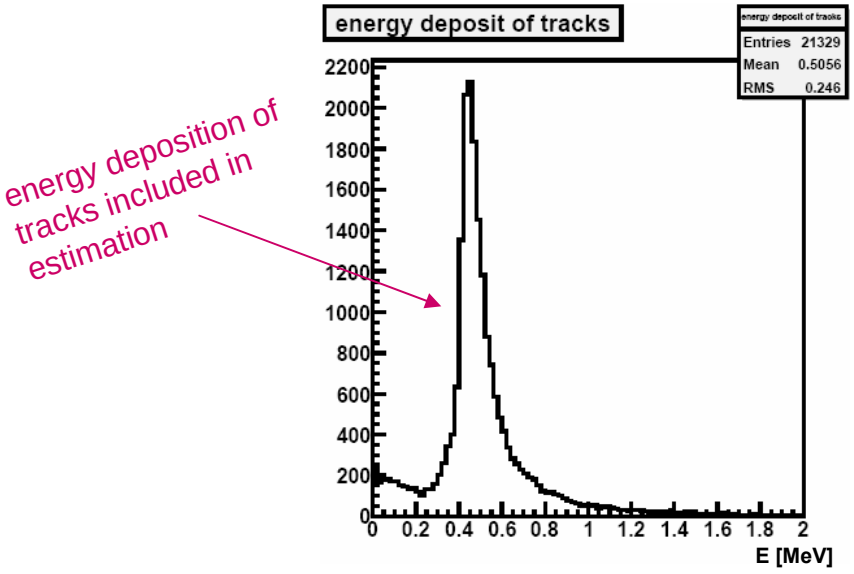
contribution to opposite side increases

Energy cuts

- in above analysis no energy cuts were made on detected track population
- some low **energy cut is needed**
- estimation of dP_A/dz was done for energy cuts



insensitive to energy cuts !!!



energy deposition of tracks included in estimation

Summary

- analytic calculation gives good description of coincidence rate
- coincidence rate is sensitive to vertex position
- estimate for dP_A/dz
- dP_A/dz is dominated by secondaries $\Longrightarrow$ sensitive to mass distribution $\Longrightarrow$ no analytic estimate for total dP_A/dz
- dP_A/dz insensitive to energy cuts