PID and relative TOF

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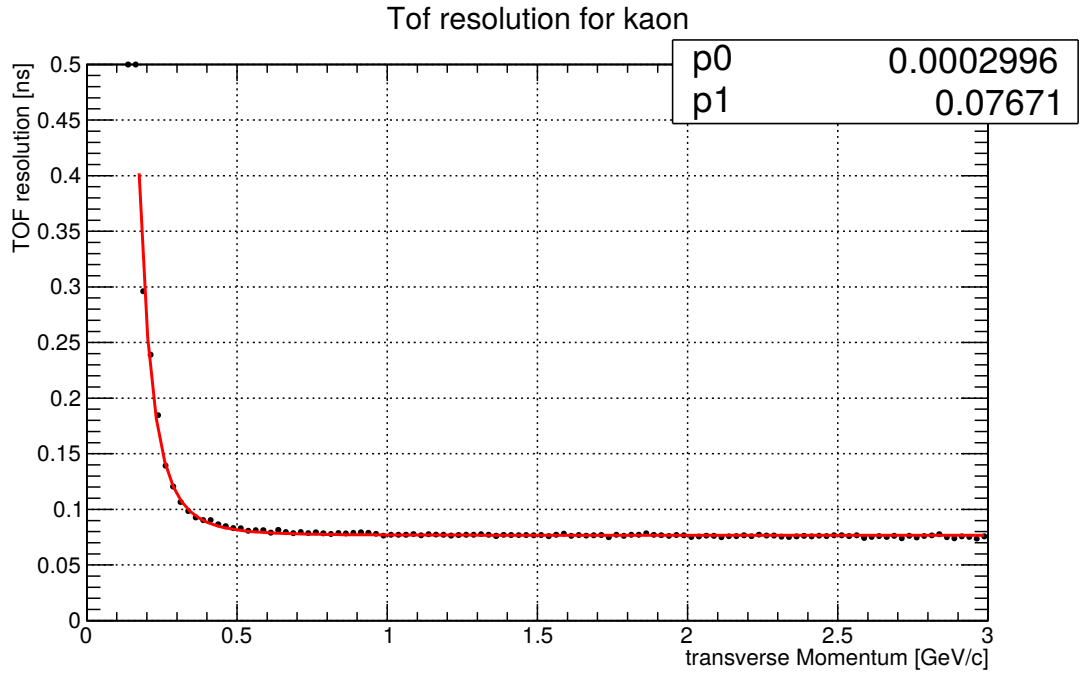
TOF based PID

- time-of-flight resolution
  - Intrinsic time resolution updated
    - $\sigma_{SciTil} = 75$ ps
  - Evaluated for all particle species
    - p, K, π, μ, e
  - Fit function:
    - $\sigma_{TOF} = \frac{p_0}{p_t^4} + p_1$



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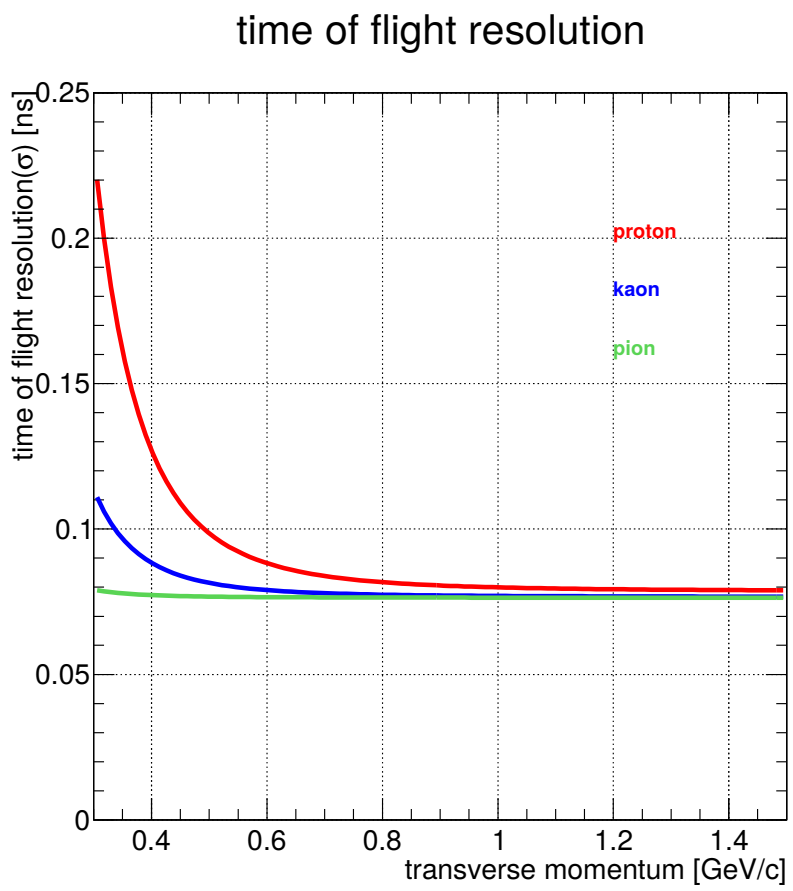
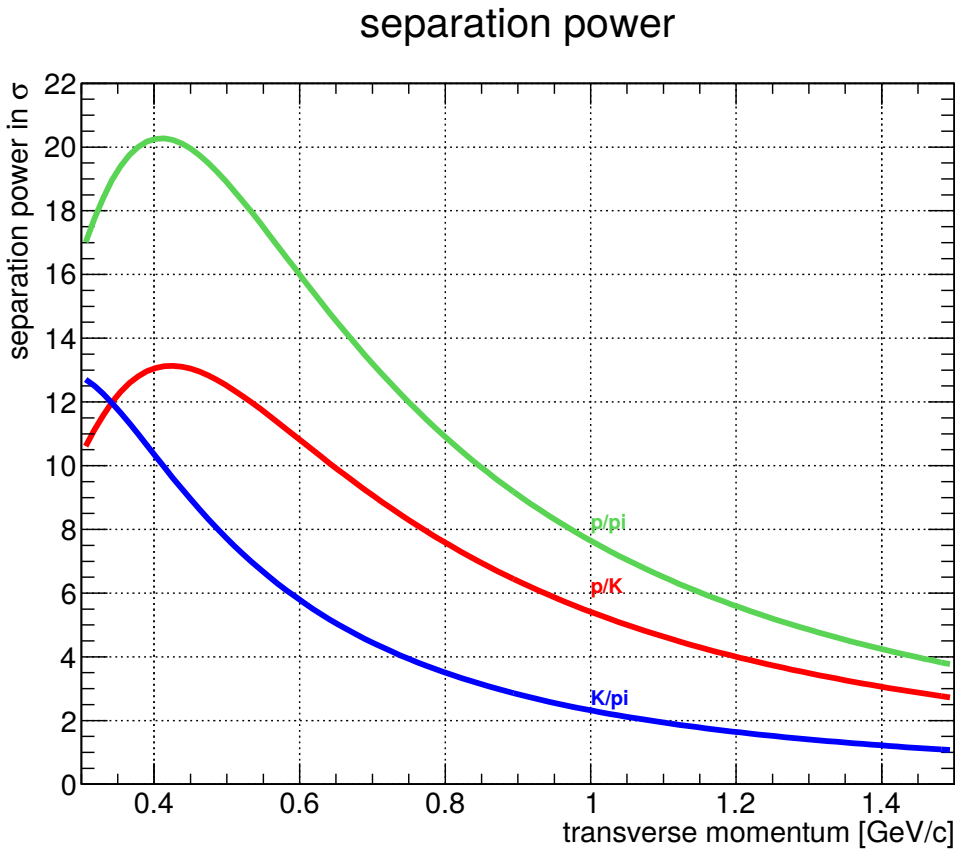


Separation power

- Time of flight
  - using p_t
  - projected track length

- $$n_\sigma = \frac{|tof_p - tof_K|}{max(\sigma_p, \sigma_K)}$$

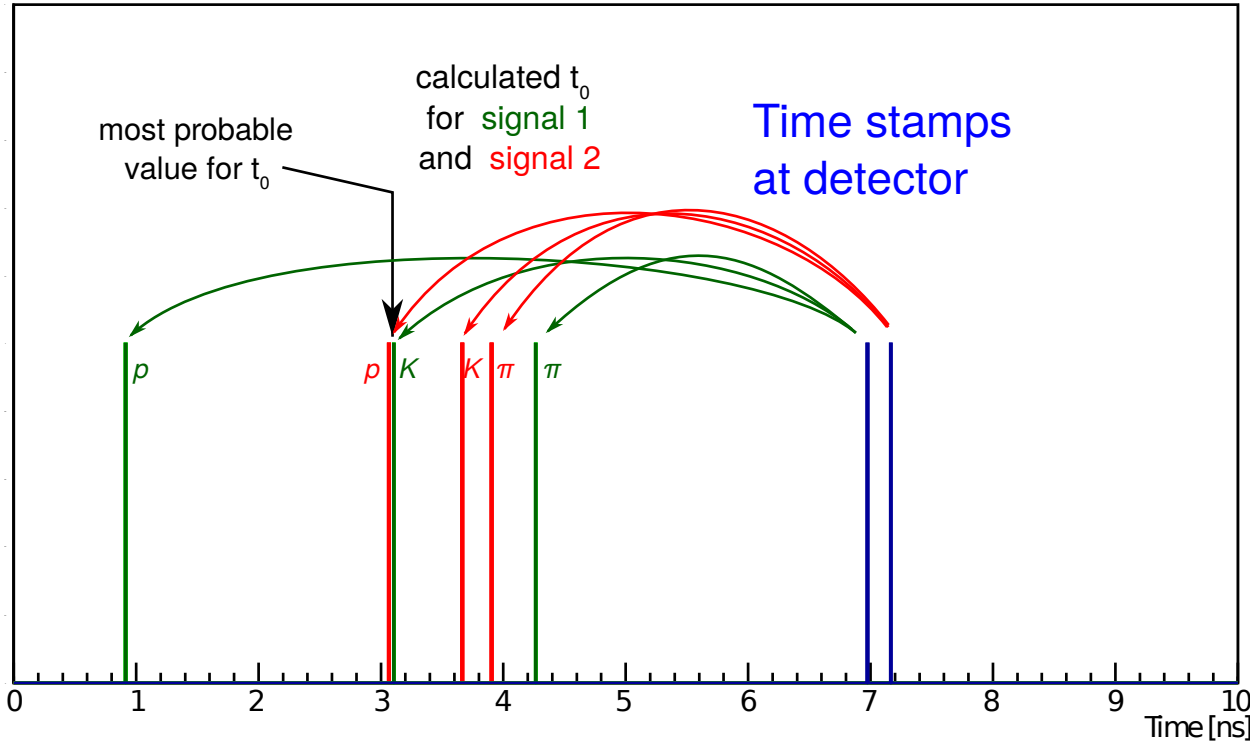


Relative Time of Flight

- Possible algorithms were discussed
  - "Motivation of the Barrel Time-of-Flight Detector for PANDA"
- See also
  - S. Spataro – Ferrara Meeting 2008
  - A. Kiselev, Yu. Naryshkin – Stockholm Meeting 2010

Basic principle

- Calculate t_s for all possible particle species and all N tracks
  - Using reconstructed track parameters
  - p, K, π, μ, e
- evaluate all 5^N mass configurations
  - Compare their X^2 weights
  - Select the "most probable"



- Minimization of the X^2 functional
  - For every mass configuration
- => weighted mean of t_{i0} ($\langle t_0 \rangle$)
-
- Select most probable mass configuration
  - Lowest X^2 Value

$$\Psi_{W_{(m_1,\ldots,m_N)}} = \frac{\sum_{i=1}^{N} (t_{i,0} - t_0)^2}{\sigma^2_{i,TOF}}$$

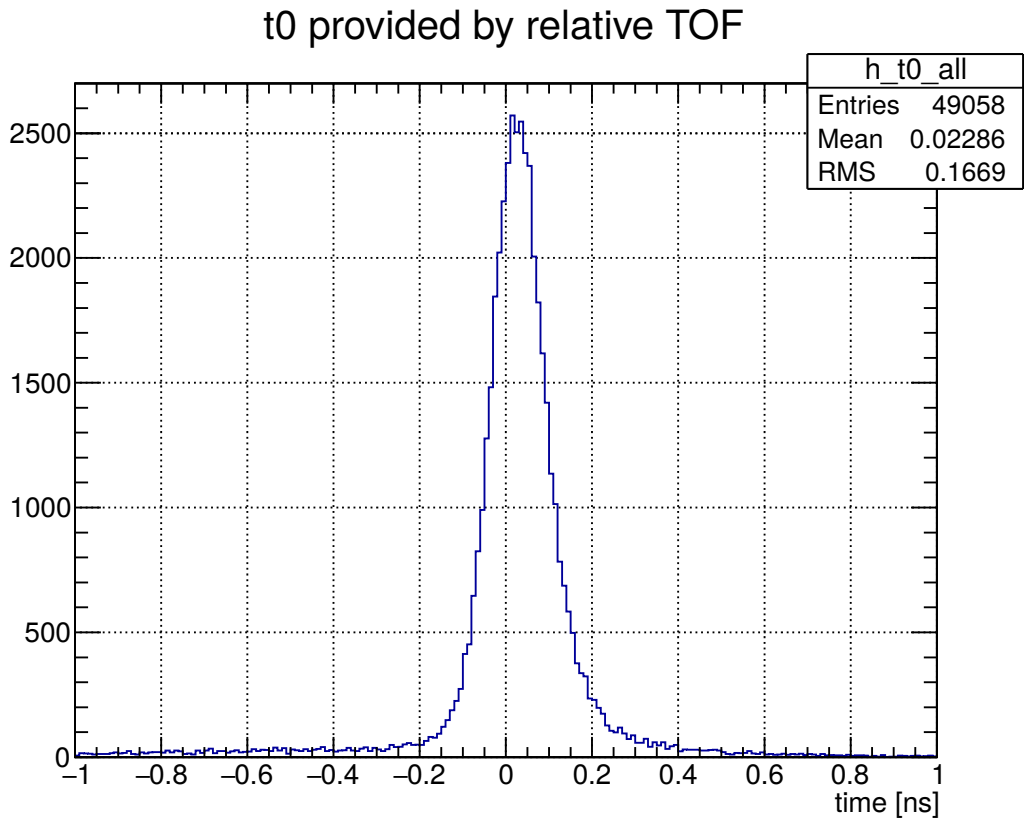
$$\langle t_0 \rangle (C) = \frac{\sum_{i=0}^{n} \frac{t_i^0}{\sigma^2_{i^{TOF}}}}{\sum_{i=1}^{n} \frac{1}{\sigma^2_{i^{TOF}}}}$$

$$t_{i,0} = t_i - \frac{l_i}{c} \cdot \sqrt{\frac{m_i^2}{p_i^2} + 1}$$

l_i = reconstructed track length
p_i = reconstructed momentum
m_i = mass assumption

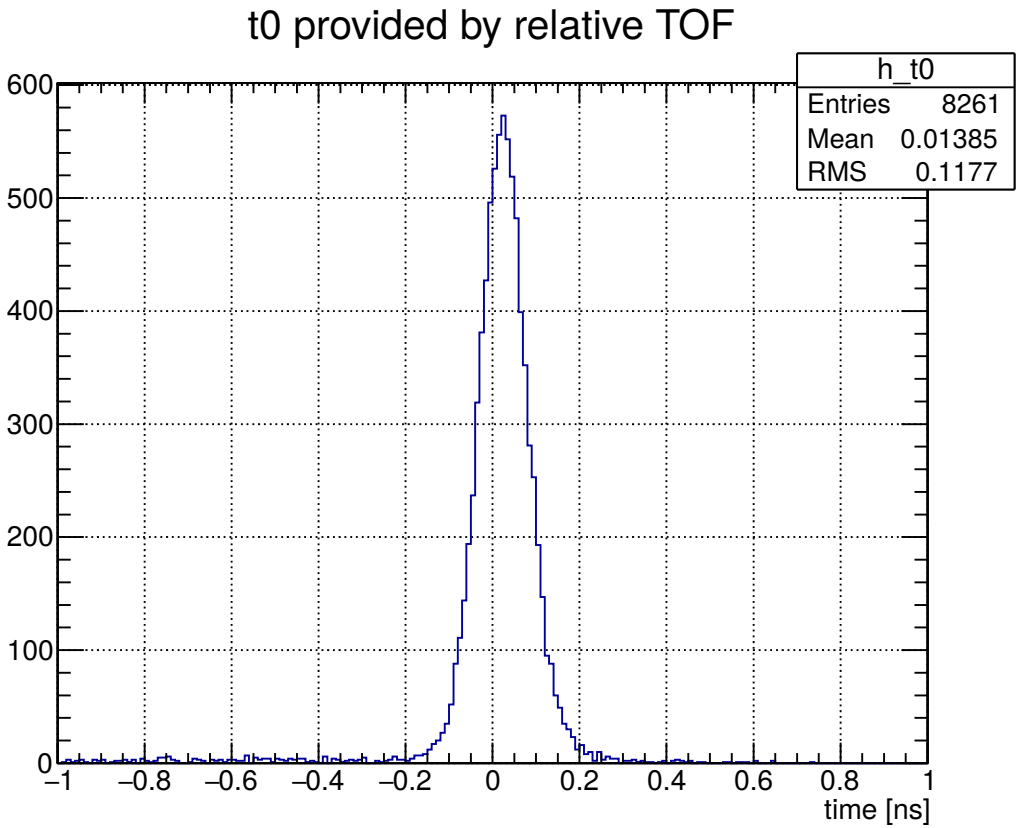
t0 determination in Pandaroot

- Relative Tof algorithm implemented in local macros
  - Pid stage
- DPM generator
- Events with N>3 tracks matched with SciTil



t0 determination in Pandaroot

- Relative Tof algorithm implemented in local macros
  - Pid stage
- DPM generator
- Events with N>3 primary tracks matched with SciTil
- Mismatched tracks are rejected (MC information)



Future enhancements

- Implementation of FTOF
  - Increased track number N per event
  - Different category of track length and momenta
- Pre-selection of t_0 time window
  - Online t_0, PID of other detectors
  - exclude wrong mass assumptions and mismatched or reconstructed tracks
  - Save computing power
- Algorithm to reject seemingly mismatched tracks
  - "Performance of the ALICE Time-Of-Flight detector at the LHC", Eur. Phys. J. Plus (2013) 128: 44

Relative time of flight PID

- PID for single particles
  - Use the probability (P-Values) of the X^2 values as relative weights
  - Probability P for the i-th track to be from particle species j
- Derived pdf (normalized) as input for global PID

$$P_{i,j} = \frac{\sum_{j}^{5^N} W_{(m_{1,\ldots},m_N)}}{\sum_{i=1} W_{(m_{1,\ldots},m_N)}}$$