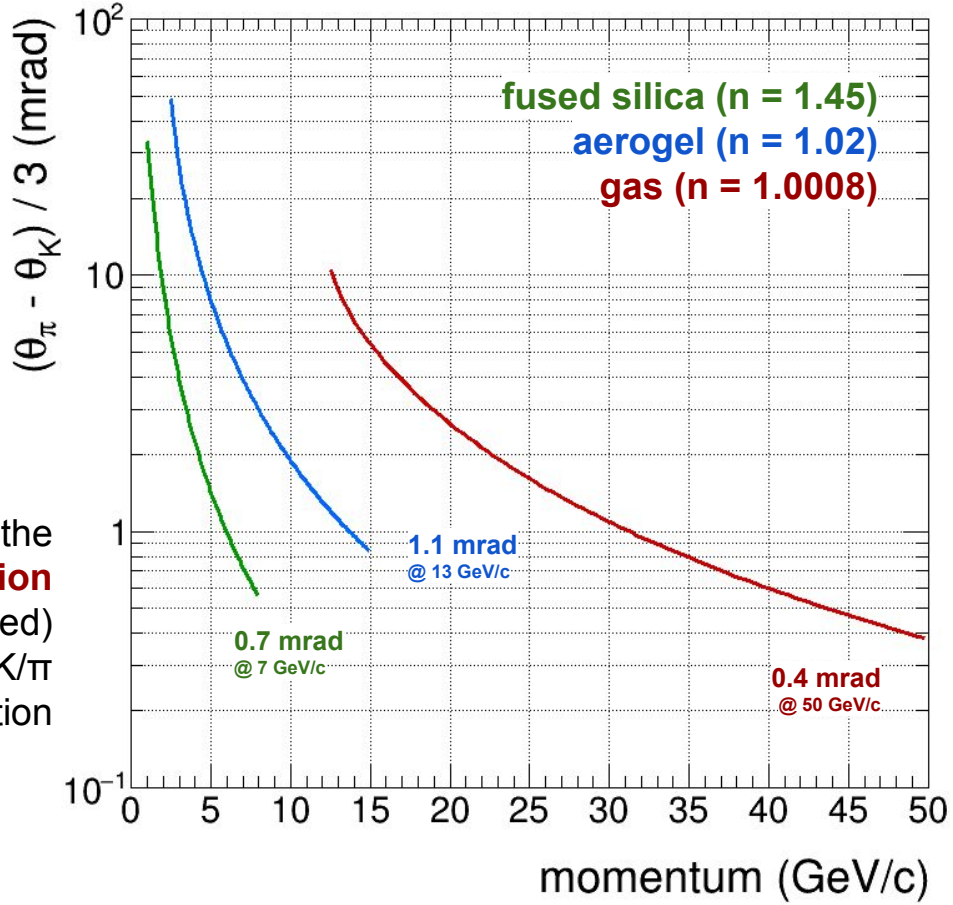
Cherenkov PID tracking thoughts

The need for 3σ K/π separation

presented last week



this corresponds to the **total angular resolution** (tracking included) required to have 3σ K/π separation

The need for 3σ K/π separation

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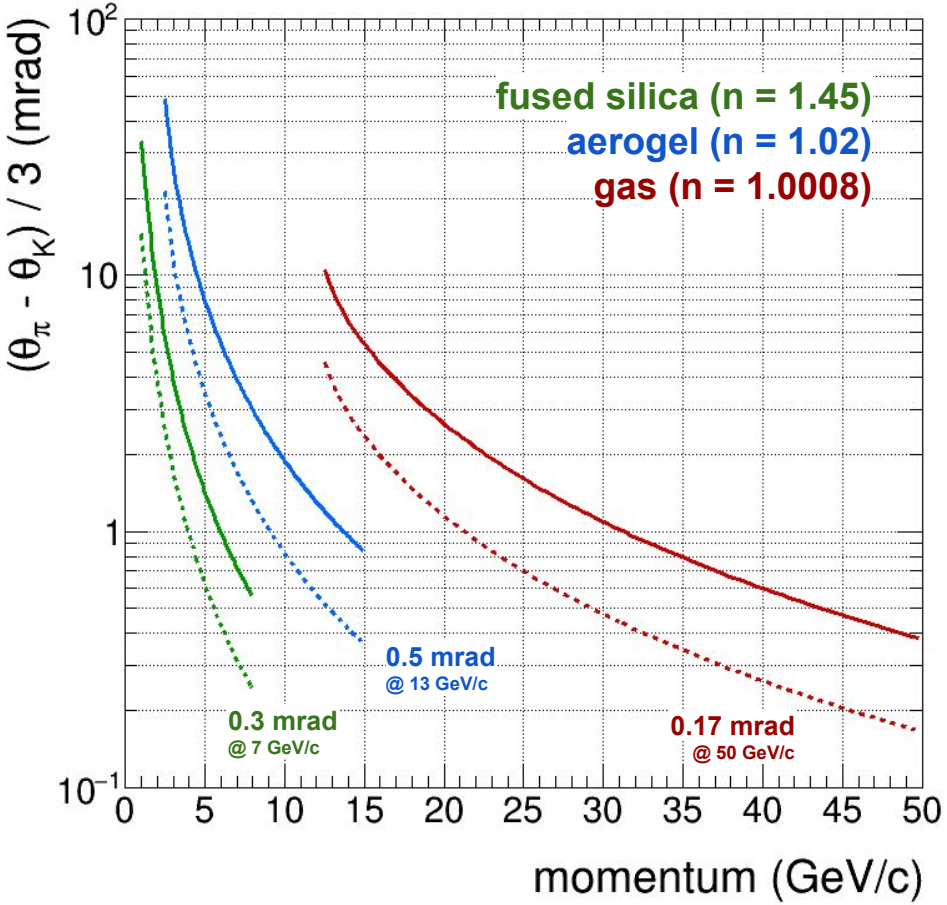

requiring that
the contribution from tracking
is small

ie. it contributes to 10% of the total absolute resolution

0.4^2 mrad = 0.36^2 (RICH) + 0.17^2 (track)
1.1^2 mrad = 1.00^2 (RICH) + 0.48^2 (track)
0.7^2 mrad = 0.63^2 (RICH) + 0.30^2 (track)

The need for 3σ K/π separation

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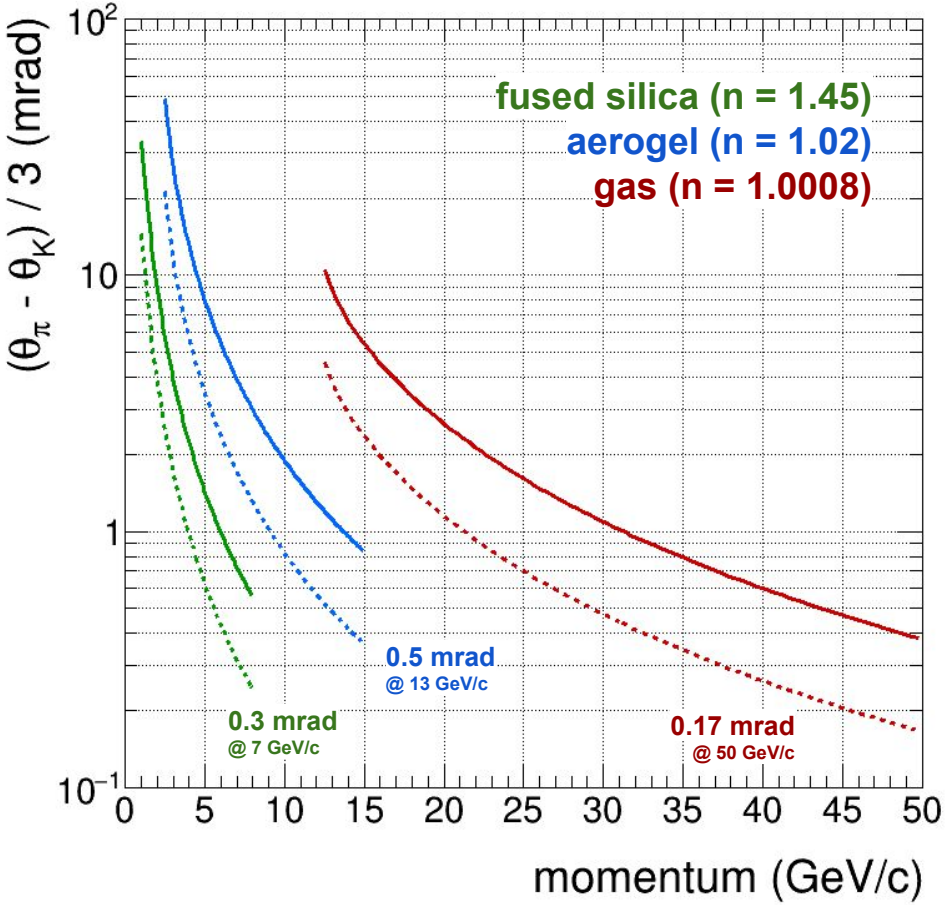

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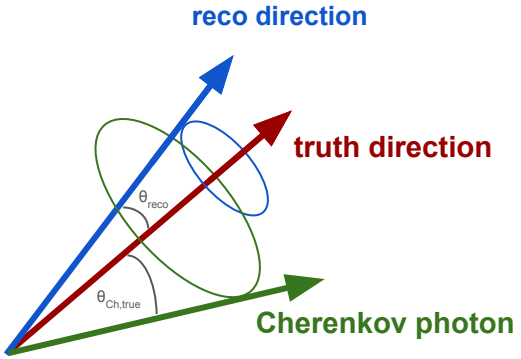
these numbers are still ~ ok
but I was **wrong to think that tracking resolution does not scale with number of photons**
it does, Elke and Evaristo are right

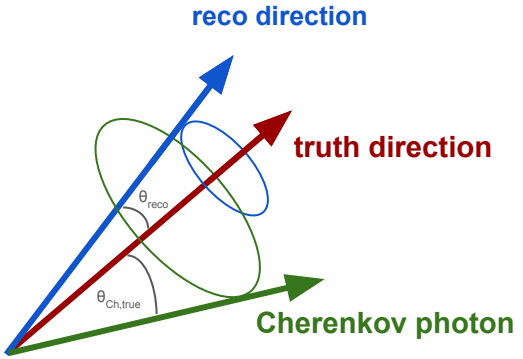
Another simplified simulation exercise



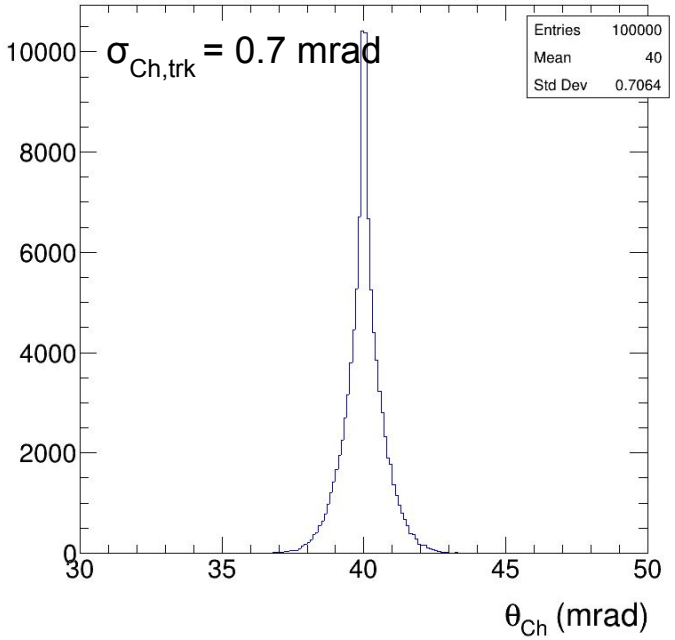
- **reconstructed track direction vector**
  - random gaussian smearing of angle wrt. truth direction θ_{reco}
  - random uniform rotation around axis of truth direction
- **Cherenkov photons direction vector**
  - N photons generated for each track
  - generated with fixed (Cherenkov) angle wrt. truth direction θ_{reco}
  - random uniform rotation around axis of truth direction
- **reconstructed Cherenkov angle θ**
  - from scalar product between
    - photon direction vector (a)
    - reconstructed track direction vector (b)

$$\cos\theta = \frac{a \cdot b}{|a||b|}$$

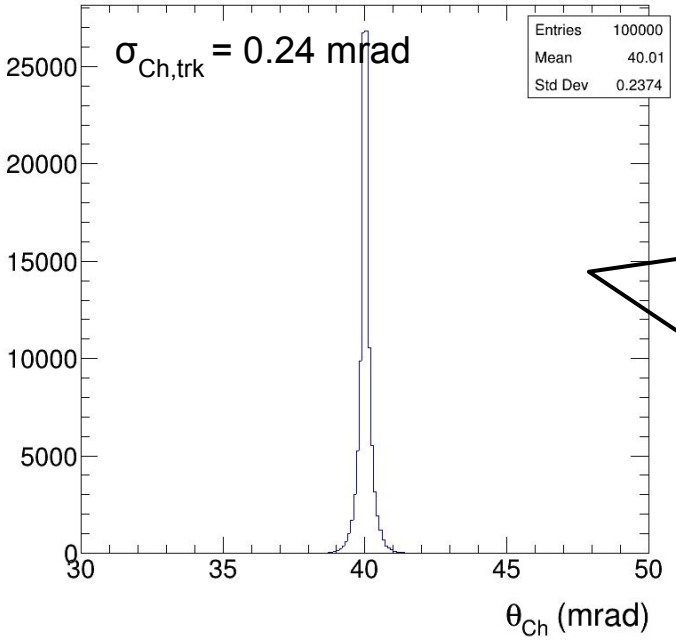
Another simplified simulation exercise



θ_{Ch} = 40 mrad
σ_{trk} = 1 mrad
N_{ph} = 1



θ_{Ch} = 40 mrad
σ_{trk} = 1 mrad
N_{ph} = 9



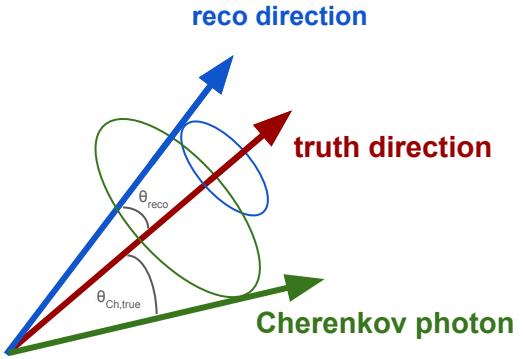
$$\cos\theta = \frac{a \cdot b}{|a||b|}$$

contribution of tracking angular resolution to the reconstructed Cherenkov angle is

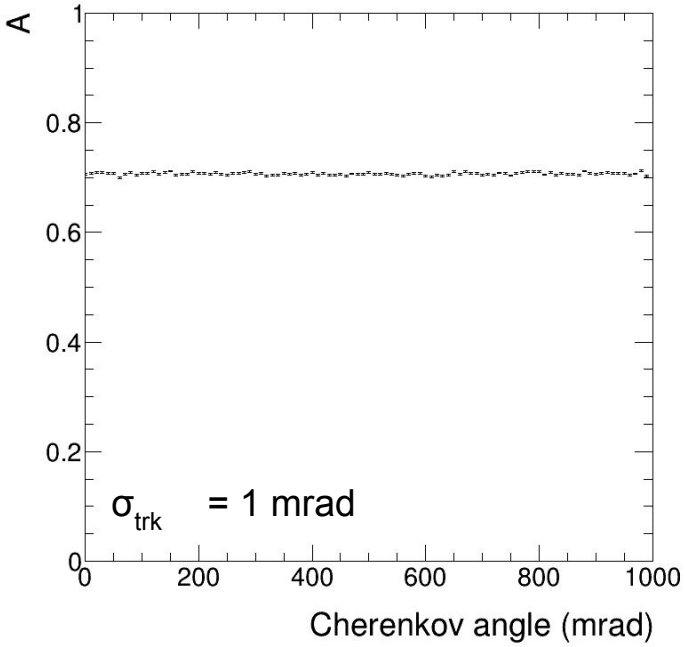
$$\sigma_{Ch,trk} = A\,\sigma_{trk} / \sqrt{N_{ph}}$$

with A ~ 0.7

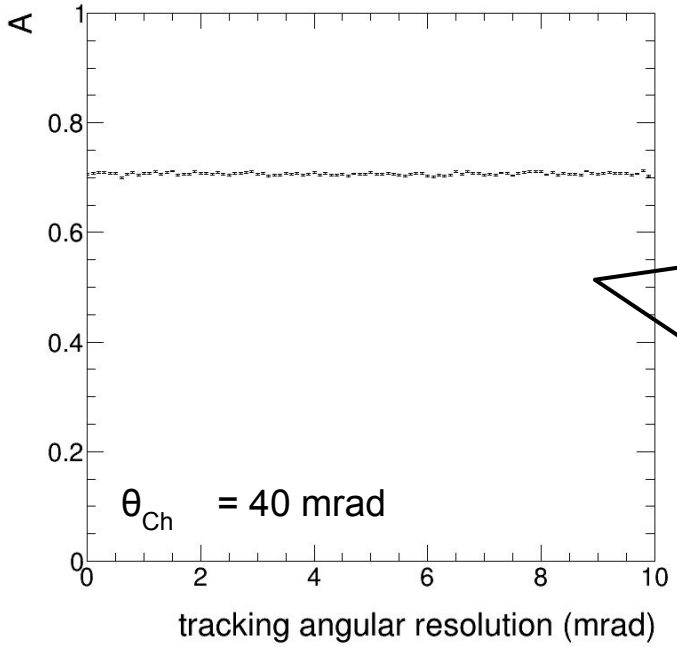
Another simplified simulation exercise



the value of A does not depend on the Cherenkov angle



the value of A does not depend on the tracking angular resolution



$$\cos\theta = \frac{\mathbf{a}\cdot\mathbf{b}}{|\mathbf{a}||\mathbf{b}|}$$

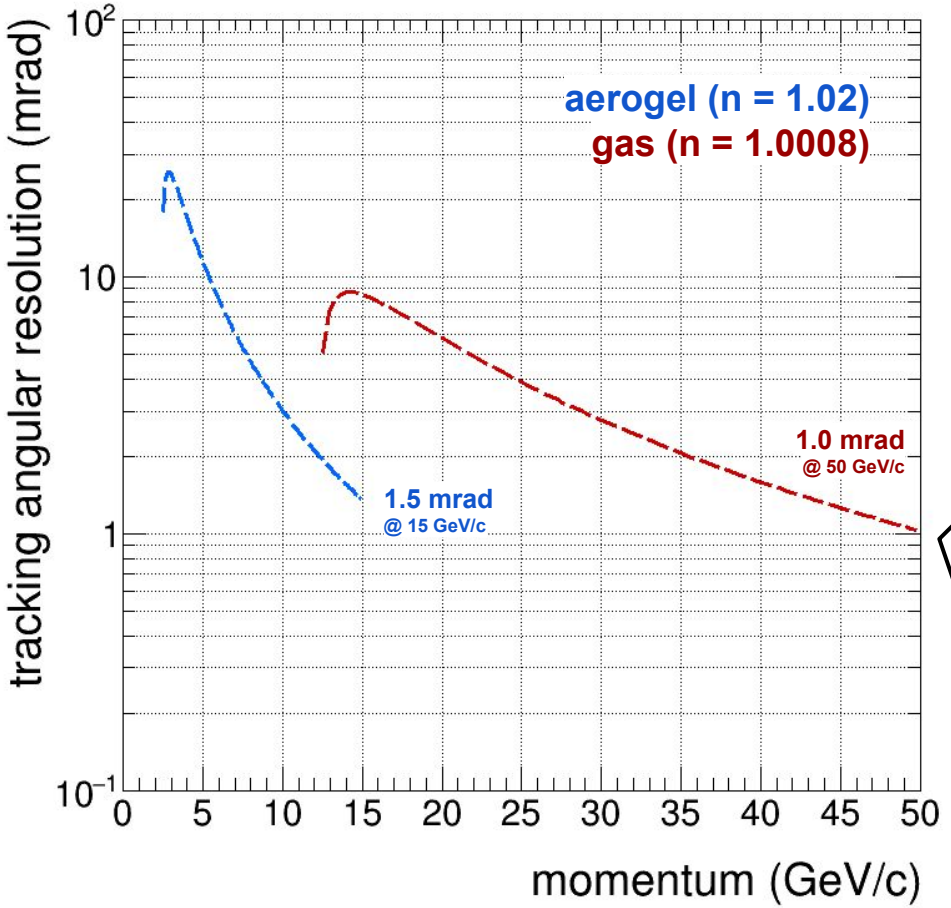
contribution of tracking angular resolution to the reconstructed Cherenkov angle is

$$\sigma_{Ch,trk} = A\,\sigma_{trk} / \sqrt{N_{ph}}$$

with A ~ 0.7

Tracking requirement for dRICH

$$\sigma_{Ch,trk} = 0.7\ \sigma_{trk} / \sqrt{N_{ph}}$$



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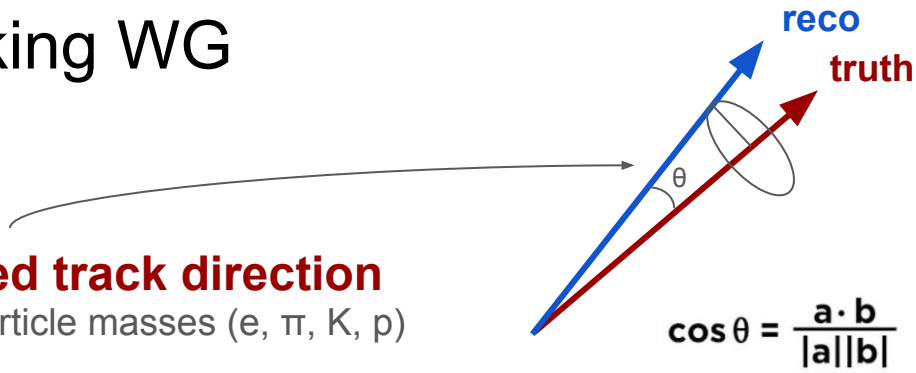
the long-dashed curves are the more reasonable estimate of requirements from tracking

obtained by scaling short-dashed curves with the formula

using Frank-Tamm for $N_{photons}$ evolution anchored to
N_{ph} = 20 at gas saturation
N_{ph} = 7 at aerogel saturation

see slides of Chandra on calculations of multiple scattering contribution for various materials / thickness

What we would need from tracking WG



- **angular resolution of reconstructed track direction**
  - as a function of (η, p) and for different particle masses (e, π, K, p)
    - the most urgent/relevant is K
  - at the various Cherenkov radiators
    - d-RICH: at the middle of the aerogel and of the gas radiators
    - m/pf-RICH: at the middle of the aerogel radiator
    - hp-DIRC: at the middle of the quartz bar
  - possibly in two configurations
    - with and without a tracking layer behind
  - with reasonable assumptions for material budget
    - support structures
    - detector materials, services and cables
- **is AC-LGAD TOF layer a good last tracking point for PID**
  - is TOF going to be readout in strips?

END