

Event plane determination with the new ALICE FIT detector

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Introduction: The ALICE experiment

The **ALICE experiment** is dedicated to the study of **quark-gluon plasma (QGP)**, a state of matter existing in hot and dense systems such as high-energy heavy-ion collisions. The experimental study of colliding systems including heavy ions, such as Pb-Pb or Pb-p, provides constraints to the theory describing the strong interaction, QCD, and gives insights about the conditions in the early universe.

Collision geometry

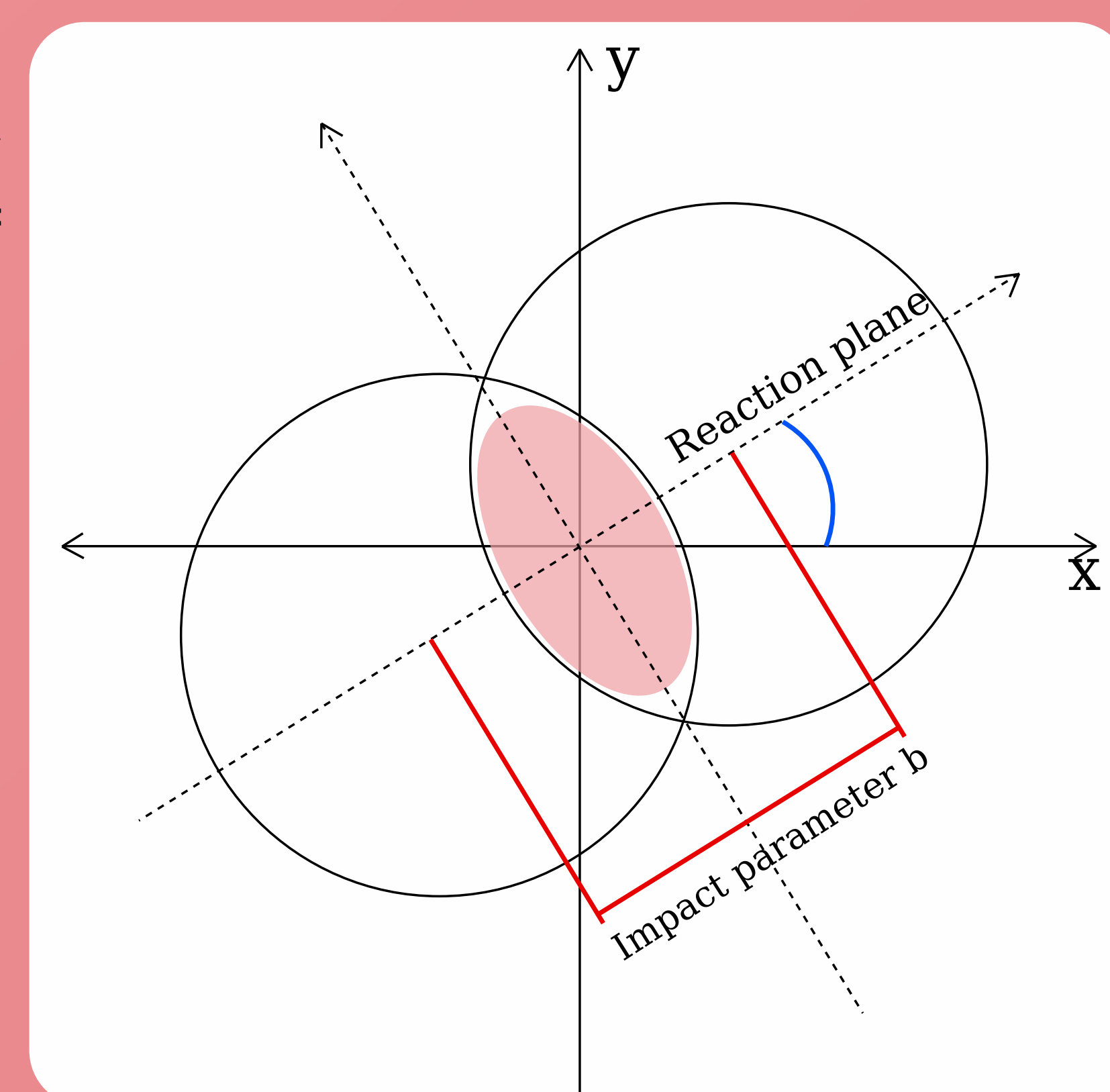
Parameter describing the geometry of the collision is **the reaction plane** determined by the beam axis and the impact parameter. Since the impact parameter cannot be directly measured the reaction plane is experimentally determined from the elliptic flow of particles which aligns with the reaction plane. This is done by calculating Q-vector using the azimuthal angles of the particles in the event and then finding out the angle Ψ_n

$$Q = \left(\sum_i w_i \cos(n\phi_i), \sum_i w_i \sin(n\phi_i) \right) \longrightarrow \Psi_n = \arctan \left(\frac{Q_{n,x}}{Q_{n,y}} \right) / n$$

when $n=2$. This estimation is called **the event plane**.

Due to the finite multiplicity in the collision, the secondary particles from surrounding material, and the detector effects, the event plane does differ from the true reaction plane and this difference is described by **the event plane resolution**. The resolution is determined using the 3-sub-event method (1).

The information about the event plane orientation is used for example in the study of jet azimuthal anisotropy (2).



Run 2: VZERO

During Run 2, the event plane was determined using **the VZERO detector** (3). VZERO consists of two plastic scintillator arrays (VZERO-A and VZERO-C) placed on both sides of the interaction point, covering pseudorapidity ranges $2.8 < \eta < 5.1$ and $-3.7 < \eta < -1.7$.

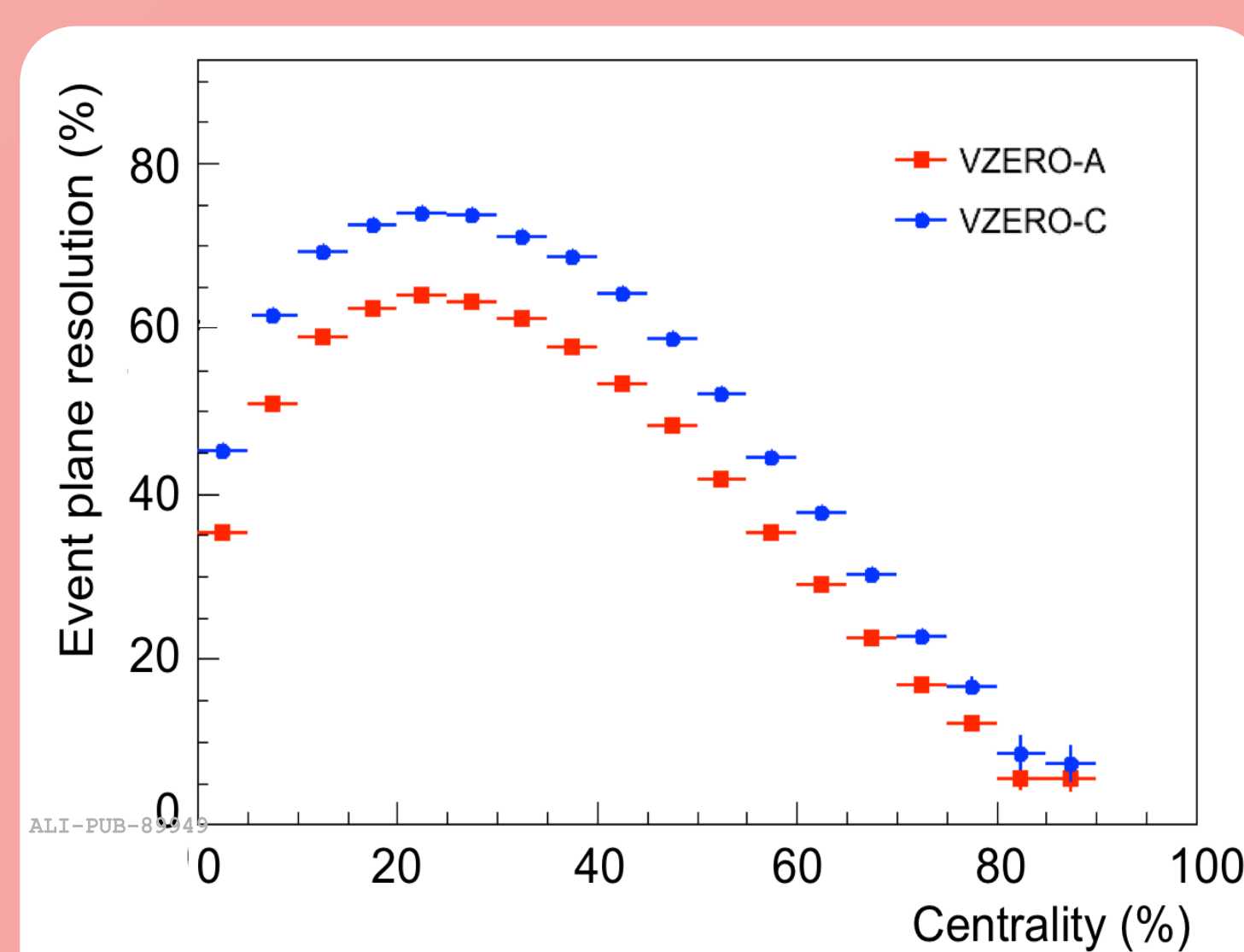
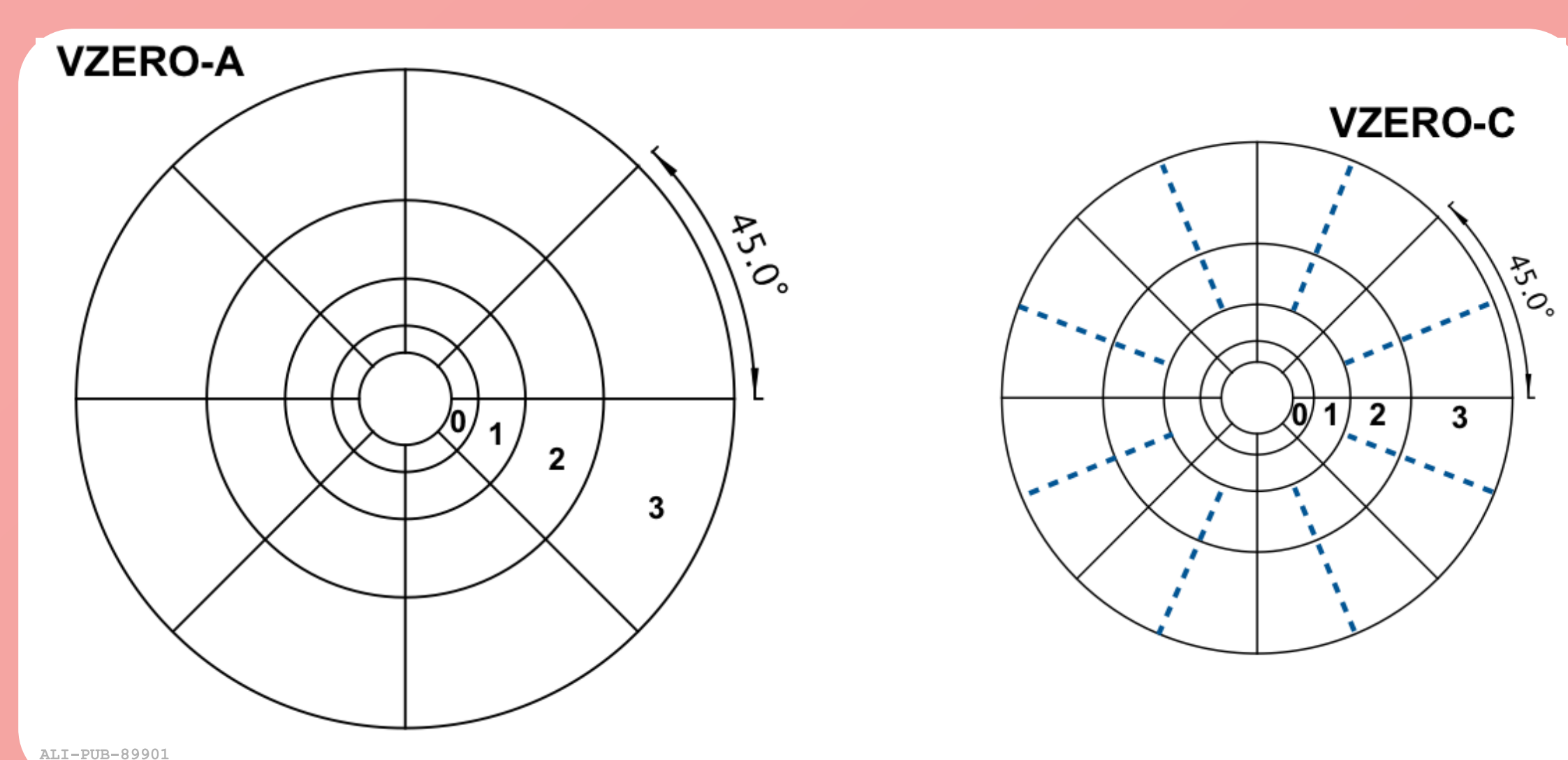


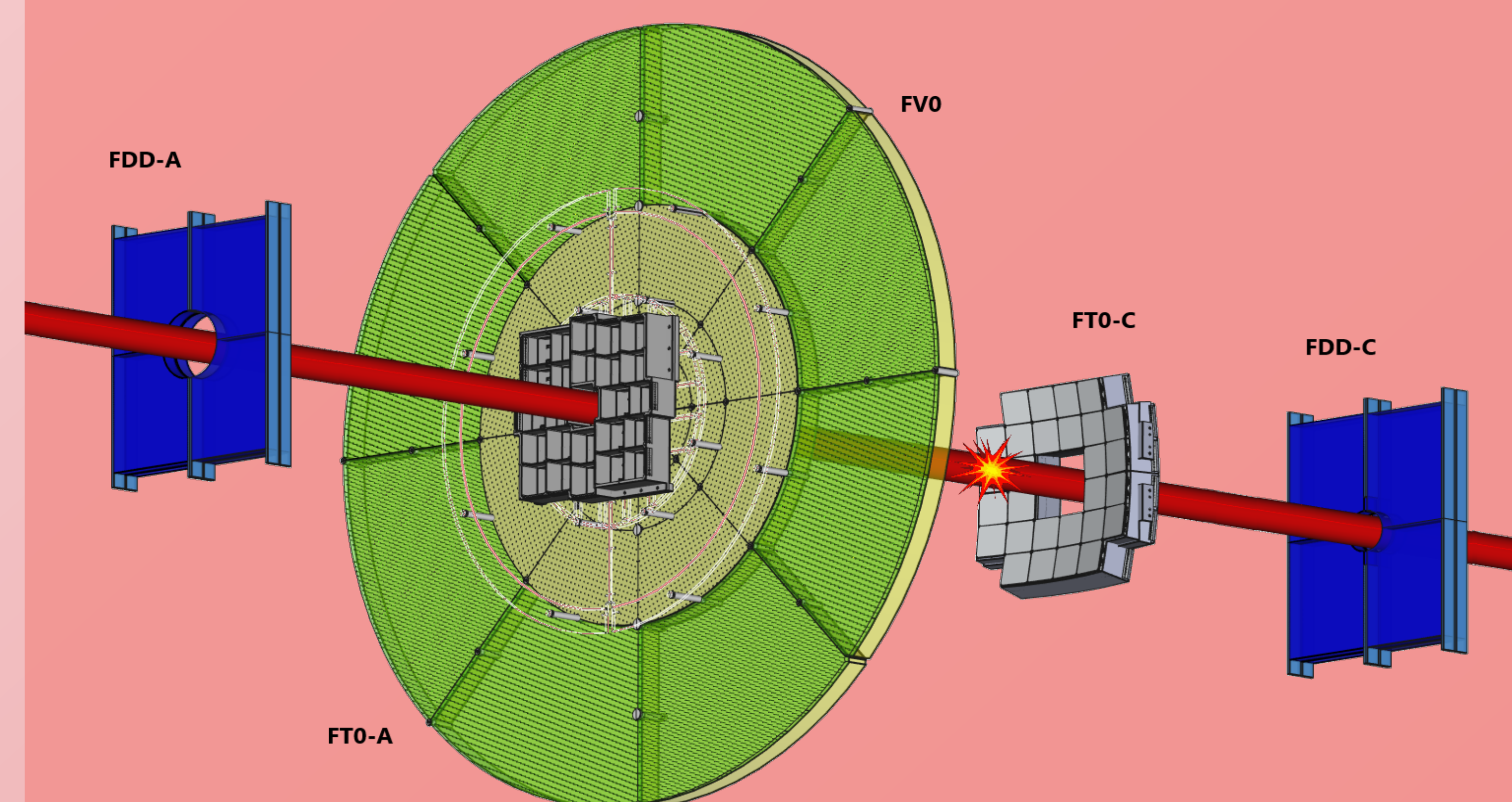
Figure 1: The measured event plane resolution during Run 2 for V0-A and V0-C.



Run 3: Fast Interaction Trigger

For the upcoming Run 3 the V0 detector system will be replaced by the upgraded FV0 scintillator array that is part of **the Fast Interaction Trigger** system (4).

Compared to the V0 system from Run 2 the new detector has improved granularity and larger acceptance ($2.2 < \eta < 5.0$). However, due to space limitations, there will be only one array on A-side.



References:

- (1) A. M. Poskanzer and S. A. Voloshin, Phys. Rev. C 58 (1998) 1671, <https://doi.org/10.1103/PhysRevC.58.1671>
- (2) ALICE Collaboration, Physics Letters B 753 (2016): 511–525, <https://doi.org/10.1016/j.physletb.2015.12.047>
- (3) ALICE Collaboration, Journal of Instrumentation 8.10 (2013): P10016–P10016, <https://doi.org/10.1088/1748-0221/8/10/P10016>
- (4) W.H. Trzaska, Nucl. Instrum. Methods Phys. Res. A 845 (2017) 463–466, <https://doi.org/10.1016/j.nima.2016.06.029>

The performance of FIT in regard to the event plane is currently being studied by simulating **the heavy-ion collisions** (AMPT), **the particle transportation** (GEANT3) through the detector geometry, and **the detector response**.