Reconstruction of charged particle tracks with the PANDA EMC

Thanachot Nasawad

Suranaree University of Technology
Thailand

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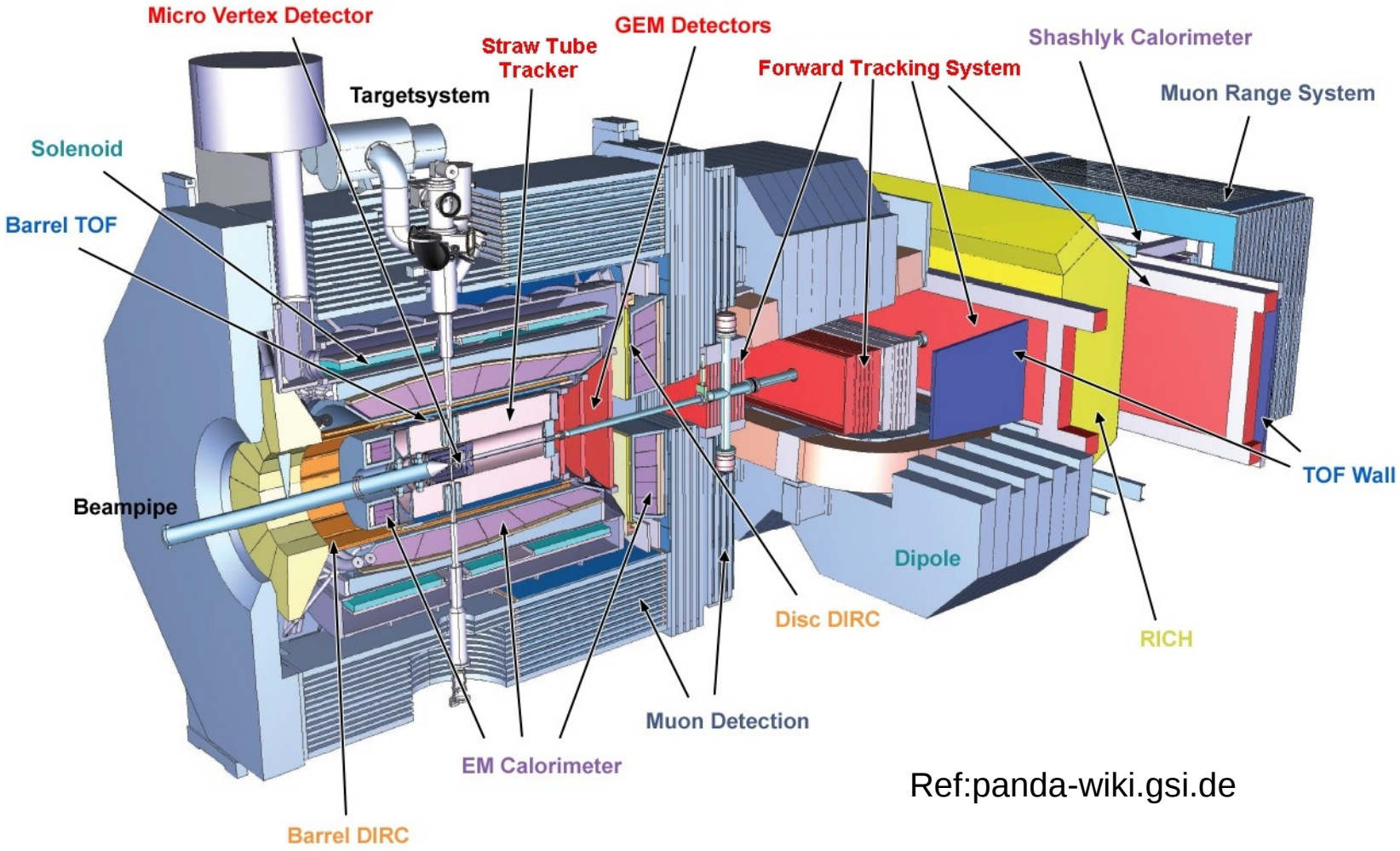
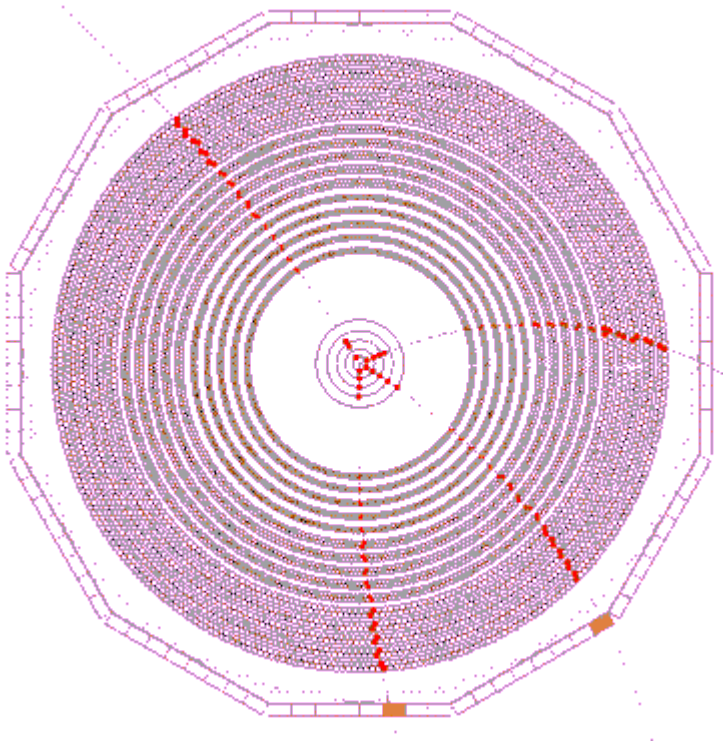
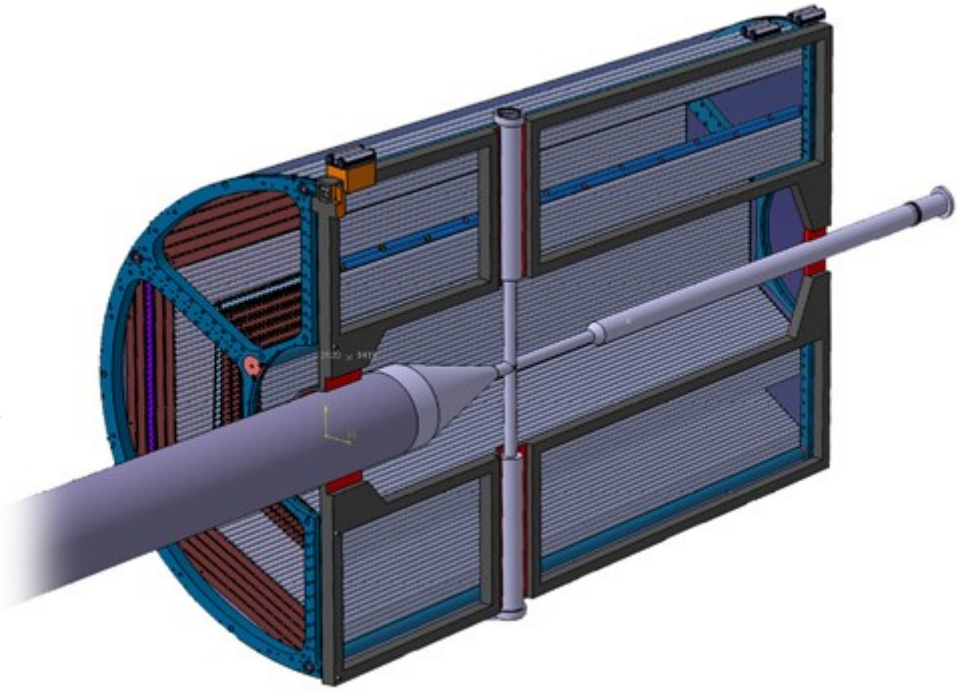
PANDA Experiment



Ref:panda-wiki.gsi.de

Straw Tube Tracker



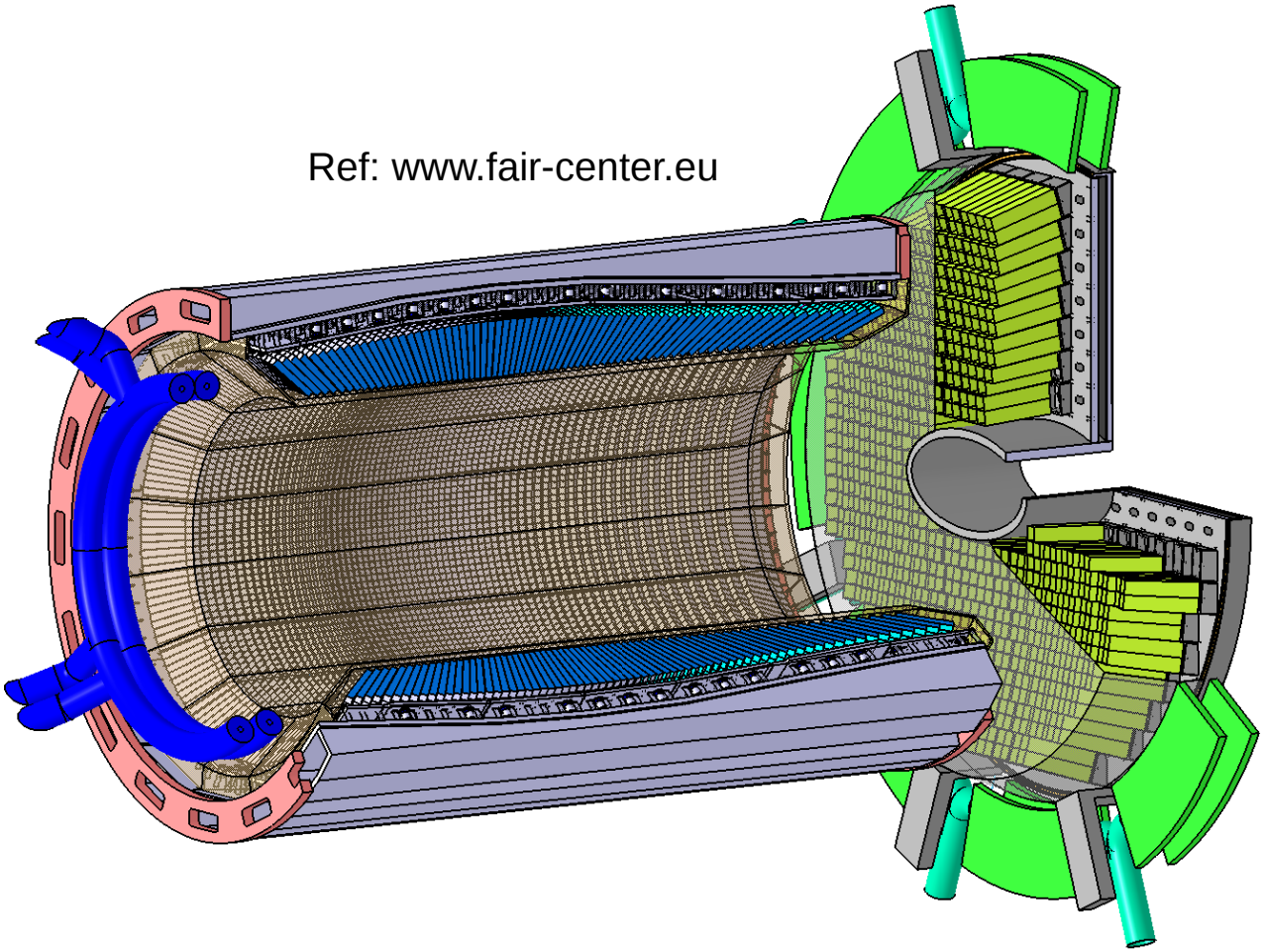


Ref: www.fair-center.eu

- Tracking charged particles

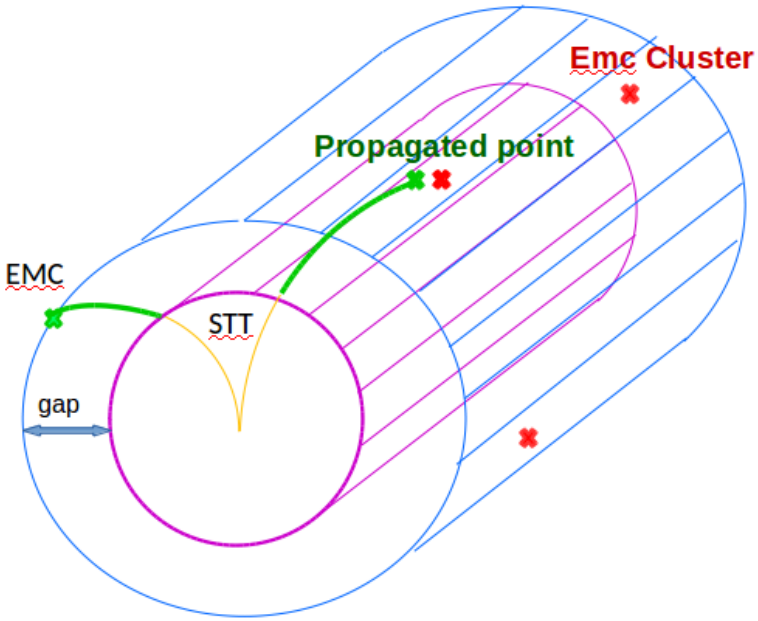
Electromagnetic Calorimeter

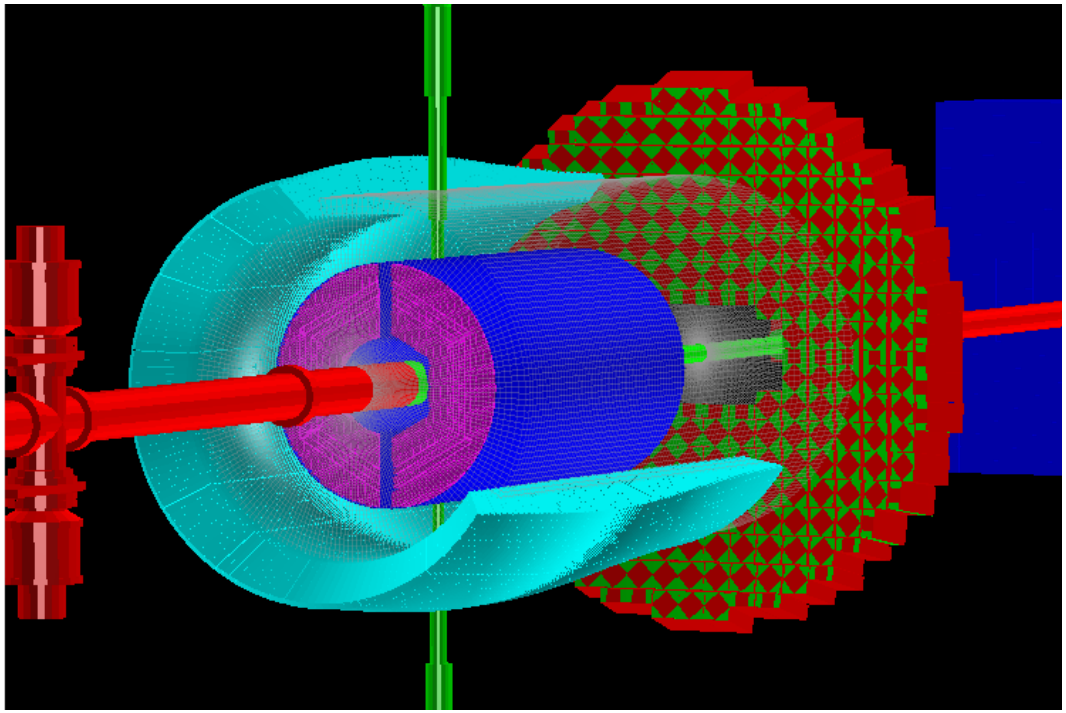
Ref: www.fair-center.eu



- Measuring the total energy of charged particles and photons

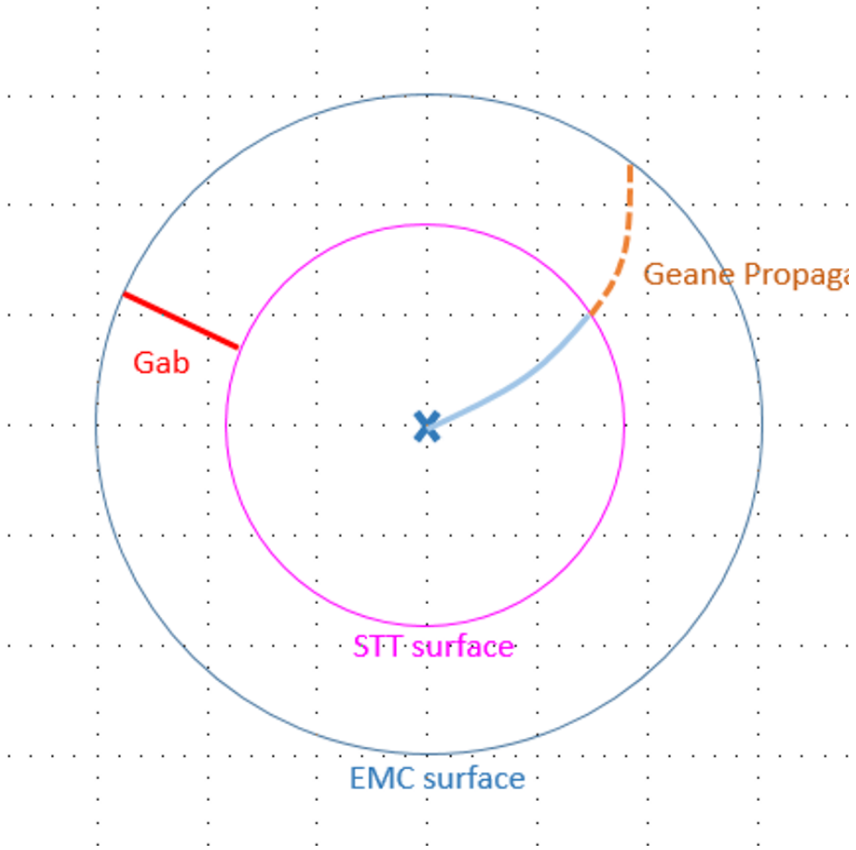
Reconstruction of charged particle tracks





- Extrapolating particle trajectories from STT surface onto the inner surface of EMC

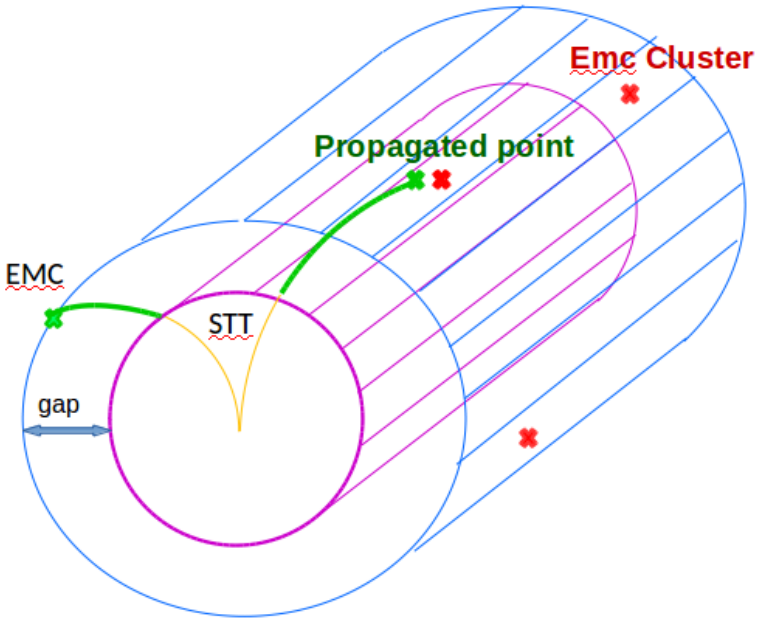
Geane propagator

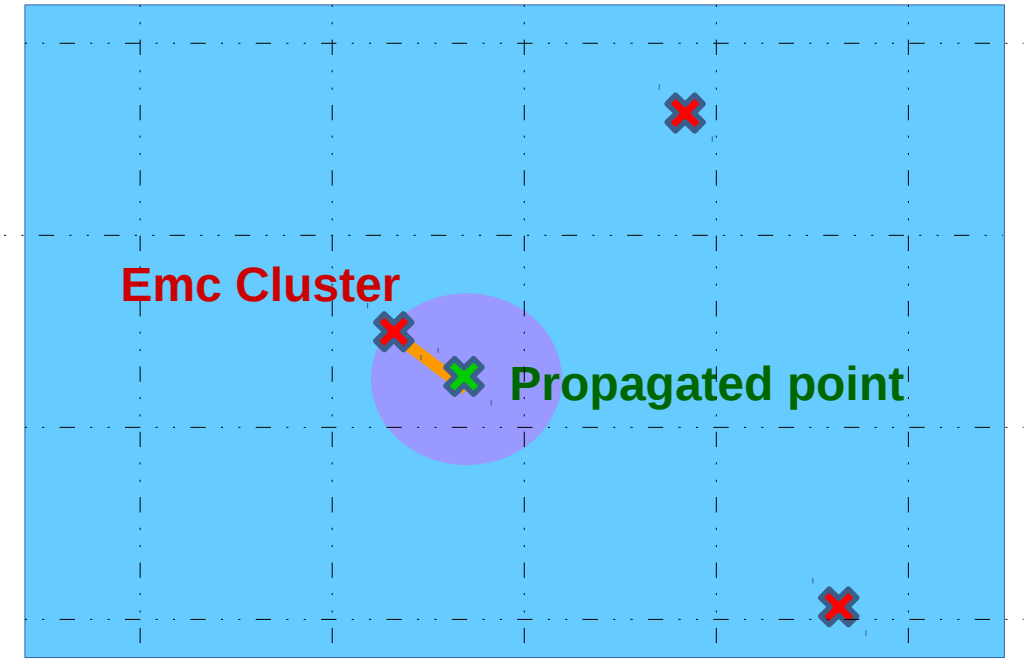


- GEANE uses the position and momentum of the tracks from STT by taking into account magnetic field, detector geometry and energy loss in the material
- GEANE currently is taking a long CPU time to process.

Our goal is to find other propagation methods which give similar results as GEANE but use less CPU time to process.

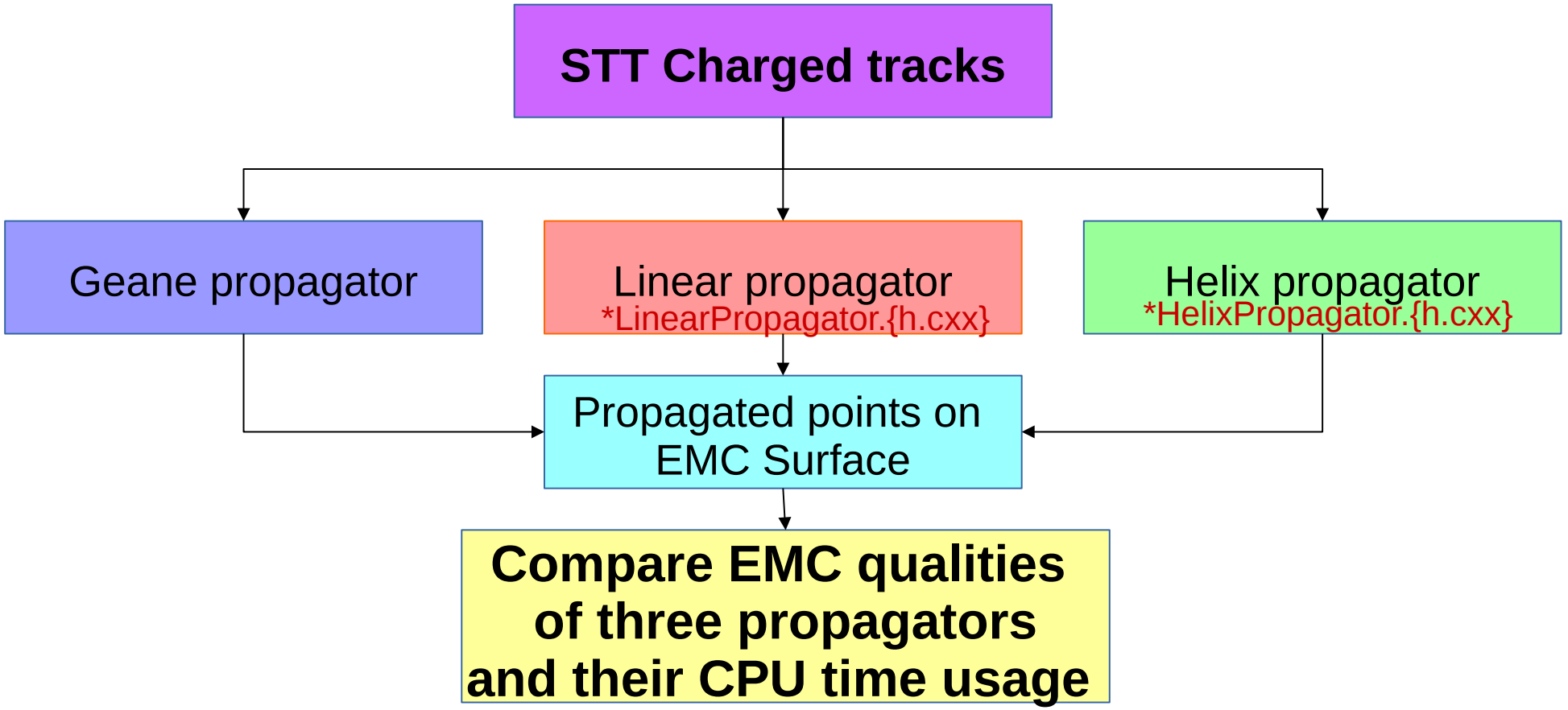
EMC quality





- EMC quality is the smallest distance between EMC cluster and Propagated point [cm^2]

Method

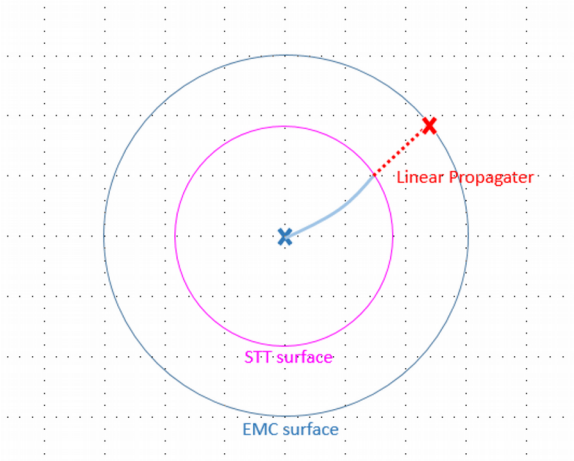


*We develop these codes by ourselves with the help from experts at Juelich.

Proposed propagators

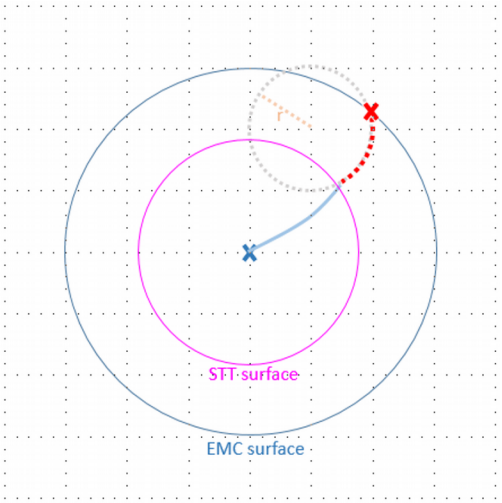
Linear propagator

- Using the position and momentum vector from the STT
- Extrapolating as a linear track

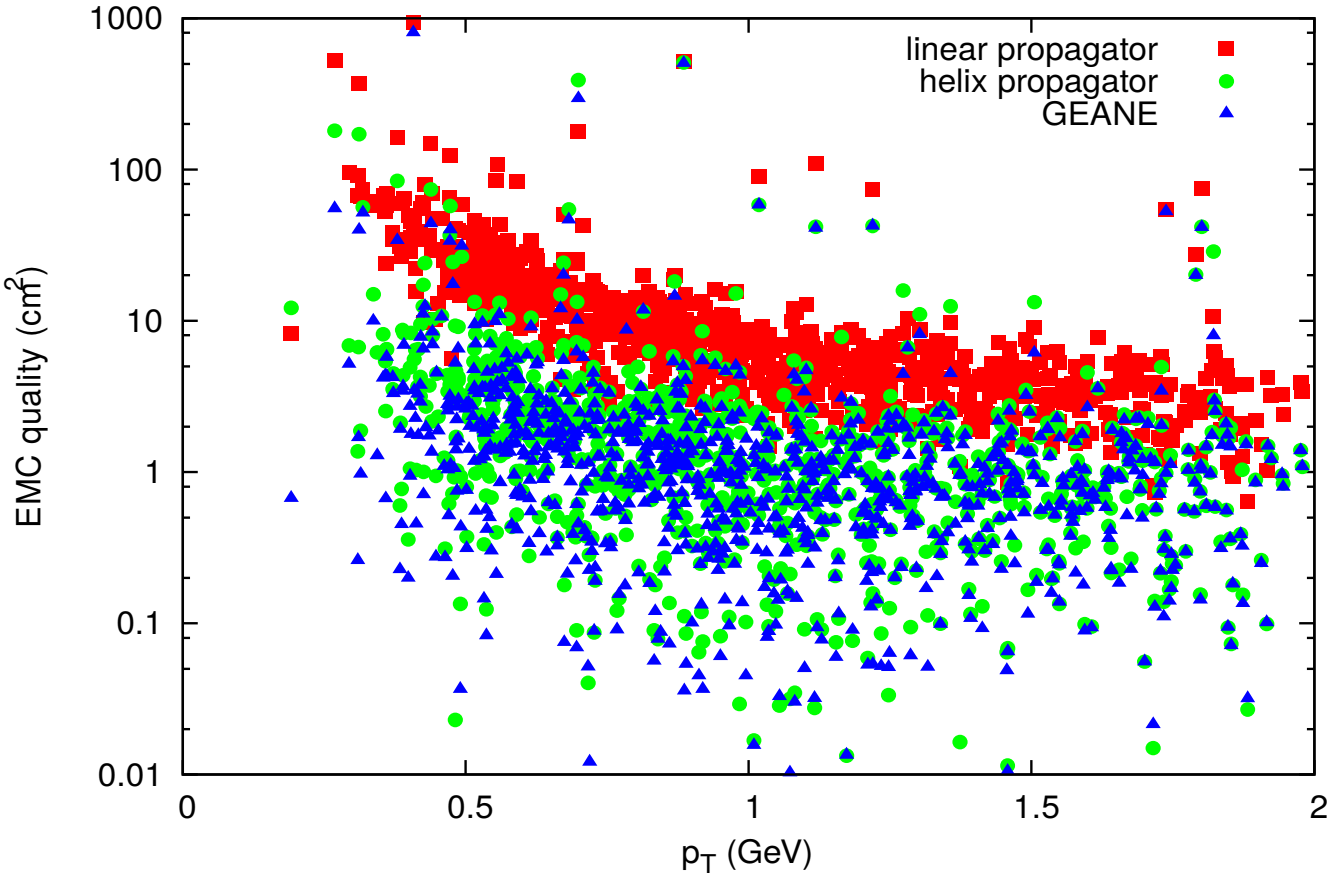


Helix propagator

- Including the magnetic field to propagate the track under the Lorentz force

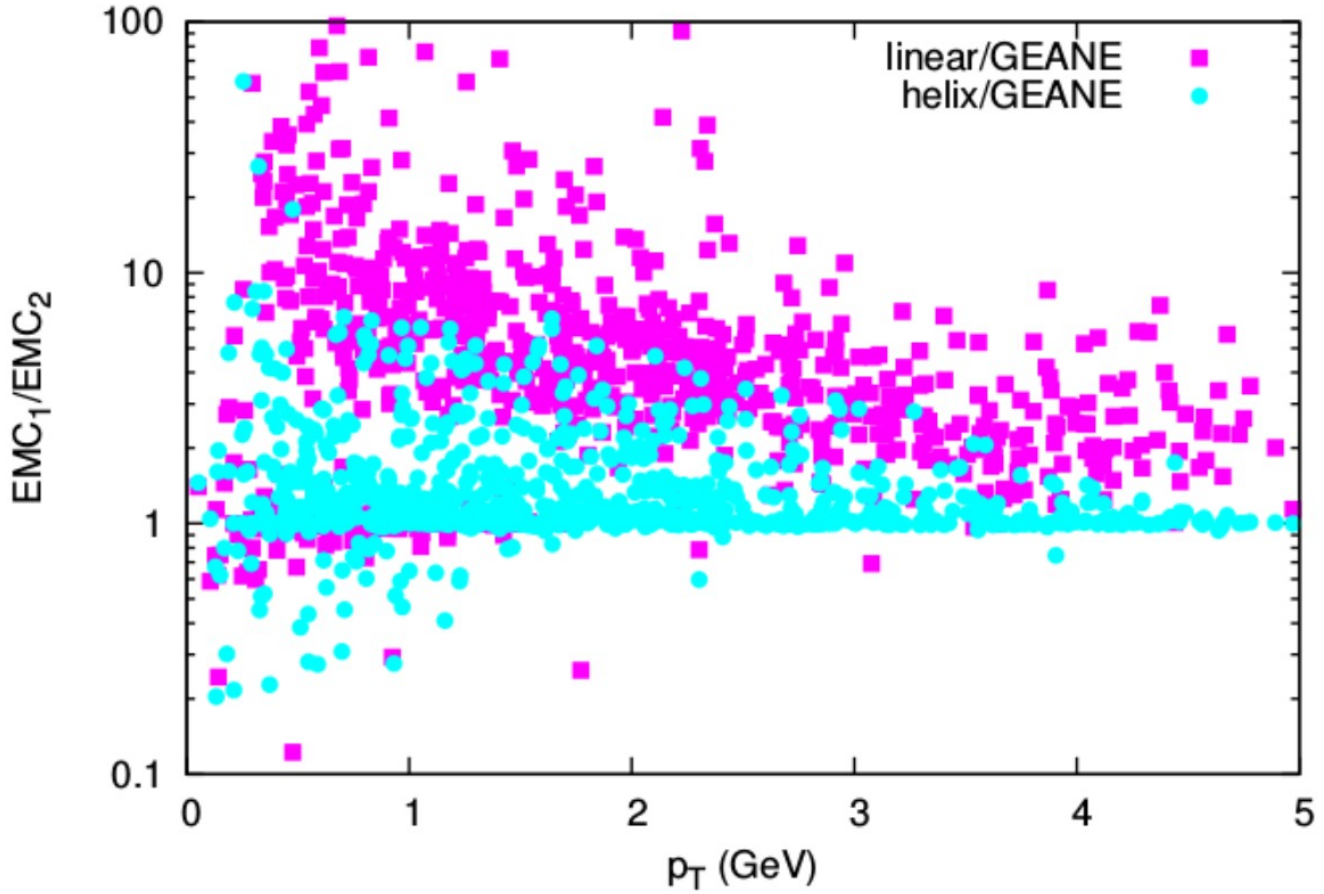


EMC quality of single charged muon



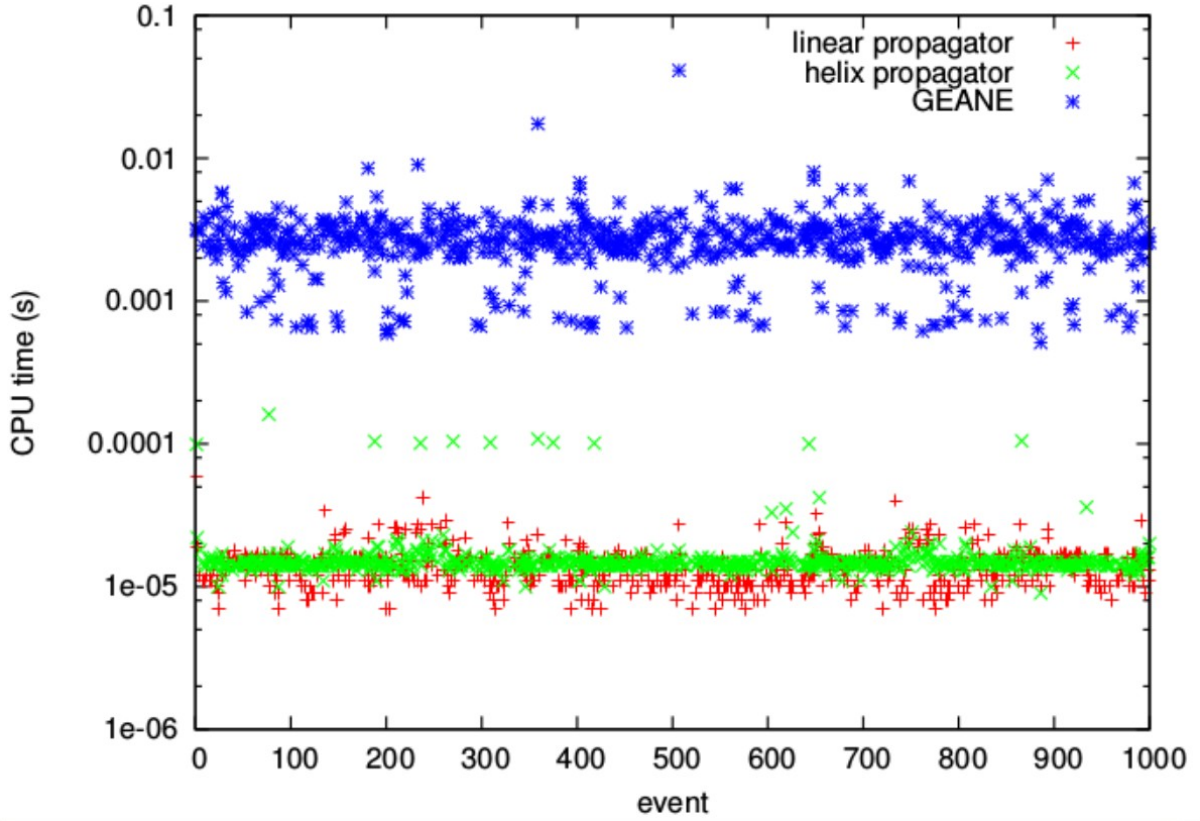
- EMC quality depends on transverse momentum
- Helix propagator and GEANE propagator give similar results

EMC quality ratio



- Helix propagator gives better results than Linear propagator

CPU time



- Linear and Helix propagators are 2-3 orders of magnitude faster than GEANE
- Helix propagator could replace GEANE

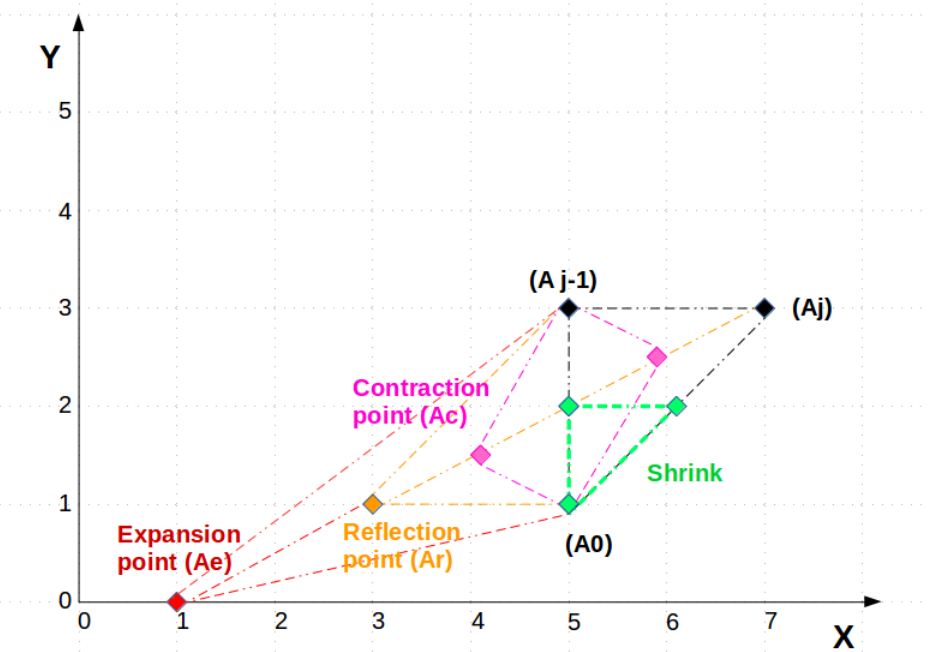
Conclusion

Successfully implemented a new method in PANDAroot to propagate particles from the STT to the EMC surface with

- Quality similar to GEANE (Helix propagator)
- Significant gain of speed

Simplex algorithm

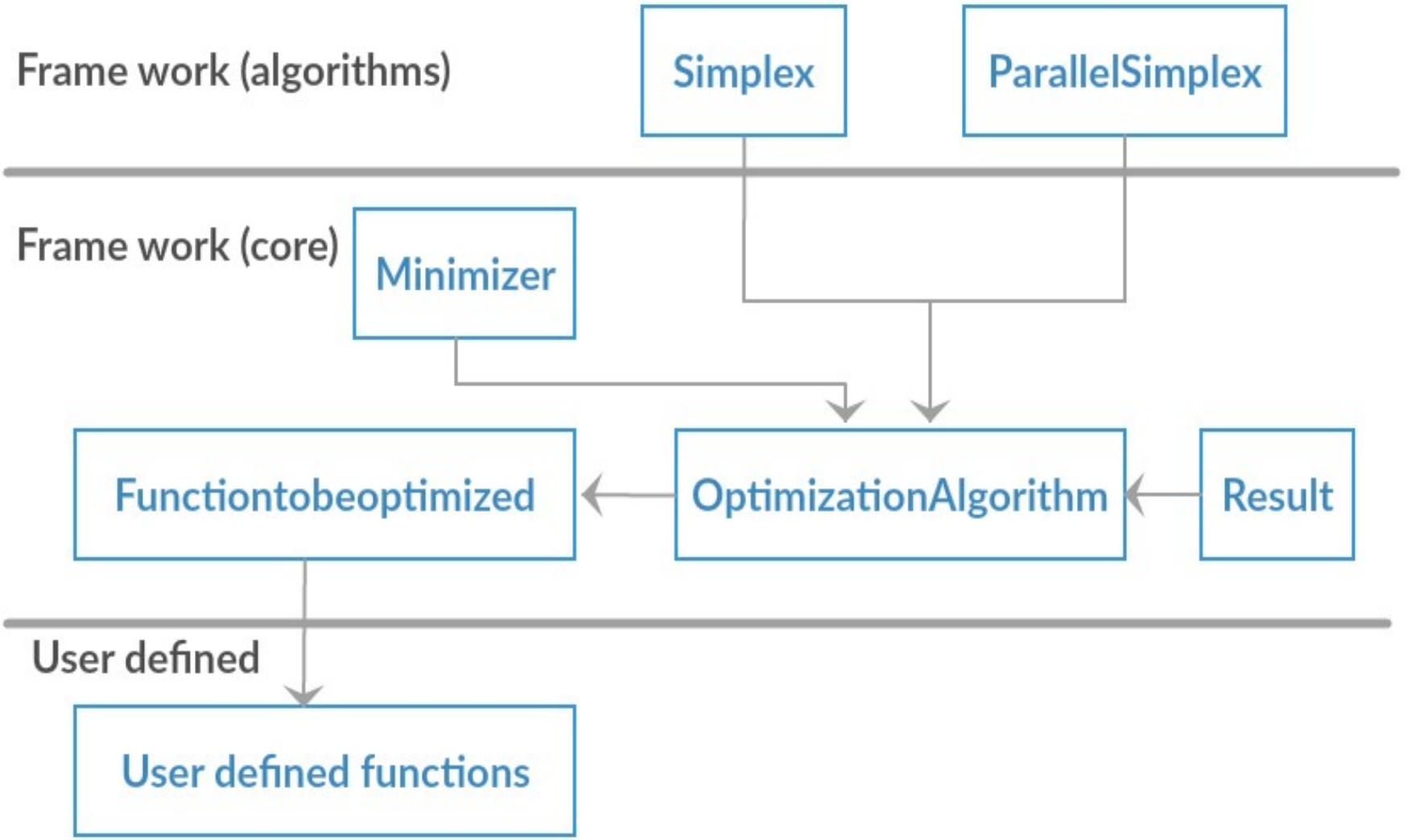
- **We implemented a generalized framework for optimization including the Simplex algorithm**
- **Finding the minimum of a J-dimensional function**
- **Move the geometrical shape (simplex) towards the minimum.**
- **Calculate new vertices:**
  - Reflection
  - Expansion
  - Contraction
  - Multiple Contraction (shrink)



Parallel Simplex

- **The Parallel Simplex follows same logic as standard simplex**
- **The Parallel Simplex updates the P worst points**
  - **standard simplex only updates one point**
    (A_0, A_1, ..., A_{J-P}, A_{J-P+1}, A_{J-P+2} …, A_J)
- **Using P processors which can be defined by user**
- **P needs to be smaller than the dimension of the problem**

Simplified diagram of the framework

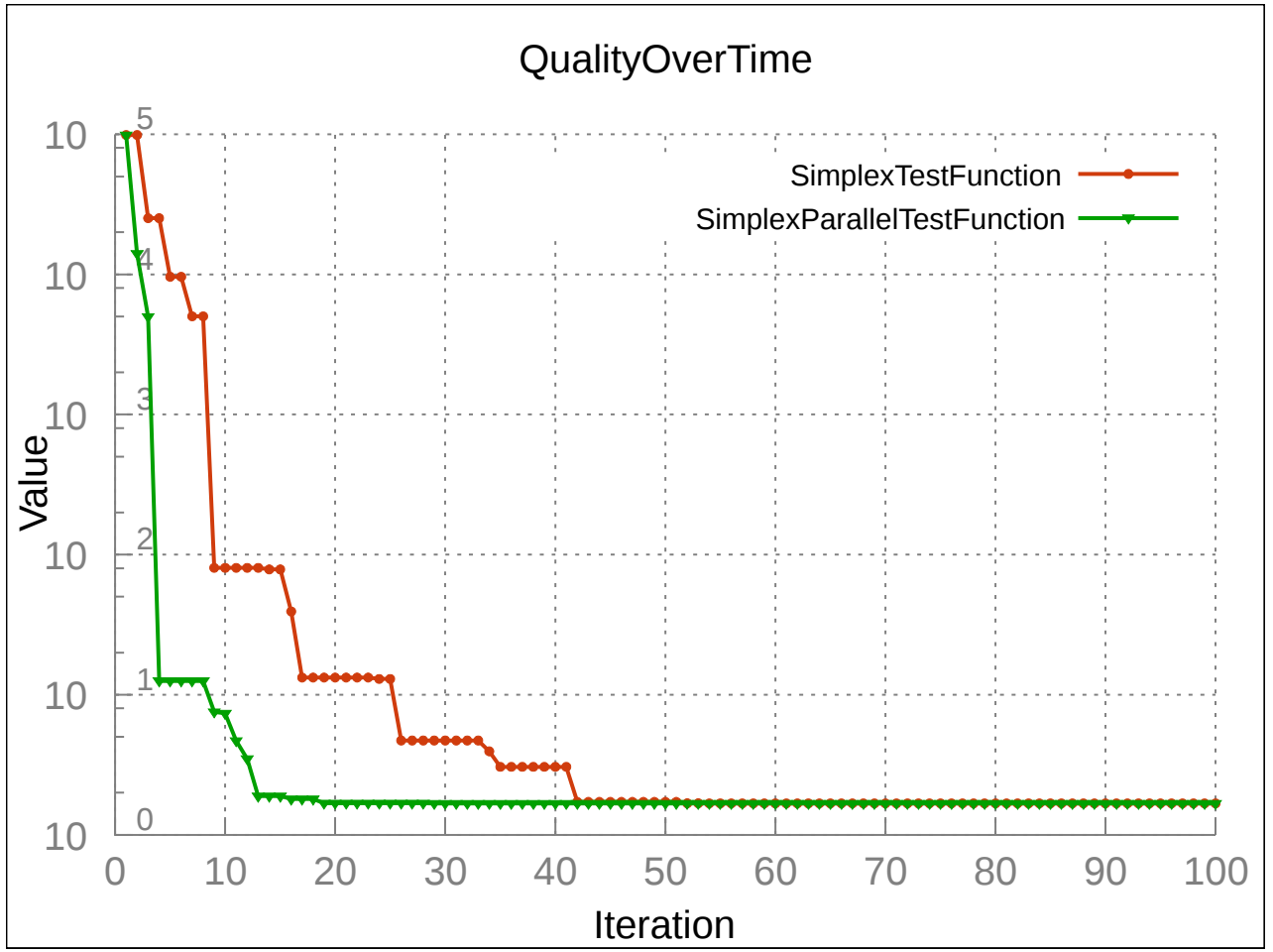


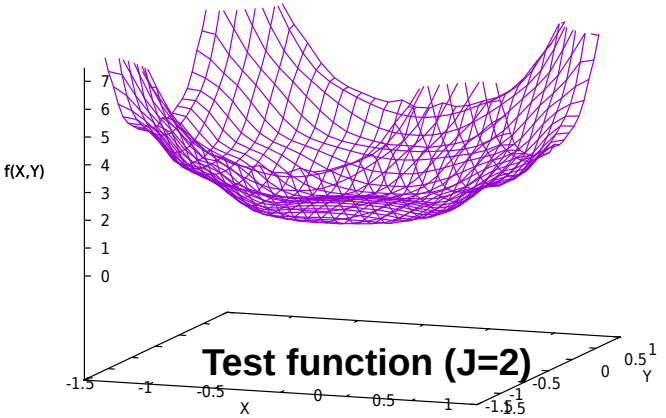
Comparing parallel and non parallel Simplex

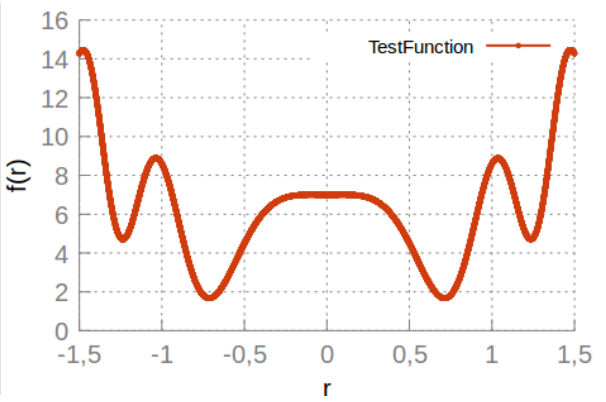
The 6-dimensional test function(d=6)

$$f(x_1, x_2, .., x_J) = 6cos^2(3\sum_{i=0}^{J} x_i^2) + e^{\sum_{i=0}^{J} x_i^2}$$

- Running the Parallel Simplex with 2 processors
- The minimum value = 1.67509







$$r = \sqrt{\sum_{i=0}^{J} x_i^2}$$

Summary

- **Successful implementation of a framework for function minimization**
- **Implementation of two particular optimization algorithms:**
  - **Nelder-Mead Simplex algorithm**
  - **Its parallel implementation**
- **The parallel Simplex converges faster and gives better results**
- **Future plan: Integrate the developed Simplex algorithm into the Geneva framework**

Thank you for your attention