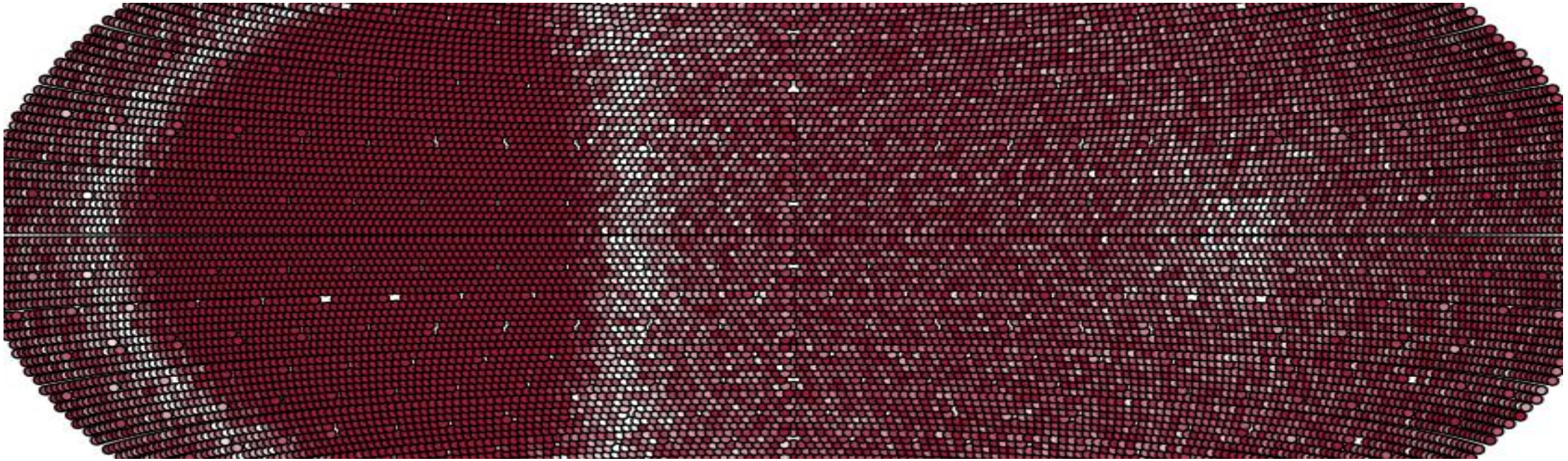
EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN



Multi muon reconstruction in the central detector

Outline

- Muon events in the central detector
- Basic muon bundle reconstruction
- Subsequent reconstruction methods
- Other projects

Muon reconstruction

μ

- Cosmic μ create isotopes in LS: imitate IBD

→ Veto (entire detector or only tube around μ track)

- Reconstruction algorithms:
  - Reconstruction with cone model
  - Least square fit
  - Machine learning
  - Topological reconstruction

  → reconstruction of single muons, passing the entire detector

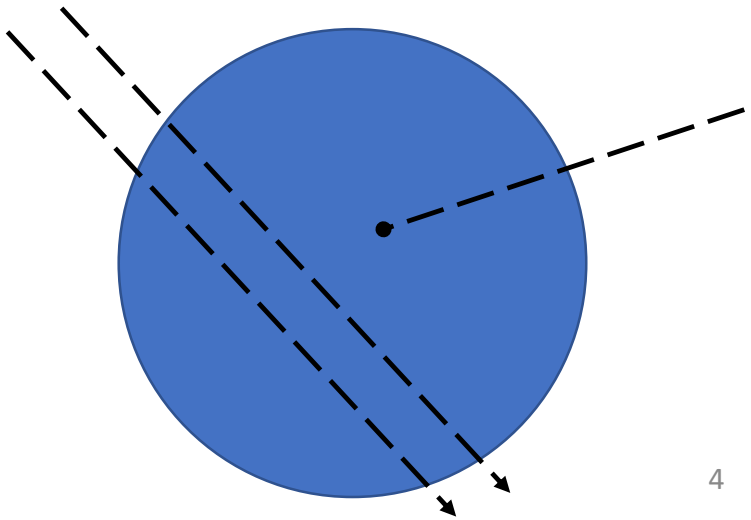
Other muon events

μ μ

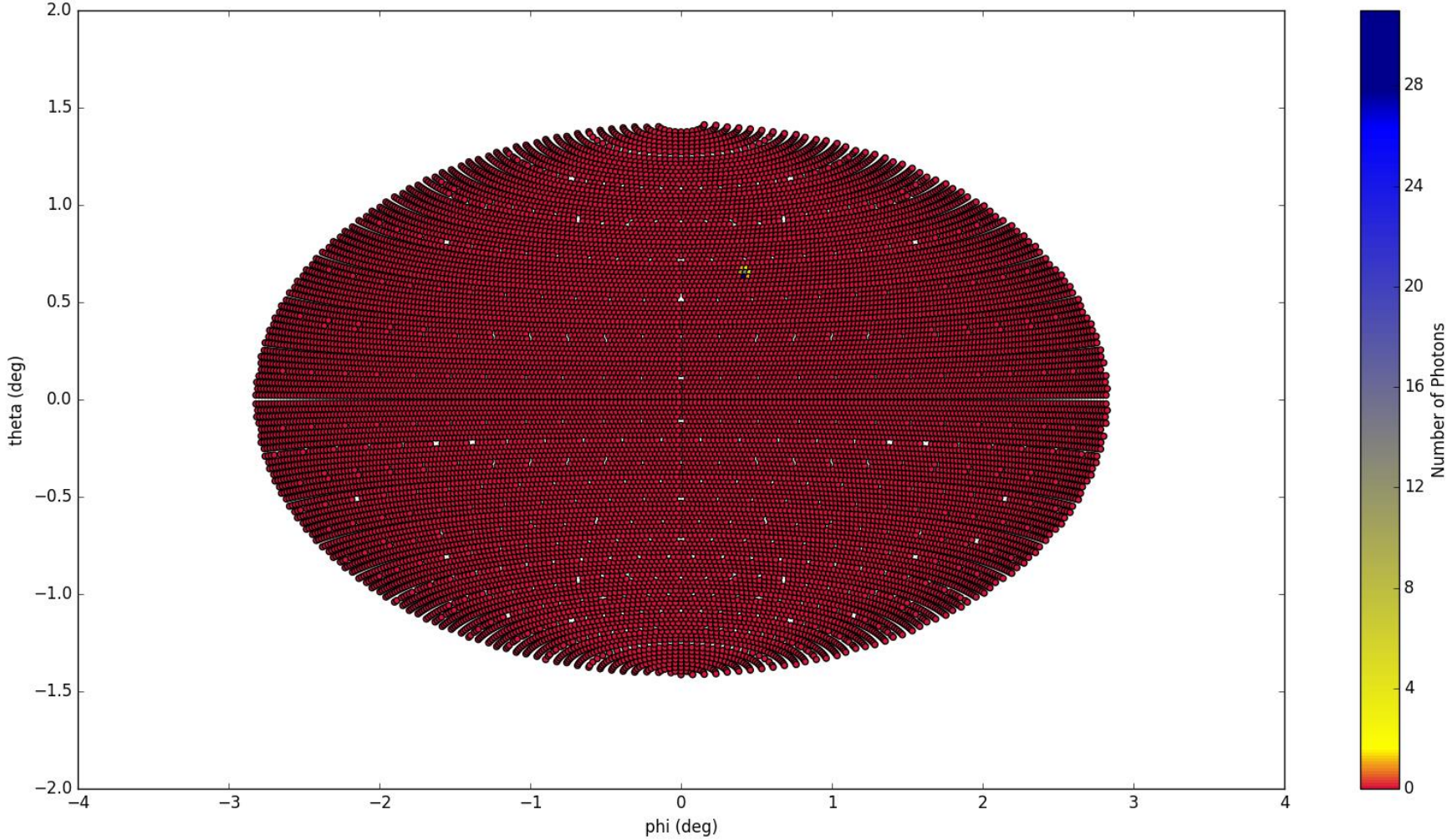
- Multi μ events /bundles (~ 0.3 Hz)
- Stopping μ

→ veto entire detector (use WP) or reconstruct the tracks with CD PMTs

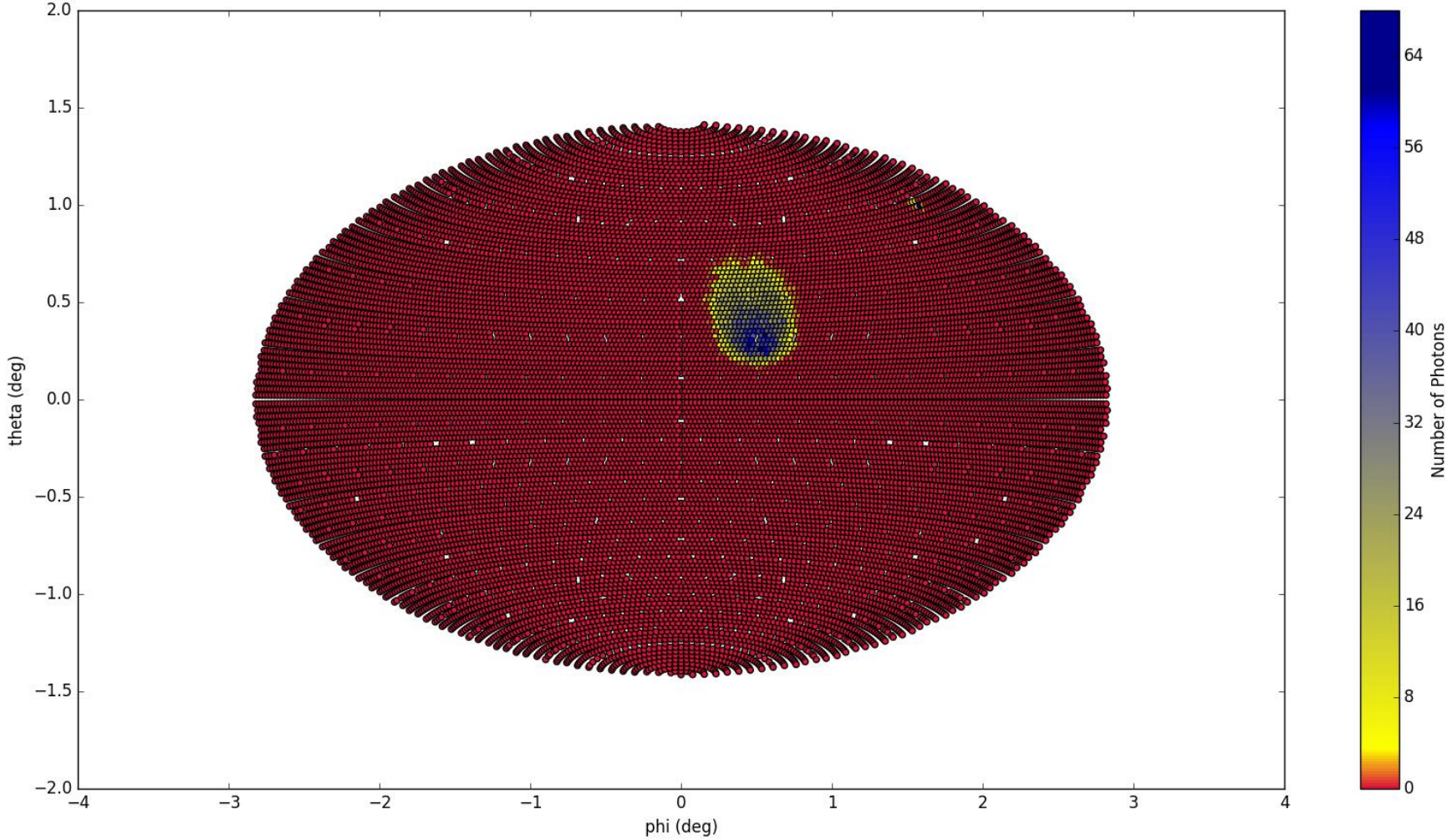
Mentioned reconstruction algorithms are not suitable



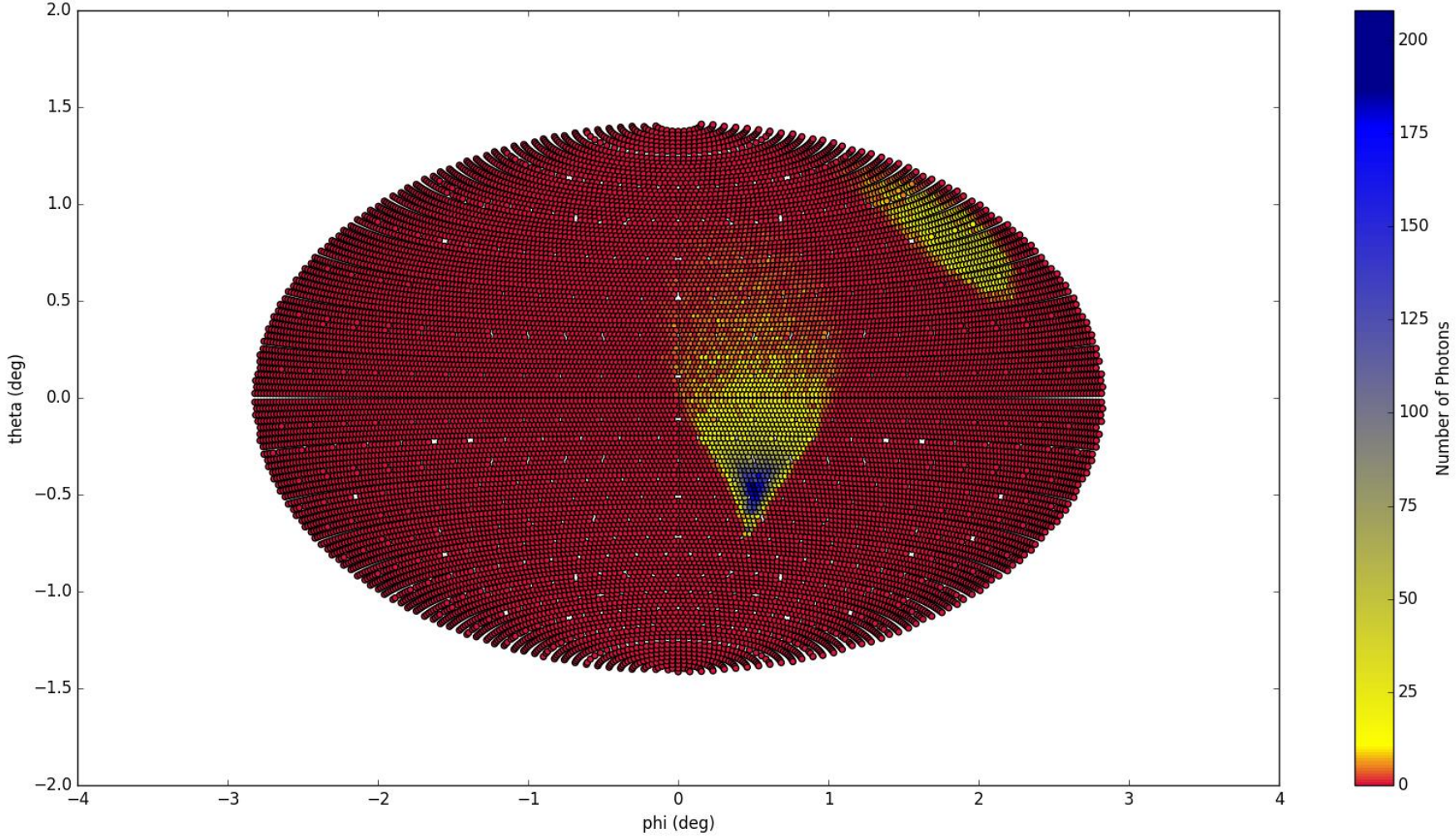
Light emission of muons in the central detector



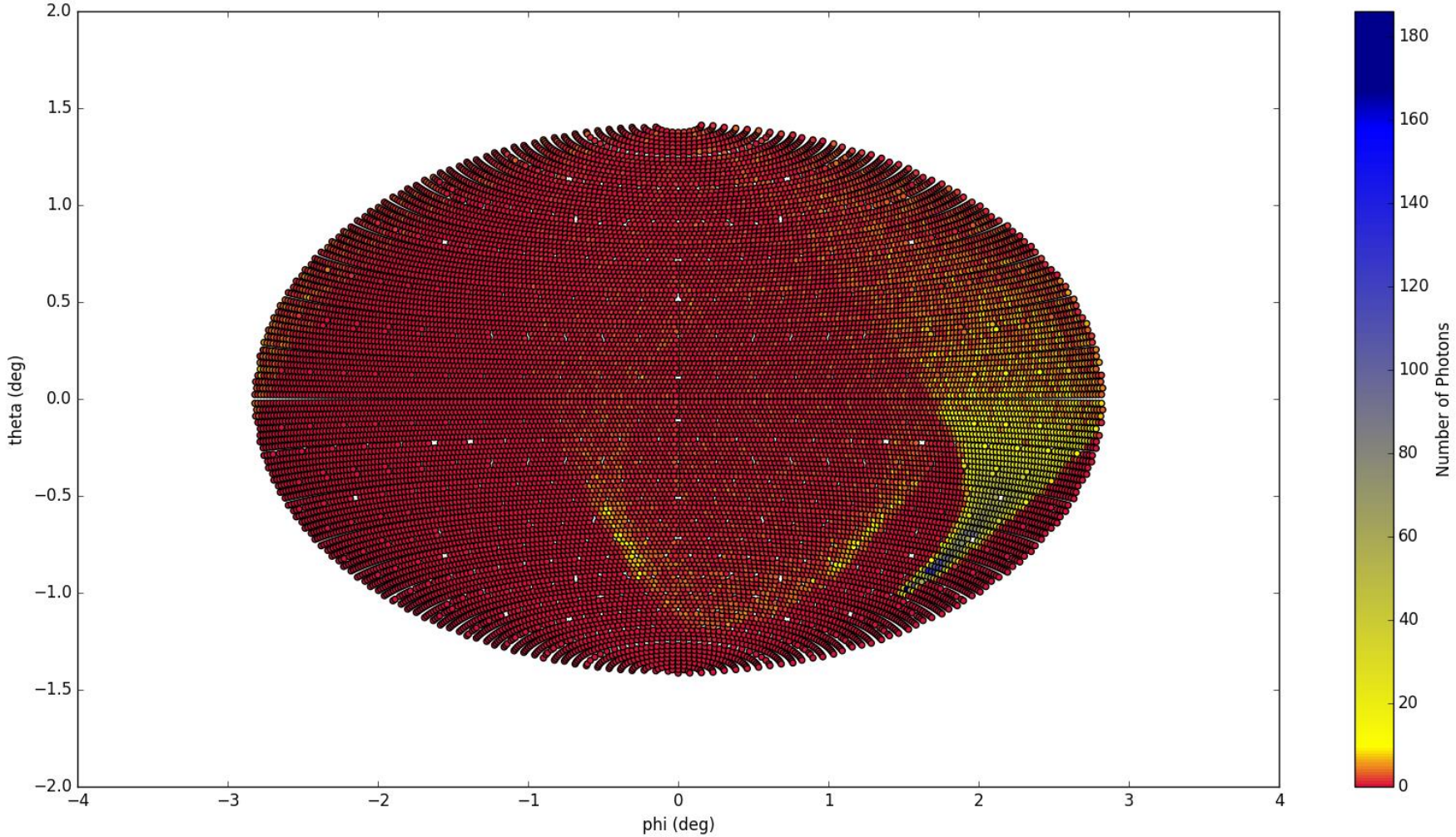
Light emission of muons in the central detector



Light emission of muons in the central detector



Light emission of muons in the central detector



Reconstruction

First reconstrcuction stage:

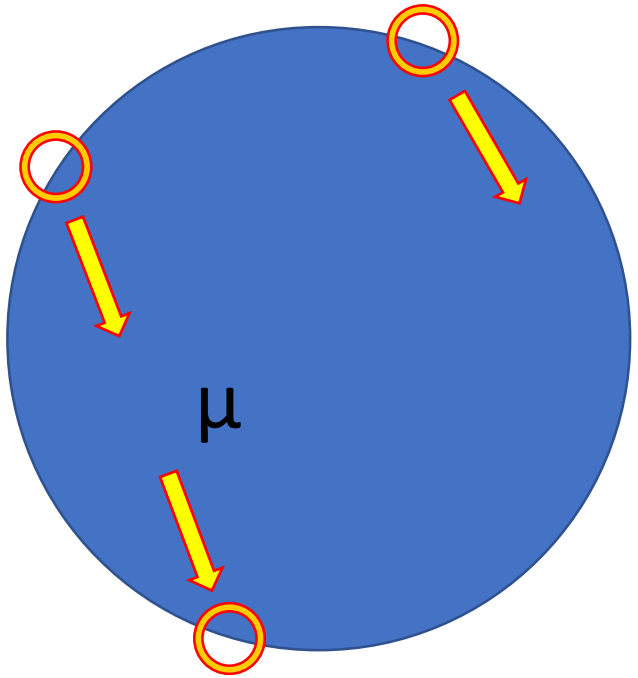
- Identify μ bundles
- reconstruct approximate track parameters with simple but fast methods

Second reconstruction stage:

- Use more sophisticated methods to reconstruct μ track precisely
- Use data from first reconstruction step

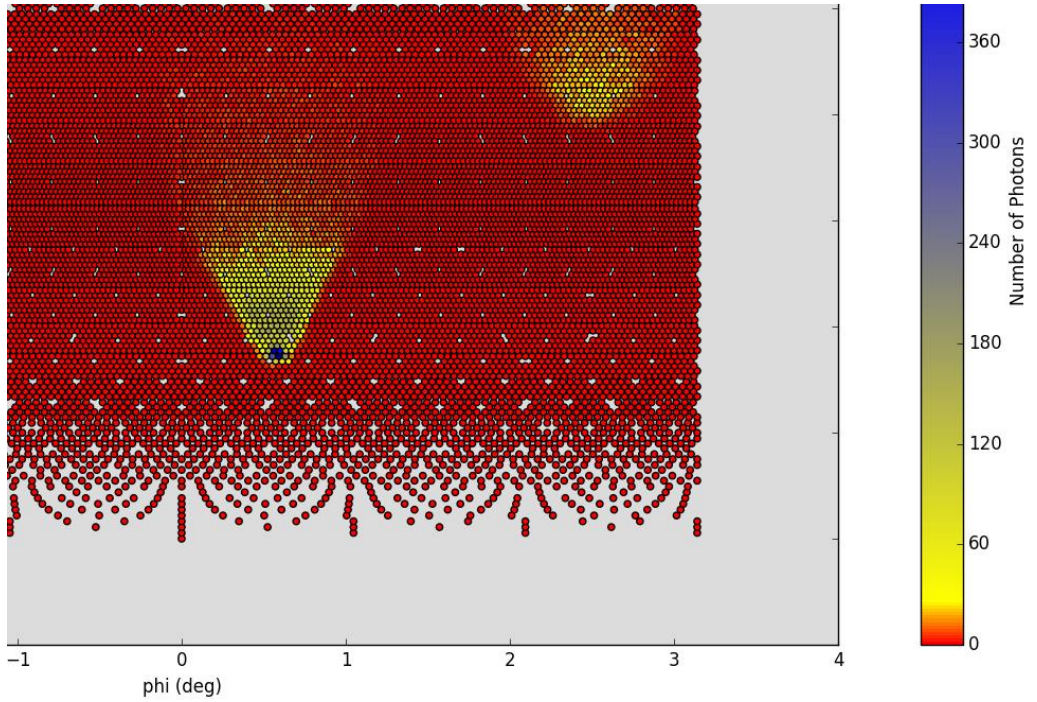
First reconstruction stage

- Reconstruct entry and exit points of the μ track
- Reconstruct direction of μ after entry / before exit



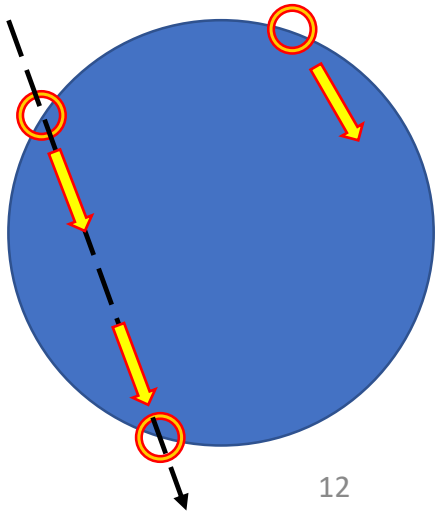
First reconstruction stage

- Time steps of 5 ns
- Divide detector surface into sectors (reduction of computation time)
- Two properties:
  - Charge cluster accumulation
    - Fit 2D-gaussian distribution
    - Comparison to previous time step
  - Characteristic shape of μ trace
    - Intersection of light cone and detector sphere



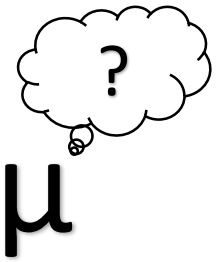
Second reconstruction stage

- Reconstruct entry and exit points of the μ track
- Reconstruct direction of μ after entry / before exit
- Allocate muon exit and entry point
- Process calculated parameters:
  - Use parameters to support established reconstruction algorithms, based on first light
  - Establish neural net and use parameters as input



Stopping muons

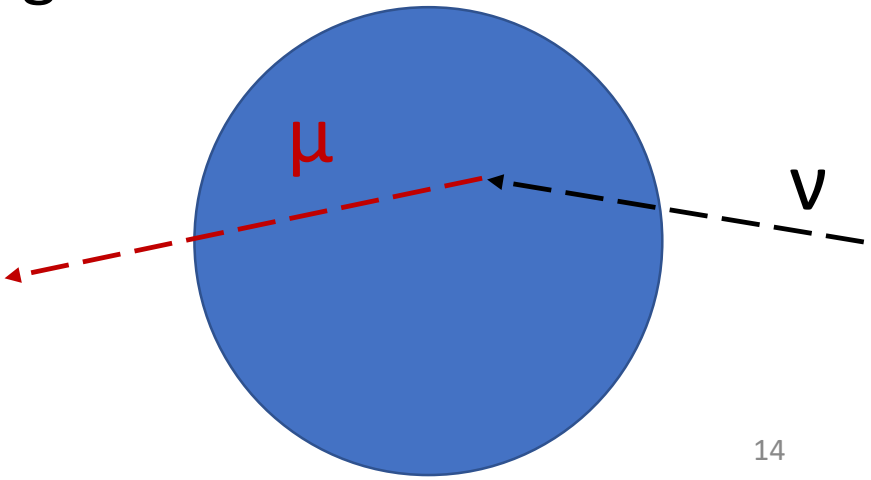
- Potential to identify stopping muons
  - Muon entry point + missing exit point first indication
  - Estimate muon track from direction after entry
  - Identify stopping point from light behaviour



Other projects

- Learning the ropes in GPU based JUNO simulations
  - Based on work of Simon Blyth
  - Simulation 200x faster

- Energy reconstruction of partially transversing muons
  - In combination with topological reconstruction
  - Analysis of energy dependent properties



Thank you.

Contact:

Axel Müller
Auf der Morgenstelle 14
72076 Tübingen · Germany
Phone: +49 7071 29-73286
Axel.mueller@uni-tuebingen.de