# Neutron spread on the transverse plane - follow-up on invisible scattering (2)

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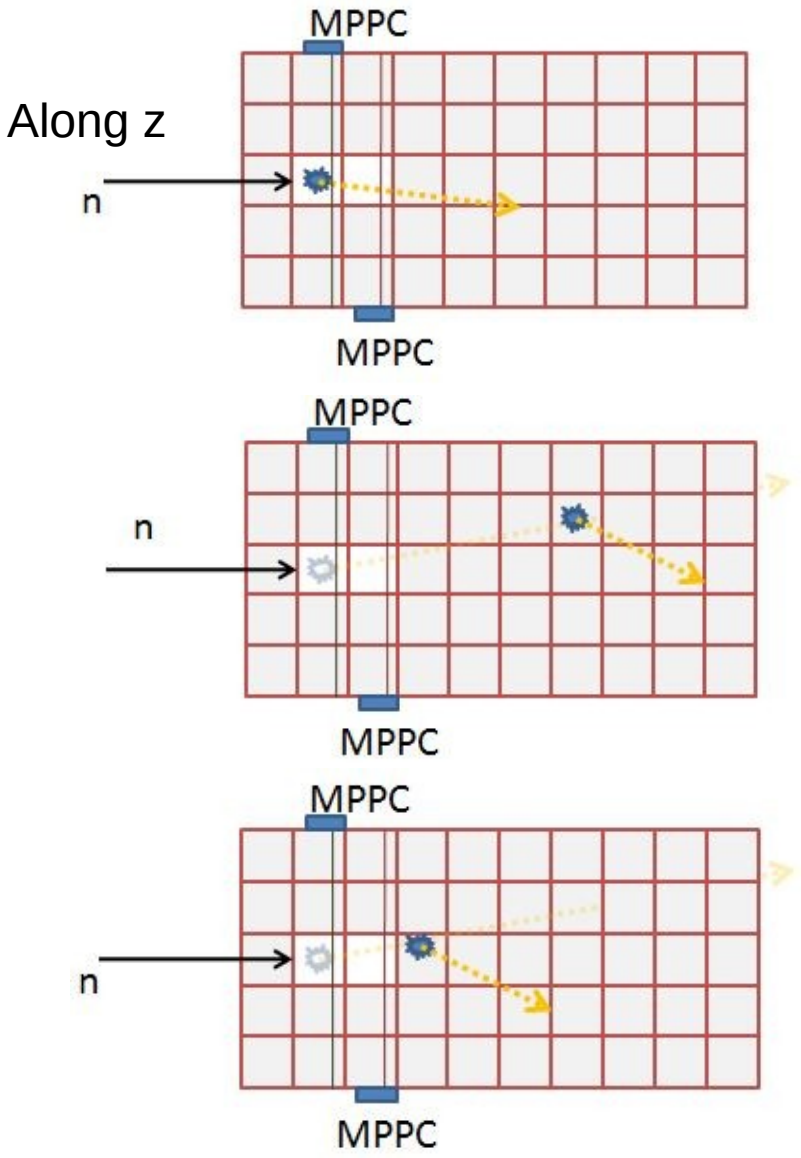
# Introduction

- Since the past weeks till next few weeks, a series of studies on the invisible scattering would happen.
- We need to understand the fraction of the neutron scattered off/in the fiducial volume, then determine some corrections and the systematics to that.

# Invisible scattering impact




- Extinction may be biased with different flux at different layers due to invisible scattering.
- A useful check is to look at the neutron vertices spread on the transverse plane.

# Selection

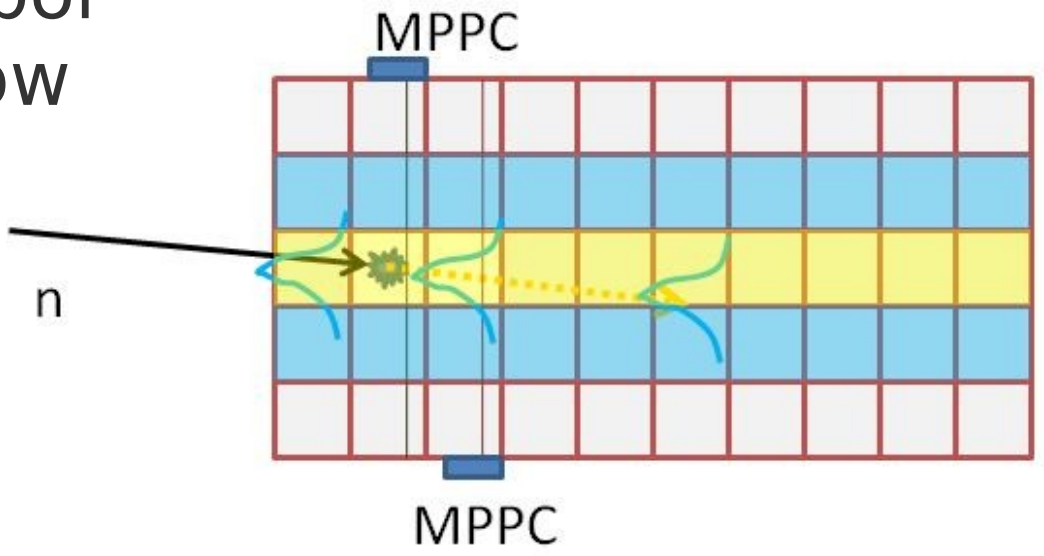
- > 5PE for each MPPC hit
- Single cluster in time
- Single cluster in space
- > 3 cubes fired
- Linearity with PCA 0.99 (needs an update)
- Line fit chi2 < 15
- No outer layer activity (all dimension)
- Vertex: first cube along z
- No neutron energy selection for now

# MC fine tuning

- Same beam size as data (tuned based on spread on the first layer)
- Same direction and center as data
- Showing two things for each layer:

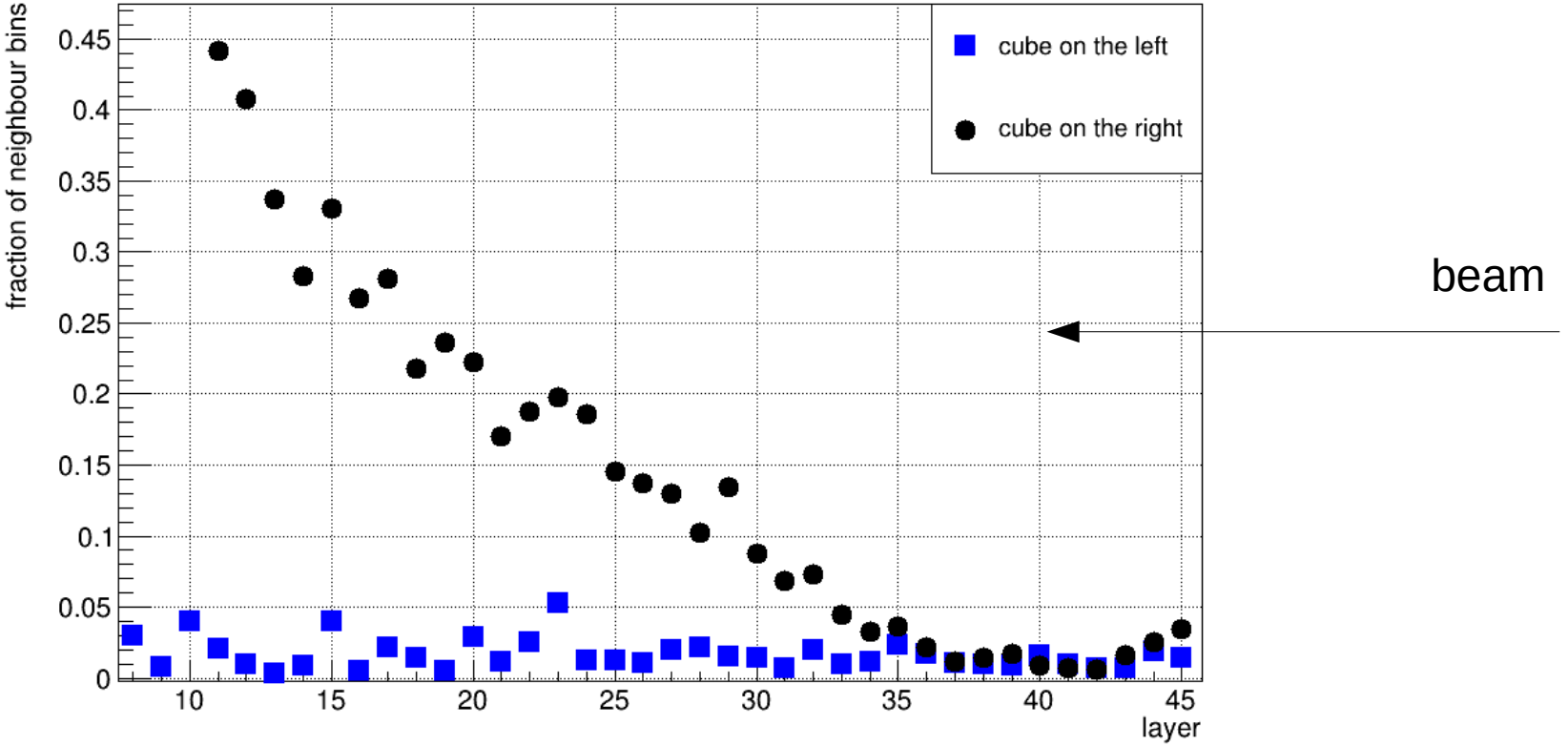
  - Fraction of neighbor rows to the main row

  - Gaussian width

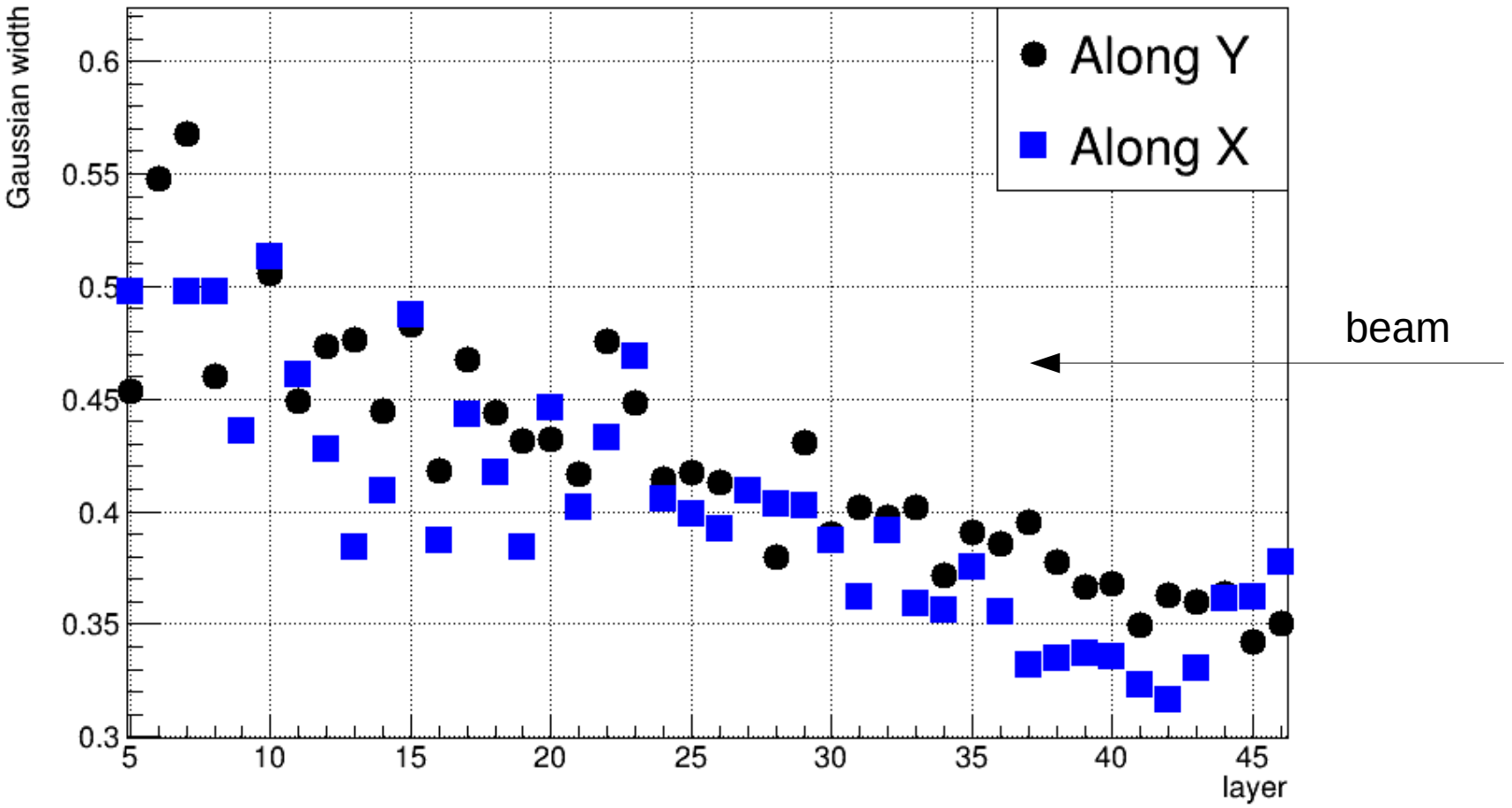


# MC – fractions in neighbor rows

- Beam has an angle
- The spread is a combination of beam center/direction and invisible scattering

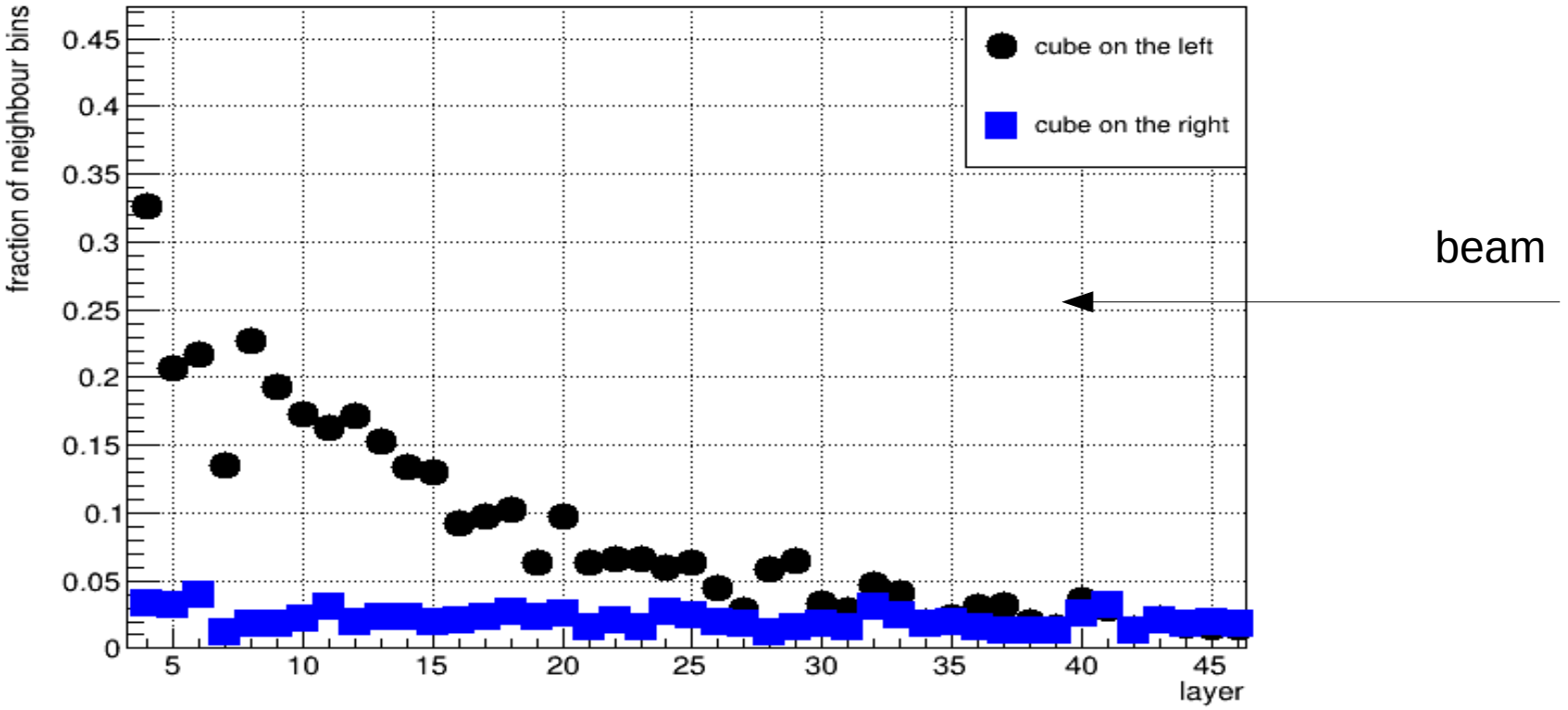


# MC- gaussian width



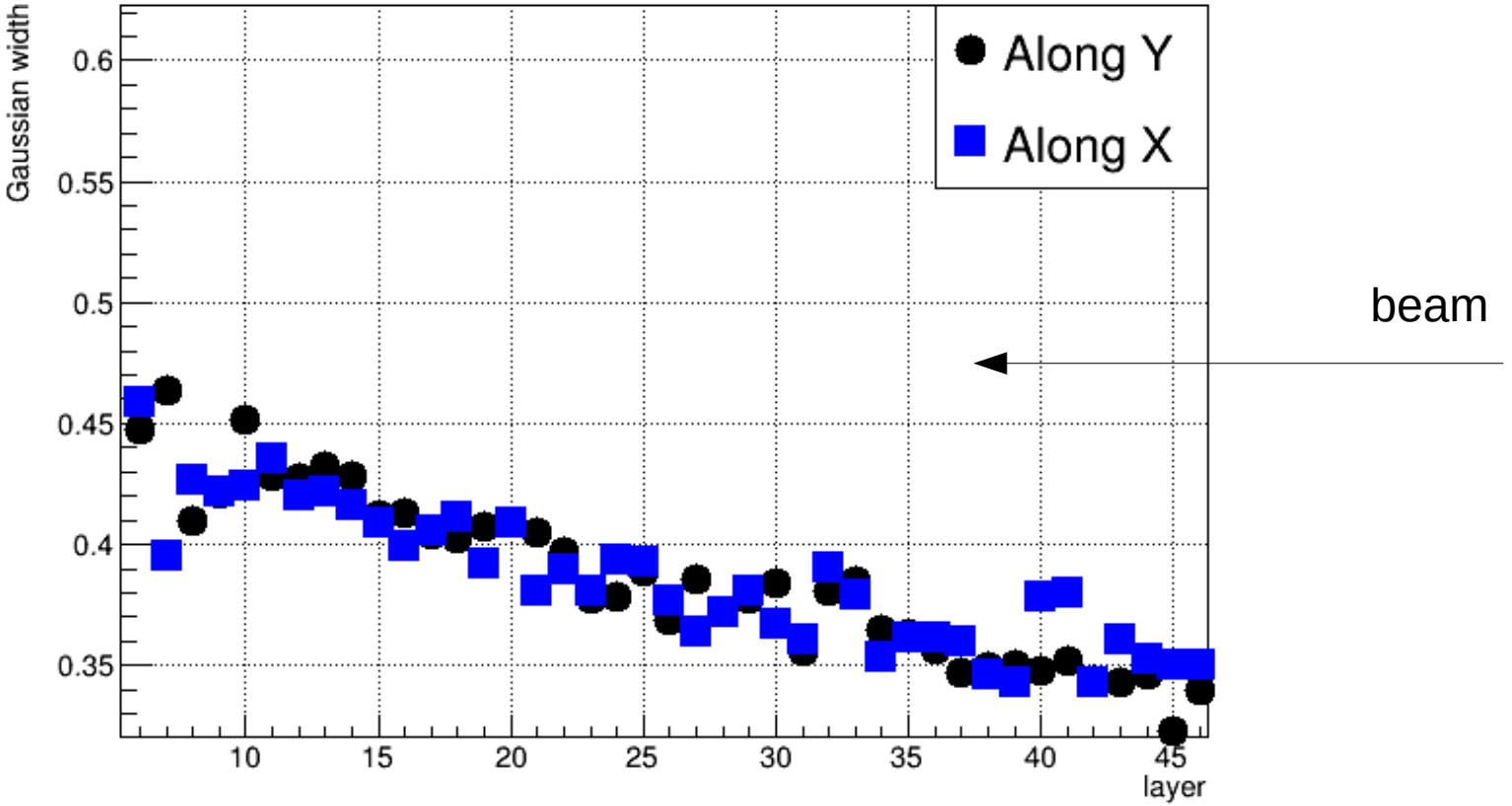
# Data – fraction of neighbor rows

- Beam size, direction and center are the “same” as MC
- The invisible scattering spread growth is smaller



# Data – gaussian width

- Similarly, the spread growth is smaller in this variable as well

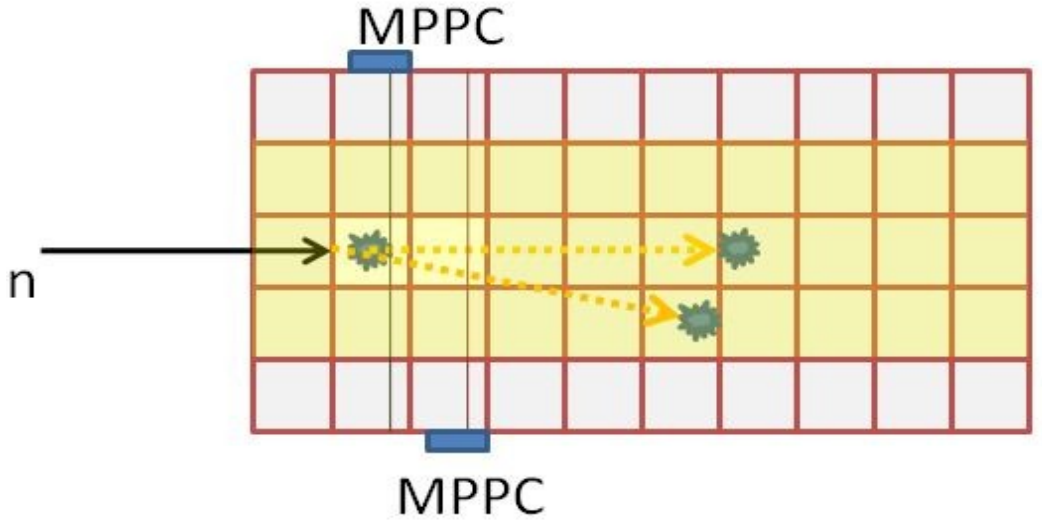


# MC further tuning

- There are two things can be tuned:

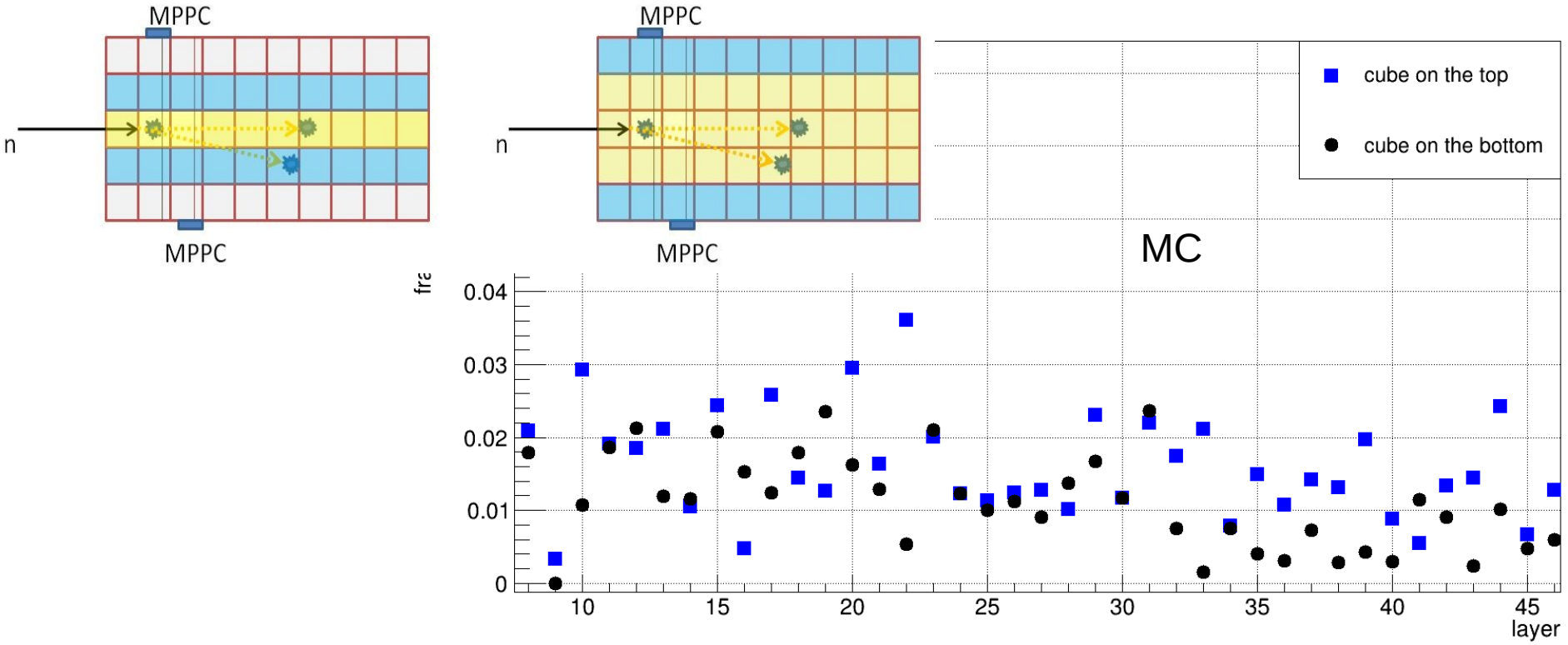
  - rate: Ideally, we would have a very tiny FV, but if we cannot, the good thing for large FV is that the overall rate of the invisibly scattered neutrons are similar even with a little different scattering angles → with a large FV, the overall neutron leakage is very small.

  - shape: The scattering angles alter the shape along z. This is something I try to tune .



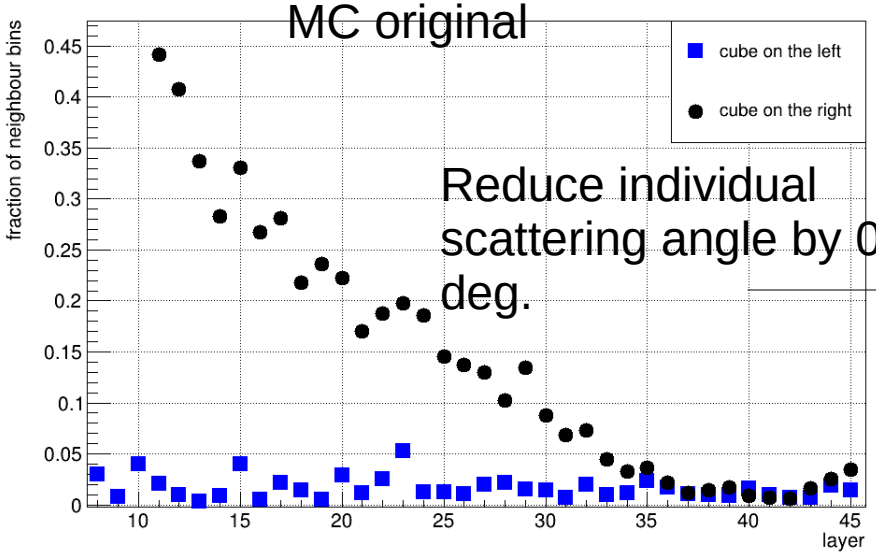
# MC tuning : invisible rate

- Take a 3x3 cross section as FV and check the fractions of neighbor bins to that FV:  The spread growth is at 1% level.



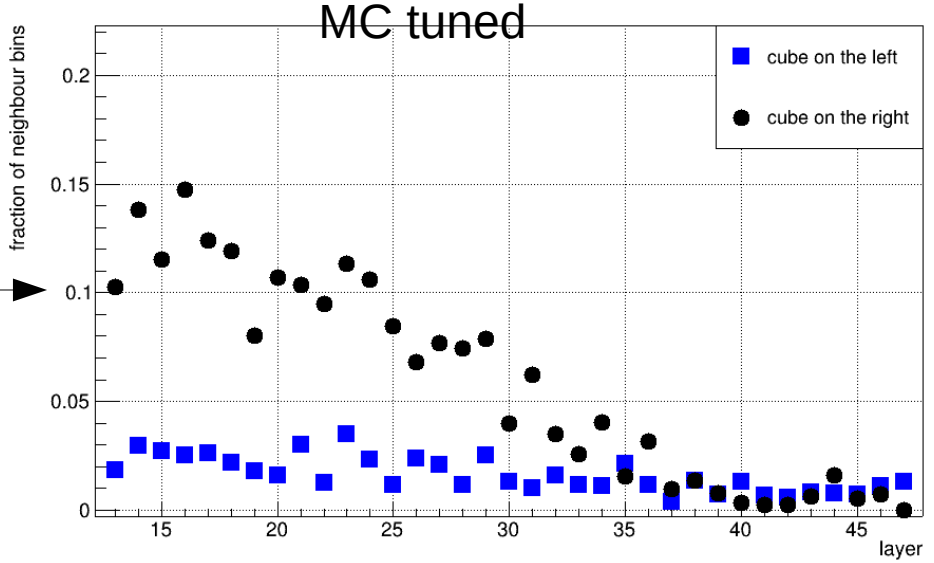
# MC tuning : z shape impact

MC original

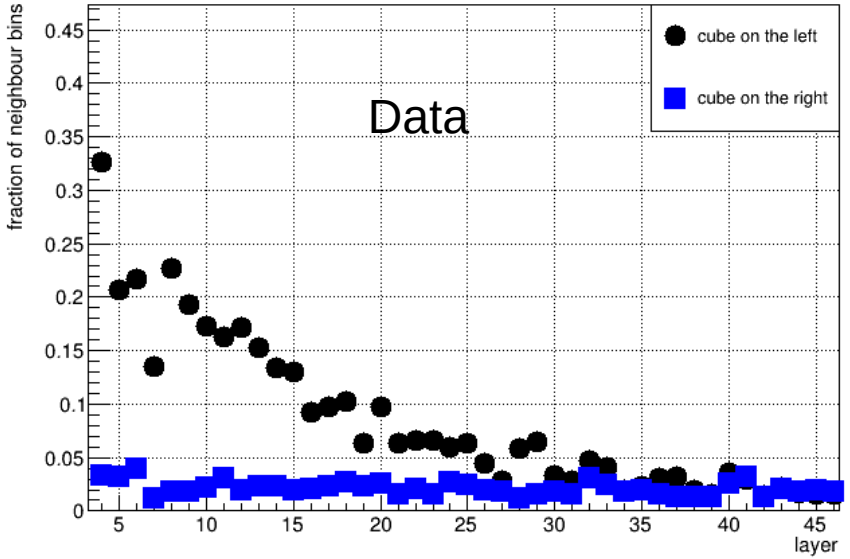



Reduce individual scattering angle by 0.05 deg.

MC tuned




Data



# Next

- For each neutron energy range:

  - Tune MC scattering angle to match data along z

  - With tuned MC, get the correction of invisible scattering by comparing ideal pencil beam to the tuned realistic beam.

- This needs a lot of computing time due to a large number of energy ranges.