Systematic uncertainty from crude resolution in oscillation calculation

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Introduction: the problem

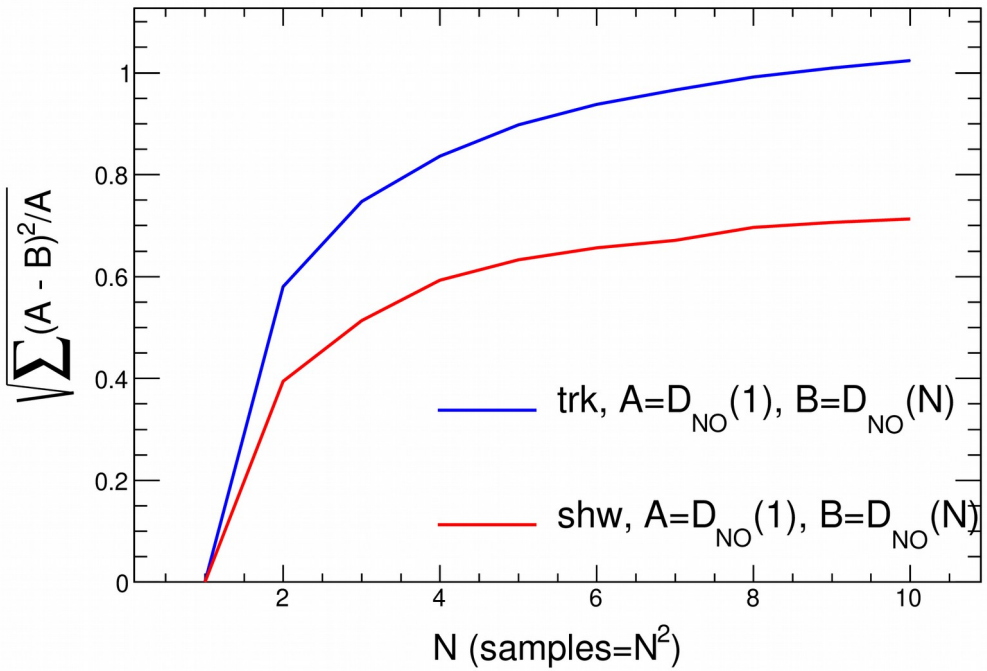
- A typical ORCA NMO analysis has 24 energy bins in range [1,100] GeV and 20 cos-theta bins in range [-1,0].
- Ideally, an average oscillation probability should be calculated for each bin → CPU drain
- In practice, bin center or a few samples inside the bin are/need to be used in fitting.

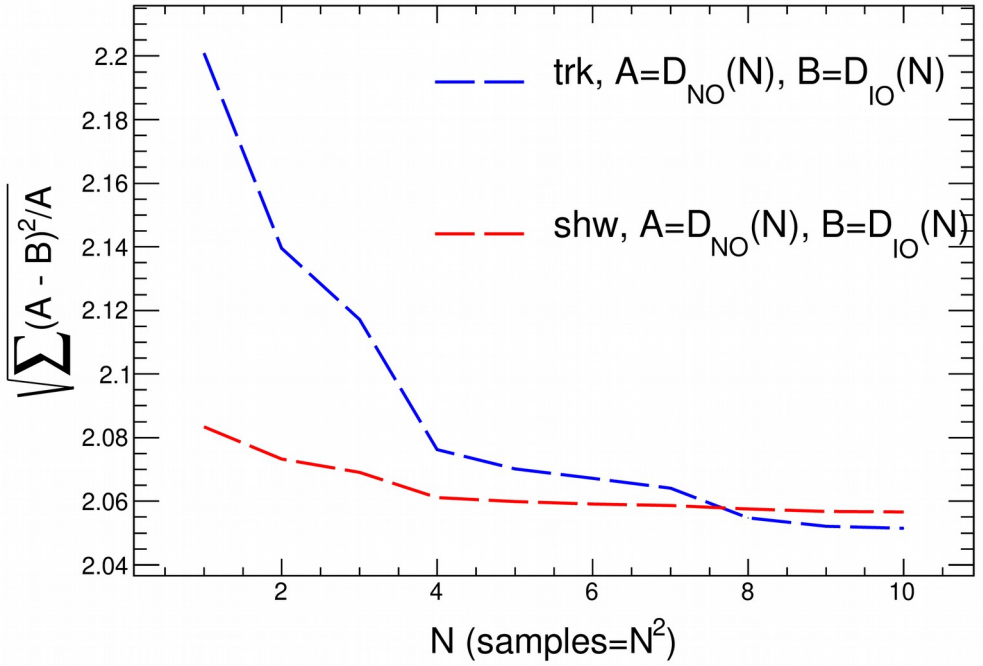
=> Question: how large of a systematic uncertainty does this introduce?

Procedure

- Introduce sampling N in each (E, ct) bin. For example, at N=2, each bin is divided to 2*2=4 sub-bins and an average osc. prob. of the 4 bins is calculated.
- Create NO and IO expectation value data $D_{NO}(N)$ and $D_{IO}(N)$ at N=[1,10].
- Calculate asymmetries
  - A($D_{NO}(N=1)$, $D_{NO}(N)$), N=[1,10]
  - A($D_{NO}(N)$, $D_{IO}(N)$), N=[1,10]
- Fit $D_{NO}(N)$ with model M(N=1) for osc. par. values

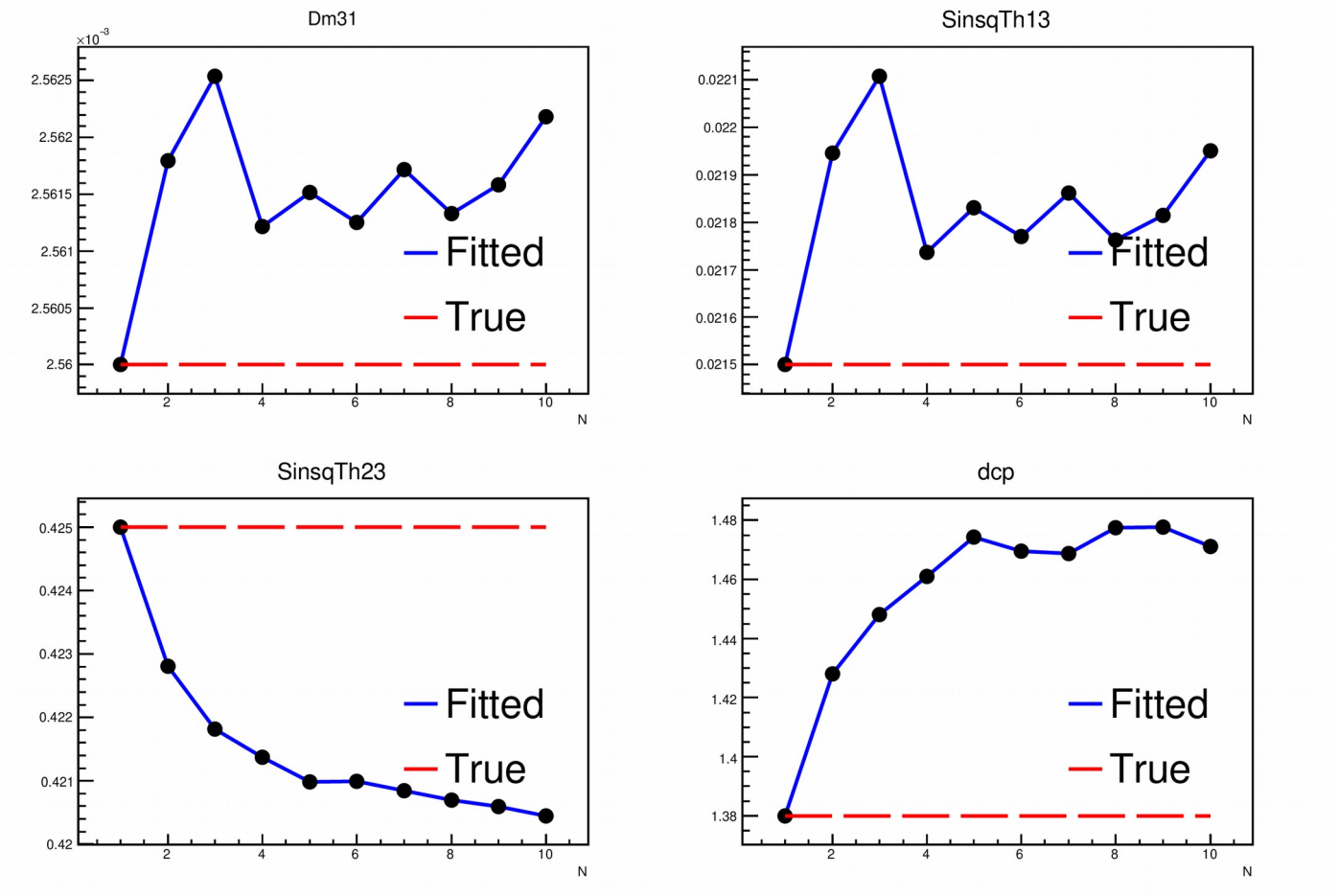
- Left plot: A($D_{NO}(N=1)$, $D_{NO}(N)$)
- Right plot: A($D_{NO}(N)$, $D_{IO}(N)$)





- Significant difference between D(1) and D(N), which can be significantly reduced by choosing N=2,3
- Difference in A(D_{NO}, D_{IO}) is of the order O(<=10%).

Fitting D_{NO}(N) with M(N=1)



- Affects delta-cp O(0.1pi), slightly also theta-23 O(1%)
- Theta-12 and dm21 also affected, but typically fixed or constrained in ORCA analyses

Summary

- Insufficient resolution in oscillation calculation introduces small systematic effects to the sensitivity and parameter estimation
- For current MC studies, this does not seem critical, but it should be kept in mind
- In fitting sea-data, N>1 should probably be considered.