

# AD maximum likelihood reconstruction optimization

Qing He

Princeton University

Dayabay Collaboration

- Cache PMT position: Remove the following two lines from fcn function, cache PMT position information in memory.

```
CLHEP::Hep3Vector pos = m_pmtGeomSvc->get(pmtid)->localPosition();  
CLHEP::Hep3Vector norm = m_pmtGeomSvc->get(pmtid)->localDirection();
```

- Simpler Minuit command: use strategy 0 for faster result, use standard tolerance, lower max Calls to 1000. (Very small effect to results.)
- Keep reflection only to 3rd order. (Small effect)
- Use AD simple result as initial value. (better initial value reduce function calls.)

- 1000 IBD events fit.

| Modification                   | time  |
|--------------------------------|-------|
| QMLF Original                  | 263 s |
| Cache PMT position             | 128 s |
| Simpler Minuit command         | 91 s  |
| Reflection only to 3rd order   | 73 s  |
| Use AD simple as initial value | 62 s  |
| AD simple                      | 19 s  |

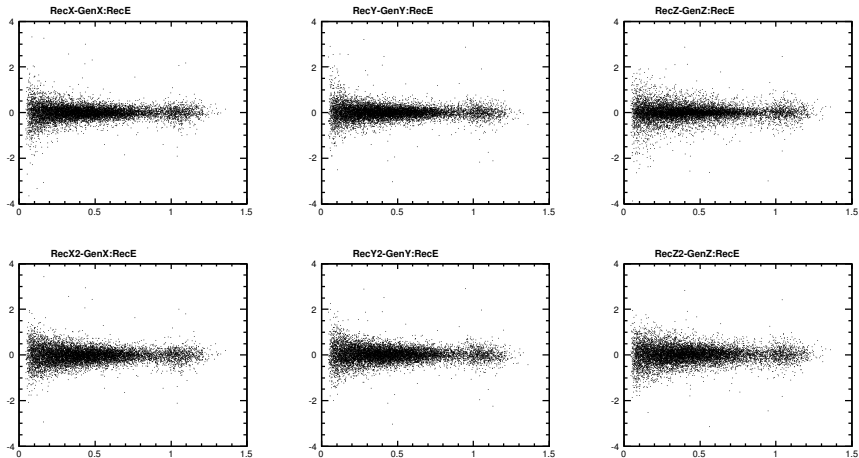
- A: 1000 readouts (IBD). B: 10000 readouts ( $K^{40}$ )

| Comparison           | 1 readout | A         | B        |
|----------------------|-----------|-----------|----------|
| Ad simple (Berkeley) | 25 s      | 55 s      | 7 m 12 s |
| QMLF optimized       | 26 s      | 148 s     | 8 m 25 s |
| QMLF original        | 26 s      | 15 m 43 s | 23 m 6 s |

- Reduced the CPU time for Maximum likelihood fit by a factor of 4.
- After optimization, Maximum likelihood fit takes about 4 times of “AD simple” CPU time (this including the time using “AD simple” as initial value).
- Code:

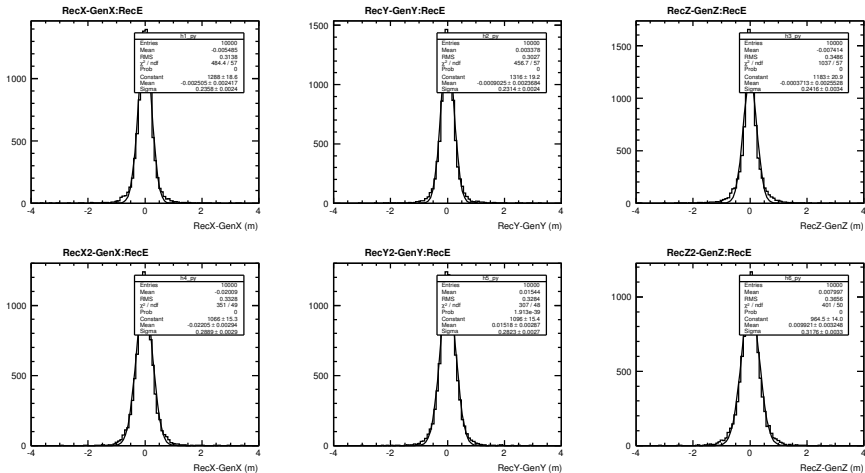
<http://dayabay.ihep.ac.cn/svn/dybsvn/people/qinghe/QMLFTool/>

# Performance



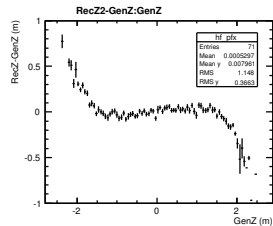
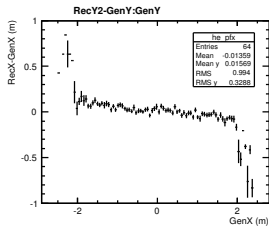
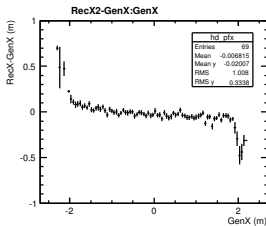
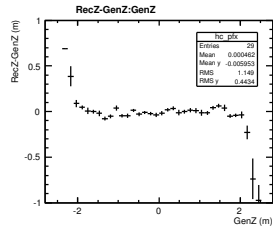
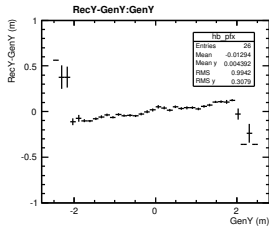
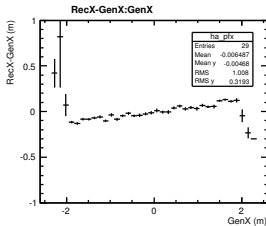
● First row: Maximum likelihood fit. Second row: Ad Simple

# Performance comparison



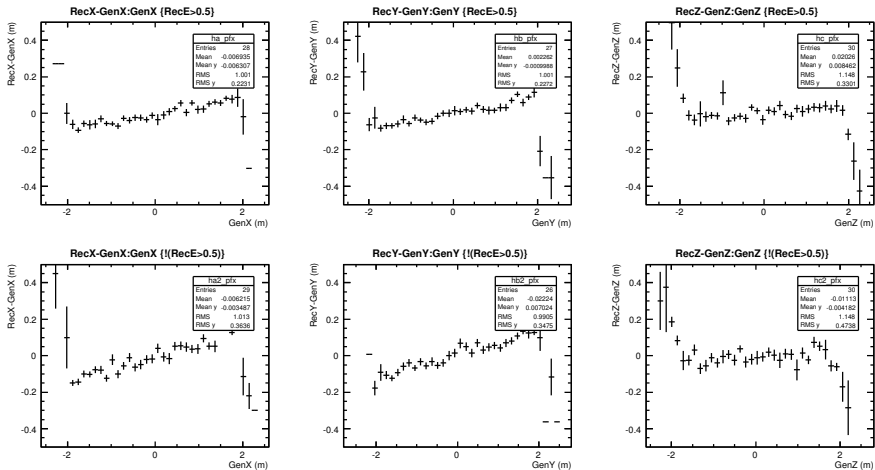
- First row: Maximum likelihood fit. Second row: Ad Simple
- Maximum likelihood has better resolution

# Performance comparison



- First row: Maximum likelihood fit. Second row: Ad Simple
- Maximum likelihood tend to pull events out while Ad simple does the opposite.
- Maximum likelihood fit has better performance at large  $|Z|$ .

# Maximum likelihood fit



- First row:  $E > 0.5$  MeV. Second row:  $E < 0.5$  MeV
- Higher energy has lower bias

- Maximum likelihood fit has better resolution and lower bias.
- The CPU time has been significantly reduced after optimization
- Code:

<http://dayabay.ihep.ac.cn/svn/dybsvn/people/qinghe/QMLFTool/>