eASTROGAM

Optimizations and polarization study of eAstrogam

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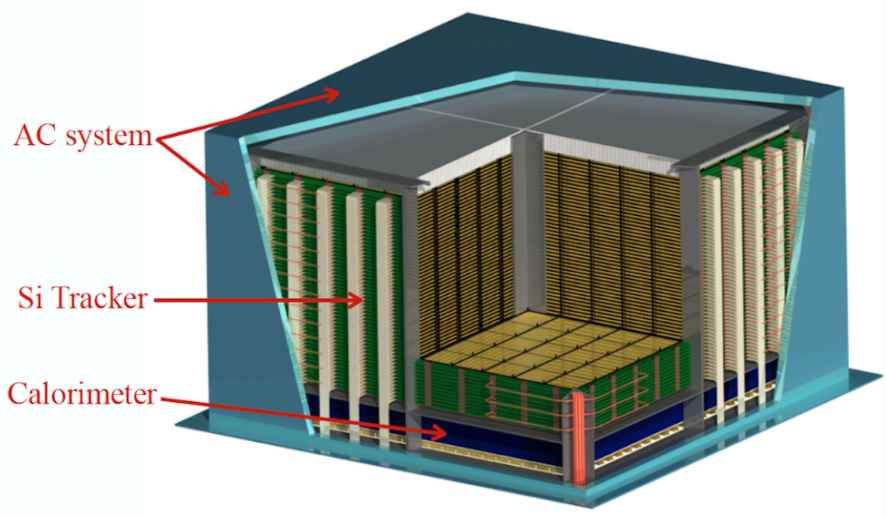
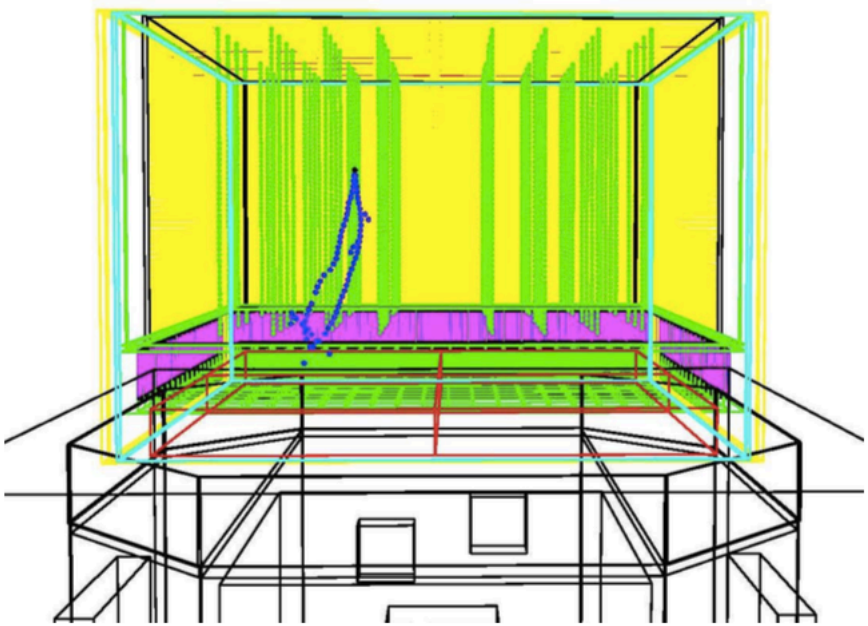
14/07/2017

MEGALib INPUT PARAMETERS

COSIMA INPUTS:

- Number of triggers: 500000 x 8
- Mono Spectrum:
  - Energies: 300, 500, 1000, 1500, 2000, 2500, 3000, 5000 keV
  - Zenith angles: 0, 30, 60, 90 degrees





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Zenith angles: 0, 30, 60, 90 degrees

Optimization parameters:

- Thickness: 100, 250, 400, 450, 500, 550 μm
- Number of Layers: 56, 70, 112
- Distance between Layers: 0.5, 0.75, 1.0 cm

Thickness(μm), Layers, ΔZ(cm)

250,	112,	0.5
400,	70,	0.75
500,	56,	1.0

→ **0.3 X_0 on axis**

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MIMREC INPUTS:

- No cuts for Energy Resolution.
- Compton events for ARM resolution:
  - All events
  - No electron tracking
  - Electron tracking

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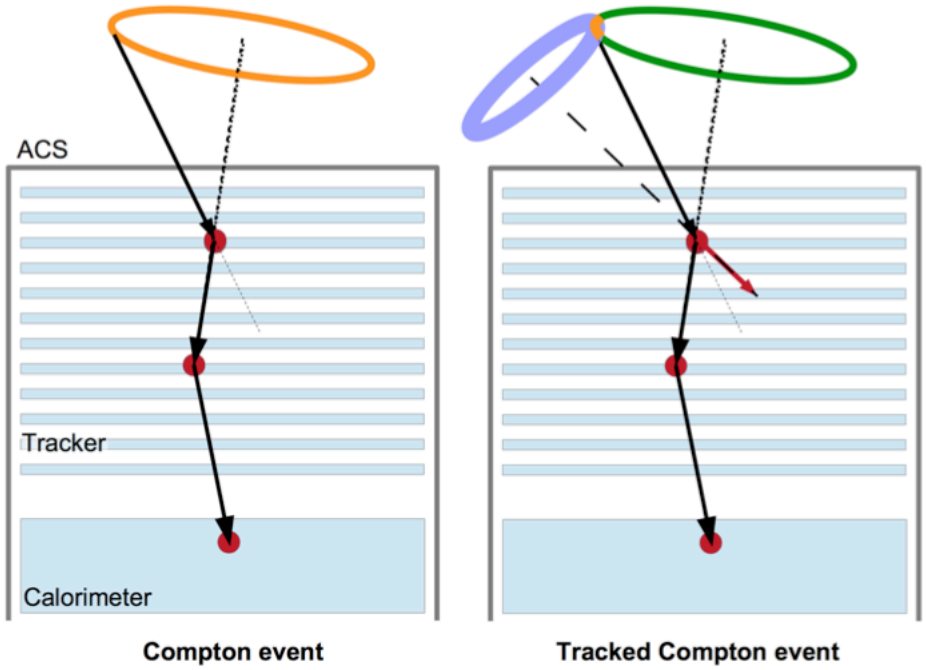
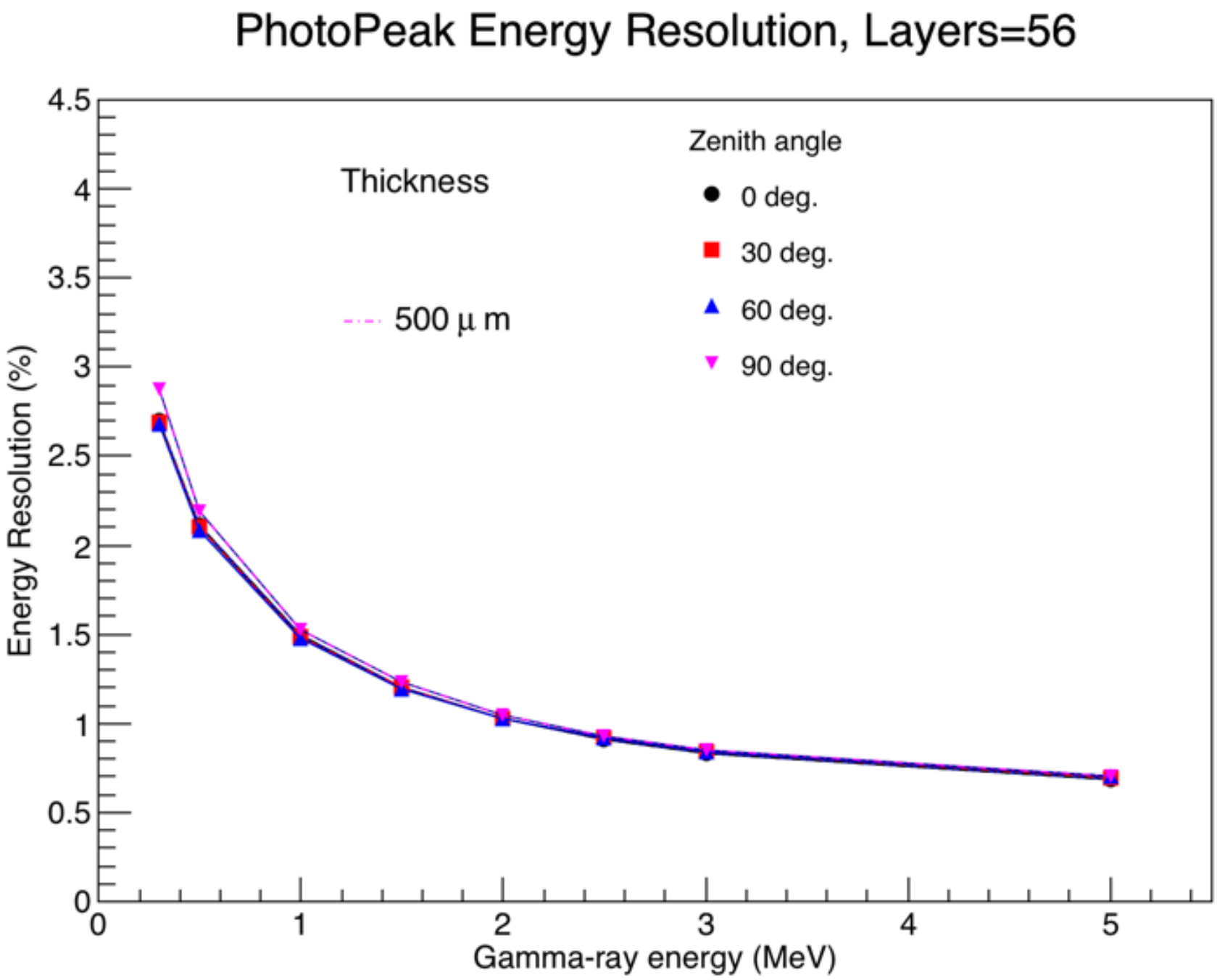
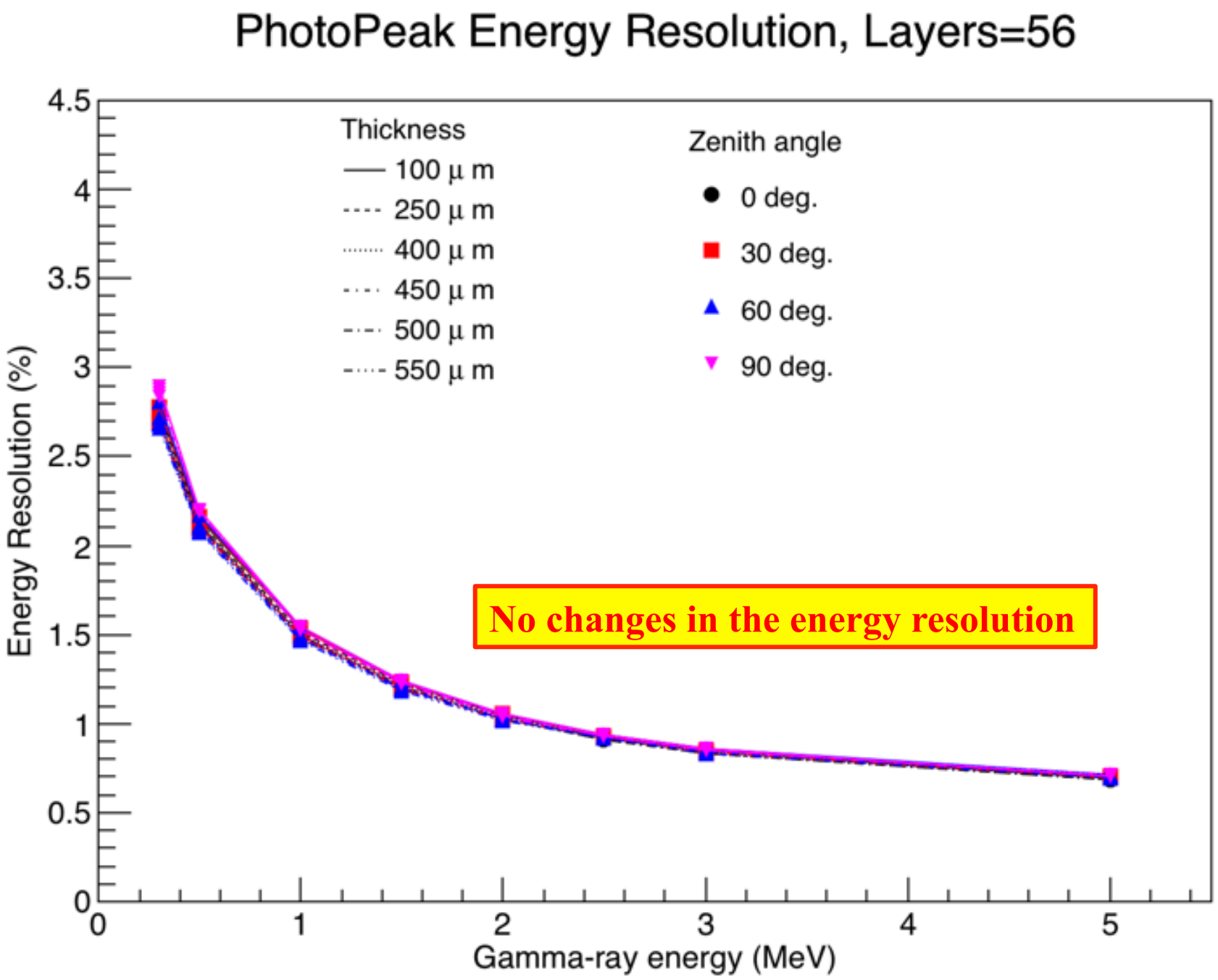
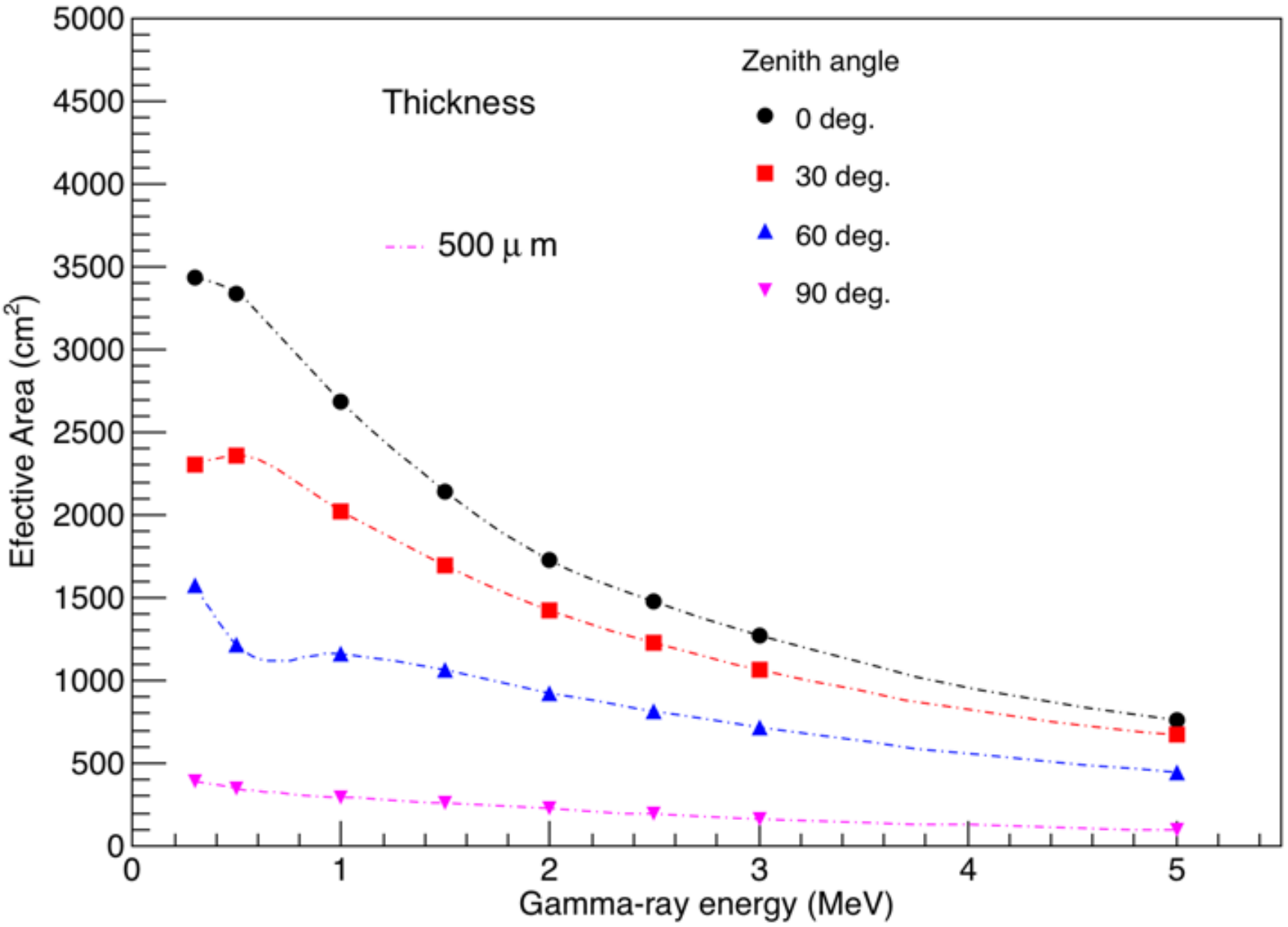


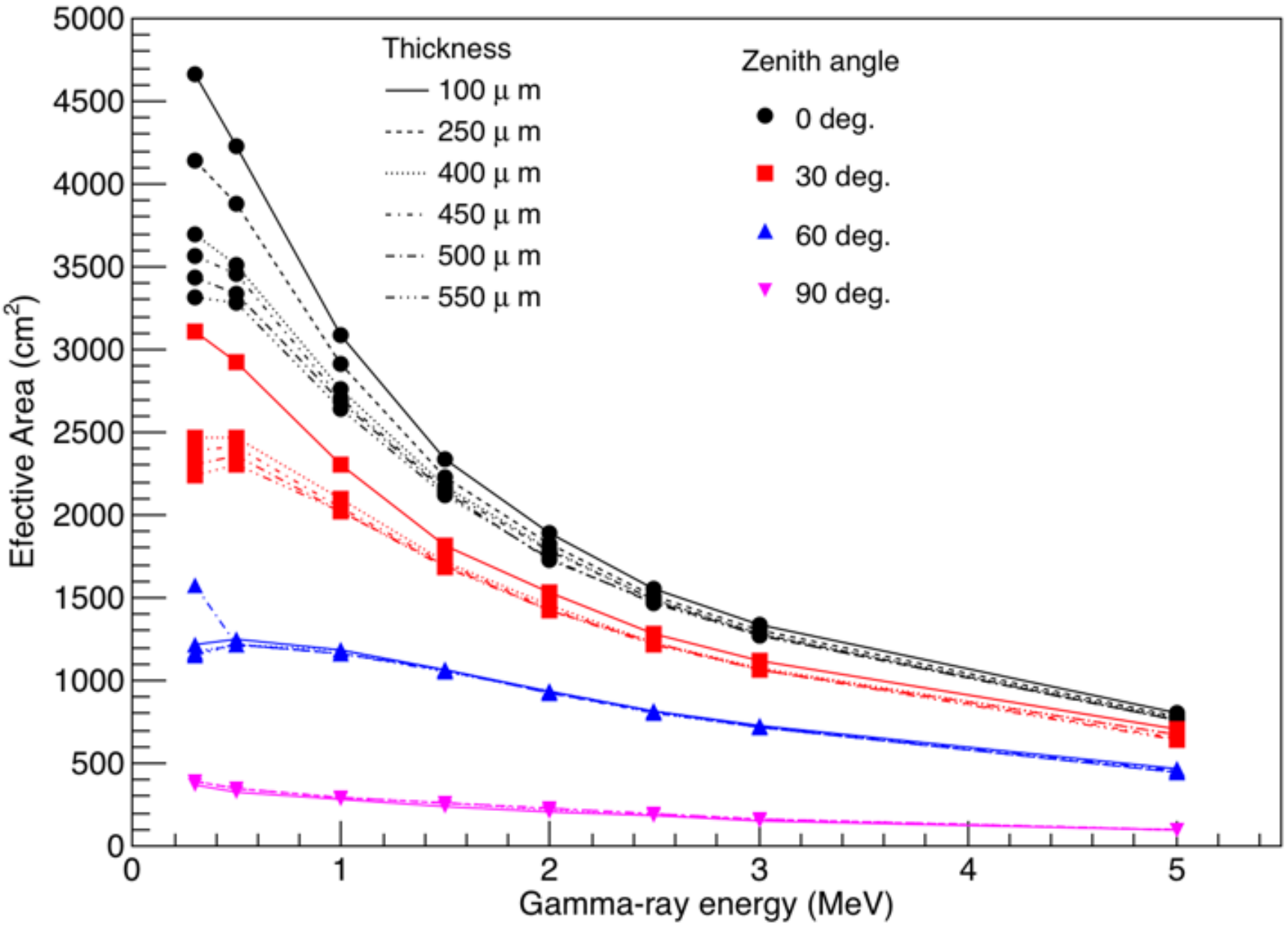
MIMREC Results:

- Energy Resolution -> NO CUTS


PhotoPeak Energy Resolution, Layers=56
Thickness
500 μ m
Zenith angle
0 deg.
30 deg.
60 deg.
90 deg.
Energy Resolution (%)
Gamma-ray energy (MeV)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
1
2
3
4
5


PhotoPeak Energy Resolution, Layers=56
Thickness
100 μ m
250 μ m
400 μ m
450 μ m
500 μ m
550 μ m
Zenith angle
0 deg.
30 deg.
60 deg.
90 deg.
No changes in the energy resolution
Energy Resolution (%)
Gamma-ray energy (MeV)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
1
2
3
4
5

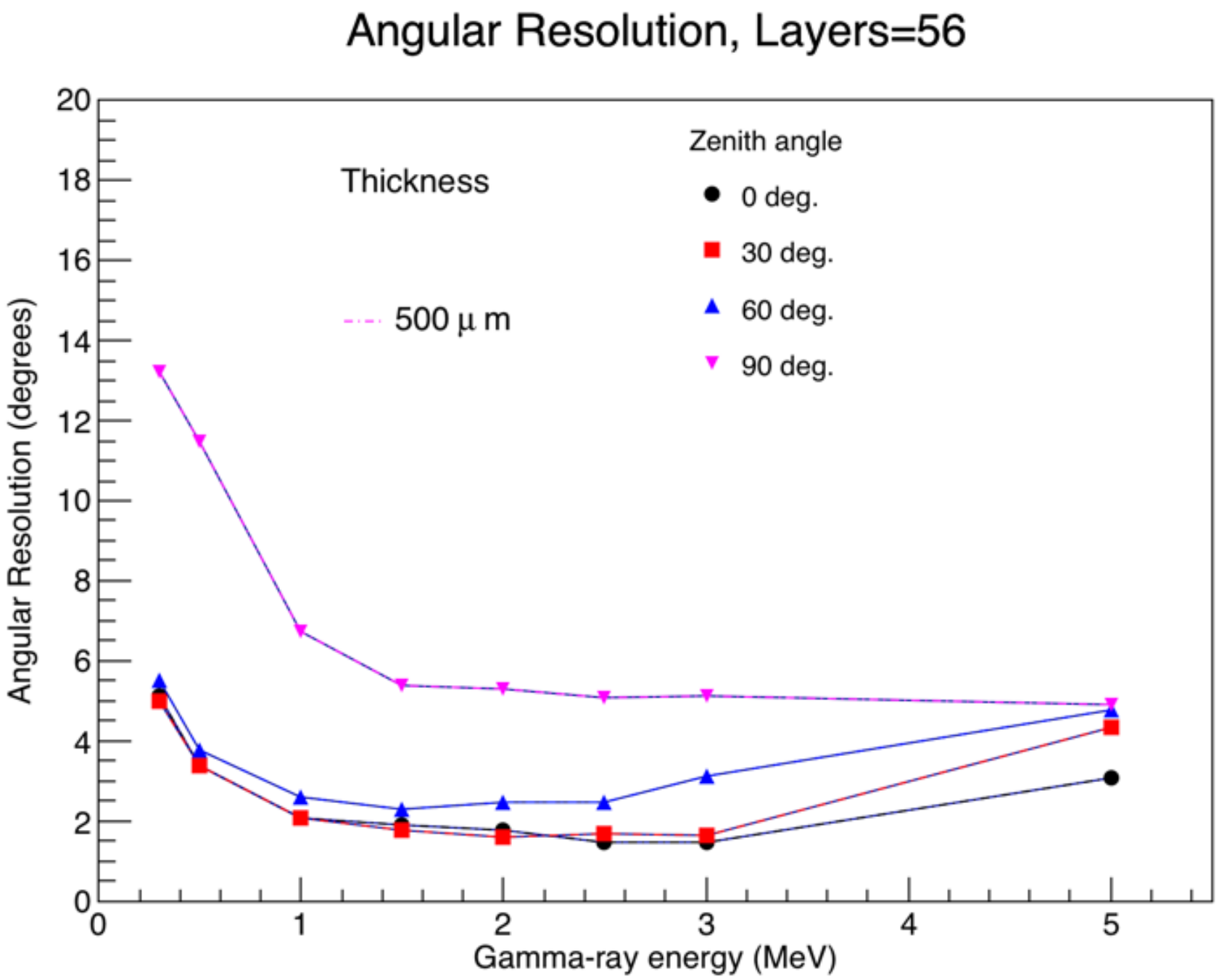

PhotoPeak Effective Area, Layers=56
Thickness
500 μ m
Zenith angle
0 deg.
30 deg.
60 deg.
90 deg.
Efective Area (cm²)
Gamma-ray energy (MeV)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
1
2
3
4
5


PhotoPeak Effective Area, Layers=56
Thickness
100 μ m
250 μ m
400 μ m
450 μ m
500 μ m
550 μ m
Zenith angle
0 deg.
30 deg.
60 deg.
90 deg.
Efective Area (cm^2)
Gamma-ray energy (MeV)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
1
2
3
4
5

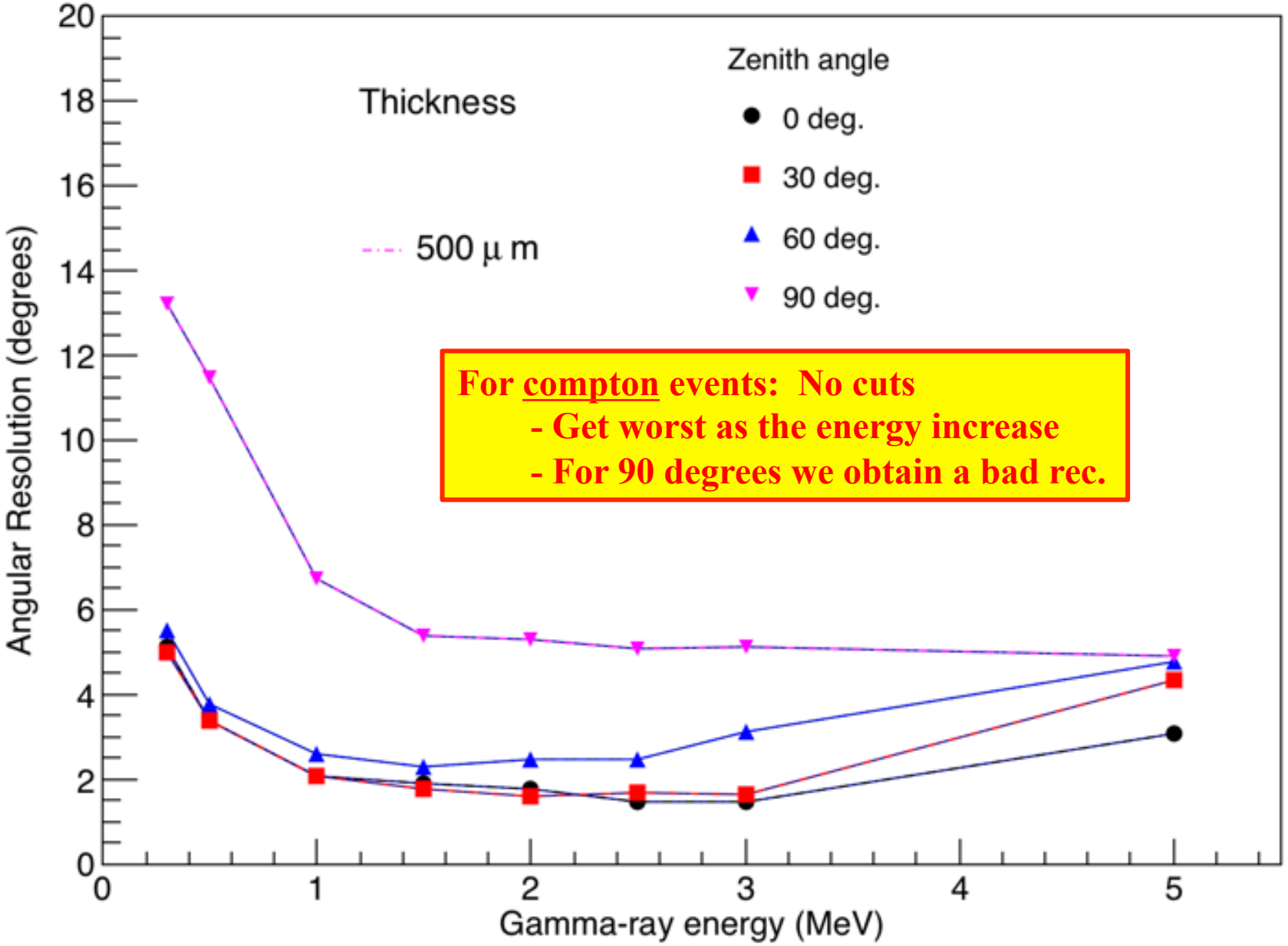
MIMREC Results:

Angular Resolution:

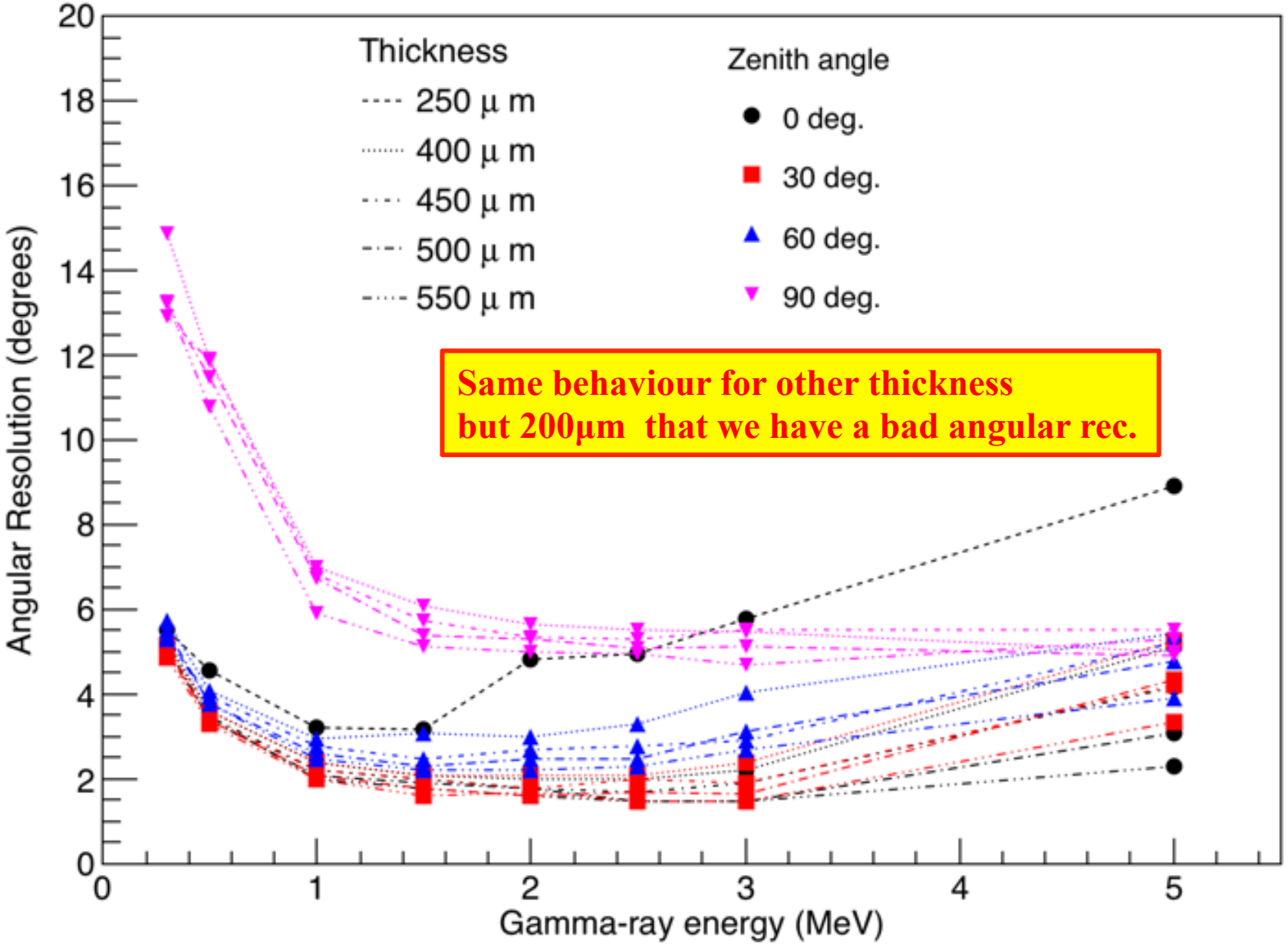
Comptons events -> NO CUTS

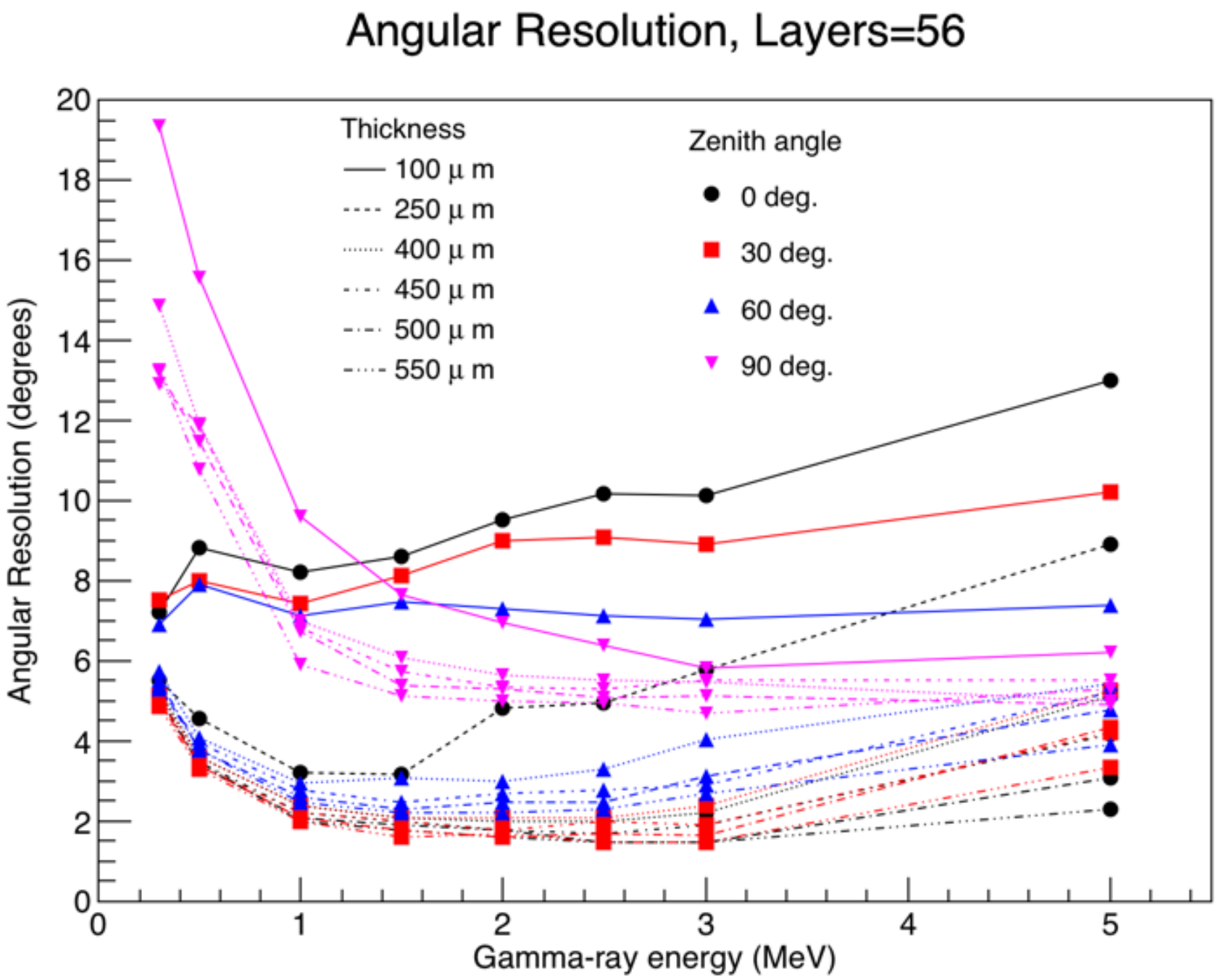

Angular Resolution, Layers=56
Thickness
500 μ m
Zenith angle
0 deg.
30 deg.
60 deg.
90 deg.
Angular Resolution (degrees)
Gamma-ray energy (MeV)
0
2
4
6
8
10
12
14
16
18
20
0
1
2
3
4
5

Angular Resolution, Layers=56

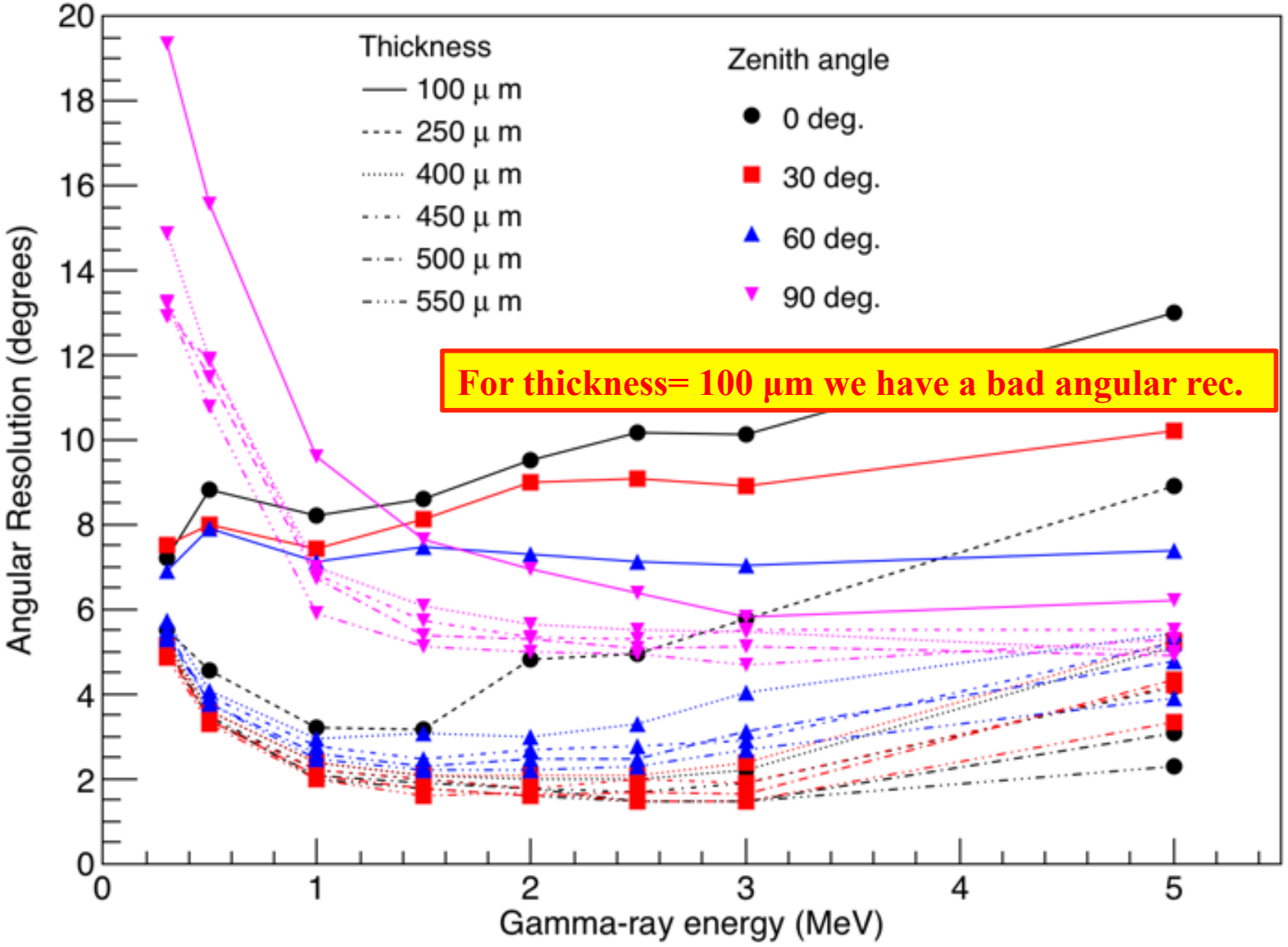


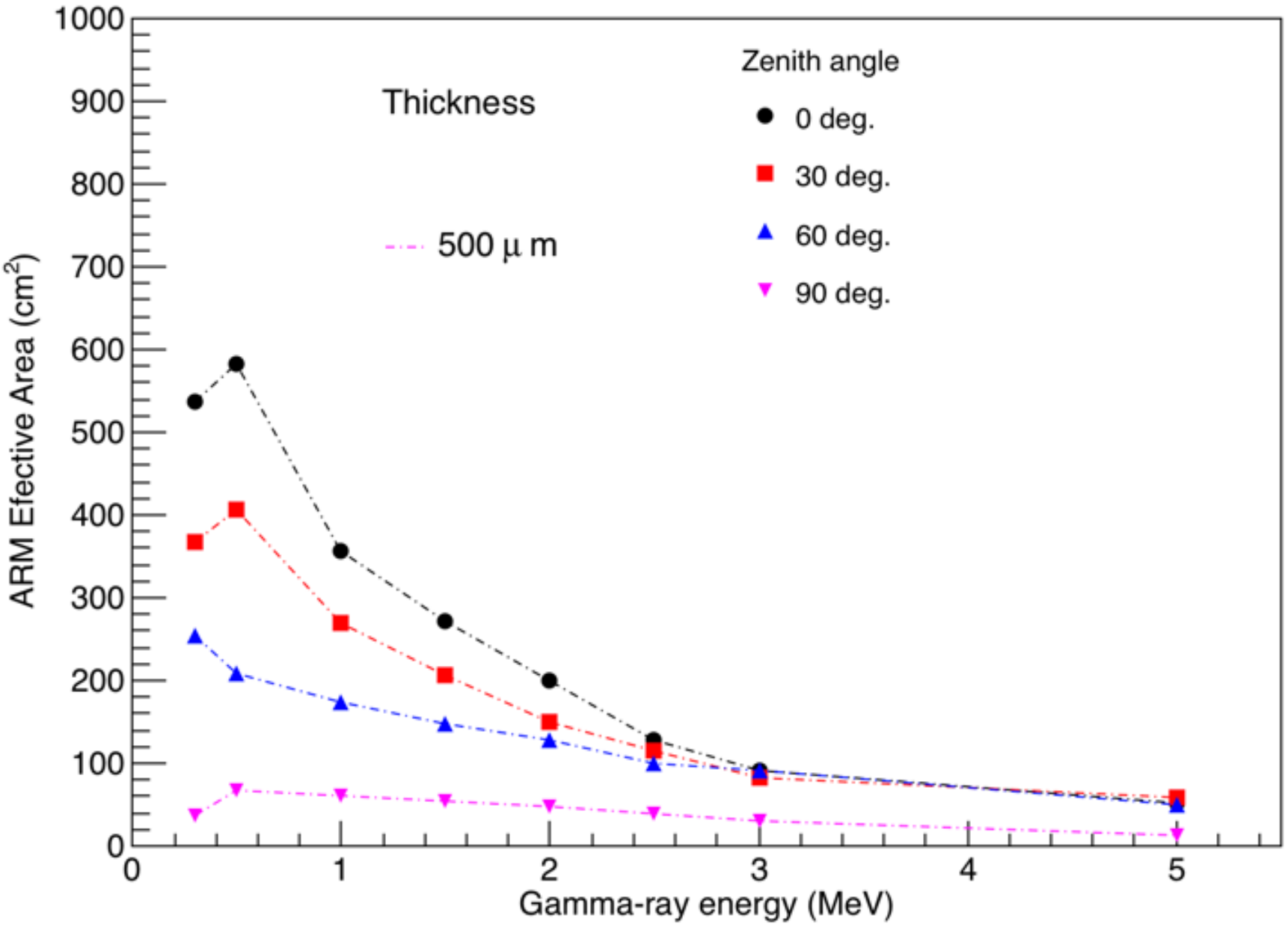
Angular Resolution, Layers=56



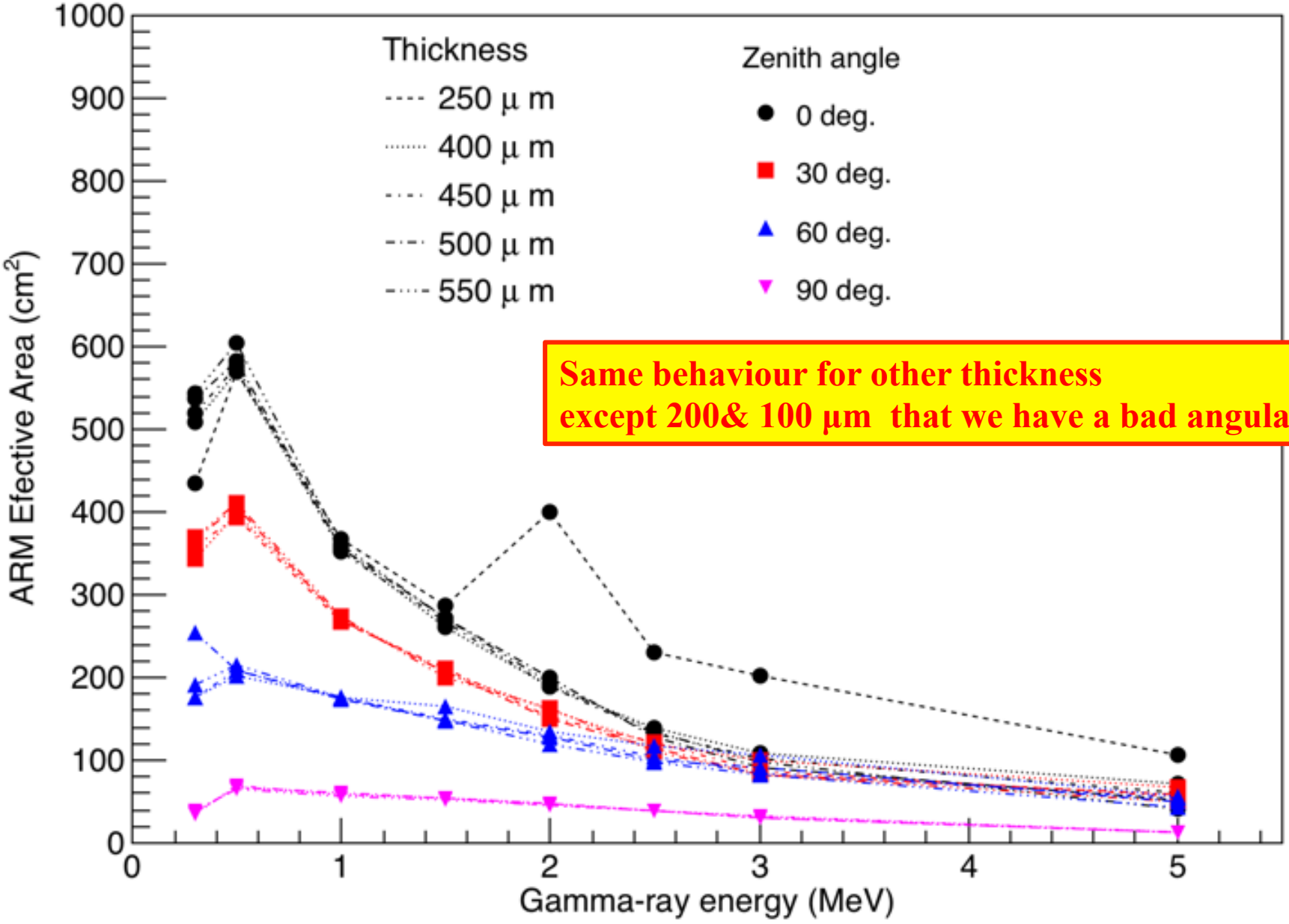

Angular Resolution, Layers=56
Thickness
100 μ m
250 μ m
400 μ m
450 μ m
500 μ m
550 μ m
Zenith angle
0 deg.
30 deg.
60 deg.
90 deg.
Angular Resolution (degrees)
Gamma-ray energy (MeV)
0
2
4
6
8
10
12
14
16
18
20
0
1
2
3
4
5

Angular Resolution, Layers=56



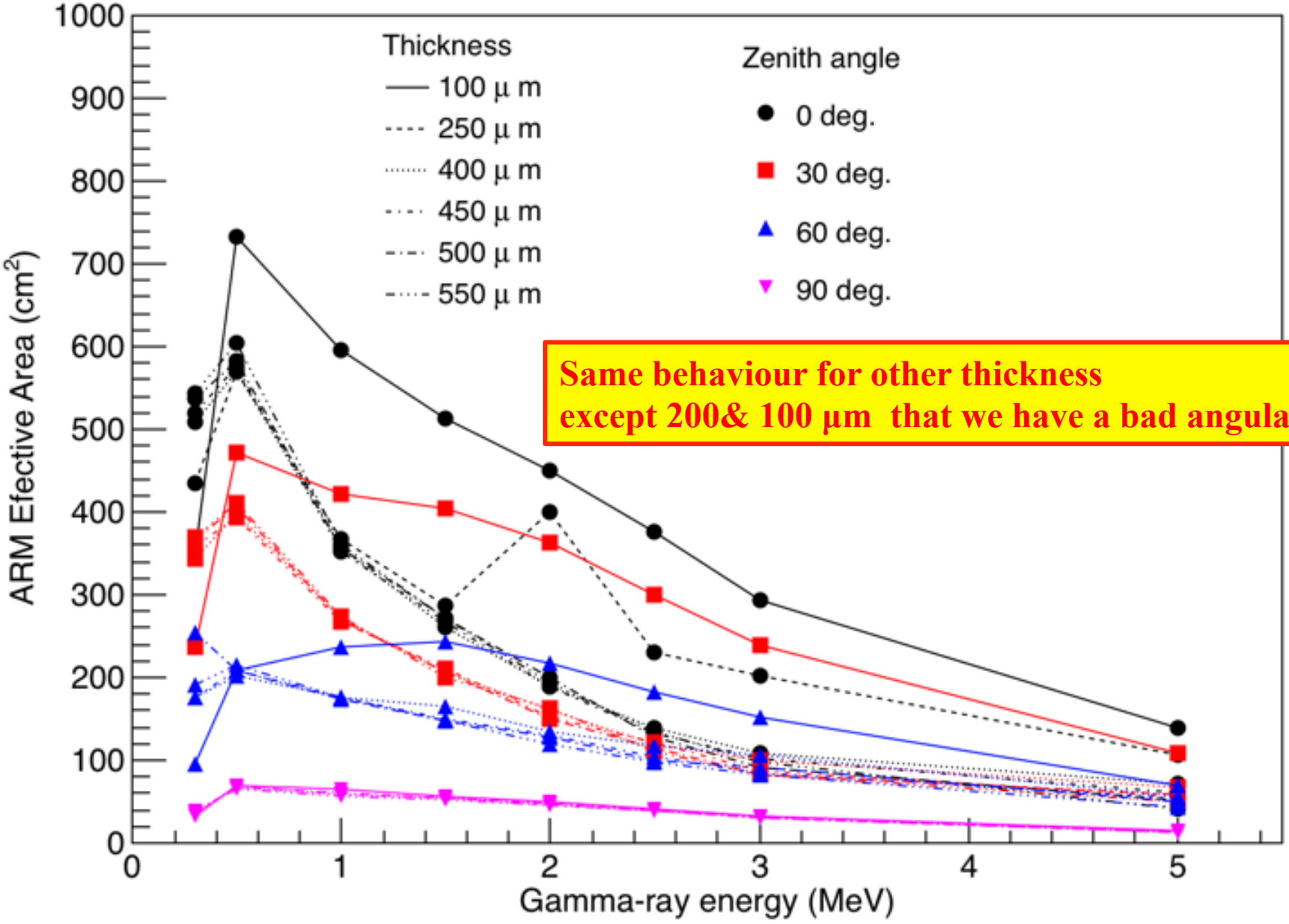

ARM Effective Area, Layers=56
Thickness
500 μ m
Zenith angle
0 deg.
30 deg.
60 deg.
90 deg.
ARM Efective Area (cm^2)
Gamma-ray energy (MeV)
0
100
200
300
400
500
600
700
800
900
1000
0
1
2
3
4
5

ARM Effective Area, Layers=56



Same behaviour for other thickness
except 200& 100 μm that we have a bad angular rec.

ARM Effective Area, Layers=56



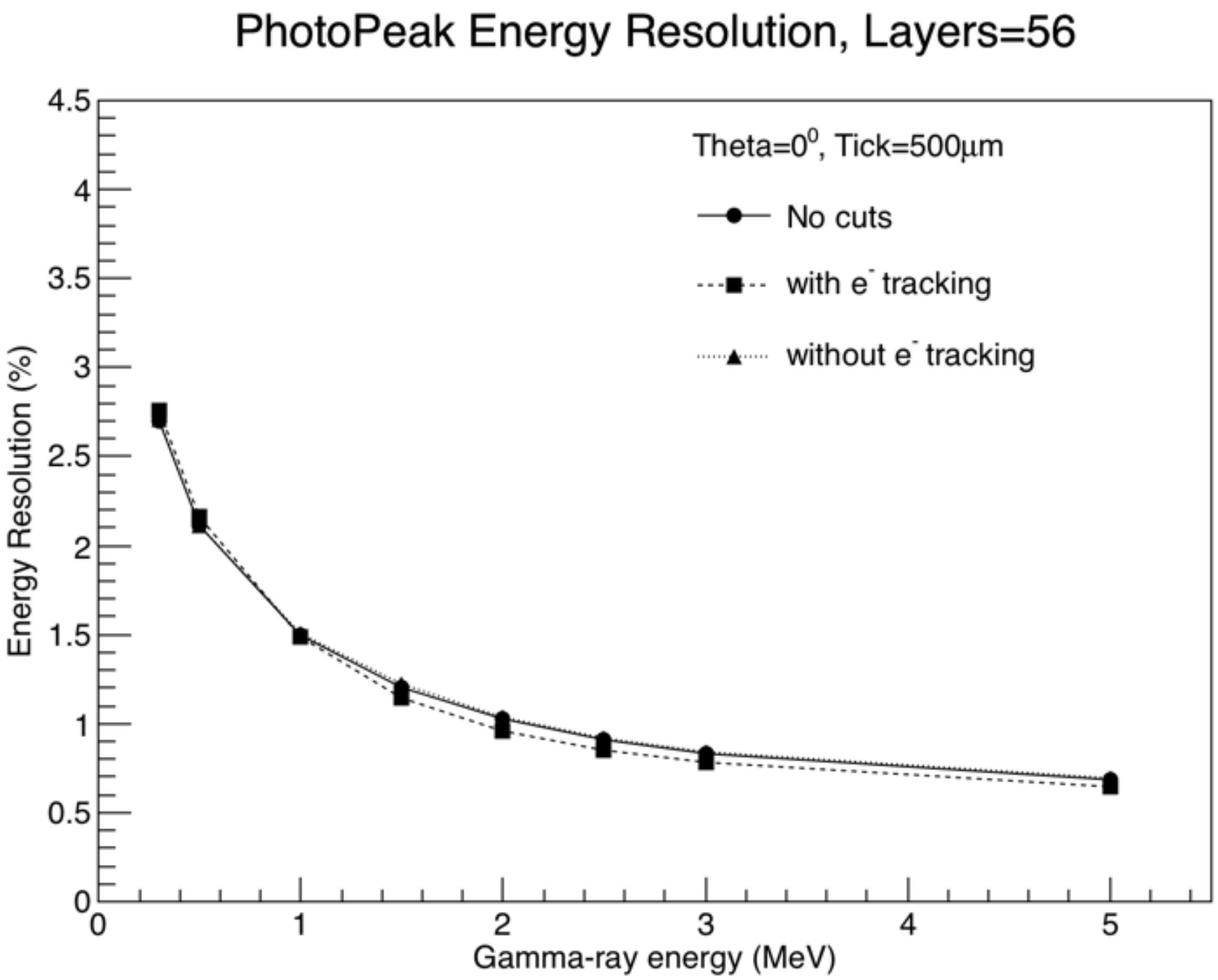
Same behaviour for other thickness
except 200& 100 μm that we have a bad angular rec.

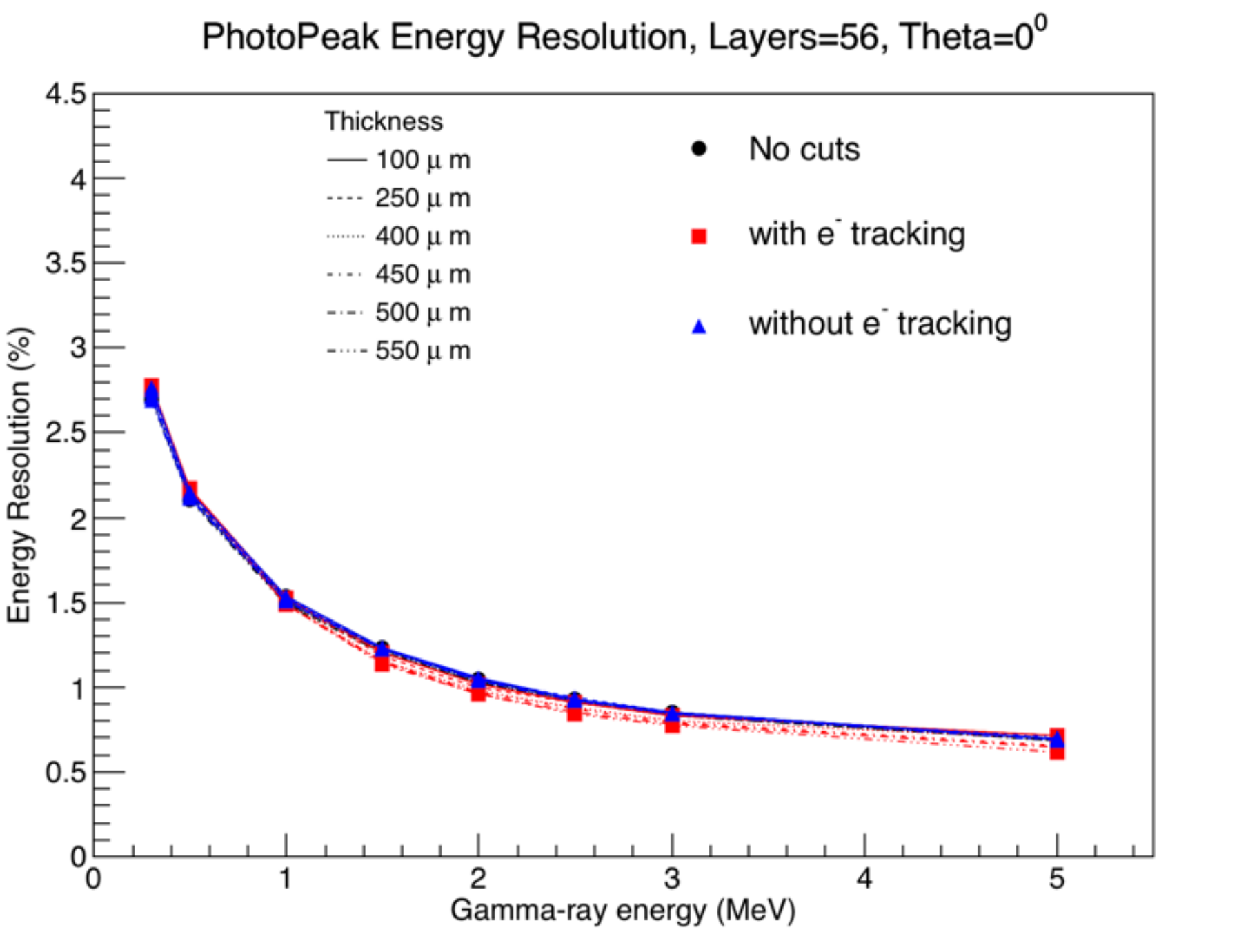
MIMREC Results:

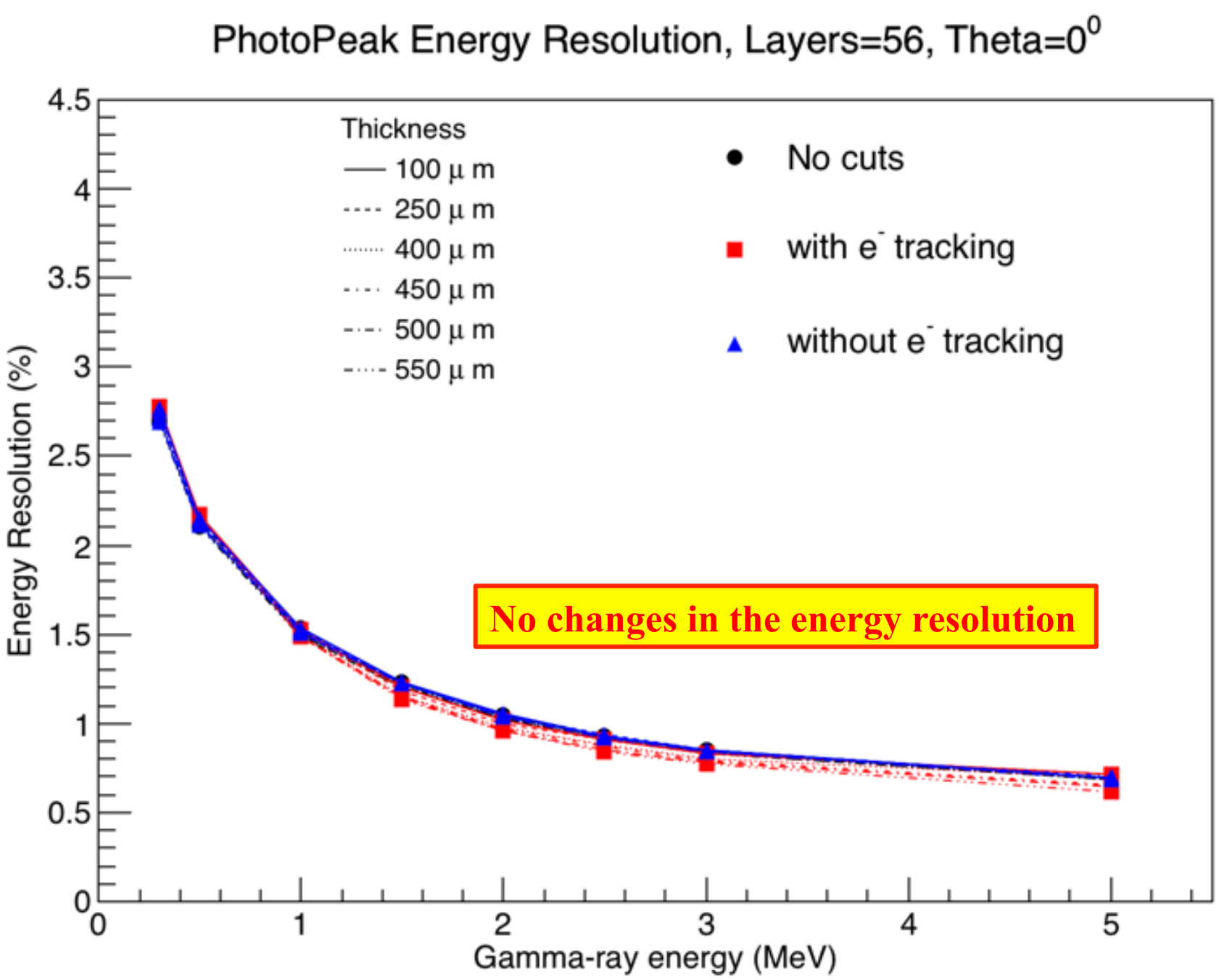
Energy & Angular Resolution:

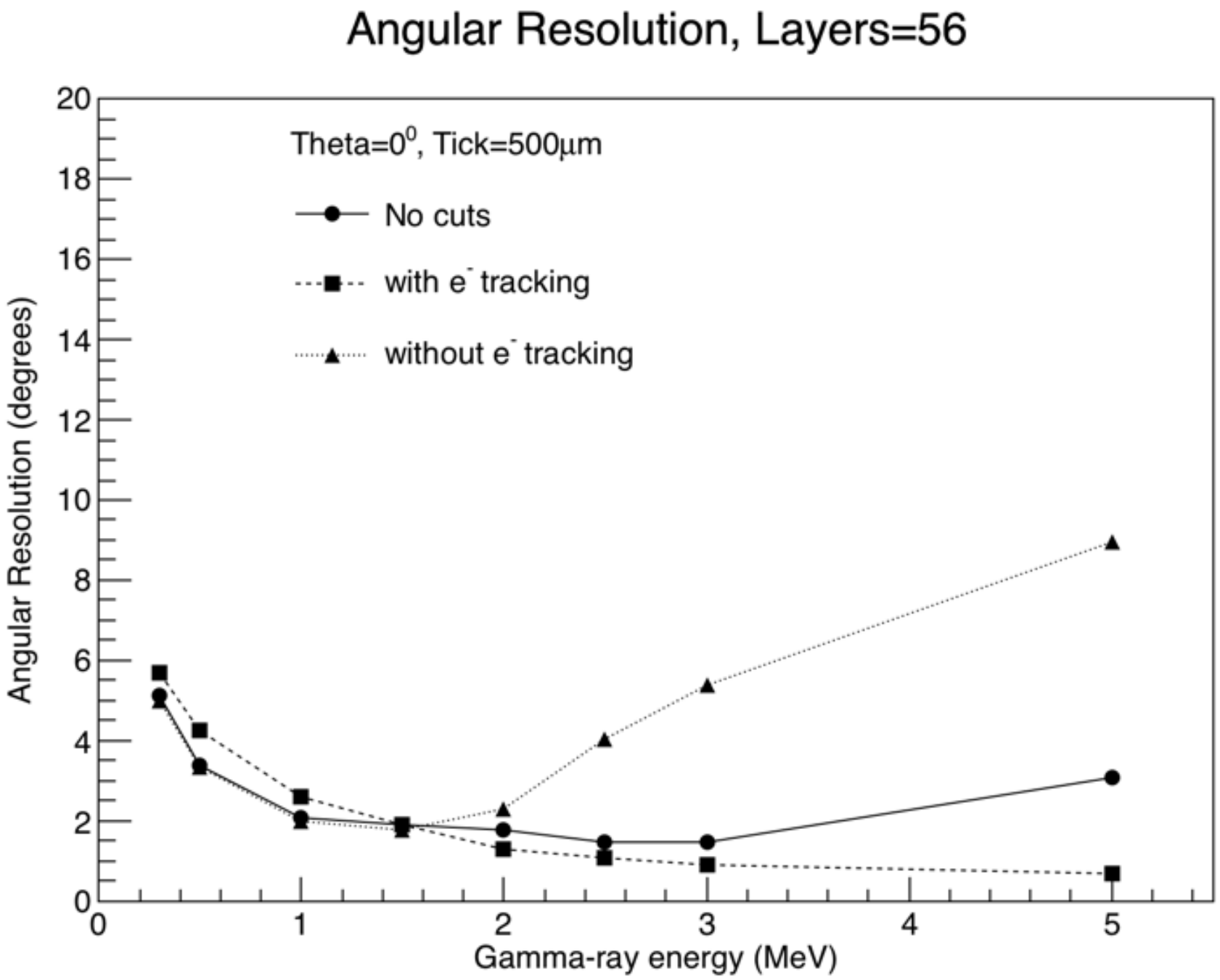
Comptons events:

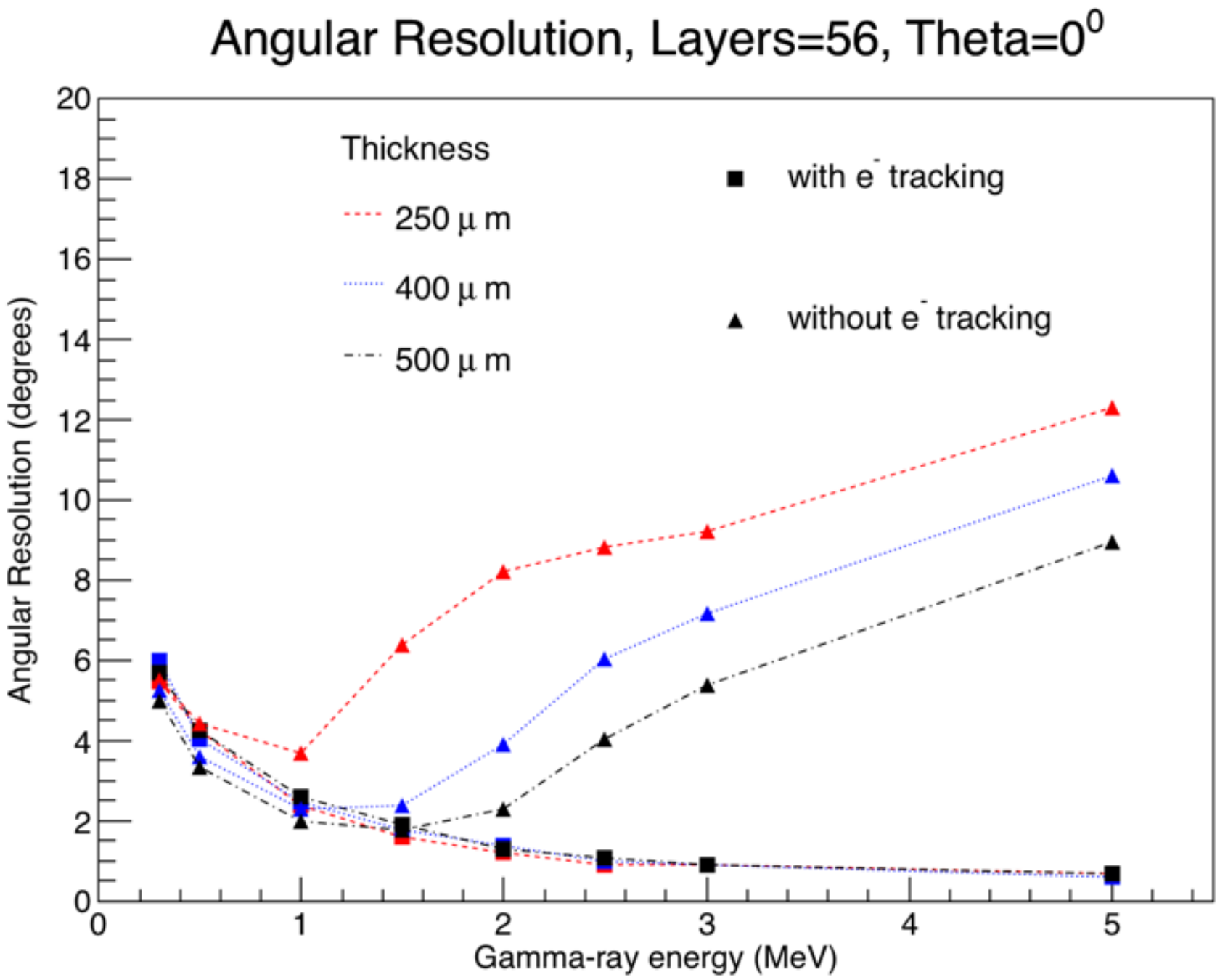
- electron tracking
- no electron traking

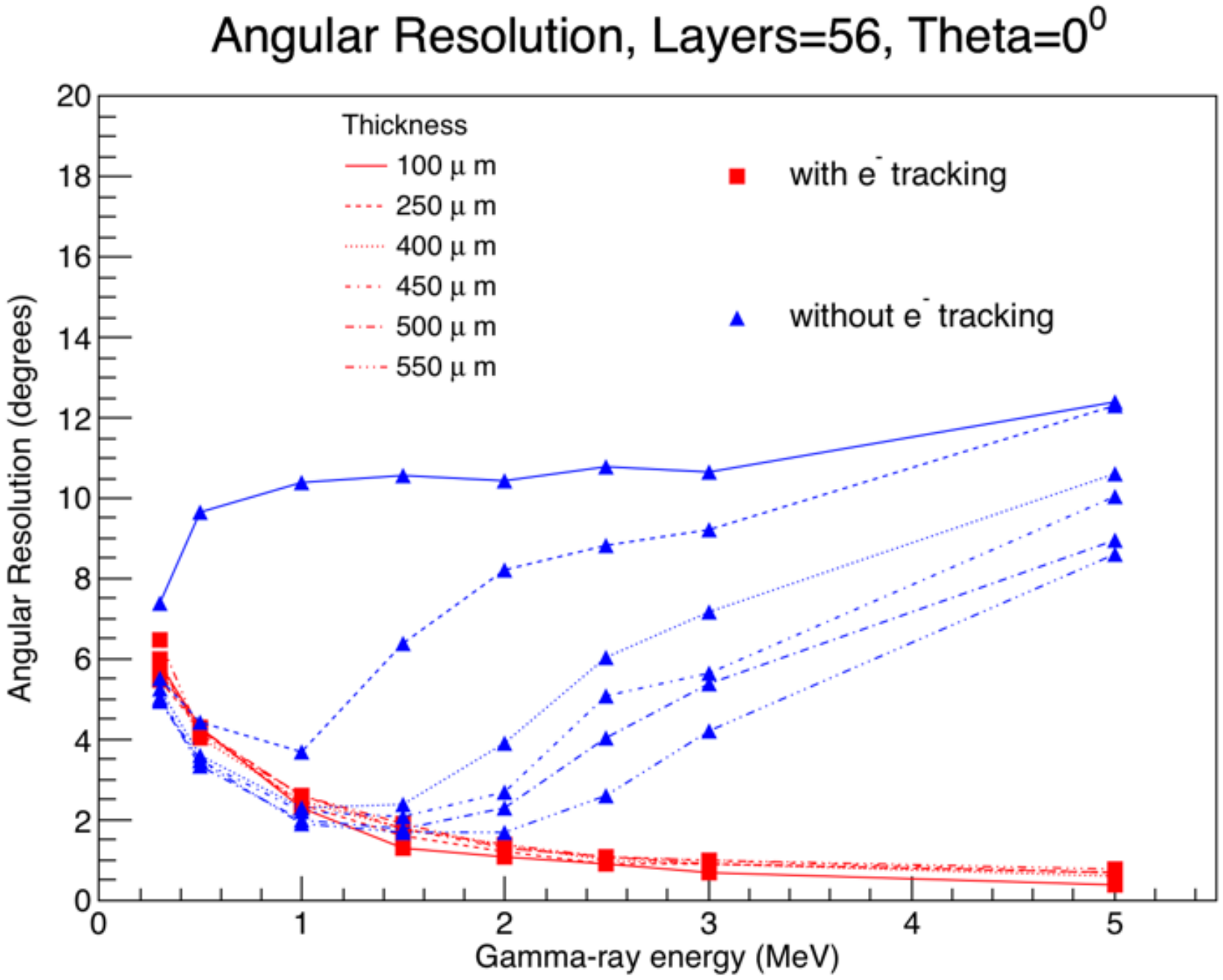

PhotoPeak Energy Resolution, Layers=56
Theta=0^0, Tick=500μm
No cuts
with e$^-$ tracking
without e$^-$ tracking
Energy Resolution (%)
Gamma-ray energy (MeV)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
1
2
3
4
5

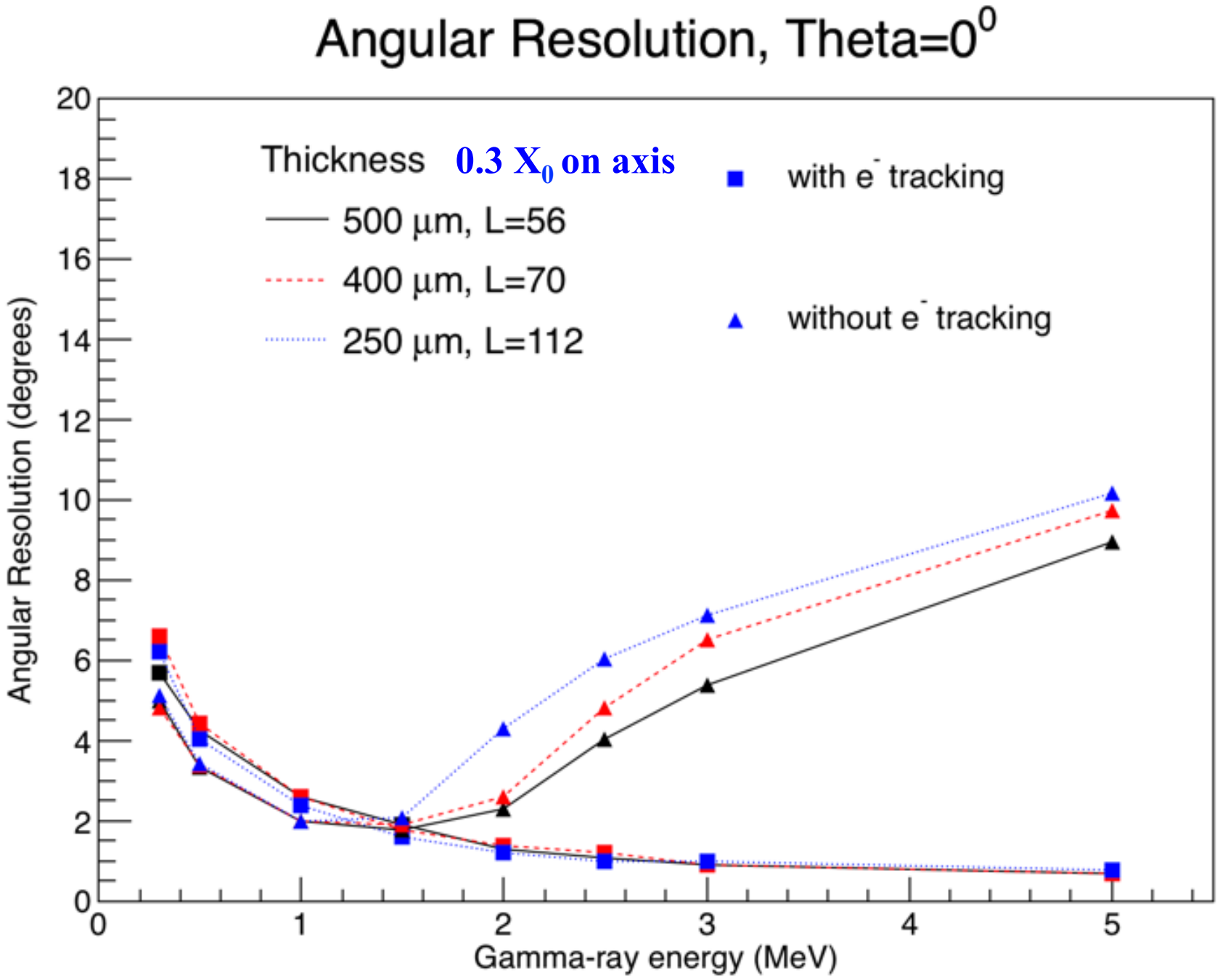

PhotoPeak Energy Resolution, Layers=56, Theta=0^0
Thickness
100 μ m
250 μ m
400 μ m
450 μ m
500 μ m
550 μ m
No cuts
with e^- tracking
without e^- tracking
Energy Resolution (%)
Gamma-ray energy (MeV)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
1
2
3
4
5

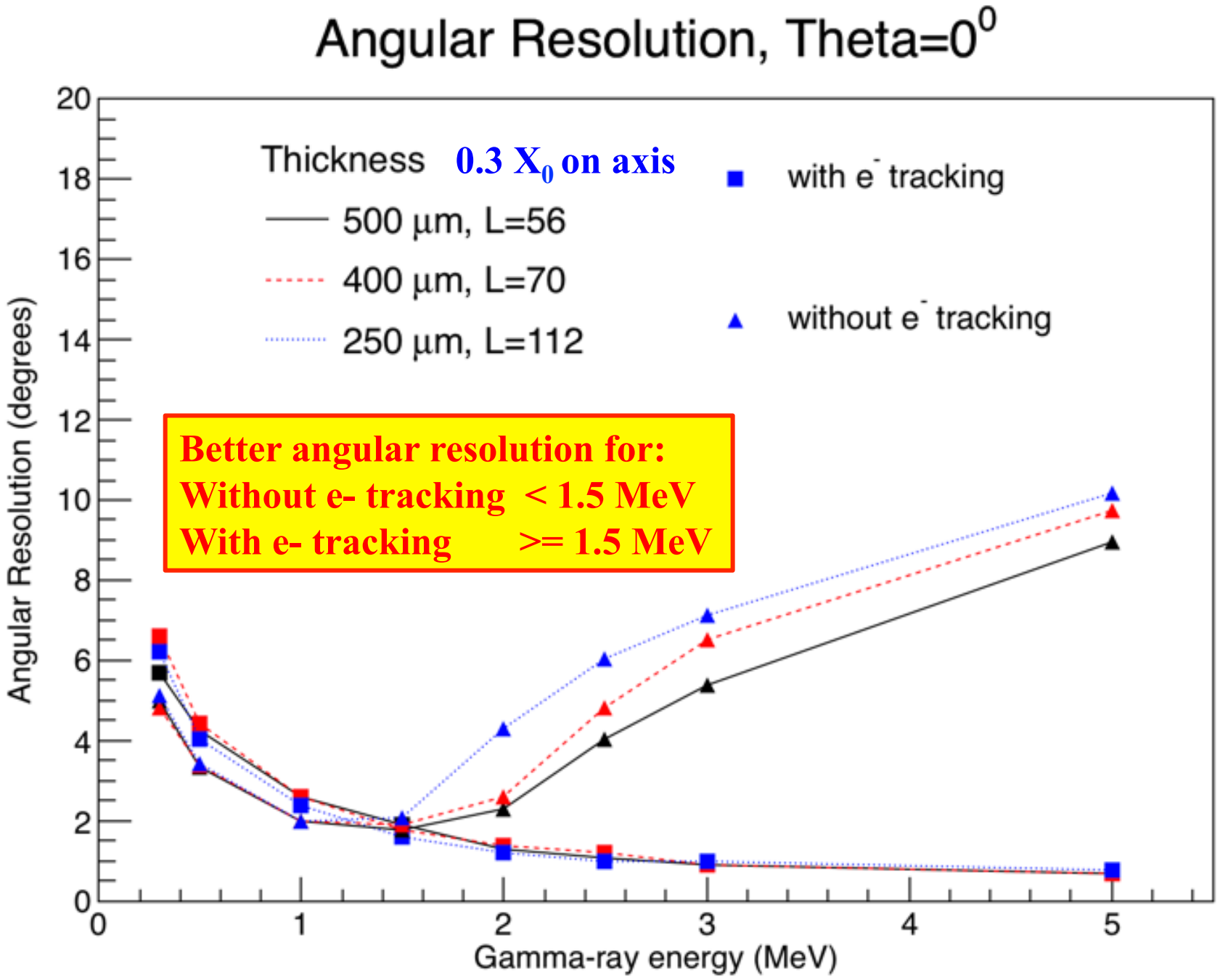

PhotoPeak Energy Resolution, Layers=56, Theta=0^0
Thickness
100 μ m
250 μ m
400 μ m
450 μ m
500 μ m
550 μ m
No cuts
with e- tracking
without e- tracking
No changes in the energy resolution
Energy Resolution (%)
Gamma-ray energy (MeV)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
1
2
3
4
5

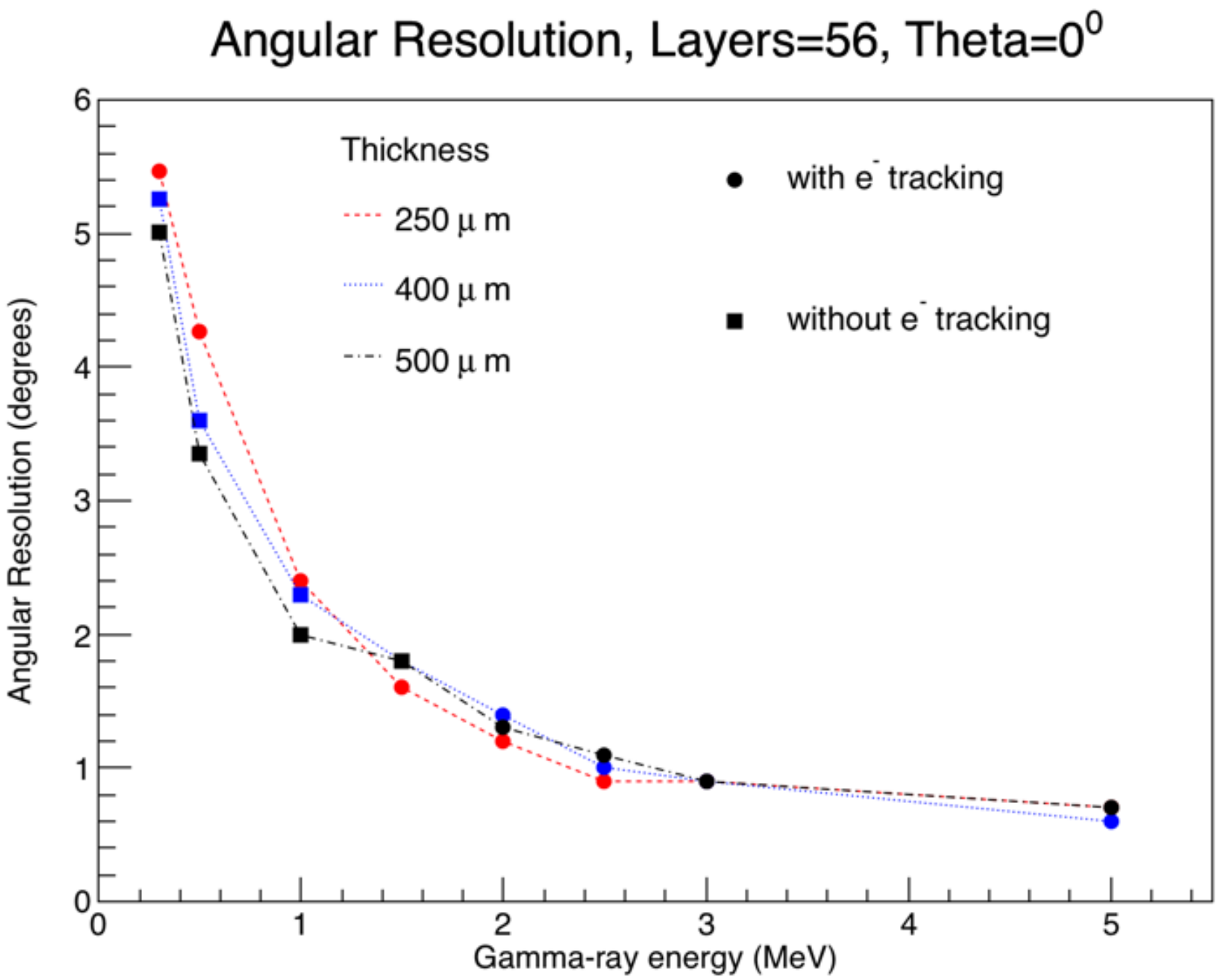

Angular Resolution, Layers=56
Theta=0^0, Tick=500μm
No cuts
with e$^-$ tracking
without e$^-$ tracking
Angular Resolution (degrees)
Gamma-ray energy (MeV)
0
2
4
6
8
10
12
14
16
18
20
0
1
2
3
4
5

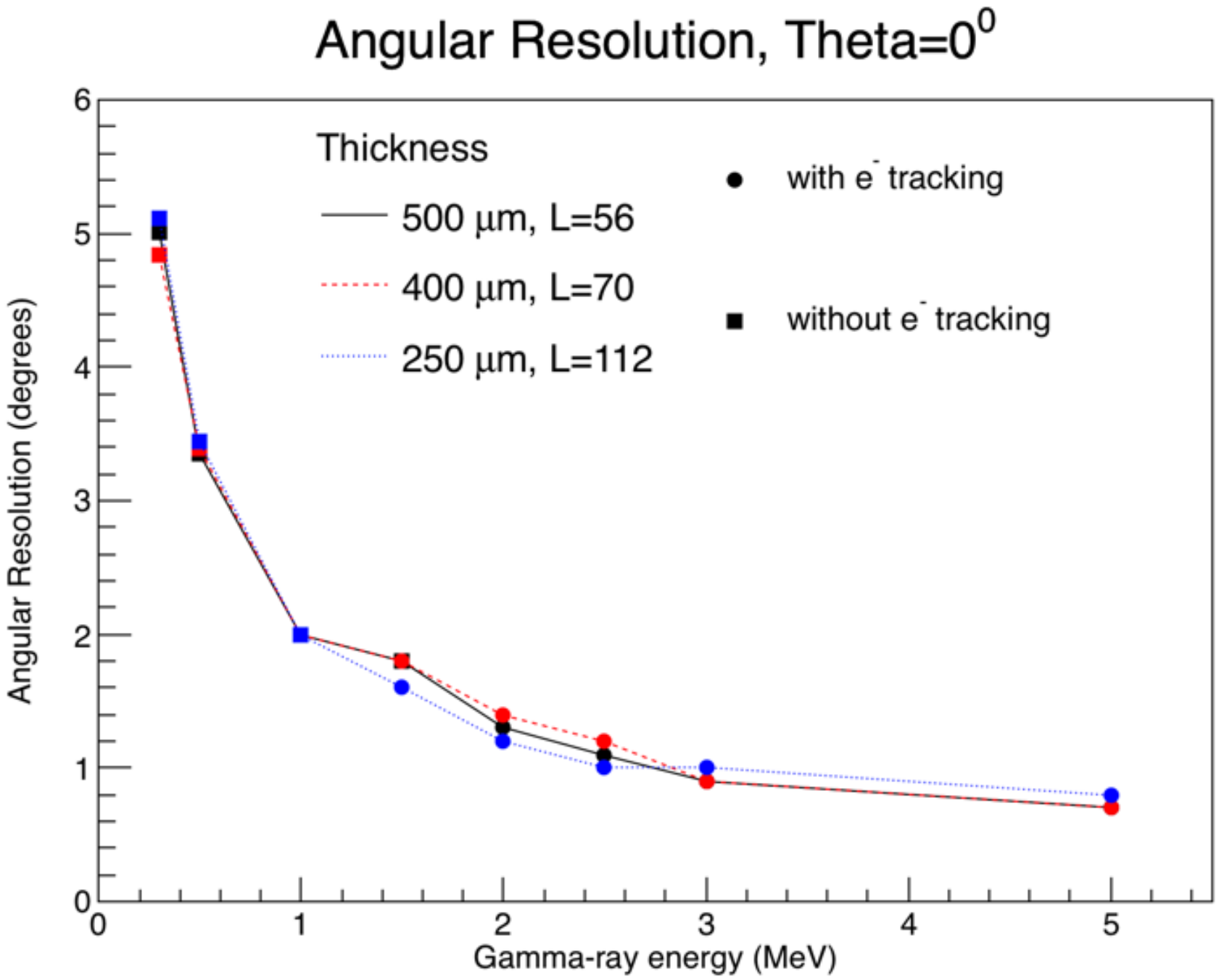

Angular Resolution, Layers=56, Theta=0^0
Thickness
250 μ m
400 μ m
500 μ m
with e- tracking
without e- tracking
Angular Resolution (degrees)
Gamma-ray energy (MeV)
0
2
4
6
8
10
12
14
16
18
20
0
1
2
3
4
5

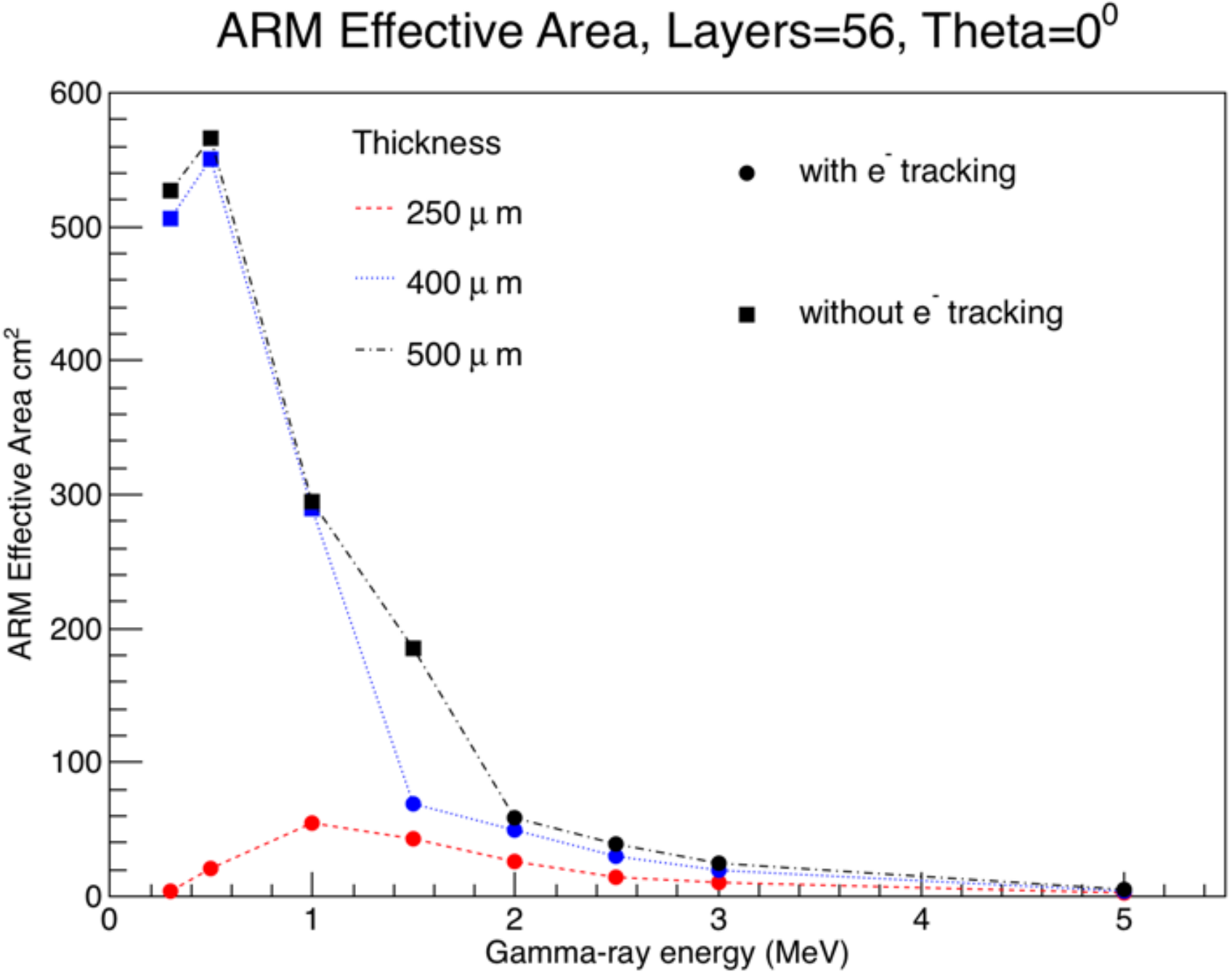

Angular Resolution, Layers=56, Theta=0^0
Thickness
100 μ m
250 μ m
400 μ m
450 μ m
500 μ m
550 μ m
with e- tracking
without e- tracking
Angular Resolution (degrees)
Gamma-ray energy (MeV)
0
2
4
6
8
10
12
14
16
18
20
0
1
2
3
4
5

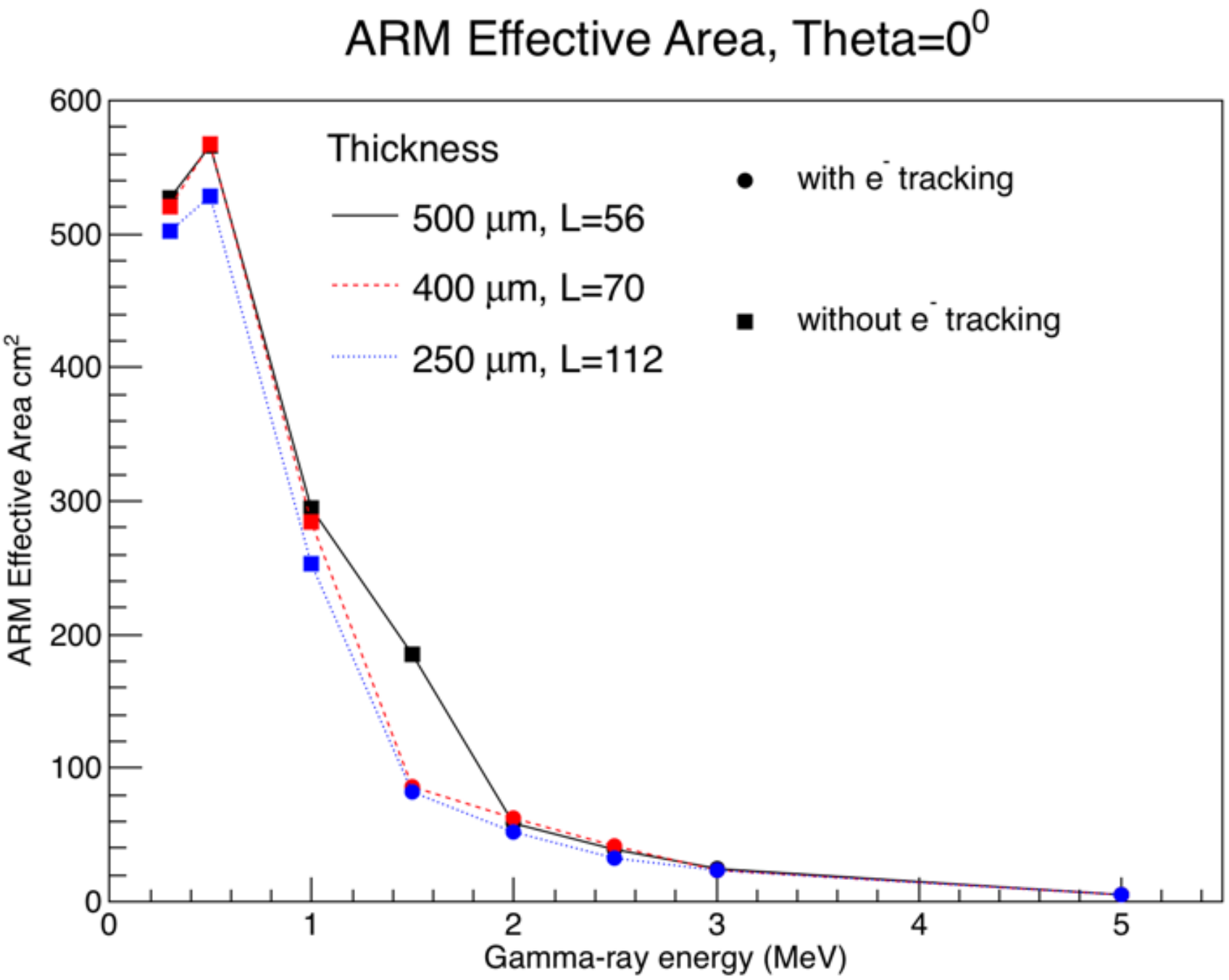

Angular Resolution, Theta=0^0
Thickness
0.3 X0 on axis
500 µm, L=56
400 µm, L=70
250 µm, L=112
with e- tracking
without e- tracking
Angular Resolution (degrees)
Gamma-ray energy (MeV)
0
2
4
6
8
10
12
14
16
18
20
0
1
2
3
4
5


Angular Resolution, Theta=0^0
Thickness 0.3 X0 on axis
500 µm, L=56
400 µm, L=70
250 µm, L=112
with e- tracking
without e- tracking
Better angular resolution for:
Without e- tracking < 1.5 MeV
With e- tracking >= 1.5 MeV
Angular Resolution (degrees)
Gamma-ray energy (MeV)
0
2
4
6
8
10
12
14
16
18
20
1
3
5


Angular Resolution, Layers=56, Theta=0^0
Thickness
250 μ m
400 μ m
500 μ m
with e- tracking
without e- tracking
Angular Resolution (degrees)
Gamma-ray energy (MeV)
0
1
2
3
4
5
6

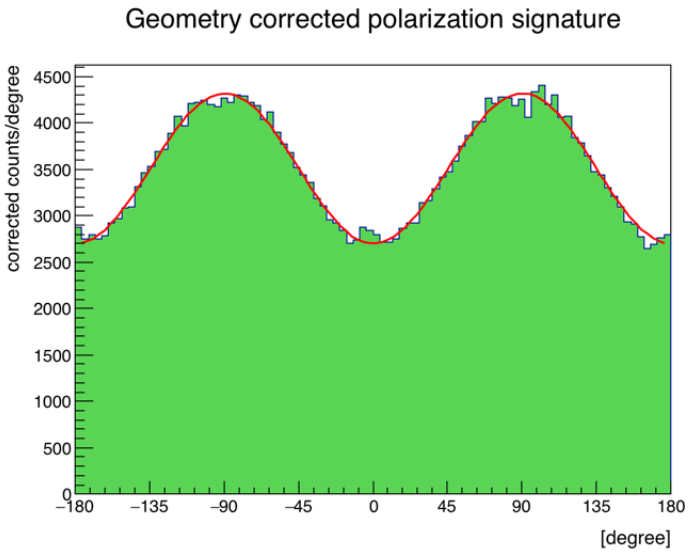

Angular Resolution, Theta=0^0
Thickness
500 μm, L=56
400 μm, L=70
250 μm, L=112
with e- tracking
without e- tracking
Angular Resolution (degrees)
Gamma-ray energy (MeV)
0
1
2
3
4
5
6

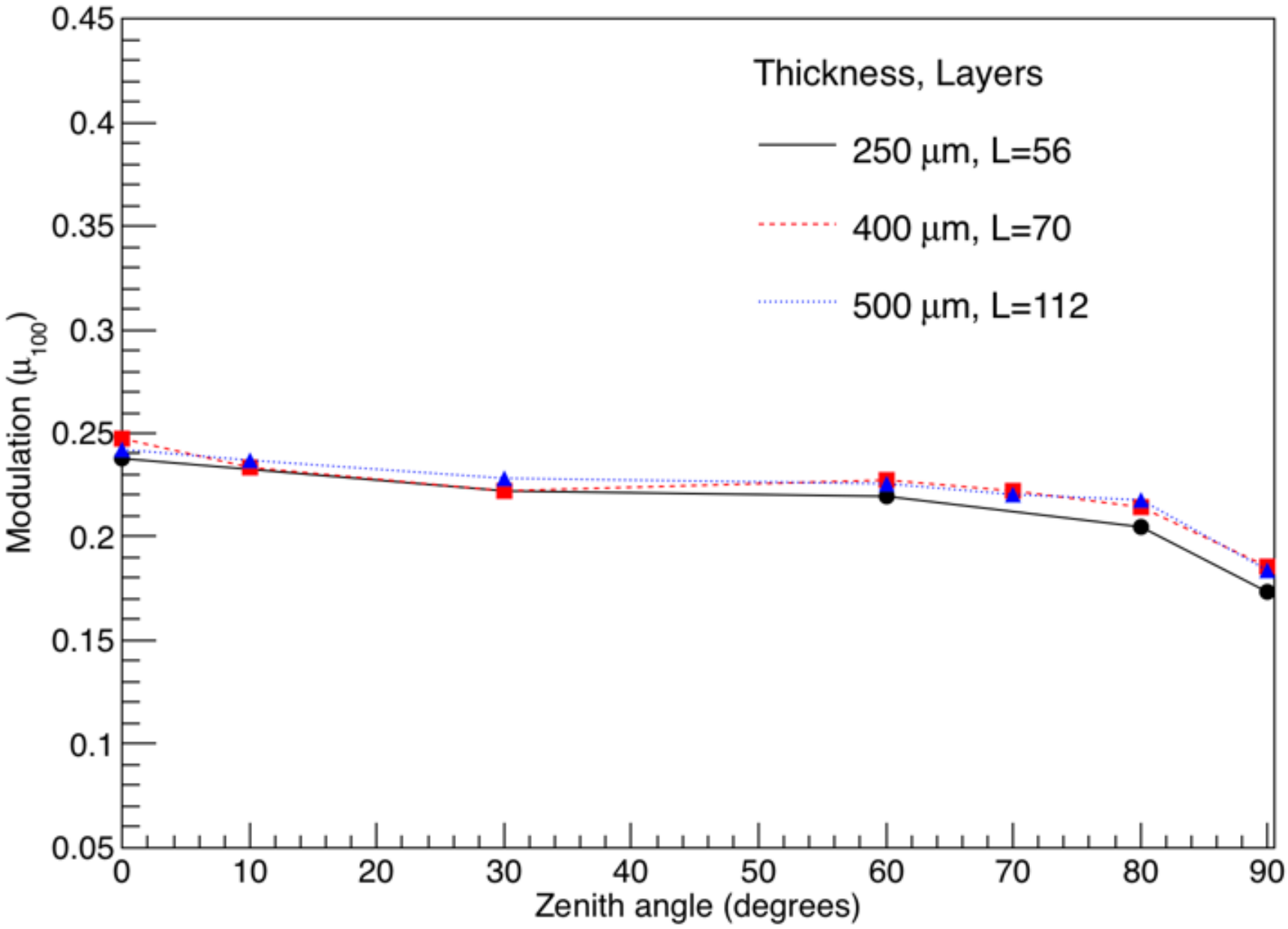

ARM Effective Area, Layers=56, Theta=0^0
ARM Effective Area cm^2
Gamma-ray energy (MeV)
Thickness
250 μ m
400 μ m
500 μ m
with e^- tracking
without e^- tracking
0
100
200
300
400
500
600
0
1
2
3
4
5


ARM Effective Area, Theta=0^0
Thickness
500 μm, L=56
400 μm, L=70
250 μm, L=112
with e- tracking
without e- tracking
ARM Effective Area cm^2
Gamma-ray energy (MeV)
0
100
200
300
400
500
600
0
1
2
3
4
5

MIMREC Results:

Polarization response




Polarization response, Energy range (500,2000) keV
Thickness, Layers
250 μm, L=56
400 μm, L=70
500 μm, L=112
Modulation (μ100)
Zenith angle (degrees)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
10
20
30
40
50
60
70
80
90

Summary & Conclusion

- Using Geant4/MEGALib we have simulated the mass model for eASTROGAM telescope.

- The main objective is the optimization of the Si-tracker geometry parameters:
  - Thickness
  - Number of Layers
  - Distance between Layers

- We have studied in the compton regime:
  - The energy & angular resolution
  - The effective area
  - Polarization response

Summary & Conclusion

- The energy resolution is independent of the geometry parameters choices.

- For the angular resolution:
  - We have to apply rec. CUTs to obtain a good AR.
    - Without e^- tracking approx. $E_0 <\approx 1.5$ MeV
    - With e^- tracking approx. $E_0 >\approx 1.5$ MeV
  - Where E_0 depends on the thickness.
  - We have found better performance when we keep the radiation lenght constant ($0.3\ X_0$) almost independent of the geometry.

- We have found that the polarization responses does not depend on the geometry parameters

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  - Where E_0 depends on the thickness.
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    - Without e^- tracking approx. $E_0 <\approx 1.5$ MeV
    - With e^- tracking approx. $E_0 >\approx 1.5$ MeV
  - Where E_0 depends on the thickness.
  - We have found better performance when we keep the radiation lenght constant ($0.3\ X_0$) almost independent of the geometry.

- We have found that the polarization responses does not depend on the geometry parameters

TOBE DONE

- Repeat the analysis using the SensitivityOptimizer to obtain
  - The energy & angular resolution
  - The effective area
  - Background rate
  - Sensitivity
- Move to the Science simulations.
- Perform same analysis for the pair-production regime