Temperature corrections in AHCAL data analysis

(under construction)

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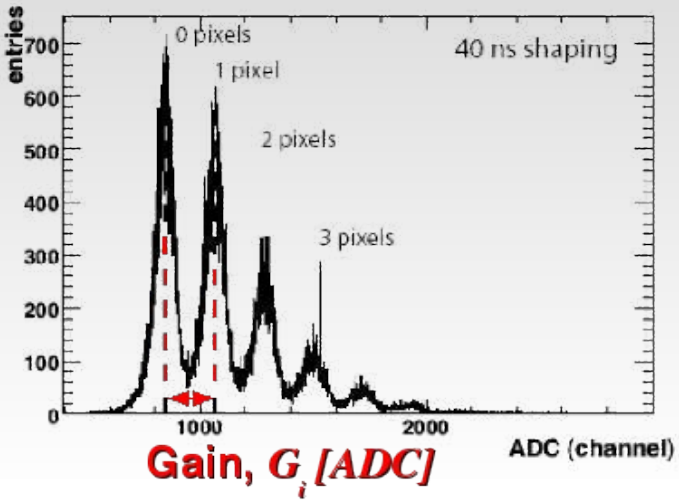
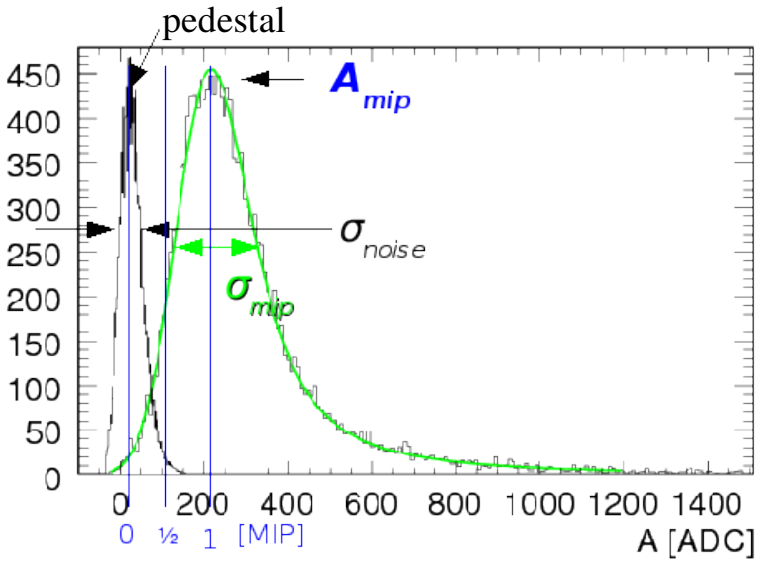
AHCAL Calibration

- 7608 tiles read out individually with SiPMs
- Calibration using μ^- as minimum ionizing particles
- Calibration Factors: A^{MIP} and G

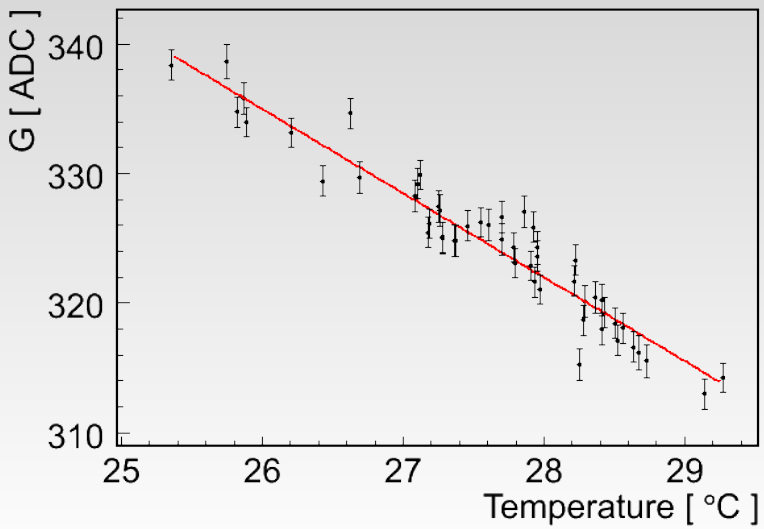


$$E[MIP] = \frac{A[\mathrm{ADC}]}{A^{\mathrm{MIP}}[\mathrm{ADC}]} \cdot f\left(A[\mathrm{pix}]\right)$$

$$A[\mathrm{pix}] = \frac{A[ADC]}{G[\mathrm{ADC}]}$$

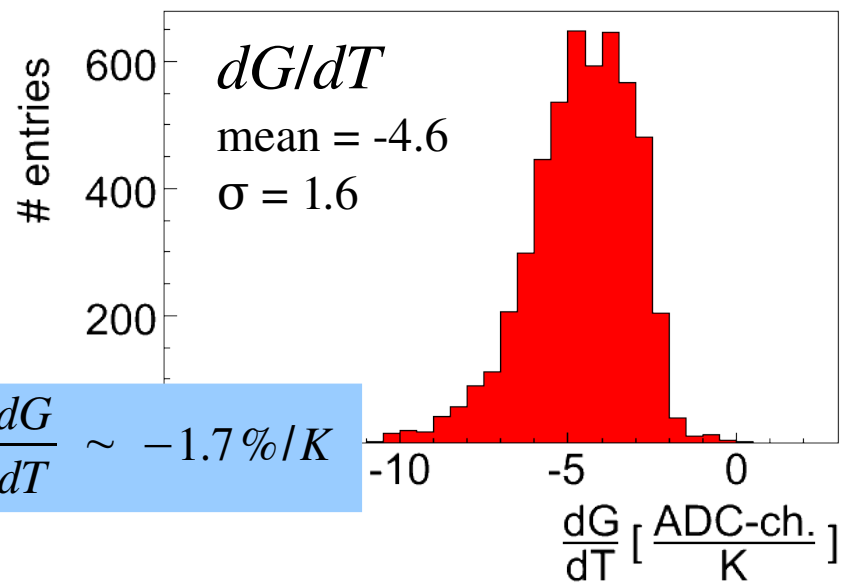


Temperature dependencies

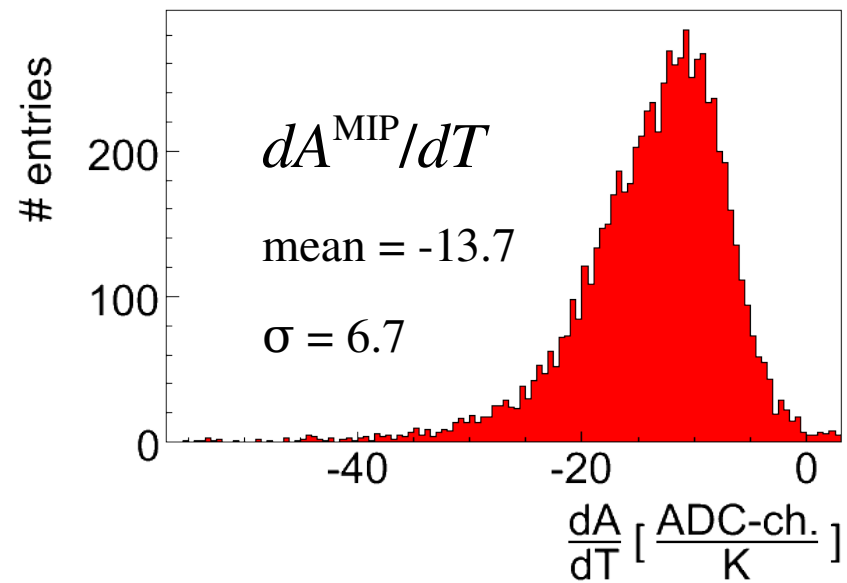


- Linear fits to determine slopes
- Big spread of slopes → is taking the average sufficient enough?

$$\frac{1}{A^{\mathrm{MIP}}}\frac{dA^{\mathrm{MIP}}}{dT} \sim -3.7\,\%/\mathrm{K}$$

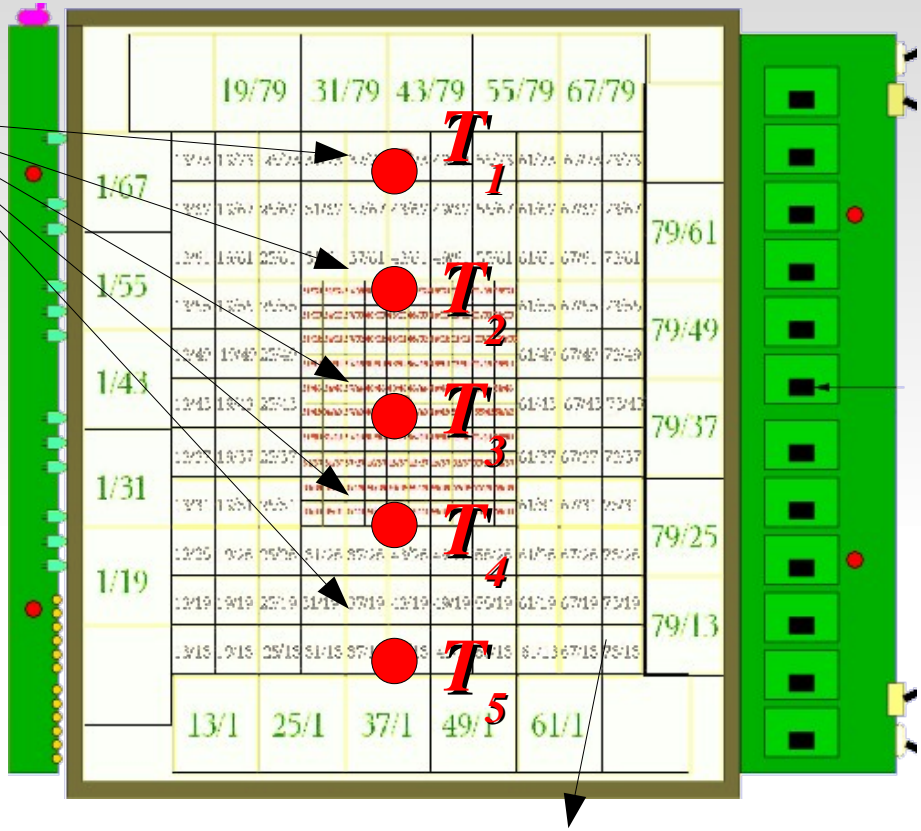


$$\frac{1}{G}\frac{dG}{dT} \sim -1.7\,\%/K$$



Temperature Measurement

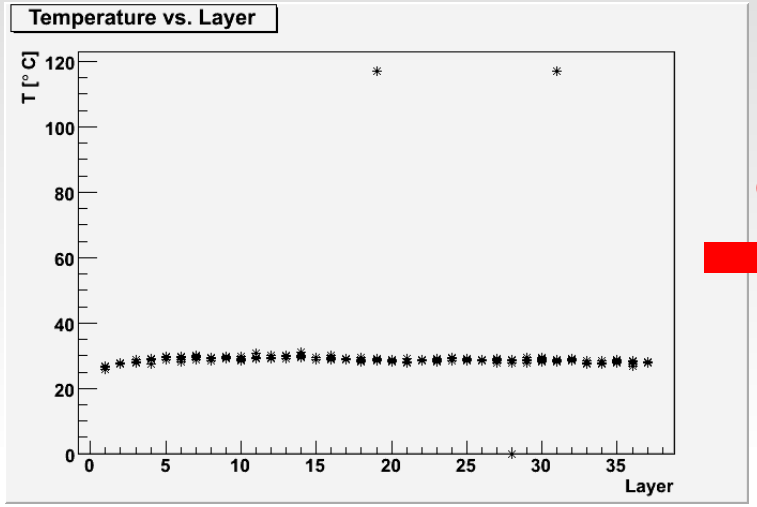
- Five sensors per module
- Calibration of sensors needs to be applied
- Faulty mapping and dead sensors need correction
- Temperature in single cells needs to be determined



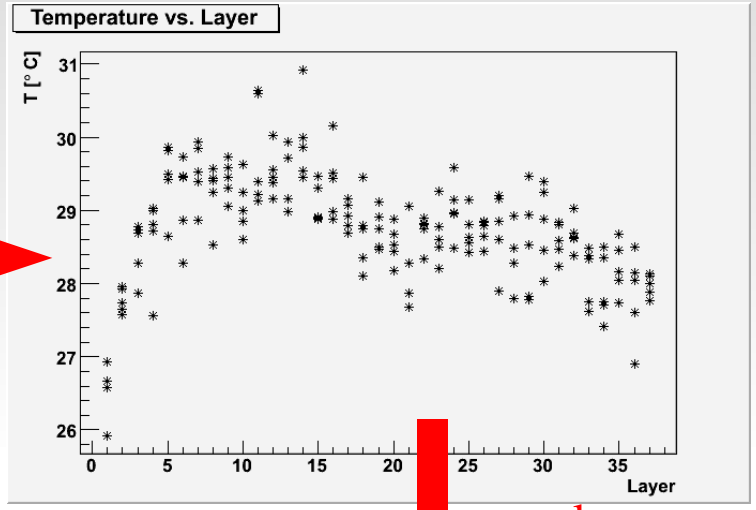
T(module,cell) = ?

➔ First simple implementation developed to get automatically corrected cell temperatures from Conditions DB in Marlin

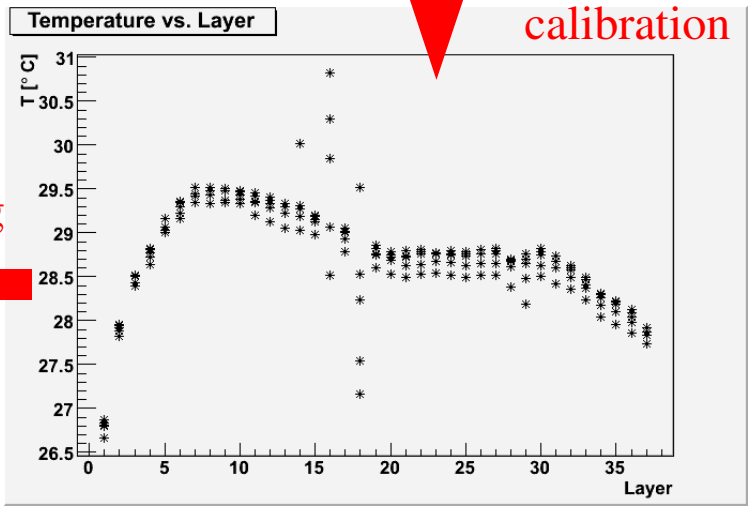
Temperature Profiles read from the CDDB in Marlin



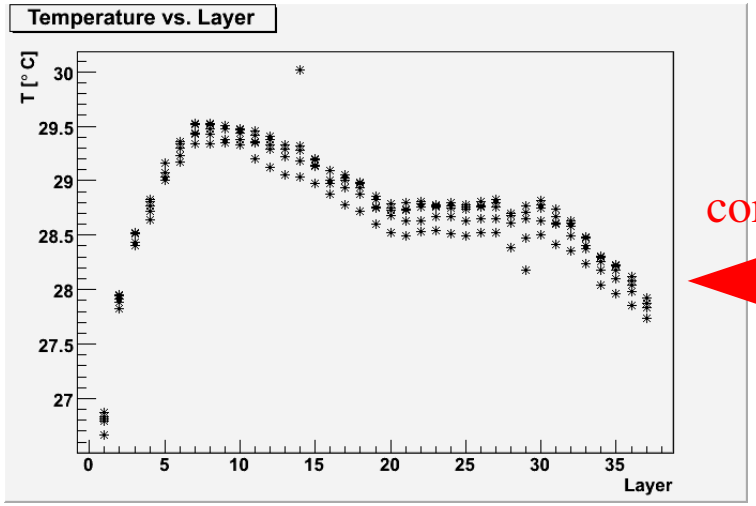
correct for dead sensors



apply sensor calibration



correct mapping



Temperature Correction

- For now:

$$M(T, cell) = M_0(cell) \cdot \left(1 - 3.7\% \cdot \Delta T\right)$$

$$G(T, cell) = G_0(cell) \cdot \left(1 - 1.7\% \cdot \Delta T^{avg}\right)$$

- Modification of the IntegratedHcalCalibrationProcessor. Now using the automatic temperature readout from CDDB.
- where *dM/dT* = -3.7%/K and *dG/dT* = -1.7% /K are averaged over the whole AHCAL

Run Set 1

- Positron runs – AHCAL only taken at CERN 2007
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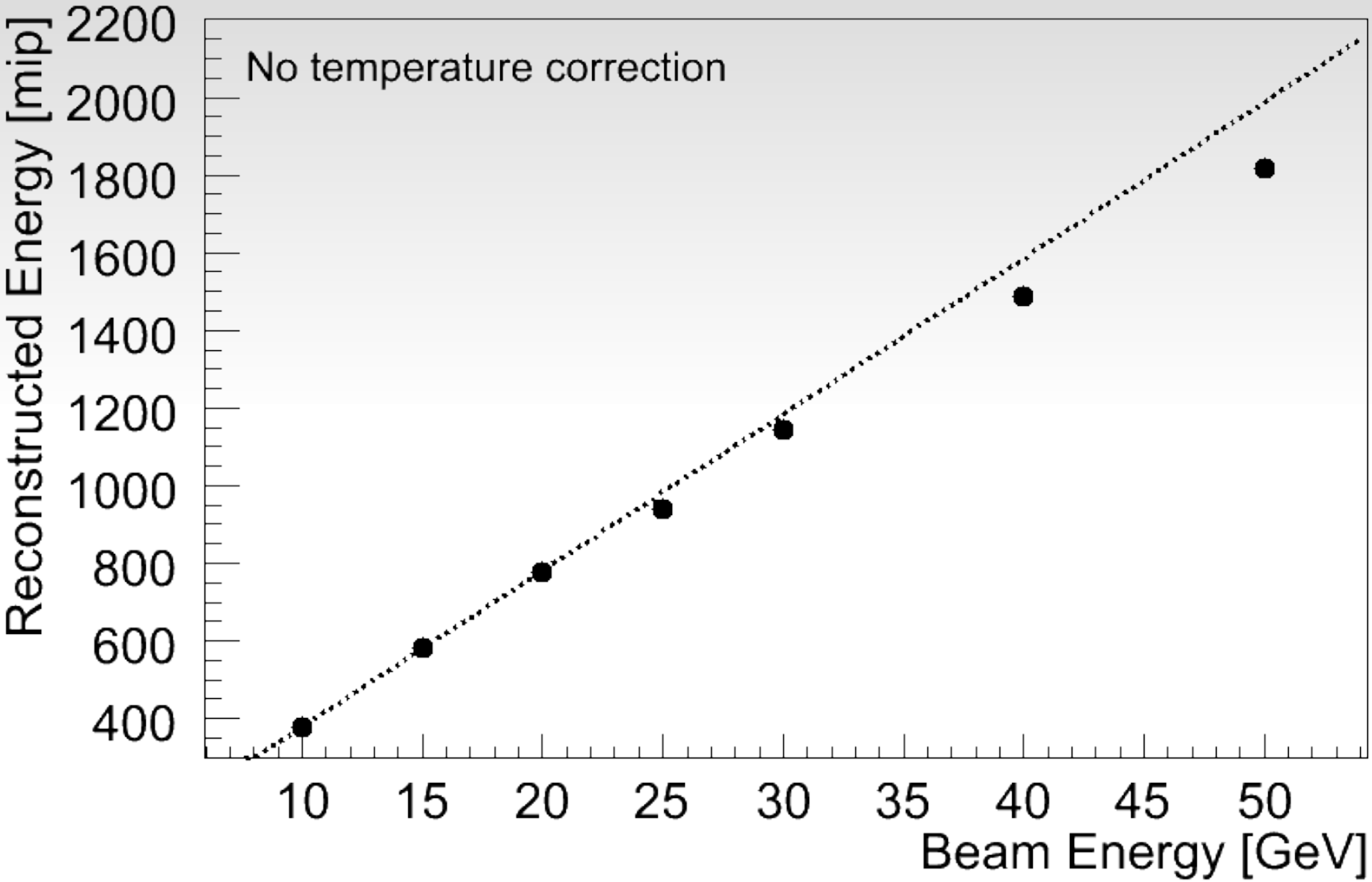
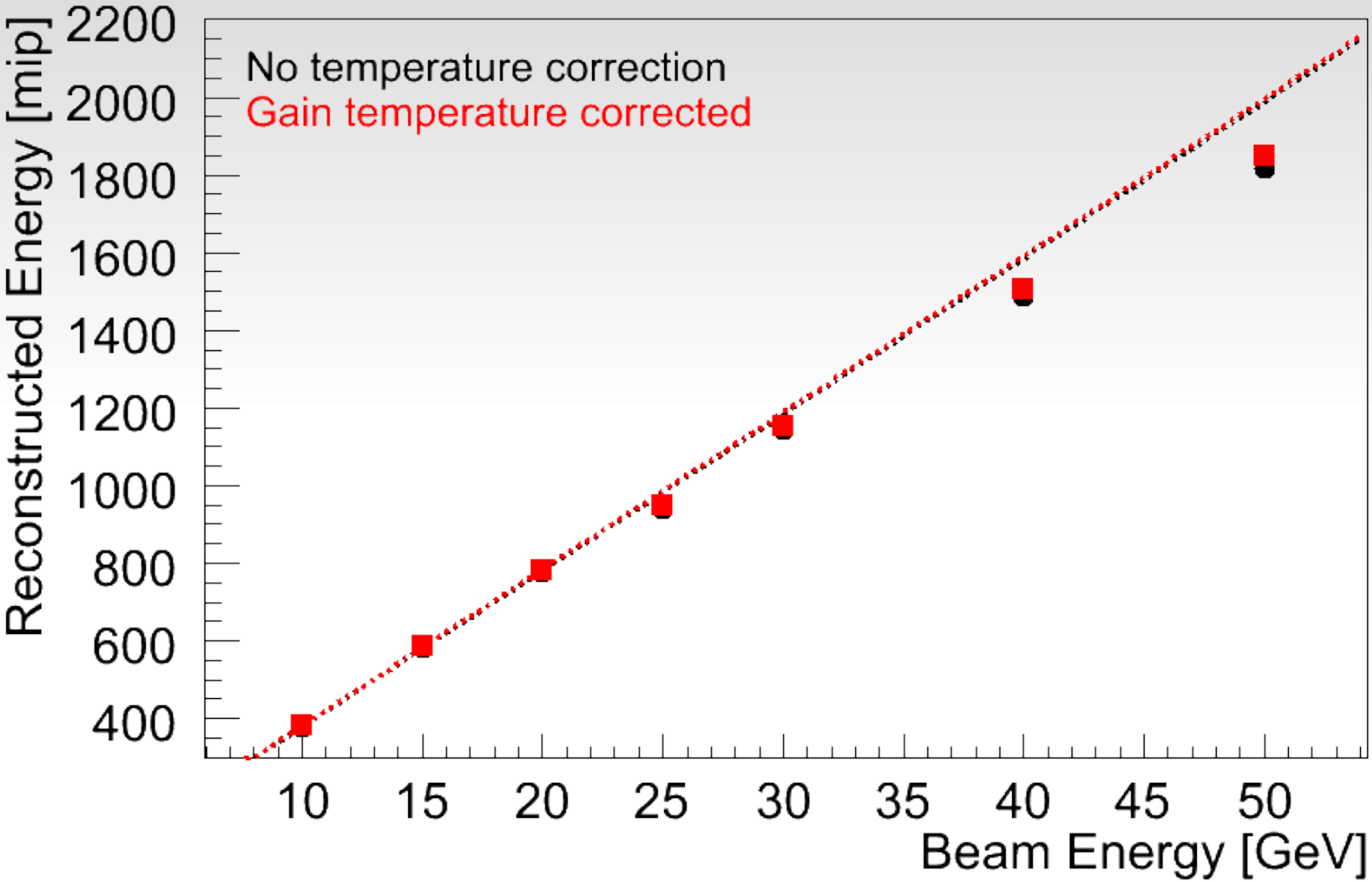
Run #	Beam [GeV]	T [°C]	x [cm]	y [cm]	Rot [°]
350128	50	28,5	-8,8	6,2	0
350129	40	28,4	-8,8	6,2	0
350132	30	28,2	-8,8	6,2	0
350133	25	28,8	-8,8	6,2	0
350137	20	27,8	-8,8	6,2	0
350134	15	28,0	-8,8	6,2	0
350118	10	28,7	-8,8	6,2	0

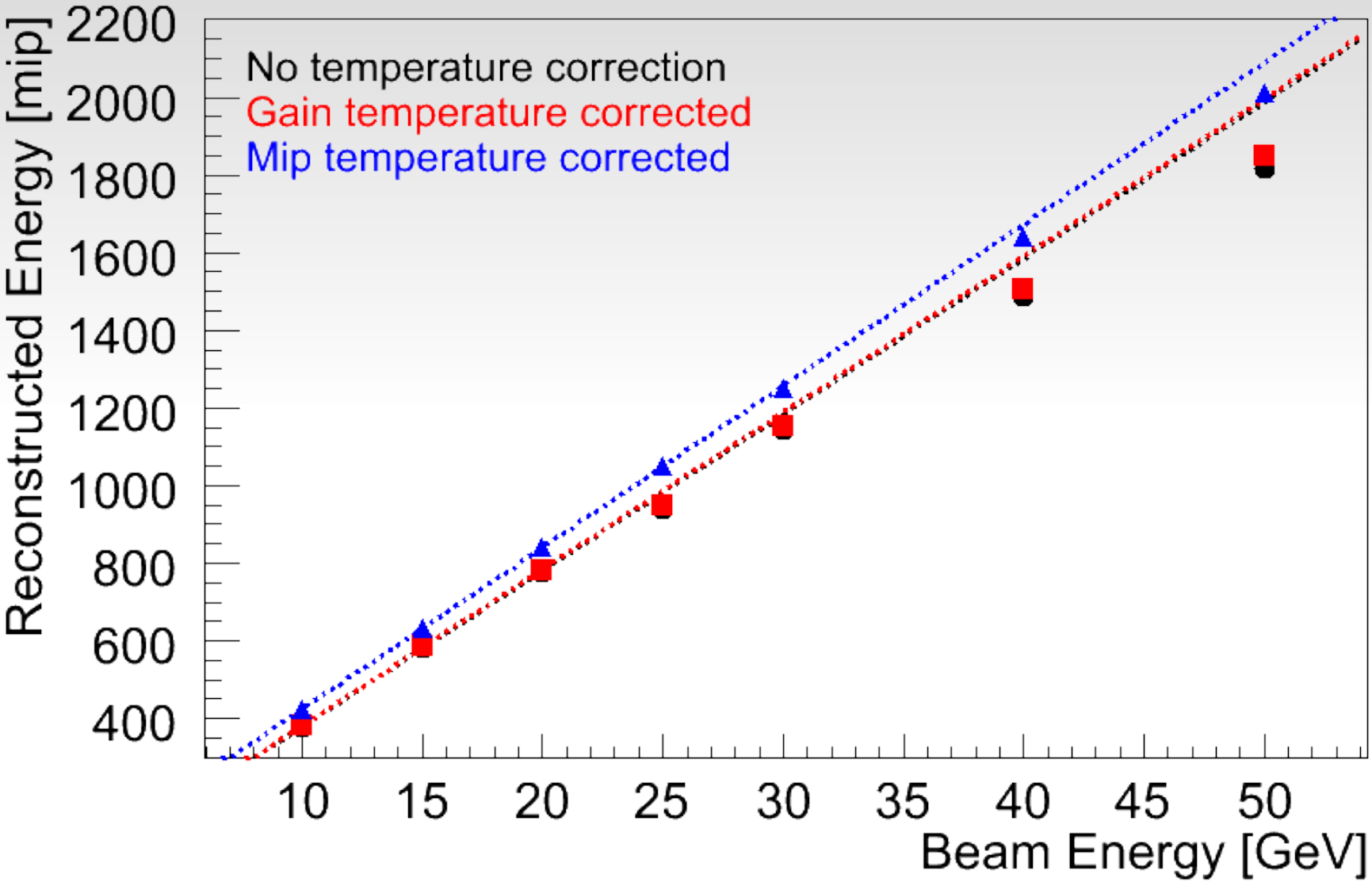
Linearity


No temperature correction
Reconstructed Energy [mip]
2200
2000
1800
1600
1400
1200
1000
800
600
400
10
15
20
25
30
35
40
45
50
Beam Energy [GeV]

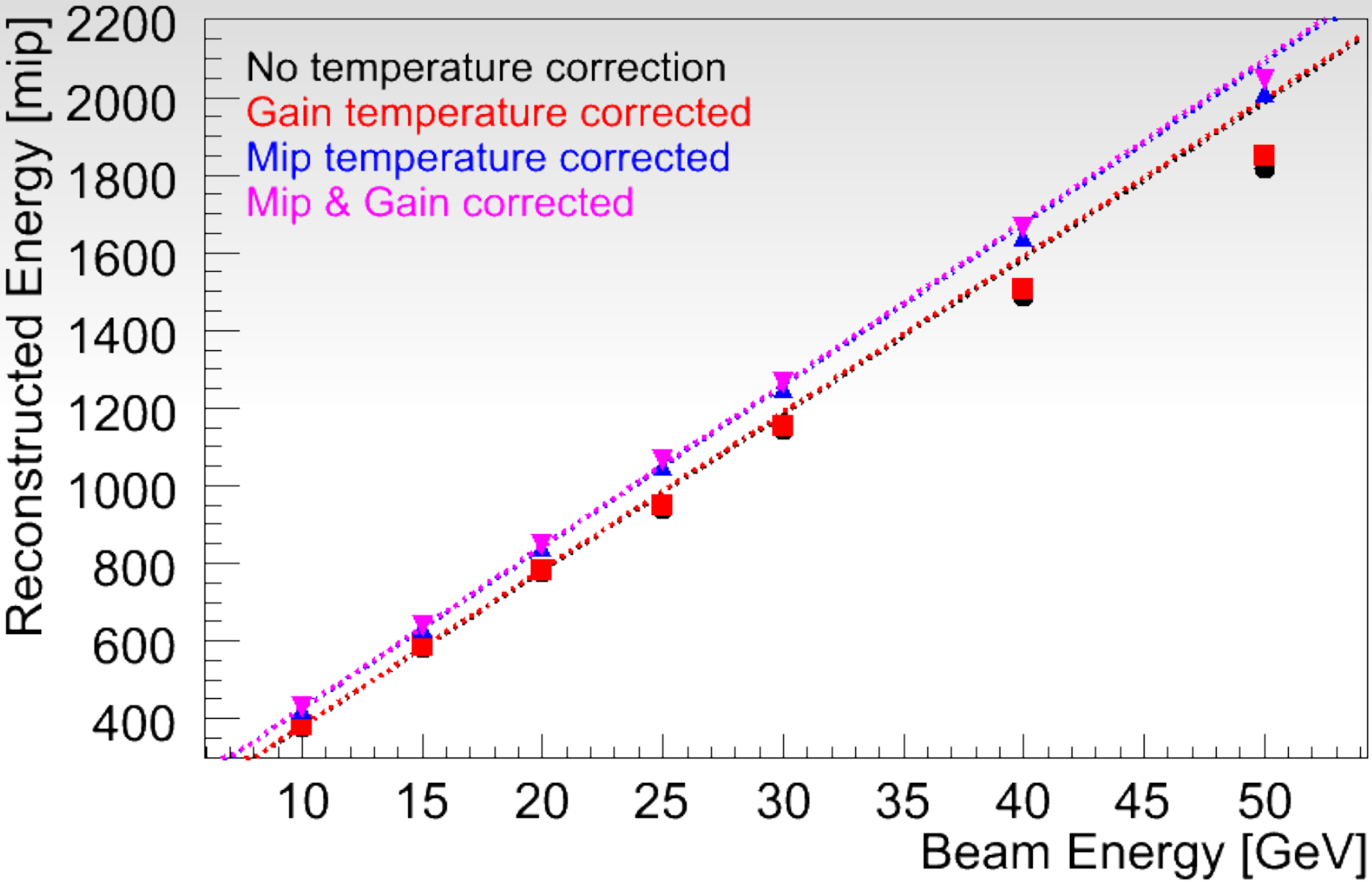
Linearity


No temperature correction
Gain temperature corrected
Reconstructed Energy [mip]
2200
2000
1800
1600
1400
1200
1000
800
600
400
10
15
20
25
30
35
40
45
50
Beam Energy [GeV]

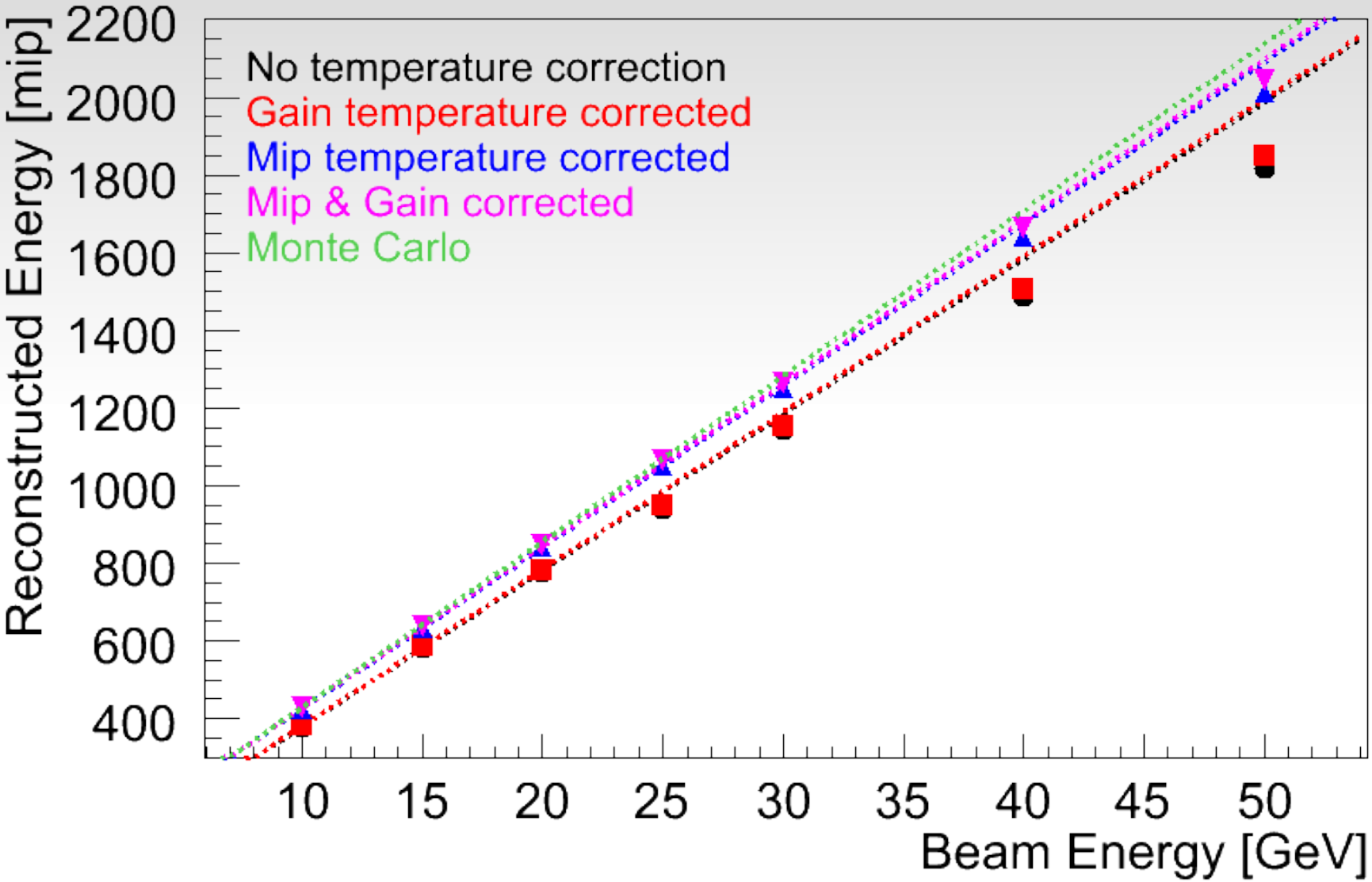
Linearity


No temperature correction
Gain temperature corrected
Mip temperature corrected
Reconstructed Energy [mip]
2200
2000
1800
1600
1400
1200
1000
800
600
400
10
15
20
25
30
35
40
45
50
Beam Energy [GeV]

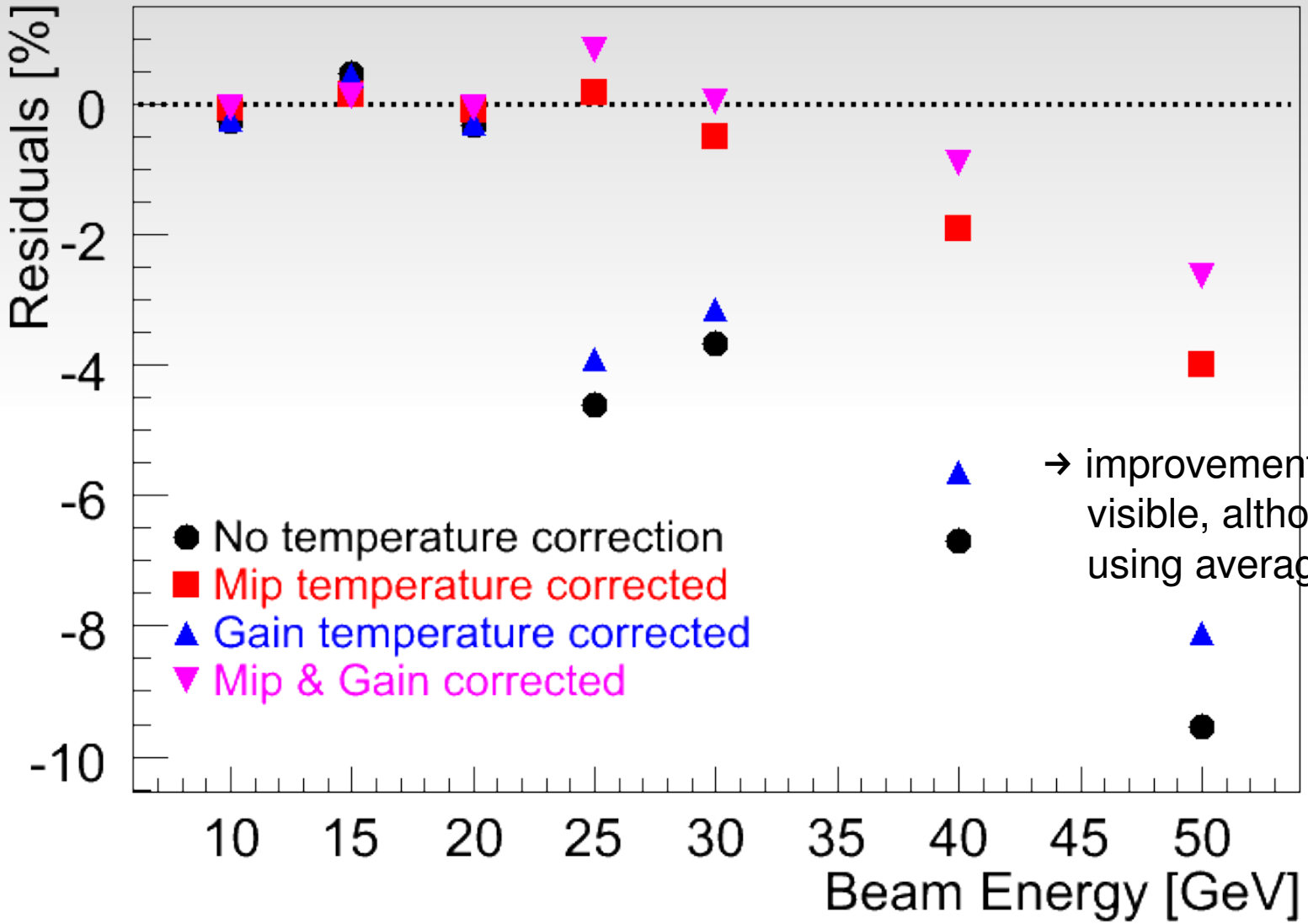
Linearity


No temperature correction
Gain temperature corrected
Mip temperature corrected
Mip & Gain corrected
Reconstructed Energy [mip]
2200
2000
1800
1600
1400
1200
1000
800
600
400
10
15
20
25
30
35
40
45
50
Beam Energy [GeV]

Linearity


No temperature correction
Gain temperature corrected
Mip temperature corrected
Mip & Gain corrected
Monte Carlo
Reconstructed Energy [mip]
2200
2000
1800
1600
1400
1200
1000
800
600
400
10
15
20
25
30
35
40
45
50
Beam Energy [GeV]

Residuals



→ improvement of linearity visible, although only using average slopes

Run Set 2

- Positron runs – AHCAL only taken at CERN 2007
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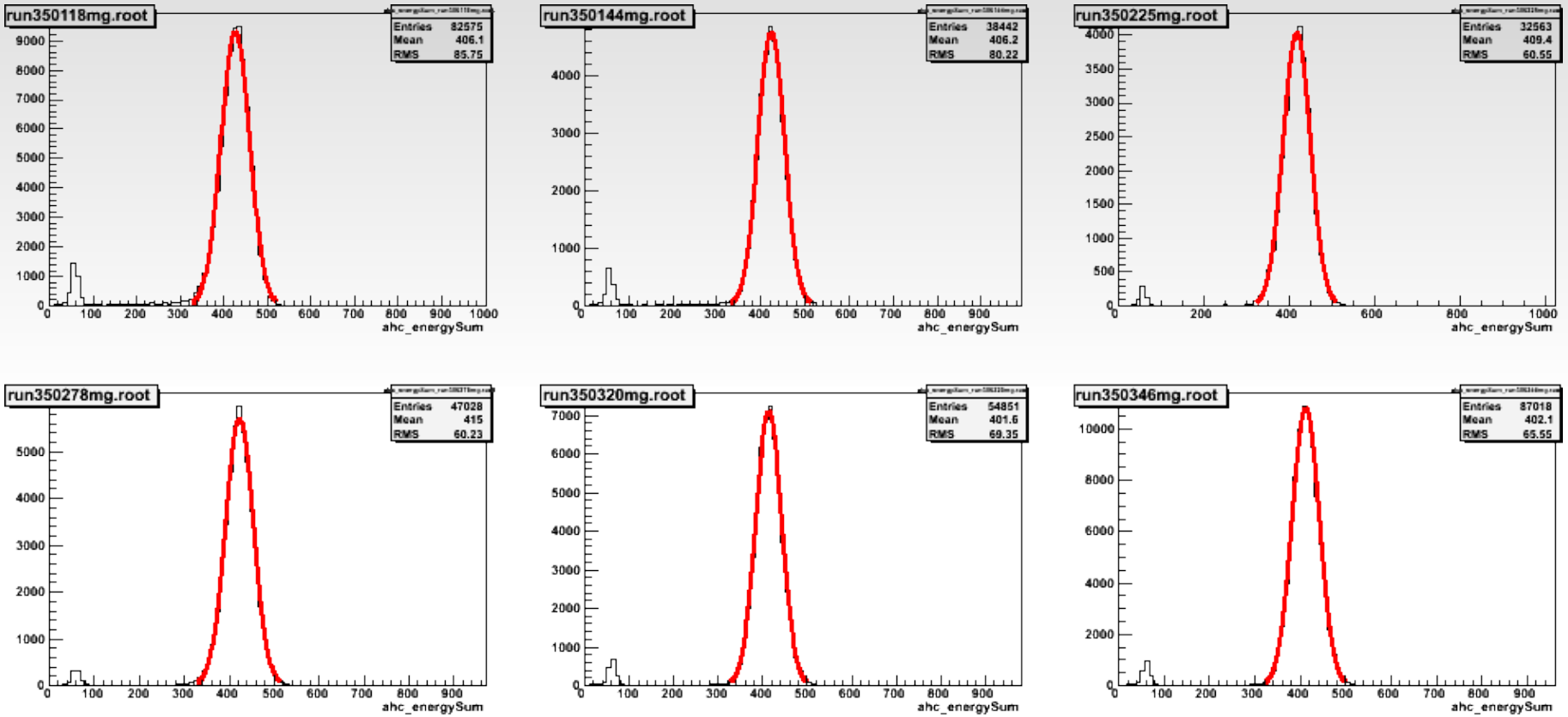
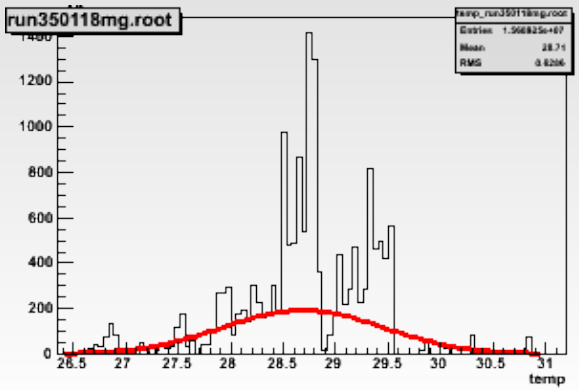
Run #	Beam [GeV]	T [°C]	x [cm]	y [cm]	Rot [°]
350118	10	28,7	-8,8	6,2	0
350144	10	27,8	0	0	0
350225	10	26,5	39	47	10
350278	10	26,8	-6	0	20
350320	10	26,3	0	0	30
350246	10	25,7	-6	0	30

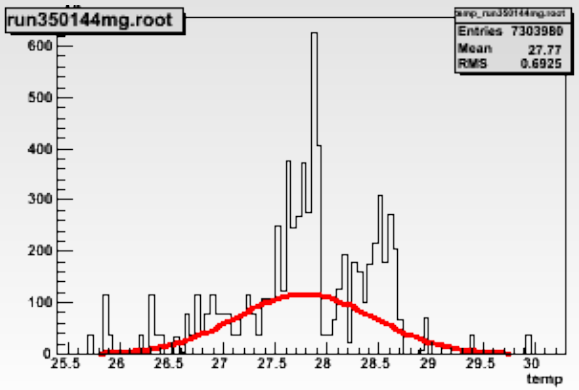
Energy Fits Set 2

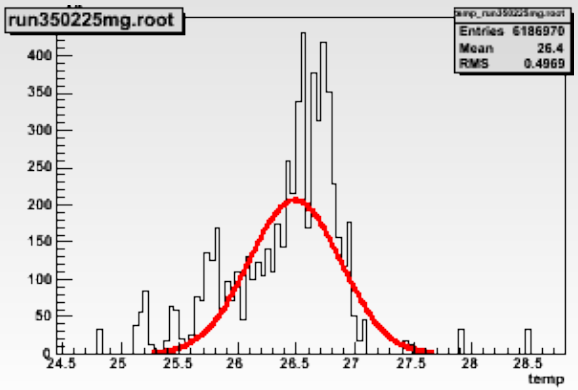


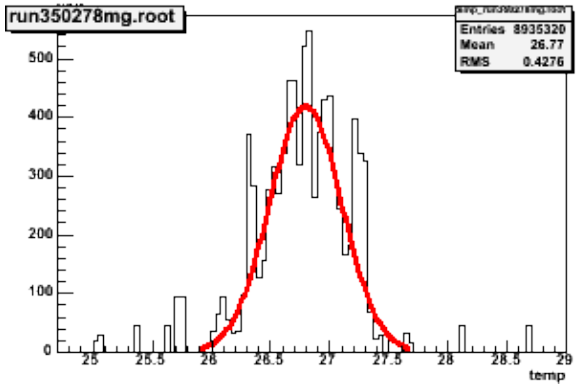
Gaussian fit to energy sum in whole AHCAL

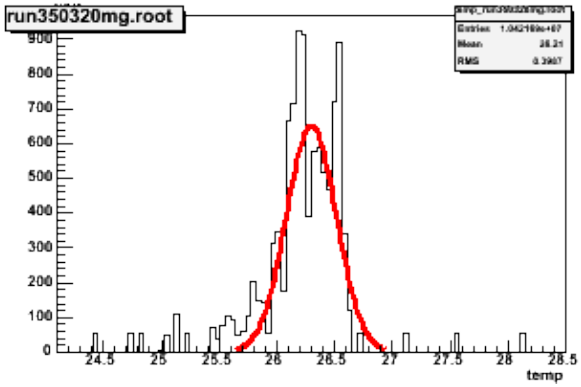
Temperatures in Set 2

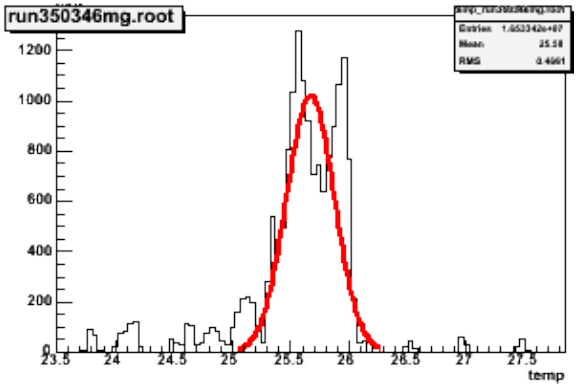




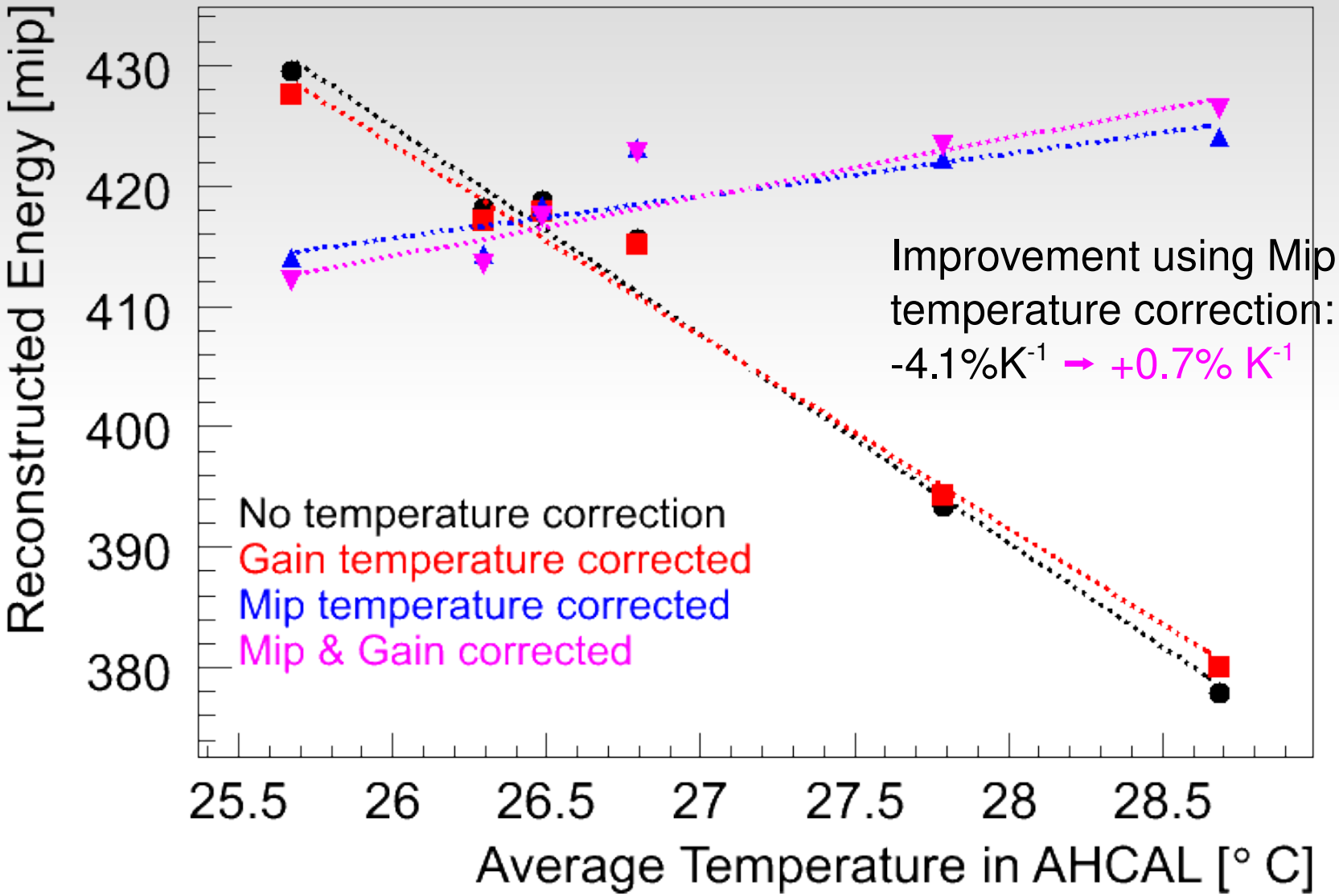




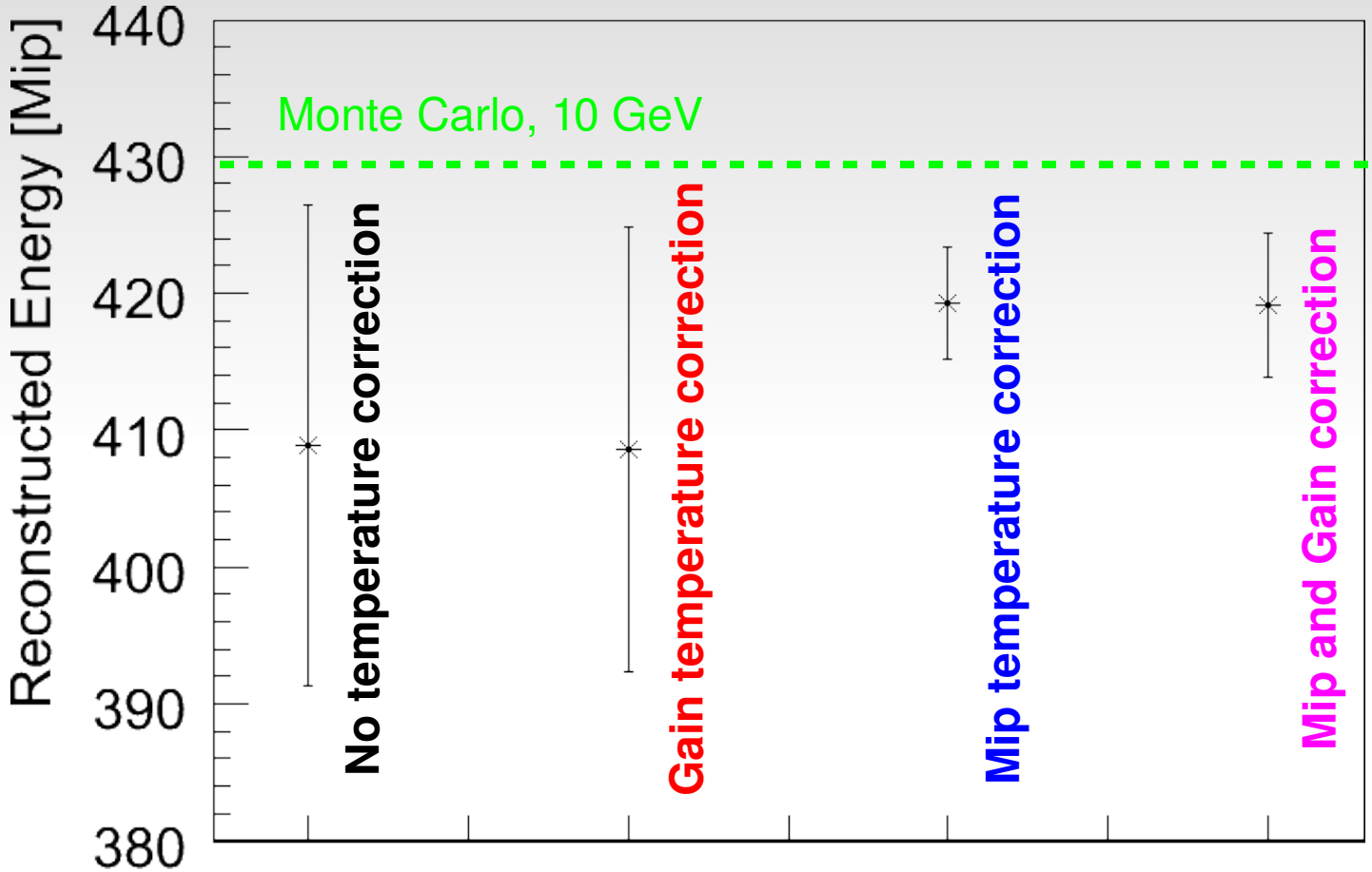




Energy vs Temperature



Energy vs Temperature(2)



Summary / Outlook

- First implementation of temperature correction available in Marlin (thanks to B.Lutz, S.Richter and N.Meyer for their support)
- Temperature correction goes into right direction but needs to further development
- Todo:
  - Use slopes determined for single cells instead of average.
  - Use cell-weighted temperature average in Energy vs. Temperature study (run set 2)
- Further integrate automatic temperature correction into Marlin