

I. BACKGROUND

A. News

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B. Parameterization

PDF for azimuth-uniform ring intensity Gaussian-distribution

$$\mathcal{P}(x, y | x_c, y_c, r_0, \sigma, A) = \frac{A}{\sqrt{2\pi}\sigma} e^{-\frac{(r-r_0)^2}{2\sigma^2}} \quad (1)$$

where $r = \sqrt{(x - x_c)^2 + (y - y_c)^2}$, (x_c, y_c) are the ring center coordinates, r_0 , σ , and A are the ring radial, Gaussian width, and amplitude parameters, respectively.

C. Results

See plots in Figs. 1 - ...

TABLE I: Fit results.

| ASIC | Ring | x_c | y_c | r_0 | σ | A |
|------|------|----------------|--------------|--------------|---------------|--------------|
| # | # | (in pixels) | | | | (arb. units) |
| 8 | 1 | 217.06±0.02 | 292.49±0.06 | 180.87±0.05 | 1.9748±0.0004 | 1482.2±0.3 |
| 8 | 2 | 215.07±0.07 | 293.72±0.13 | 214.77±0.15 | 1.8426±0.0024 | 409.2±0.2 |
| 12* | 1 | 22.178±0.004 | 297.3±0.0005 | 180.87-fixed | 2.3321±0.0003 | 2030.0±0.3 |
| 12 | 2 | 33.500±0.006 | 286.50±0.02 | 202.94±0.02 | 1.7032±0.0006 | 808.1±0.2 |
| 10 | 4 | 387.34±0.03 | 289.65±0.05 | 362-fixed | 4.69±0.01 | 204.4±0.3 |
| 10 | 3 | 389.7±0.9 | 290.2±0.6 | 294.5±0.6 | 3.266±0.008 | 210.3±0.4 |
| 13* | 3 | -157.60±0.03 | 268.01±0.02 | 295-fixed | 2.538±0.003 | 299.2±0.3 |
| 13* | 4 | -125.276±0.002 | 303.2±0.004 | 362-fixed | 1.3704±0.0003 | 1305.7±0.2 |
| 9* | 4 | 208.4±0.8 | 462.1±1.9 | 361.3±2.0 | 4.84±0.02 | 114.6±0.4 |
| 14* | 4 | 40.87±0.08 | 487.94±0.02 | 362-fixed | 2.355±0.009 | 136.3±0.3 |

TABLE II: Fit results.

| ASIC | Ring | x_c | y_c | r_0 | σ | A |
|------|------|--------------|--------------|---------------|---------------|--------------|
| # | # | (in pixels) | | | | (arb. units) |
| 8 | 1 | 218.27±0.02 | 297.22±0.03 | 185.73±0.03 | 1.9690±0.0004 | 1473.7±0.3 |
| | 2 | | | 219.30±0.03 | 1.880±0.001 | 411.8±0.2 |
| 12 | 1 | 27.355±0.002 | 302.7±0.0004 | 185.89±0.0004 | 2.3144±0.0003 | 1958.8±0.3 |
| | 2 | | | 218.97±0.0001 | 1.9044±0.0006 | 838.7±0.2 |

ASIC10, Ring 3 and 4:

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FCN=4.43953e+06 FROM MIGRAD      STATUS=CONVERGED      243 CALLS      244 TOTAL
                                EDM=9.93737e-08    STRATEGY= 1    ERROR MATRIX UNCERTAINTY    3.1 per cent

EXT PARAMETER                                STEP      FIRST
NO.   NAME      VALUE      ERROR      SIZE      DERIVATIVE
1   xC          4.22050e+02   2.89542e-02  -0.00000e+00   4.25496e-02
2   yC          3.10835e+02   3.98195e-02  -0.00000e+00   3.80802e-02

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| | | | | | |
|---|----|-------------|-------------|--------------|--------------|
| 3 | R1 | 3.32503e+02 | 6.26606e-03 | 0.00000e+00 | -7.35965e-02 |
| 4 | S1 | 3.28016e+00 | 7.04429e-03 | -0.00000e+00 | 3.52465e-02 |
| 5 | A1 | 2.09988e+02 | 3.59129e-01 | -0.00000e+00 | -1.11076e-04 |
| 6 | R2 | 4.02190e+02 | 9.65642e-03 | -0.00000e+00 | 1.46037e-02 |
| 7 | S2 | 4.66203e+00 | 7.24215e-03 | 0.00000e+00 | -6.51065e-02 |
| 8 | A2 | 2.05711e+02 | 2.62424e-01 | 0.00000e+00 | 8.45034e-04 |

ASIC12, Ring 1 and 2:

FCN=1.08582e+09 FROM MIGRAD STATUS=CONVERGED 237 CALLS 238 TOTAL
EDM=0.00336739 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.1 per cent

| EXT PARAMETER | | | | STEP | FIRST |
|---------------|------|-------------|-------------|--------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | 2.73553e+01 | 1.59297e-03 | -0.00000e+00 | -7.46443e+00 |
| 2 | yC | 3.02708e+02 | 4.01465e-04 | 0.00000e+00 | -1.06861e+01 |
| 3 | R1 | 1.85890e+02 | 3.69758e-04 | 0.00000e+00 | -2.25637e+01 |
| 4 | S1 | 2.31441e+00 | 3.44217e-04 | -0.00000e+00 | 4.32447e+01 |
| 5 | A1 | 1.95881e+03 | 2.50797e-01 | 0.00000e+00 | -8.15379e-02 |
| 6 | R2 | 2.18971e+02 | 7.37031e-04 | -0.00000e+00 | 3.30686e+01 |
| 7 | S2 | 1.90446e+00 | 6.07201e-04 | 0.00000e+00 | -2.07350e+02 |
| 8 | A2 | 8.38708e+02 | 2.19133e-01 | 0.00000e+00 | 1.25933e-01 |

ASIC08, Ring 1 and 2:

FCN=9.75261e+08 FROM MIGRAD STATUS=FAILED 288 CALLS 289 TOTAL
EDM=0.00251894 STRATEGY= 1 ERR MATRIX APPROXIMATE

| EXT PARAMETER | | | APPROXIMATE | STEP | FIRST |
|---------------|------|-------------|-------------|-------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | 2.18257e+02 | 1.30388e-02 | 1.96701e-02 | -2.01050e+01 |
| 2 | yC | 2.97219e+02 | 2.34903e-02 | 6.14686e-03 | -2.19610e+01 |
| 3 | R1 | 1.85729e+02 | 2.57332e-02 | 6.21603e-03 | 3.24918e+01 |
| 4 | S1 | 1.96902e+00 | 4.10235e-04 | 5.05606e-03 | 4.66119e+01 |

| | | | | | |
|---|----|-------------|-------------|-------------|--------------|
| 5 | A1 | 1.47372e+03 | 2.64728e-01 | 3.28971e+00 | -2.10934e-02 |
| 6 | R2 | 2.19301e+02 | 2.60101e-02 | 1.77603e-02 | -2.20921e+00 |
| 7 | S2 | 1.87957e+00 | 1.30519e-03 | 1.52574e-02 | 5.17526e+00 |
| 8 | A2 | 4.11752e+02 | 2.27865e-01 | 2.75113e+00 | 1.50116e-01 |

ASIC14, Ring 4:

FCN=8.24951e+06 FROM MIGRAD STATUS=CONVERGED 176 CALLS 177 TOTAL
 EDM=4.5112e-06 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.7 per cent

| EXT PARAMETER | | | | STEP | FIRST |
|---------------|------|-------------|-------------|--------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | 4.08652e+01 | 8.17988e-02 | -0.00000e+00 | 1.37097e-01 |
| 2 | yC | 4.87945e+02 | 1.72022e-02 | 0.00000e+00 | -7.06540e-01 |
| 3 | R1 | 3.62000e+02 | fixed | | |
| 4 | S1 | 2.35541e+00 | 8.85786e-03 | 0.00000e+00 | -3.81678e-01 |
| 5 | A1 | 1.36262e+02 | 3.27535e-01 | 0.00000e+00 | 5.67332e-03 |

ASIC09, Ring 4:

FCN=953860 FROM MIGRAD STATUS=CONVERGED 357 CALLS 358 TOTAL
 EDM=6.69294e-08 STRATEGY= 1 ERROR MATRIX ACCURATE

| EXT PARAMETER | | | | STEP | FIRST |
|---------------|------|-------------|-------------|-------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | 2.08408e+02 | 8.37666e-01 | 1.83637e-02 | 7.18019e-04 |
| 2 | yC | 4.62056e+02 | 1.88523e+00 | 9.39305e-03 | 6.56405e-04 |
| 3 | R1 | 3.61312e+02 | 2.04303e+00 | 8.36258e-03 | -1.03694e-03 |
| 4 | S1 | 4.83687e+00 | 2.44834e-02 | 7.97924e-03 | 1.58680e-02 |
| 5 | A1 | 1.14610e+02 | 4.04266e-01 | 1.40118e-01 | -1.44763e-04 |

ASIC13, Ring 4:

FCN=8.30882e+08 FROM MIGRAD STATUS=CONVERGED 173 CALLS 174 TOTAL
 EDM=0.000141807 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.3 per cent

| EXT PARAMETER | | | | STEP | FIRST |
|---------------|------|--------------|-------------|--------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | -1.25276e+02 | 2.41757e-03 | -0.00000e+00 | -3.13499e+01 |
| 2 | yC | 3.03183e+02 | 4.12757e-03 | -0.00000e+00 | 2.36029e+01 |
| 3 | R1 | 3.62000e+02 | fixed | | |
| 4 | S1 | 1.37038e+00 | 3.01320e-04 | 0.00000e+00 | 2.88353e+01 |
| 5 | A1 | 1.30570e+03 | 2.19886e-01 | 0.00000e+00 | -2.25400e-02 |

ASIC13, Ring 3:

FCN=8.92594e+08 FROM MIGRAD STATUS=FAILED 122 CALLS 123 TOTAL

EDM=3.66943e-05 STRATEGY= 1 ERR MATRIX APPROXIMATE

| EXT PARAMETER | | | | STEP | FIRST |
|---------------|------|--------------|-------------|-------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | -1.57599e+02 | 2.70262e-02 | 5.33246e-02 | -5.50753e-01 |
| 2 | yC | 2.68014e+02 | 2.46505e-02 | 4.87876e-02 | 2.69602e-01 |
| 3 | R1 | 2.95000e+02 | fixed | | |
| 4 | S1 | 2.53883e+00 | 3.45924e-03 | 3.42257e-02 | 2.70884e+00 |
| 5 | A1 | 2.99183e+02 | 2.82799e-01 | 2.99936e+00 | -2.02889e-02 |

FCN=8.92586e+08 FROM MIGRAD STATUS=FAILED 376 CALLS 377 TOTAL

EDM=0.00516117 STRATEGY= 1 ERR MATRIX APPROXIMATE

| EXT PARAMETER | | | | STEP | FIRST |
|---------------|------|--------------|-------------|-------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | -1.32330e+02 | 6.65053e-02 | 5.26286e-02 | 1.31945e+00 |
| 2 | yC | 2.42591e+02 | 8.94083e-02 | 4.74636e-02 | -5.96441e-01 |
| 3 | R1 | 2.59306e+02 | 1.06293e-01 | 3.52470e-02 | 7.85665e-01 |
| 4 | S1 | 2.49056e+00 | 4.52459e-03 | 3.40370e-02 | 2.96034e+01 |
| 5 | A1 | 2.98678e+02 | 3.06108e-01 | 2.98899e+00 | -7.49691e-02 |

ASIC10, Ring 3:

FCN=5.04391e+06 FROM MIGRAD STATUS=CONVERGED 360 CALLS 361 TOTAL
 EDM=1.53667e-07 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 3.4 per cent

| EXT PARAMETER | | | | STEP | FIRST |
|---------------|------|-------------|-------------|-------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | 3.89698e+02 | 9.06815e-01 | 0.00000e+00 | -5.06861e-02 |
| 2 | yC | 2.90168e+02 | 6.19985e-01 | 0.00000e+00 | -3.94276e-02 |
| 3 | R1 | 2.94496e+02 | 1.08713e+00 | 0.00000e+00 | 6.43456e-02 |
| 4 | S1 | 3.26597e+00 | 7.51508e-03 | 0.00000e+00 | -8.38522e-02 |
| 5 | A1 | 2.10314e+02 | 3.77867e-01 | 0.00000e+00 | 6.50575e-04 |

ASIC10, Ring 4:

FCN=4.97743e+06 FROM MIGRAD STATUS=CONVERGED 109 CALLS 110 TOTAL
 EDM=6.00179e-07 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.3 per cent

| EXT PARAMETER | | | | STEP | FIRST |
|---------------|------|-------------|-------------|--------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | 3.87340e+02 | 2.84972e-02 | -0.00000e+00 | -7.17720e-03 |
| 2 | yC | 2.89653e+02 | 4.66303e-02 | 0.00000e+00 | -2.99956e-02 |
| 3 | R1 | 3.62000e+02 | fixed | | |
| 4 | S1 | 4.69200e+00 | 9.22837e-03 | 0.00000e+00 | -1.19144e-01 |
| 5 | A1 | 2.04392e+02 | 3.31685e-01 | -0.00000e+00 | 1.70498e-03 |

ASIC12, Ring 2:

FCN=1.1746e+09 FROM MIGRAD STATUS=FAILED 143 CALLS 144 TOTAL
 EDM=0.00418562 STRATEGY= 1 ERR MATRIX APPROXIMATE

| EXT PARAMETER | | APPROXIMATE | STEP | FIRST |
|---------------|--|-------------|------|-------|
|---------------|--|-------------|------|-------|

| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
|-----|------|-------------|-------------|-------------|-------------|
| 1 | xC | 3.34996e+01 | 5.67621e-03 | 1.95302e-02 | 3.02762e+01 |
| 2 | yC | 2.86502e+02 | 1.76382e-02 | 9.14296e-03 | 4.56278e+00 |
| 3 | R1 | 2.02936e+02 | 1.70964e-02 | 8.28049e-03 | 9.57217e+00 |
| 4 | S1 | 1.70324e+00 | 5.93118e-04 | 7.20505e-03 | 1.23014e+01 |
| 5 | A1 | 8.08055e+02 | 2.14618e-01 | 2.77795e+00 | 3.31784e-02 |

ASIC12, Ring 1:

FCN=1.10591e+09 FROM MIGRAD STATUS=CONVERGED 107 CALLS 108 TOTAL
EDM=0.000369084 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.0 per cent

| EXT PARAMETER | | STEP | | FIRST | |
|---------------|------|-------------|-------------|-------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | 2.21778e+01 | 4.28300e-03 | 0.00000e+00 | -7.72395e+00 |
| 2 | yC | 2.97282e+02 | 4.84869e-04 | 0.00000e+00 | 3.37752e+00 |
| 3 | R1 | 1.80869e+02 | fixed | | |
| 4 | S1 | 2.33211e+00 | 3.28789e-04 | 0.00000e+00 | -7.89049e+01 |
| 5 | A1 | 2.02996e+03 | 2.54308e-01 | 0.00000e+00 | 3.13274e-02 |

ASIC08, Ring 2:

FCN=1.02189e+09 FROM MIGRAD STATUS=FAILED 177 CALLS 178 TOTAL
EDM=0.00767127 STRATEGY= 1 ERR MATRIX APPROXIMATE

| EXT PARAMETER | | APPROXIMATE | | STEP | |
|---------------|------|-------------|-------------|-------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | 2.15069e+02 | 7.56839e-02 | 3.37797e-02 | -6.63222e+00 |
| 2 | yC | 2.93715e+02 | 1.29384e-01 | 2.08842e-02 | 3.93560e+00 |
| 3 | R1 | 2.14766e+02 | 1.46526e-01 | 1.77635e-02 | -1.19262e+00 |
| 4 | S1 | 1.84263e+00 | 2.37674e-03 | 1.53876e-02 | 1.11250e+02 |
| 5 | A1 | 4.09164e+02 | 2.31550e-01 | 2.78923e+00 | -3.08143e-01 |

ASIC08, Ring 1:

FCN=9.80429e+08 FROM MIGRAD STATUS=FAILED 211 CALLS 212 TOTAL

| EXT PARAMETER | | APPROXIMATE | | STEP | FIRST |
|---------------|------|-------------|-------------|-------------|--------------|
| NO. | NAME | VALUE | ERROR | SIZE | DERIVATIVE |
| 1 | xC | 2.17062e+02 | 2.29829e-02 | 2.49842e-02 | 4.60982e+00 |
| 2 | yC | 2.92493e+02 | 5.05631e-02 | 6.45295e-03 | -6.40226e+00 |
| 3 | R1 | 1.80869e+02 | 5.42983e-02 | 6.24791e-03 | 2.96525e+00 |
| 4 | S1 | 1.97476e+00 | 4.27708e-04 | 5.09003e-03 | 6.72184e+01 |
| 5 | A1 | 1.48218e+03 | 2.70417e-01 | 3.31591e+00 | -1.33251e-02 |

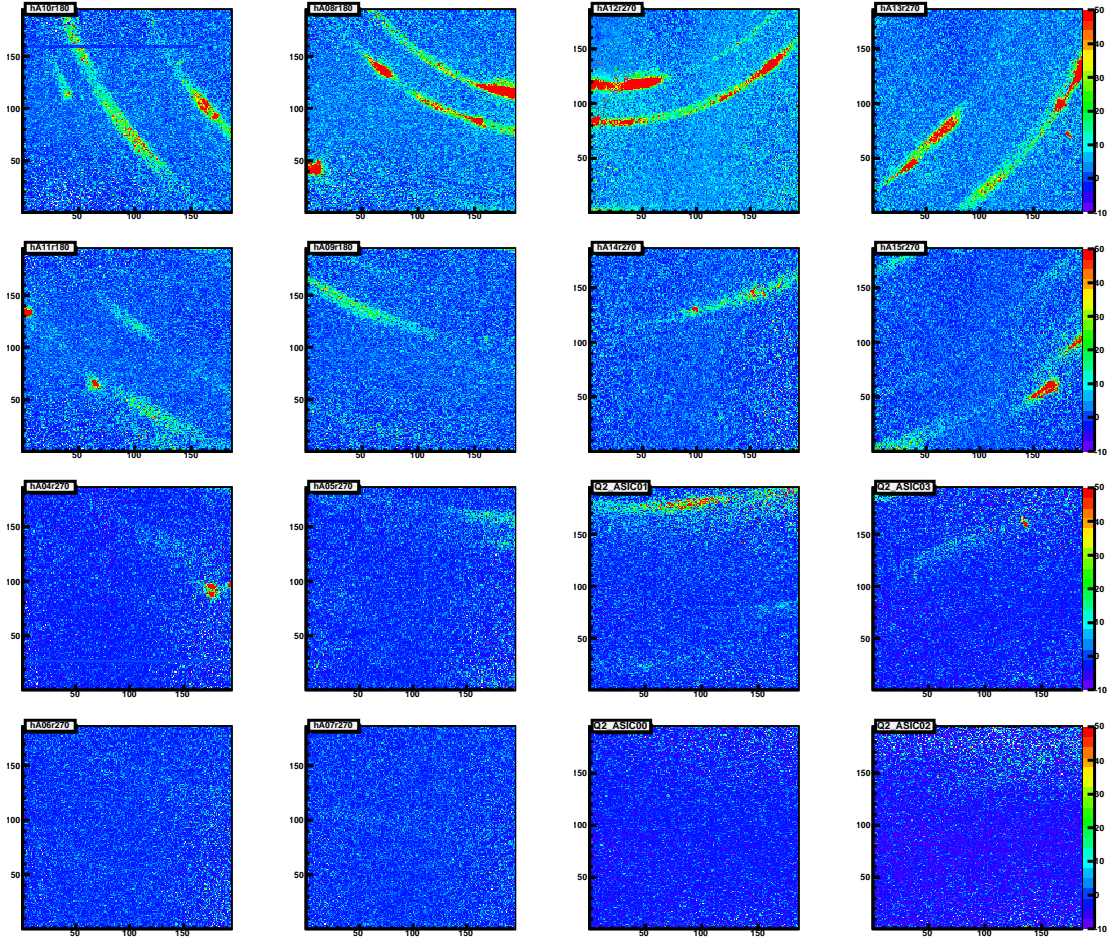


FIG. 1: r0547-s00-asic07, event 5: background is subtracted.

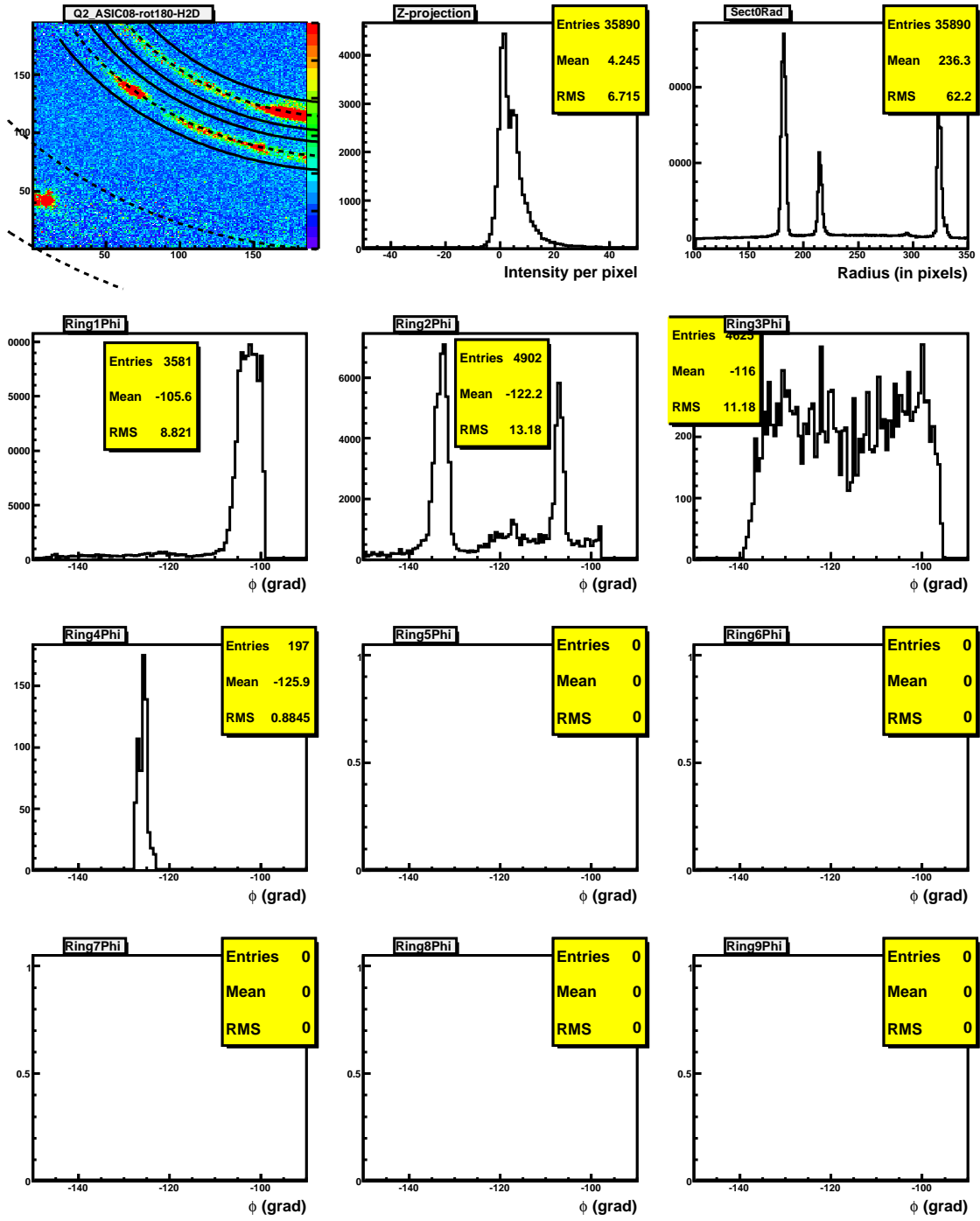


FIG. 2: r0547-s00-asic08, event 51: $r - \phi$ projections.

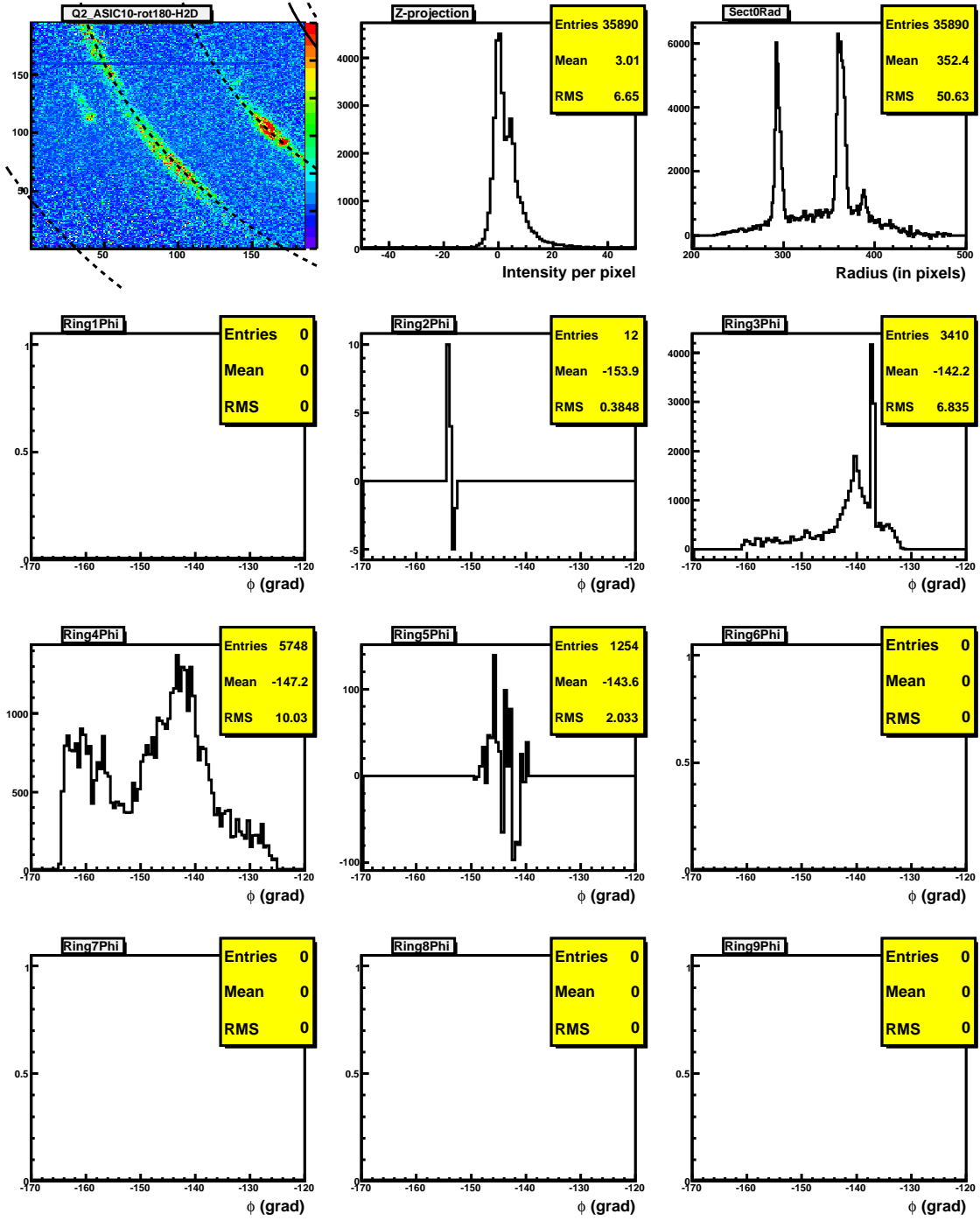


FIG. 3: r0547-s00-asic10, event 51: $r - \phi$ projections.

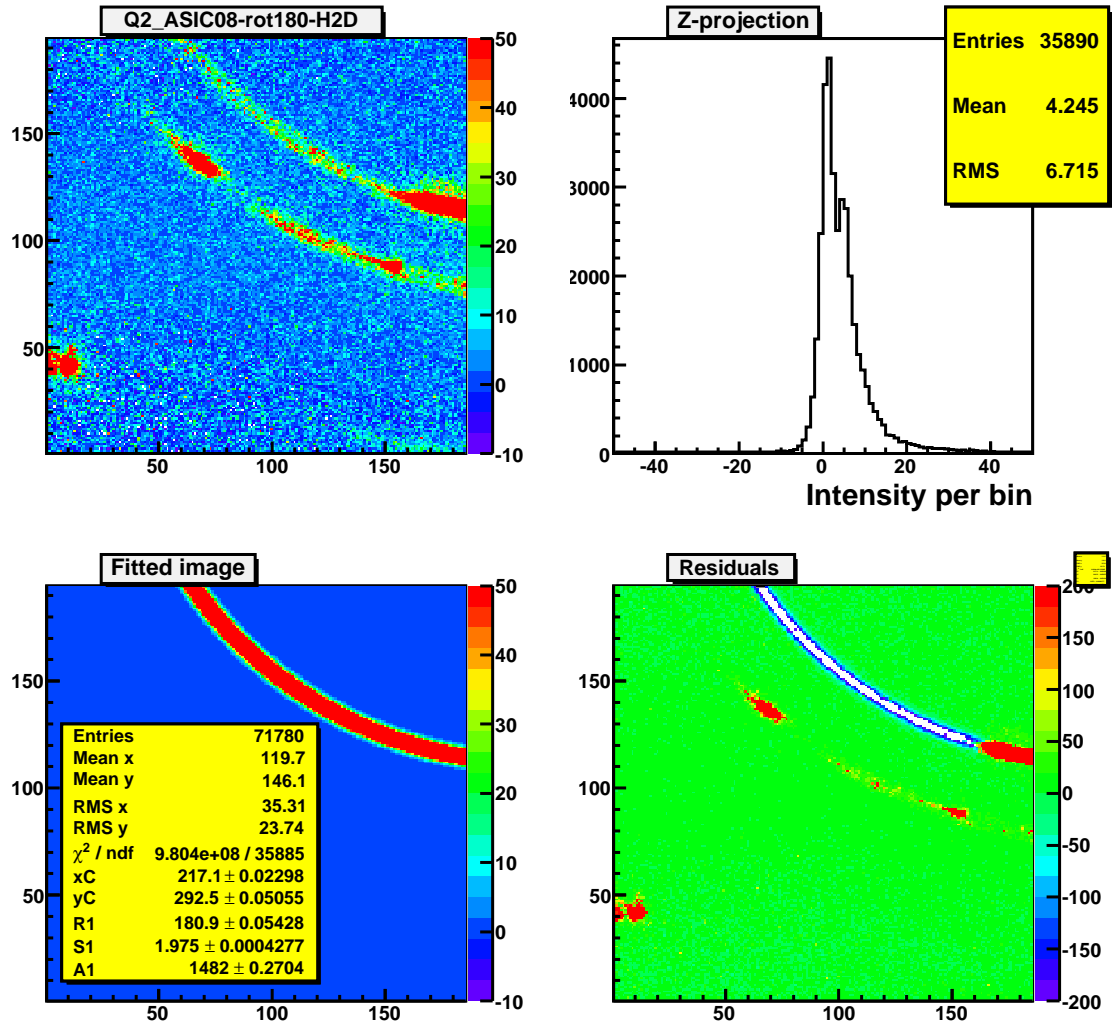


FIG. 4: r0547-s00-asic08, event 51: fit to a single ring 1.

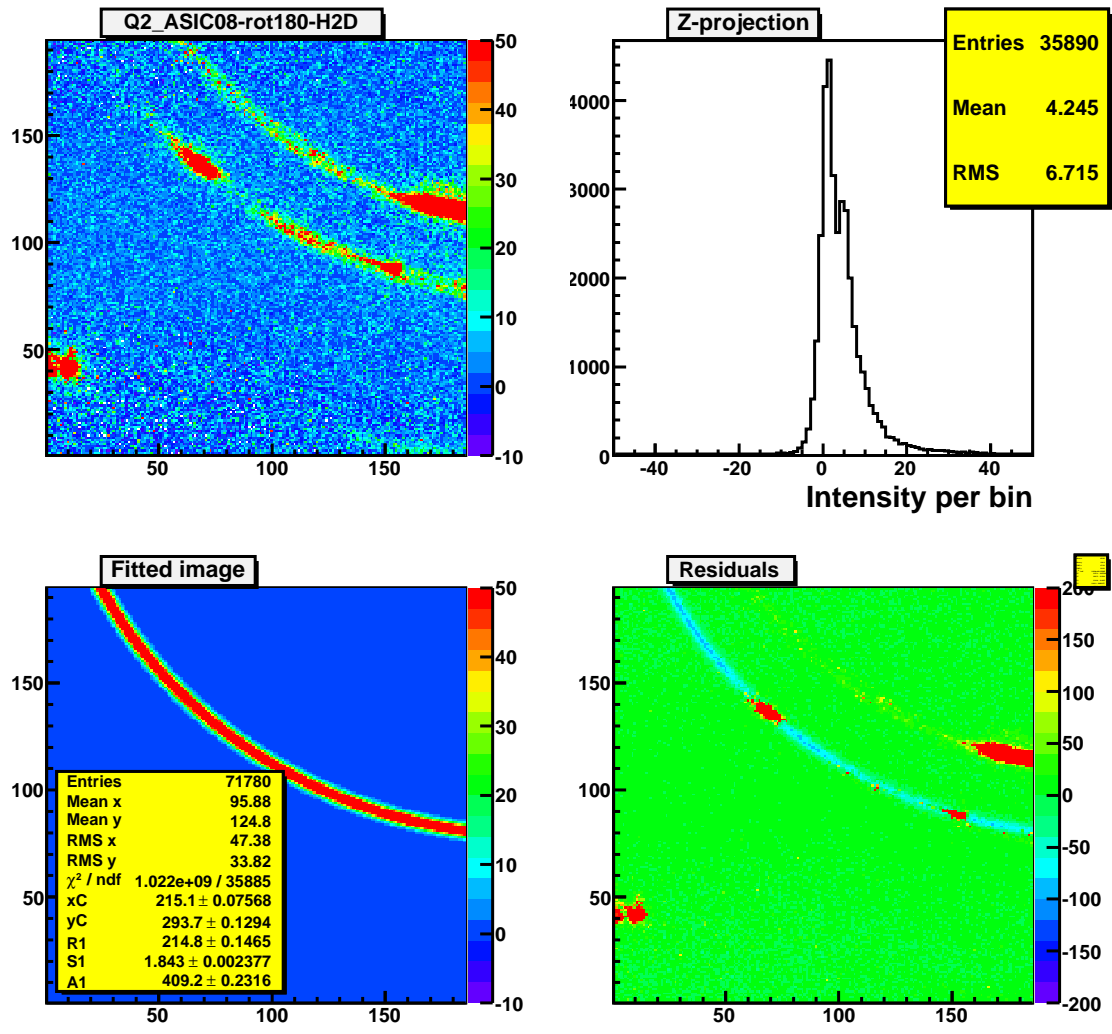


FIG. 5: r0547-s00-asic08, event 51: fit to the single ring 2.

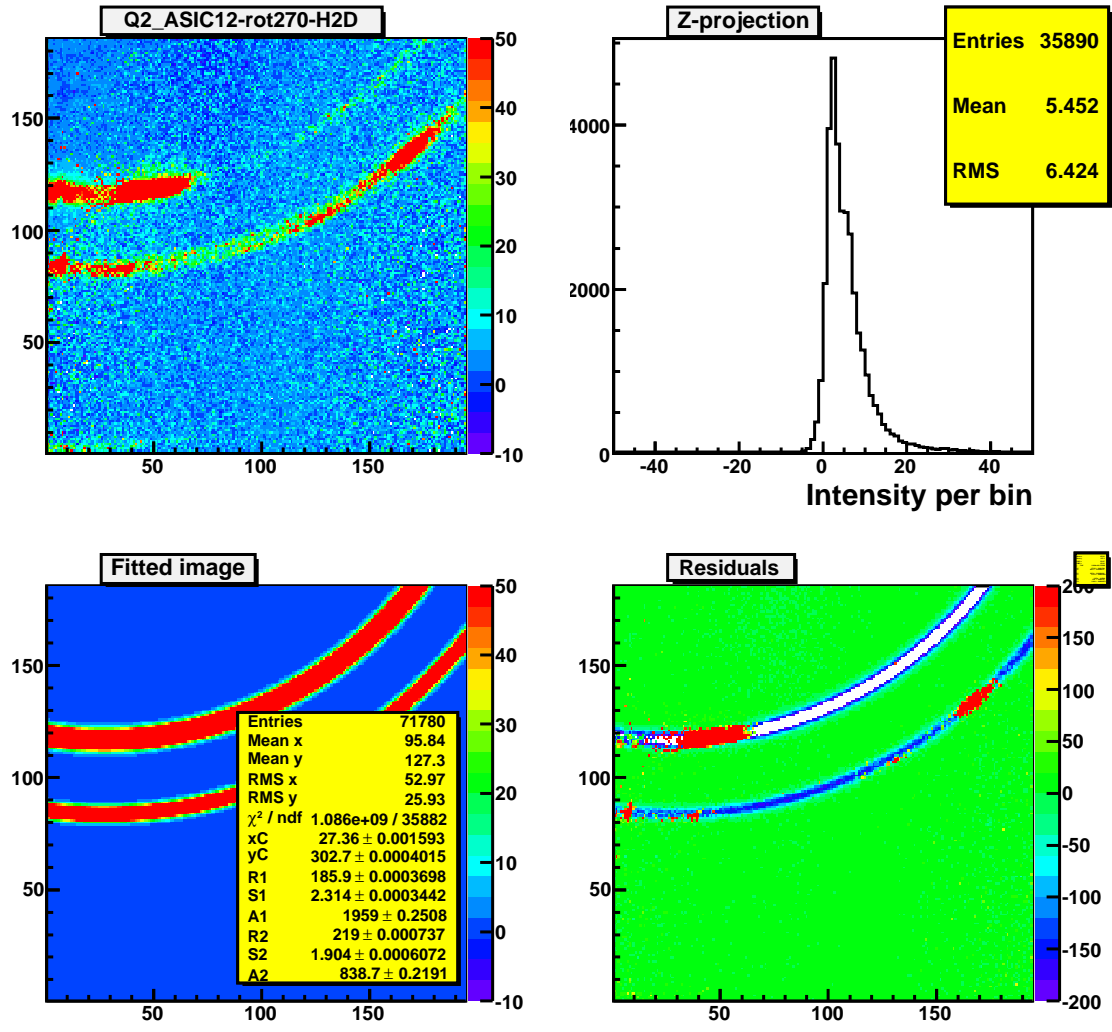


FIG. 6: r0547-s00-asic12, event 51: fit to the single rings 1 and 2.