

LEBT beam data

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Introduction

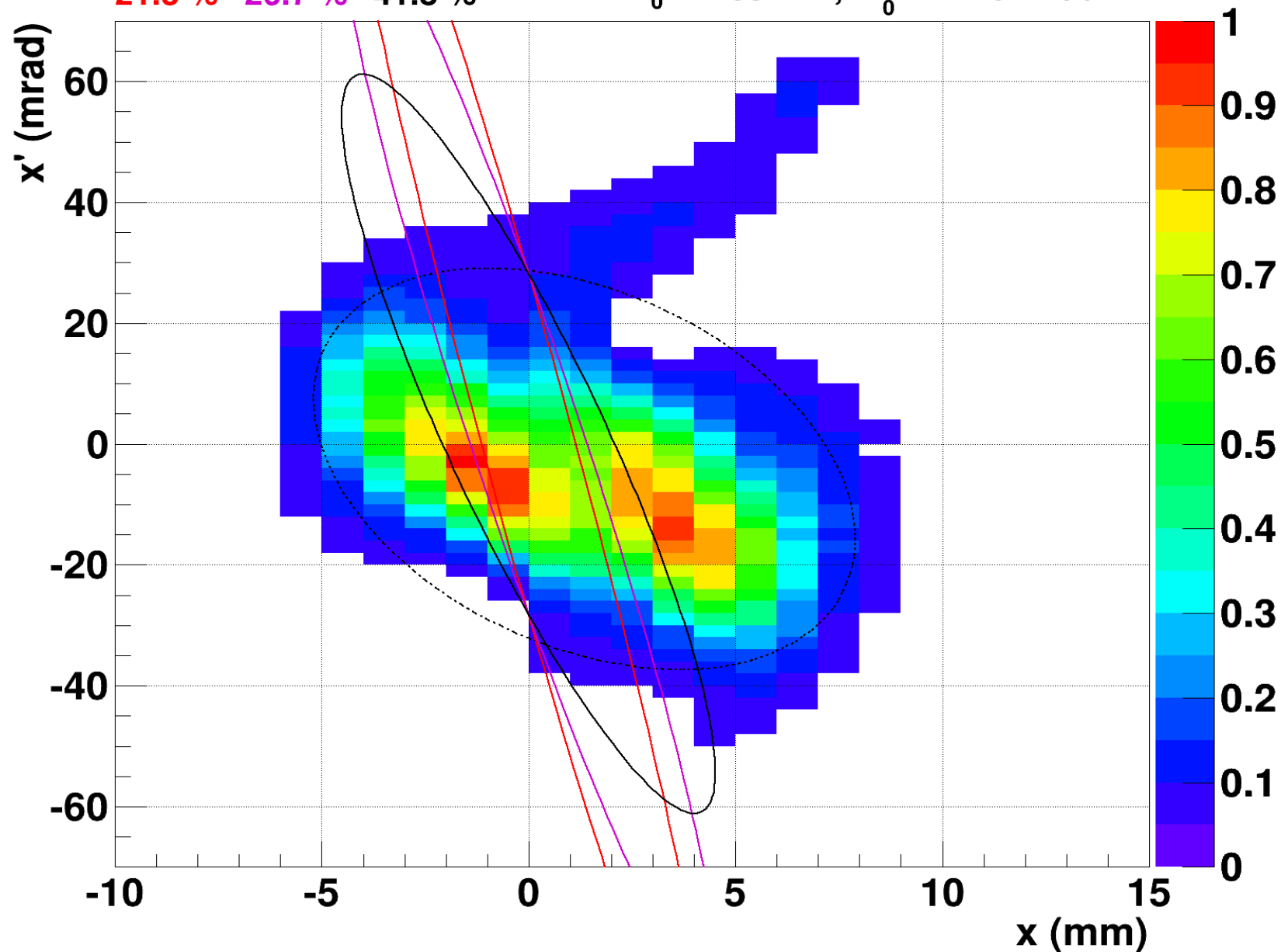
- Plots of LEBT emittance scanner data for 65 keV beam
 - Data taking campaign over past few weeks by Christoph, Scott, Dan
- x-x' and y-y' profile scans at end of LEBT
 - Plot headings correspond to
 - Run number, Horiz then Vert scan, 3 solenoid currents (S1-S2-S3), PA settings
 - Data runs have fixed solenoid currents $S1 = 130$ A, $S2 = 80$ A
 - S3 (reversed current polarity) varied about -220 A: -140 to -245 A
 - Removed spurious “noise”; intensity threshold = 5% maximum intensity
 - Intensity weighted $\langle xx \rangle$, $\langle x x' \rangle$, $\langle x' x' \rangle \Rightarrow$ data Twiss 100% (dotted) ellipse
 - Measured rms emittance = 100% ellipse area/4
- Emittance scans compared to RFQ acceptance
 - Ideal, matched case (red ellipse)
 - Transmission $\sim 90\%$ case for $\gamma = 0.65 \gamma_0$ (purple ellipse)
 - Transmission $\sim 75\%$ case for $\gamma = 0.30 \gamma_0$ (black ellipse)
- Intensity fractions quoted within the RFQ acceptance (for the 3 cases)

Run 638 H 130,080,-220A; 13A, 21kV

$\alpha_x = 0.37$, $\beta_x = 0.21$, $\gamma_x = 5.41$; norm rms $\epsilon_x = 0.60$

21.3 % 26.7 % 41.8 %

$x_0 = 1.35$ mm, $x'_0 = -4.15$ mrad



Run 639 V 130,080,-220A; 13A, 21kV

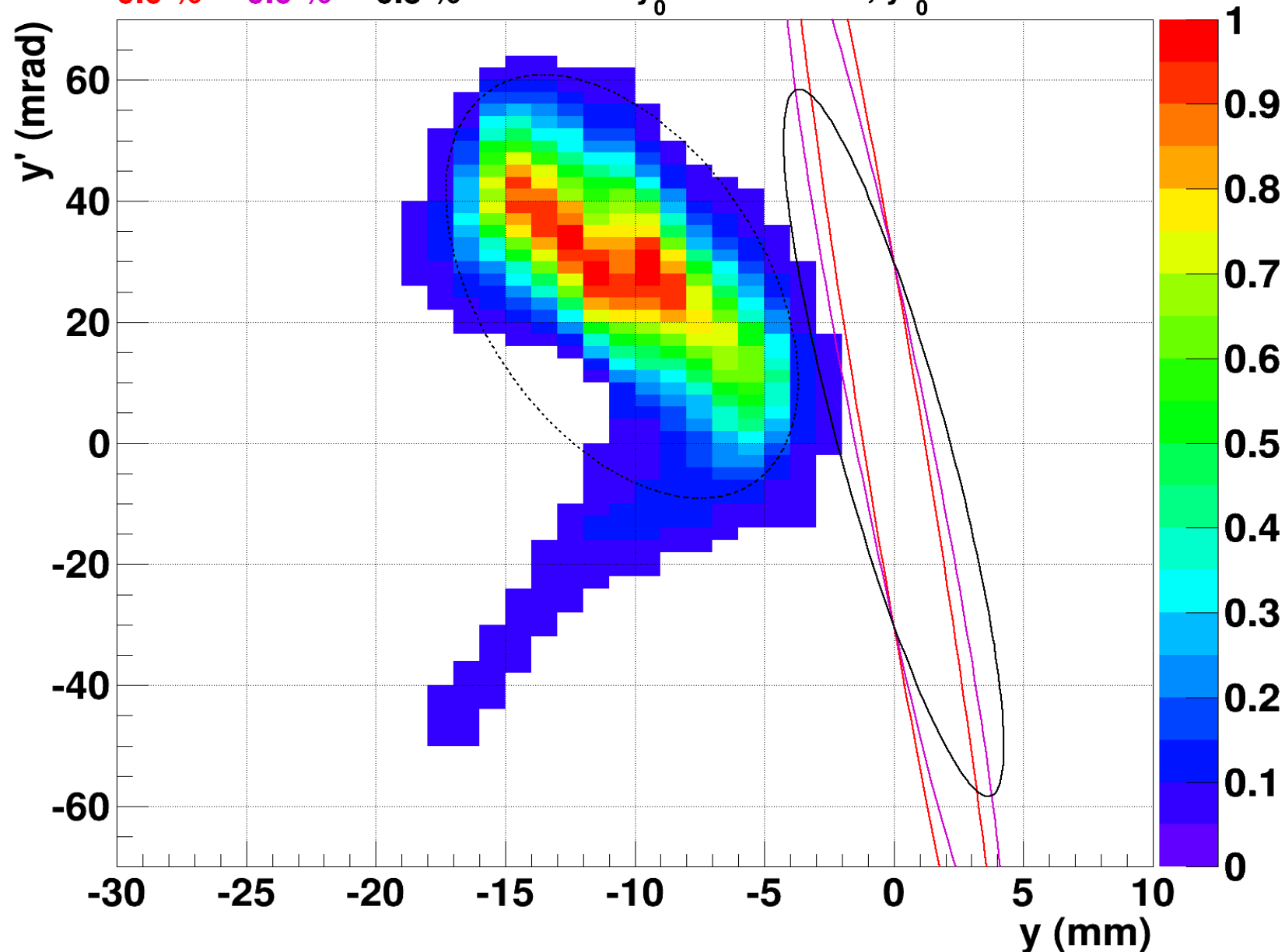
$\alpha_y = 0.49$, $\beta_y = 0.22$, $\gamma_y = 5.74$; norm rms $\epsilon_y = 0.63$

0.0 %

0.0 %

0.3 %

$y_0 = -10.49$ mm, $y'_0 = 25.84$ mrad

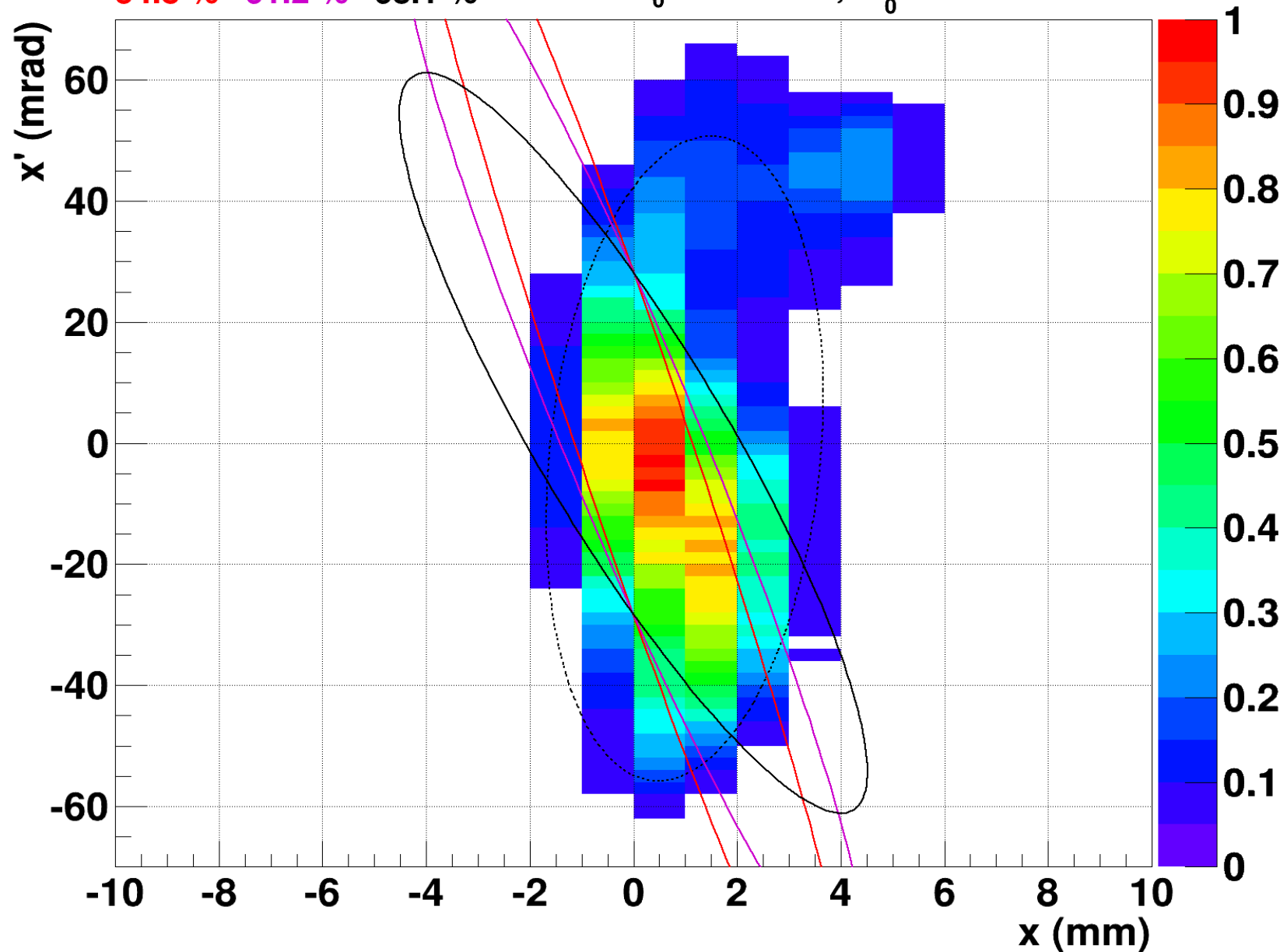


Run 641 H 130,080,-220A; 11A, 18kV

$\alpha_x = -0.19$, $\beta_x = 0.05$, $\gamma_x = 20.32$; norm rms $\epsilon_x = 0.41$

54.8 % 61.2 % 68.1 %

$x_0 = 0.99$ mm, $x'_0 = -2.56$ mrad

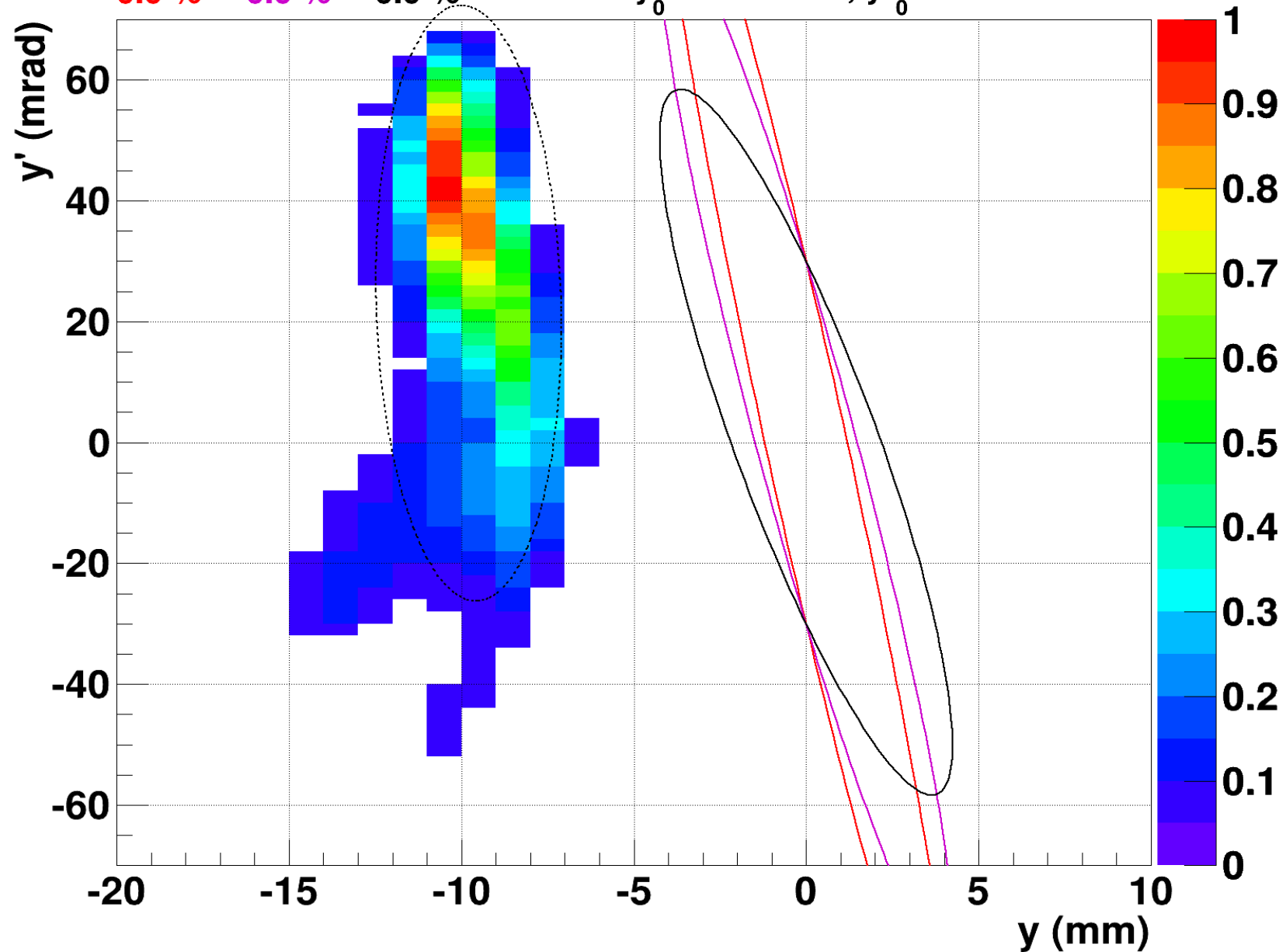


Run 640 V 130,080,-220A; 11A, 18kV

$\alpha_y = 0.08$, $\beta_y = 0.05$, $\gamma_y = 18.38$; norm rms $\epsilon_y = 0.39$

0.0 % 0.0 % 0.0 %

$y_0 = -9.79$ mm, $y'_0 = 23.03$ mrad

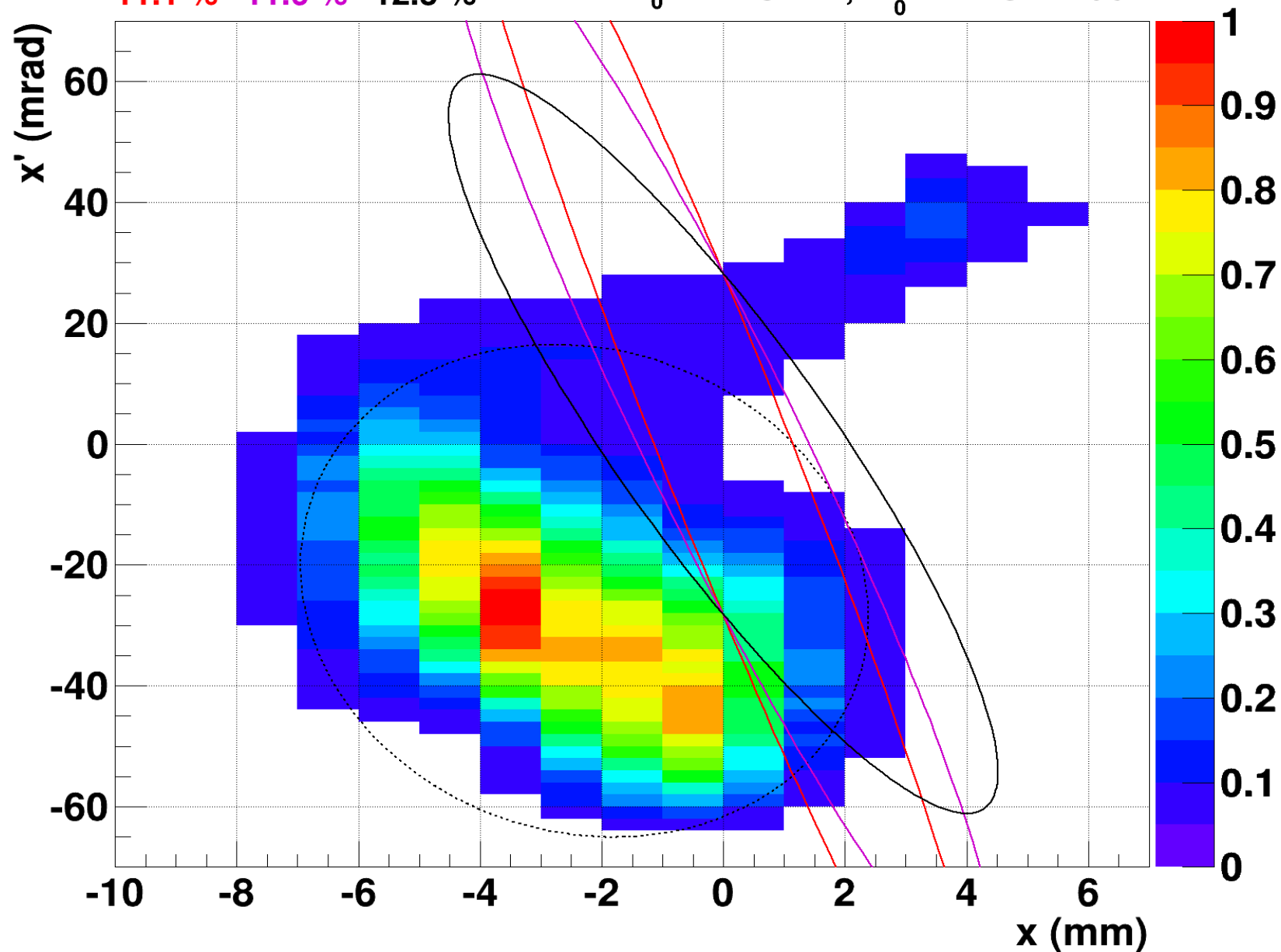


Run 642 H 130,080,-220A; 15A, 22kV

$\alpha_x = 0.10$, $\beta_x = 0.12$, $\gamma_x = 8.78$; norm rms $\epsilon_x = 0.56$

11.1 % 11.6 % 12.3 %

$x_0 = -2.28$ mm, $x'_0 = -24.32$ mrad

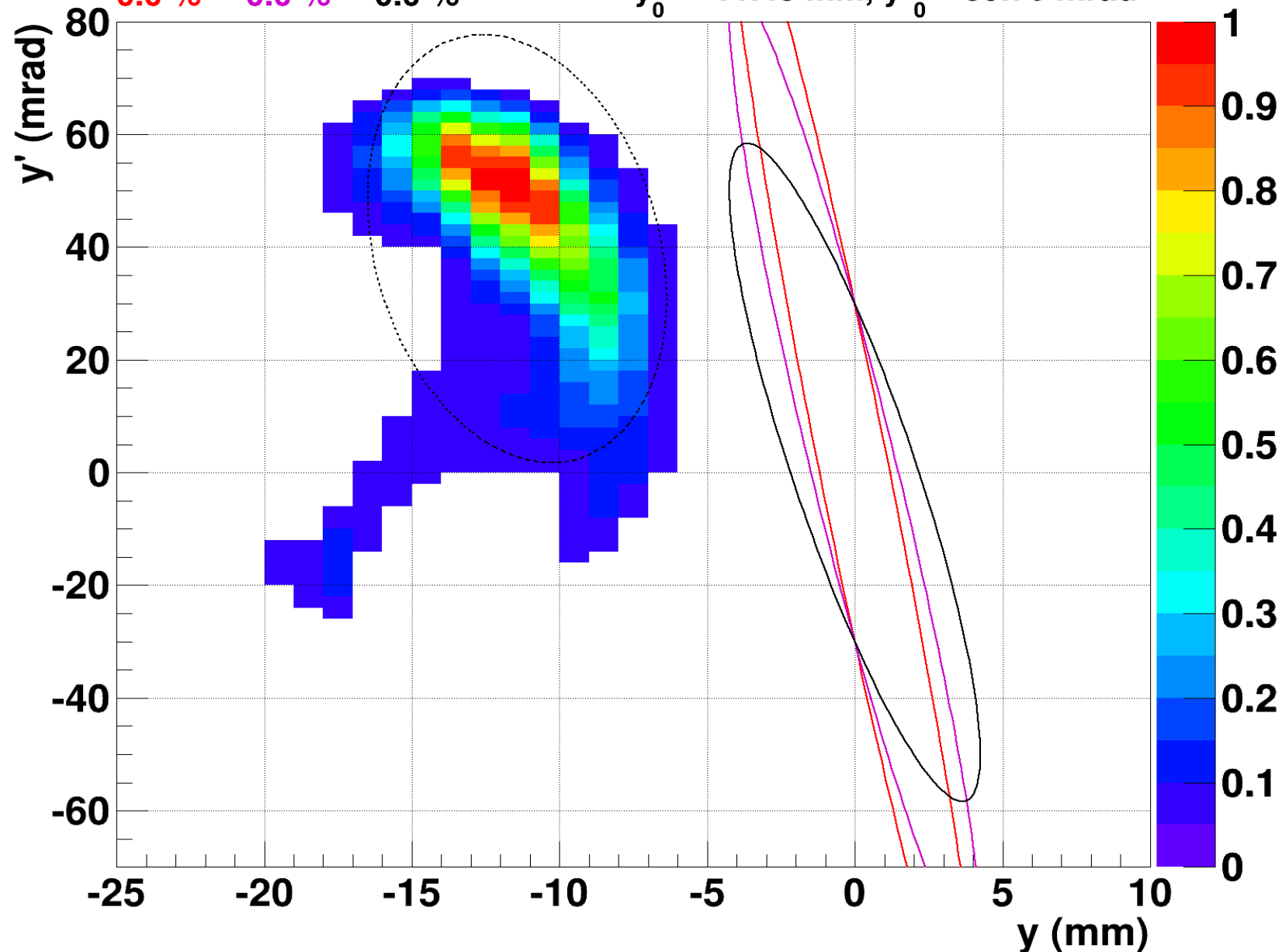


Run 643 V 130,080,-220A; 15A, 22kV

$\alpha_y = 0.24$, $\beta_y = 0.14$, $\gamma_y = 7.71$; norm rms $\epsilon_y = 0.55$

0.0 % 0.0 % 0.0 %

$y_0 = -11.43$ mm, $y'_0 = 39.70$ mrad

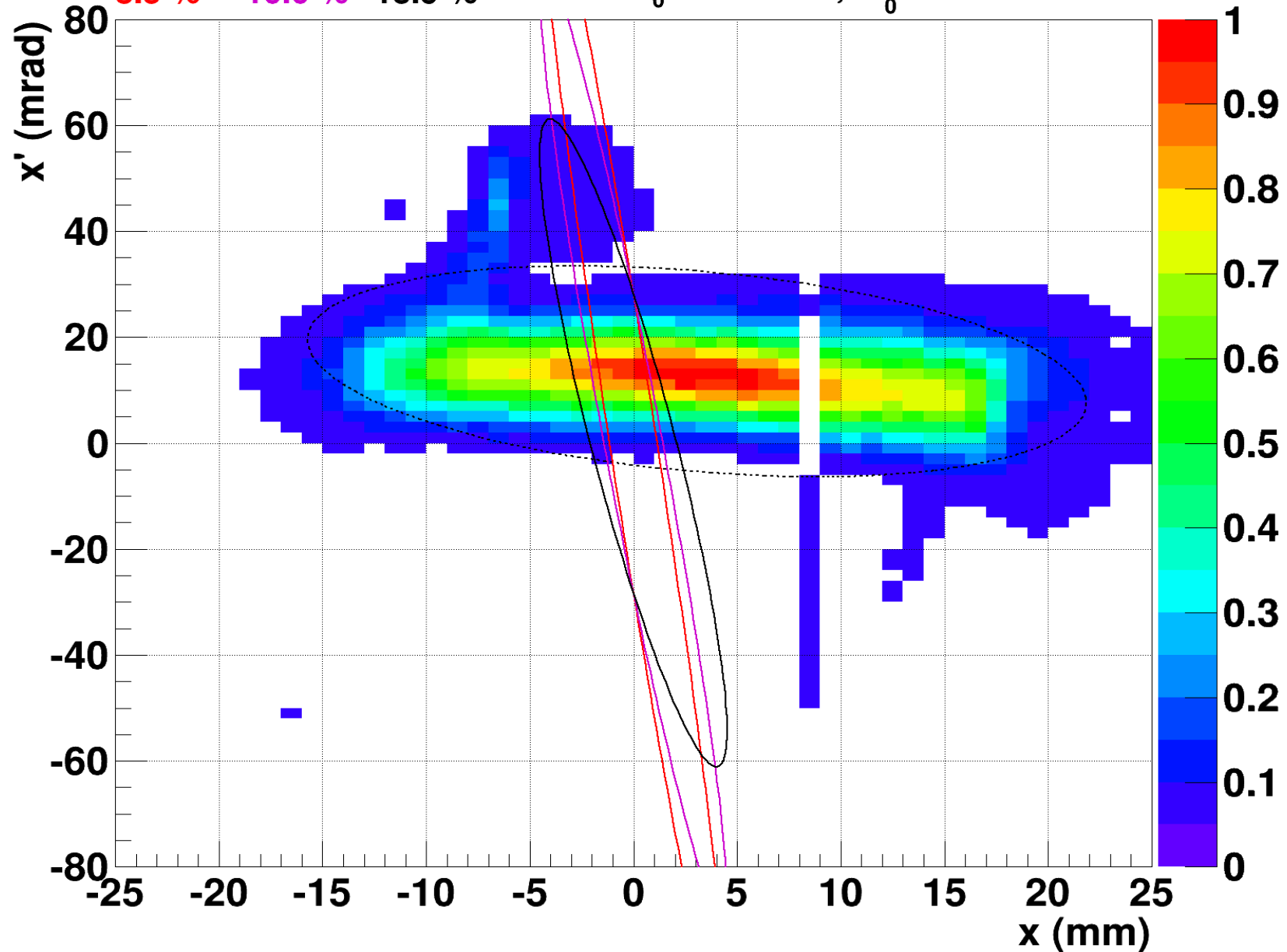


Run 687 H 130,080,-140A; 11.5A, 21kV

$\alpha_x = 0.32$, $\beta_x = 0.99$, $\gamma_x = 1.11$; norm rms $\epsilon_x = 1.05$

8.5 % 10.0 % 13.9 %

$x_0 = 3.06$ mm, $x'_0 = 13.53$ mrad



Run 664 V 130,080,-140A; 11.5A, 21kV

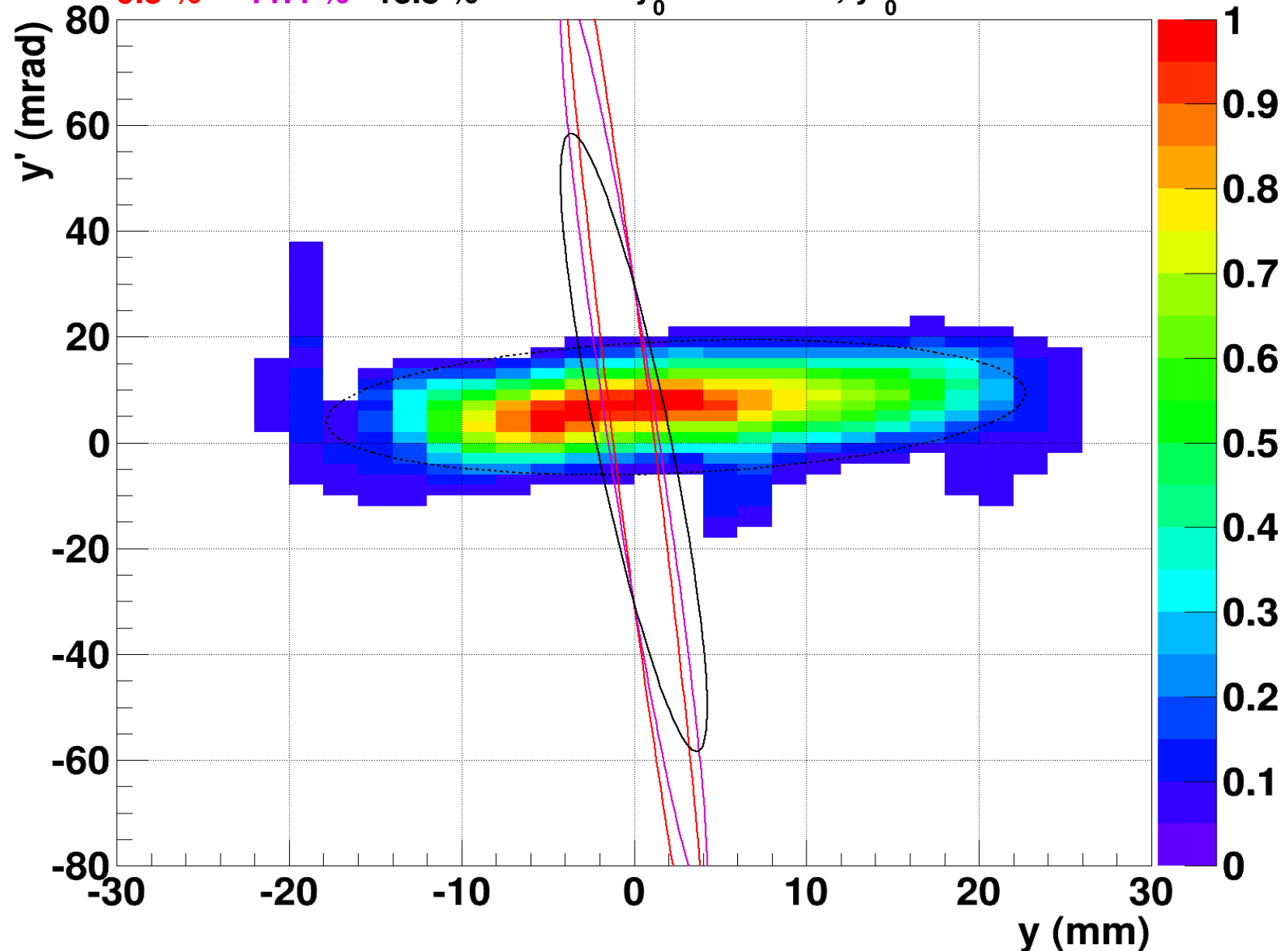
$\alpha_y = -0.22$, $\beta_y = 1.62$, $\gamma_y = 0.64$; norm rms $\epsilon_y = 0.74$

9.5 %

11.4 %

13.8 %

$y_0 = 2.45$ mm, $y'_0 = 6.69$ mrad

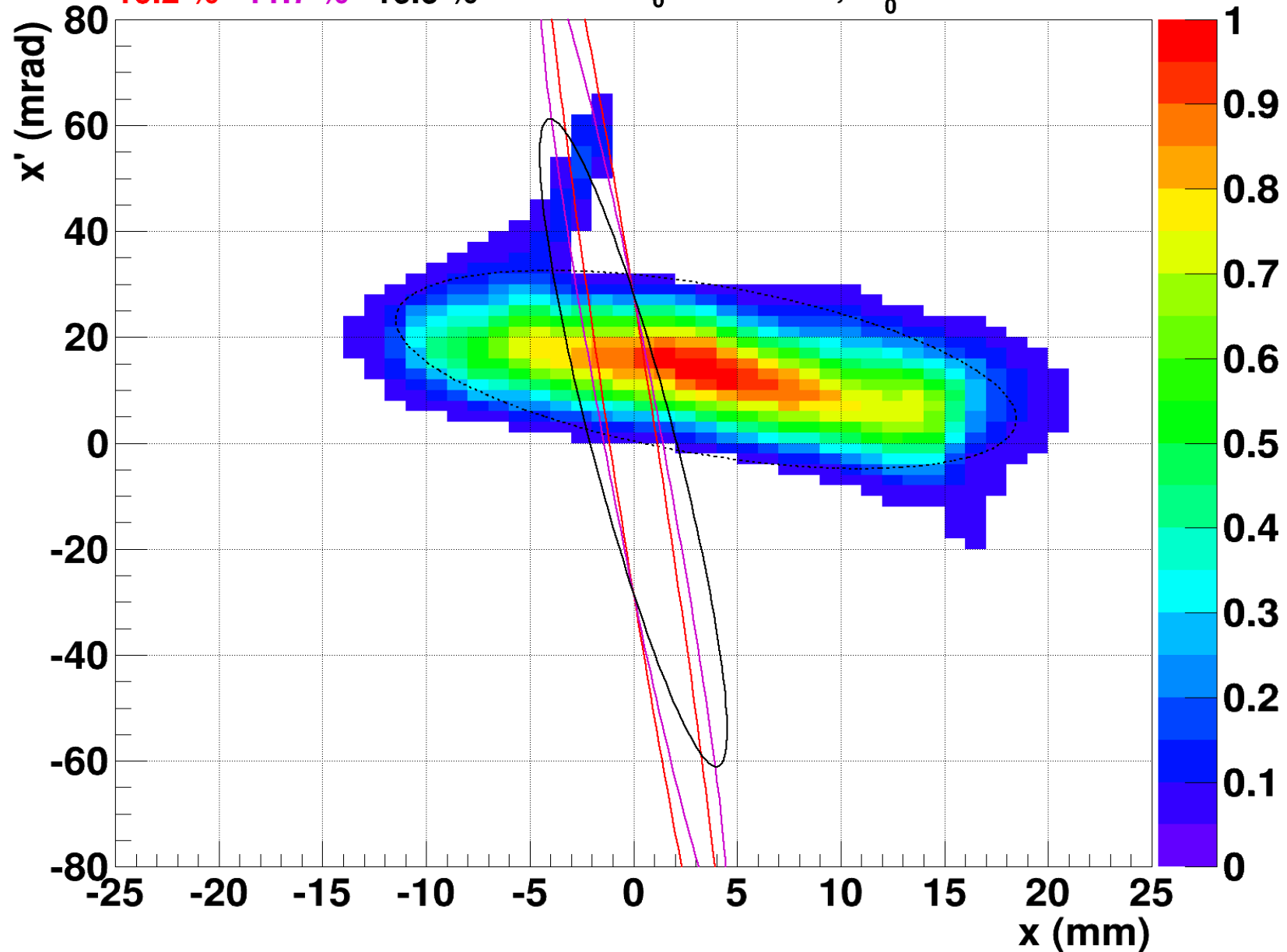


Run 686 H 130,080,-160A; 11.5A, 21kV

$\alpha_x = 0.58$, $\beta_x = 0.92$, $\gamma_x = 1.45$; norm rms $\epsilon_x = 0.71$

10.2 % 11.7 % 16.6 %

$x_0 = 3.51$ mm, $x'_0 = 13.90$ mrad

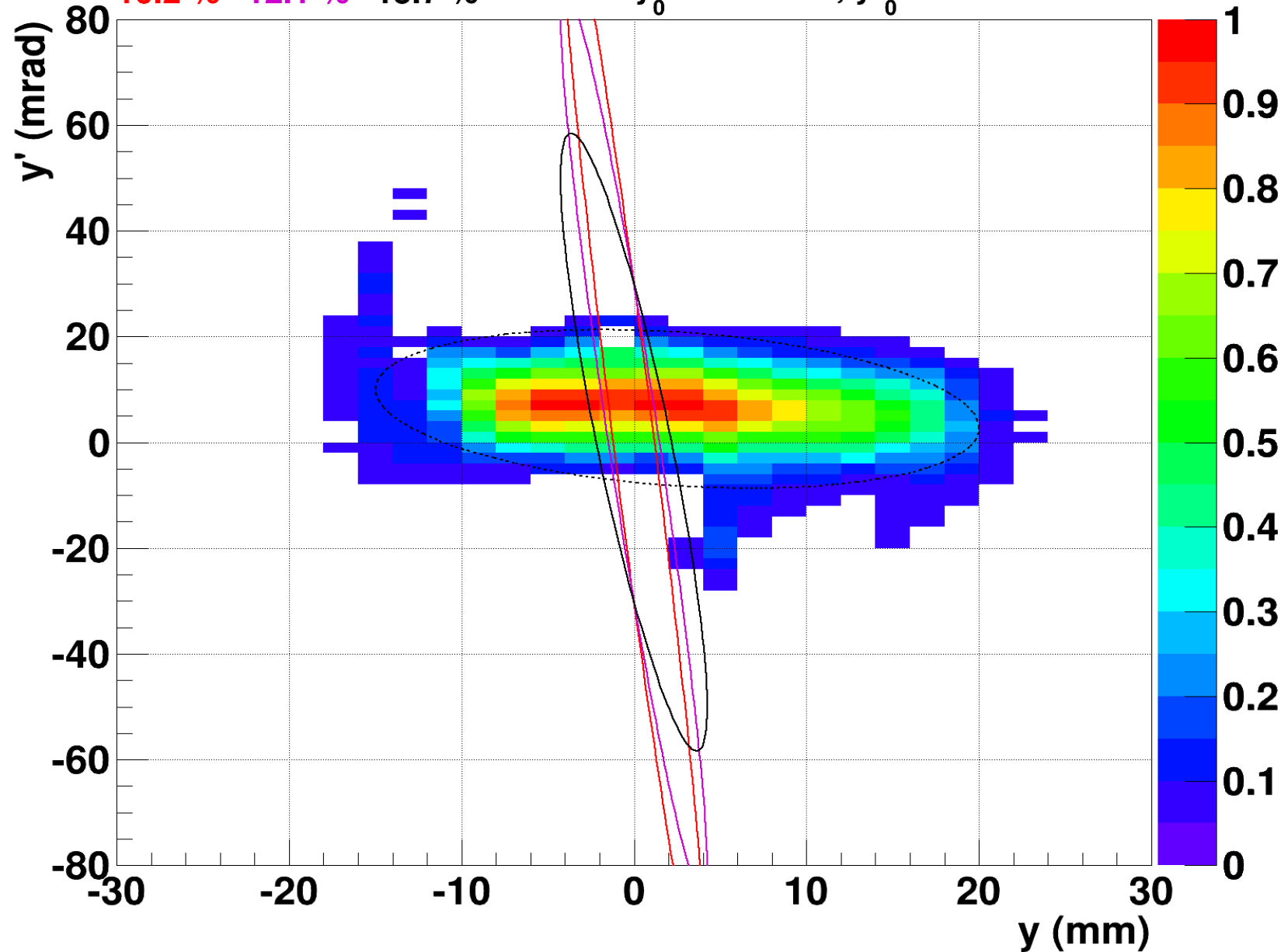


Run 663 V 130,080,-160A; 11.5A, 21kV

$\alpha_y = 0.25$, $\beta_y = 1.20$, $\gamma_y = 0.88$; norm rms $\epsilon_y = 0.75$

10.2 % 12.1 % 15.7 %

$y_0 = 2.51$ mm, $y'_0 = 6.32$ mrad

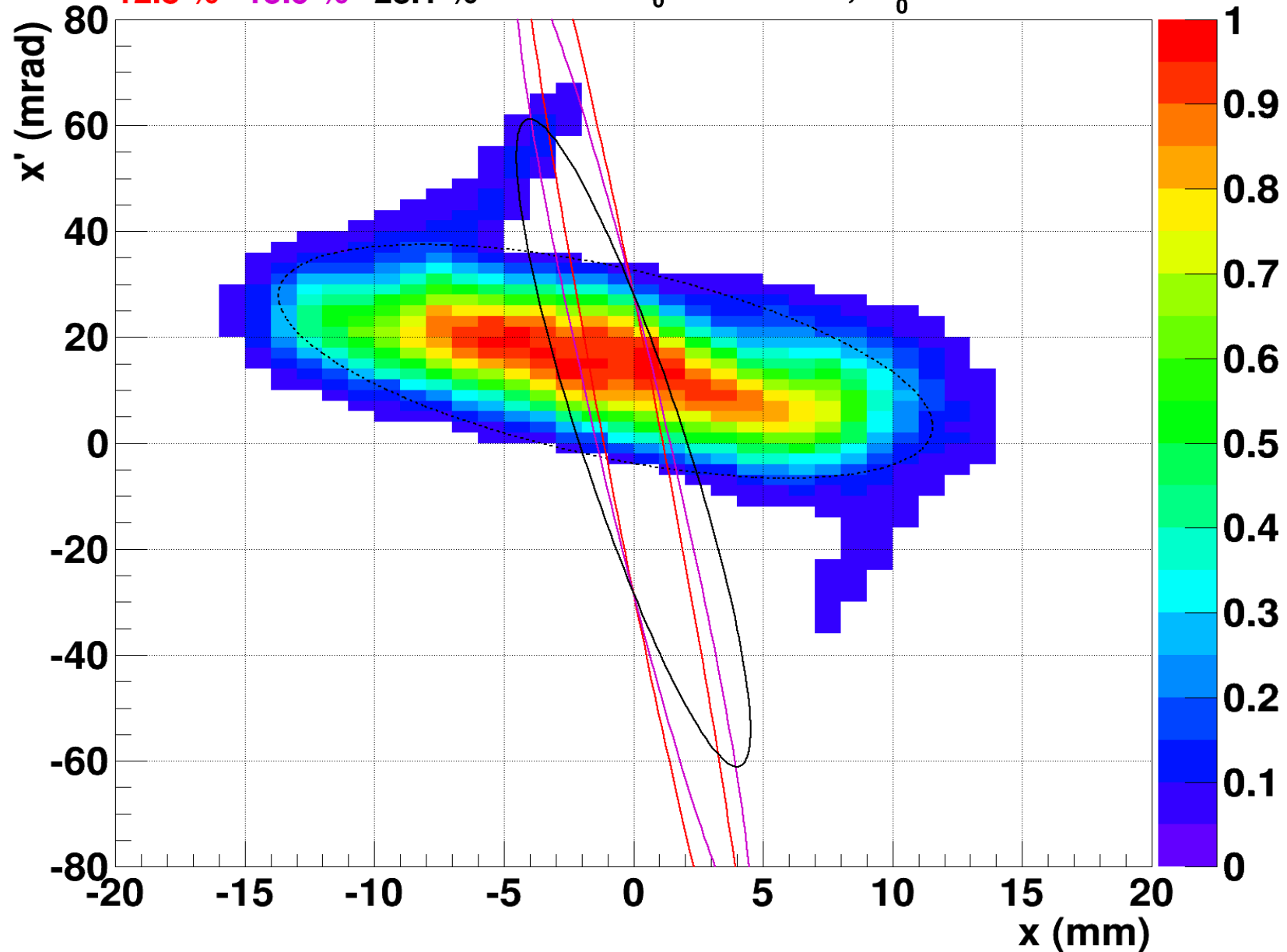


Run 685 H 130,080,-180A; 11.5A, 21kV

$\alpha_x = 0.68$, $\beta_x = 0.69$, $\gamma_x = 2.11$; norm rms $\epsilon_x = 0.68$

12.8 % 15.9 % 23.1 %

$x_0 = -1.08$ mm, $x'_0 = 15.44$ mrad

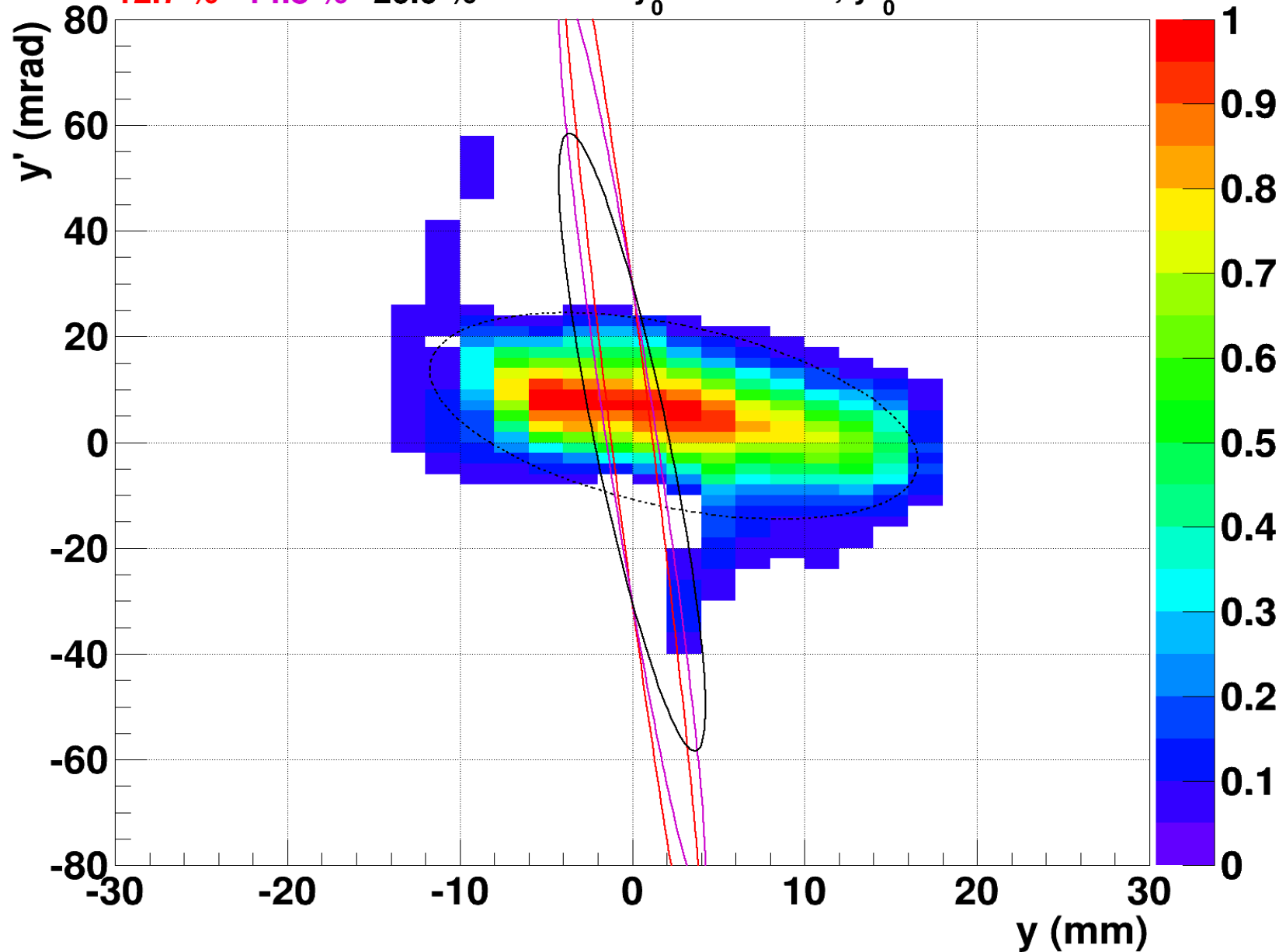


Run 657 V 130,080,-180A; 11.5A, 21kV

$\alpha_y = 0.49$, $\beta_y = 0.81$, $\gamma_y = 1.54$; norm rms $\epsilon_y = 0.73$

12.7 % 14.8 % 20.0 %

$y_0 = 2.42$ mm, $y'_0 = 4.97$ mrad

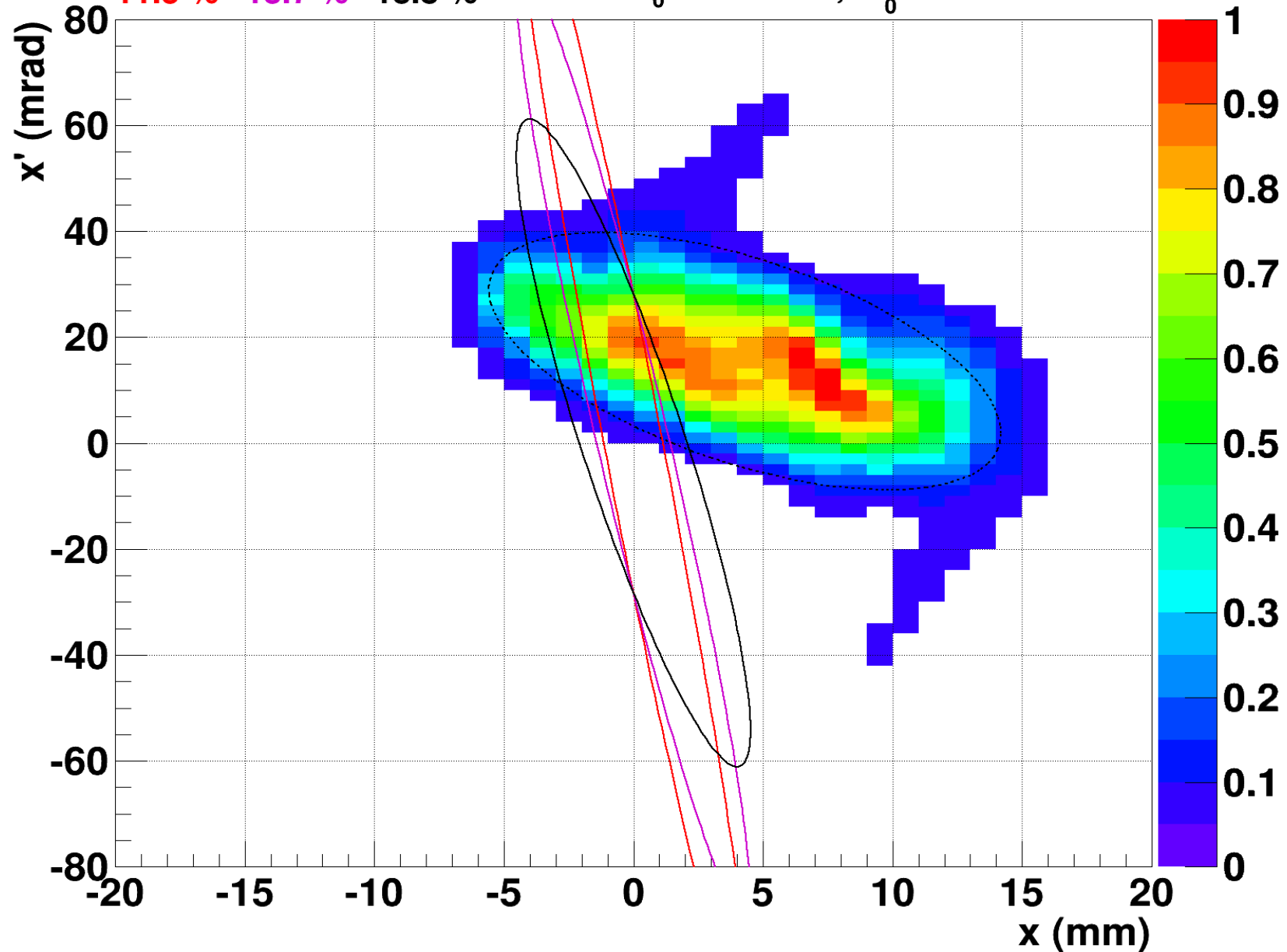


Run 683 H 130,080,-200A; 11.5A, 21kV

$\alpha_x = 0.68$, $\beta_x = 0.49$, $\gamma_x = 2.96$; norm rms $\epsilon_x = 0.59$

11.5 % 13.7 % 18.8 %

$x_0 = 4.31$ mm, $x'_0 = 15.42$ mrad

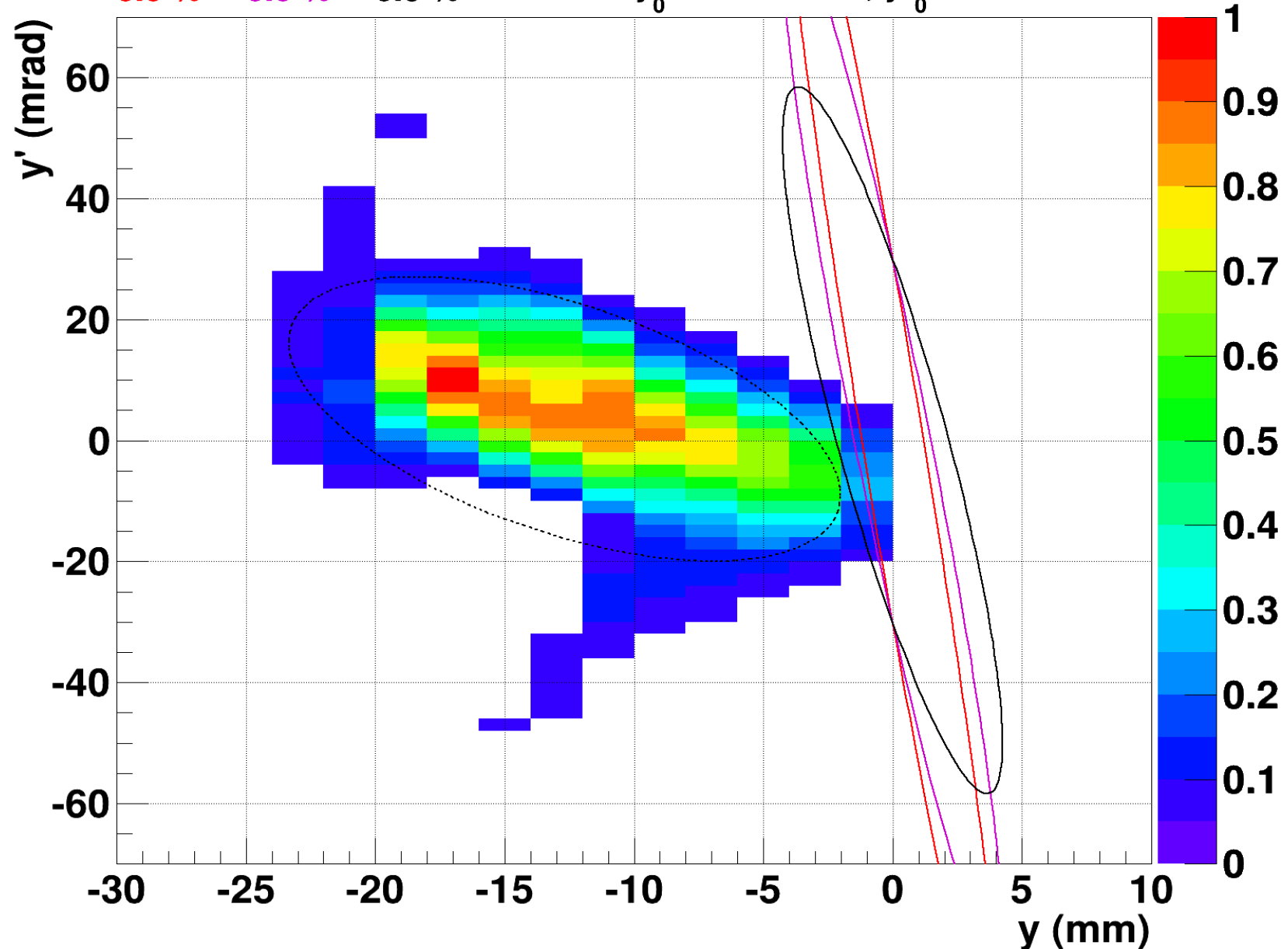


Run 655 V 130,080,-200A; 11.5A, 21kV

$\alpha_y = 0.64$, $\beta_y = 0.54$, $\gamma_y = 2.62$; norm rms $\epsilon_y = 0.62$

0.0 % 0.0 % 0.6 %

$y_0 = -12.68$ mm, $y'_0 = 3.55$ mrad

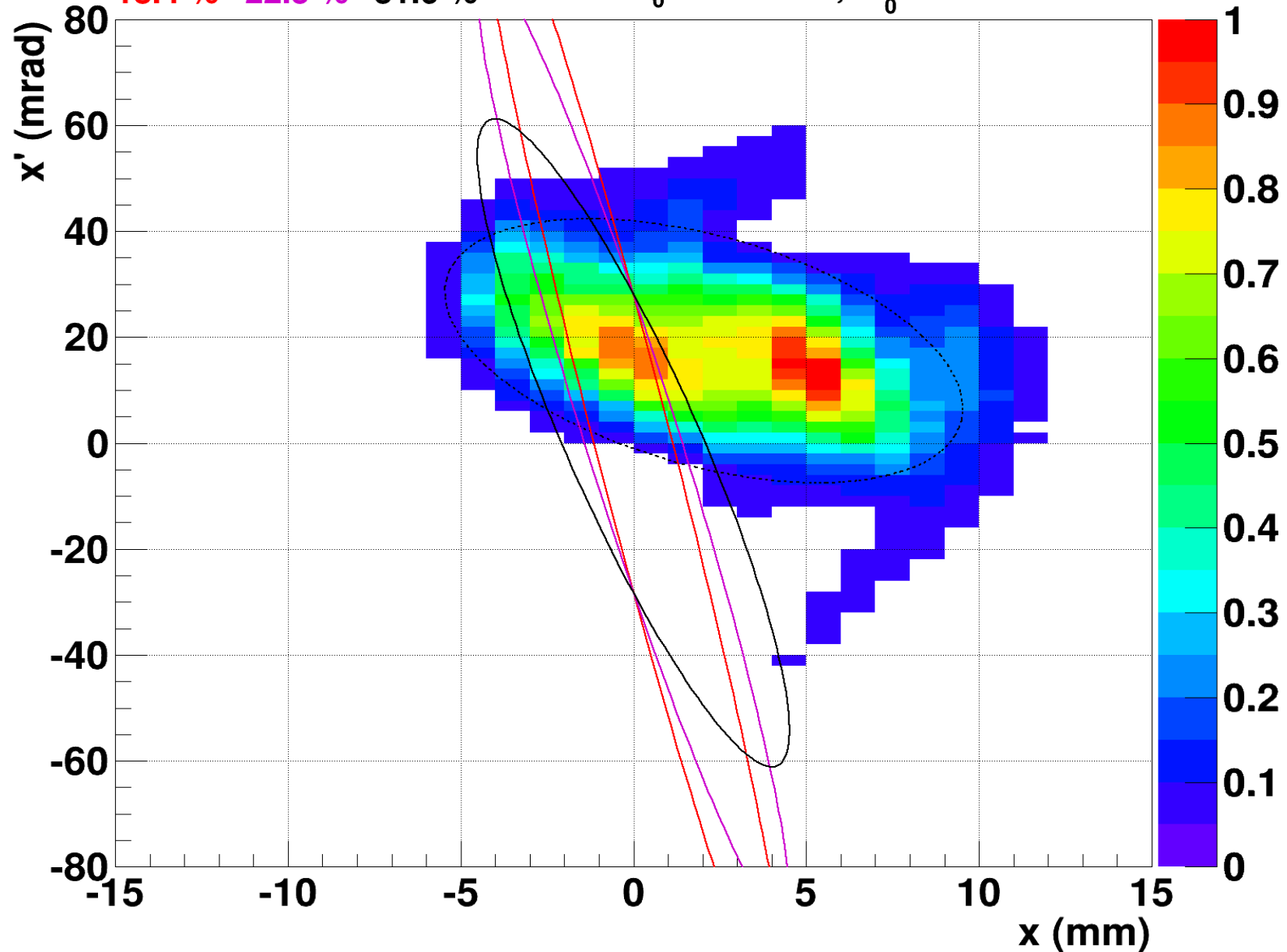


Run 681 H 130,080,-220A; 11.5A, 21kV

$\alpha_x = 0.49$, $\beta_x = 0.34$, $\gamma_x = 3.70$; norm rms $\epsilon_x = 0.49$

18.4 % 22.5 % 31.6 %

$x_0 = 2.04$ mm, $x'_0 = 17.44$ mrad

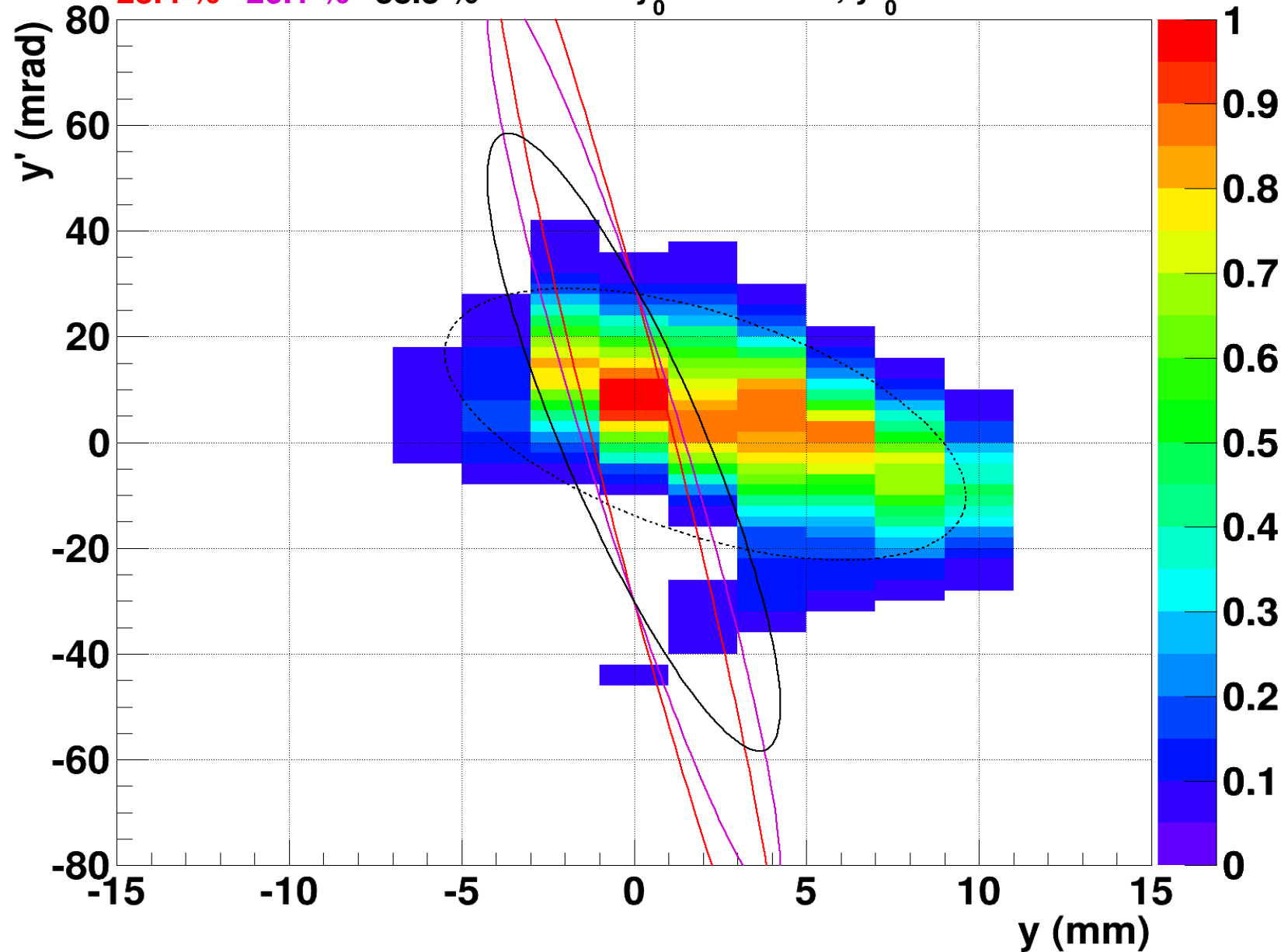


Run 658 V 130,080,-220A; 11.5A, 21kV

$\alpha_y = 0.62$, $\beta_y = 0.35$, $\gamma_y = 4.00$; norm rms $\epsilon_y = 0.49$

23.4 % 26.1 % 38.3 %

$y_0 = 2.08$ mm, $y'_0 = 3.39$ mrad

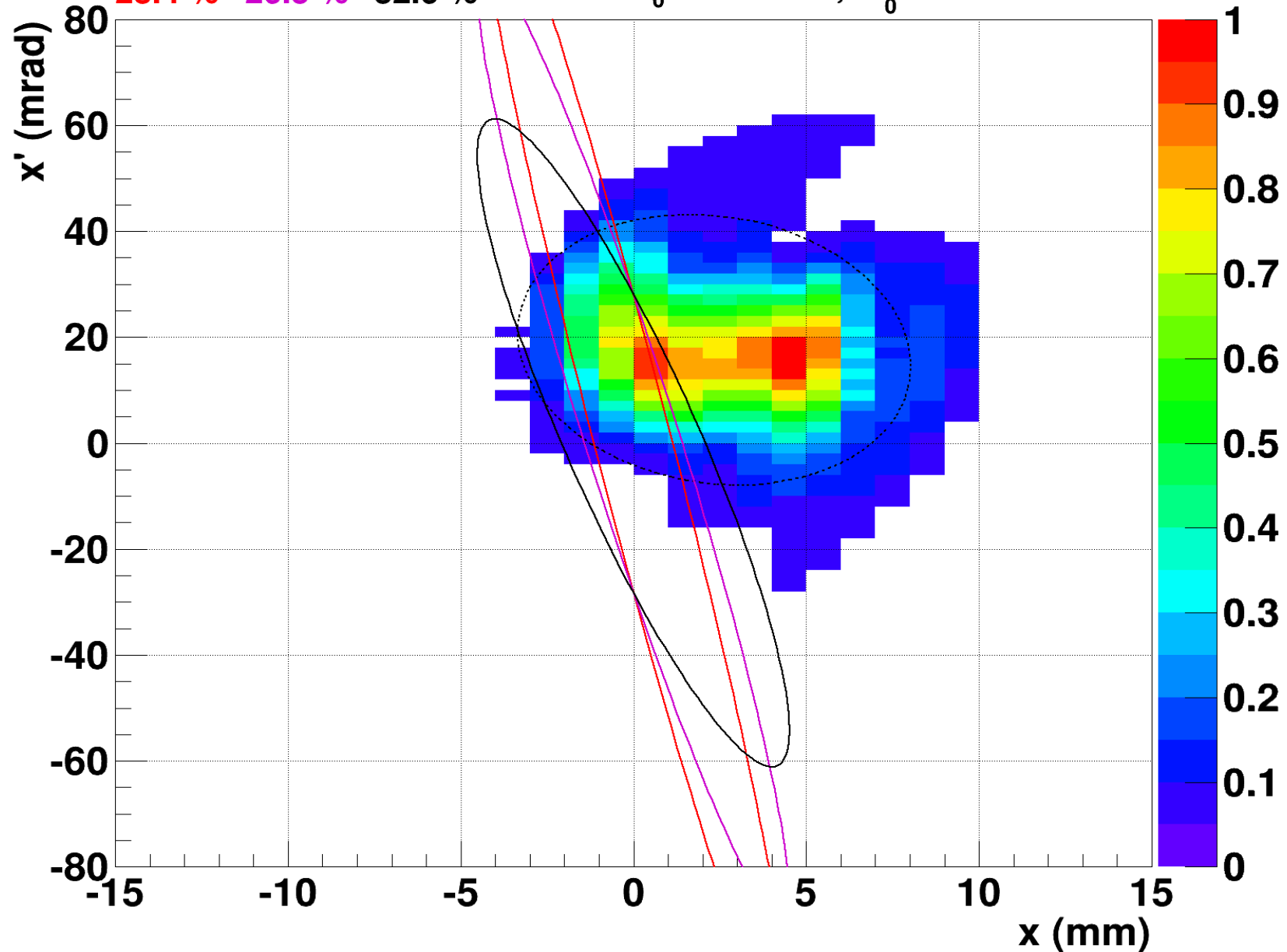


Run 676 H 130,080,-240A; 11.5A, 21kV

$\alpha_x = 0.12$, $\beta_x = 0.22$, $\gamma_x = 4.52$; norm rms $\epsilon_x = 0.42$

23.4 % 26.5 % 32.6 %

$x_0 = 2.34$ mm, $x'_0 = 17.61$ mrad

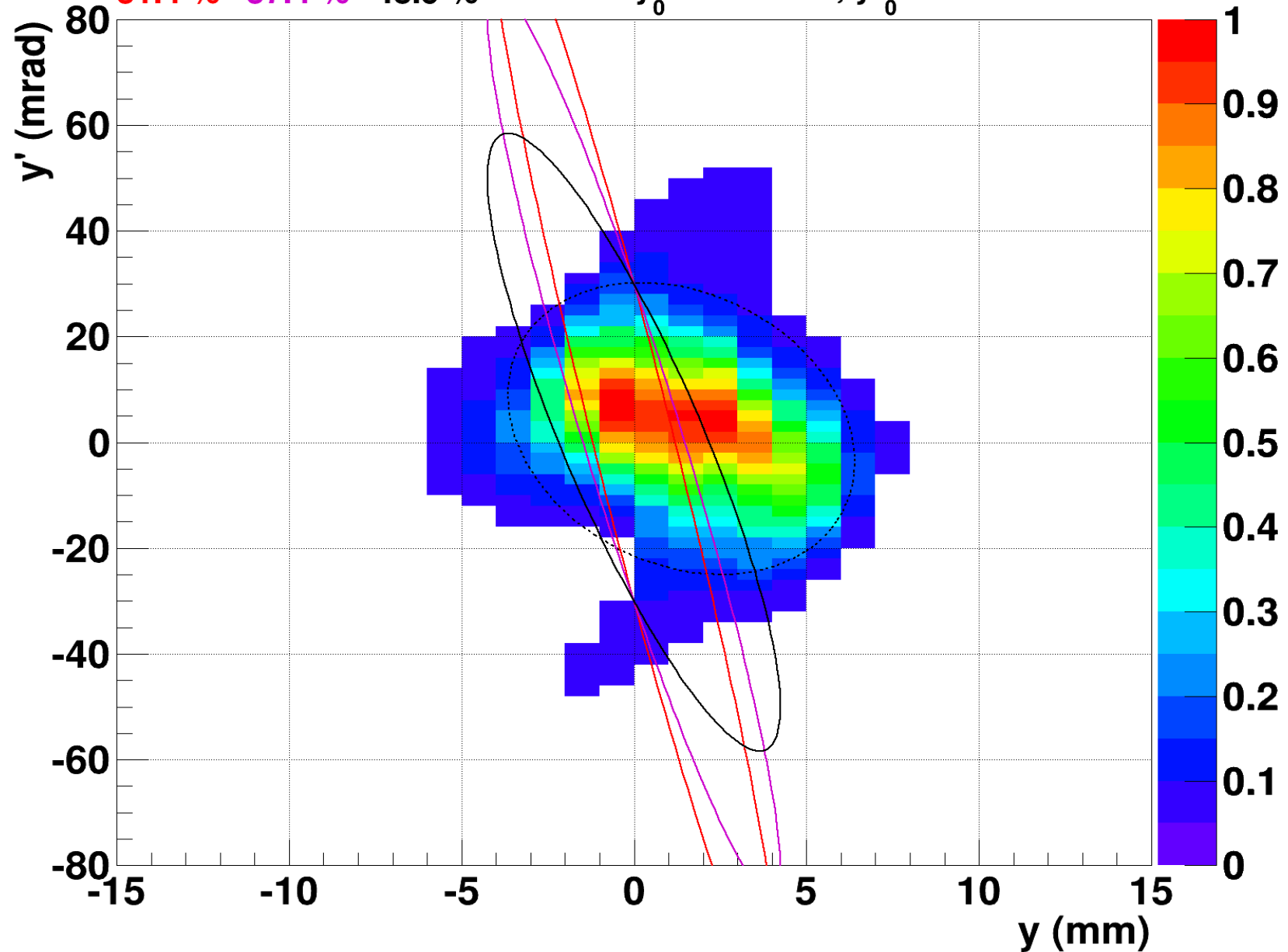


Run 660 V 130,080,-240A; 11.5A, 21kV

$\alpha_y = 0.23$, $\beta_y = 0.19$, $\gamma_y = 5.63$; norm rms $\epsilon_y = 0.40$

31.4 % 37.4 % 48.9 %

$y_0 = 1.37$ mm, $y'_0 = 2.60$ mrad

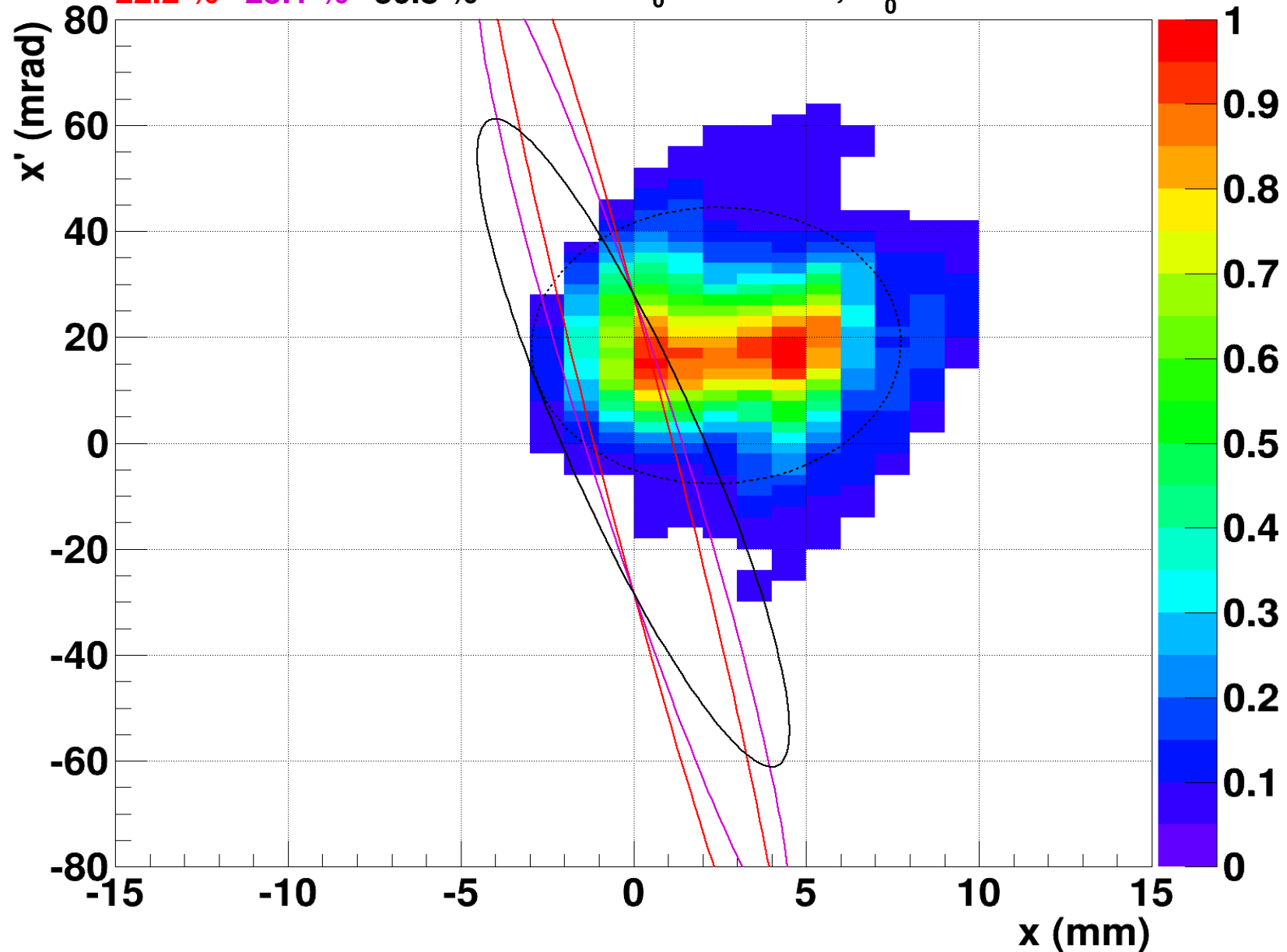


Run 678 H 130,080,-245A; 11.5A, 21kV

$\alpha_x = -0.02$, $\beta_x = 0.20$, $\gamma_x = 4.88$; norm rms $\epsilon_x = 0.41$

22.2 % 25.1 % 30.8 %

$x_0 = 2.40$ mm, $x'_0 = 18.40$ mrad

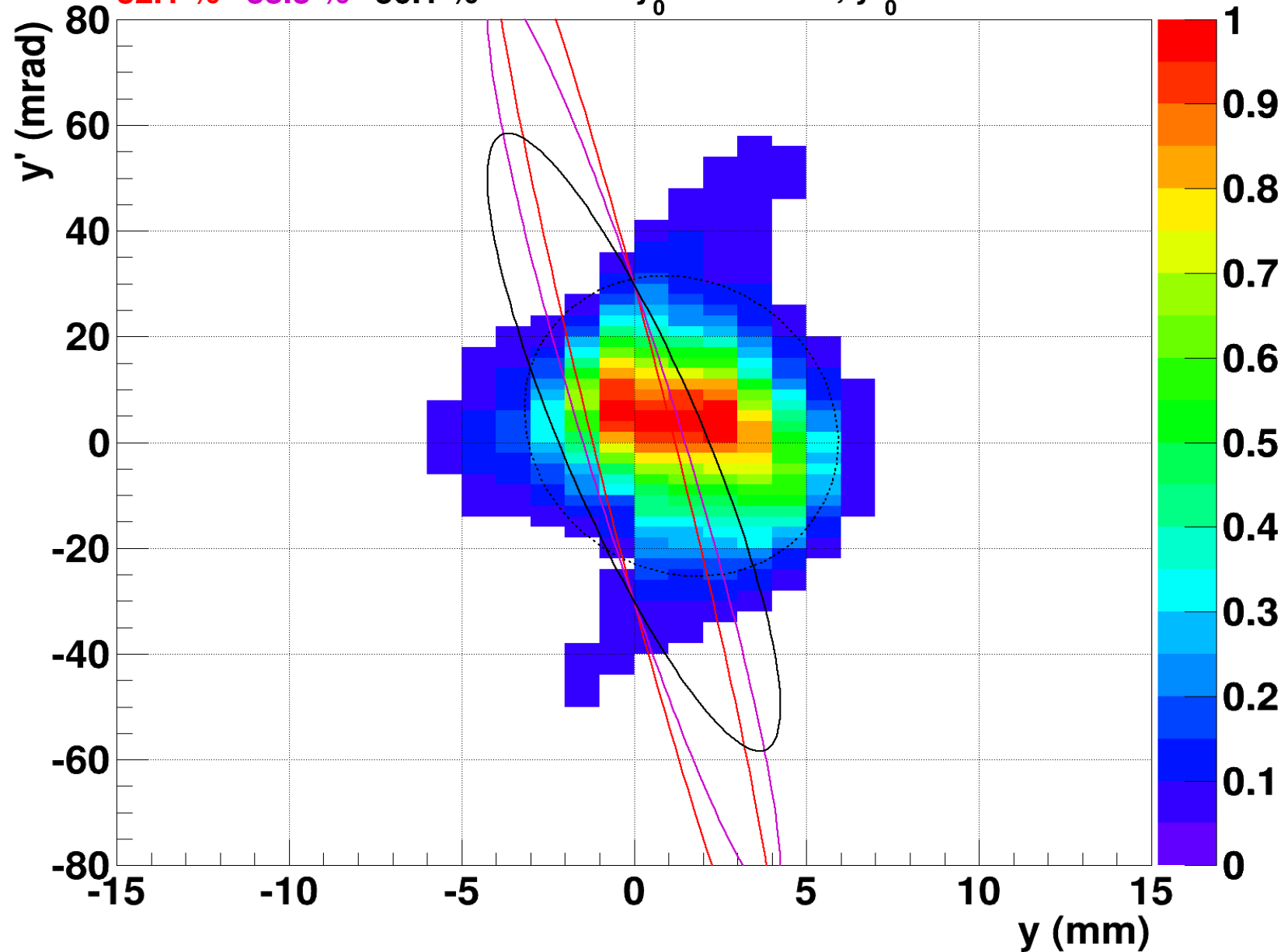


Run 661 V 130,080,-245A; 11.5A, 21kV

$\alpha_y = 0.11$, $\beta_y = 0.16$, $\gamma_y = 6.28$; norm rms $\epsilon_y = 0.38$

32.1 % 38.3 % 50.1 %

$y_0 = 1.37$ mm, $y'_0 = 3.07$ mrad

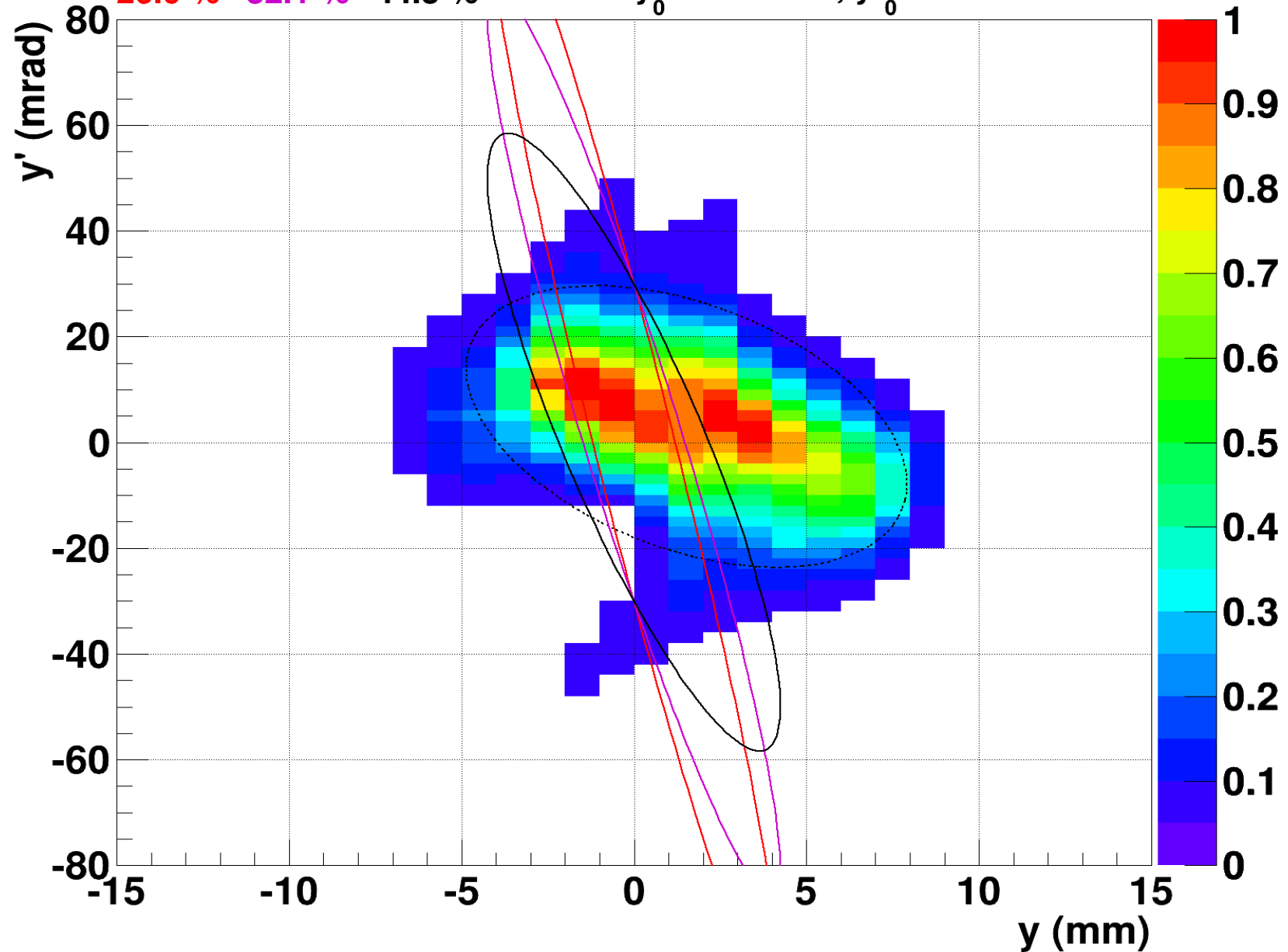


Run 662 V 130,080,-230A; 11.5A, 21kV

$\alpha_y = 0.45$, $\beta_y = 0.26$, $\gamma_y = 4.57$; norm rms $\epsilon_y = 0.46$

26.0 % 32.1 % 44.3 %

$y_0 = 1.53$ mm, $y'_0 = 2.99$ mrad

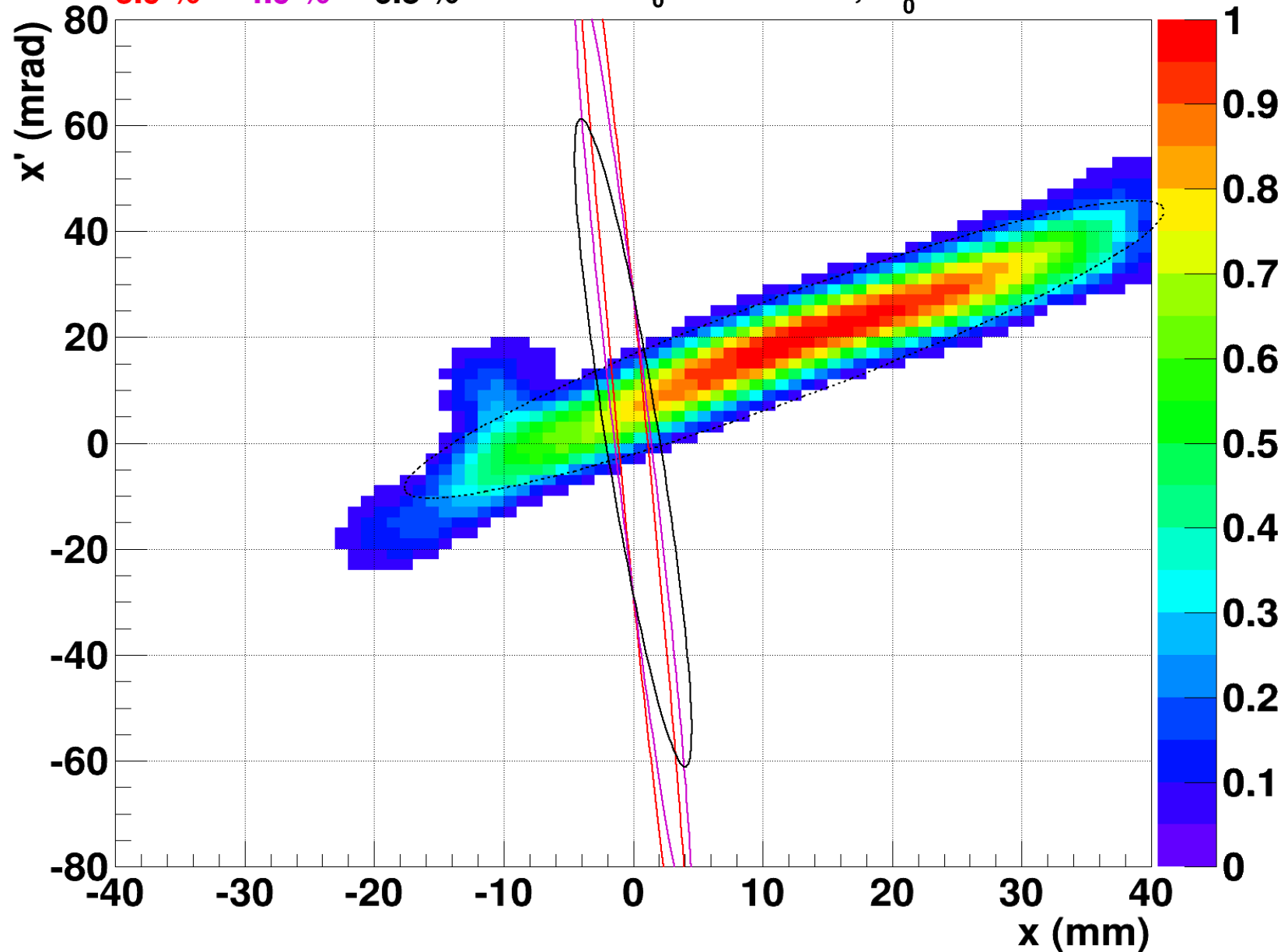


Run 688 V 130,080,000A; 11.5A, 21kV

$\alpha_x = -2.55$, $\beta_x = 2.86$, $\gamma_x = 2.62$; norm rms $\epsilon_x = 0.88$

3.9 % 4.9 % 6.8 %

$x_0 = 11.66$ mm, $x'_0 = 17.68$ mrad

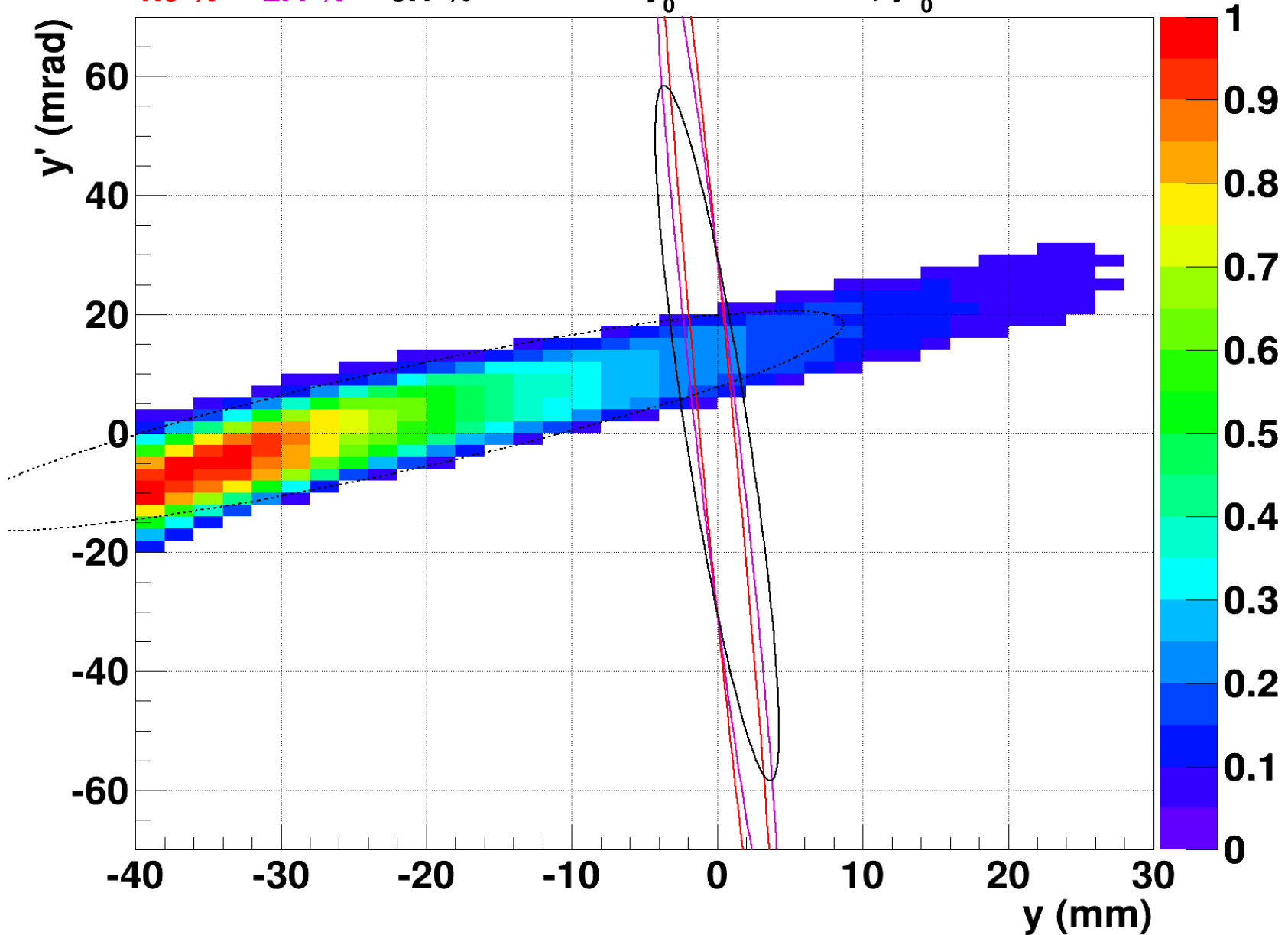


Run 654 V 000,000,000A; 11.5A, 21kV

$\alpha_y = -1.86$, $\beta_y = 3.52$, $\gamma_y = 1.27$; norm rms $\epsilon_y = 0.79$

1.5 % 2.4 % 3.1 %

$y_0 = -22.11$ mm, $y'_0 = 2.06$ mrad

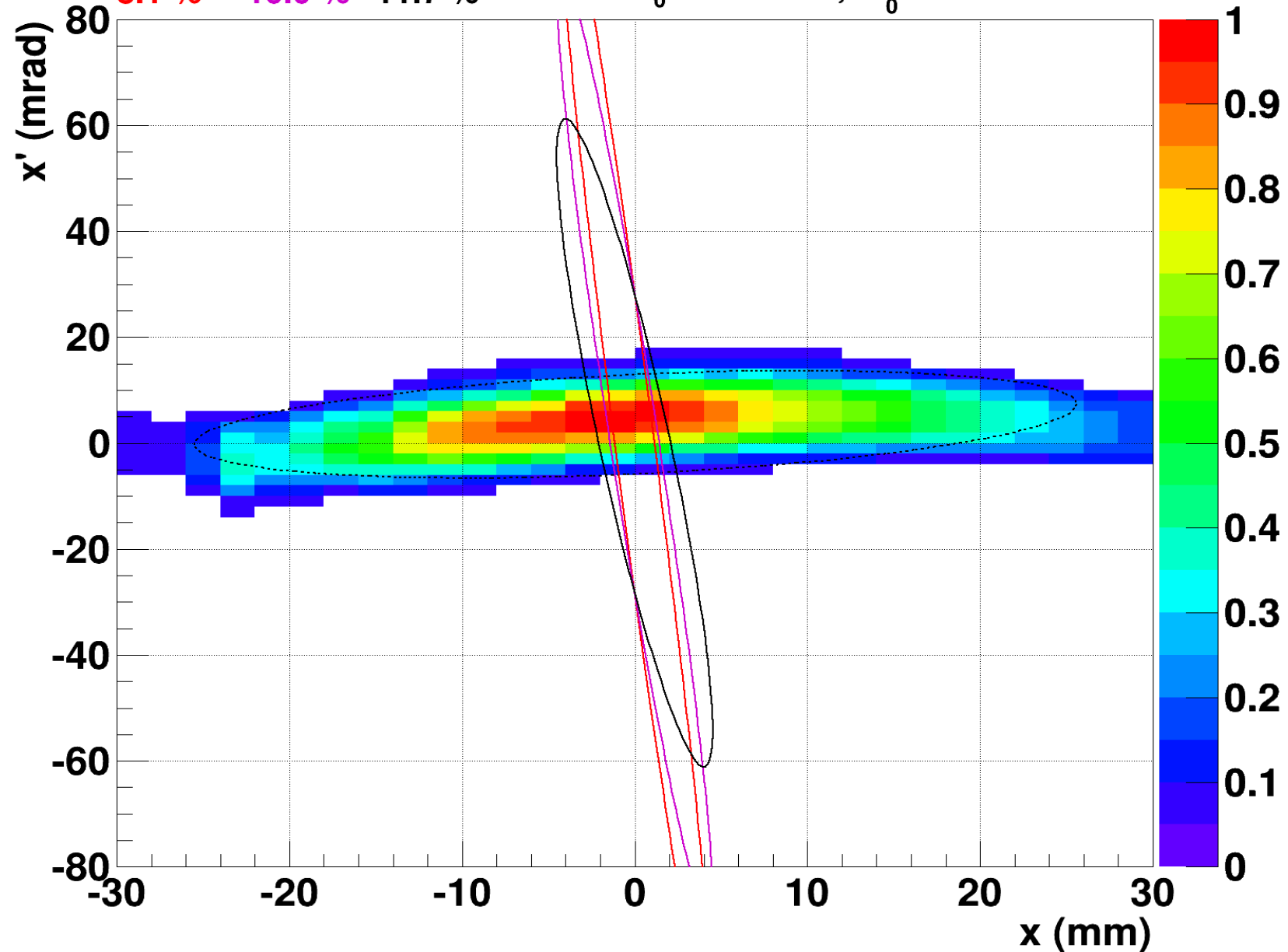


Run 856 H 070,070,-070A; 12.8A, 21kV

$\alpha_x = -0.41$, $\beta_x = 2.72$, $\gamma_x = 0.43$; norm rms $\epsilon_x = 0.70$

8.1 % 10.0 % 11.7 %

$x_0 = 0.05$ mm, $x'_0 = 3.54$ mrad

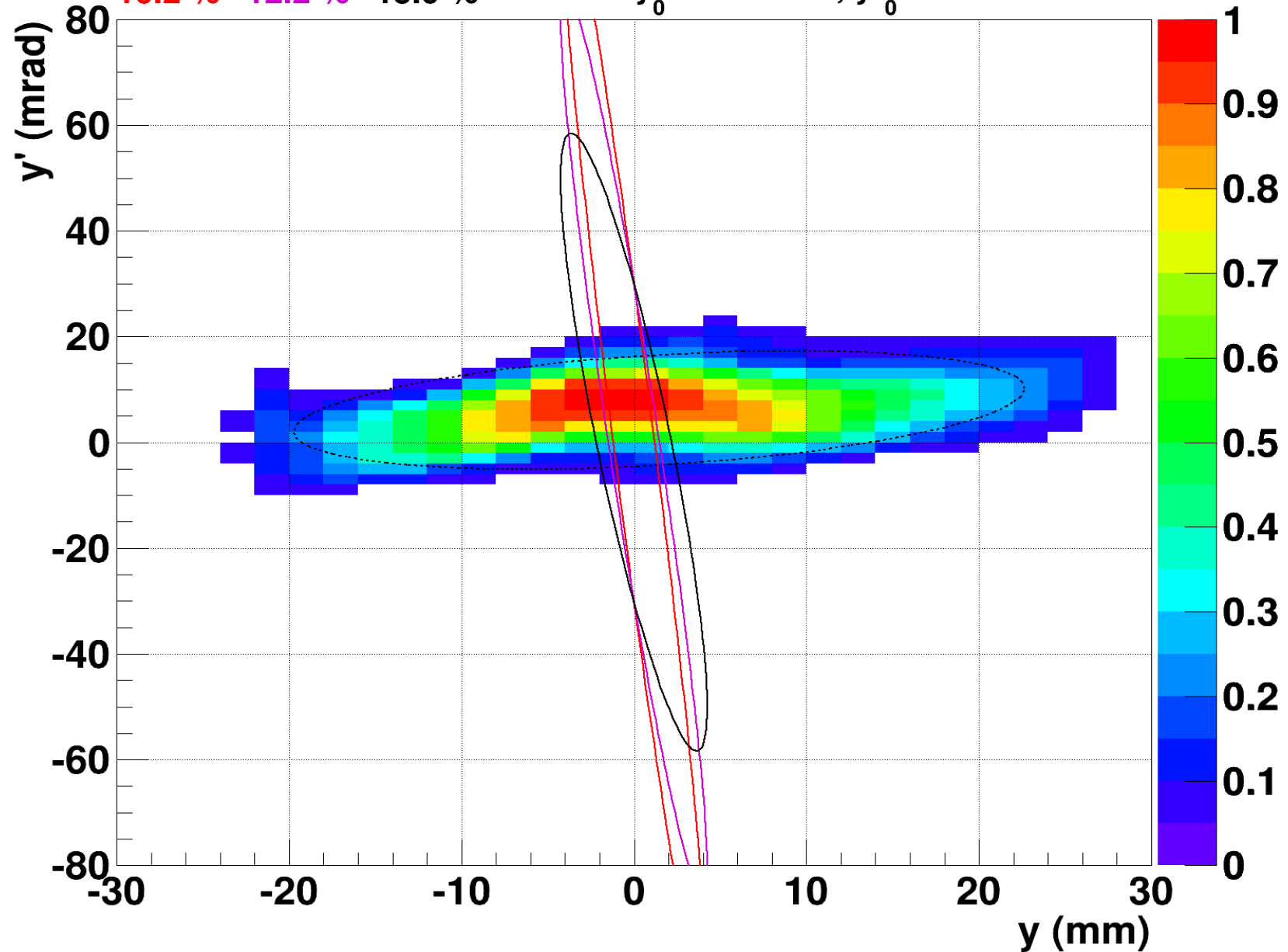


Run 857 V 070,070,-070A; 12.8A, 21kV

$\alpha_y = -0.40$, $\beta_y = 2.03$, $\gamma_y = 0.57$; norm rms $\epsilon_y = 0.65$

10.2 % 12.2 % 15.0 %

$y_0 = 1.47$ mm, $y'_0 = 6.11$ mrad



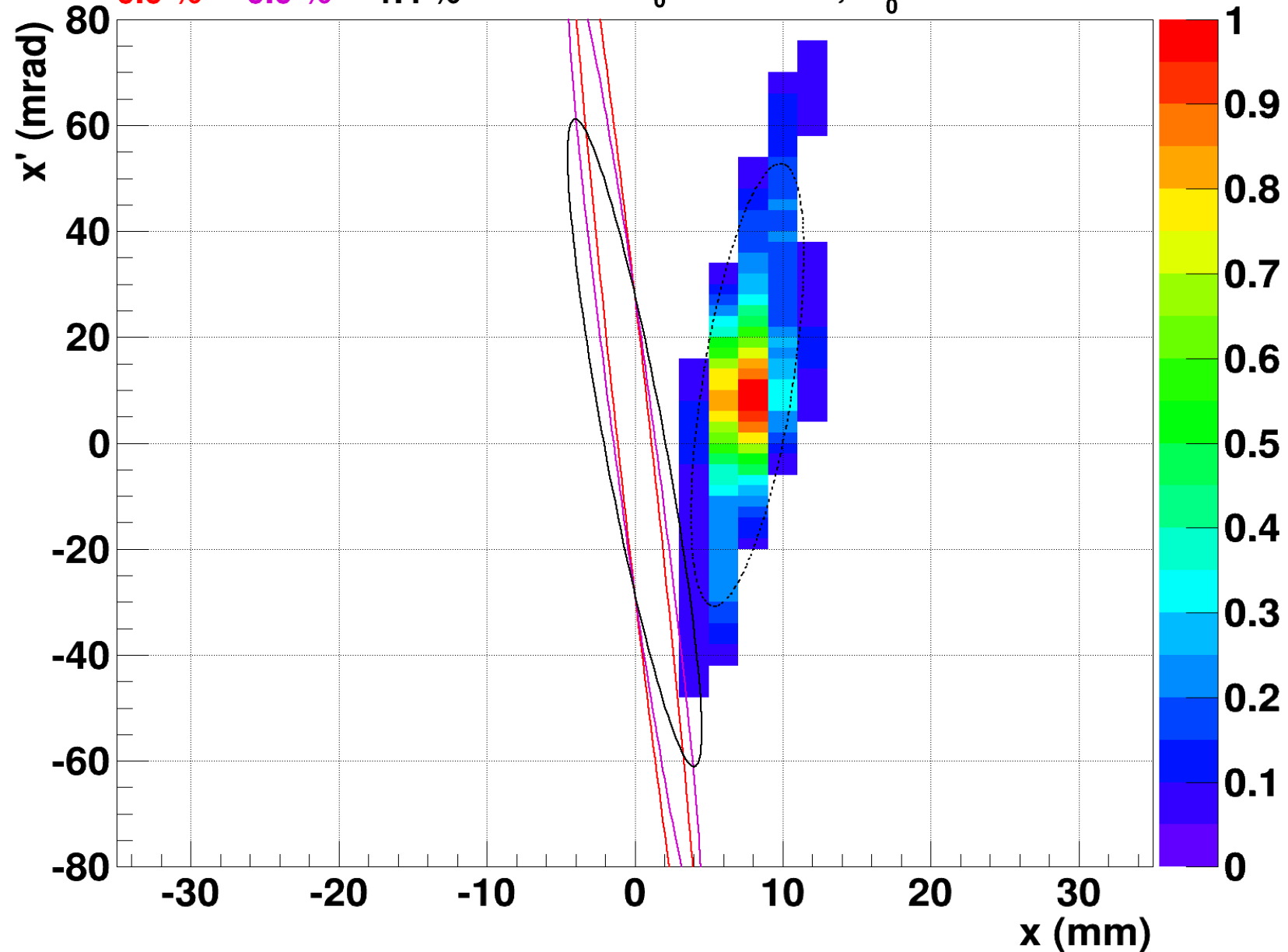
Variation of S2 (&S3)

Run 872 H 130,000,-245A; 12.5A, 21kV

$\alpha_x = -0.73$, $\beta_x = 0.11$, $\gamma_x = 13.58$; norm rms $\epsilon_x = 0.38$

0.0 % 0.0 % 1.4 %

$x_0 = 7.62$ mm, $x'_0 = 10.98$ mrad

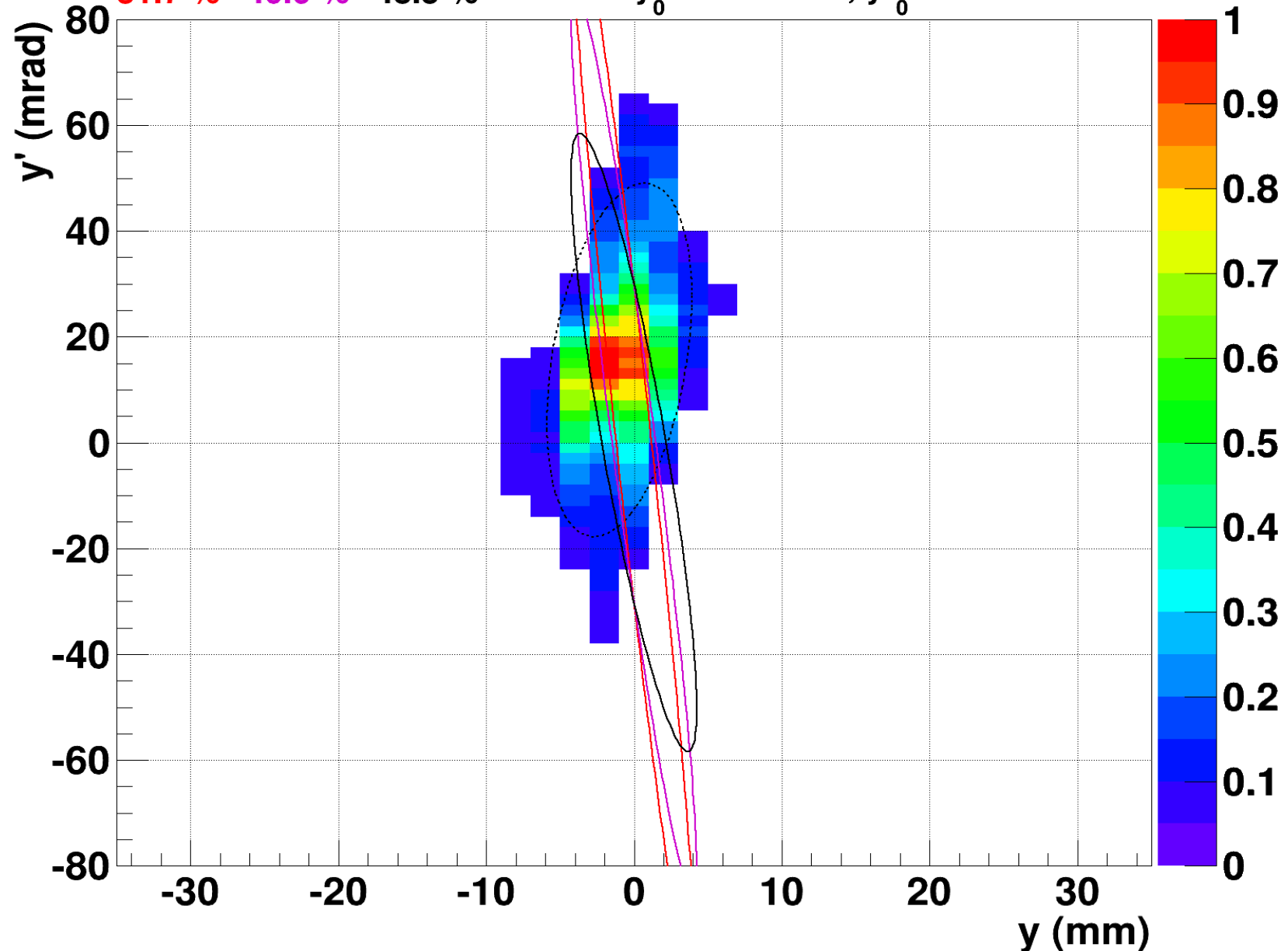


Run 871 V 130,000,-245A; 12.5A, 21kV

$\alpha_y = -0.37$, $\beta_y = 0.16$, $\gamma_y = 7.28$; norm rms $\epsilon_y = 0.45$

31.7 % 40.6 % 48.5 %

$y_0 = -0.98$ mm, $y'_0 = 15.59$ mrad

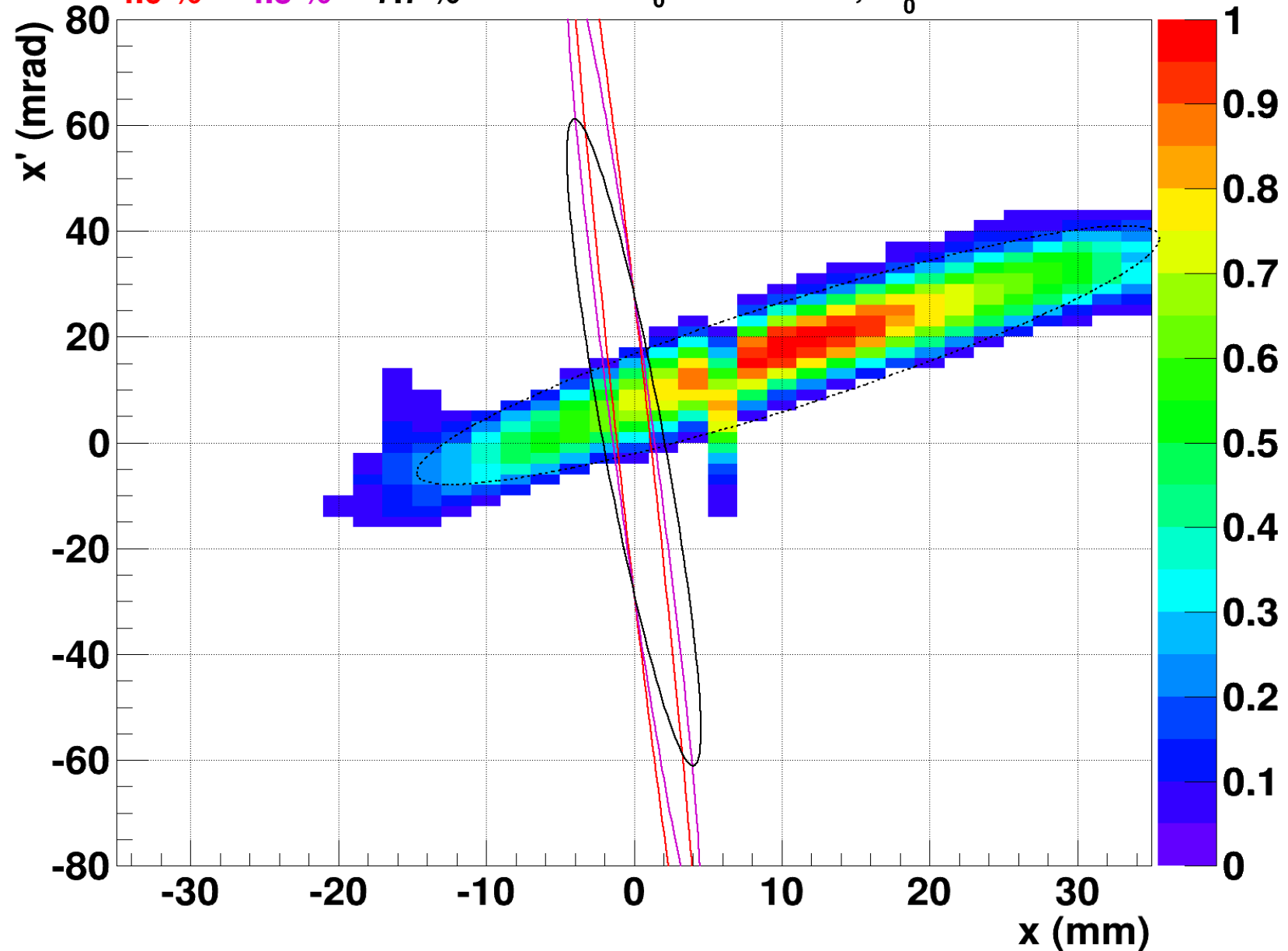


Run 873 H 130,080,000A; 12.5A, 21kV

$\alpha_x = -2.14$, $\beta_x = 2.43$, $\gamma_x = 2.29$; norm rms $\epsilon_x = 0.77$

4.0 % 4.3 % 7.7 %

$x_0 = 10.45$ mm, $x'_0 = 16.50$ mrad

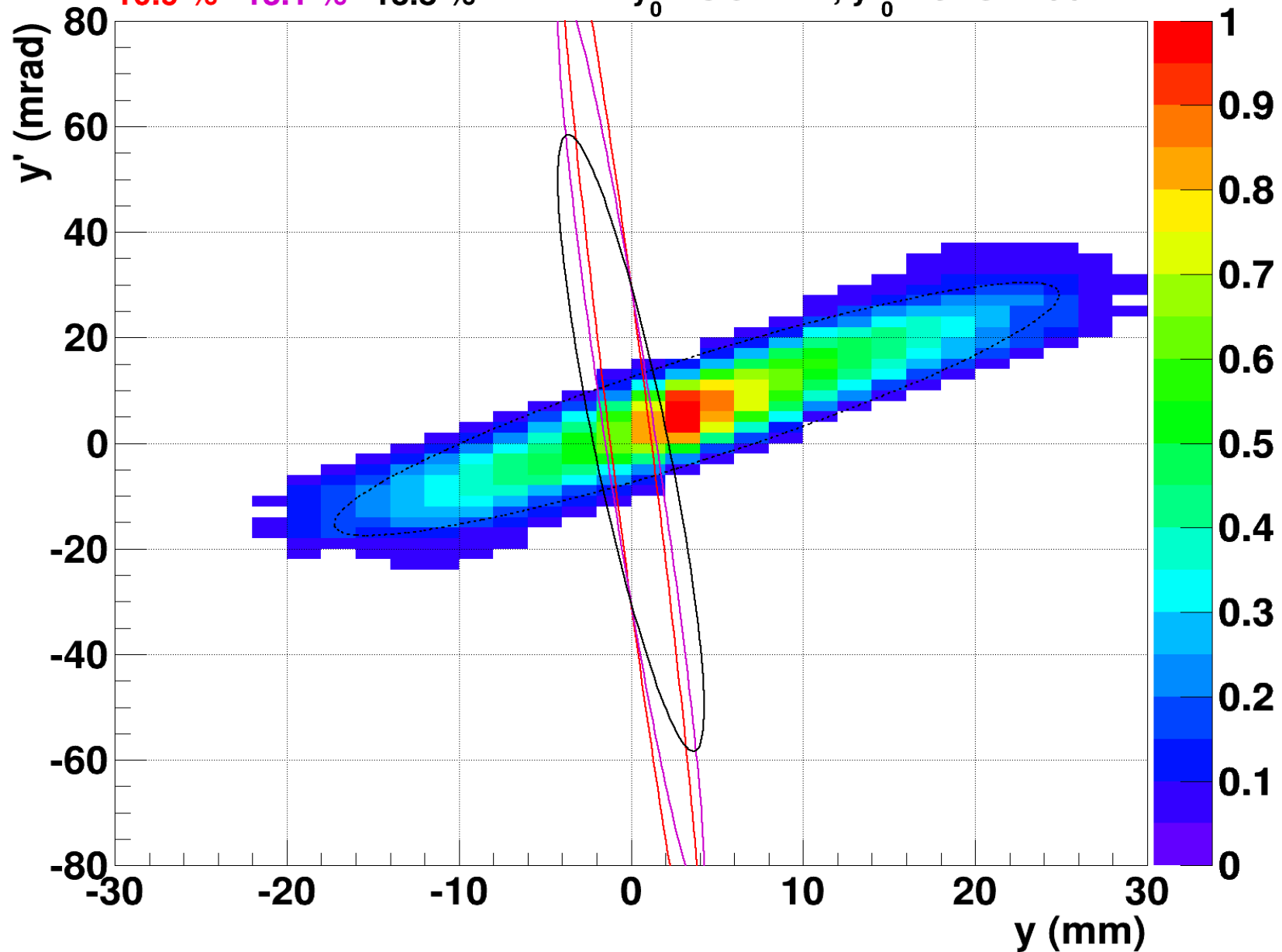


Run 858 V 130,080,000A; 12.5A, 21kV

$\alpha_y = -2.15$, $\beta_y = 2.09$, $\gamma_y = 2.70$; norm rms $\epsilon_y = 0.63$

10.9 % 13.1 % 13.8 %

$y_0 = 3.82$ mm, $y'_0 = 6.45$ mrad

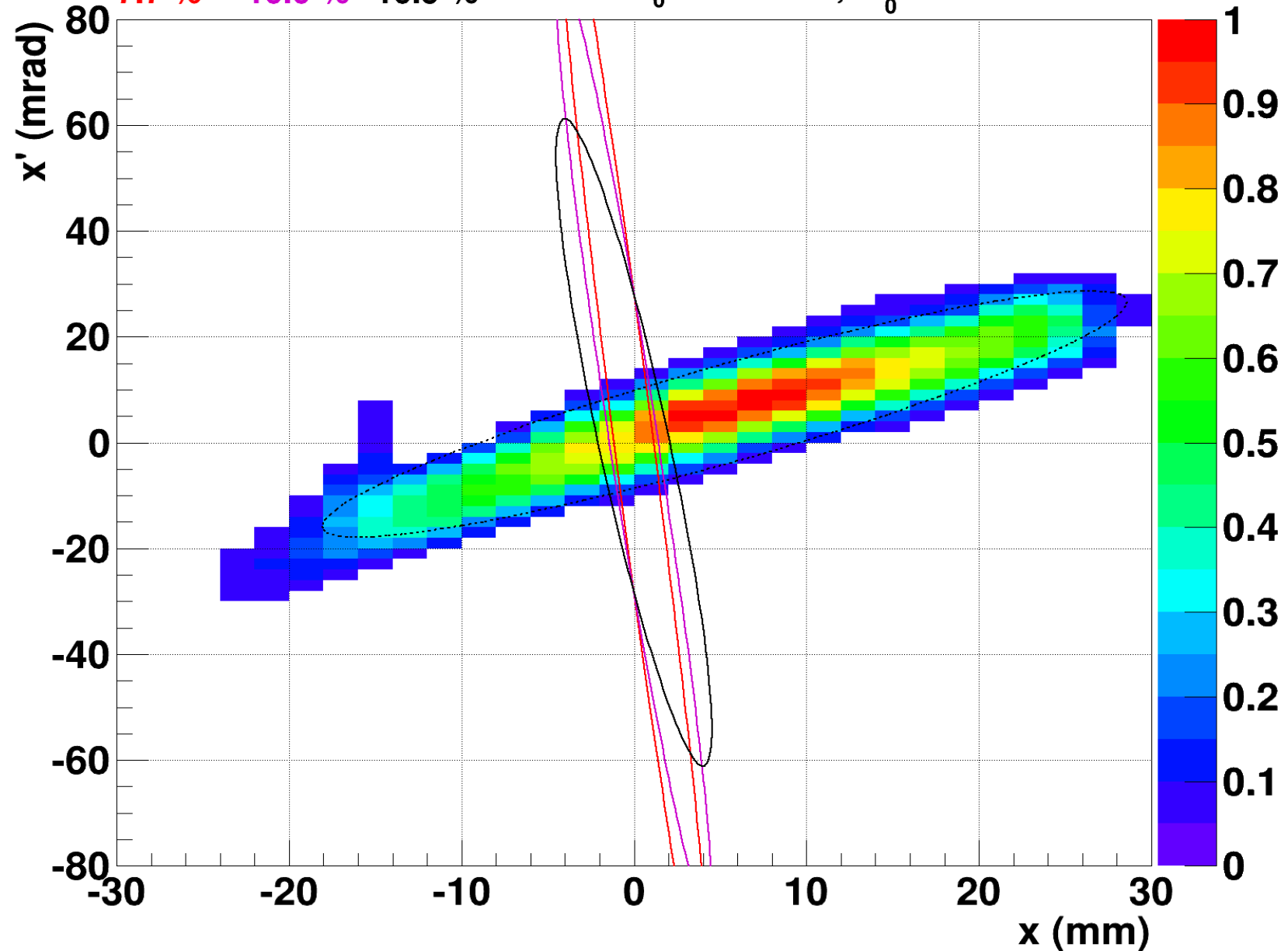


Run 874 H 130,100,000A; 12.5A, 21kV

$\alpha_x = -2.23$, $\beta_x = 2.45$, $\gamma_x = 2.43$; norm rms $\epsilon_x = 0.65$

7.7 % 10.0 % 10.9 %

$x_0 = 5.26$ mm, $x'_0 = 5.38$ mrad

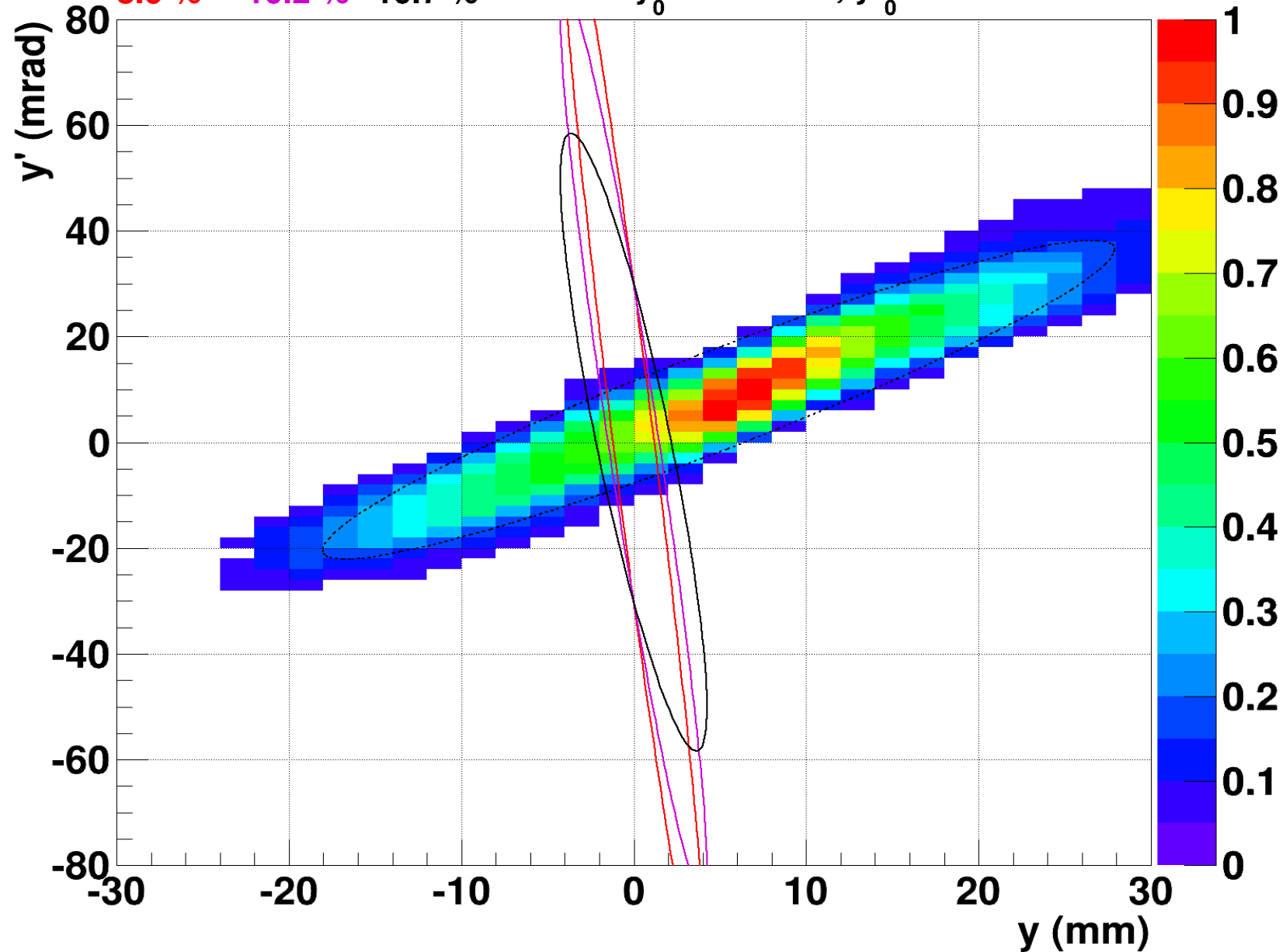


Run 868 V 130,100,000A; 12.5A, 21kV

$\alpha_y = -2.87$, $\beta_y = 2.32$, $\gamma_y = 3.99$; norm rms $\epsilon_y = 0.67$

8.6 % 10.2 % 10.7 %

$y_0 = 4.93$ mm, $y'_0 = 8.05$ mrad

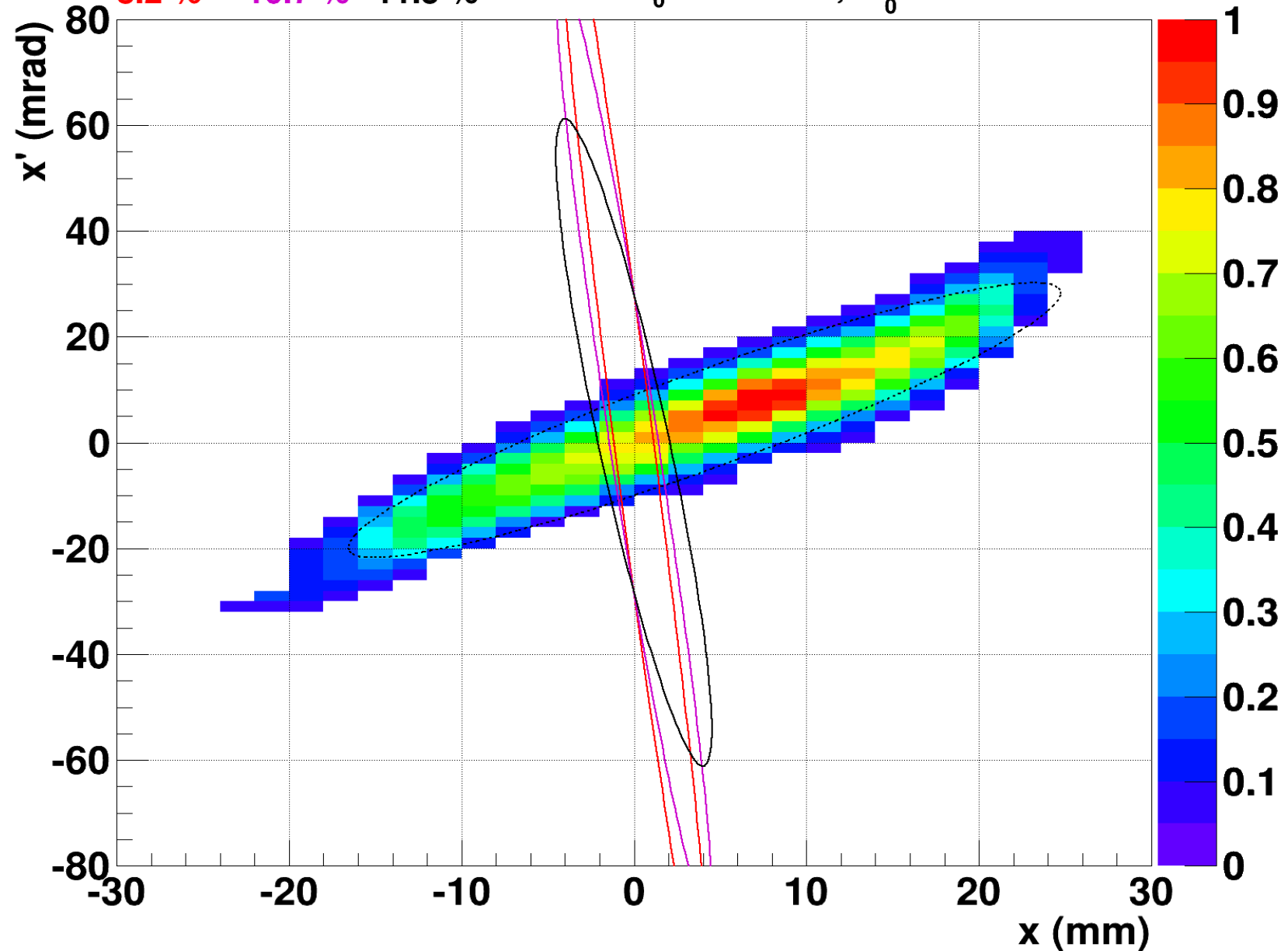


Run 875 H 130,130,000A; 12.5A, 21kV

$\alpha_x = -2.47$, $\beta_x = 2.12$, $\gamma_x = 3.35$; norm rms $\epsilon_x = 0.59$

8.2 % 10.7 % 11.5 %

$x_0 = 4.11$ mm, $x'_0 = 4.24$ mrad

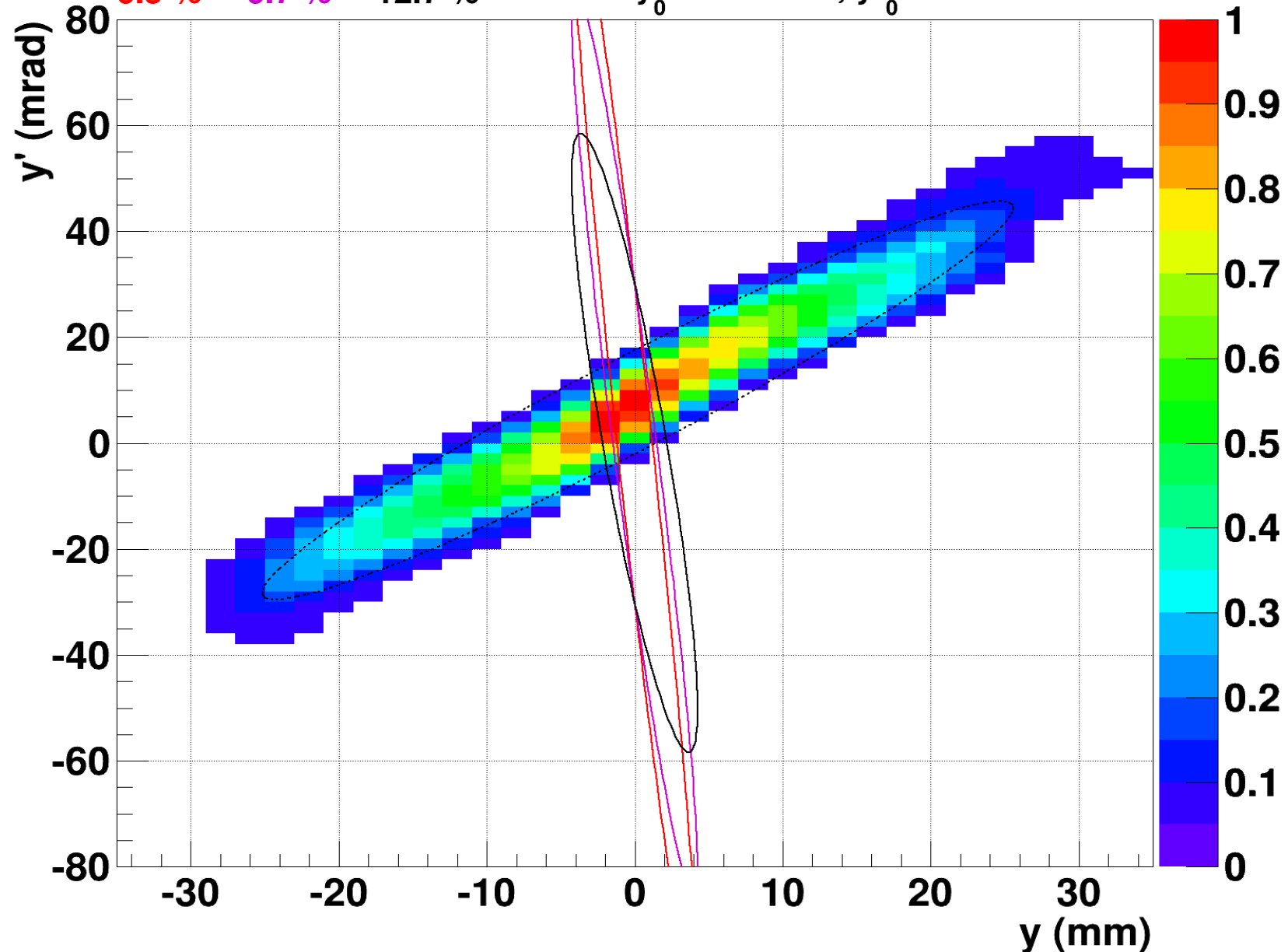


Run 869 V 130,130,000A; 12.5A, 21kV

$\alpha_y = -3.70$, $\beta_y = 2.59$, $\gamma_y = 5.69$; norm rms $\epsilon_y = 0.73$

6.5 % 6.7 % 12.7 %

$y_0 = 0.22$ mm, $y'_0 = 8.05$ mrad

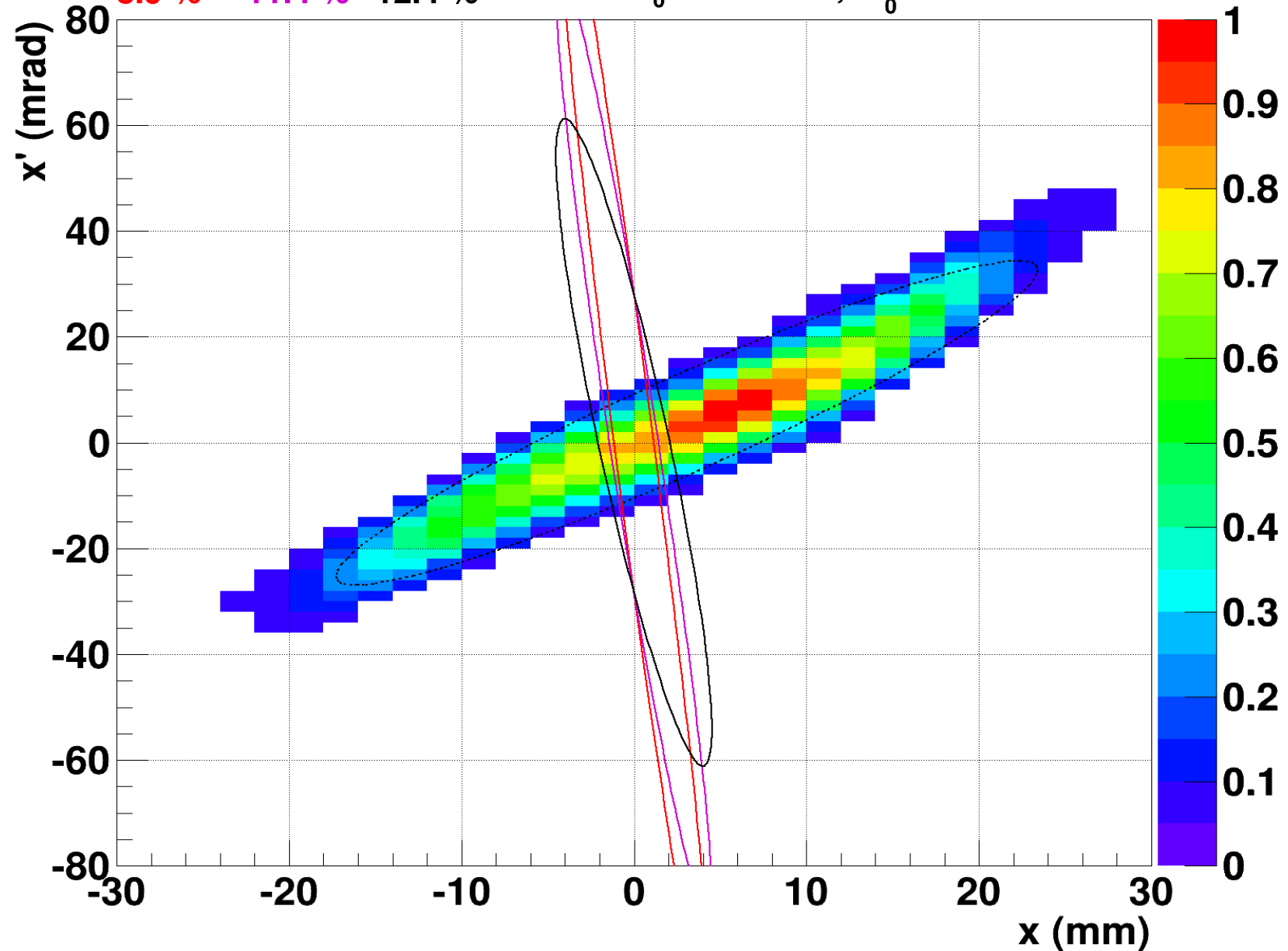


Run 876 H 130,150,000A; 12.5A, 21kV

$\alpha_x = -2.91$, $\beta_x = 2.04$, $\gamma_x = 4.63$; norm rms $\epsilon_x = 0.60$

8.9 % 11.4 % 12.4 %

$x_0 = 3.08$ mm, $x'_0 = 3.70$ mrad

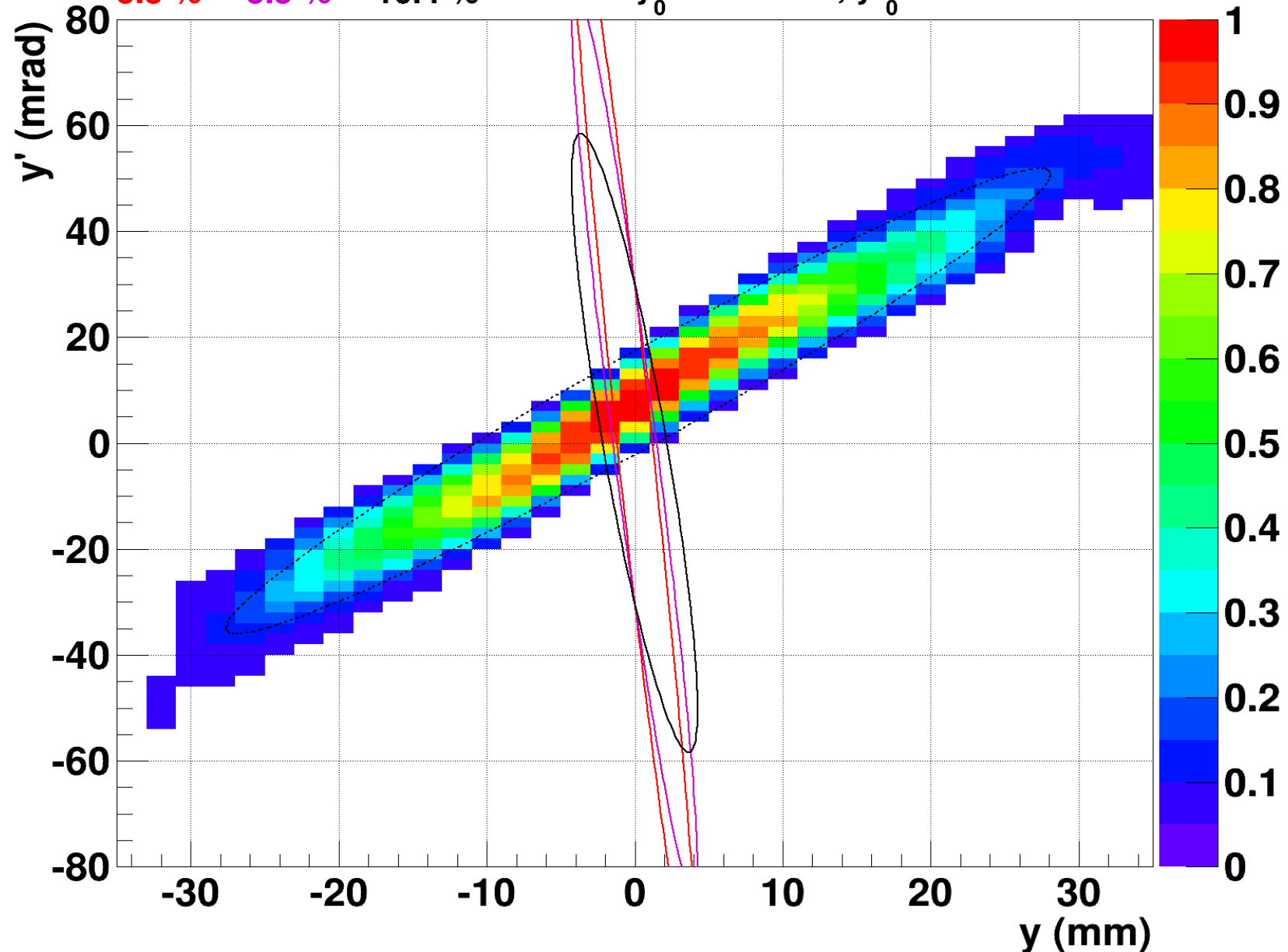


Run 870 V 130,150,000A; 12.5A, 21kV

$\alpha_y = -4.36$, $\beta_y = 2.84$, $\gamma_y = 7.06$; norm rms $\epsilon_y = 0.80$

5.3 % 5.5 % 10.4 %

$y_0 = 0.27$ mm, $y'_0 = 7.94$ mrad

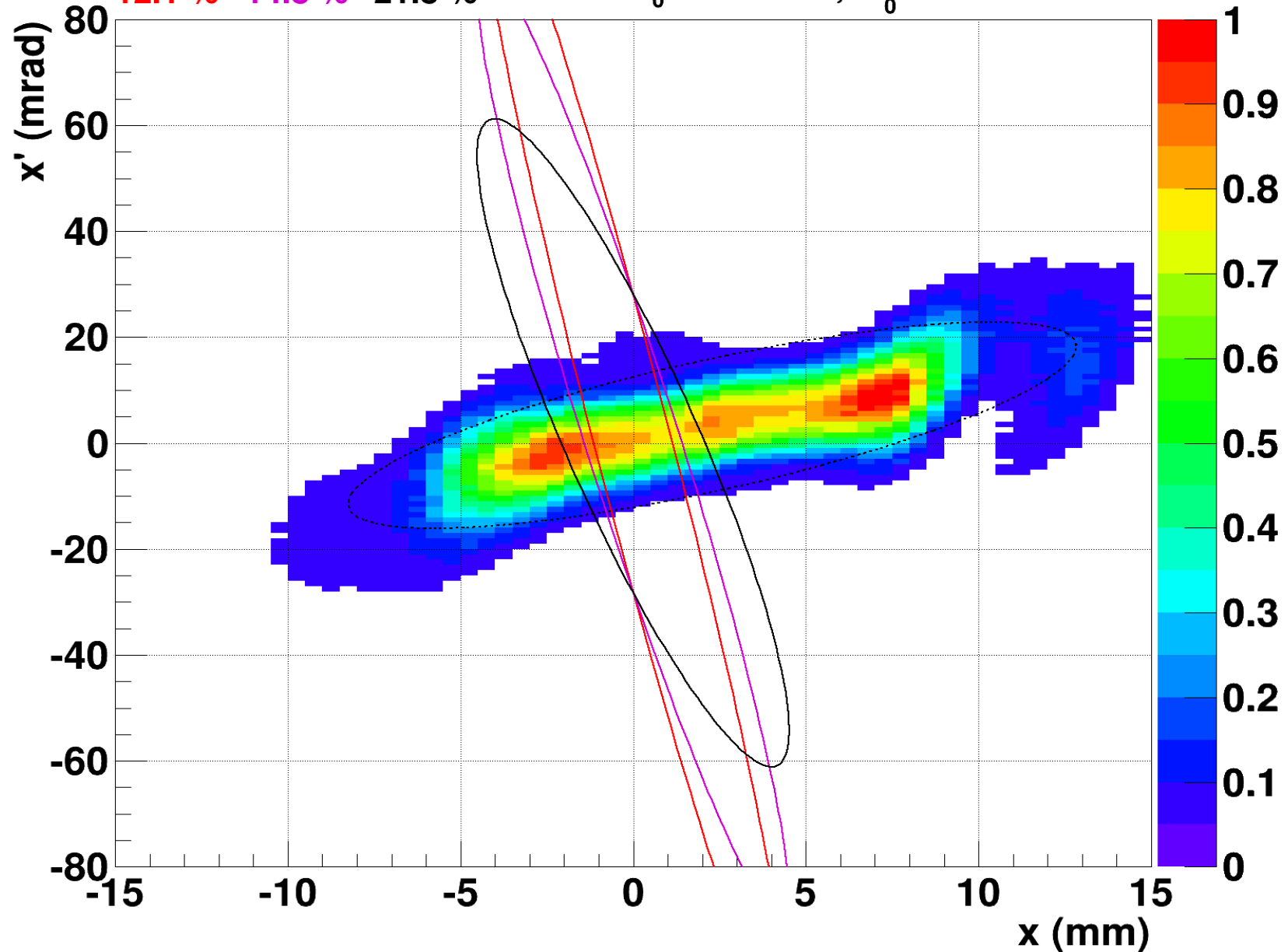


Run 877 H 130,150,-245A; 12.5A, 21kV

$\alpha_x = -1.18$, $\beta_x = 0.84$, $\gamma_x = 2.85$; norm rms $\epsilon_x = 0.39$

12.1 % 14.8 % 21.8 %

$x_0 = 2.29$ mm, $x'_0 = 3.36$ mrad

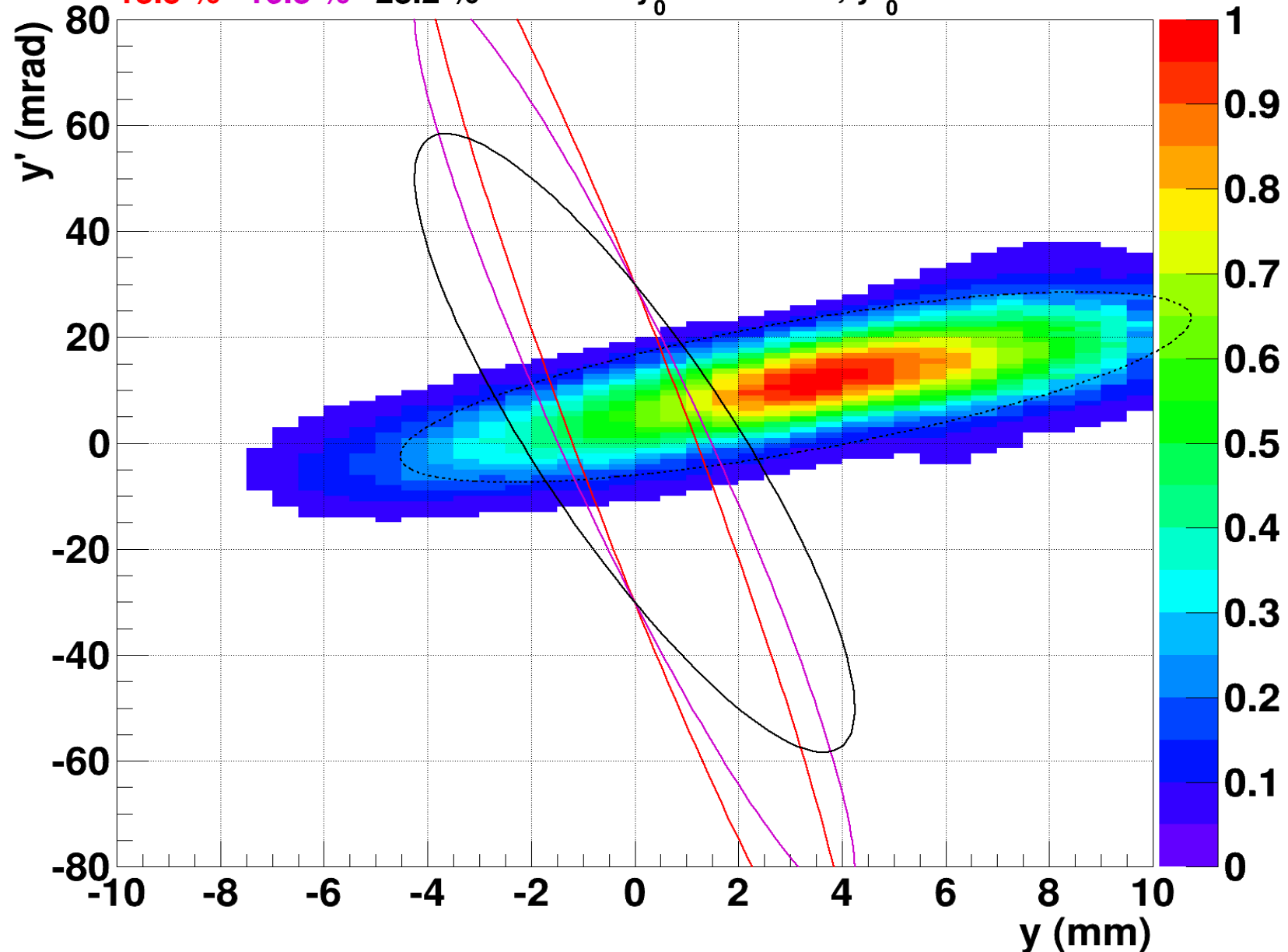


Run 865 V 130,150,-245A; 12.5A, 21kV

$\alpha_y = -1.04$, $\beta_y = 0.61$, $\gamma_y = 3.40$; norm rms $\epsilon_y = 0.28$

13.5 % 16.3 % 23.2 %

$y_0 = 3.11$ mm, $y'_0 = 10.59$ mrad

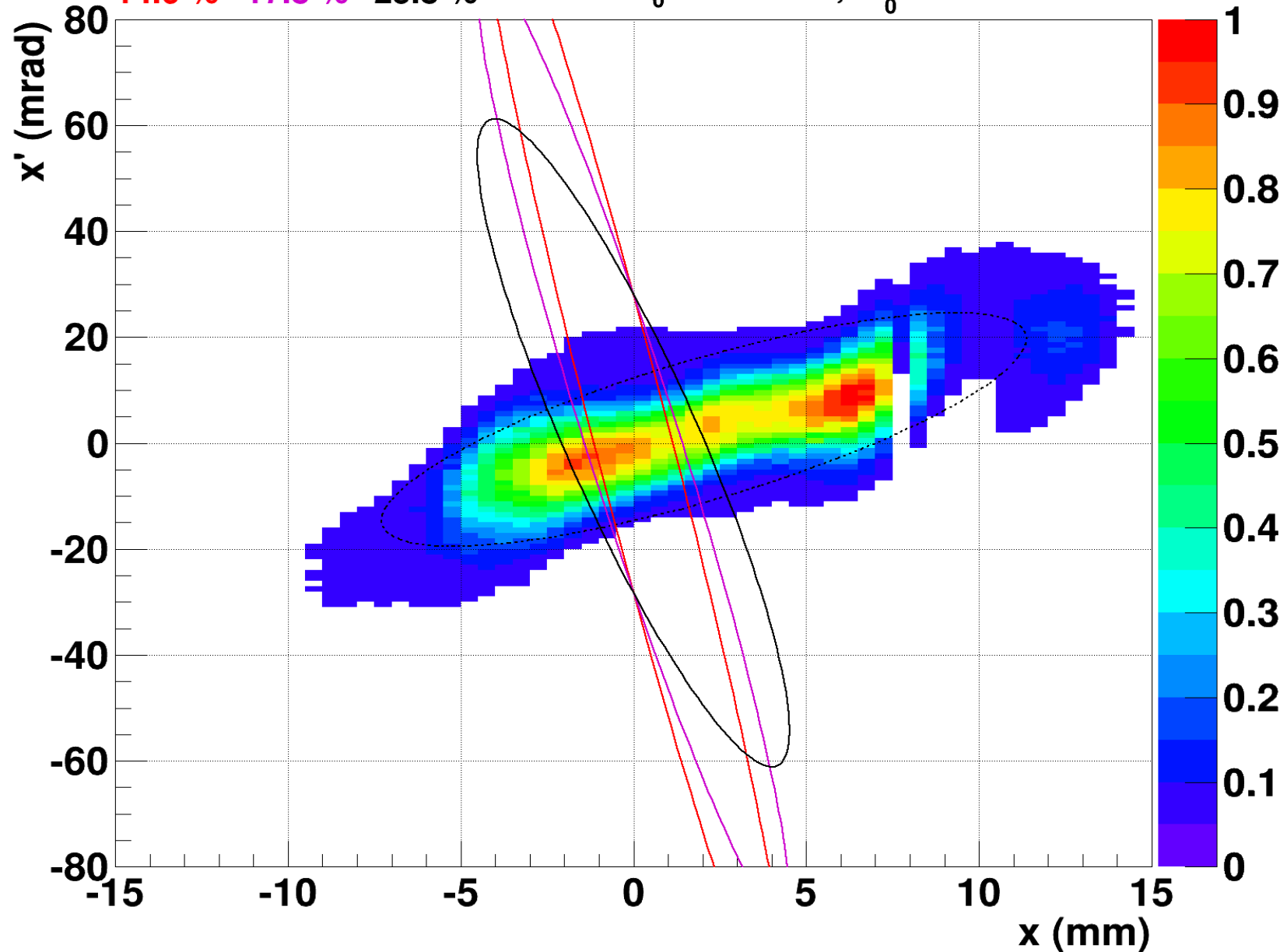


Run 878 H 130,130,-245A; 12.5A, 21kV

$\alpha_x = -1.24$, $\beta_x = 0.68$, $\gamma_x = 3.76$; norm rms $\epsilon_x = 0.38$

14.6 % 17.8 % 25.8 %

$x_0 = 2.04$ mm, $x'_0 = 2.54$ mrad

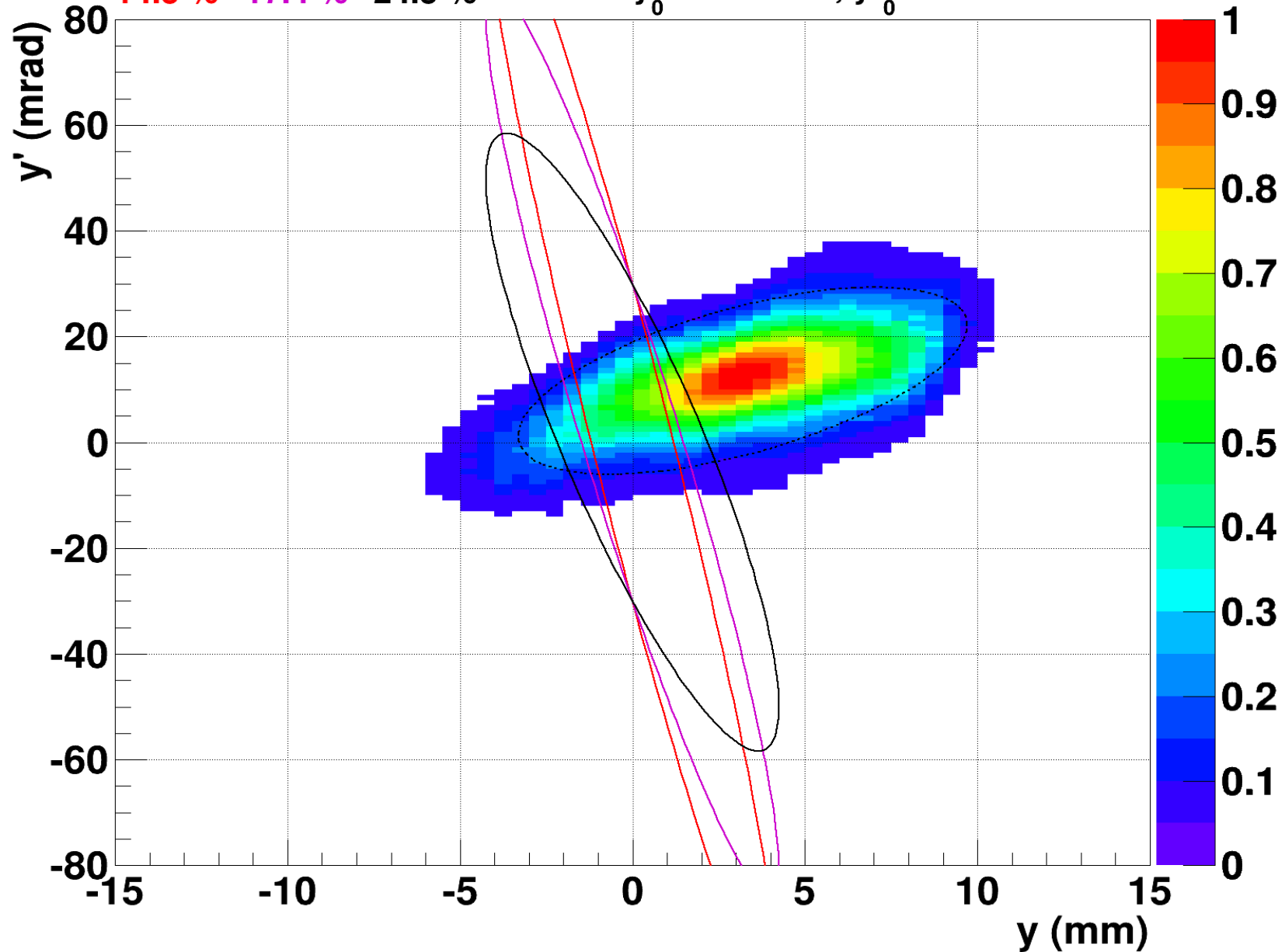


Run 862 V 130,130,-245A; 12.5A, 21kV

$\alpha_y = -0.74$, $\beta_y = 0.46$, $\gamma_y = 3.37$; norm rms $\epsilon_y = 0.27$

14.5 % 17.4 % 24.5 %

$y_0 = 3.19$ mm, $y'_0 = 11.65$ mrad

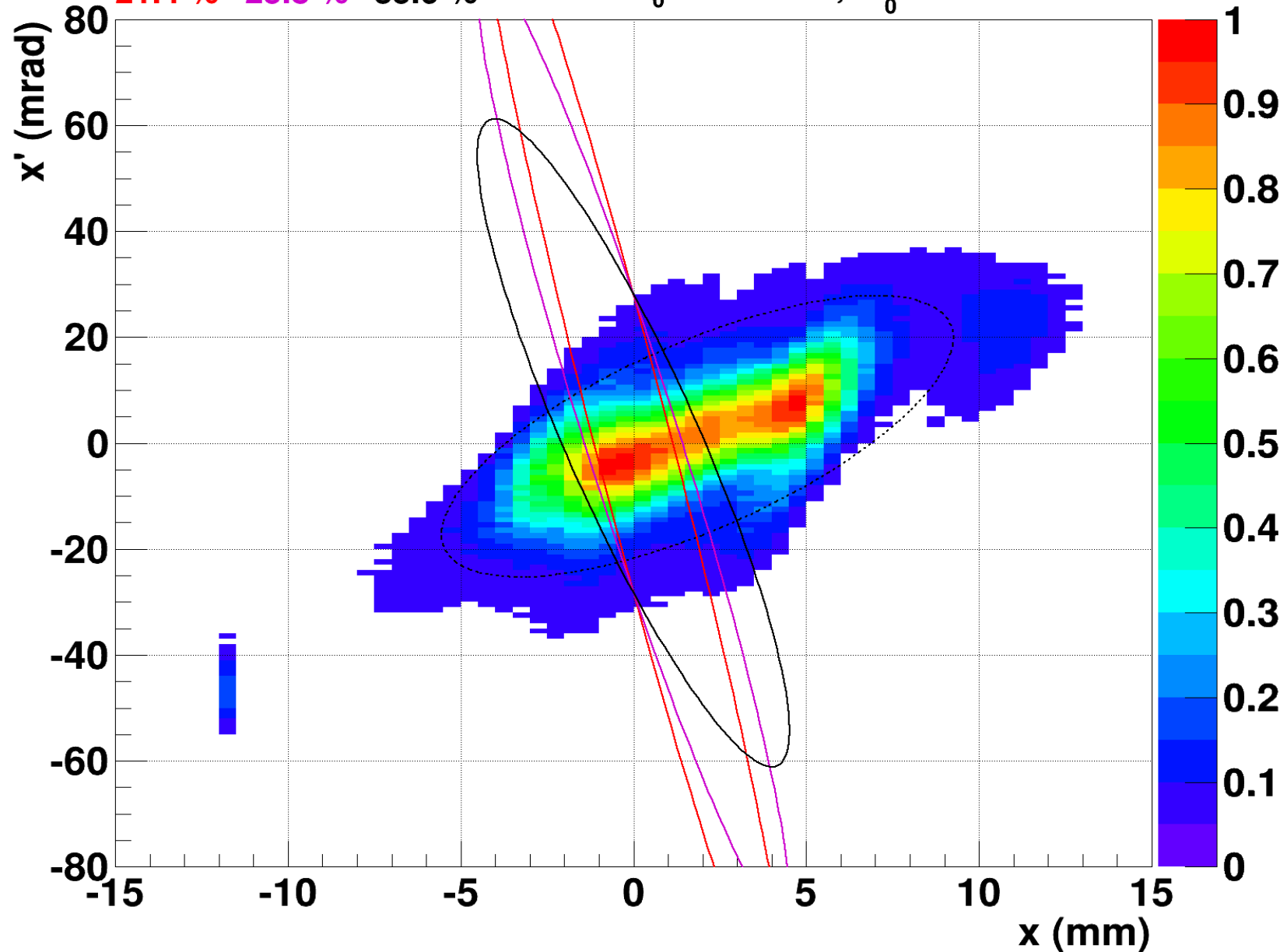


Run 879 H 130,100,-245A; 12.5A, 21kV

$\alpha_x = -0.98$, $\beta_x = 0.39$, $\gamma_x = 5.01$; norm rms $\epsilon_x = 0.41$

21.4 % 25.8 % 35.6 %

$x_0 = 1.86$ mm, $x'_0 = 1.27$ mrad

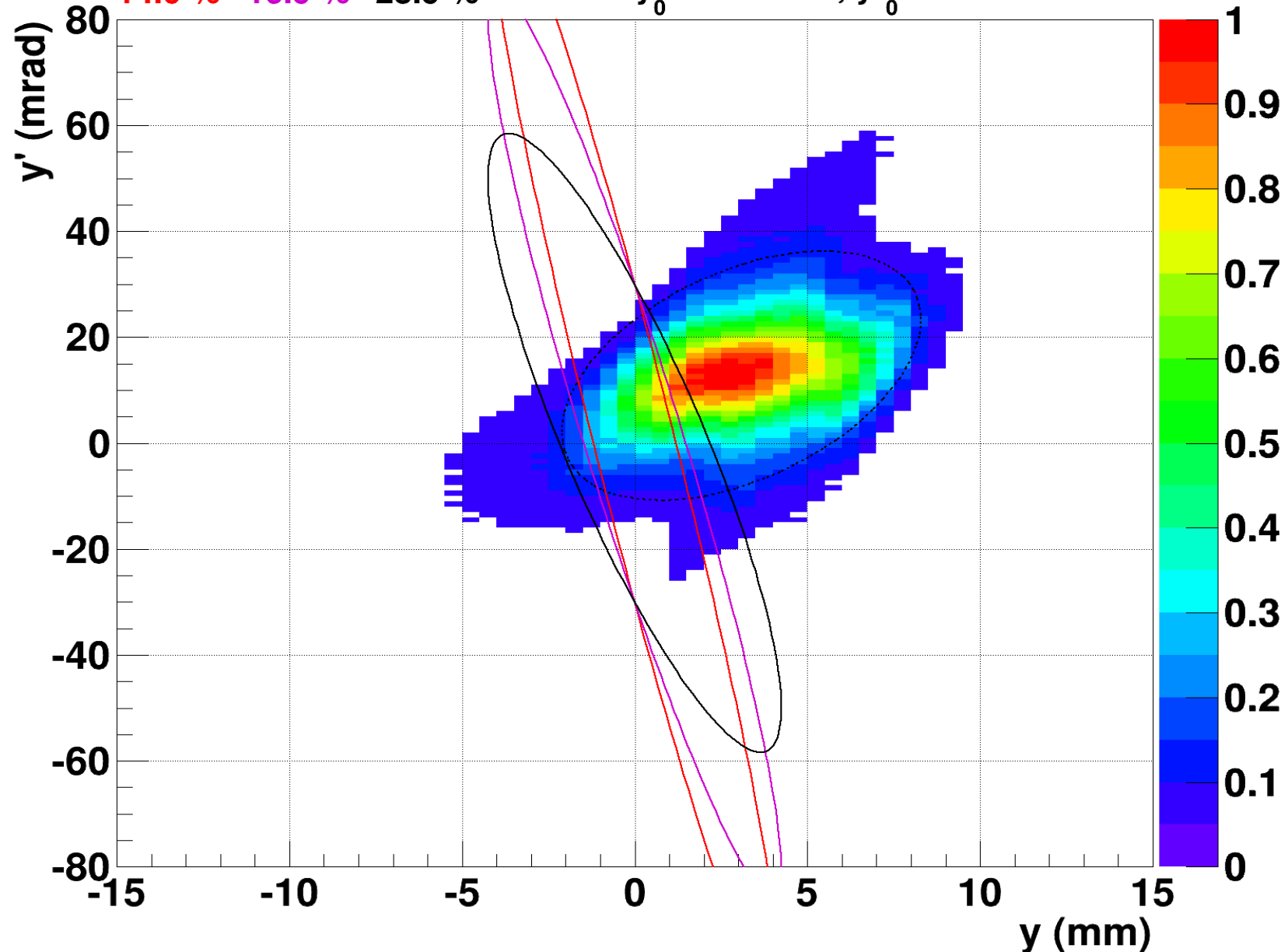


Run 861 V 130,100,-245A; 12.5A, 21kV

$\alpha_y = -0.51$, $\beta_y = 0.25$, $\gamma_y = 5.08$; norm rms $\epsilon_y = 0.32$

14.0 % 16.9 % 23.9 %

$y_0 = 3.09$ mm, $y'_0 = 12.71$ mrad

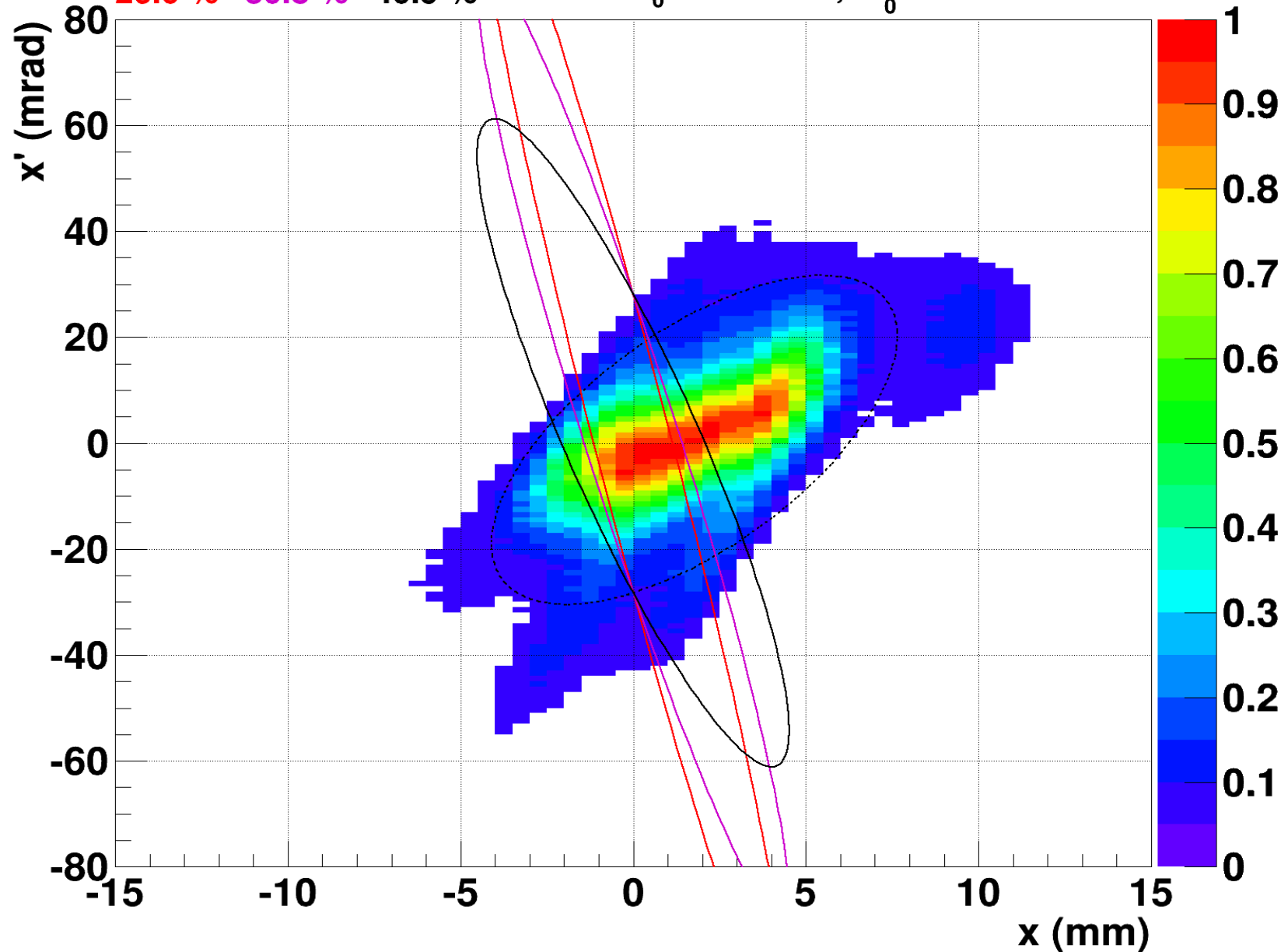


Run 880 H 130,080,-245A; 12.5A, 21kV

$\alpha_x = -0.82$, $\beta_x = 0.24$, $\gamma_x = 6.83$; norm rms $\epsilon_x = 0.42$

26.0 % 30.8 % 40.9 %

$x_0 = 1.78$ mm, $x'_0 = 0.58$ mrad

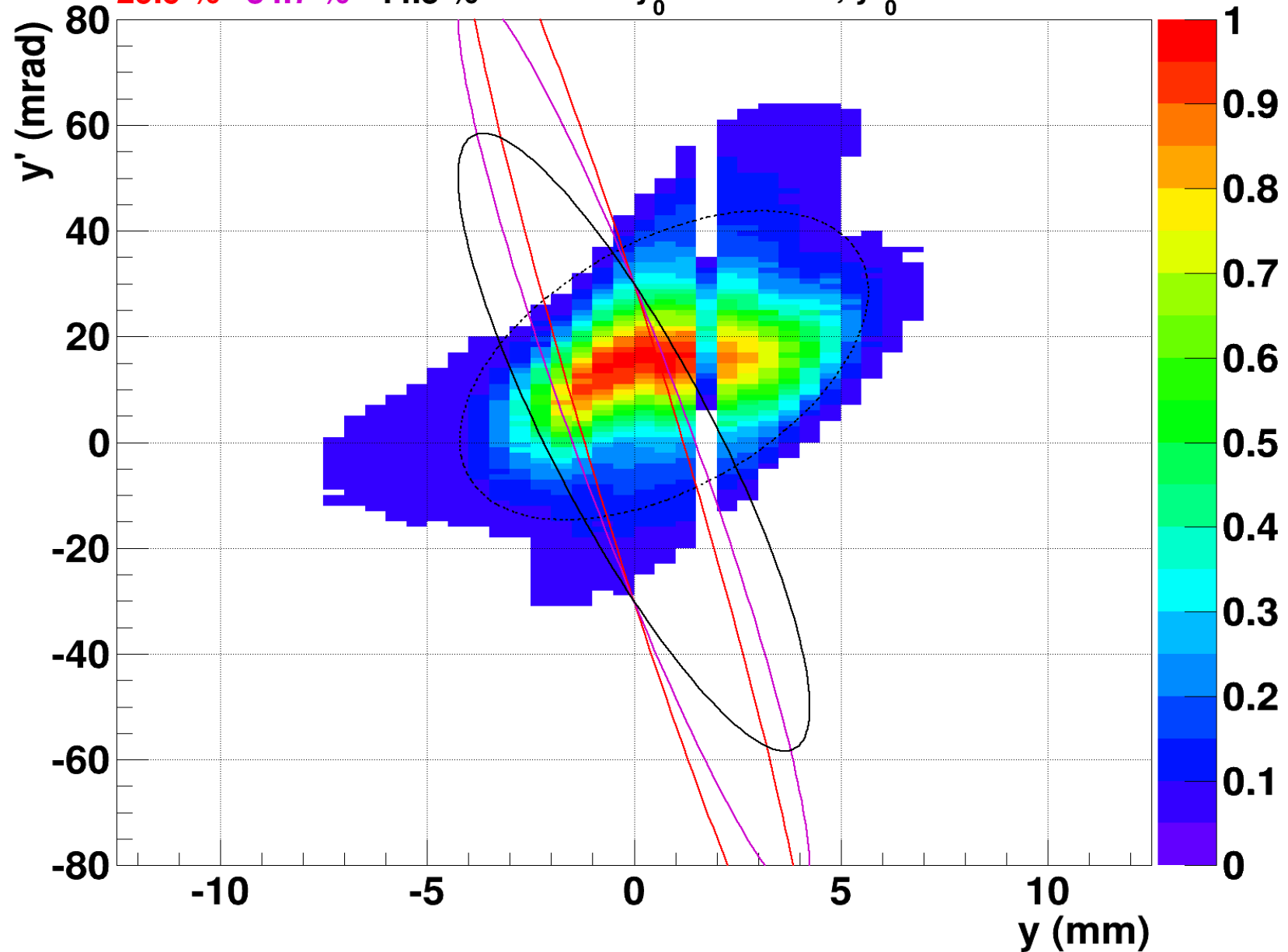


Run 866 V 130,080,-245A; 12.5A, 21kV

$\alpha_y = -0.55$, $\beta_y = 0.19$, $\gamma_y = 6.76$; norm rms $\epsilon_y = 0.37$

29.9 % 34.7 % 44.5 %

$y_0 = 0.73$ mm, $y'_0 = 14.52$ mrad

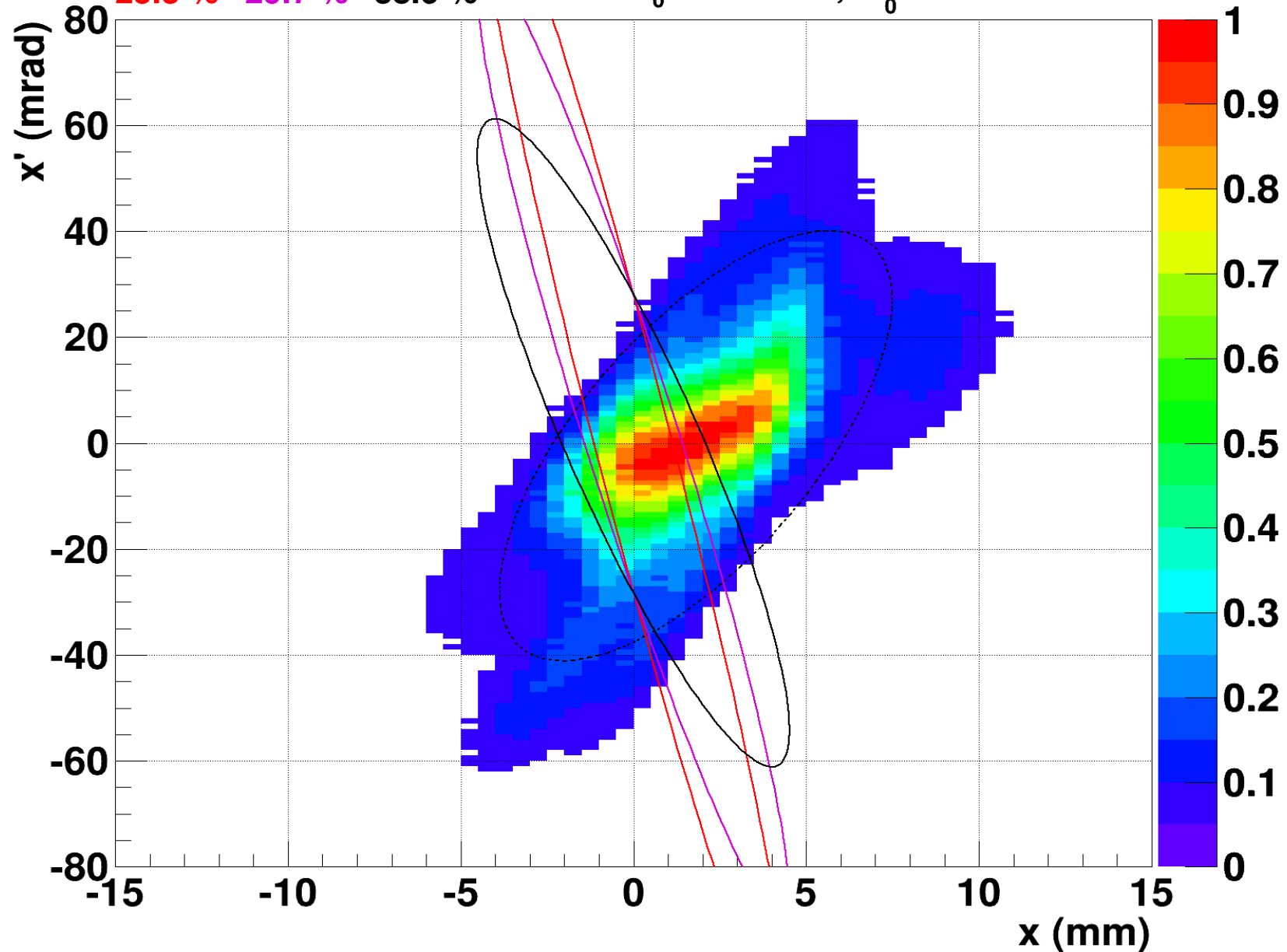


Run 881 H 130,060,-245A; 12.5A, 21kV

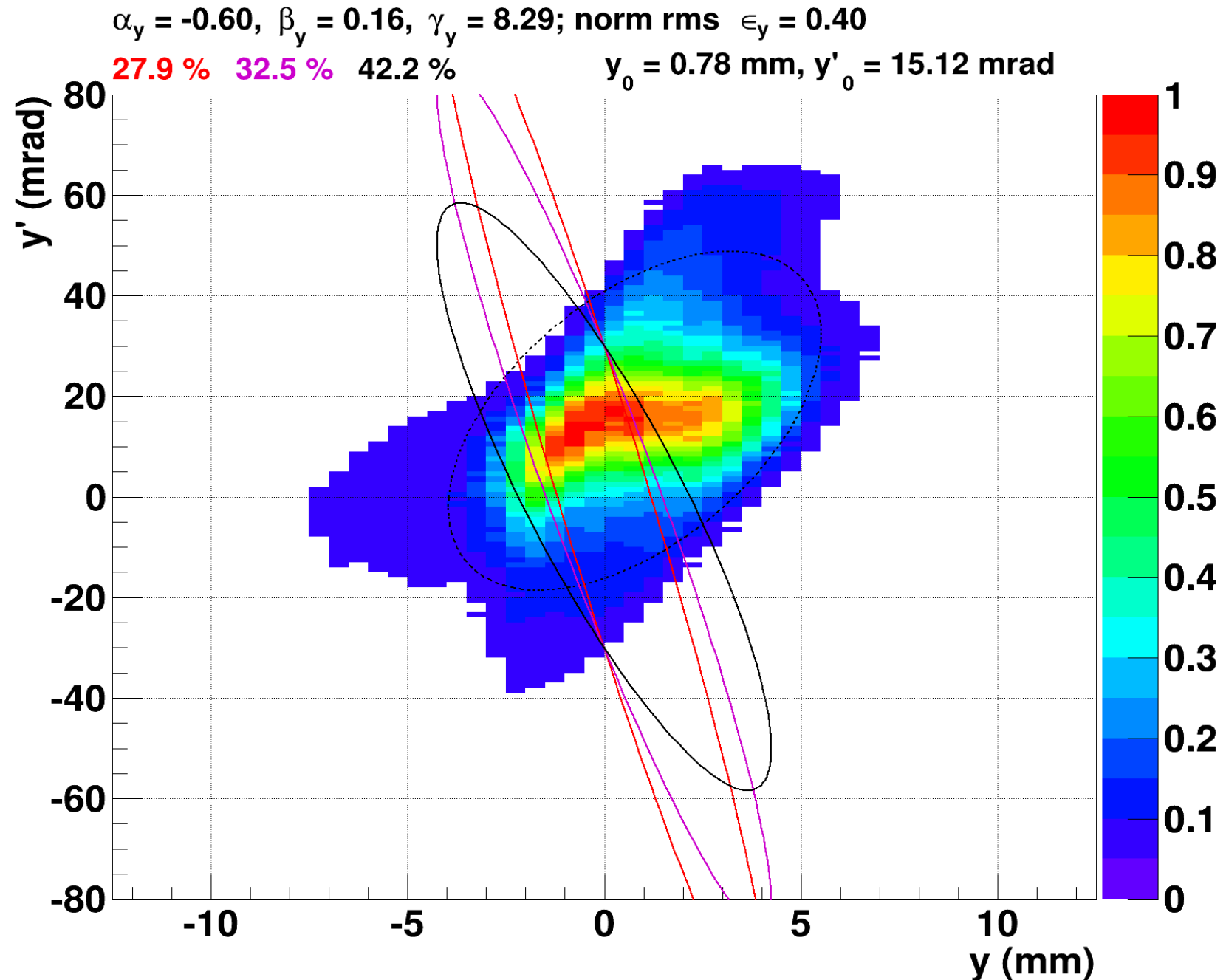
$\alpha_x = -0.92$, $\beta_x = 0.19$, $\gamma_x = 9.71$; norm rms $\epsilon_x = 0.50$

25.3 % 29.7 % 38.6 %

$x_0 = 1.81$ mm, $x'_0 = -0.52$ mrad

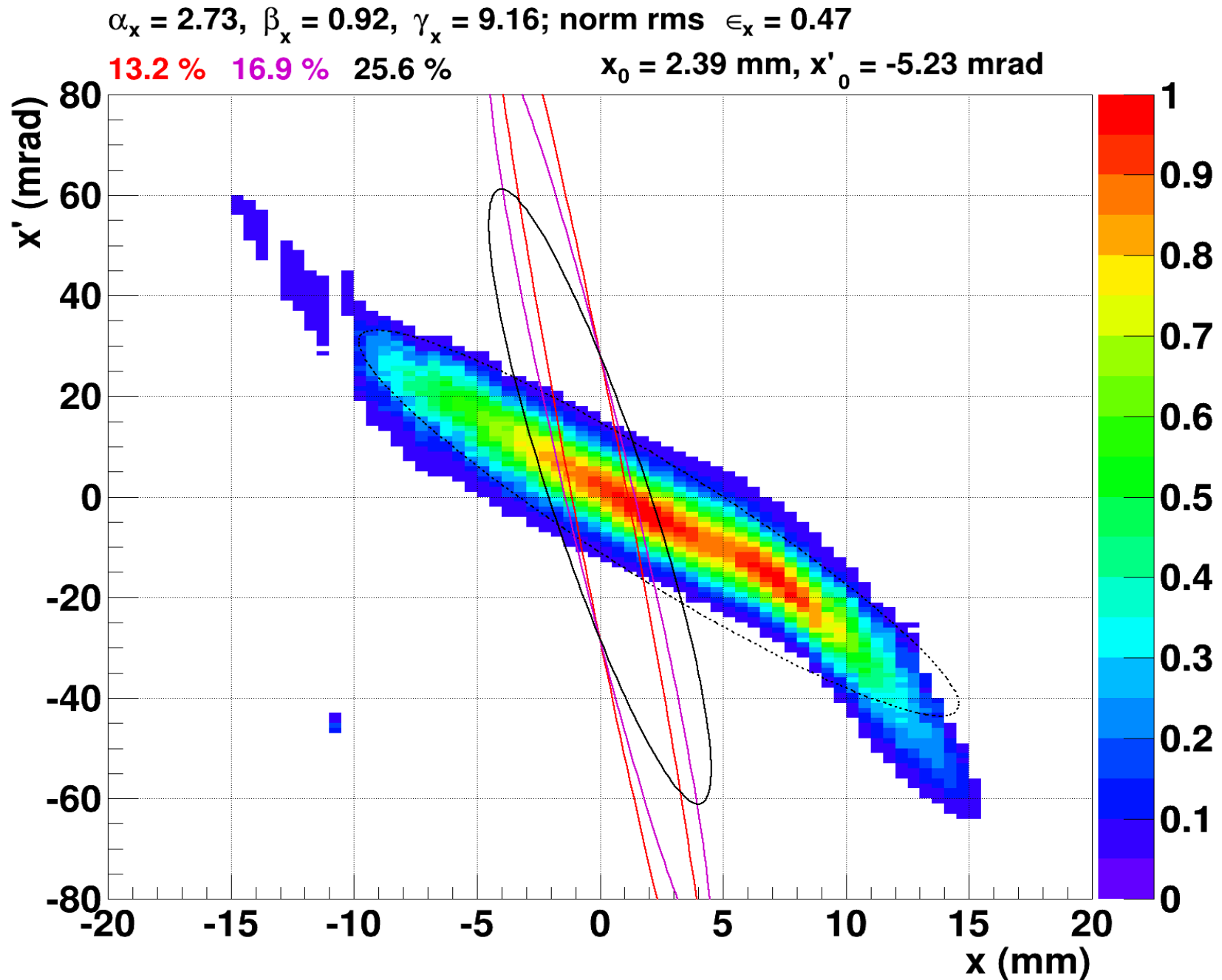


Run 867 V 130,060,-245A; 12.5A, 21kV

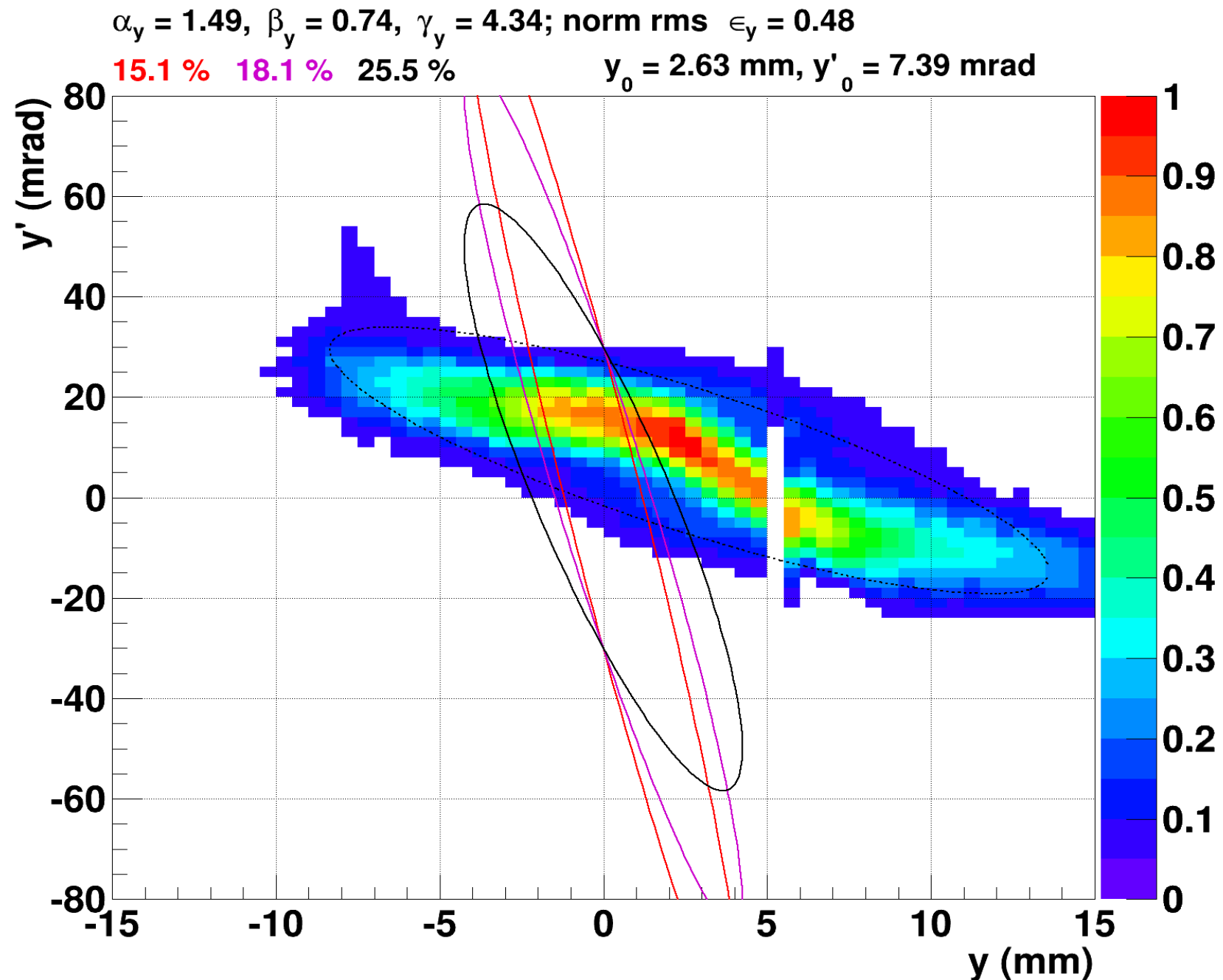


Variation of polarities

Run 900 H +130,+080,+150A; 13.5A, 21kV



Run 893 V +130,+080,+150A; 13.5A, 21kV

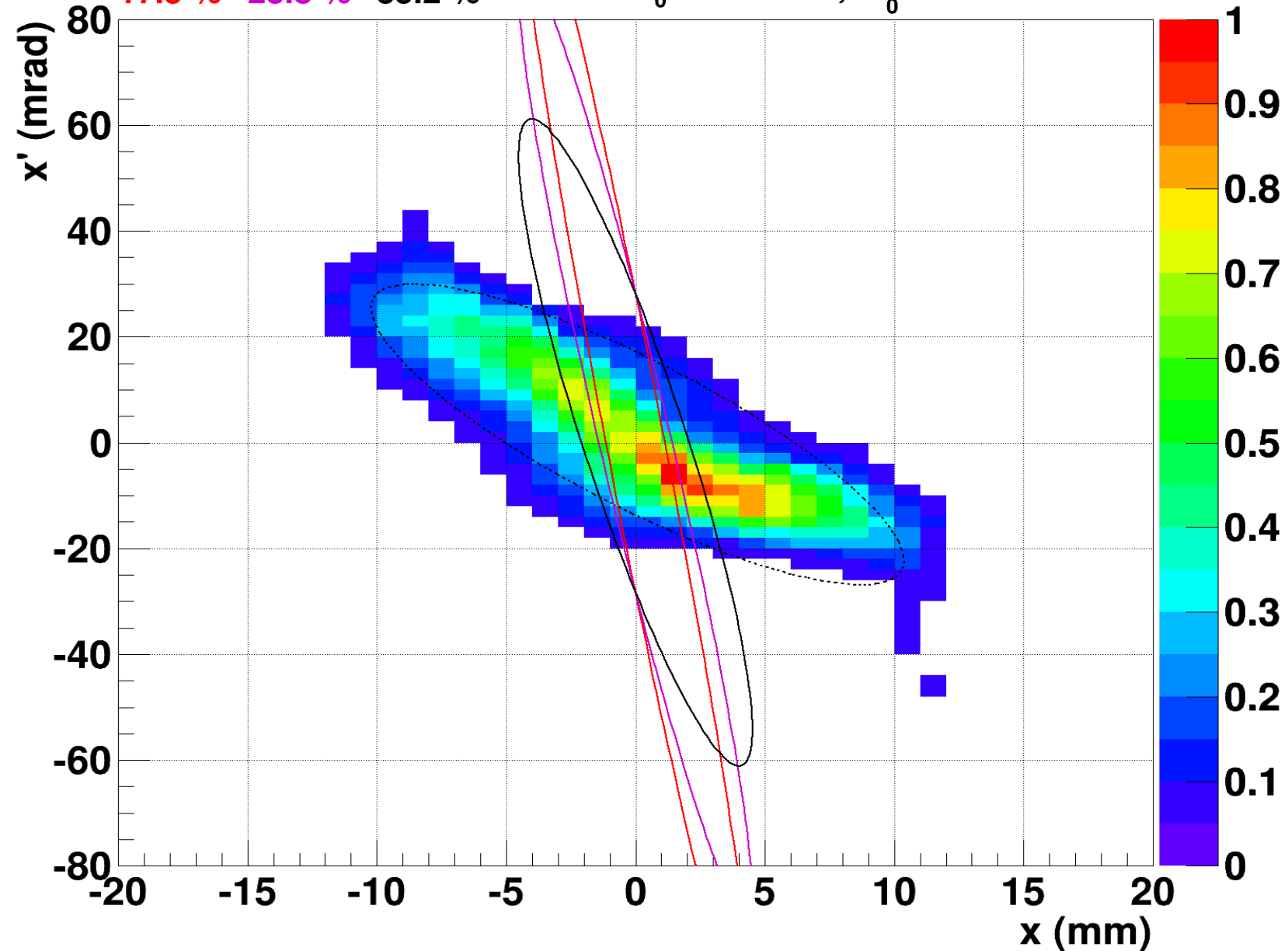


Run 901 H +130,+080,-150A; 13.5A, 21kV

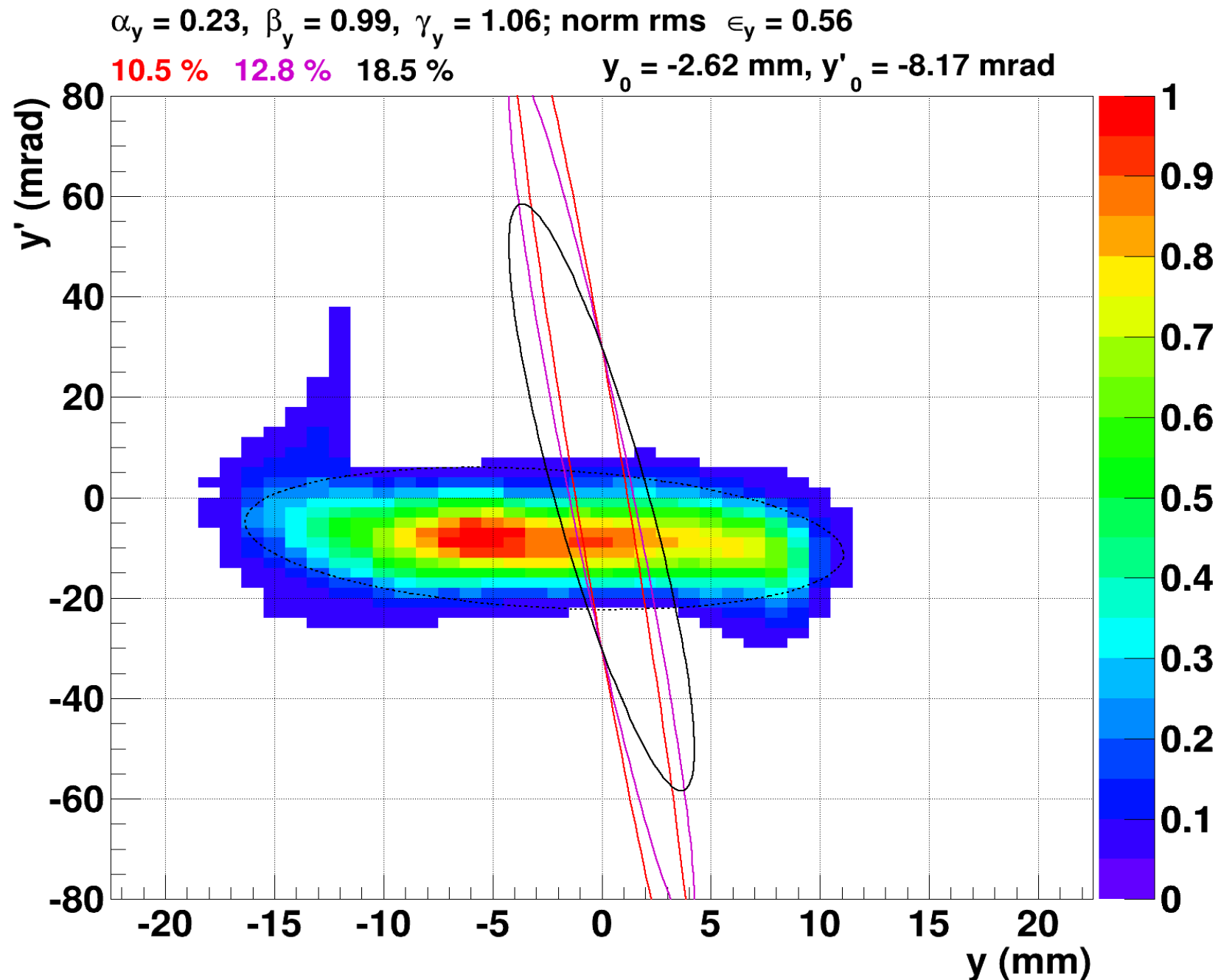
$\alpha_x = 1.54$, $\beta_x = 0.67$, $\gamma_x = 5.07$; norm rms $\epsilon_x = 0.47$

17.5 % 23.8 % 35.2 %

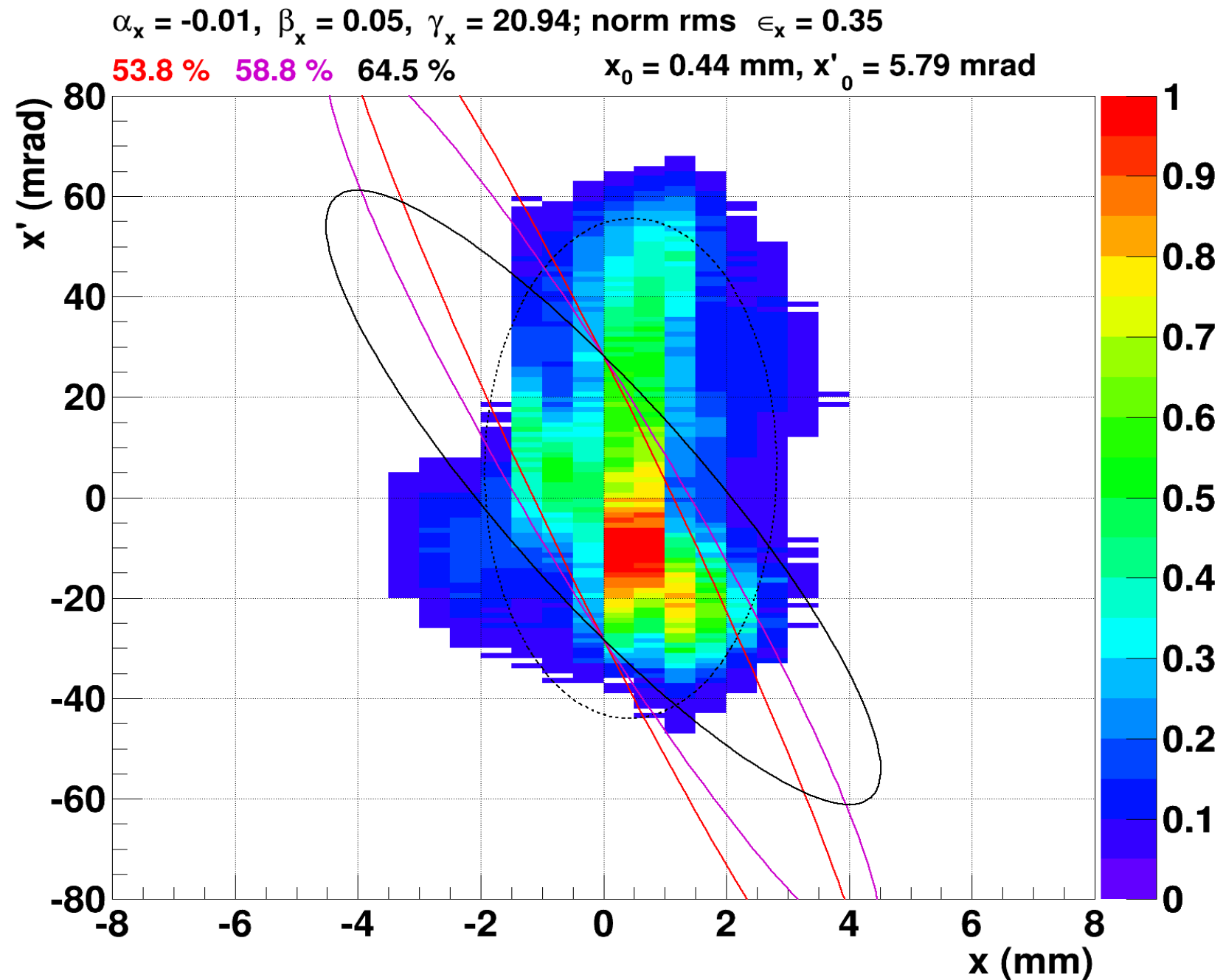
$x_0 = 0.08$ mm, $x'_0 = 1.54$ mrad



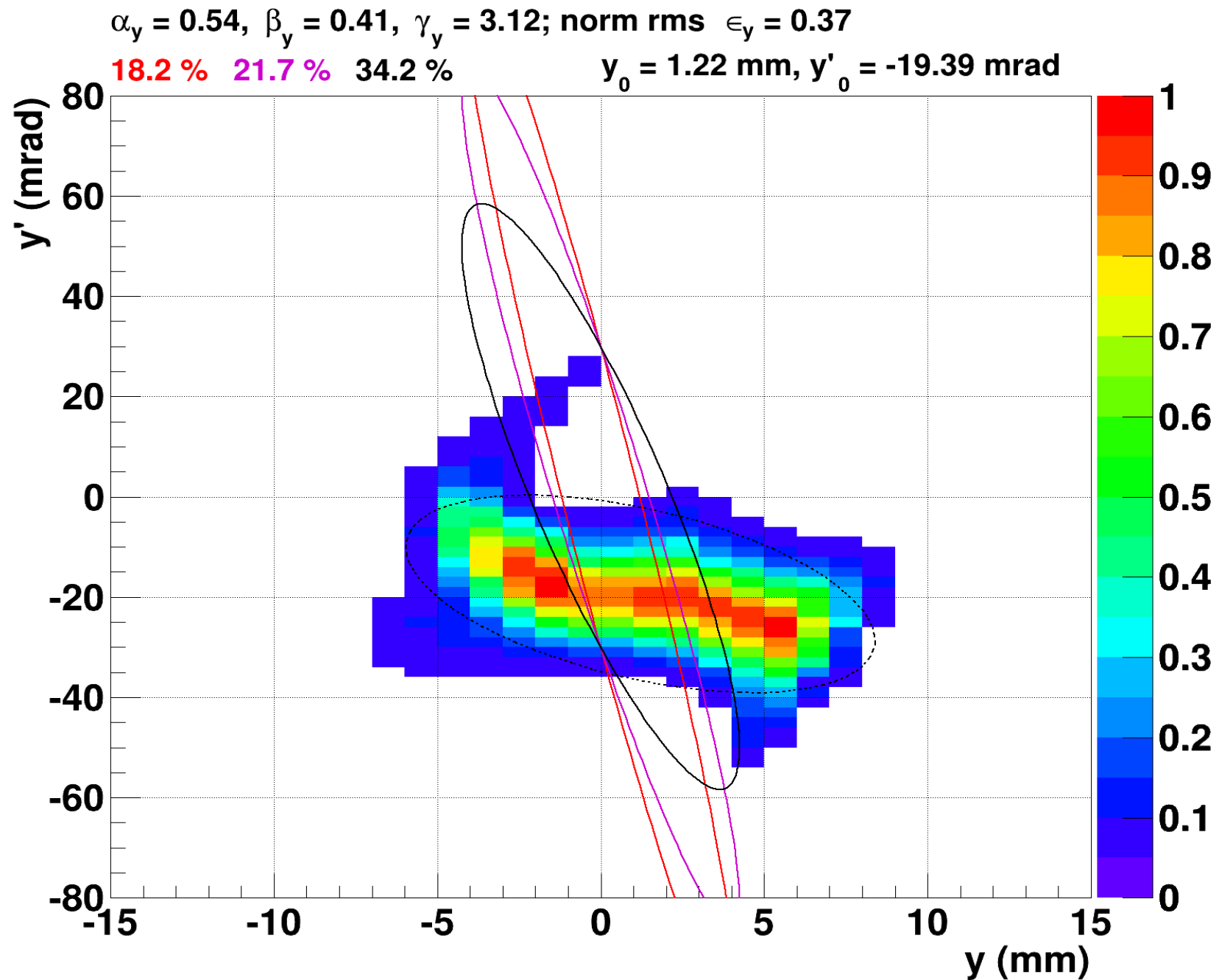
Run 912 V +130,+080,-150A; 13.5A, 21kV



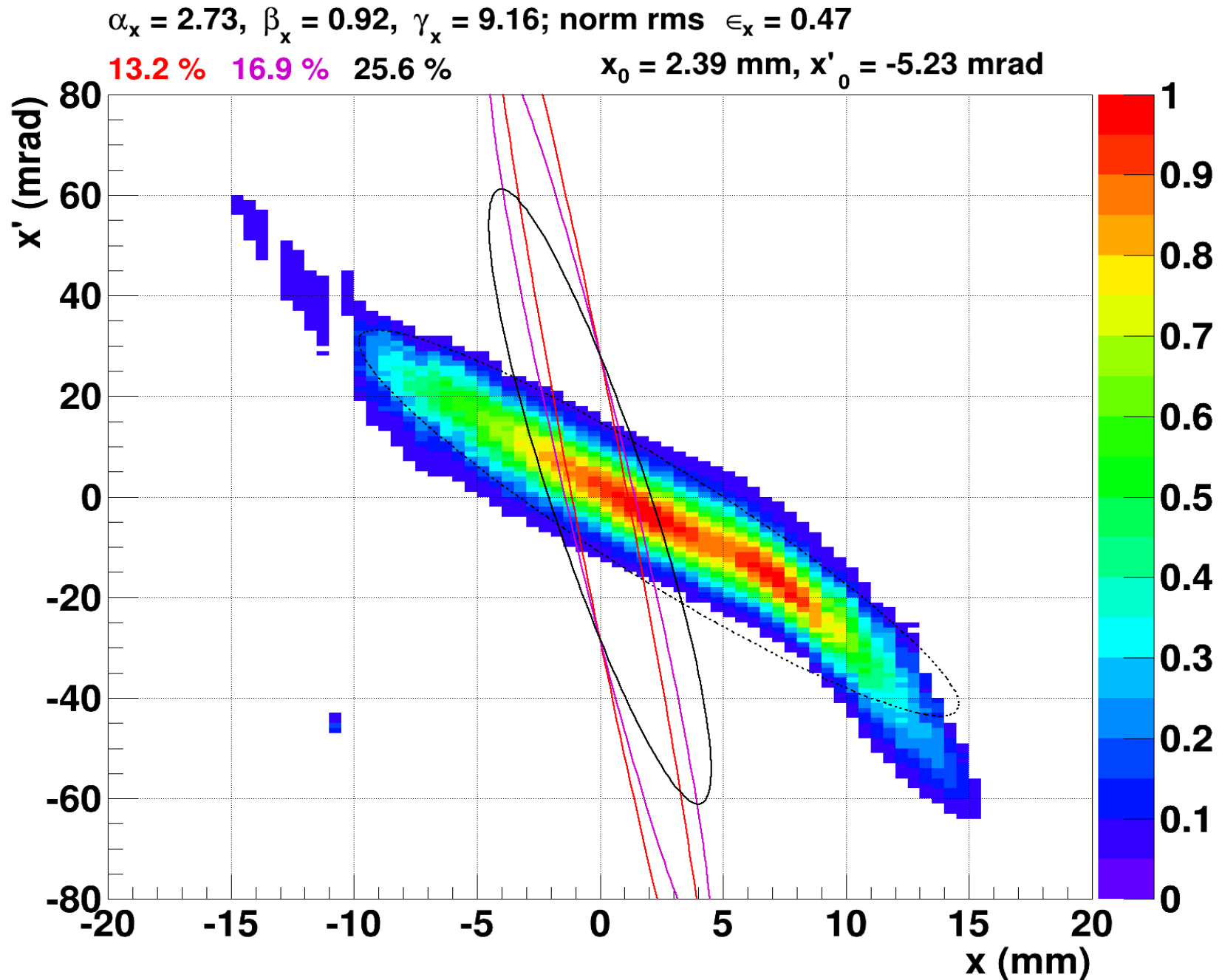
Run 902 H +130,+080,-200A; 13.5A, 21kV



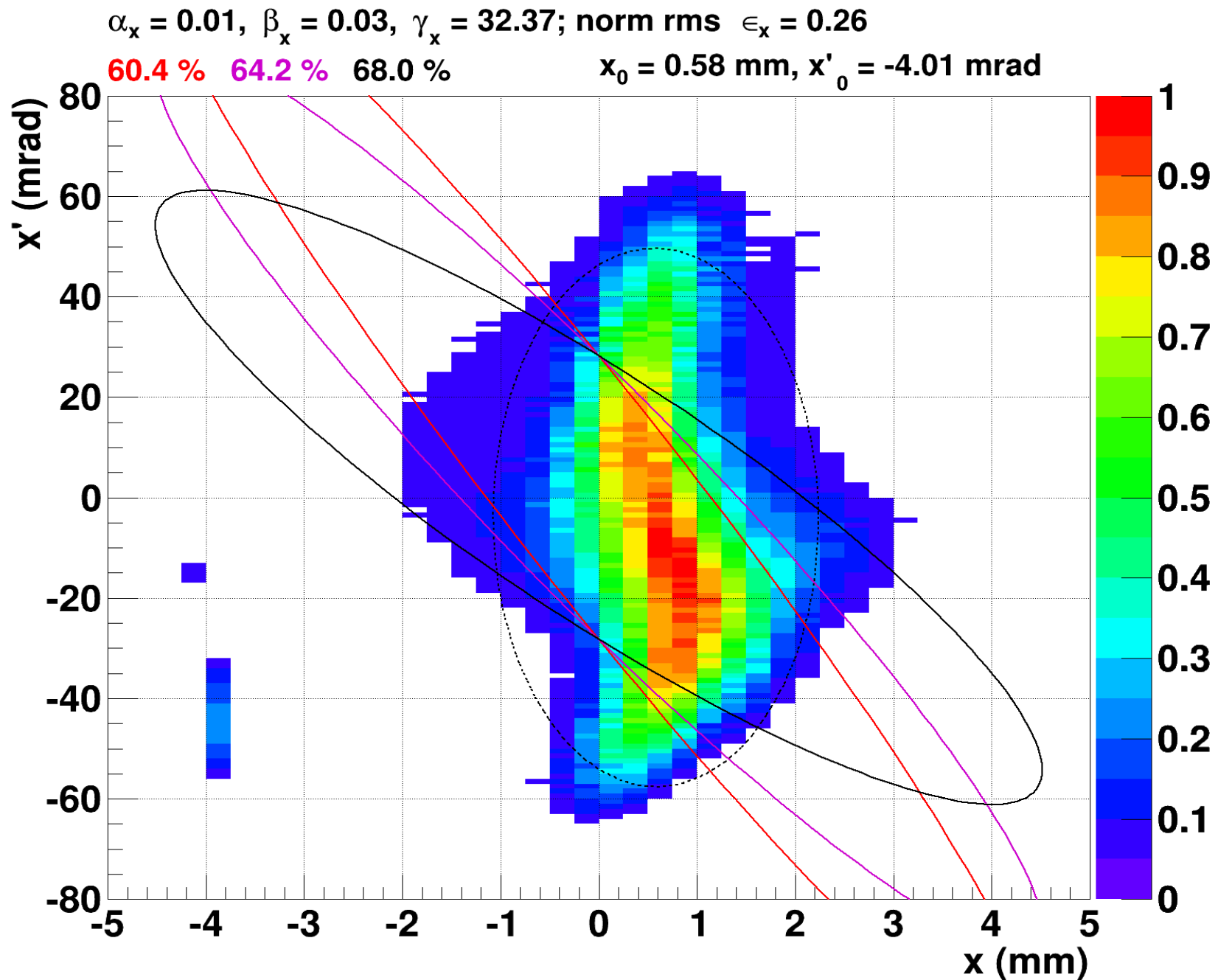
Run 913 V +130,+080,-200A; 13.5A, 21kV



Run 900 H +130,+080,+150A; 13.5A, 21kV



Run 898 H +130,+080,+200A; 13.5A, 21kV

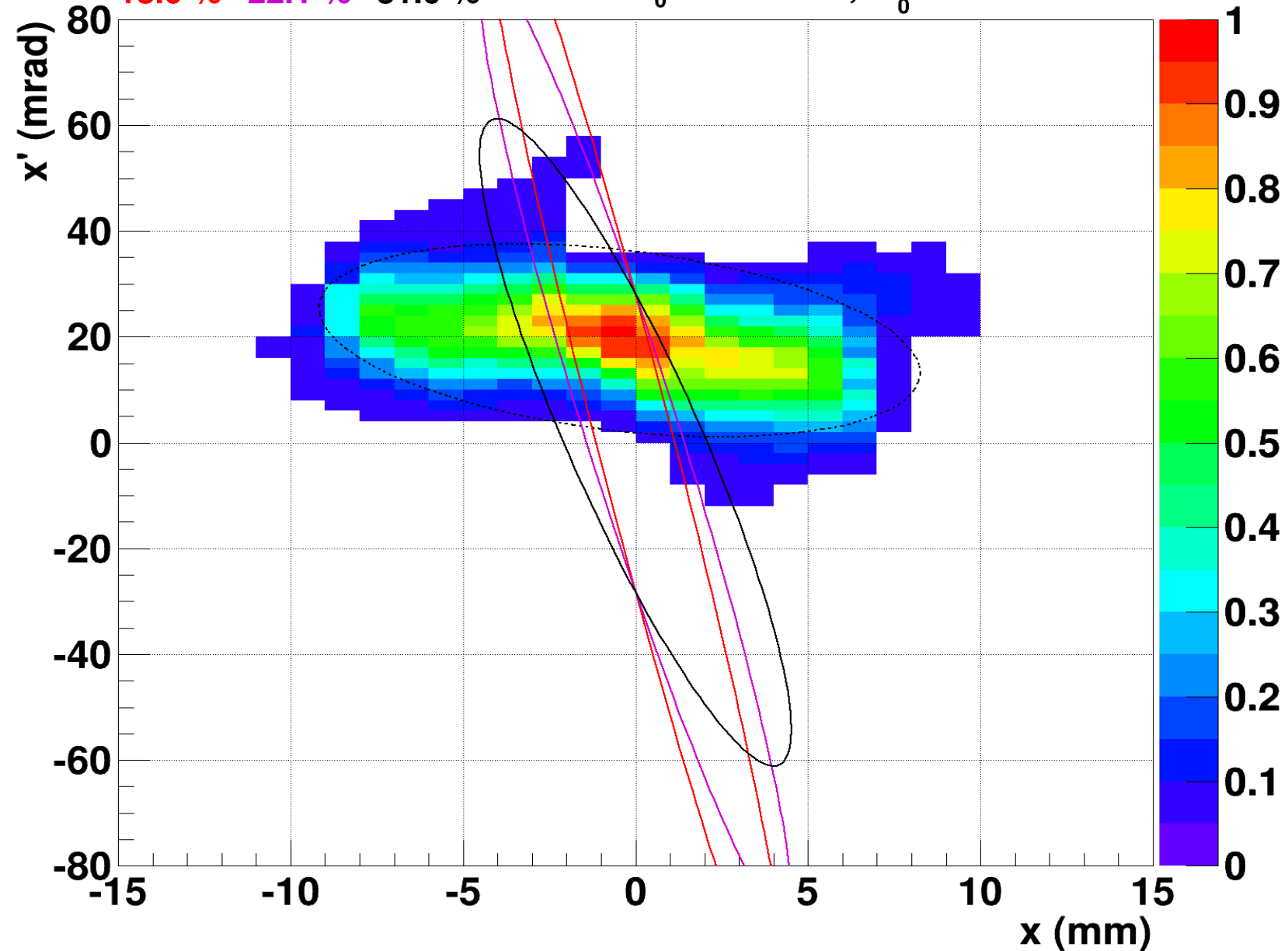


Run 907 H -130,+080,+200A; 13.5A, 21kV

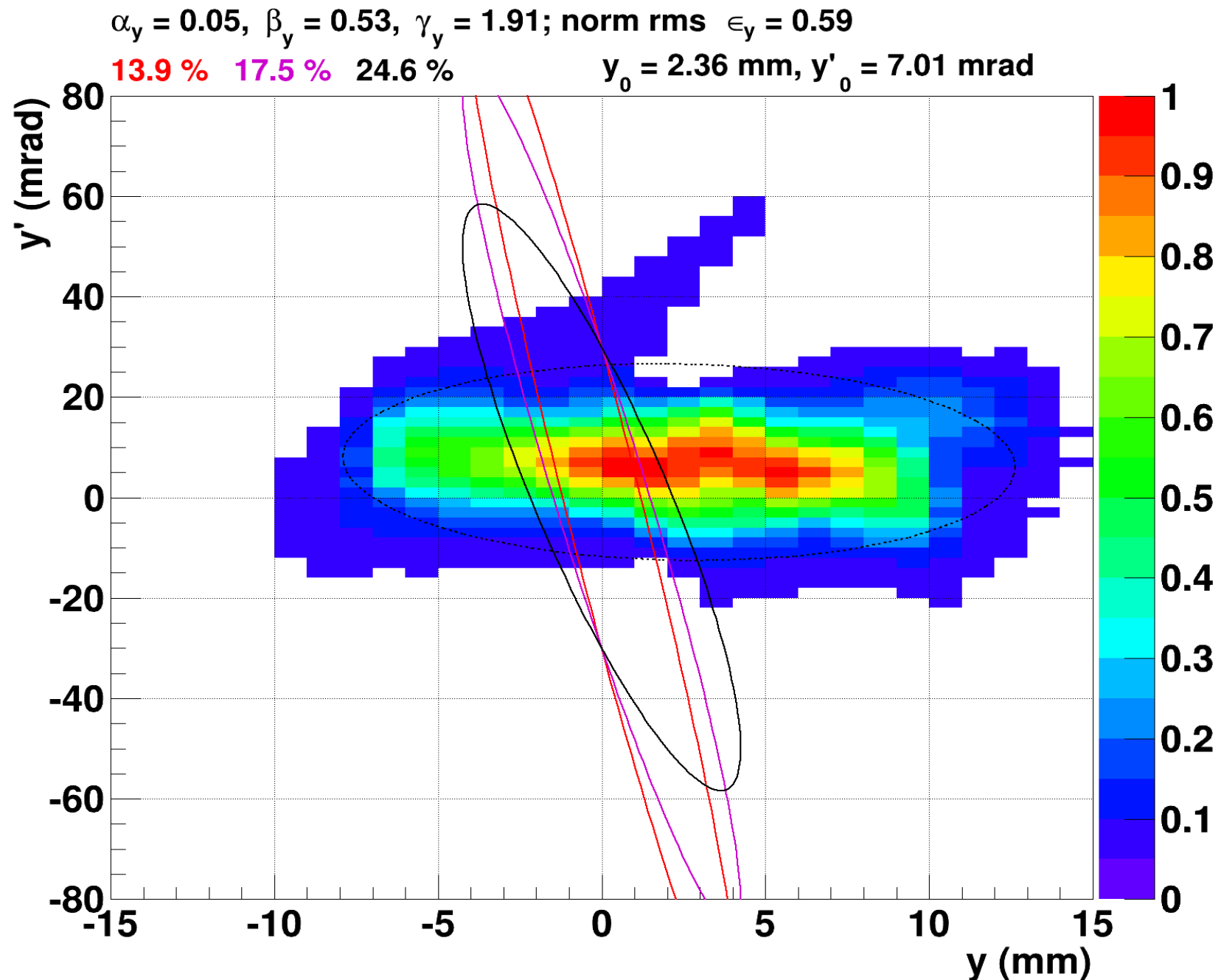
$\alpha_x = 0.36$, $\beta_x = 0.51$, $\gamma_x = 2.22$; norm rms $\epsilon_x = 0.44$

18.0 % 22.1 % 31.0 %

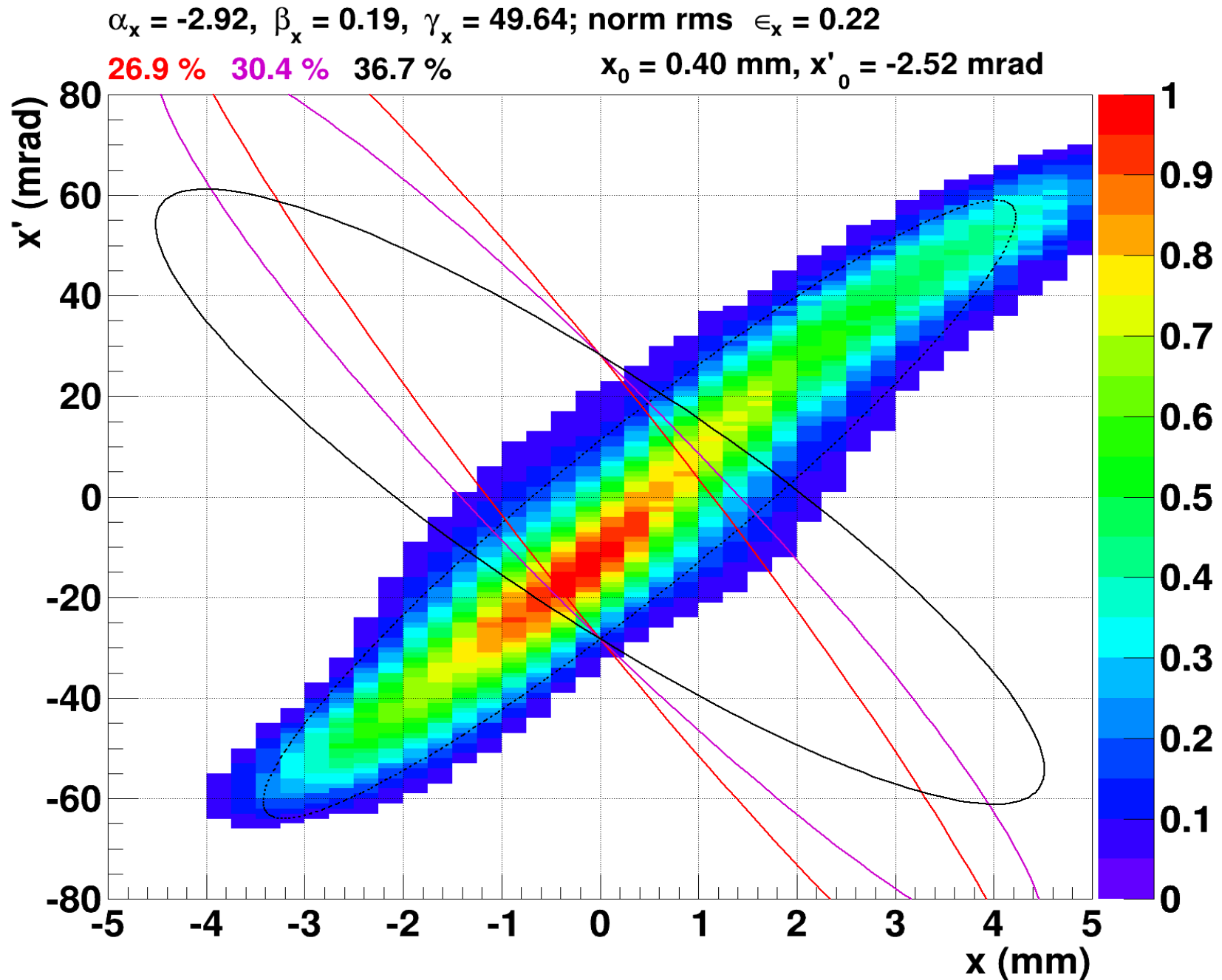
$x_0 = -0.46$ mm, $x'_0 = 19.28$ mrad



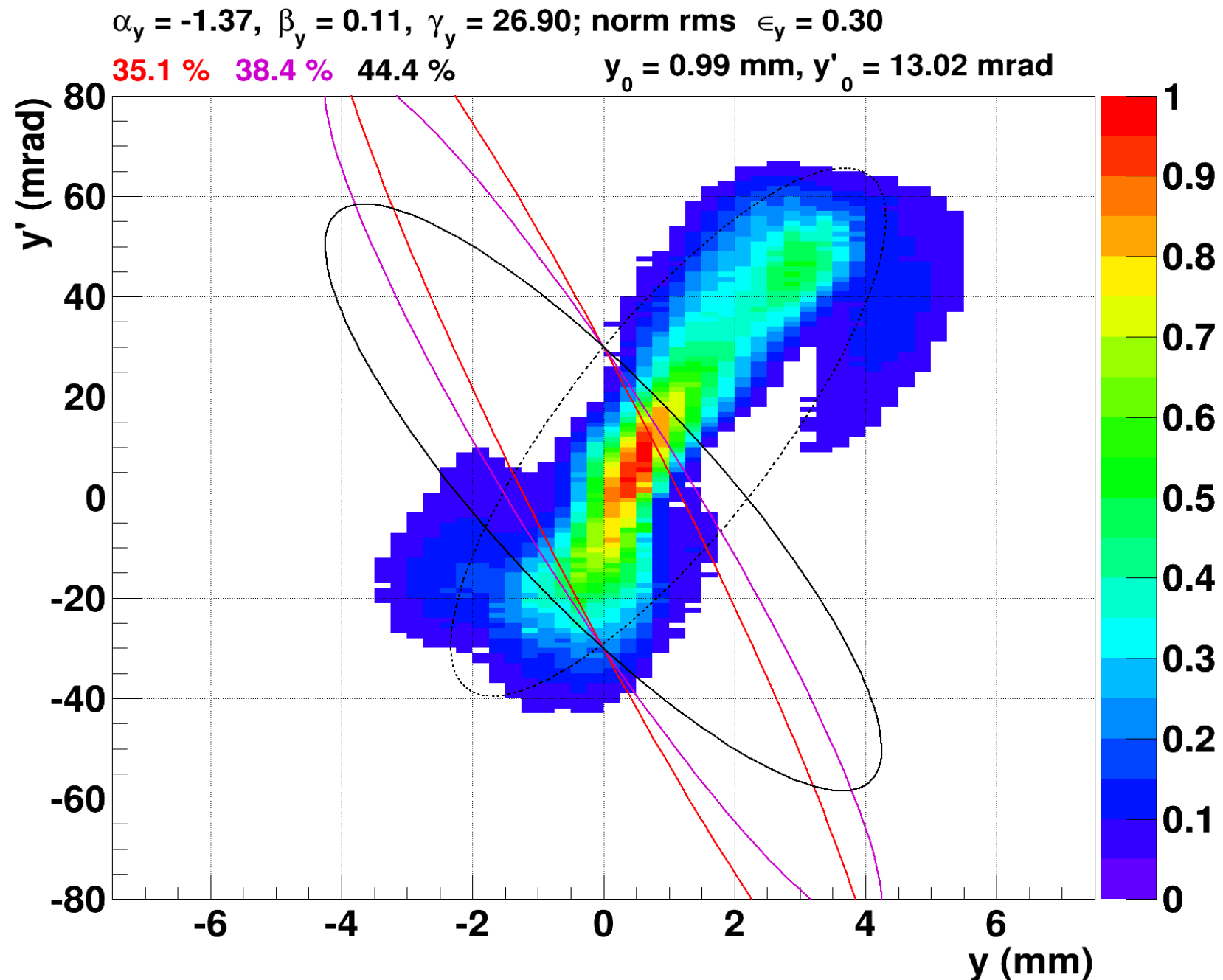
Run 910 V -130,+080,+200A; 13.5A, 21kV



Run 899 H +130,+080,+220A; 13.5A, 21kV



Run 892 V +130,+080,+220A; 13.5A, 21kV

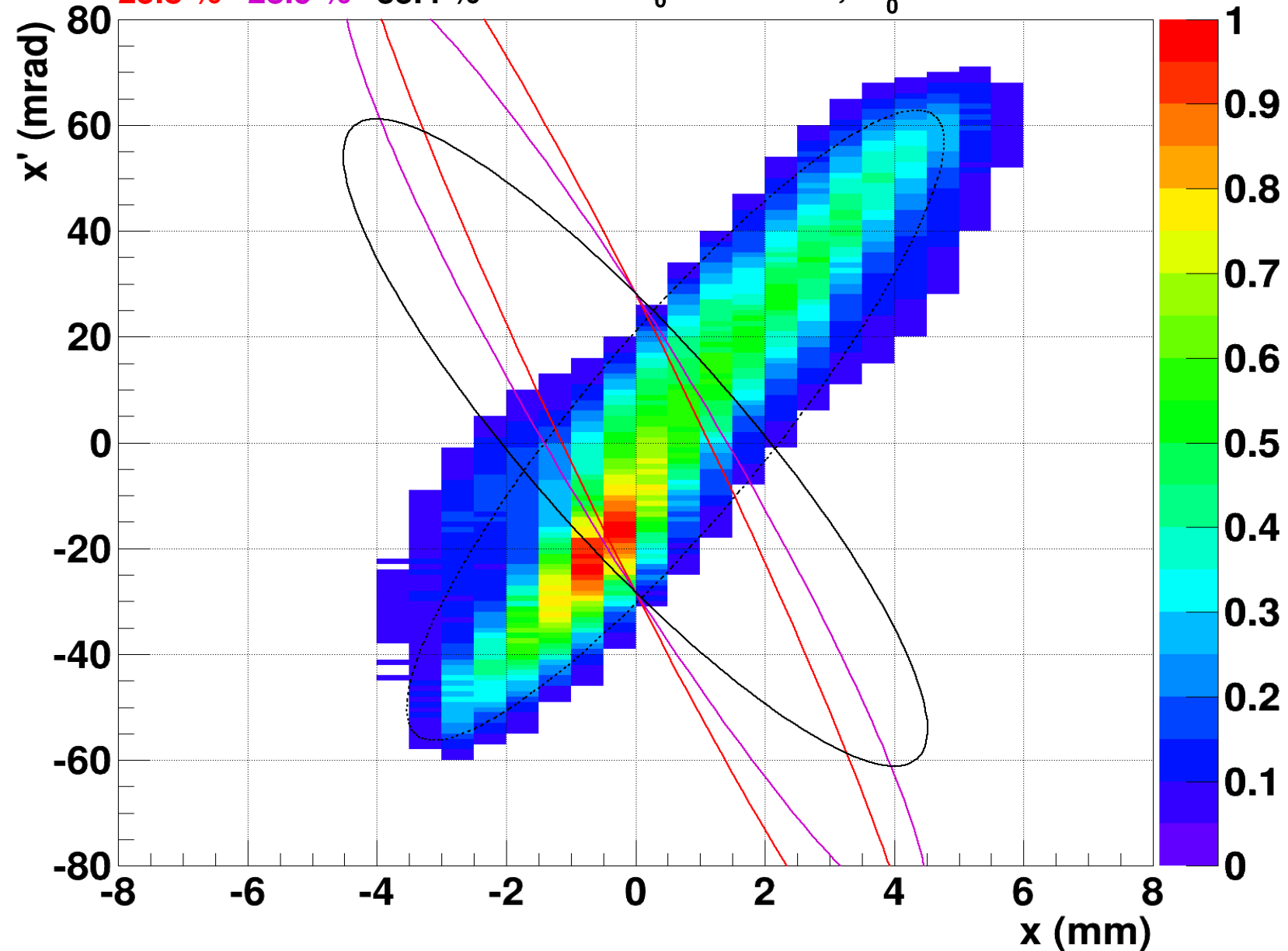


Run 903 H +130,+080,-220A; 13.5A, 21kV

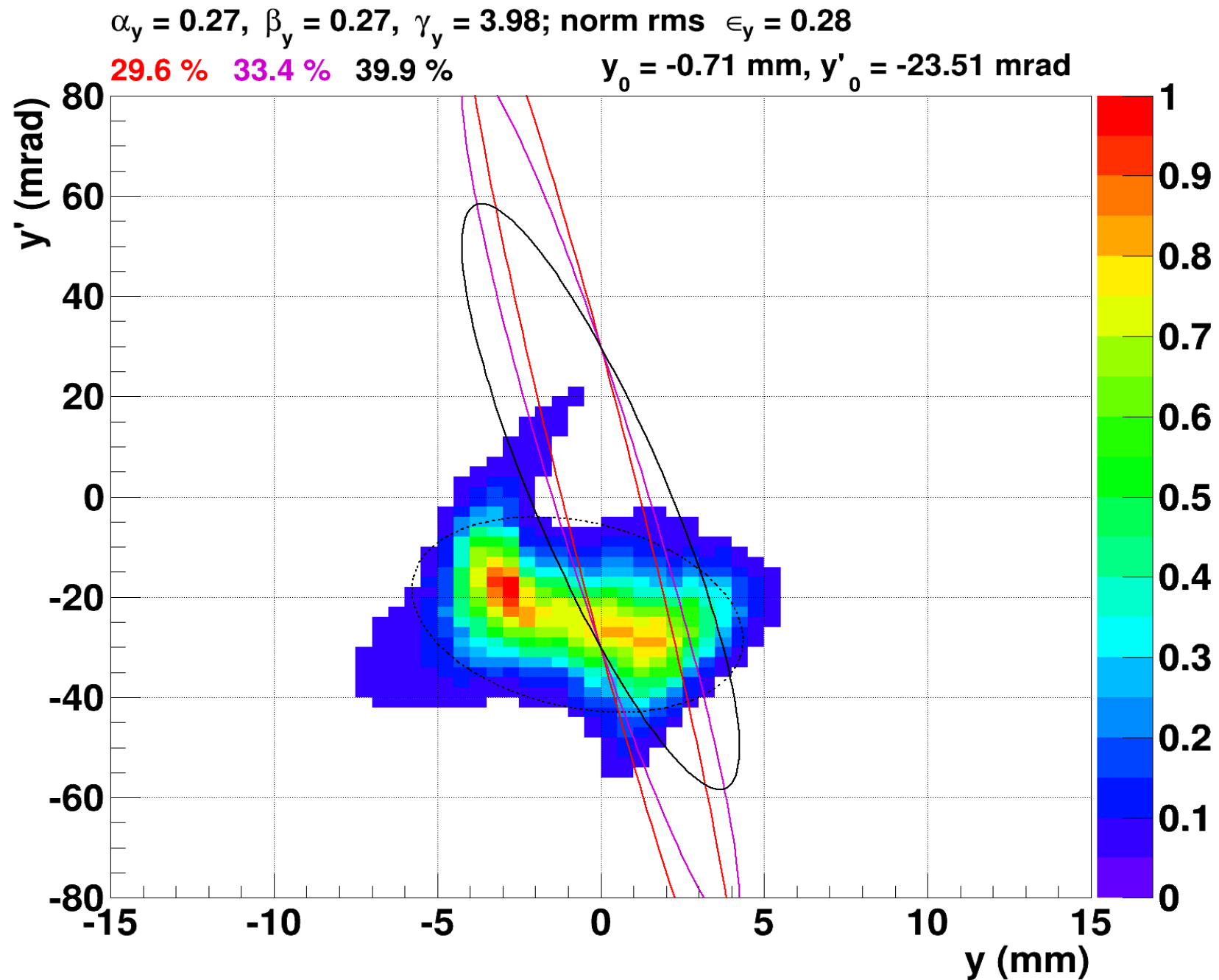
$\alpha_x = -2.06$, $\beta_x = 0.16$, $\gamma_x = 32.77$; norm rms $\epsilon_x = 0.32$

25.8 % 28.9 % 35.4 %

$x_0 = 0.62$ mm, $x'_0 = 3.27$ mrad



Run 914 V +130,+080,-220A; 13.5A, 21kV

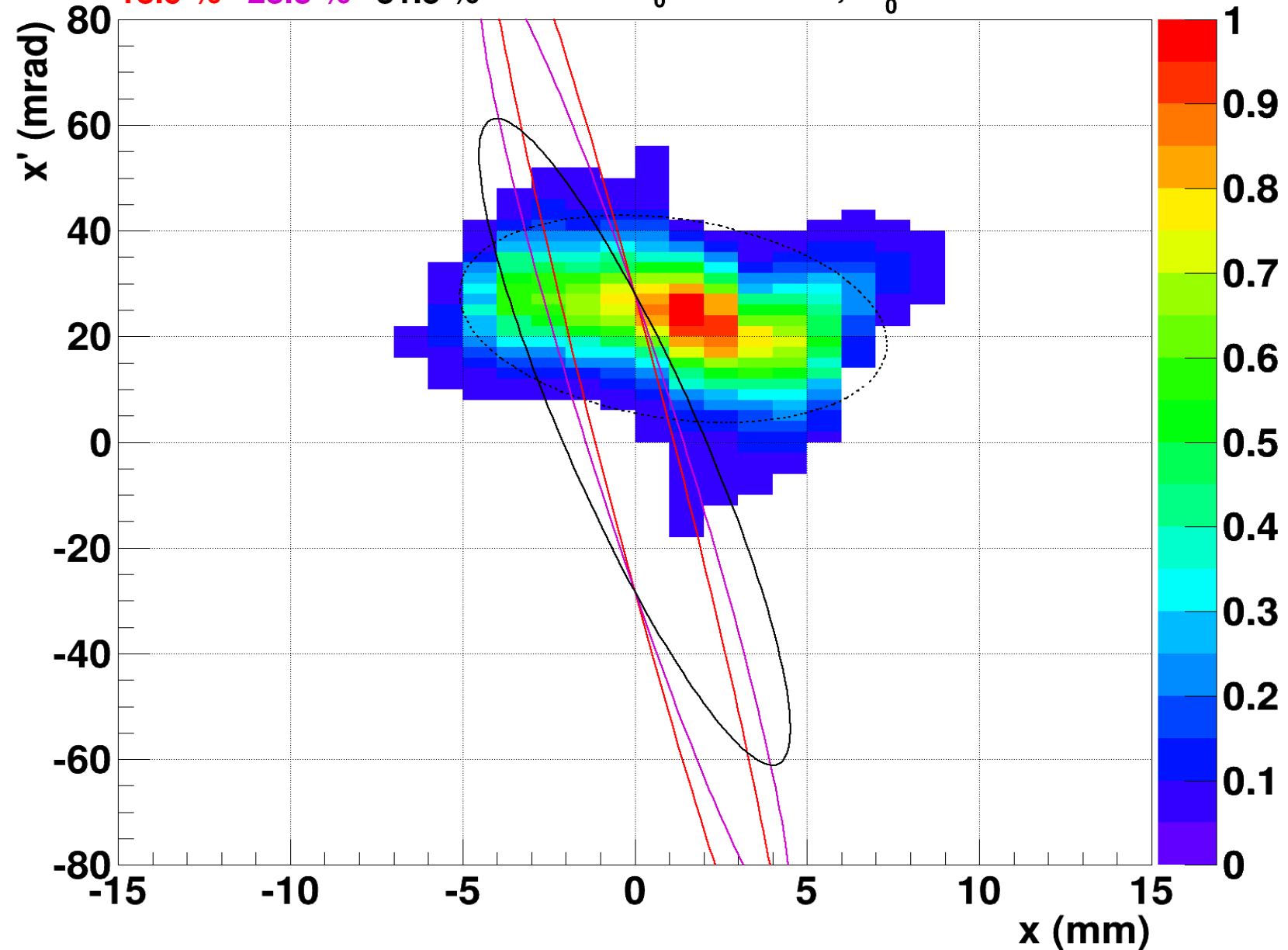


Run 908 H -130,+080,+220A; 13.5A, 21kV

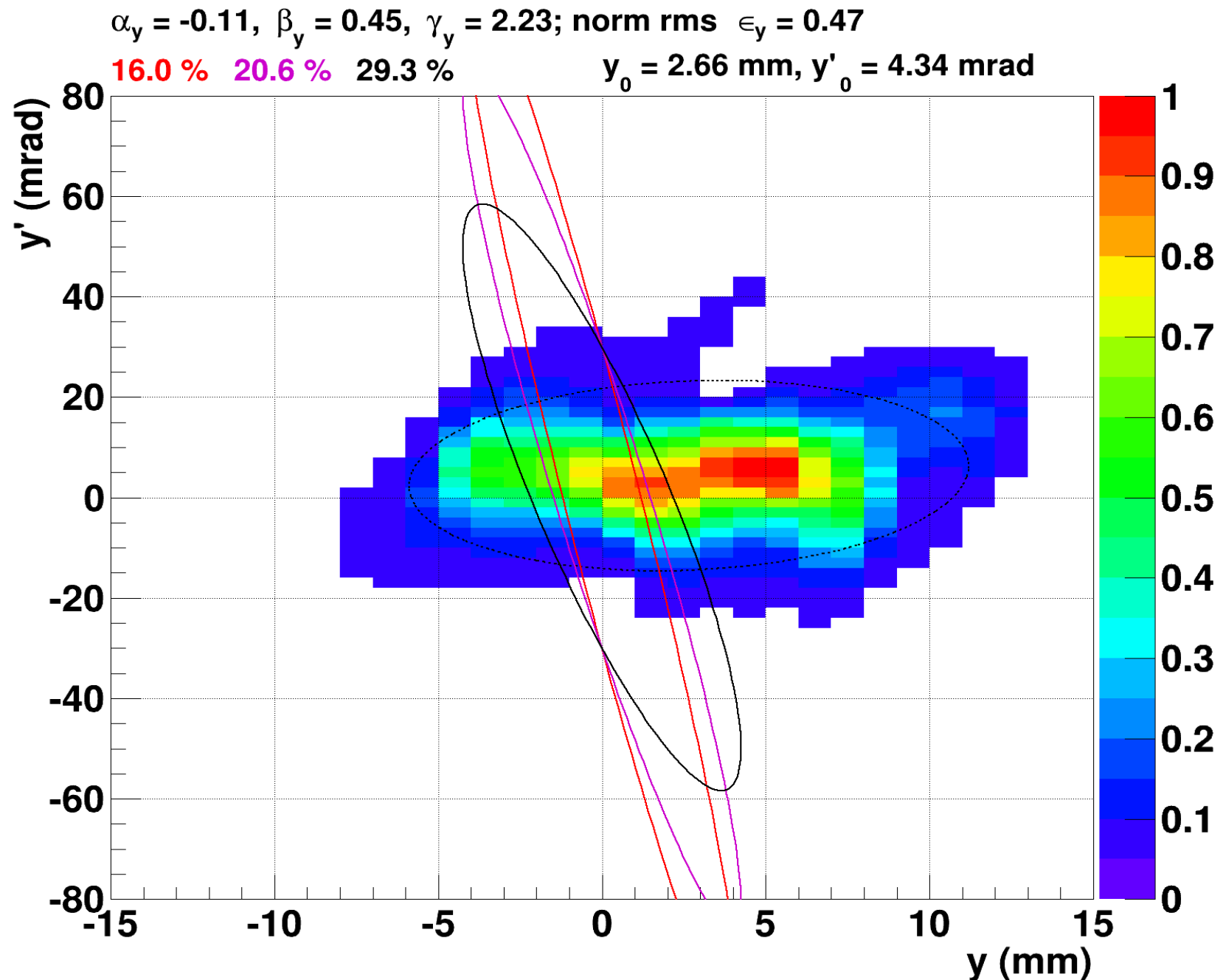
$\alpha_x = 0.25$, $\beta_x = 0.33$, $\gamma_x = 3.26$; norm rms $\epsilon_x = 0.35$

18.9 % 23.3 % 31.5 %

$x_0 = 1.12$ mm, $x'_0 = 23.32$ mrad



Run 909 V -130,+080,+220A; 13.5A, 21kV



GPT Sim: Solenoid currents range

I_1 (A)	I_2 (A)	I_3 (A)	RFQ eff (%)	Focus length (cm)
0	50 – 140	190 – 240	75 - 85	4 – >22
25	50 – 140	190 – 240	75 – 85	4 – >22
50	40 – 140	190 – 240	75 – 85	4 – >22
75	0 – 120	200 – 250	75 – 86	4 – 22
100	0 – 120	200 – 250	75 – 87	4 – 20
125	0 – 100	210 – 250	76 – 88	4 – 16
137	0 – 80	220 – 250	77 – 86	4 – 12
150	0 – 50	240 – 250	77 – 78	4 – 8
175	0 – 70	230 – 250	50 – 60	8 – 12
200	200 – 250	250	53 – 65	20 – >22

$I_1 \gtrsim 175$ A gives over-focusing of the beam inside LEBT
 $\Rightarrow$ high I_2 & I_3 needed to focus beam again