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Mt2 endpoint considerations at non-physical chi

Christopher Lester† and Alan Barr‡

† *Cavendish Laboratory, J.J.Thomson Avenue, Cambridge, CB3 0HE, UK*
‡ *Department of Physics, University of Oxford, Keble Road, Oxford, OX1 3RH, UK*

Email address: †lester@hep.phy.cam.ac.uk, ‡a.barr@physics.ox.ac.uk

What not to conclude from the endpoint position due to the presence of feet.

1 Introduction

Note that figures 49, 51 and 53 which are all case 6s show a distribution with two clear parts lying on top of one another. One component (the narrower) appears to have a hard cut off at respectively 429 GeV, 480 GeV and 527 GeV. It would not be surprising if this component comes from unbalanced MT2 solutions where it would be equal to the mass on one side of the event (at least at the kink) and this would be given at the kink by the standard mll endpoint formula. However

$$\frac{(500^2 - 300^2)(300^2 - 100^2)}{300^2} = 377^2 \tag{1}$$

so the above explanation must be wrong.

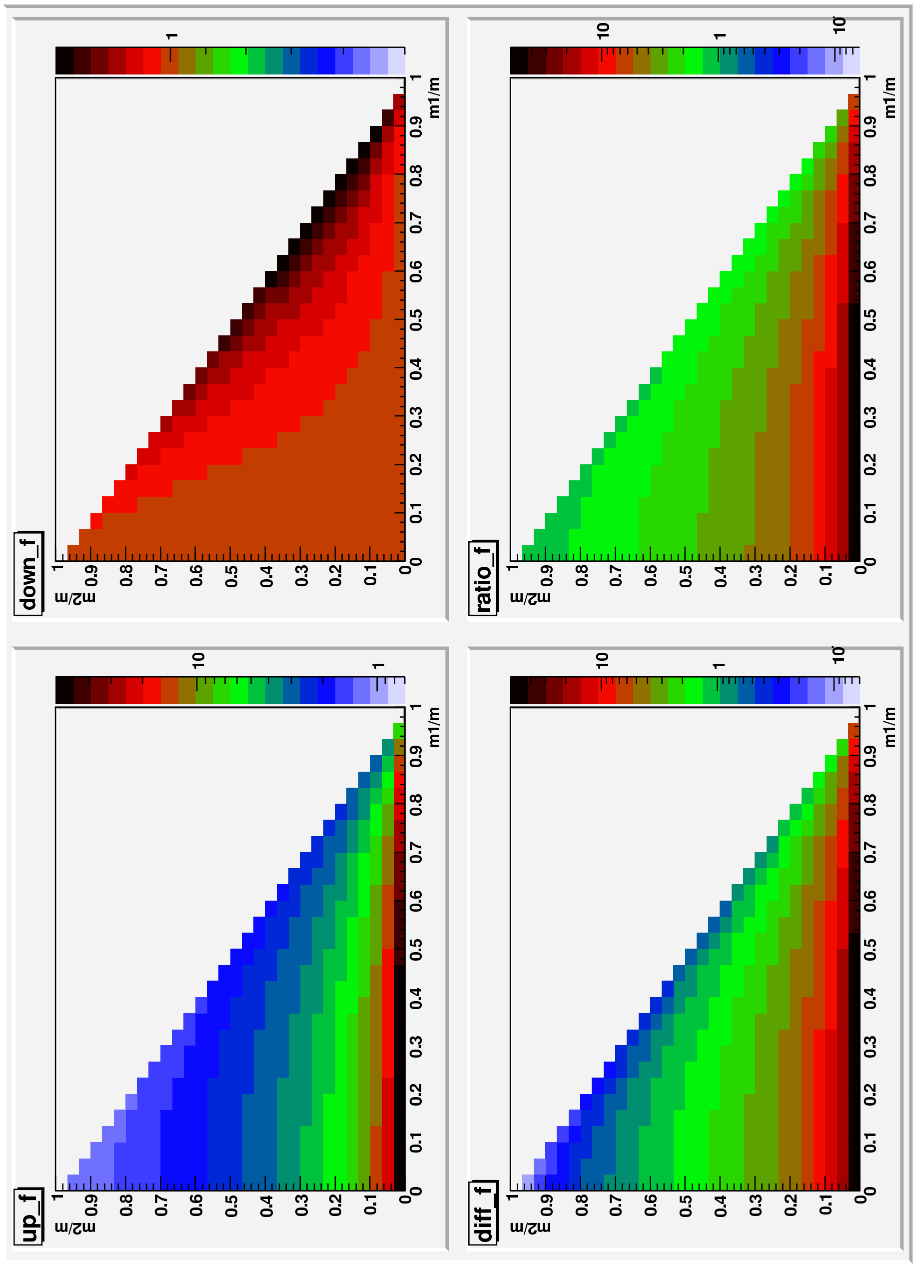

Figure 1: P.S. To help myself work out what to expect, I made a plot of the predicted change gradients ($dm_t/dmhat$ unsquared) as a function of m1/m and m2/m which can be found for the 2-body case at:

Case		Foot at $\chi = 50$ (too small)	Foot at $\chi = 100$ (just right)	Foot at $\chi = 150$ (too big)
TwoBody	2	NO	NO	YES
ThreeBody	3v	NO	NO	YES
ThreeBody	3s	NO	NO	YES
FourBody	4	NO	NO	YES
SixBody	6v	NO	NO	NO
SixBody	6s	NO	NO	YES

Table 1: Table summarises the places where "dangerous" feet are observed for the cases considered later on.
"MAYBE" means the evidence is not clear. "Probably NO" means past evidence has indicated that the foot is absent, but the evidence is not yet attached to this document. "?" means the plots have not yet been generated.

Case	energy trend $\chi = 50$ nearing endpoint	energy trend $\chi = 100$ nearing endpoint	energy trend $\chi = 150$ nearing endpoint	Fig.
2	falling finite	constant finite	becoming very large	20
3v	falling finite	constant finite	constant finite	27
3s	falling finite	constant finite	becoming very large	34
4	constant finite?	constant finite?	constant finite?	41
6v	constant finite?	constant finite?	becoming large?	48
6s	constant finite?	constant finite?	hard to tell?	55

Table 2: Summary of relationship between energy of 1st radiated quark and eventual mt2 value.

Case	PT trend $\chi = 50$ nearing endpoint	PT trend $\chi = 100$ nearing endpoint	PT trend $\chi = 150$ nearing endpoint	Fig.
2	diverging	constant finite	large (ND?)	2
3v	large (ND?)	constant finite	large (ND?)	3
3s	large (ND?)	constant finite	large (ND?)	4
4	not very large	constant finite	not very large	5
6v	no clear trend	constant finite	no clear trend	6
6s	large	constant finite	large (ND?)	7

Table 3: Summary of relationship between PT of initial gluino and eventual mt or mt2 value. "ND" = Not (apparently) Diverging.

Case	PT trend $\chi = 50$ nearing endpoint	PT trend $\chi = 100$ nearing endpoint	PT trend $\chi = 150$ nearing endpoint	Fig.
2	diverging	constant finite	large (ND?)	8
3v	large (ND?)	constant finite	large (ND?)	9
3s	large (ND?)	constant finite	large (ND?)	10
4	tiny bit larger	constant finite	large (ND?)	11
6v	no clear trend	constant finite	large	12
6s	perhaps large	constant finite	large (ND?)	13

Table 4: Summary of relationship between PT of initial state radiation and eventual mt or mt2 value. This table seems to have the clearest endpoint correlation data overall.

Case	Some PT Status	(SPT) Fig	Zero PT Status	(ZPT) Fig
2	Kink	60	Smooth	66
3v	Kink	61	Kink	67
3s	Kink	62	Kink	68
4	Kink	63	Smooth	69
6v	Kink	64	Kink	70
6s	Kink	65	Kink	71

Table 5: Erm

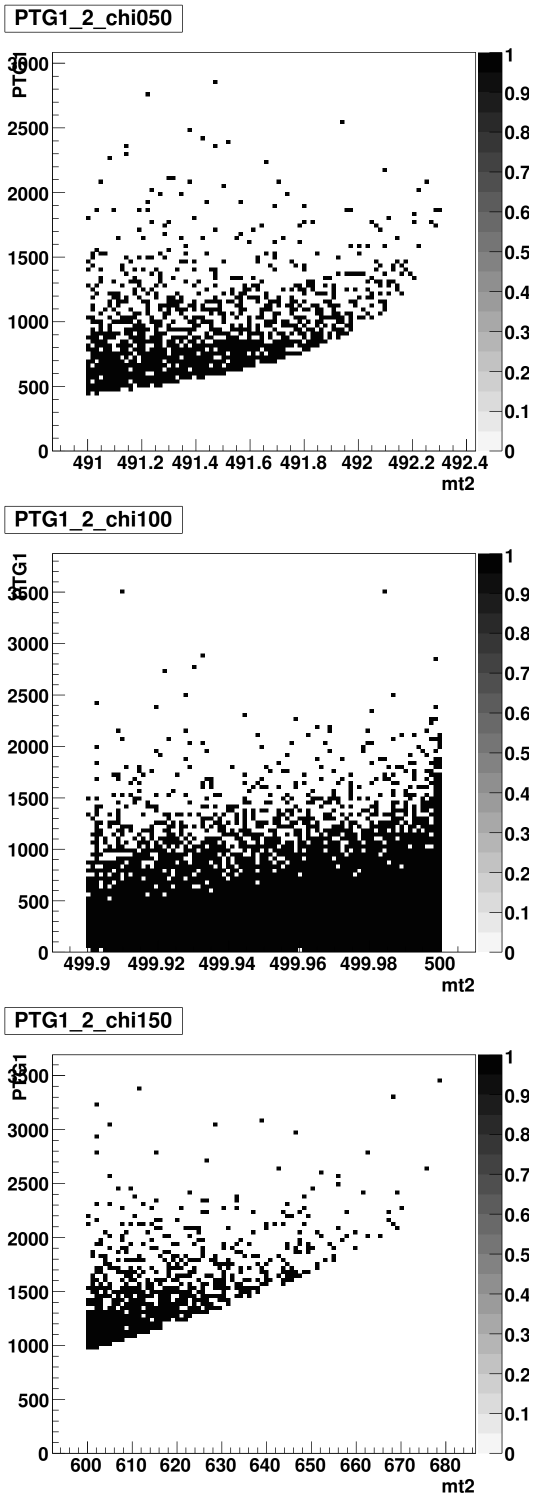

Figure 2: PT of initial gluino for events in M2 or MT2 tail.

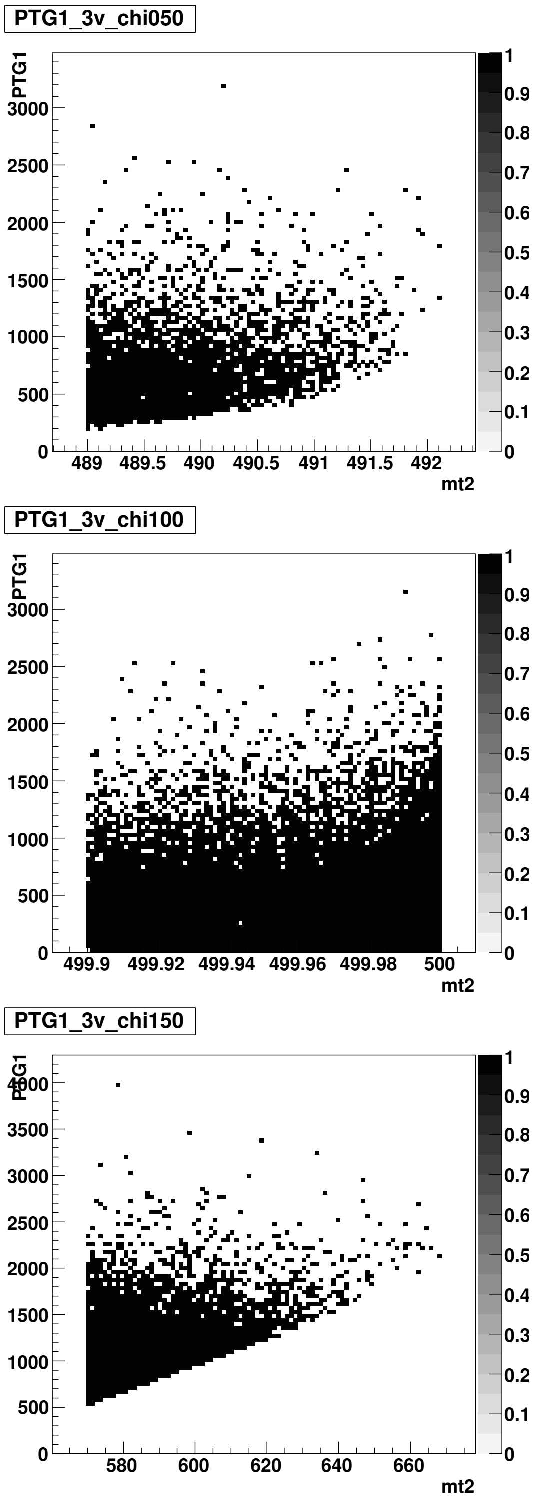

Figure 3: PT of initial gluino for events in M2 or MT2 tail.

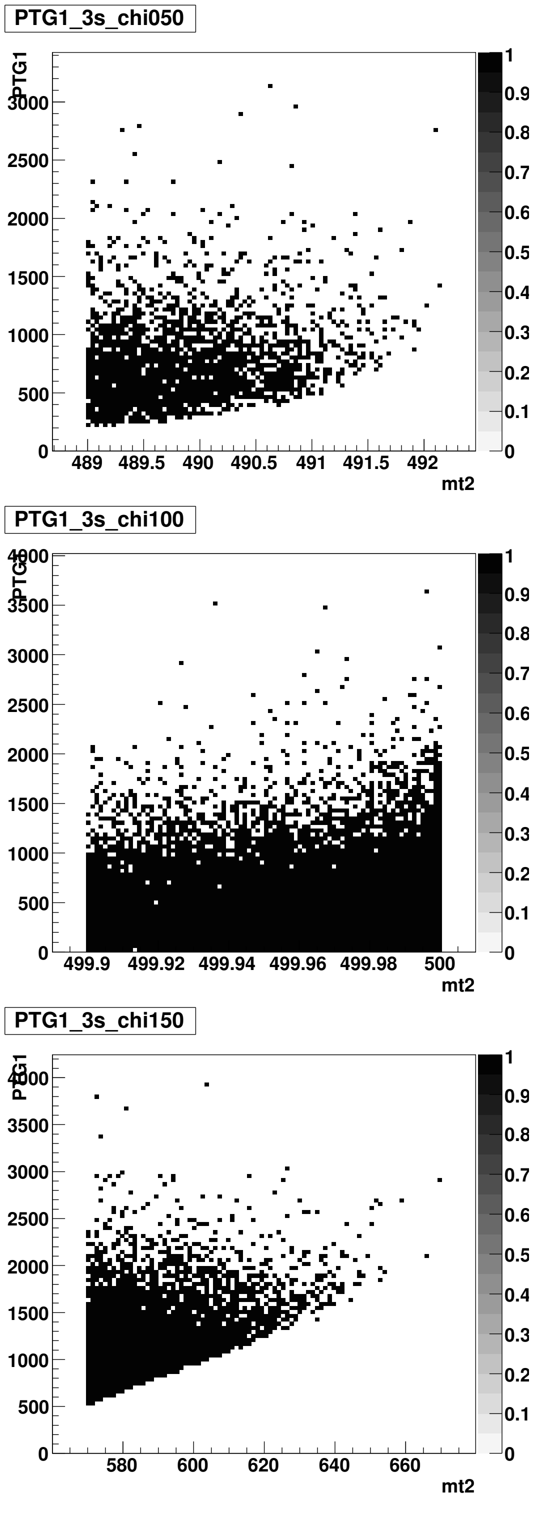

Figure 4: PT of initial gluino for events in M2 or MT2 tail.

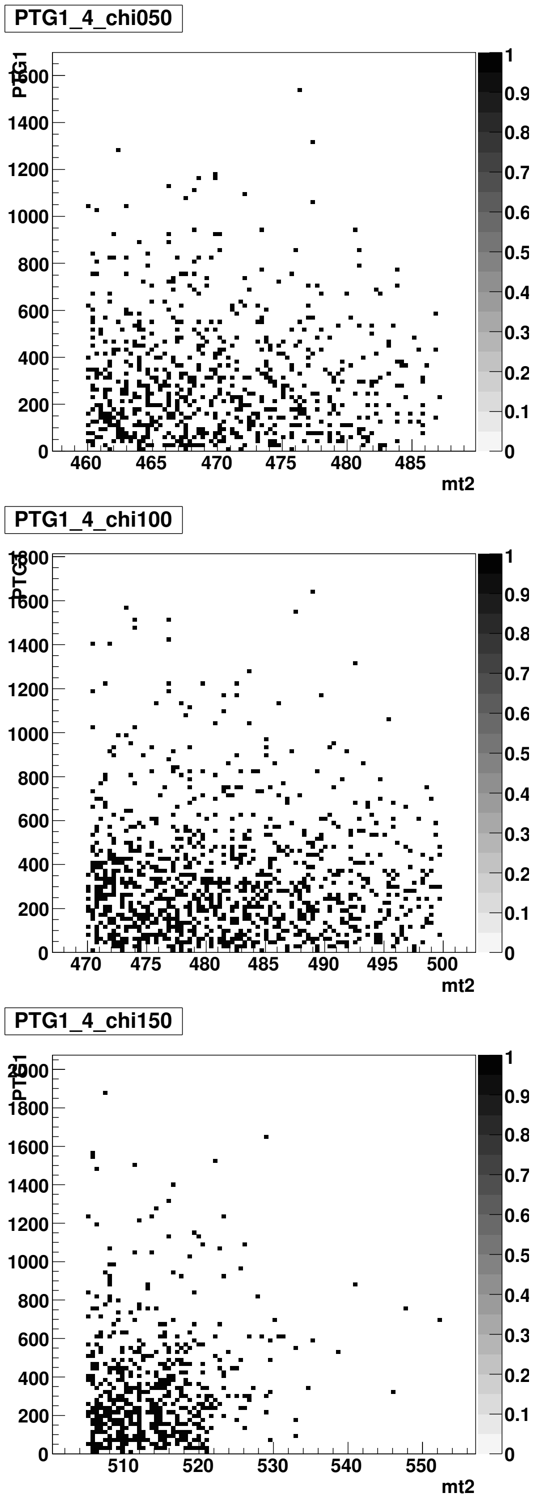

Figure 5: PT of initial gluino for events in M2 or MT2 tail.

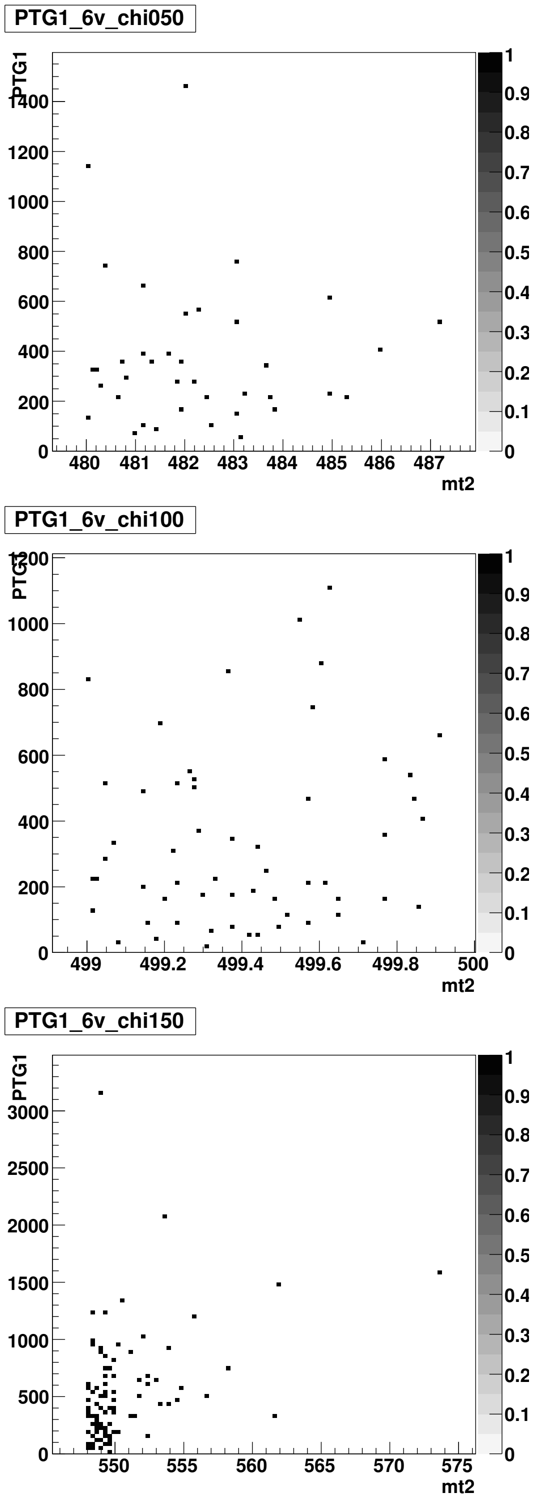

Figure 6: PT of initial gluino for events in M2 or MT2 tail.

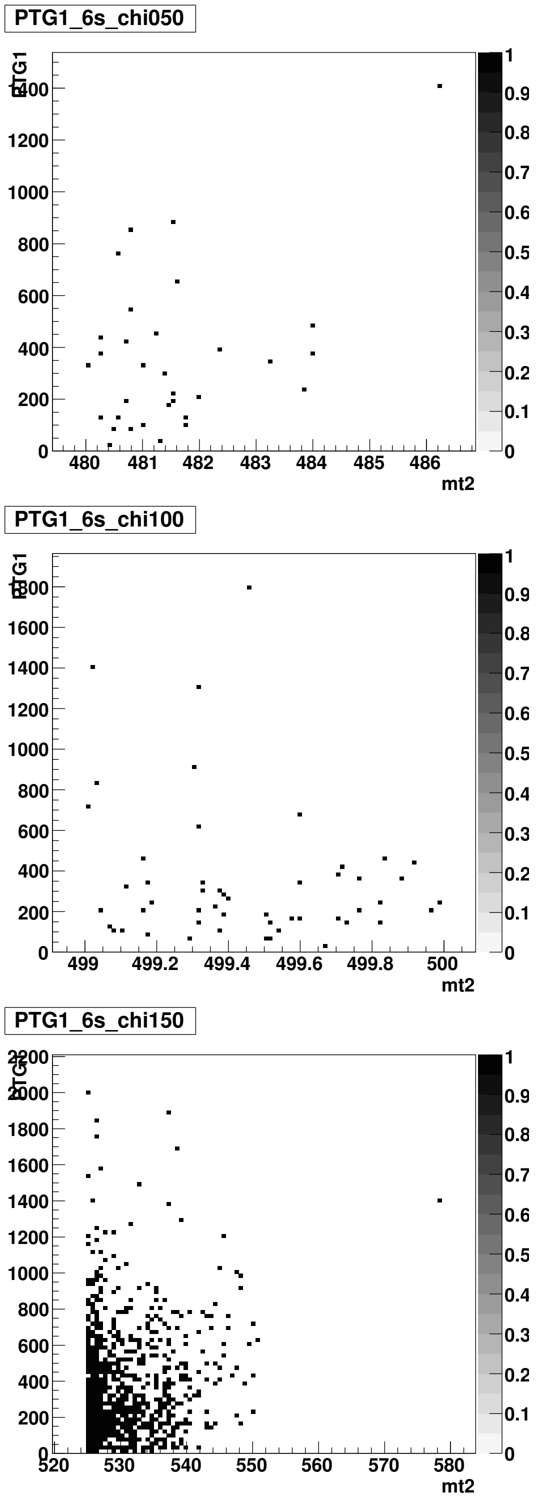

Figure 7: PT of initial gluino for events in M2 or MT2 tail.

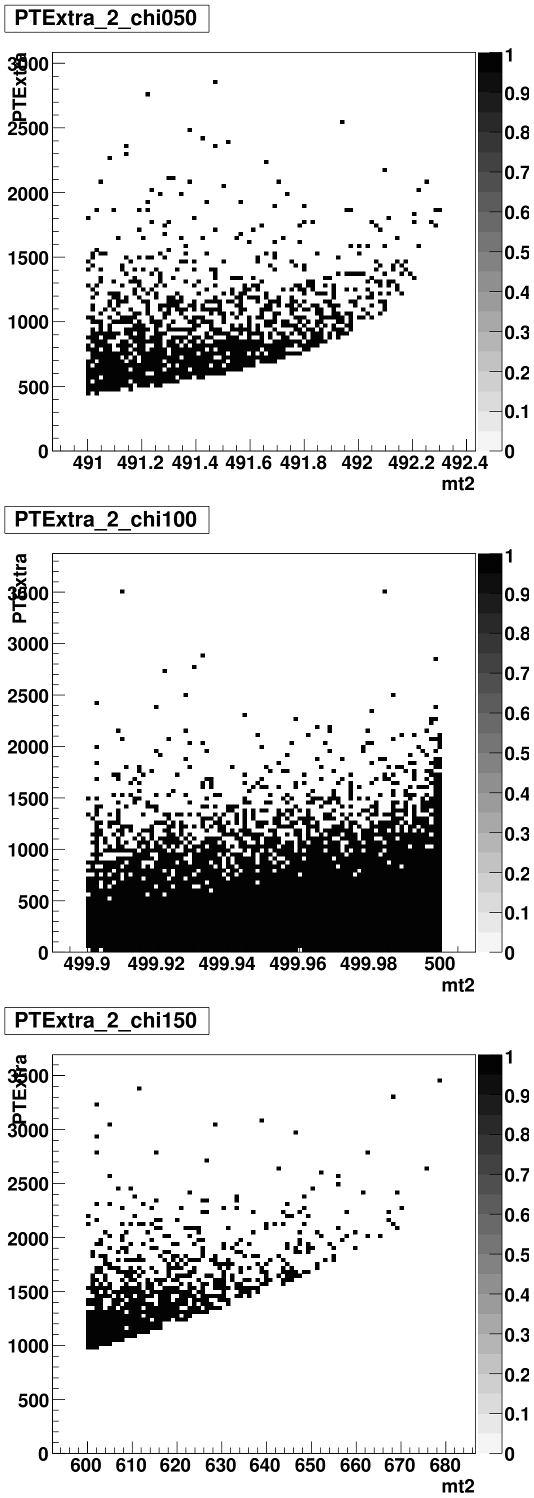

Figure 8: PT of initial state radiation for events in M2 or MT2 tail.

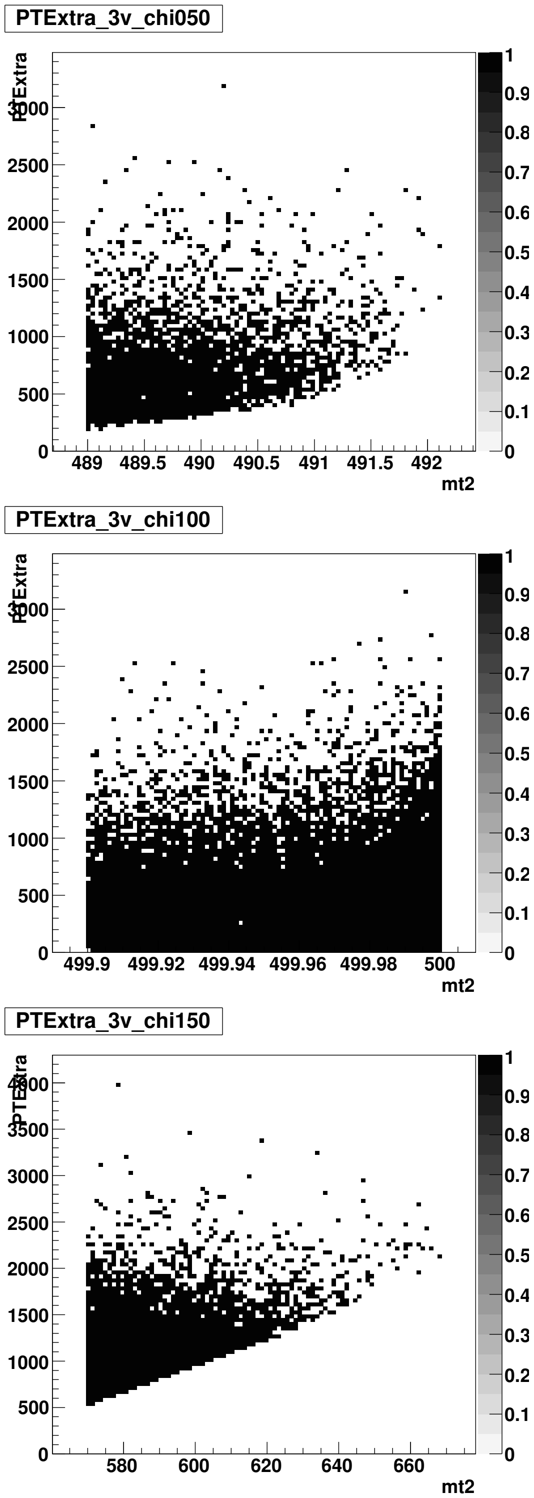

Figure 9: PT of initial state radiation for events in M2 or MT2 tail.

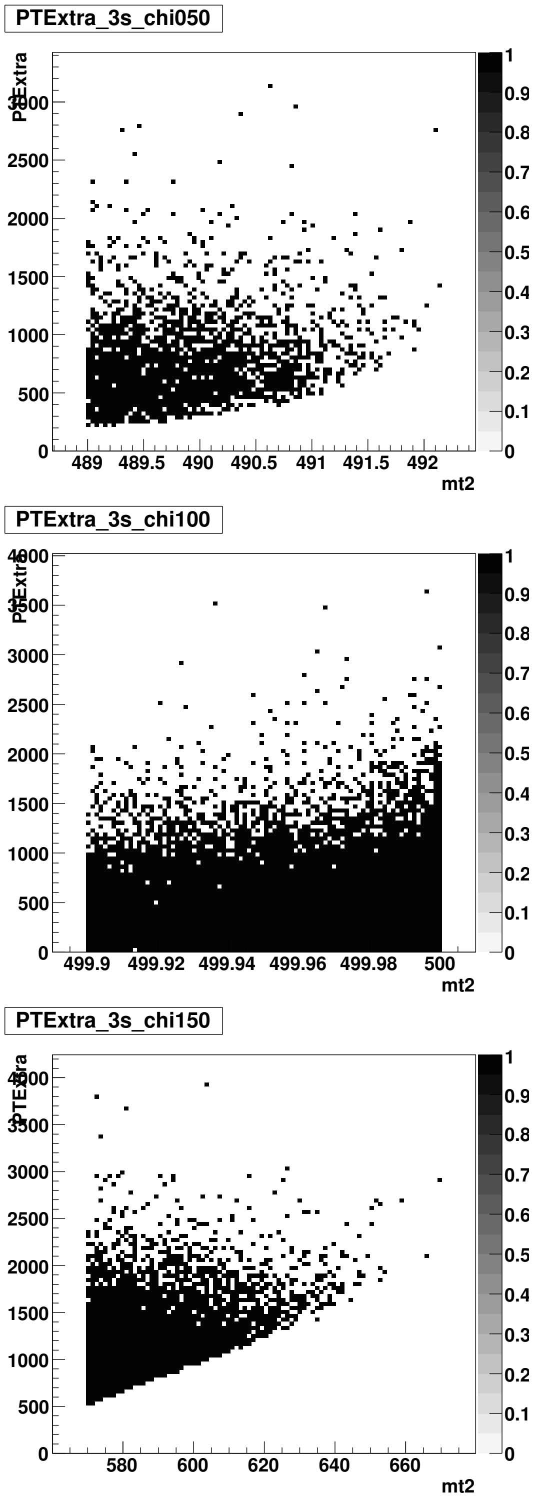

Figure 10: PT of initial state radiation for events in M2 or MT2 tail.

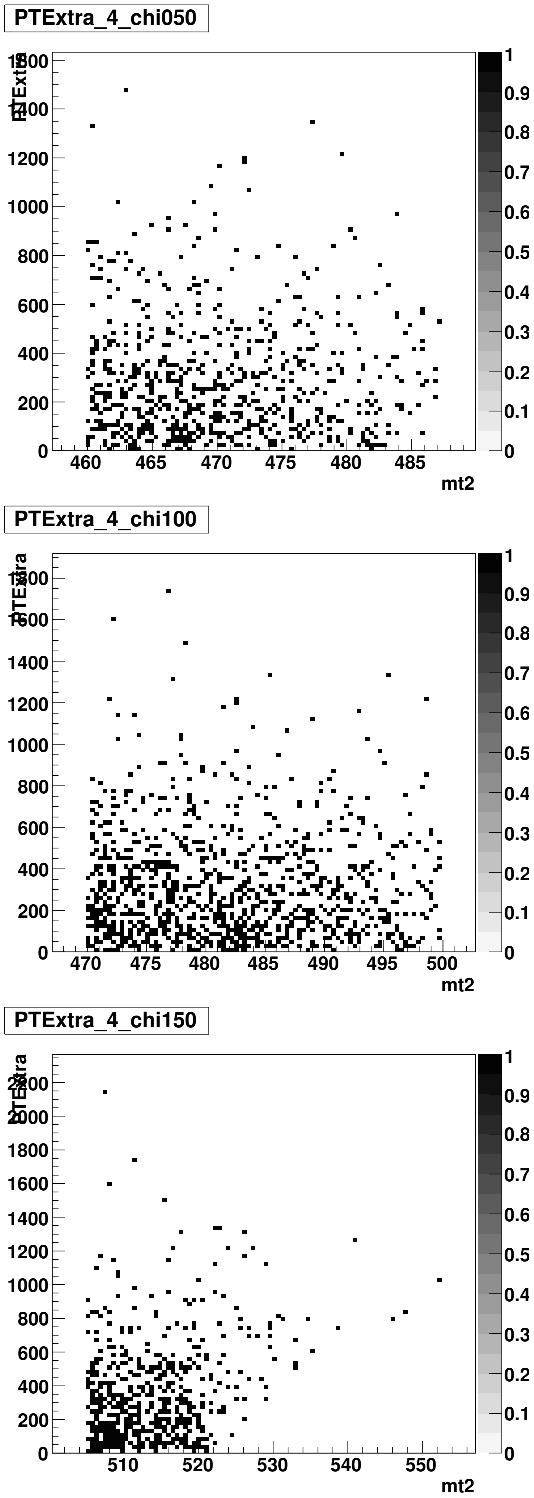

Figure 11: PT of initial state radiation for events in M2 or MT2 tail.

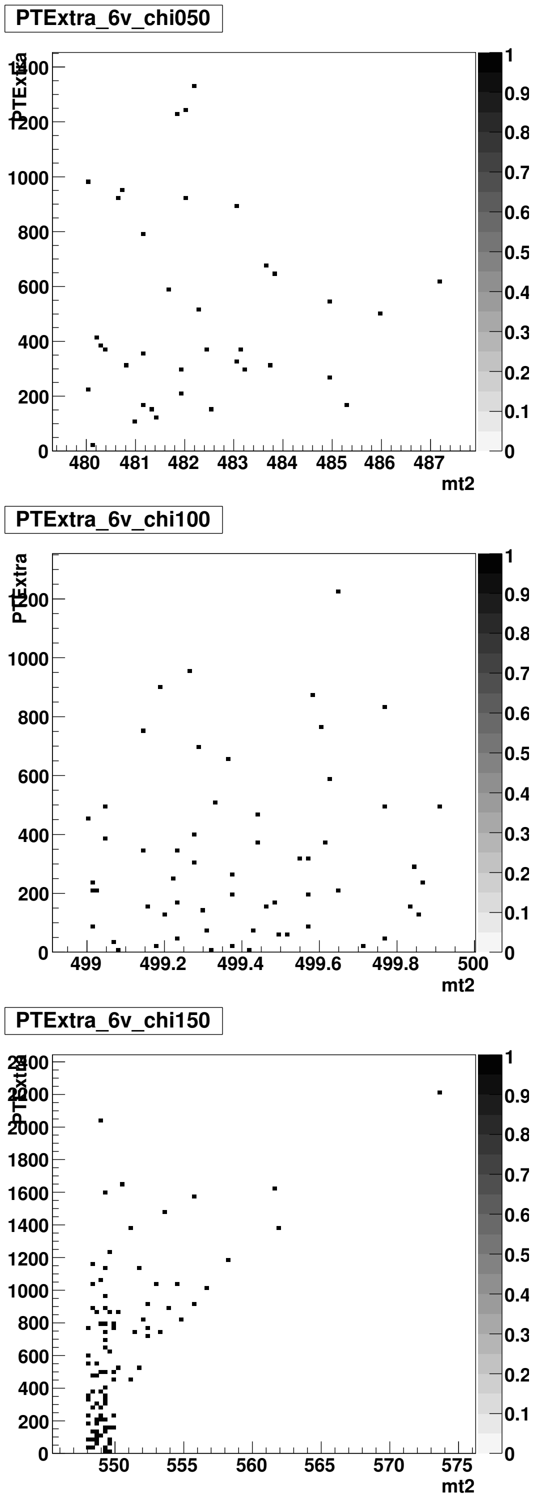

Figure 12: PT of initial state radiation for events in M2 or MT2 tail.

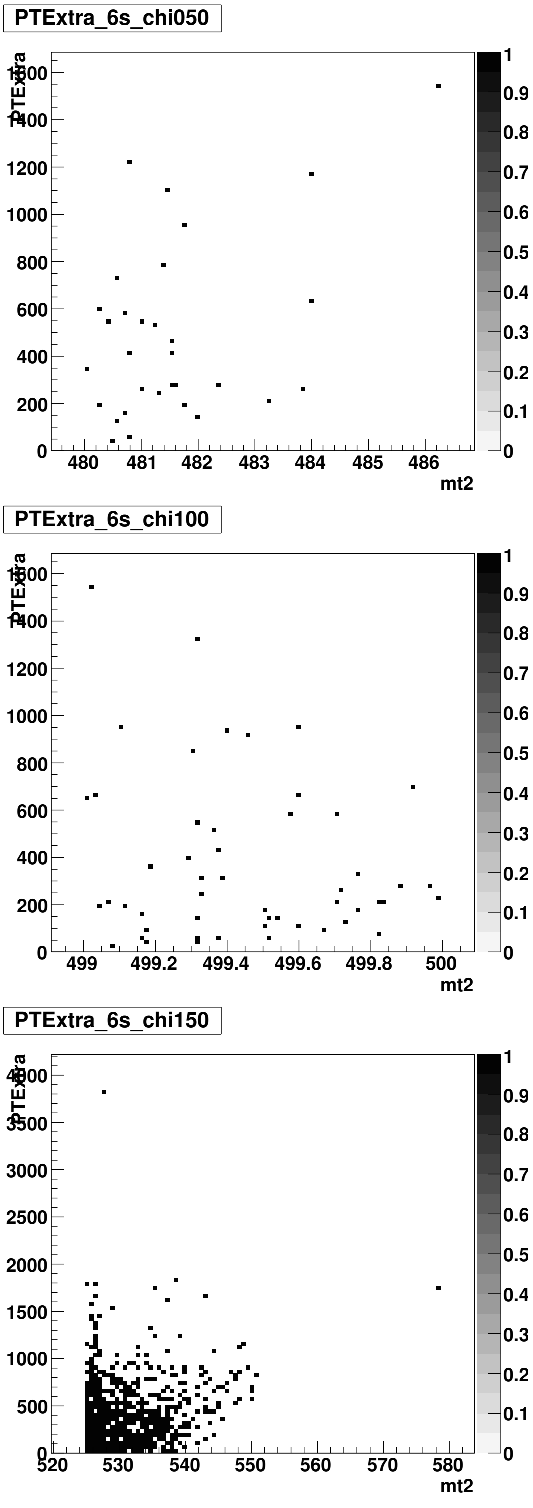

Figure 13: PT of initial state radiation for events in M2 or MT2 tail.

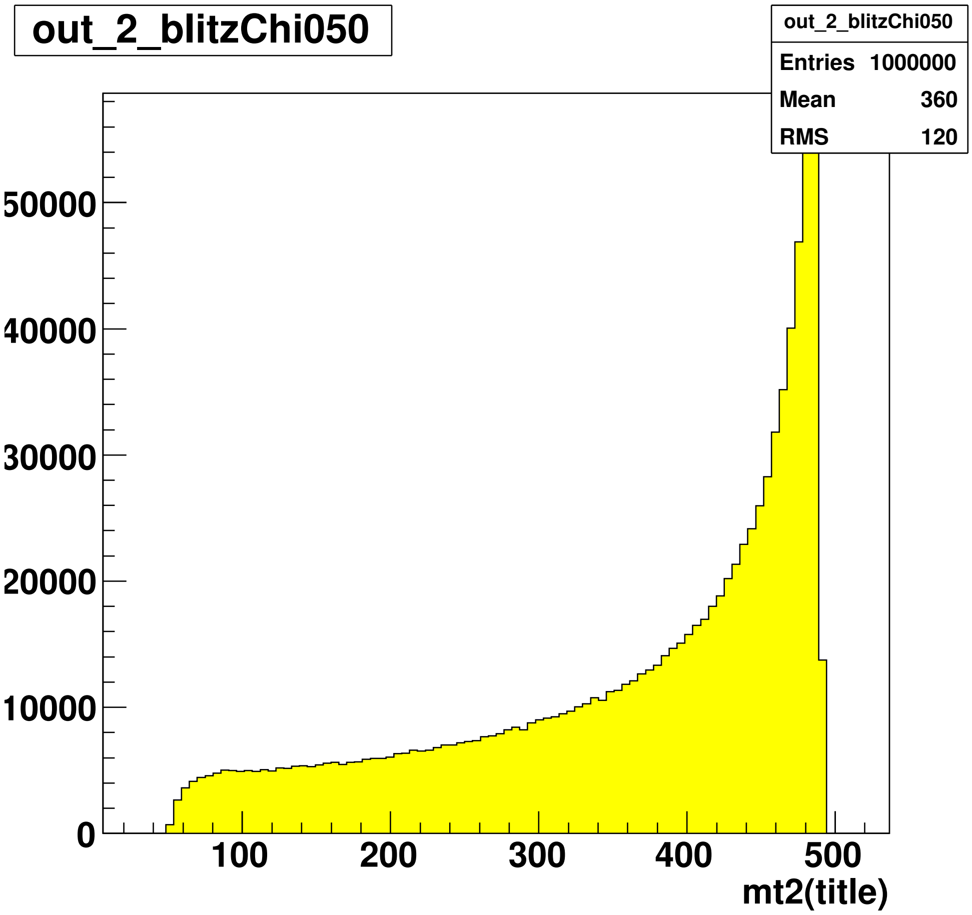

Figure 14: This shows the MT2 distribution obtained from TwoBody Ben-style events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 50 (i.e. too small by 50%). There might be a tiny foot, but un balance I would say there isn't one. See zoomed in plot in fig 15. Generated by toyFour.cc in "blitz" mode.

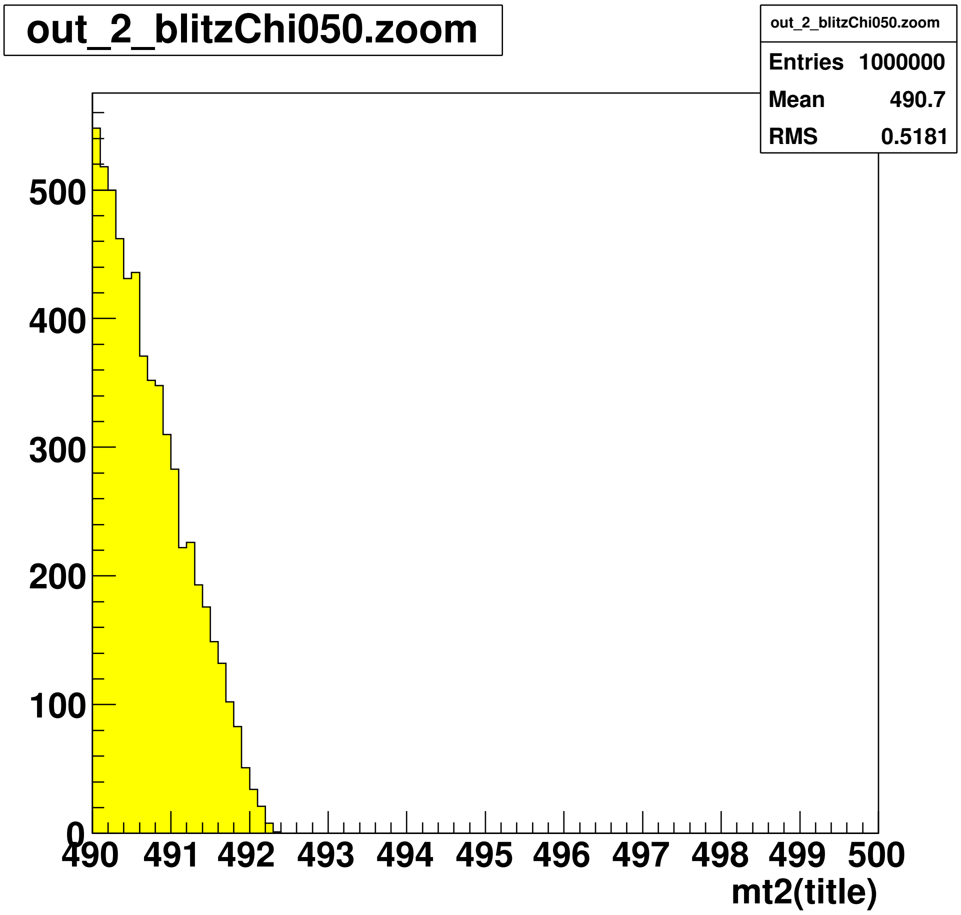

Figure 15: Zoomed in to the tip of fig 14

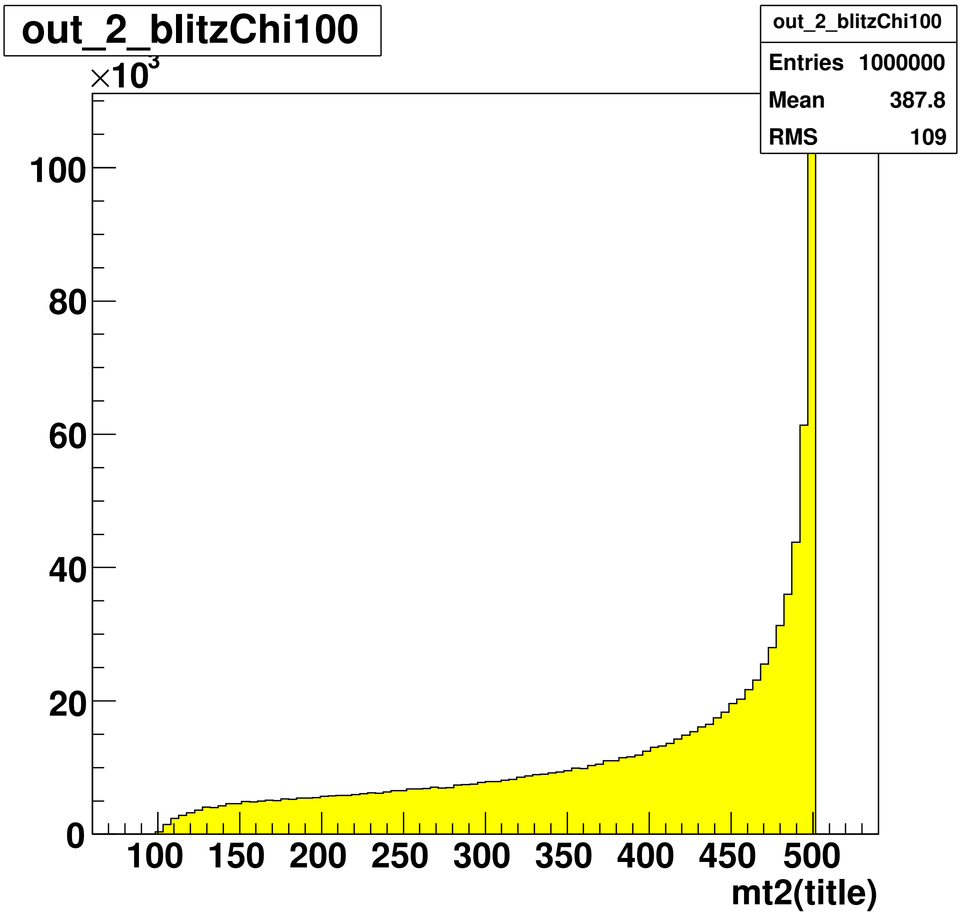

Figure 16: This shows the MT2 distribution obtained from TwoBody Ben-style events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 100 (i.e. just right). Note the absence of a foot. See zoomed in plot in fig 17. Generated by toyFour.cc in “blitz” mode.

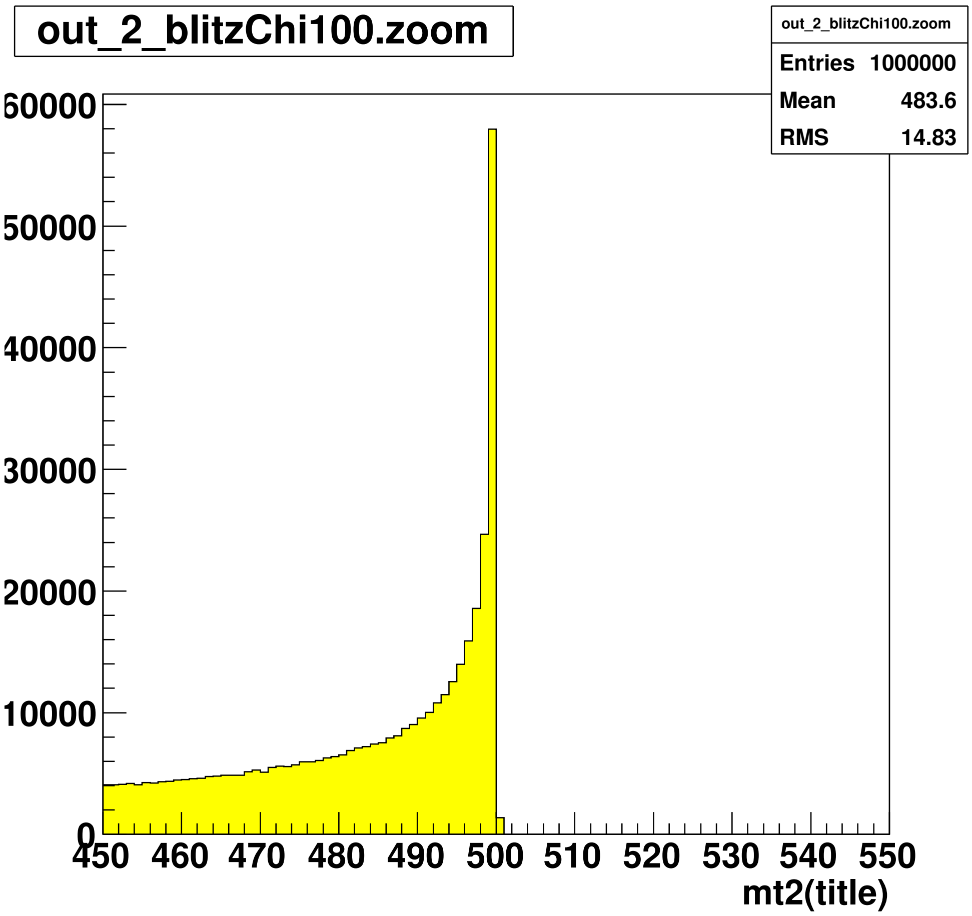

Figure 17: Zoomed in to the tip of fig 16

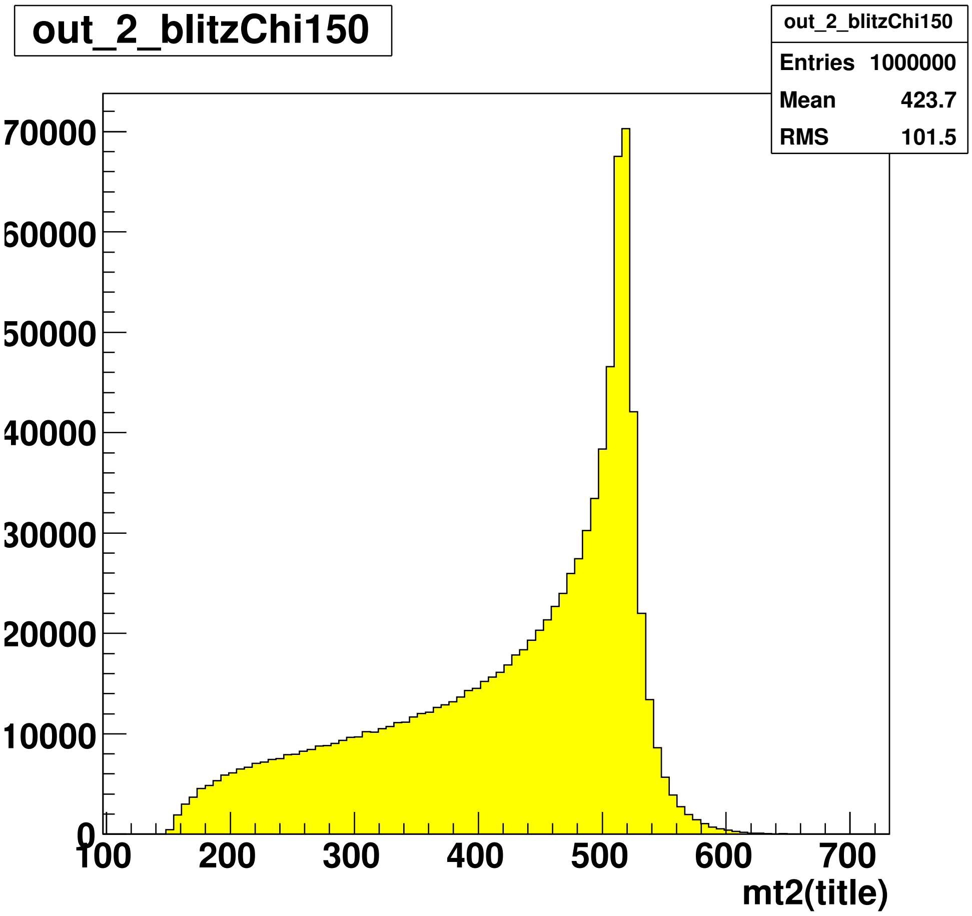

Figure 18: This shows the MT2 distribution obtained from TwoBody Ben-style events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 150 (i.e. too big by 50%). Note the BIG foot. Is it real? See zoomed in plot in fig 19. Generated by toyFour.cc in “blitz” mode.

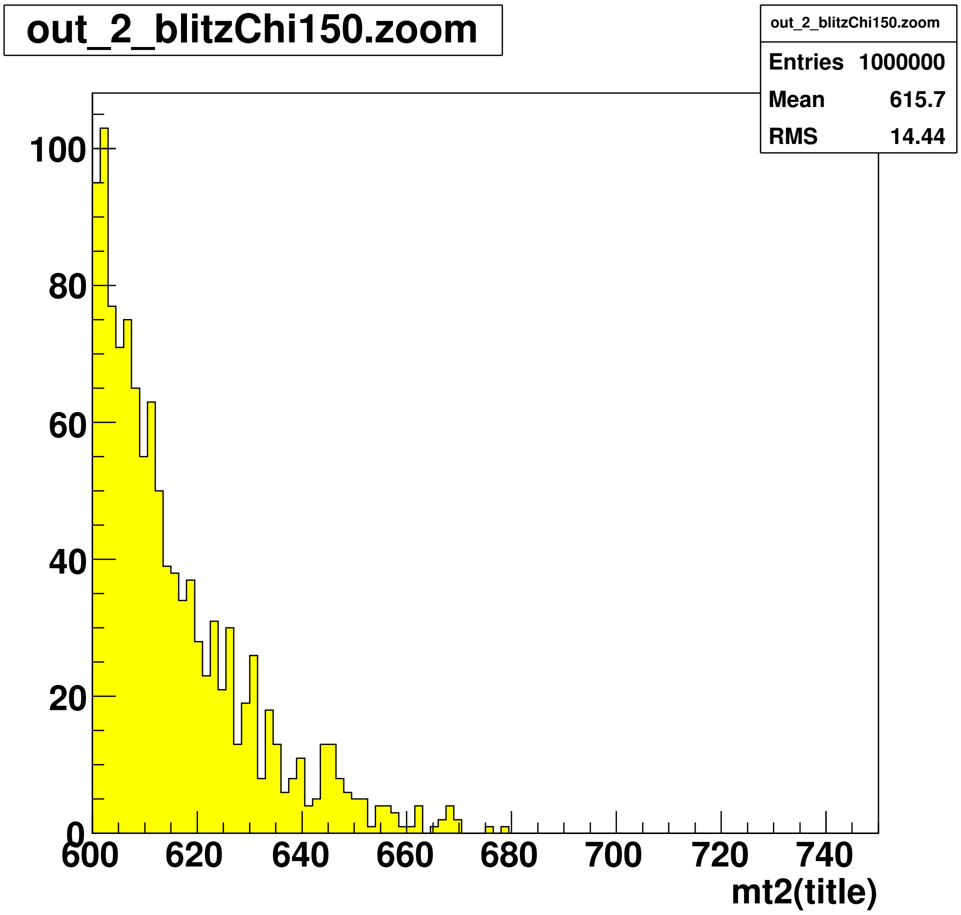

Figure 19: Zoomed in to the tip of fig 18

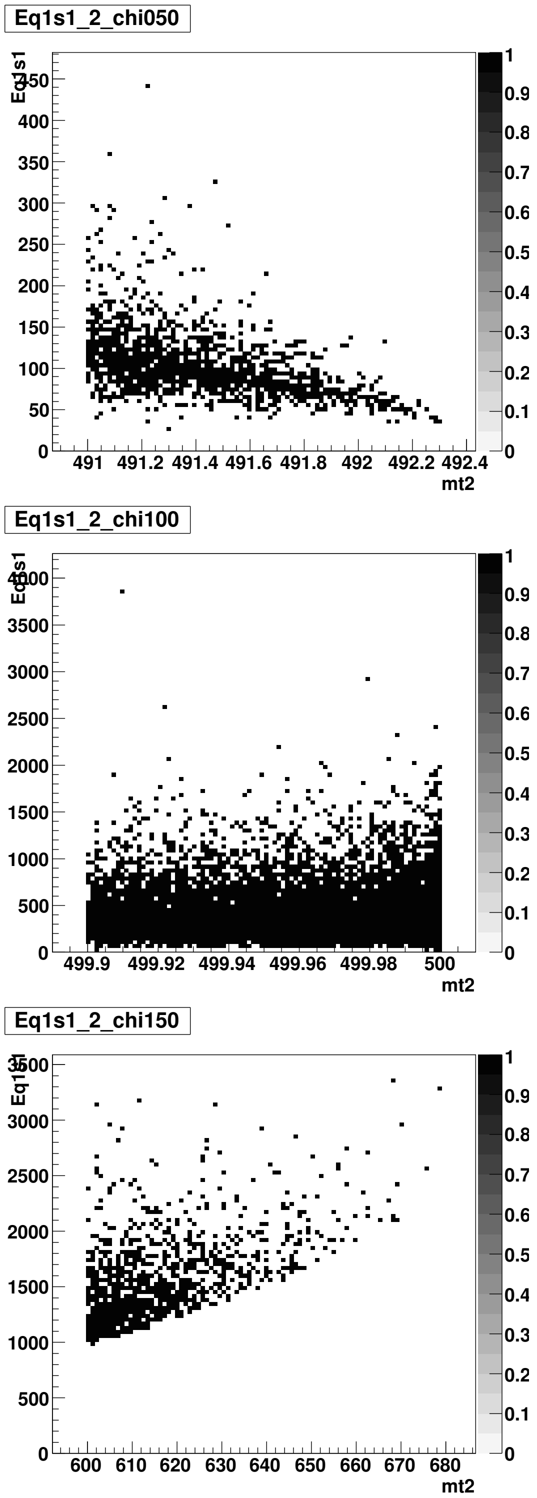

Figure 20: Energies of quarks for events in M2 or MT2 tail.

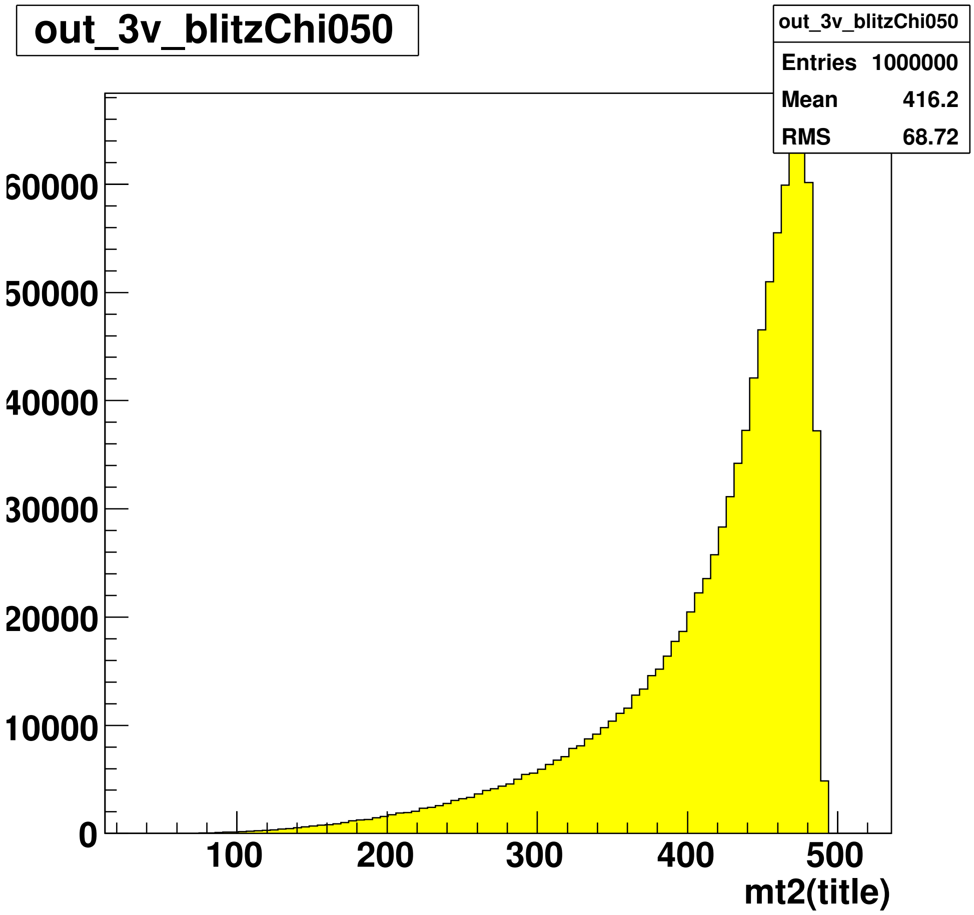

Figure 21: This shows the MT2 distribution obtained from ThreeBody Ben-style events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 50 (i.e. too small by 50%). There might be a tiny foot, but un balance I would say there isn't one. See zoomed in plot in fig 22. Generated by toyFour.cc in "blitz" mode.

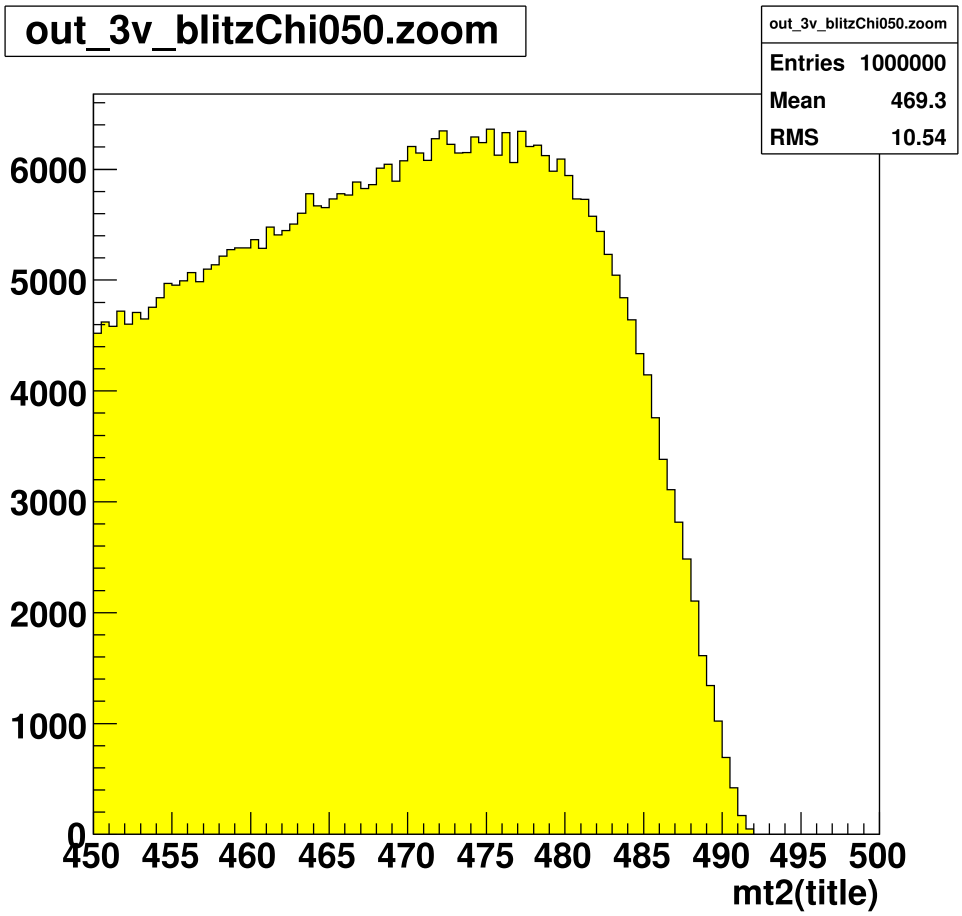

Figure 22: Zoomed in to the tip of fig 21

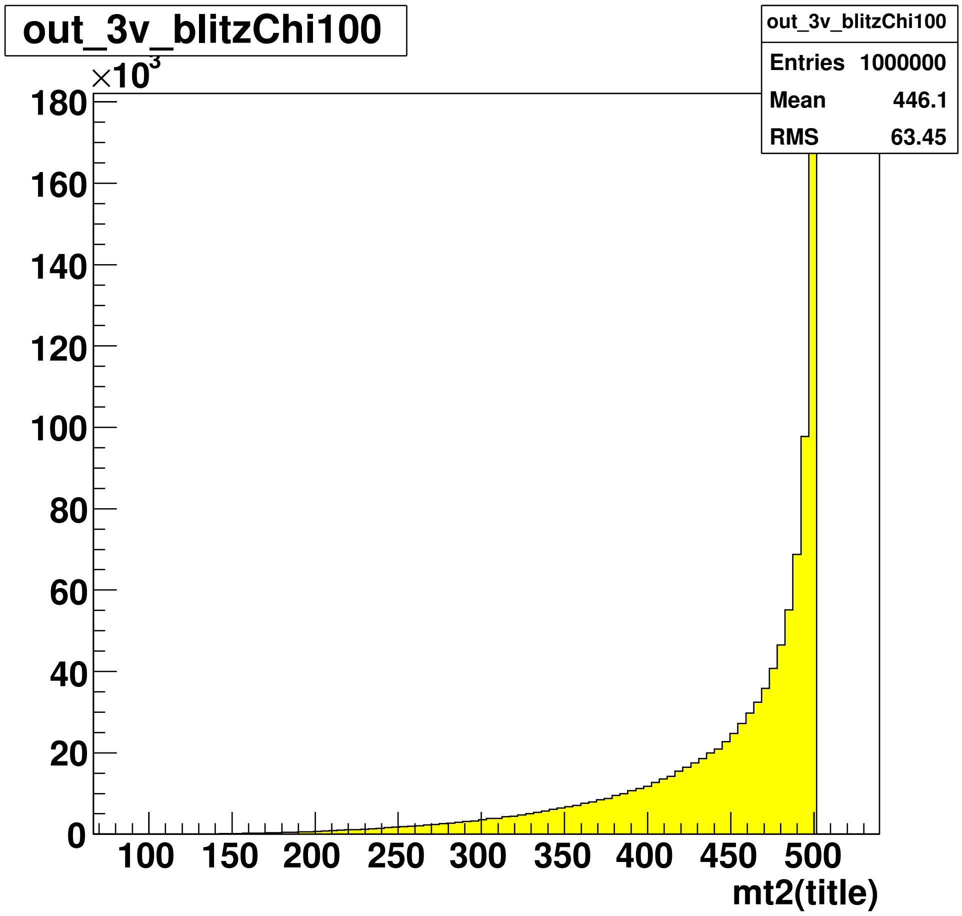

Figure 23: This shows the MT2 distribution obtained from ThreeBody Ben-style events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 100 (i.e. just right). Note the absence of a foot. See zoomed in plot in fig 24. Generated by toyFour.cc in "blitz" mode.

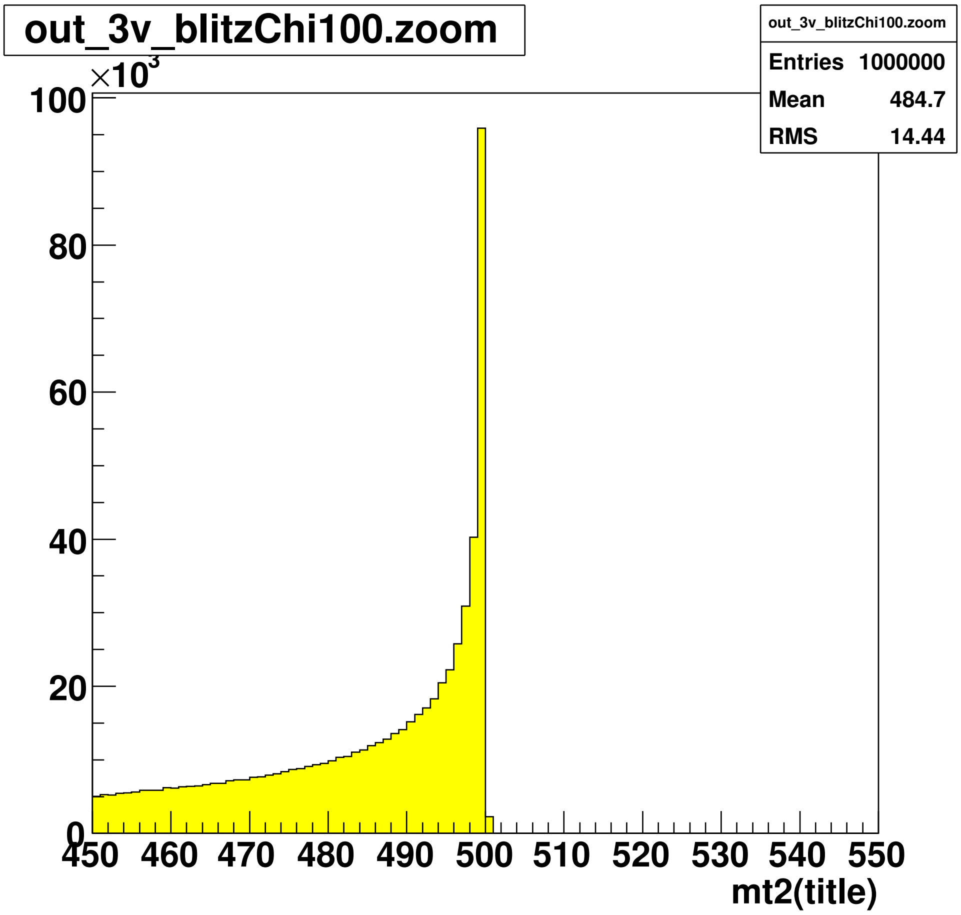

Figure 24: Zoomed in to the tip of fig 23

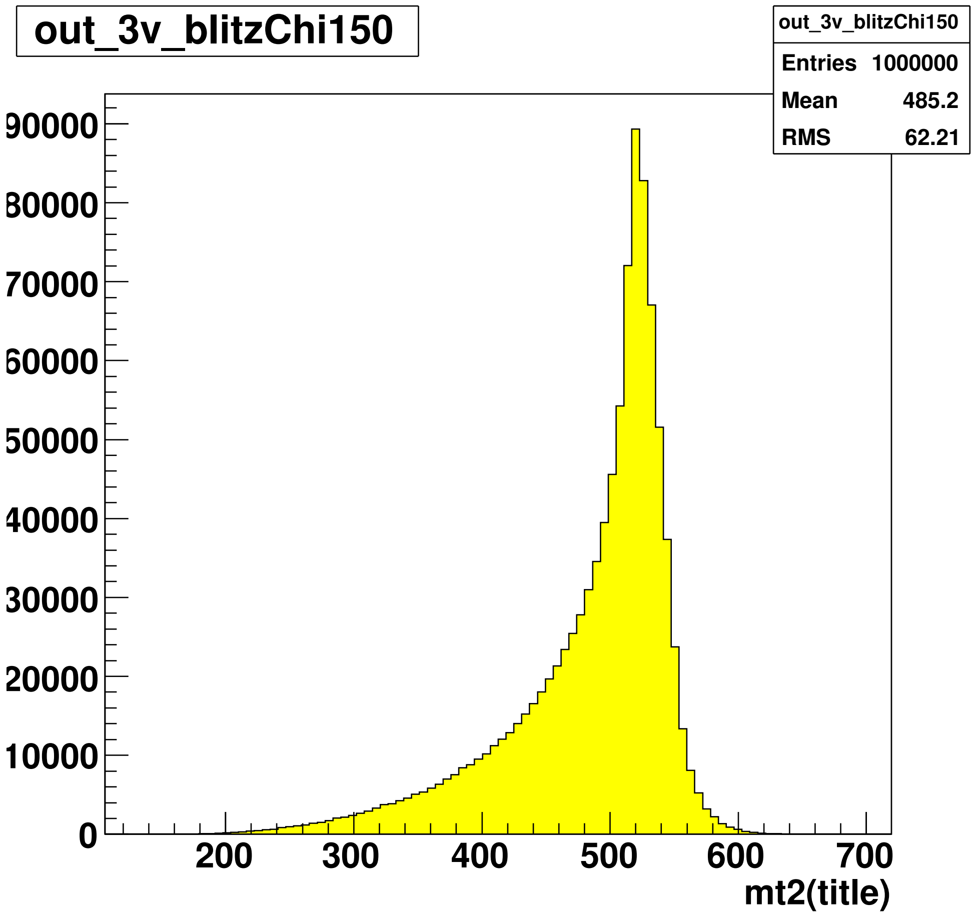

Figure 25: This shows the MT2 distribution obtained from ThreeBody Ben-style events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 150 (i.e. too big by 50%). Note the BIG foot. Is it real? See zoomed in plot in fig 26. Generated by toyFour.cc in "blitz" mode.

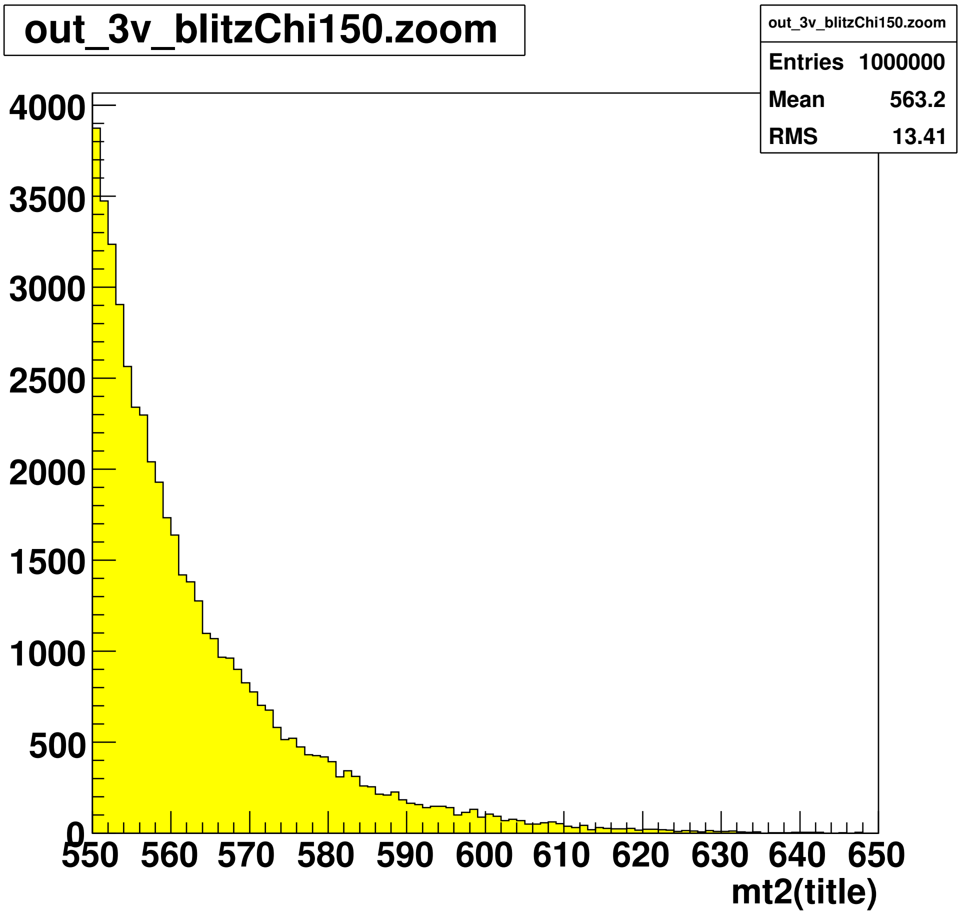

Figure 26: Zoomed in to the tip of fig 25

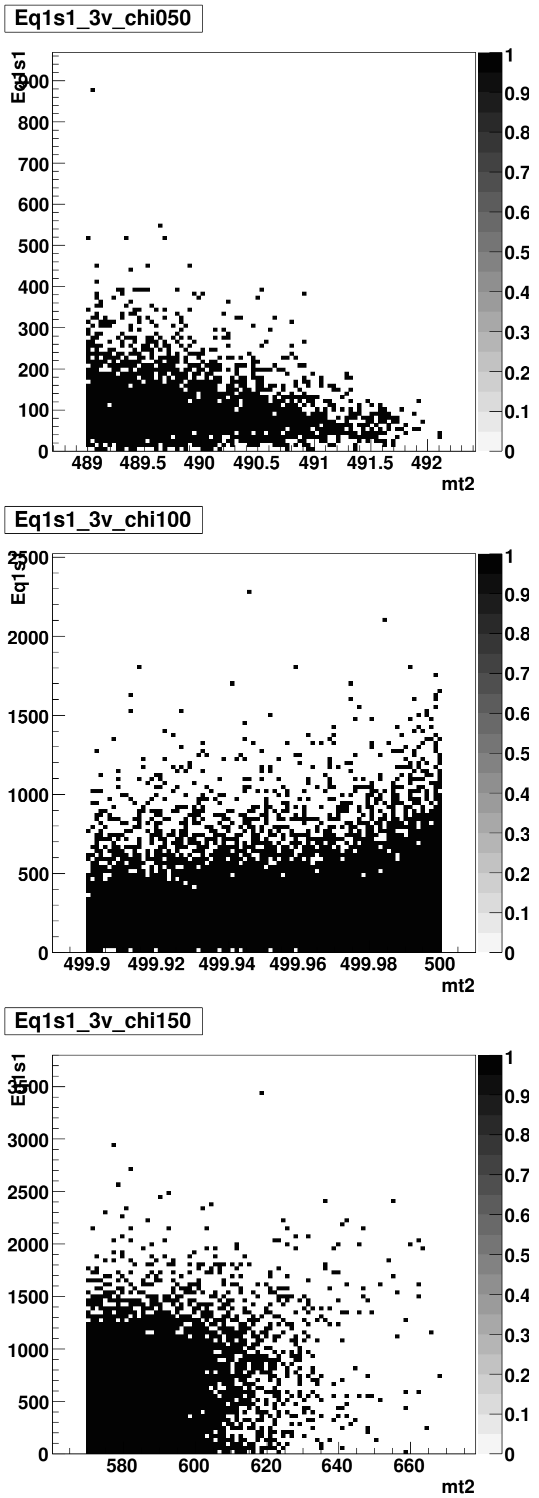

Figure 27: Energies of quarks for events in M2 or MT2 tail.

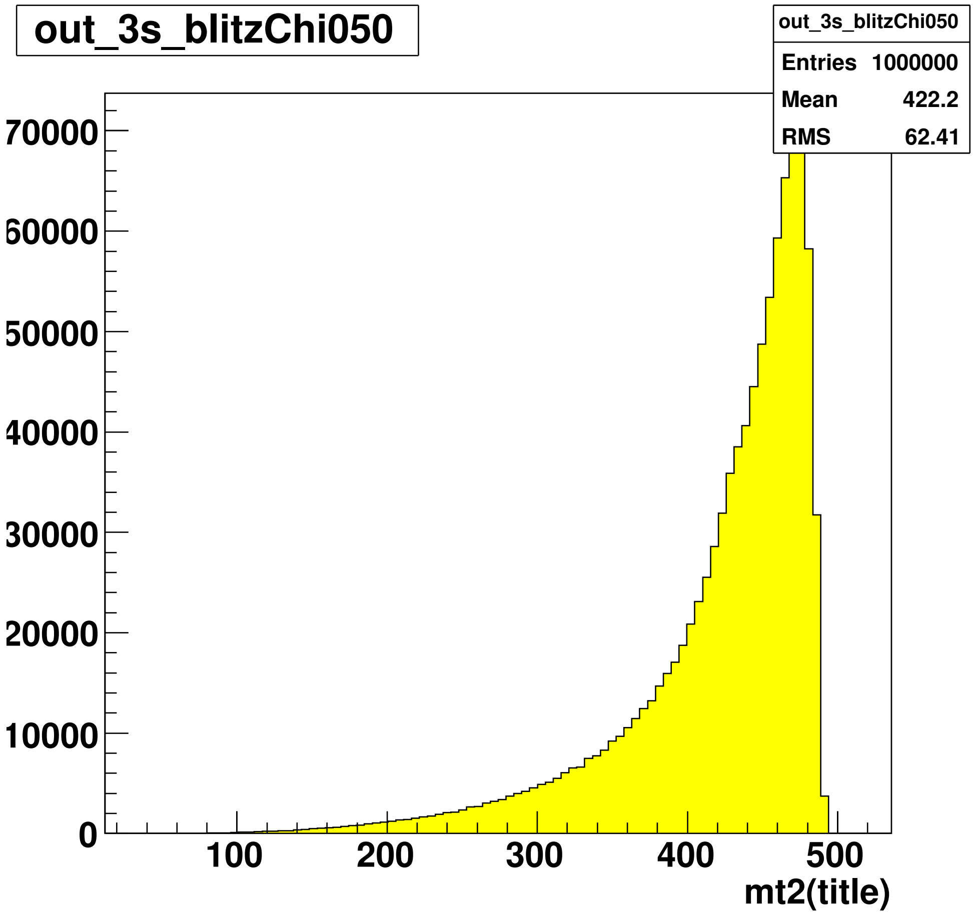

Figure 28: This shows the MT2 distribution obtained from ThreeBody events WITH ON SHELL SQUARK of mass 300 with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 50 (i.e. too small by 50%). There might be a tiny foot, but un balance I would say there isn't one. See zoomed in plot in fig 29. Generated by toyFour.cc in "blitz" mode.

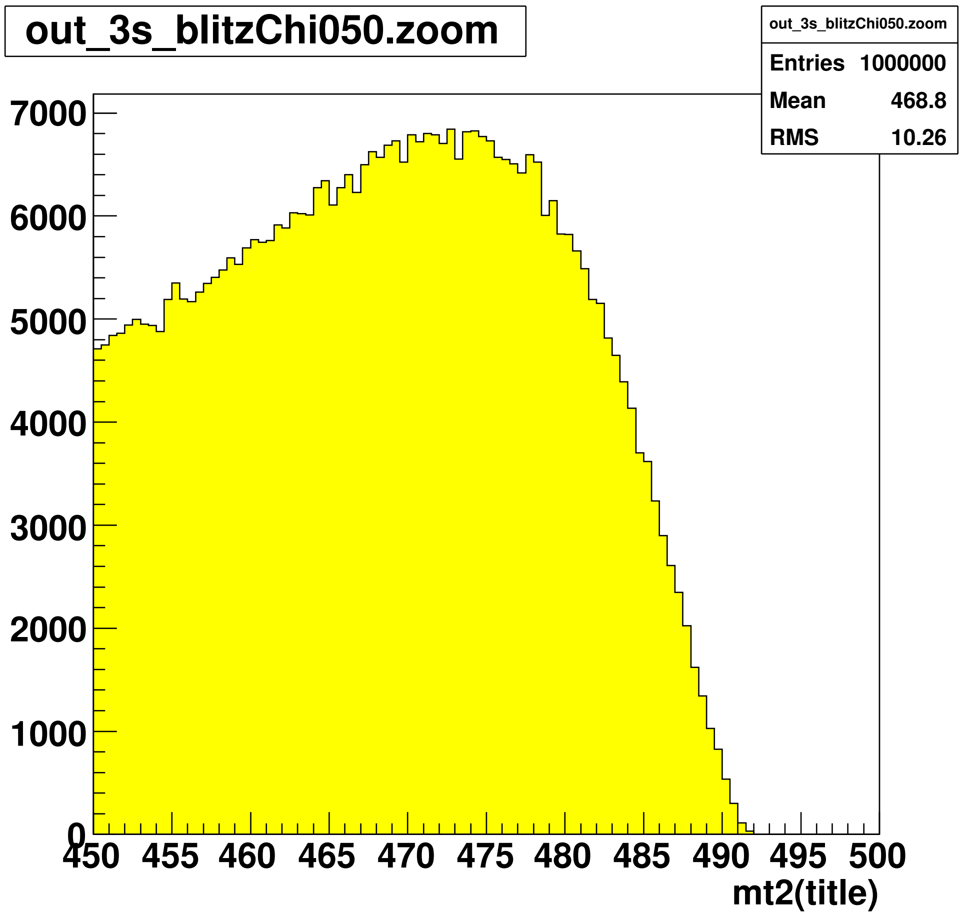

Figure 29: Zoomed in to the tip of fig 28

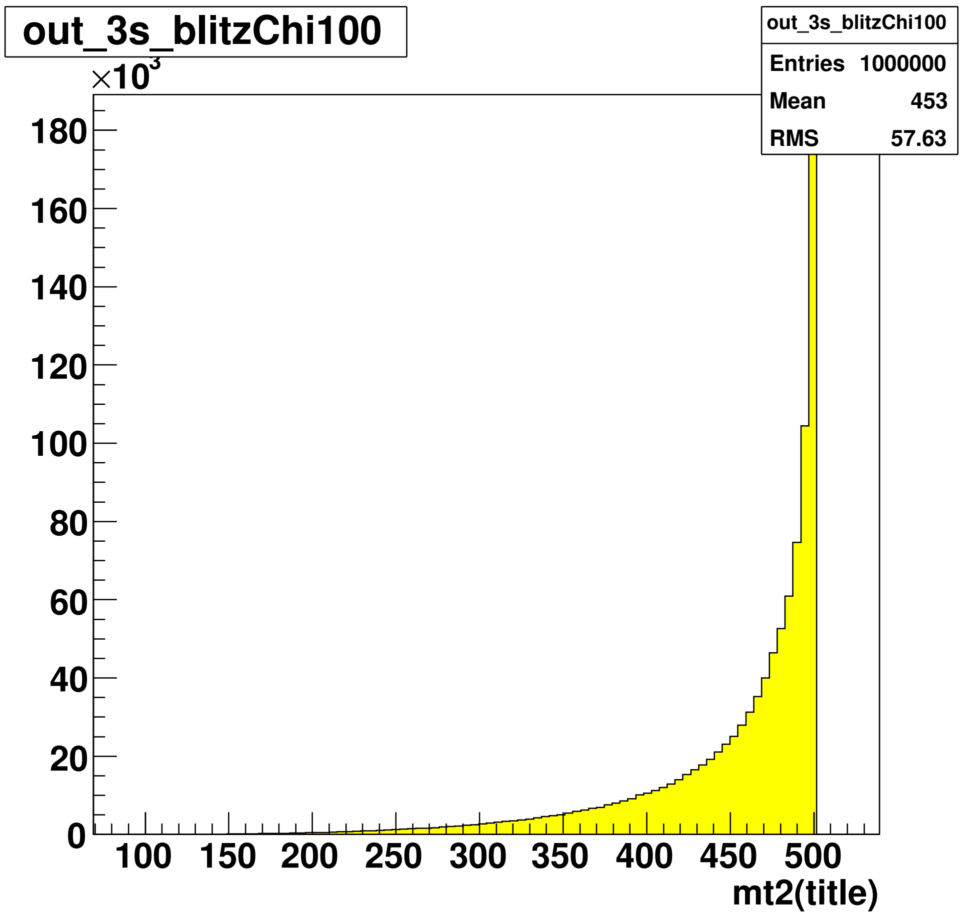

Figure 30: This shows the MT2 distribution obtained from ThreeBody events WITH ON SHELL SQUARK of mass 300 with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 100 (i.e. just right). Note the absence of a foot. See zoomed in plot in fig 31. Generated by toyFour.cc in "blitz" mode.

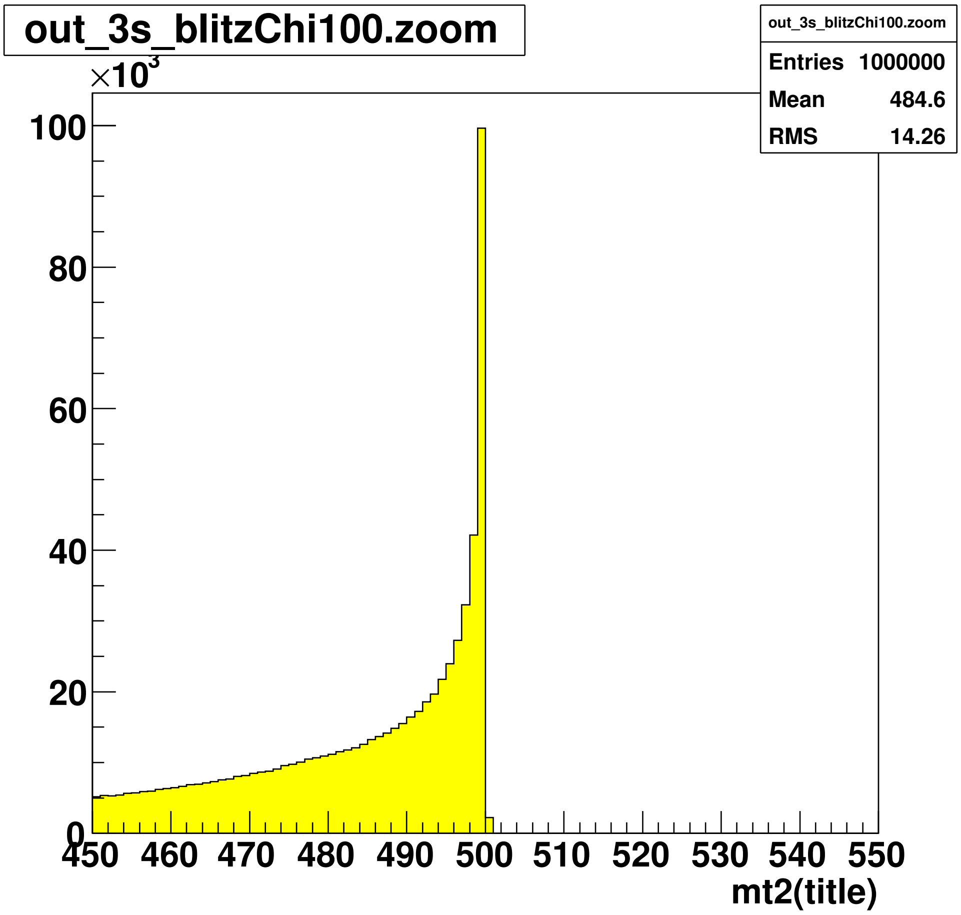

Figure 31: Zoomed in to the tip of fig 30

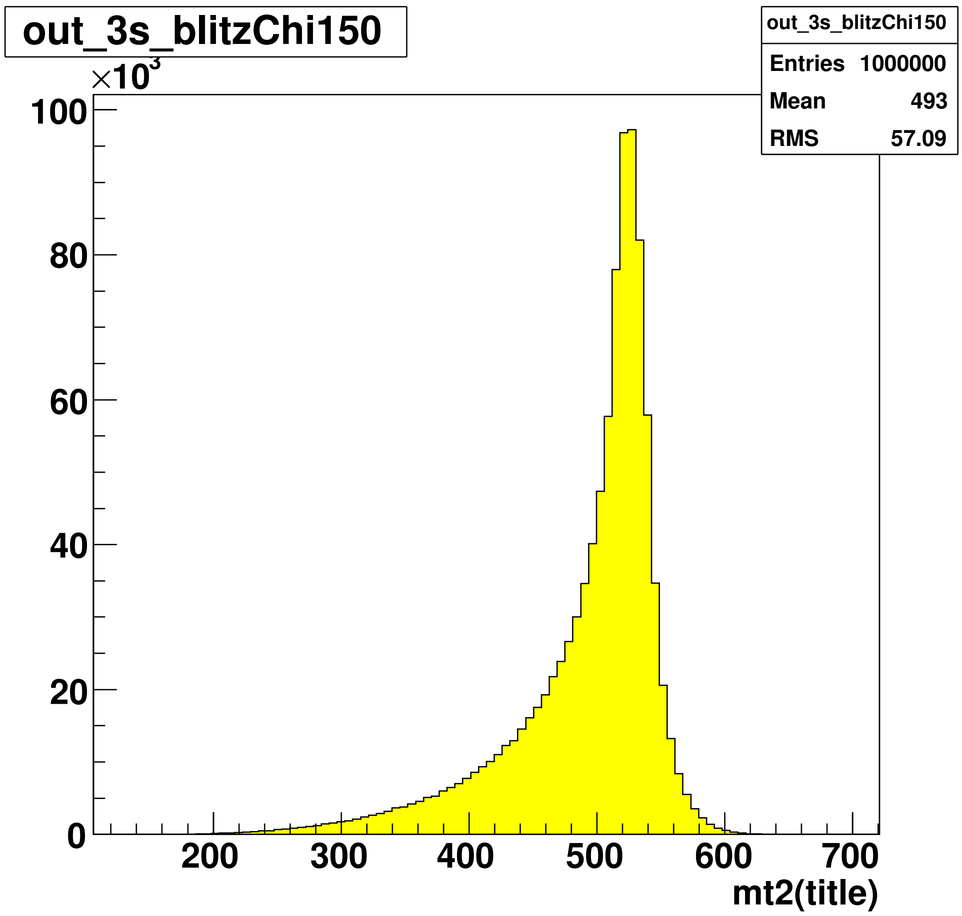

Figure 32: This shows the MT2 distribution obtained from ThreeBody events WITH ON SHELL SQUARK of mass 300 with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 150 (i.e. too big by 50%). Note the BIG foot. Is it real? See zoomed in plot in fig 33. Generated by toyFour.cc in “blitz” mode.

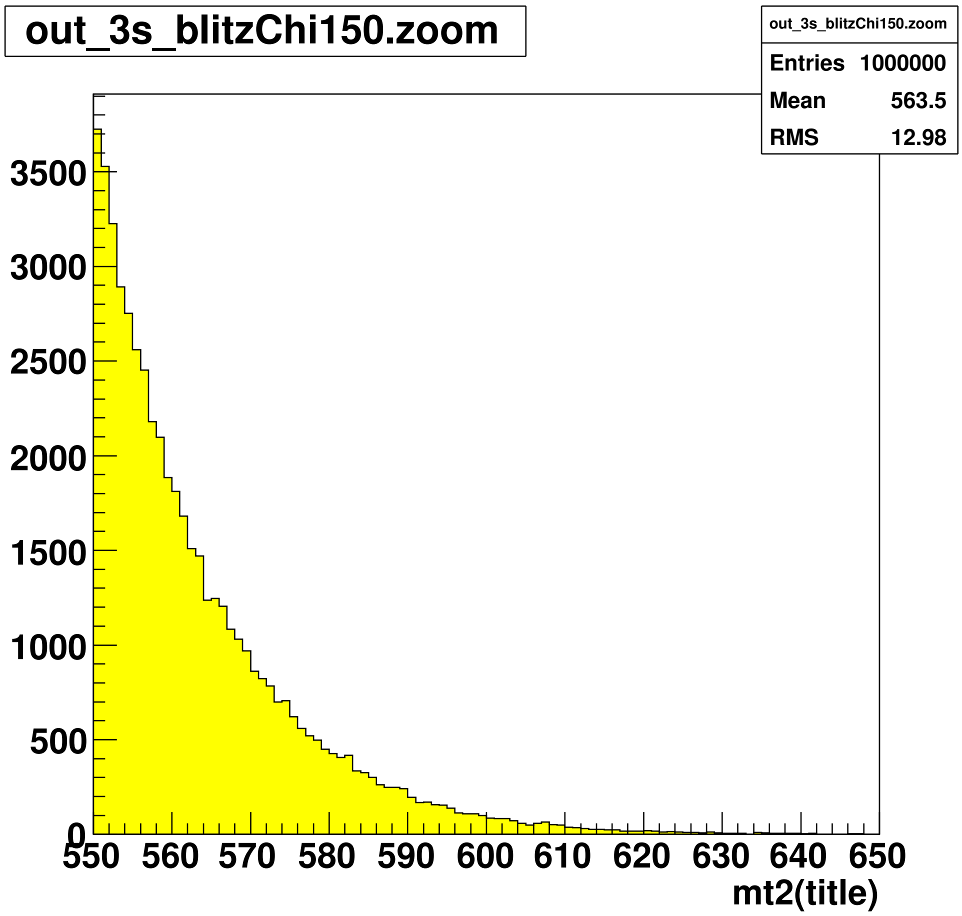

Figure 33: Zoomed in to the tip of fig 32

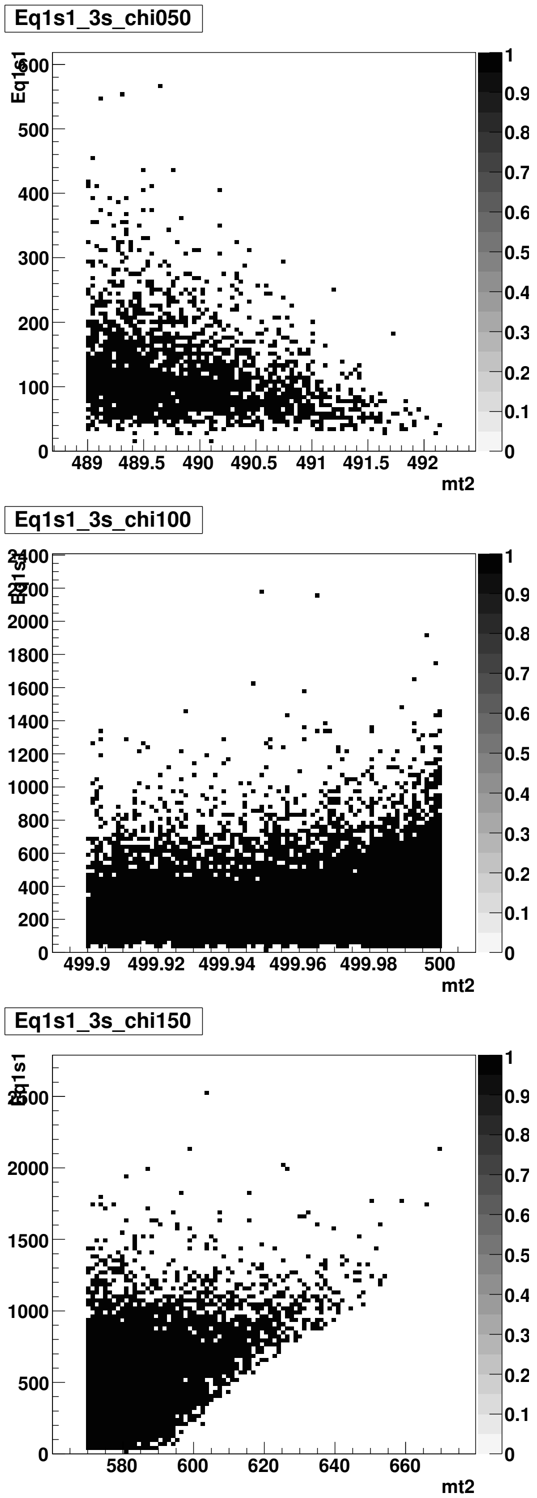

Figure 34: Energies of quarks for events in M2 or MT2 tail.

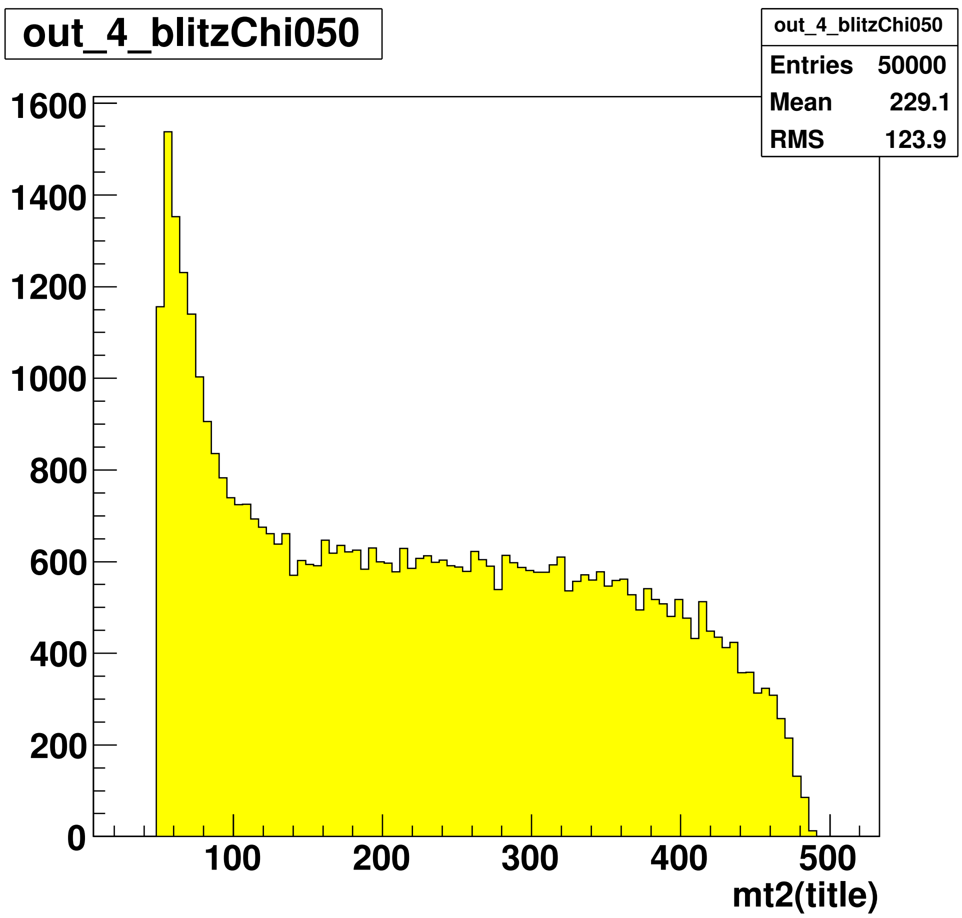

Figure 35: This shows the MT2 distribution obtained from ThreeBody Ben-style events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 50 (i.e. too small by 50%). There might be a tiny foot, but un balance I would say there isn't one. See zoomed in plot in fig 36. Generated by toyFour.cc in "blitz" mode.

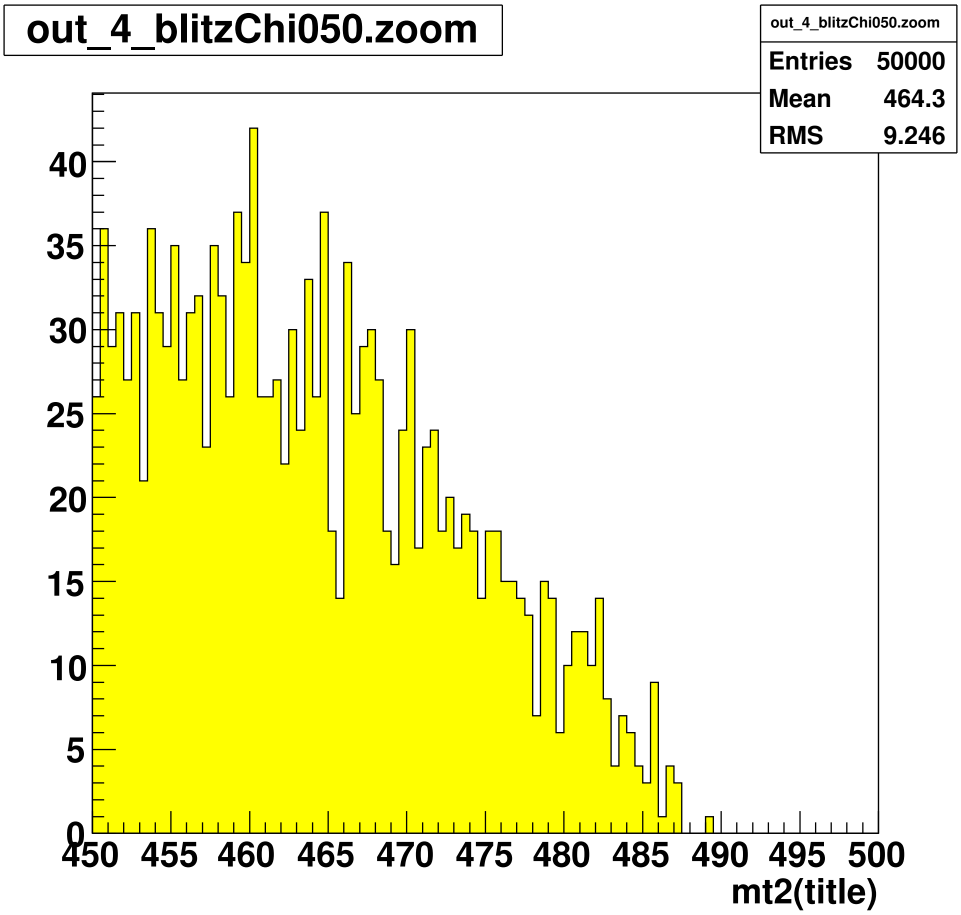

Figure 36: Zoomed in to the tip of fig 35

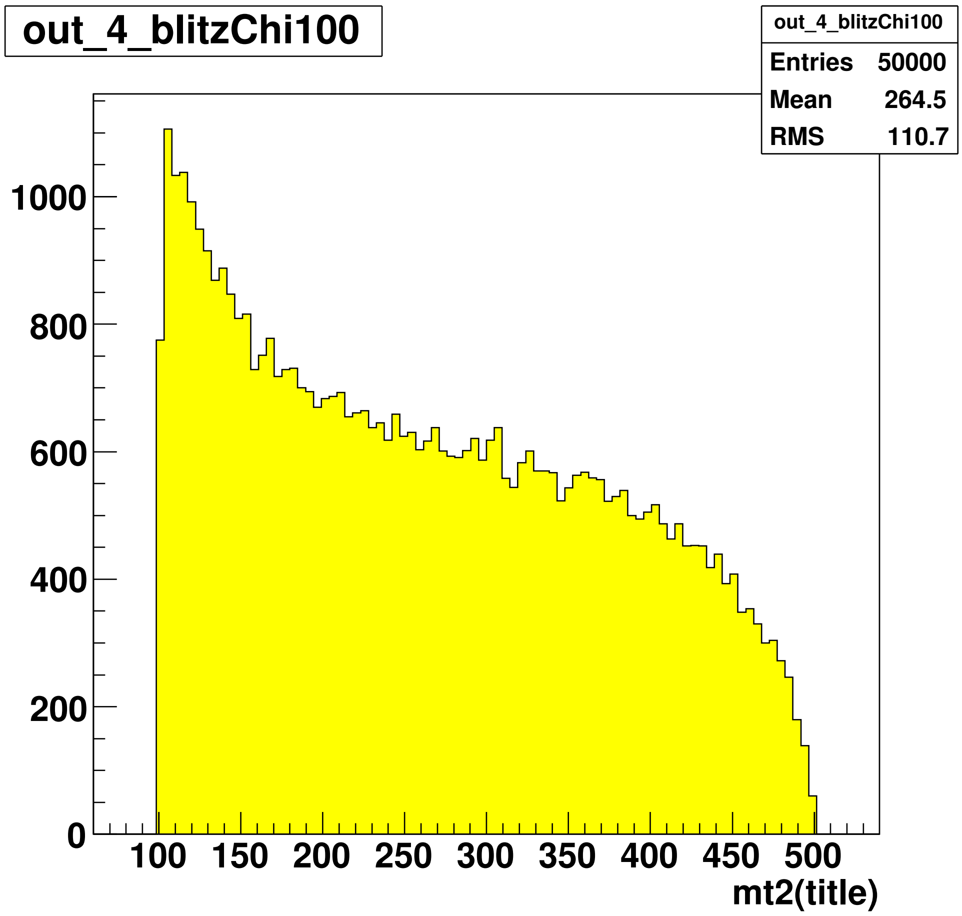

Figure 37: This shows the MT2 distribution obtained from ThreeBody Ben-style events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 100 (i.e. just right). Note the absence of a foot. See zoomed in plot in fig 38. Generated by toyFour.cc in "blitz" mode.

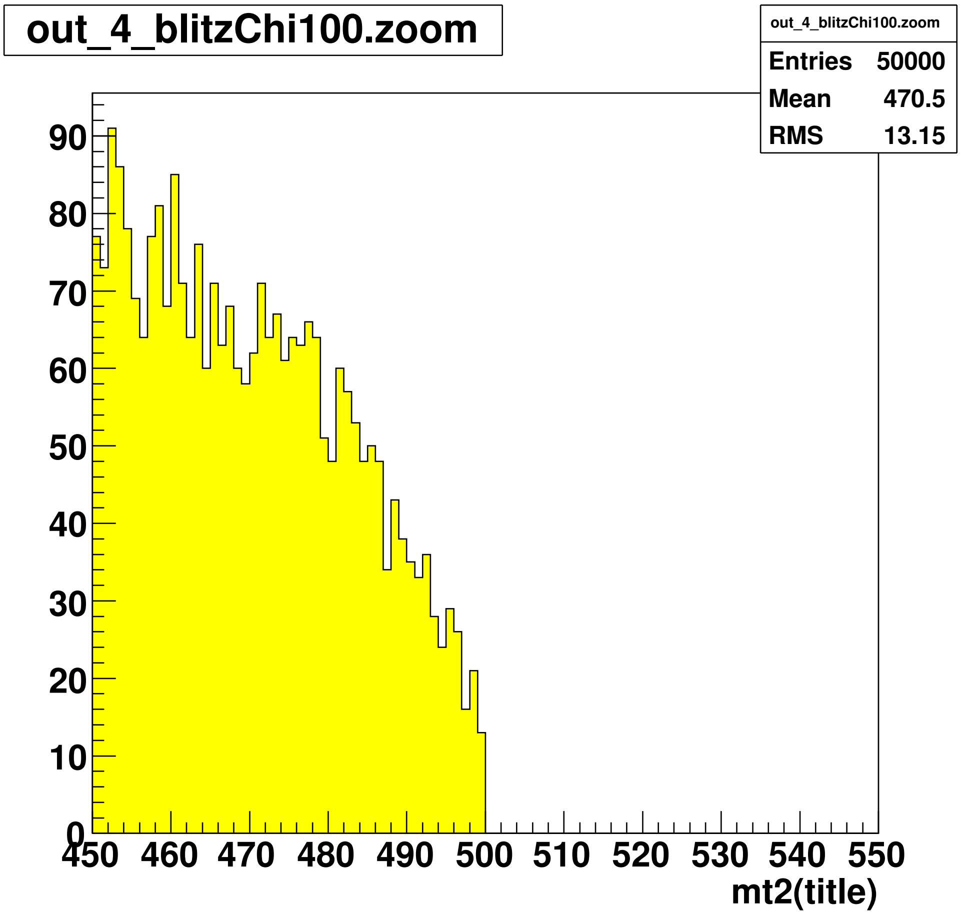

Figure 38: Zoomed in to the tip of fig 37

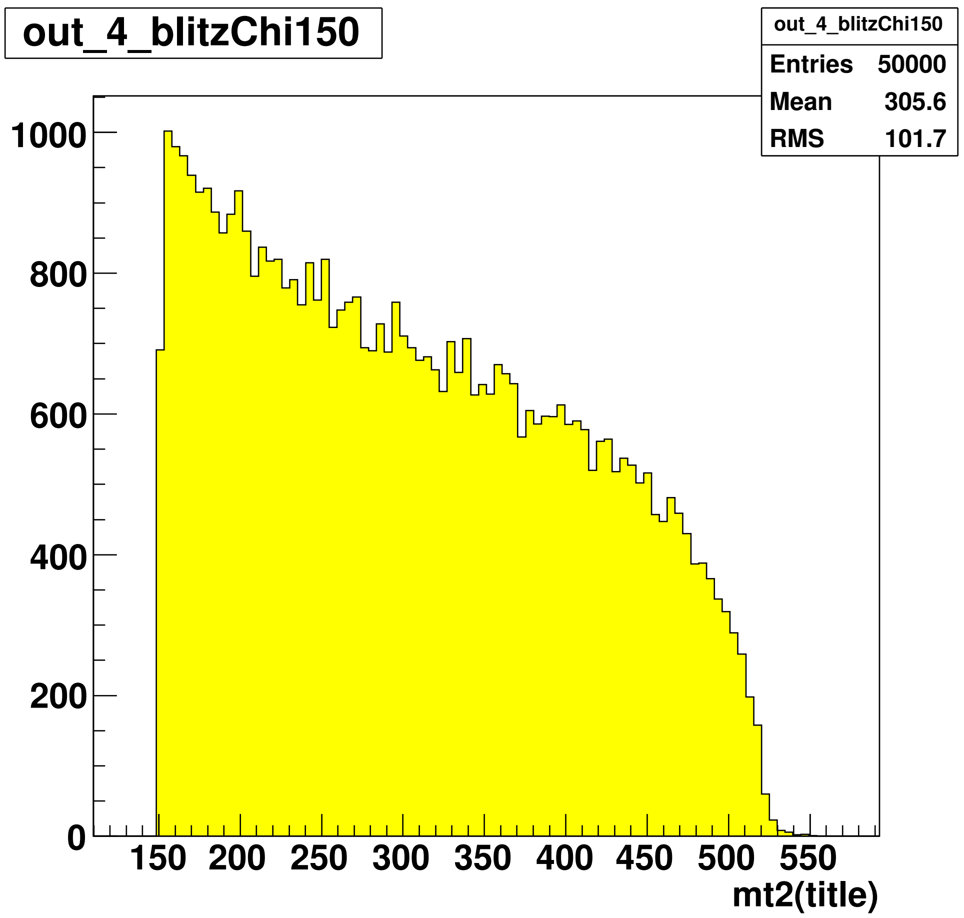

Figure 39: This shows the MT2 distribution obtained from ThreeBody Ben-style events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 150 (i.e. too big by 50%). Note the BIG foot. Is it real? See zoomed in plot in fig 40. Generated by toyFour.cc in "blitz" mode.

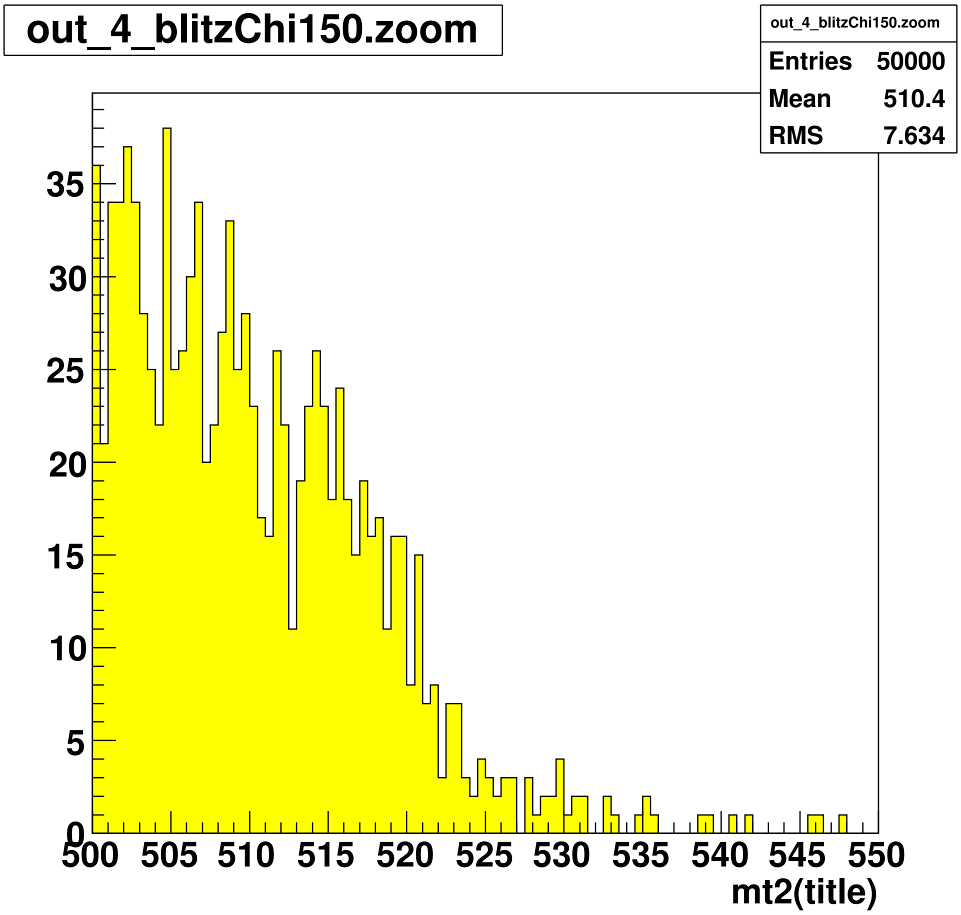

Figure 40: Zoomed in to the tip of fig 39

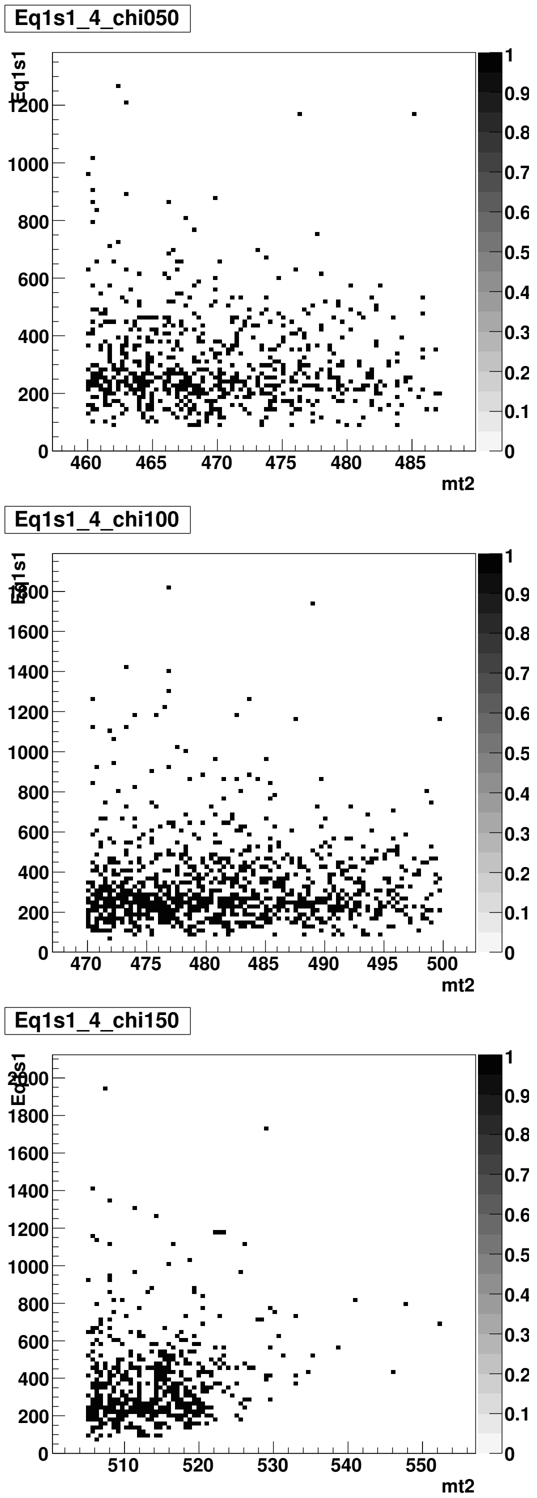

Figure 41: Energies of quarks for events in M2 or MT2 tail.

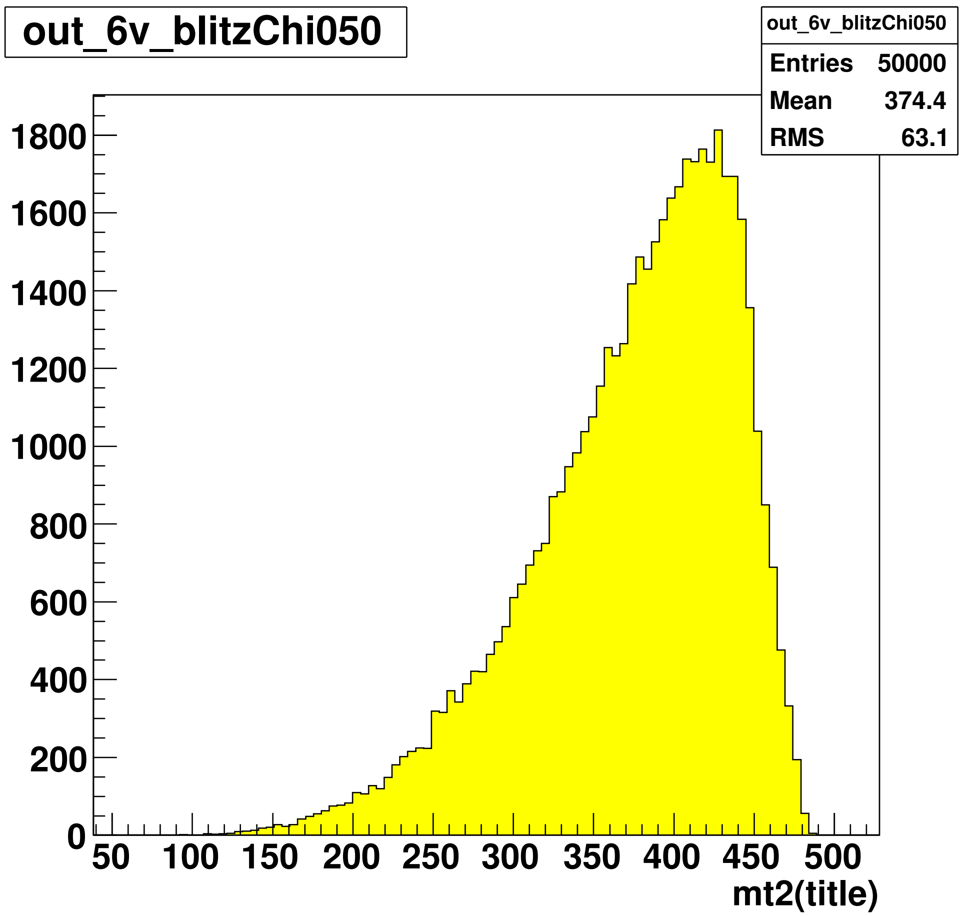

Figure 42: This shows the MT2 distribution obtained from SixBody events with independent three-body decays on each side via a virtual squark with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 50 (i.e. too small by 50%). There might be a tiny foot, but un balance I would say there isn't one. See zoomed in plot in fig 43. Generated by toyFour.cc in "blitz" mode.

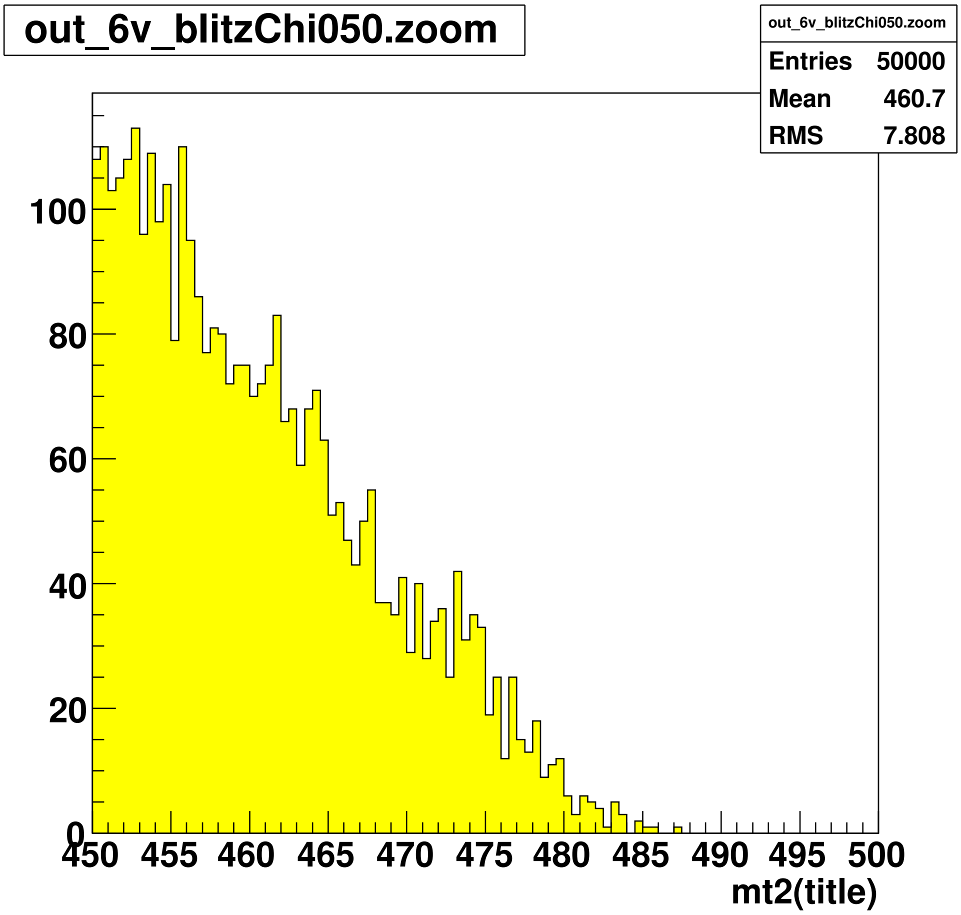

Figure 43: Zoomed in to the tip of fig 42

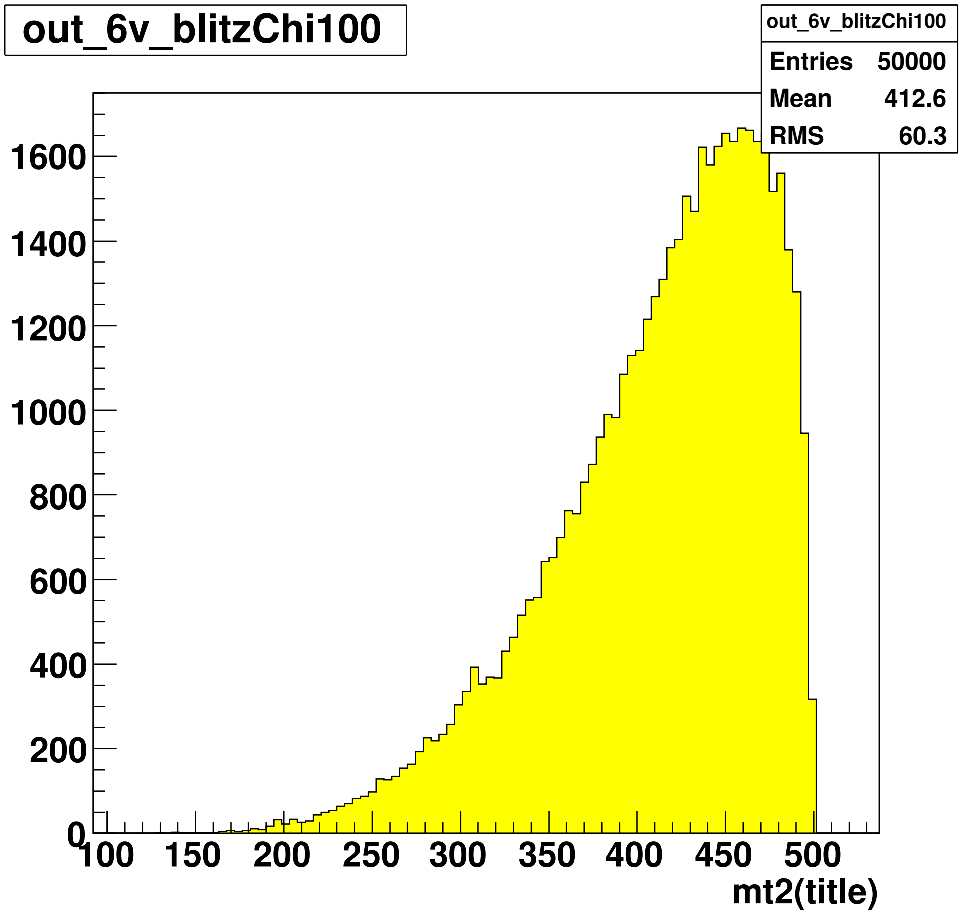

Figure 44: This shows the MT2 distribution obtained from SixBody events with independent three-body decays on each side via a virtual squark with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 100 (i.e. just right). Note the absence of a foot. See zoomed in plot in fig 45. Generated by toyFour.cc in “blitz” mode.

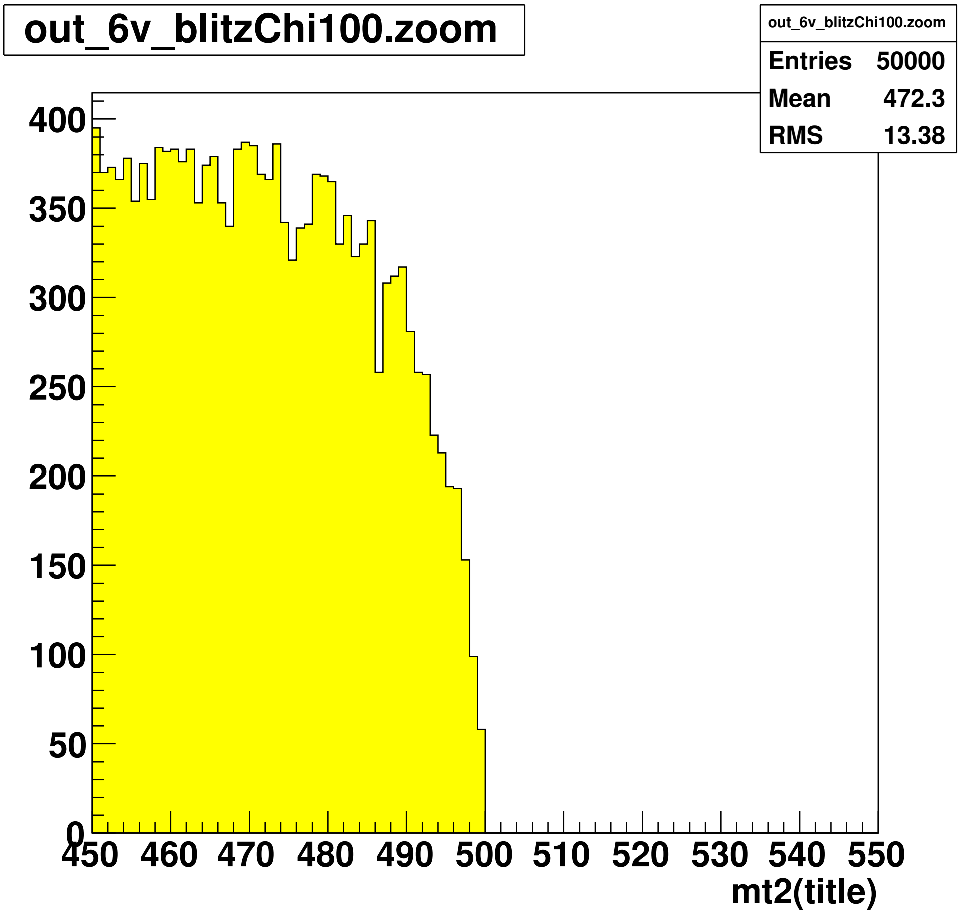

Figure 45: Zoomed in to the tip of fig 44

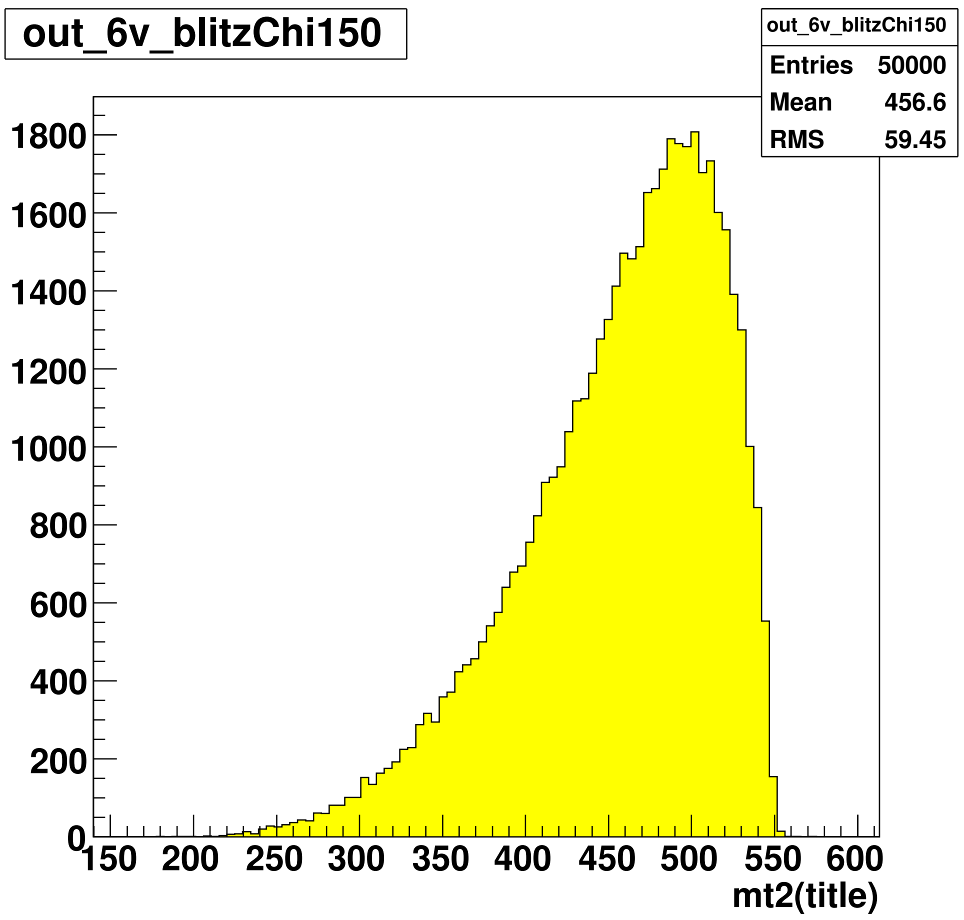

Figure 46: This shows the MT2 distribution obtained from SixBody events with independent three-body decays on each side via a virtual squark with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 150 (i.e. too big by 50%). Note the BIG foot. Is it real? See zoomed in plot in fig 47. Generated by toyFour.cc in “blitz” mode.

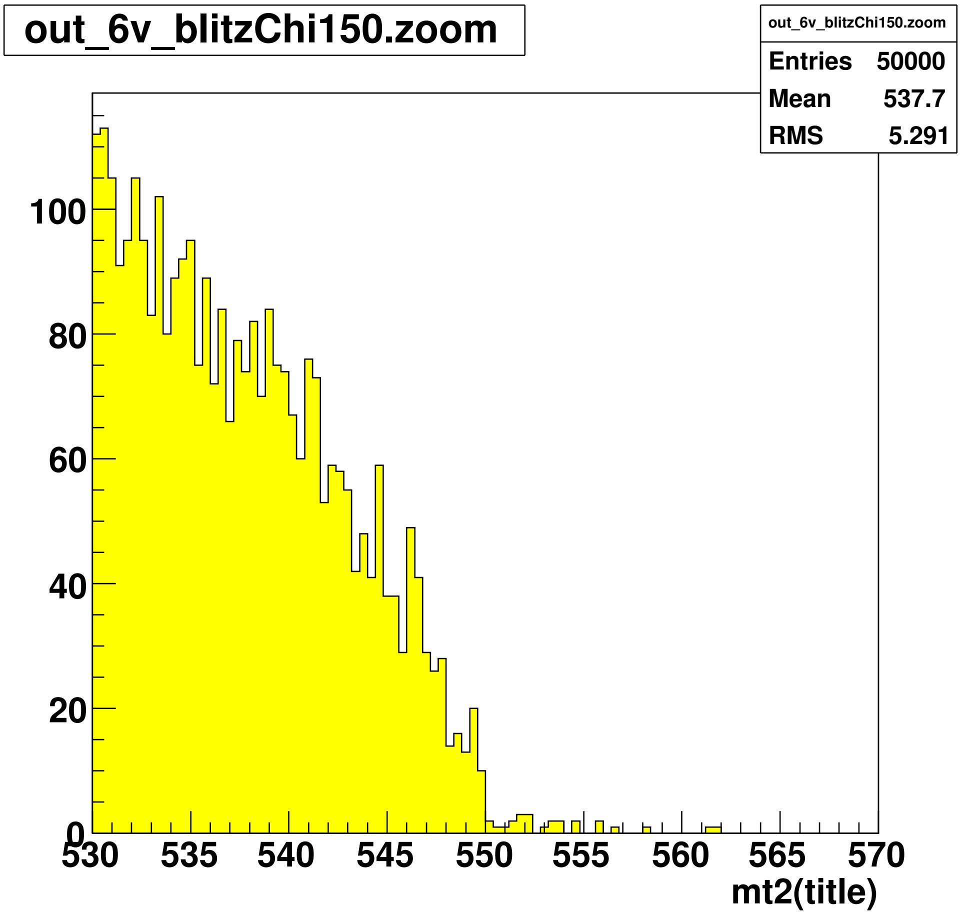

Figure 47: Zoomed in to the tip of fig 46

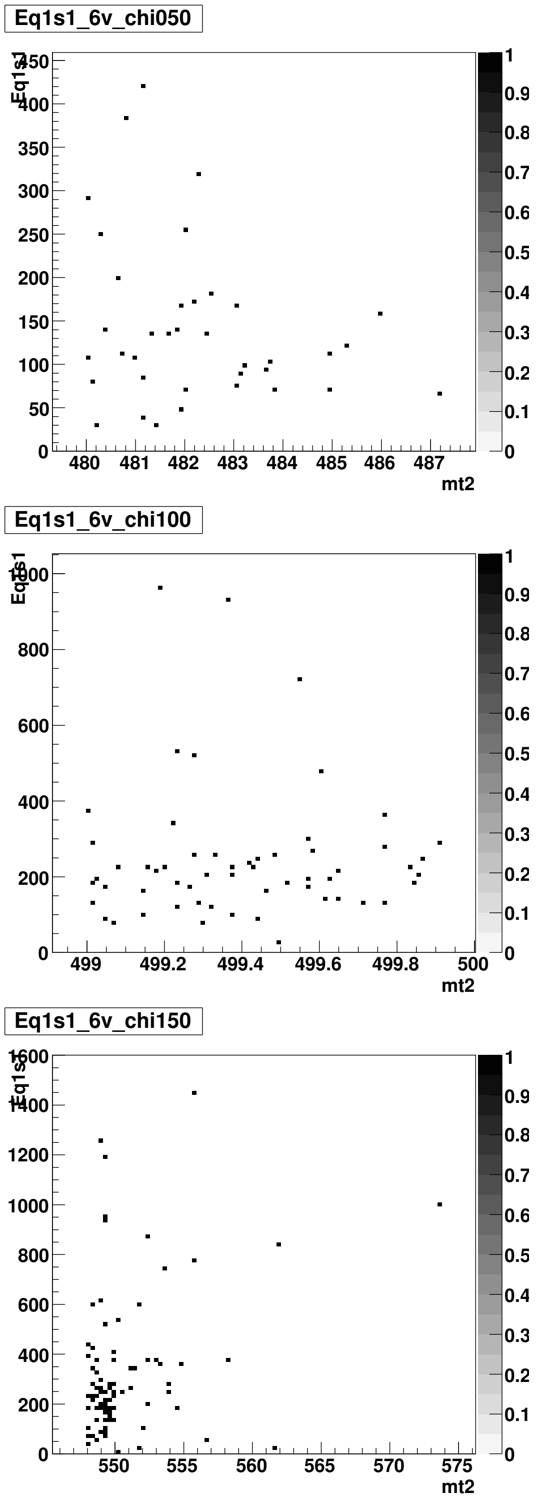

Figure 48: Energies of quarks for events in M2 or MT2 tail.

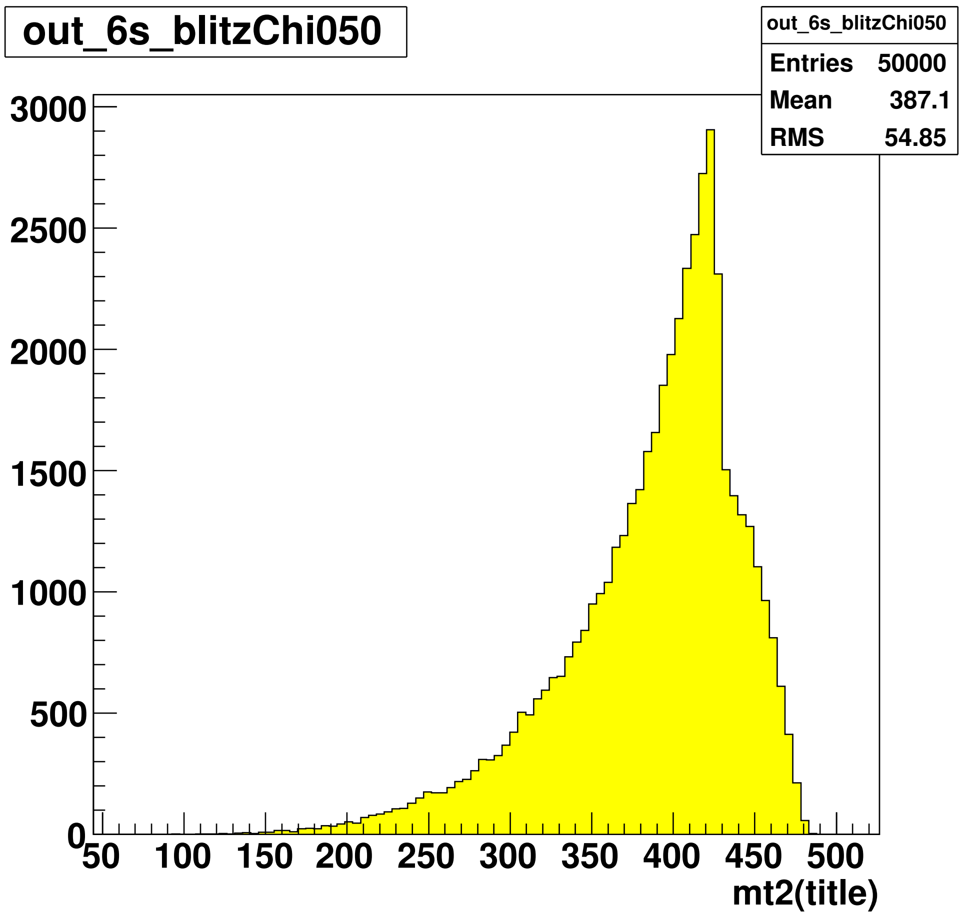

Figure 49: This shows the MT2 distribution obtained from SixBody events with two successive sequential two-body decays on each side via an on-shell squark with MHeavysparticle = 500, Msquark = 300, Mlightsparticle = 100, and with chi = 50 (i.e. too small by 50%). There might be a tiny foot, but un balance I would say there isn't one. See zoomed in plot in fig 50. Generated by toyFour.cc in "blitz" mode.

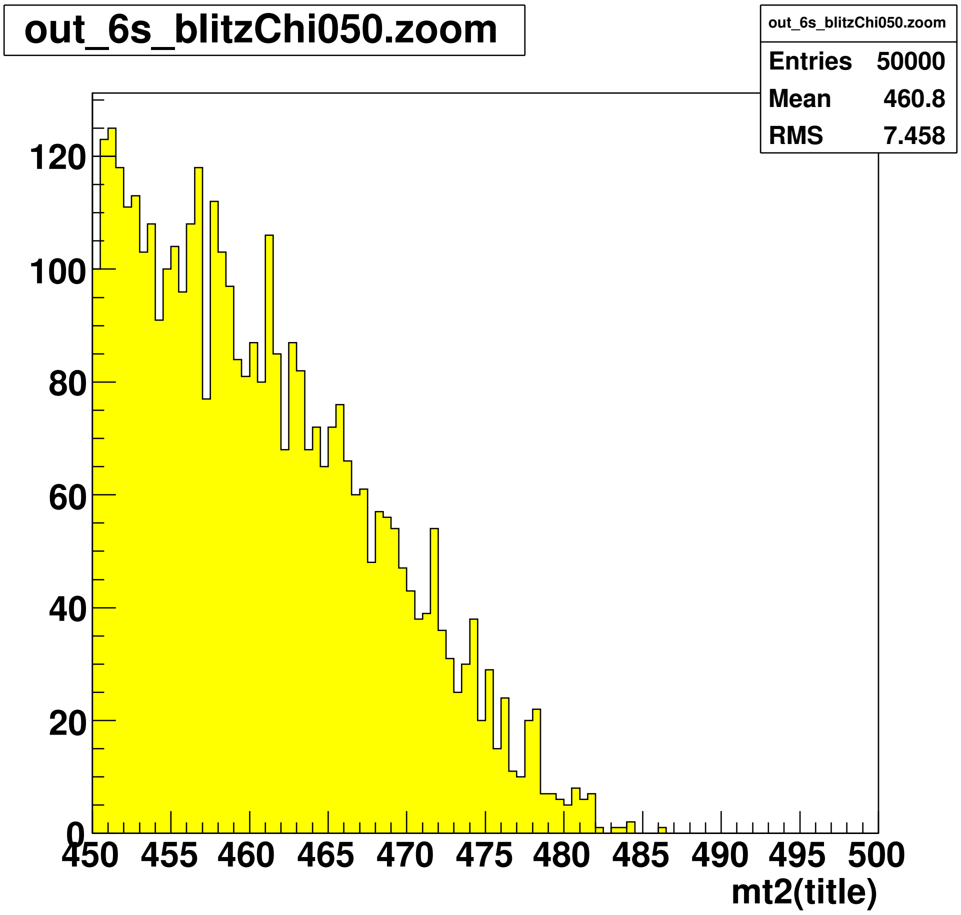

Figure 50: Zoomed in to the tip of fig 49

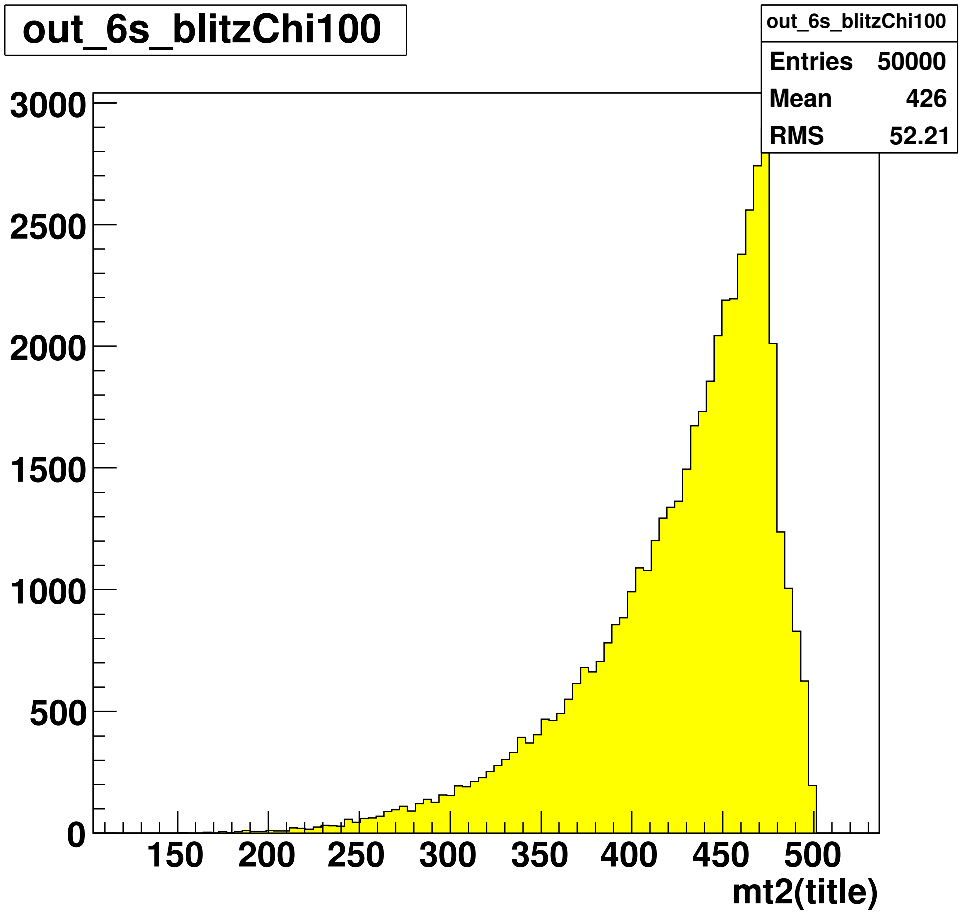

Figure 51: This shows the MT2 distribution obtained from SixBody events with two successive sequential two-body decays on each side via an on-shell squark with MHeavysparticle = 500, Msquark = 300, Mlightsparticle = 100, and with chi = 100 (i.e. just right). Note the absence of a foot. See zoomed in plot in fig 52. Generated by toyFour.cc in “blitz” mode.

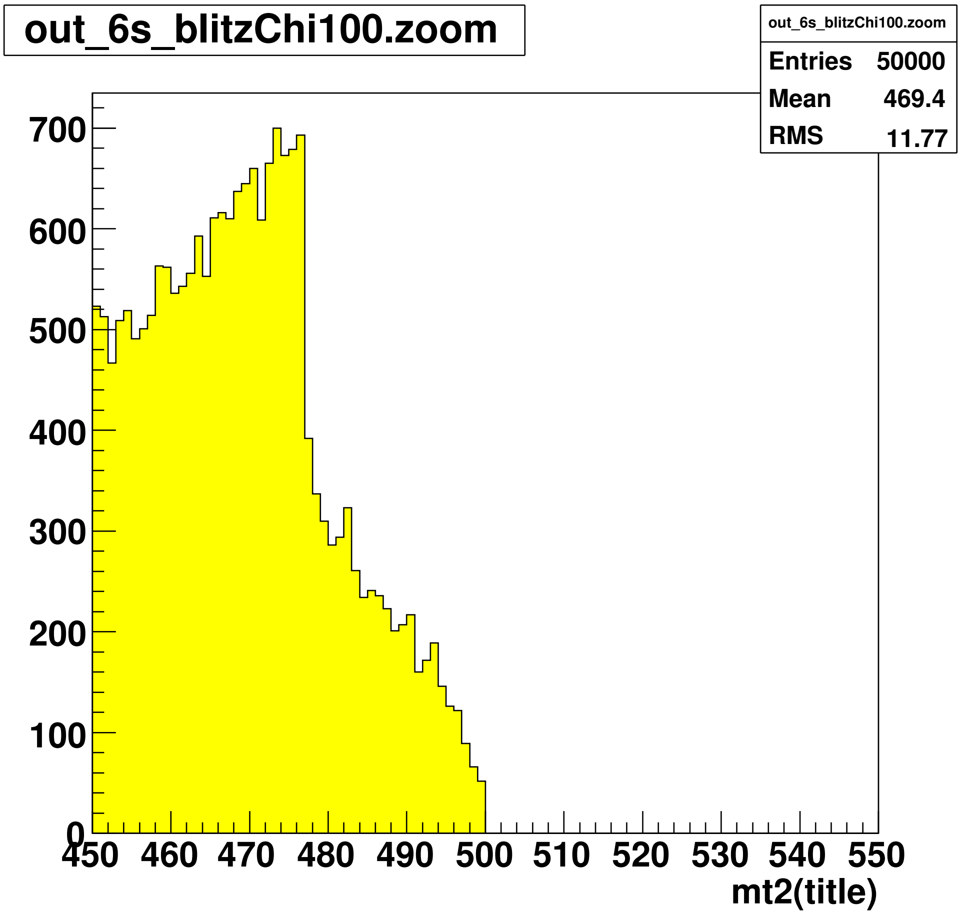

Figure 52: Zoomed in to the tip of fig 51

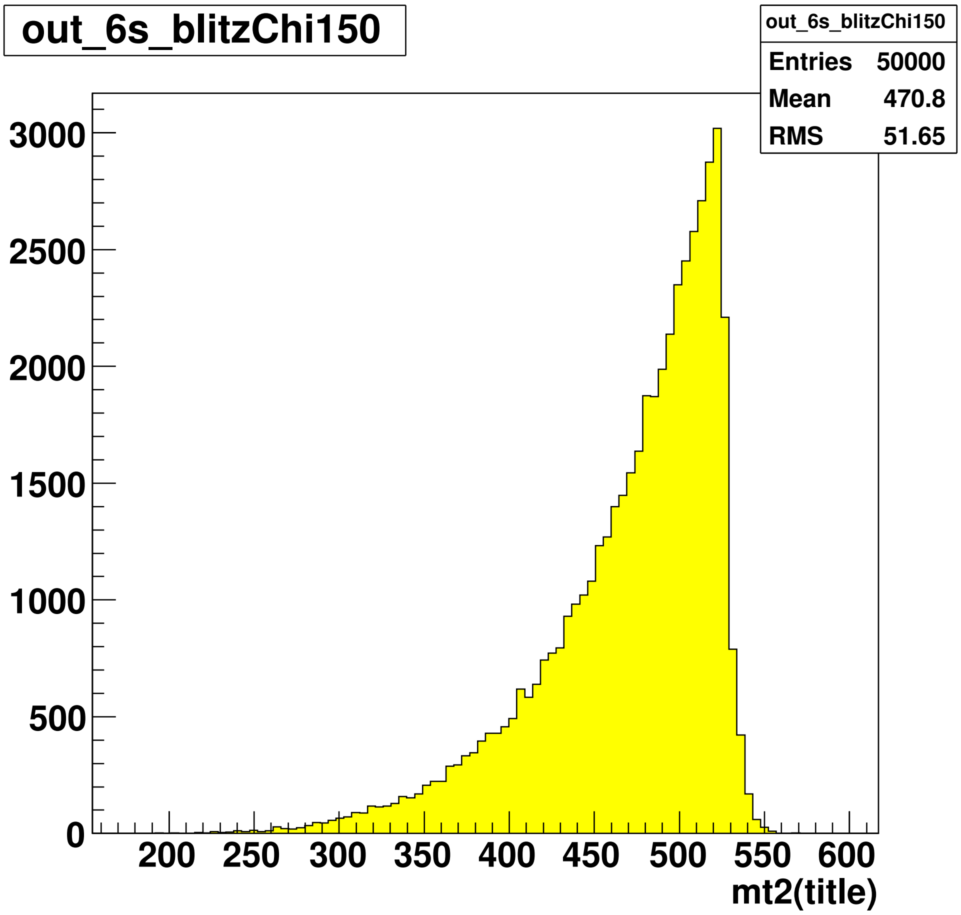

Figure 53: This shows the MT2 distribution obtained from SixBody events with two successive sequential two-body decays on each side via an on-shell squark with MHeavysparticle = 500, Msquark = 300, Mlightsparticle = 100, and with chi = 150 (i.e. too big by 50%). Note the BIG foot. Is it real? See zoomed in plot in fig 54. Generated by toyFour.cc in "blitz" mode.

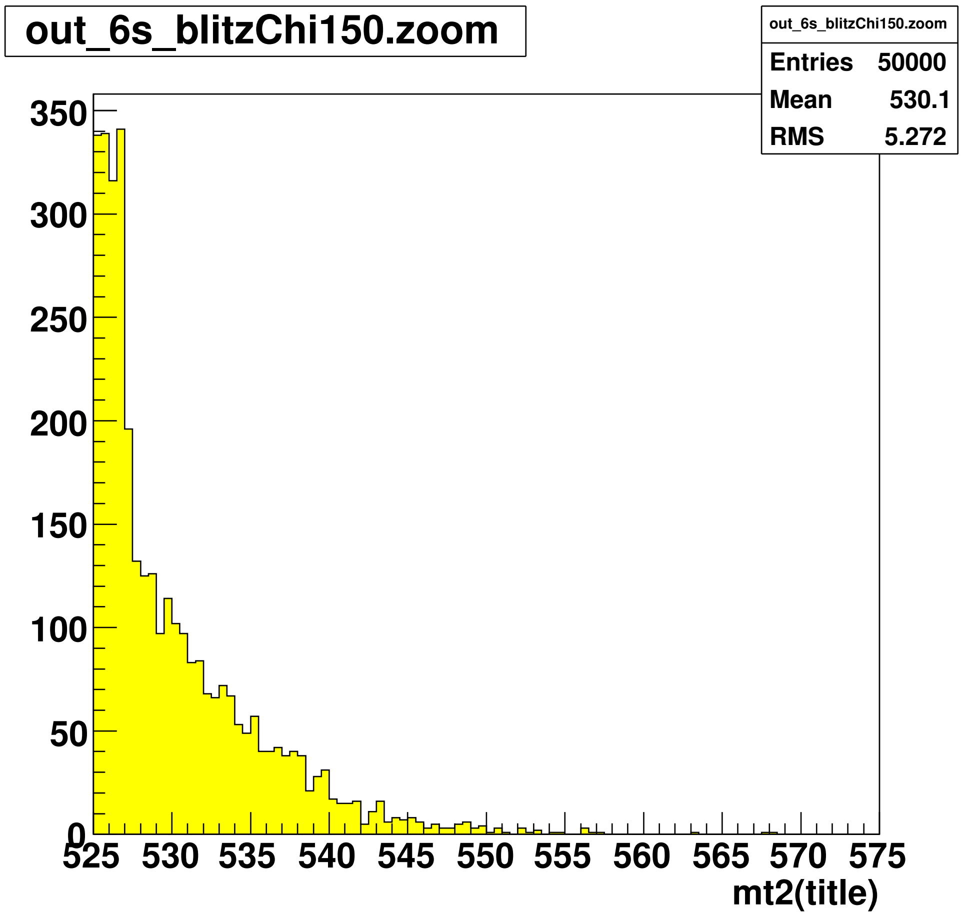

Figure 54: Zoomed in to the tip of fig 53

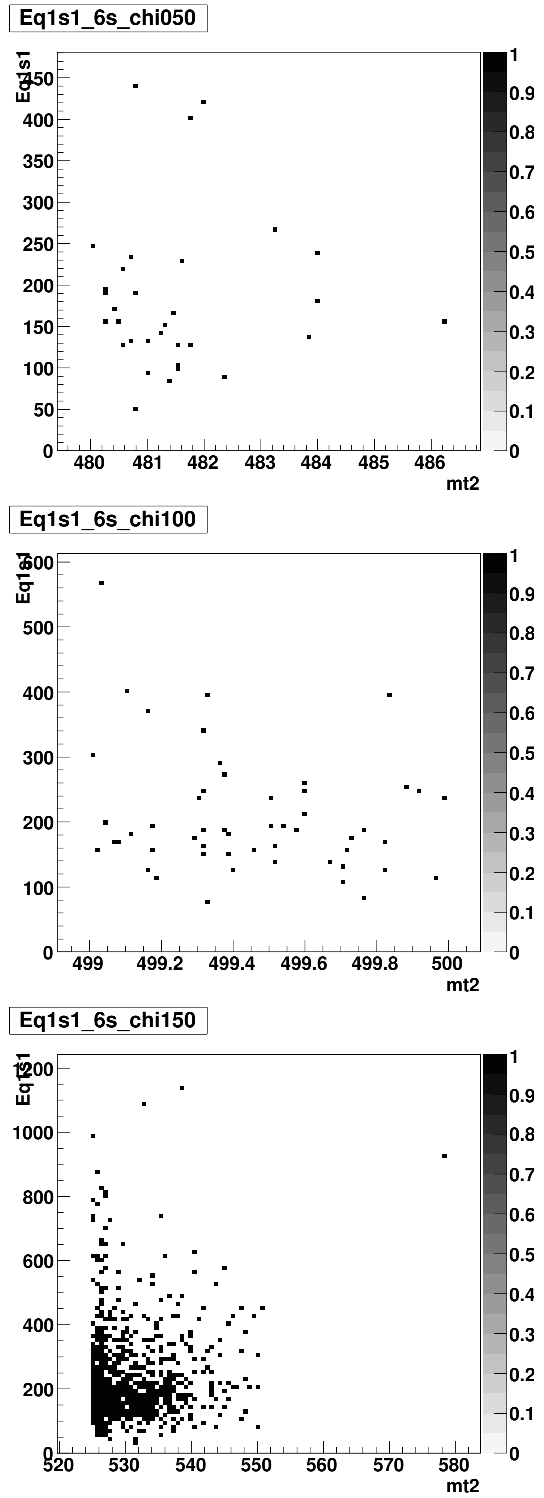

Figure 55: Energies of quarks for events in M2 or MT2 tail.

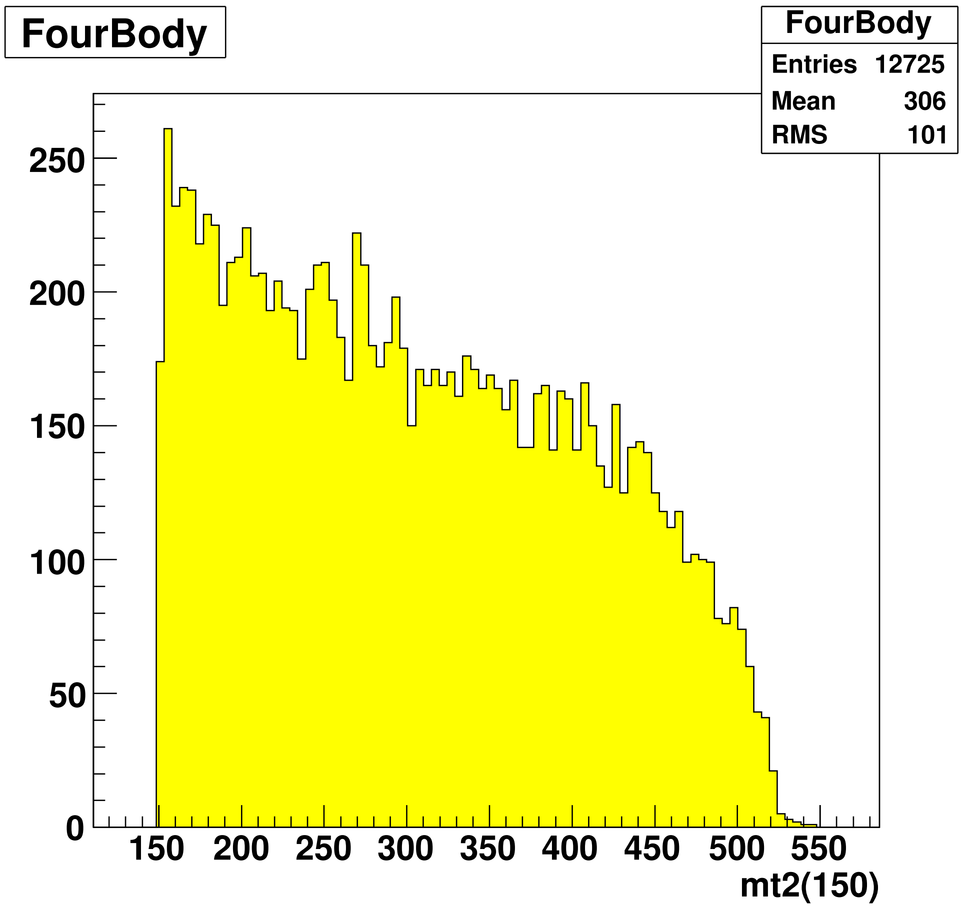

Figure 56: This shows the MT2 distribution obtained from "classic" mt2 events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 150 (i.e. too big by 50%). Note the small foot. Is it real? See zoomed in plot in fig 57. Generated by toyFour.cc in "blitz" mode. Note that the foot occupies a whopping 50% of the distance between 500GeV (the max for chi=mlight) and 550GeV .. the tip of the foot. The foot cannot therefore be neglected if one seeks to measure chi from it!

Blah blah

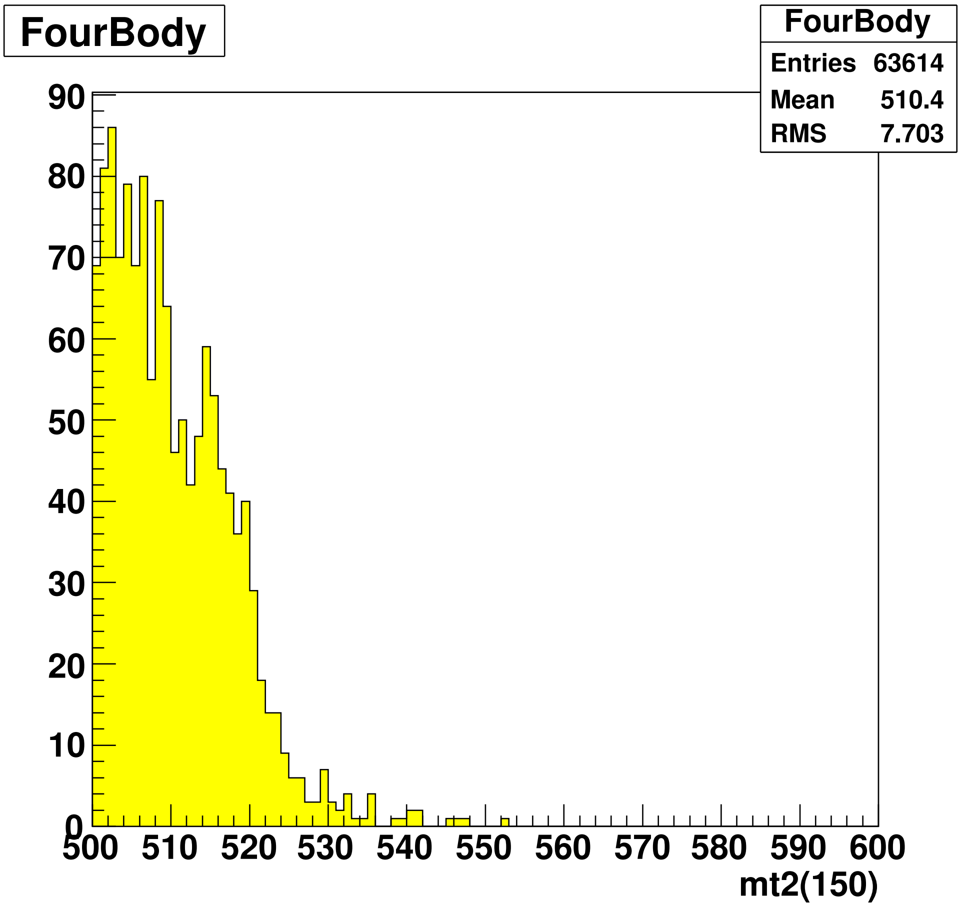

Figure 57: Zoomed in to the tip of fig 56

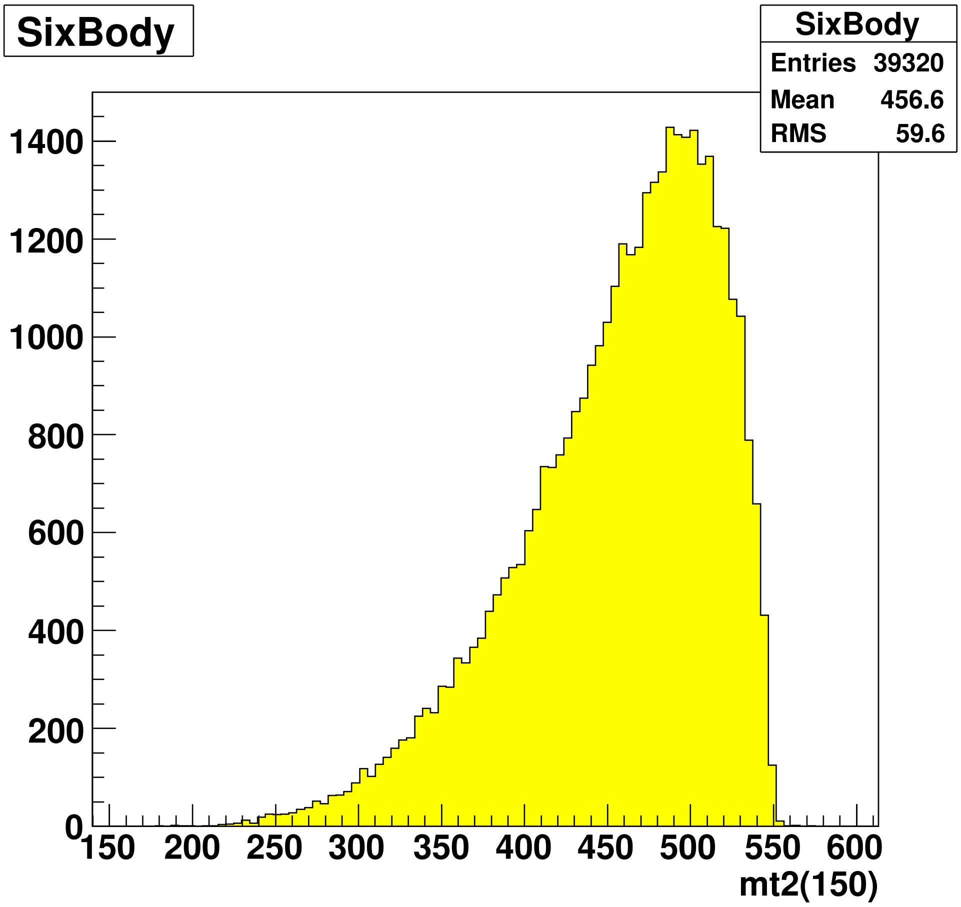

Figure 58: This shows the MT2 distribution obtained from "Korean style gluino three body decay" mt2 events with MHeavysparticle = 500, Mlightsparticle = 100, and with chi = 150 (i.e. too big by 50%). Note the small foot – smaller than in the 56. Is it real? Or is it different See zoomed in plot in fig 59. Generated by toySix.cc in "blitz" mode.

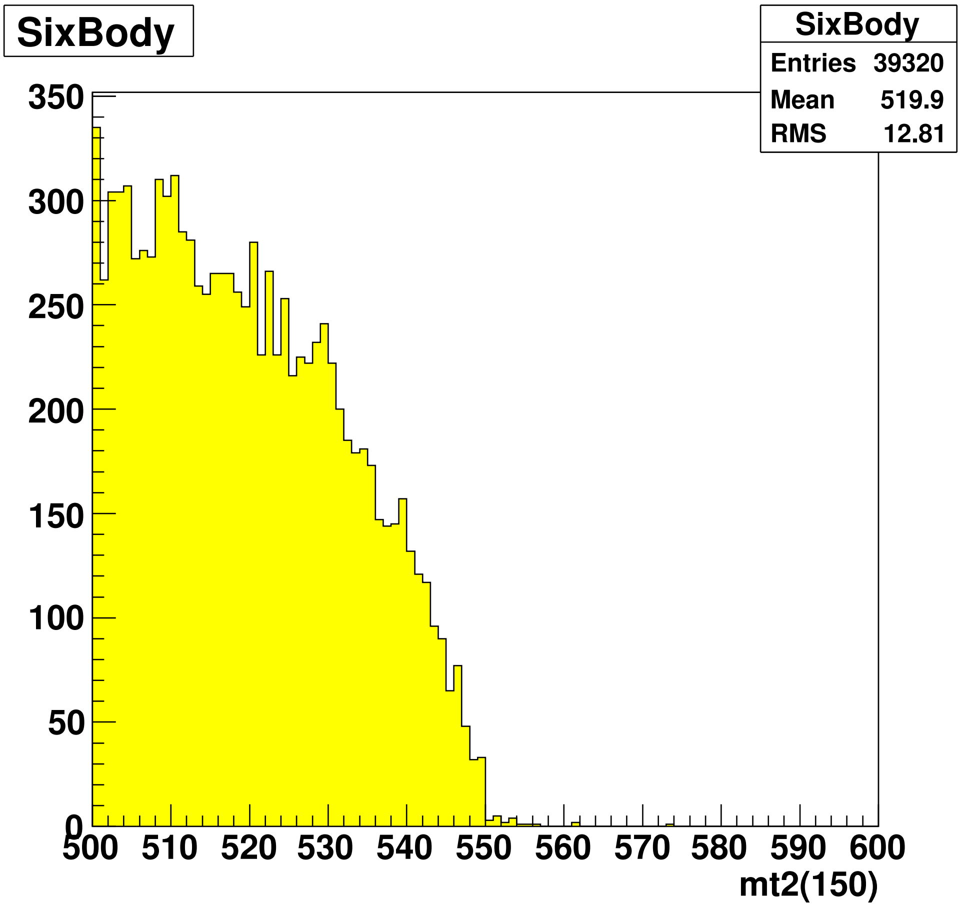

Figure 59: Zoomed in to the tip of fig 58

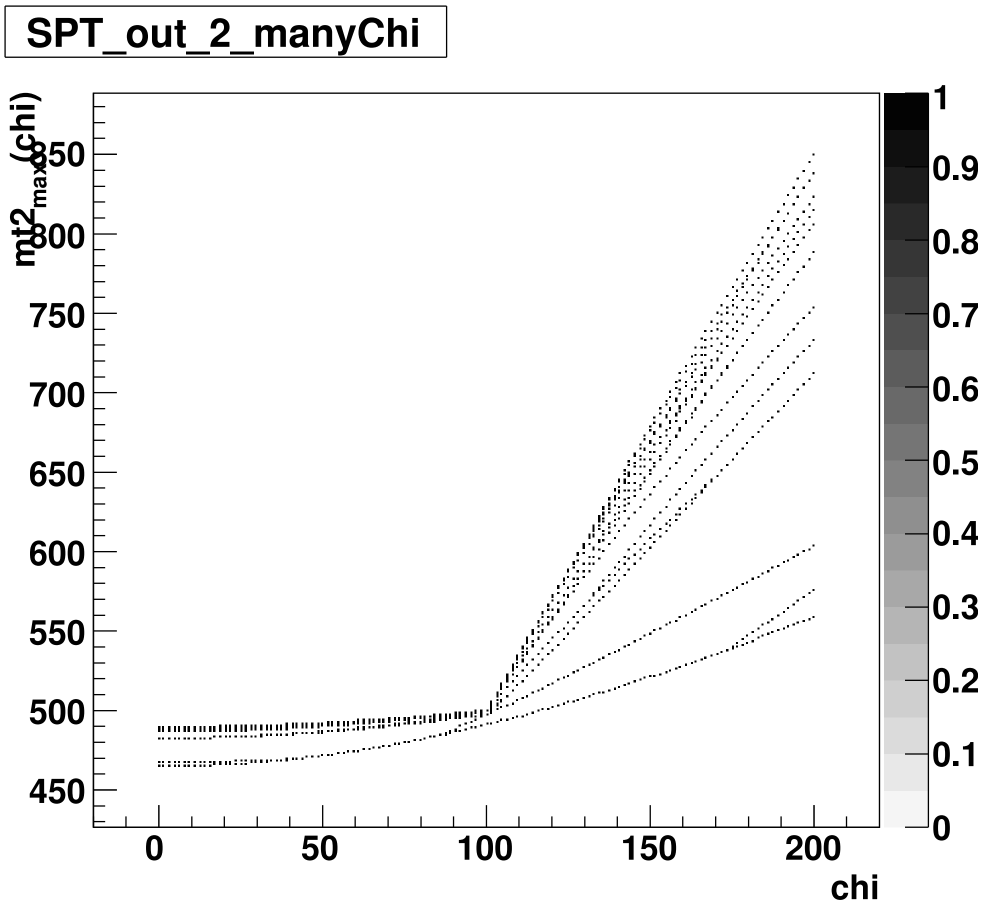

Figure 60: The single particle Ben Griapos MT like transvers mass endpoint calculated by numerical filling of available phase space for mheavyslepton = 500 mlightsparticle=100 and massless quark, and various values of chi along the bottom. This plot is sensitive to tips of feet and errors in MT2 distro and calculators, and work must be done to convince oneself that the kink is reliable, and if due only to feet, those feet themselved must be real and not artefacts.

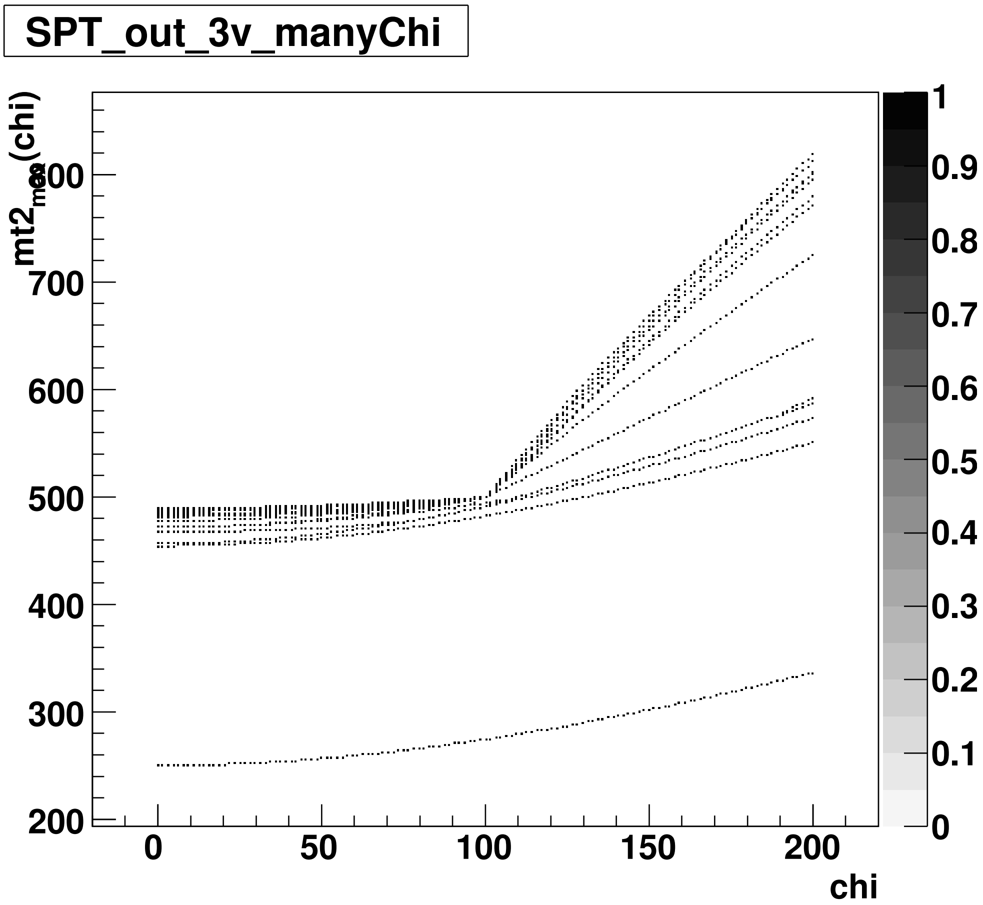

Figure 61: No caption yet

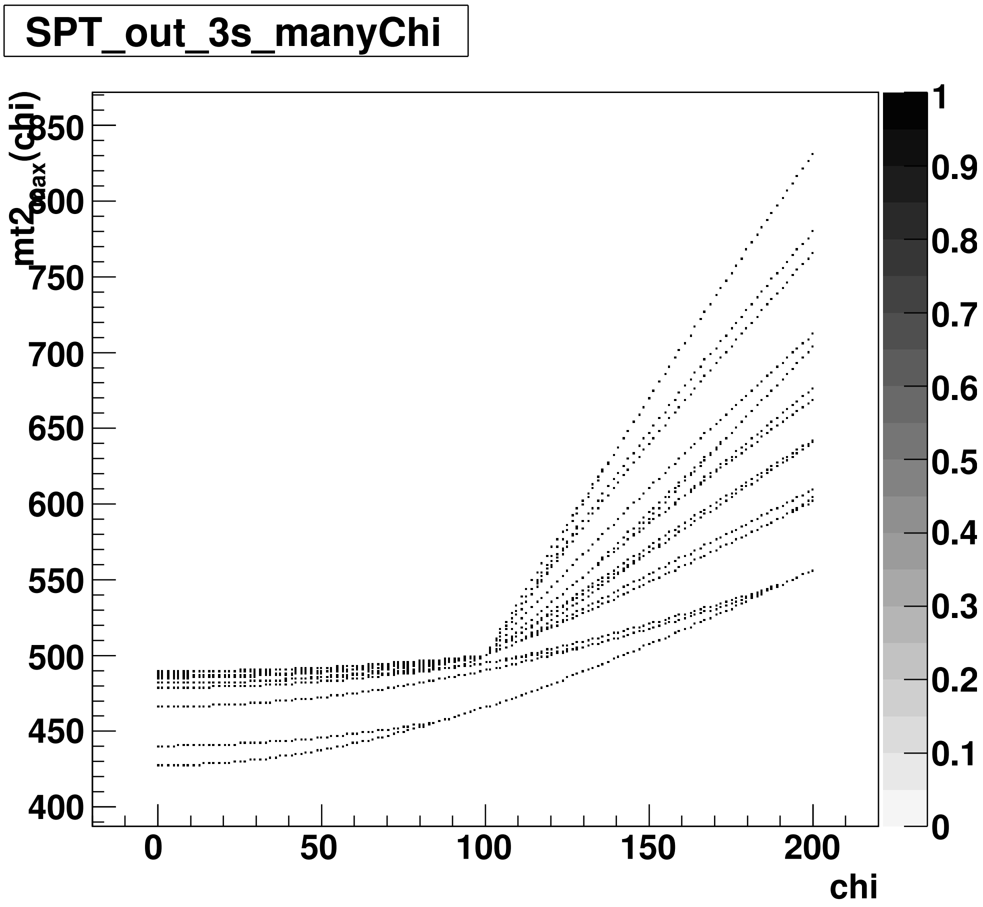

Figure 62: No caption yet

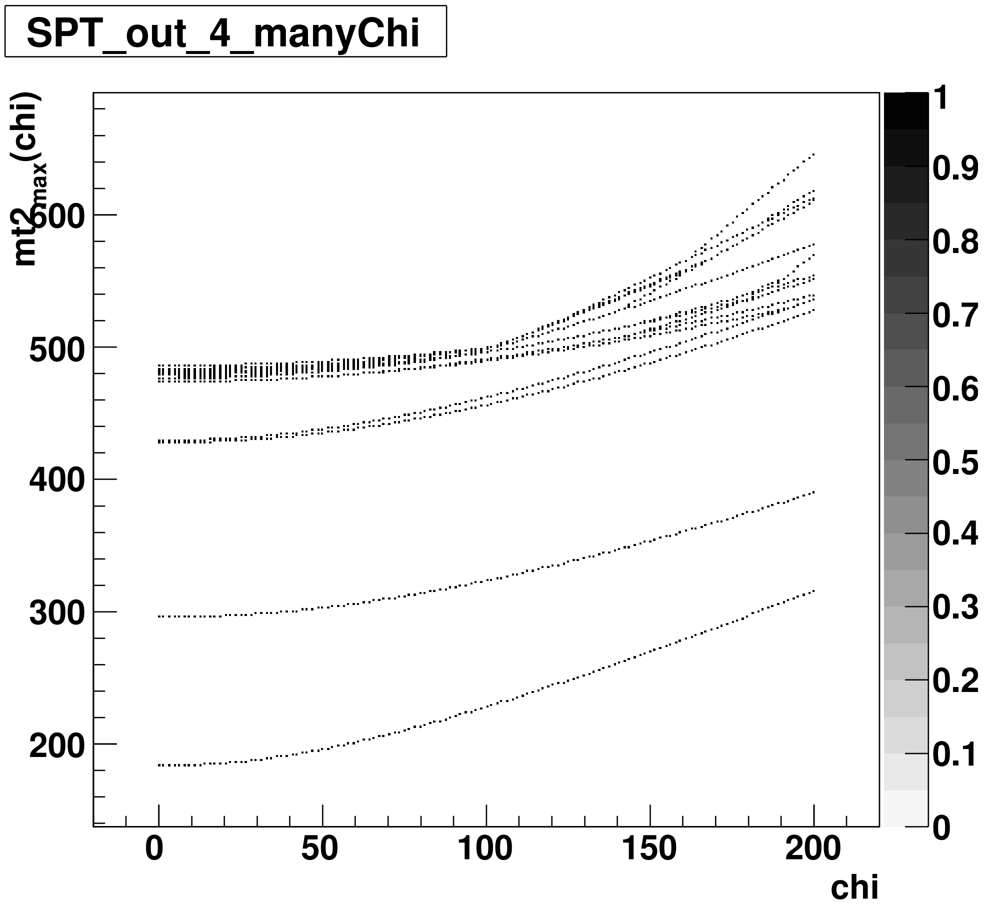

Figure 63: Mt2 endpoint calculated by numerical filling of available phase space for mheavyslepton = 500 mlightsparticle=100 with classic MT2 topology, and various values of chi along the bottom. This plot is sensitive to tips of feet and errors in MT2 distro and calculators, and work must be done to convince oneself that the kink is reliable, and if due only to feet, those feet themselved must be real and not artefacts.

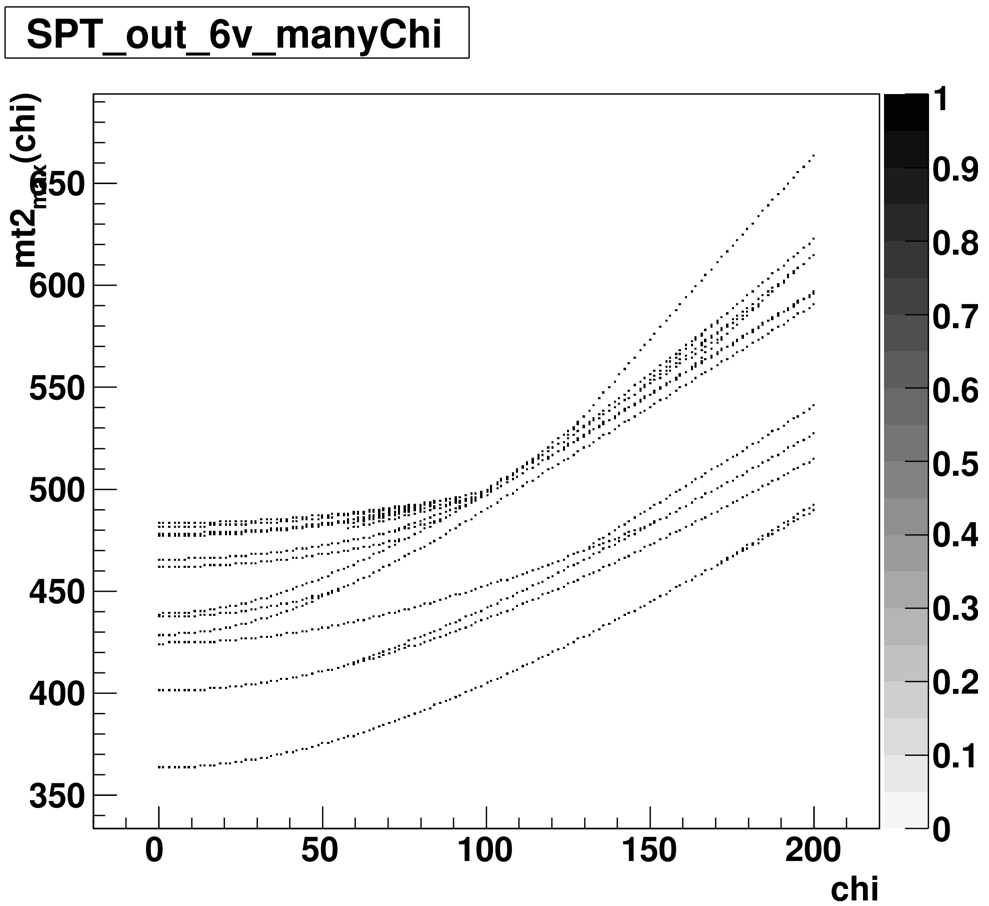

Figure 64: Mt2 endpoint calculated by numerical filling of available phase space for mgluino = 500 mlightsparticle=100, with on each side gluino → q q chi (i.e. virtual topology of Korean paper) and with perfect identification of which two qs to connect together to form a pseudo particle on each side. And various values of chi along the bottom. This plot is sensitive to tips of feet and errors in MT2 distro and calculators, and work must be done to convince oneself that the kink is reliable, and if due only to feet, those feet themselved must be real and not artefacts.

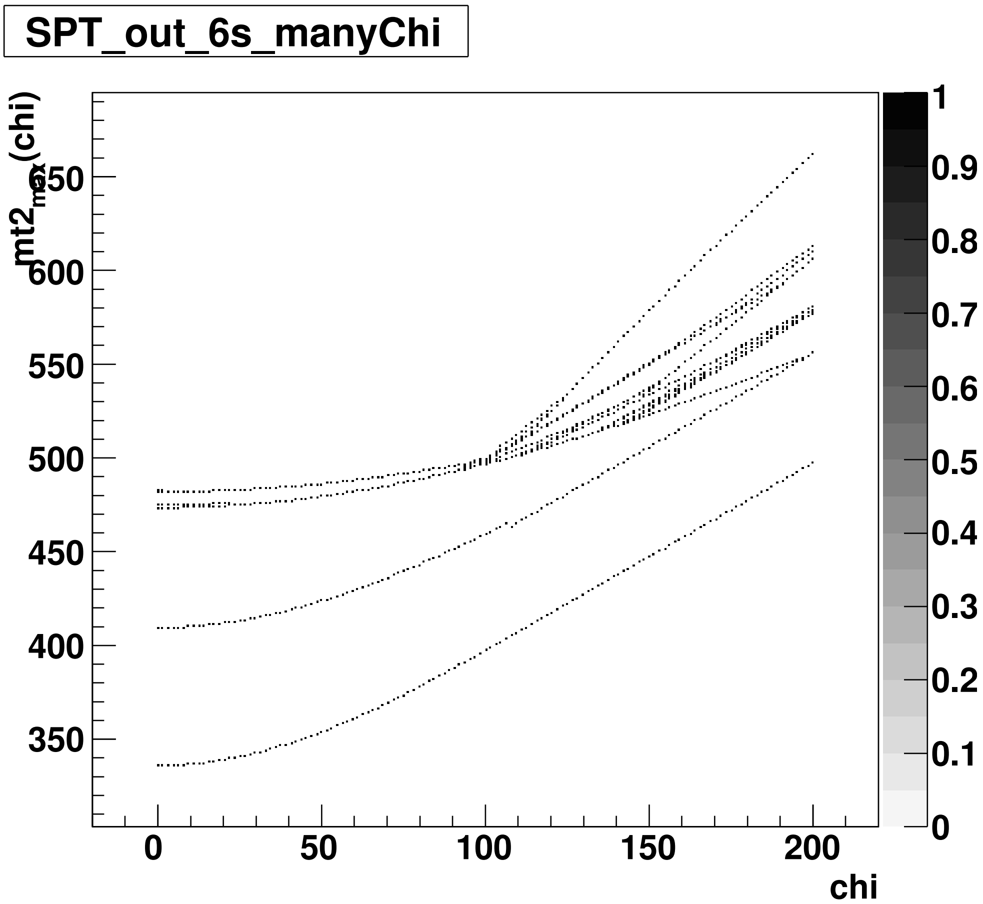

Figure 65: Mt2 endpoint calculated by numerical filling of available phase space for mgluino = 500, msquark=300, mlightsparticle=100, with on each side gluino → q squark → q chi (i.e. sequential topology of Korean paper) and with perfect identification of which two qs to connect together to form a pseudo particle on each side. And various values of chi along the bottom. This plot is sensitive to tips of feet and errors in MT2 distro and calculators, and work must be done to convince oneself that the kink is reliable, and if due only to feet, those feet themselved must be real and not artefacts.

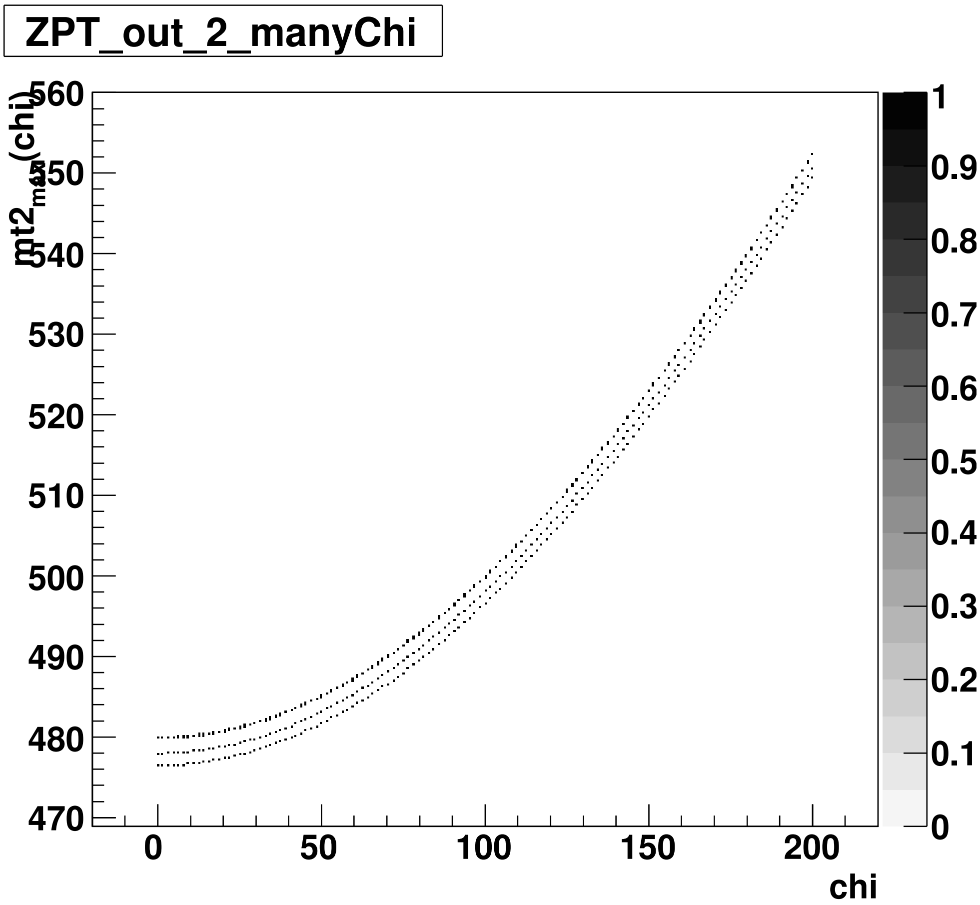

Figure 66: No caption yet

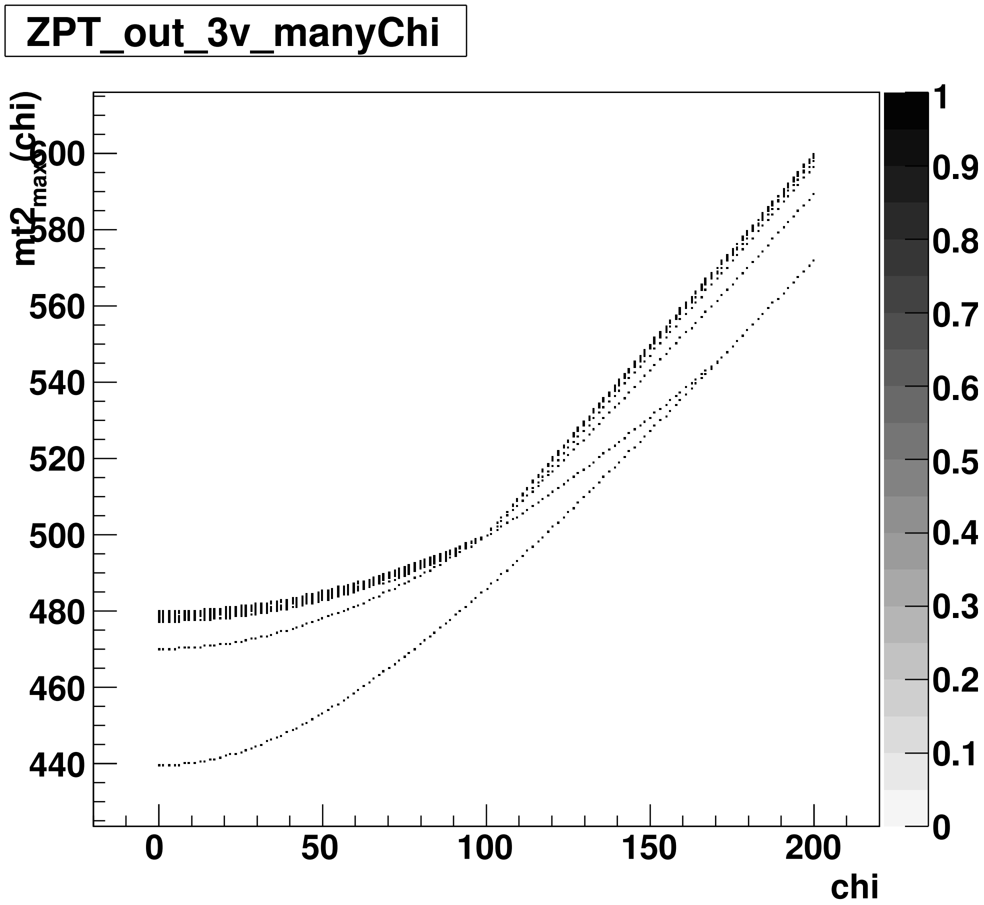

Figure 67: No caption yet

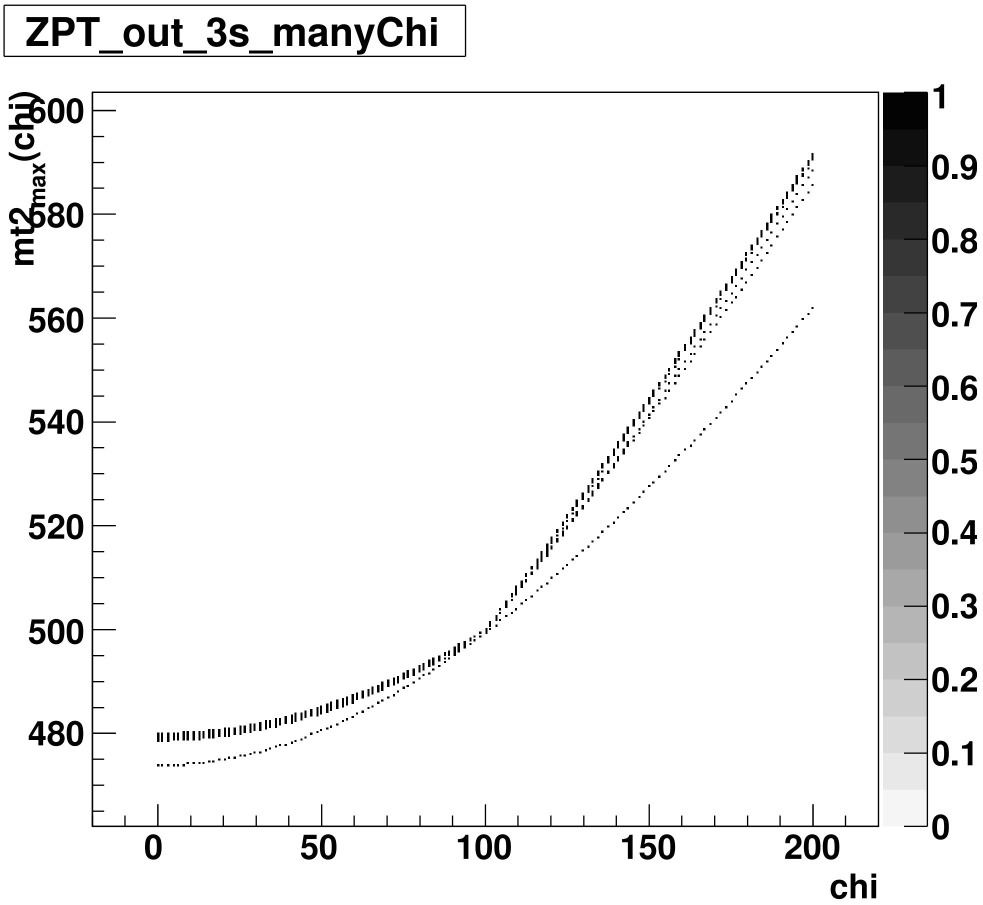

Figure 68: No caption yet

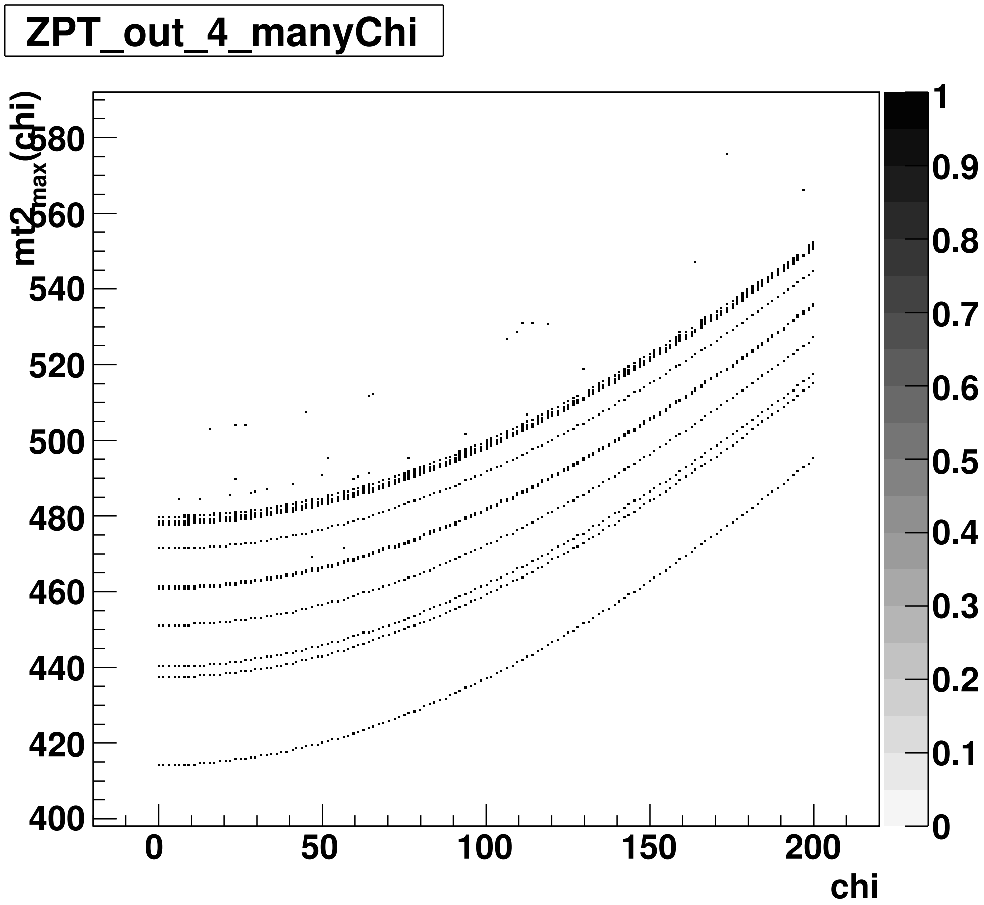

Figure 69: No caption yet

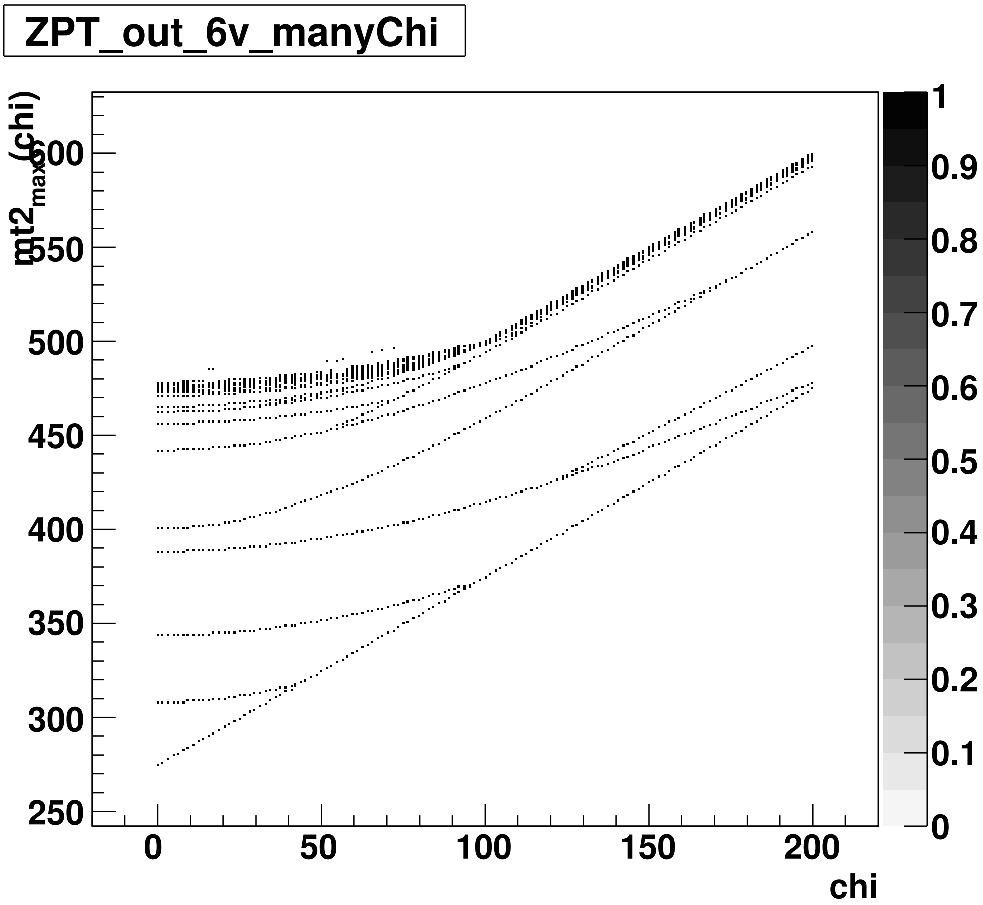

Figure 70: No caption yet

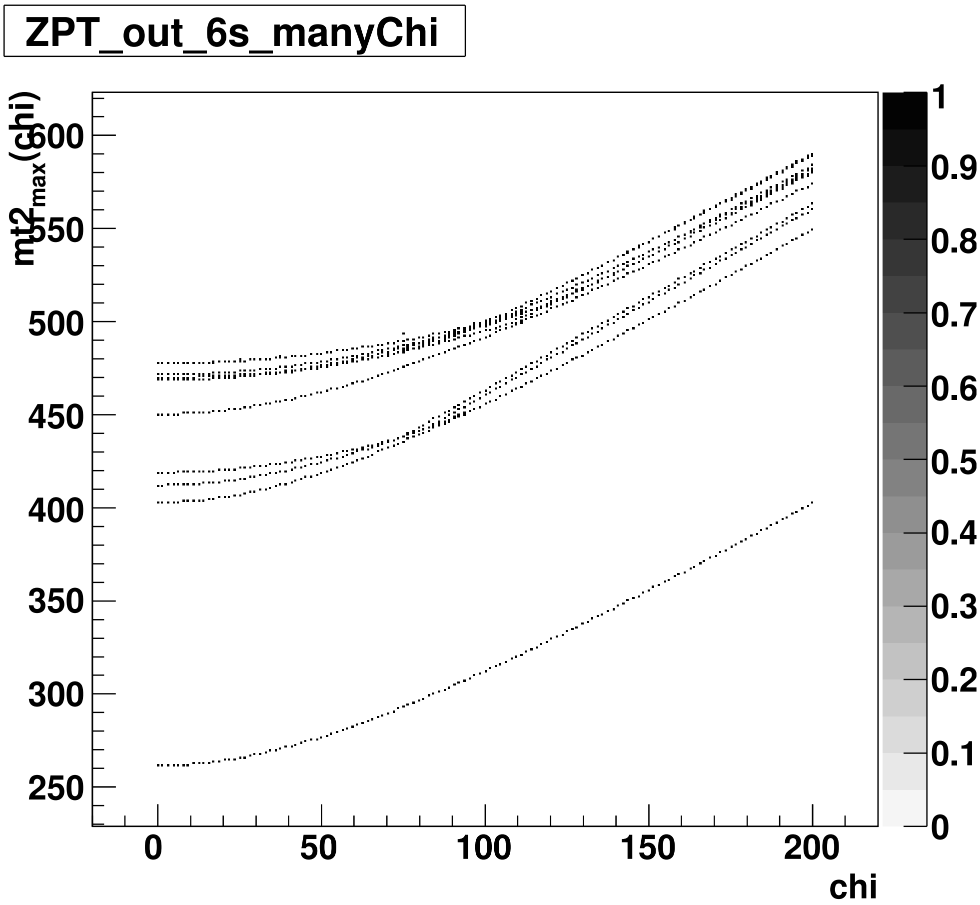

Figure 71: No caption yet