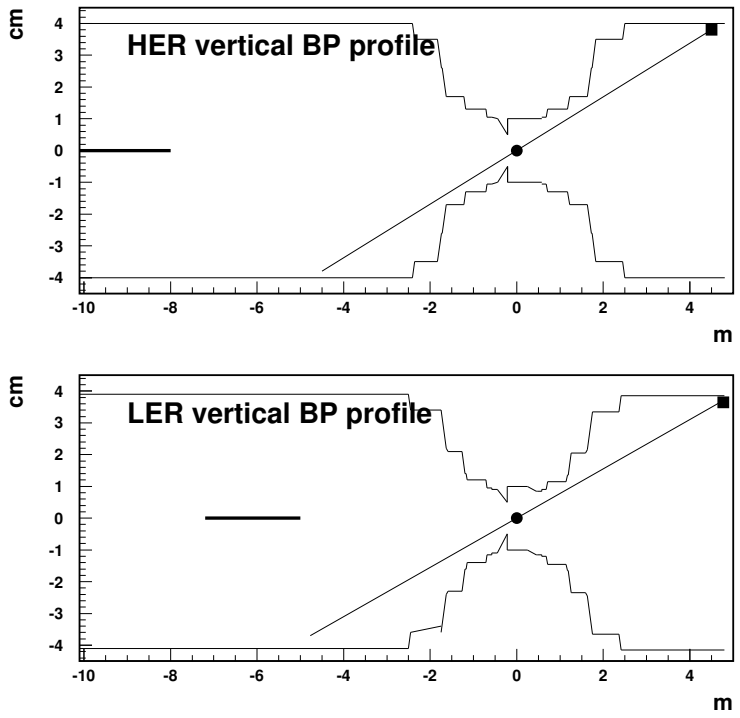
Angular scans.

Presented here are angular scans from Feb. 28, 2021 (last day we took scans in the 2021 Spring Run). Only the three telescopes that were seeing light are shown.

Images are expected to show the Beam Pipe openings according to Fig. 1. In the Figure, the vacuum mirror for the down telescopes are shown, along with a line of sight going through the Interaction point (IP). Light coming from the narrow opening directly behind the IP should be seen, with a typical angular width of order 1cm over 5 meters.



The thick line in each graph shows the location of the last bending magnet in each Beam

Line (BL), and metrological measurements are incorporated in the plots, with 1.2 mrad vertical tilt for the outgoing positron BL, and 0.1 mrad for the electron BL.

From the two BL features, one expects that for good alignment backgrounds will be higher in the electron BL, due to lower angle of the vacuum mirrors (8.2 versus 8.6 mrad), and a much larger angle of reflection for radiation coming from the last dipole. This was the case in 2016 and 2017.

How to read the scans. The scans are presented in pages 4 to 9 of this document. Photomultipliers 0-7 belong to electron telescope UP. PMTs 8-15 electron telescope DOWN. PMTs 16-23 belong to positron telescope DOWN and showed no light, so they are not shown. PMTs 24-31 belong to positron telescope UP. The first four in each octet are x-polarized (red,green, blue and violet), the second four are y-polarized (violet, blue, green, and red).

Each telescope had different angular features. The beamstrahlung spot is square, with size between 6.2 and 6.9 mm at the collimator, depending on telescope. Both UP telescopes had 8 mm collimators, and electron DOWN had 19mm collimator (to study if a large collimator could help smooth background fluctuations). Further, the positron UP telescope has a motor coordinate to angle calibration which differs from the other three by a factor 1.75 (it is a different mount, which we had to substitute when real estate constraints forced this primary mirror to be more than twice as far from the BL than the other three).

Finally, the angular direction that moves the mirrors in the (y-z plane), that is, vertical combined with the direction of the observed beam. is vertical in the plots of the UP telescopes, but horizontal for the electron DOWN (due to the fact that it is the only telescope with an even number of Optical Channel mirrors). The angular calibration for the (x-z) motor is half that of the (y-z) motor, or about 1mrad for 2200 units per mrad and 1100 unit per mrad. (Positron telescope UP is respectively 3800 and 1900 units per mrad).

Results.

A topological difference between the electron telescopes is apparent. The UP one has one spot, plus a small reflection spot not always present in scans. The DOWN telescope has

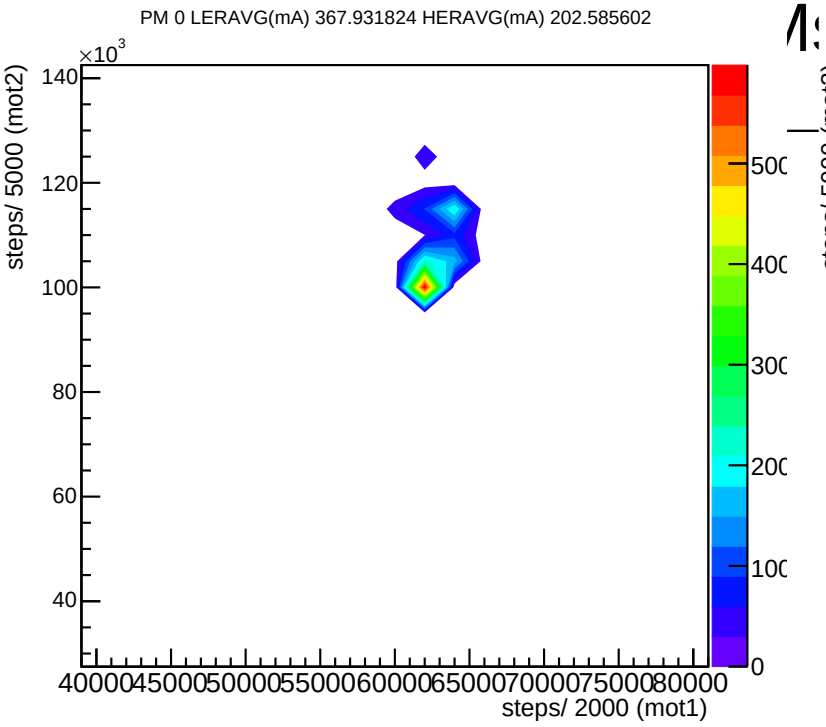
one main spot (high and to the left), one pure background reflection low and left, and two downstream reflections to the right. Three spots, high left, and both to the right, have a beamstrahlung signal.

We can identify the proper IP spot based on maximum total intensity and maximum beamstrahlung signal. Also the other two beamstrahlung spots must be reflections due to being downstream of the IP spot, and being at the same longitudinal position along the Beam Pipe. A proper IP spot will not have a reflection of itself at the same longitudinal position.

The interpretation of differing scans is that the observation angles of the two telescopes must be different. We can not measure angles using backgrounds, since we do not have a good model for backgrounds. We have however a good model for beamstrahlung.

In Fall 2021 we have equipped both telescopes with the same collimators and in December 2021 we will also conduct a telescope to telescope calibration, so that we can directly measure the angles involved, based on the relative beamstrahlung strength.

The other salient feature is that the positron telescope has, unexpectedly, a higher background and bluer light compared to the electron telescopes. It has also been equipped with the same collimator as the other two in September 2021, so that relative angle comparisons can be performed against the electron telescopes, based on beasmtrahlung rates.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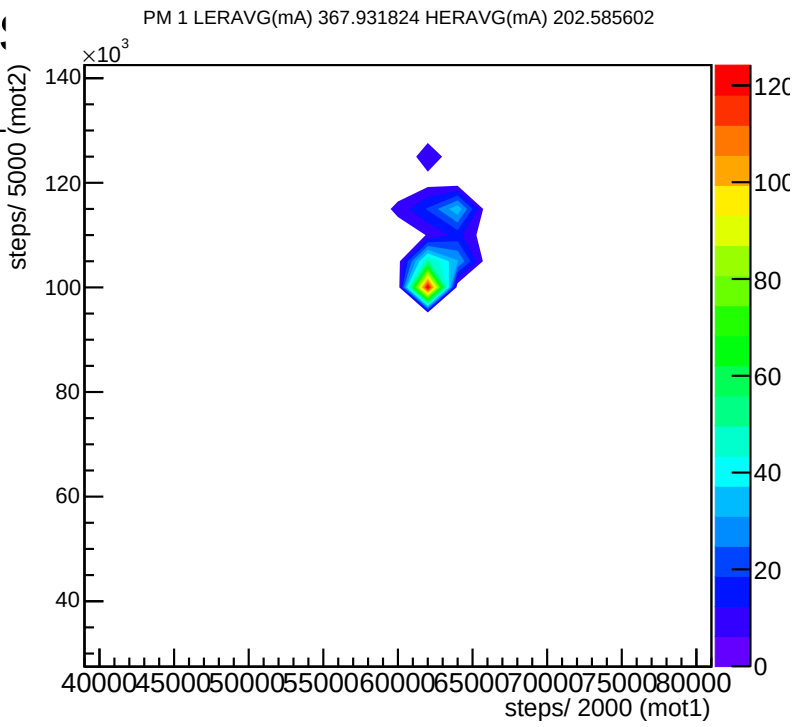
steps/ 5000 (mot2)
steps/ 2000 (mot1)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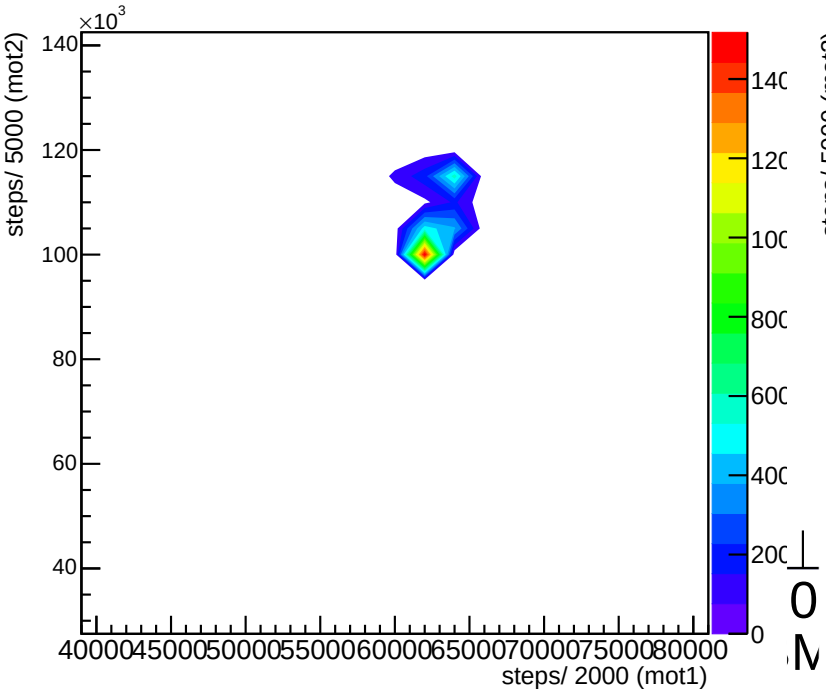
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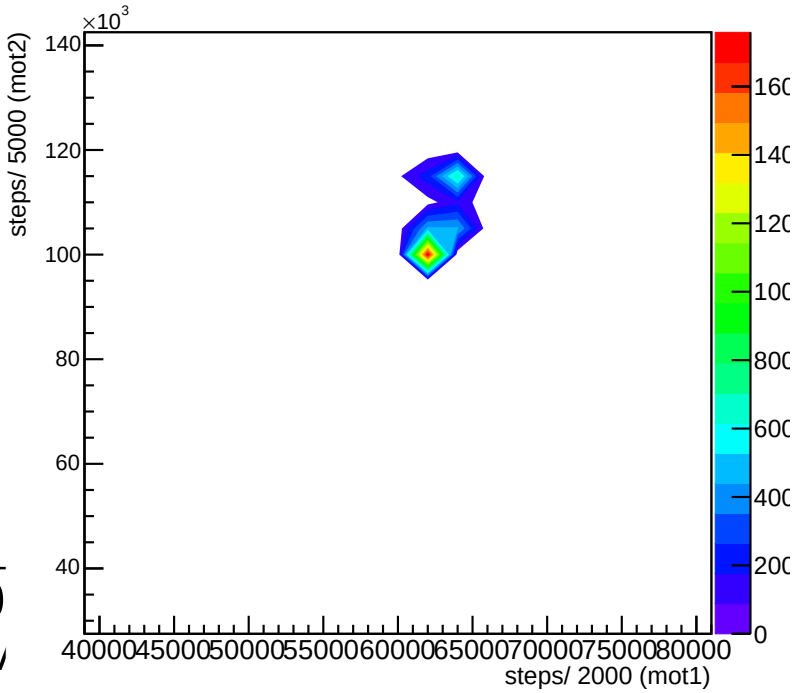
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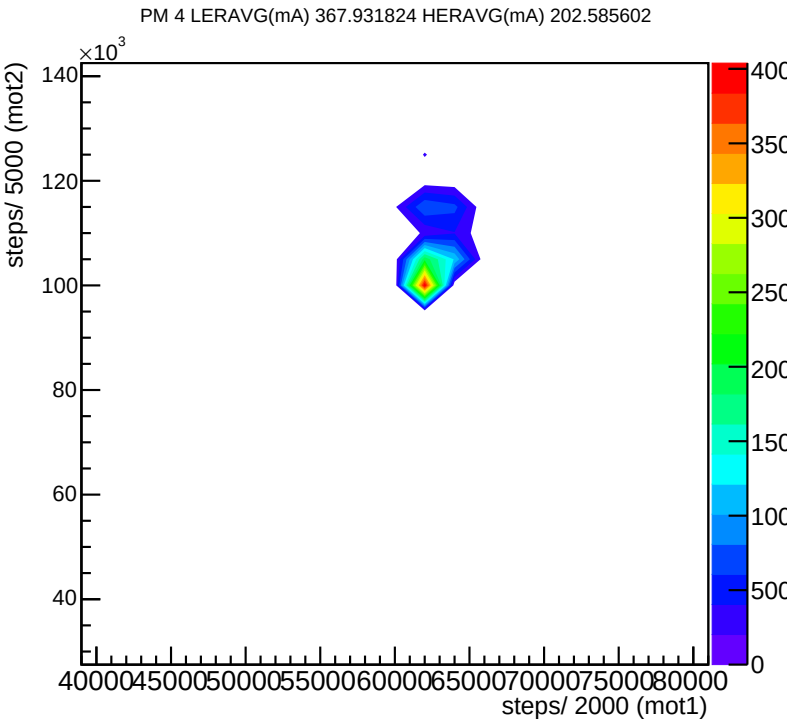
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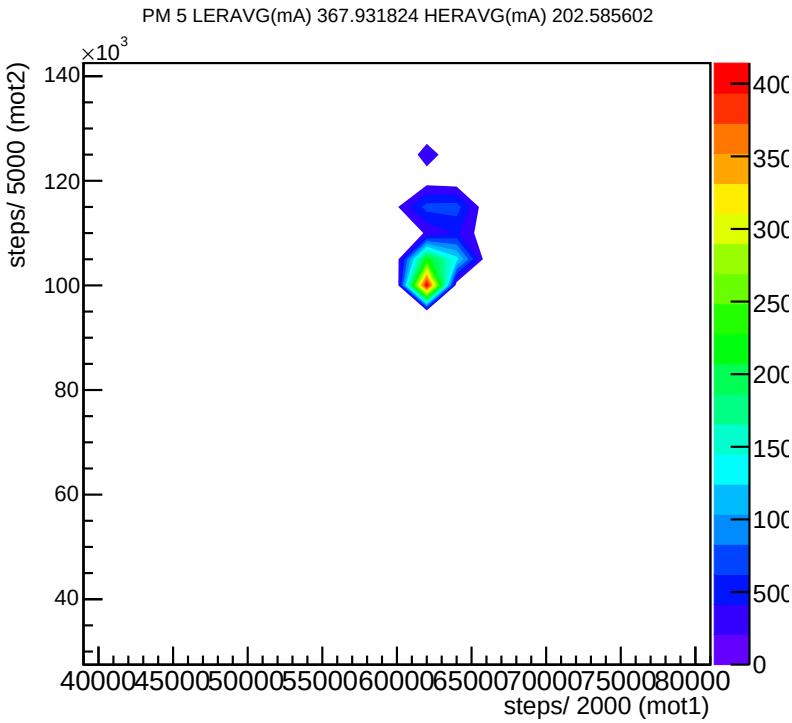
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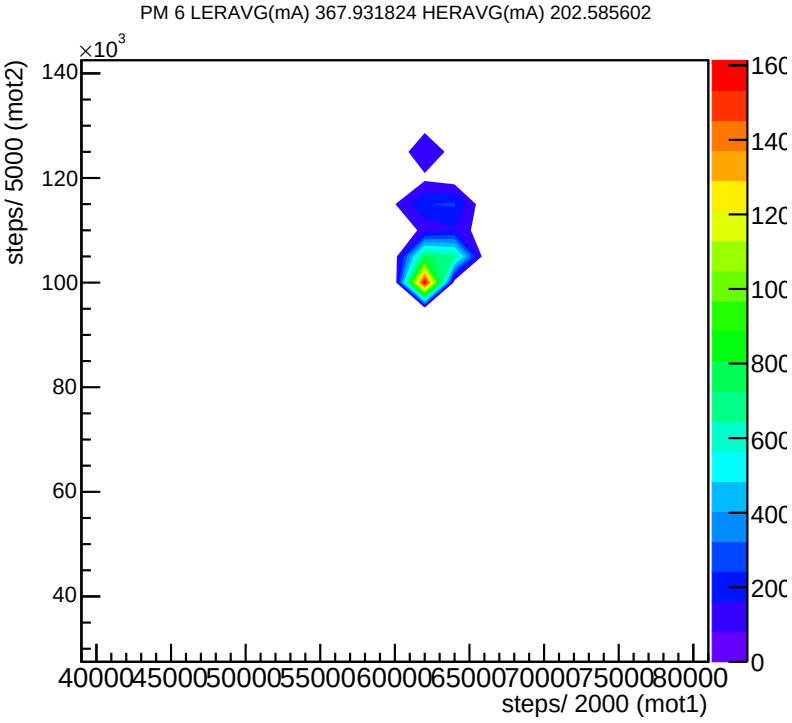
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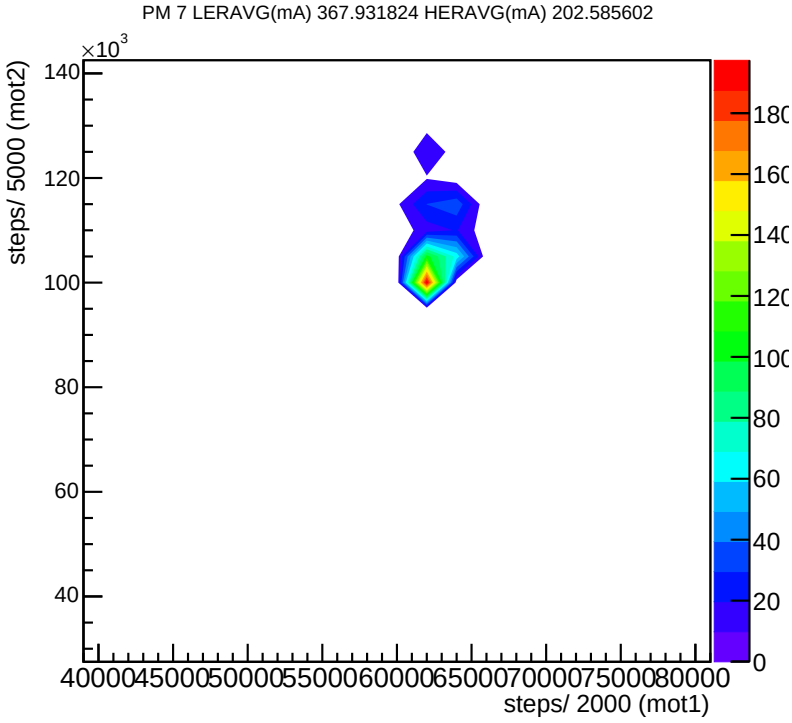
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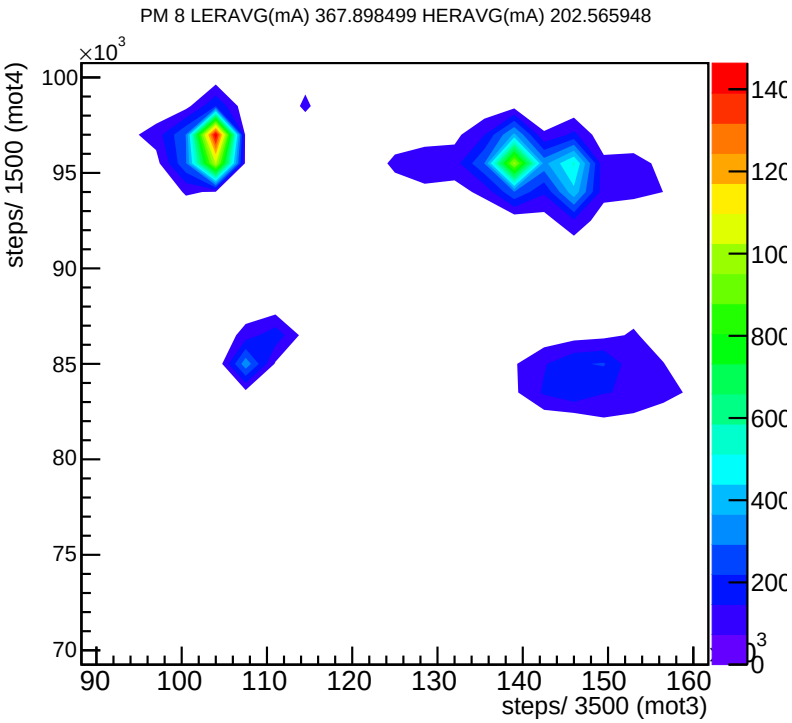
steps/ 2000 (mot1)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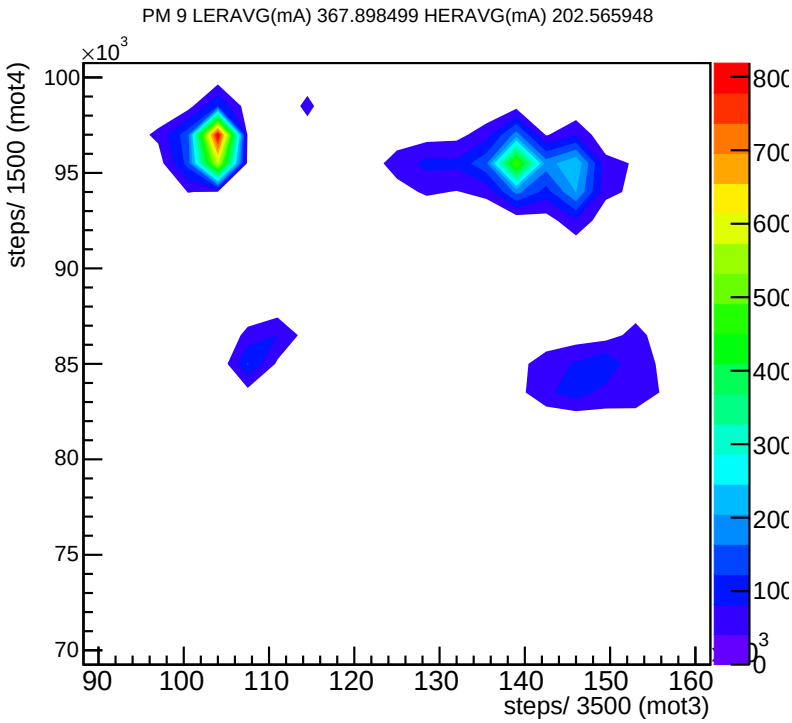
steps/ 3500 (mot3)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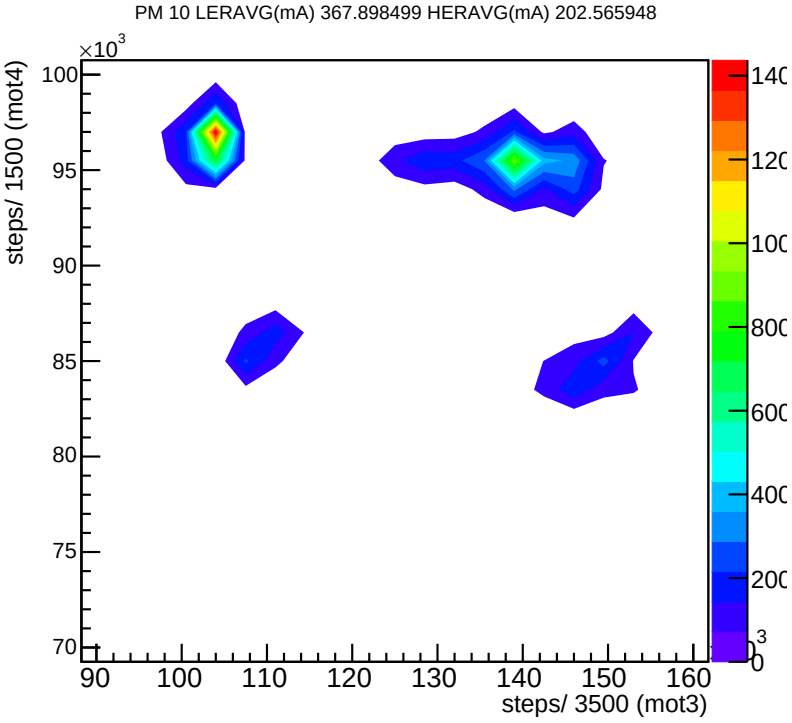
steps/ 3500 (mot3)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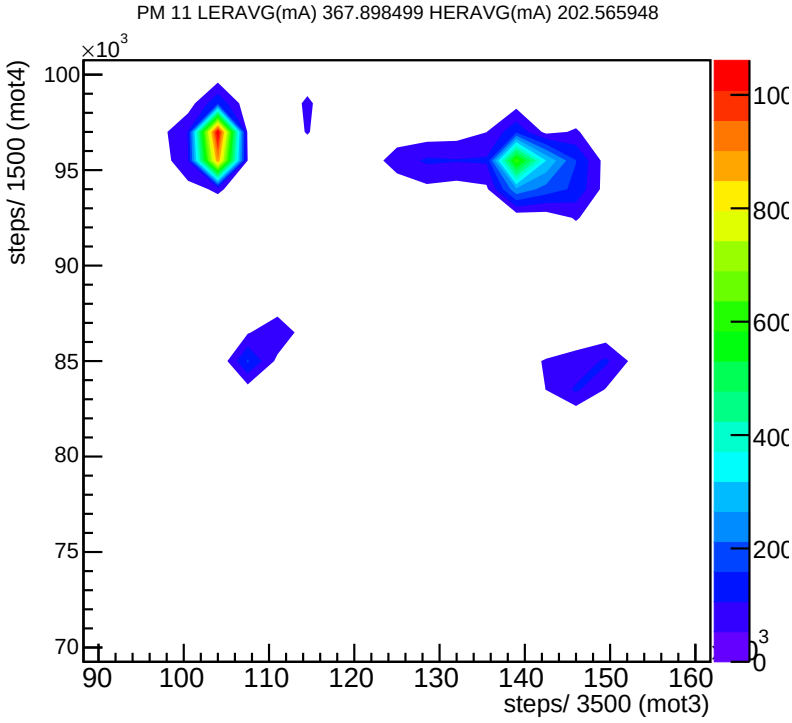
steps/ 3500 (mot3)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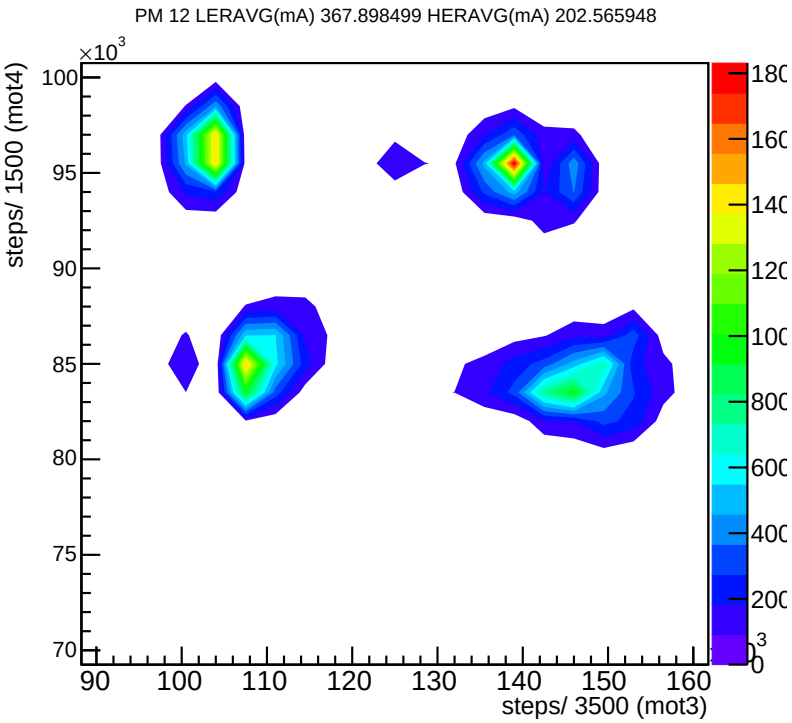
steps/ 3500 (mot3)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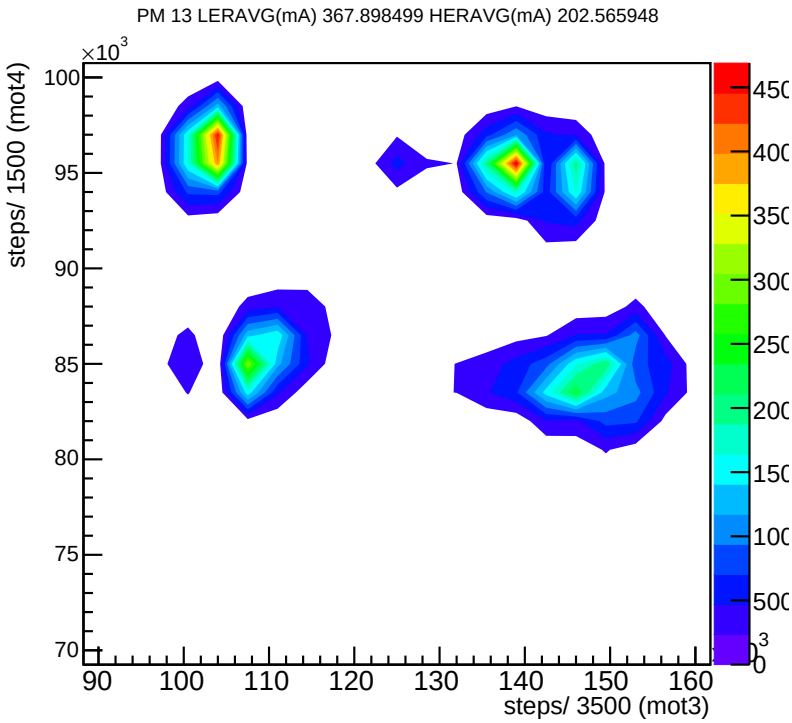
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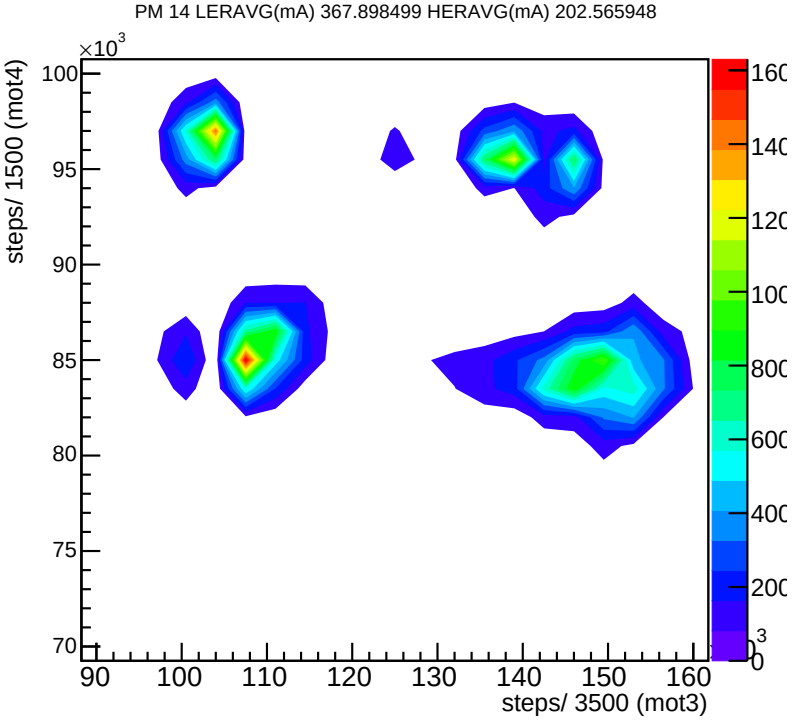
steps/ 3500 (mot3)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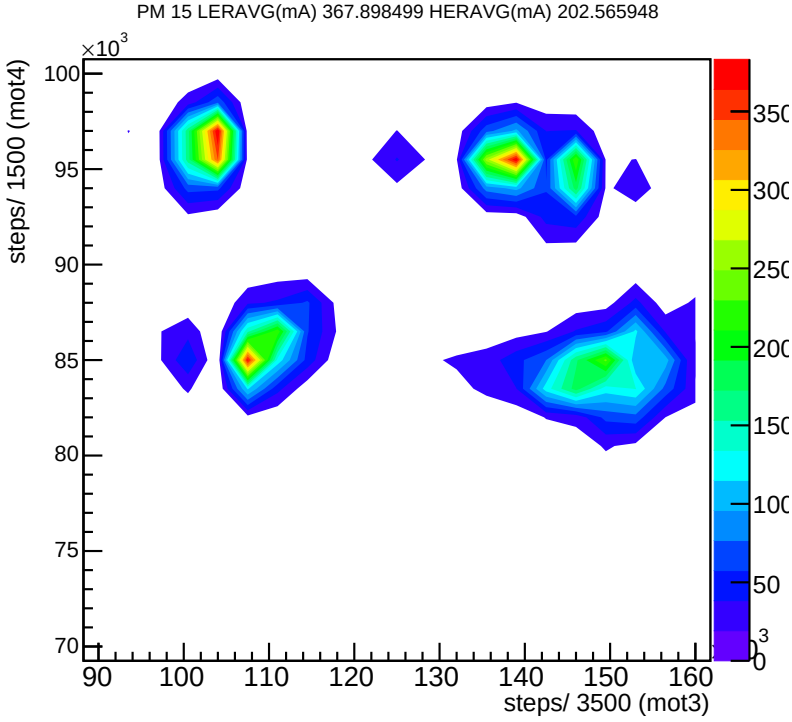
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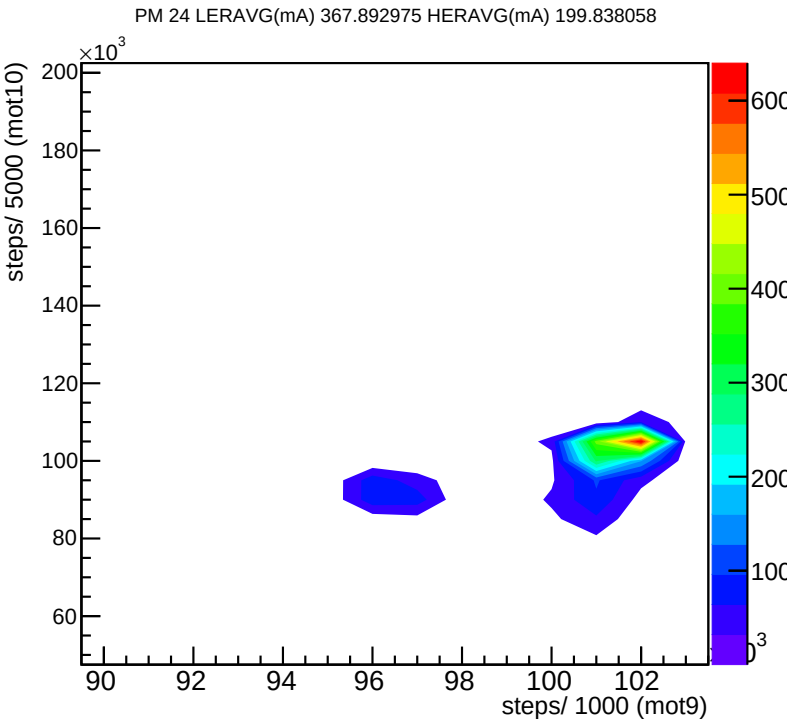
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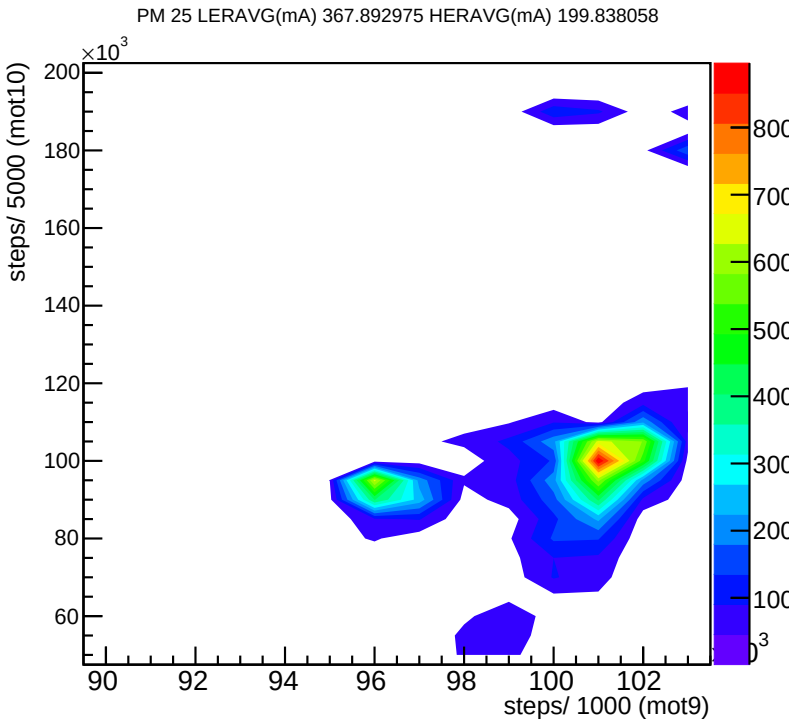
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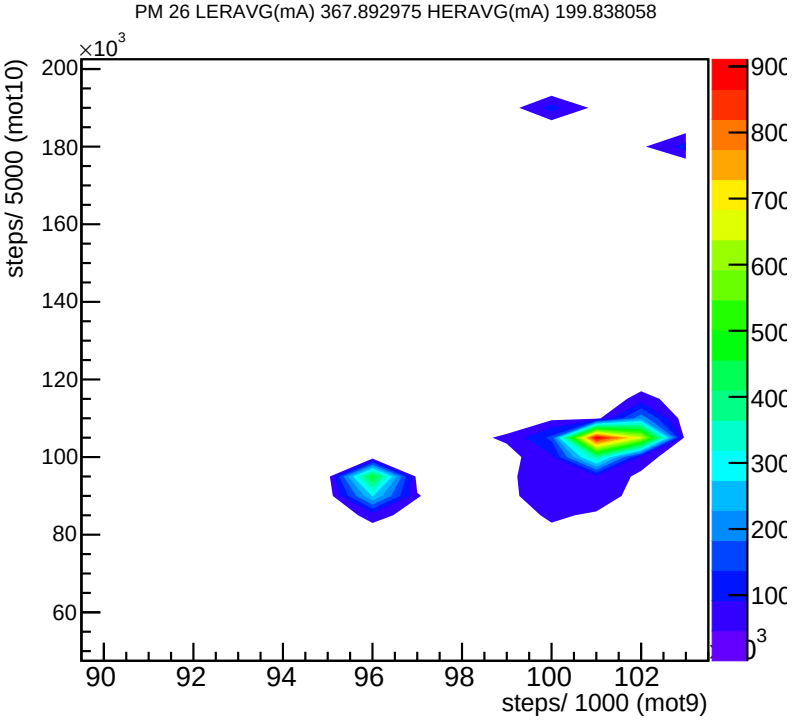
steps/ 1000 (mot9)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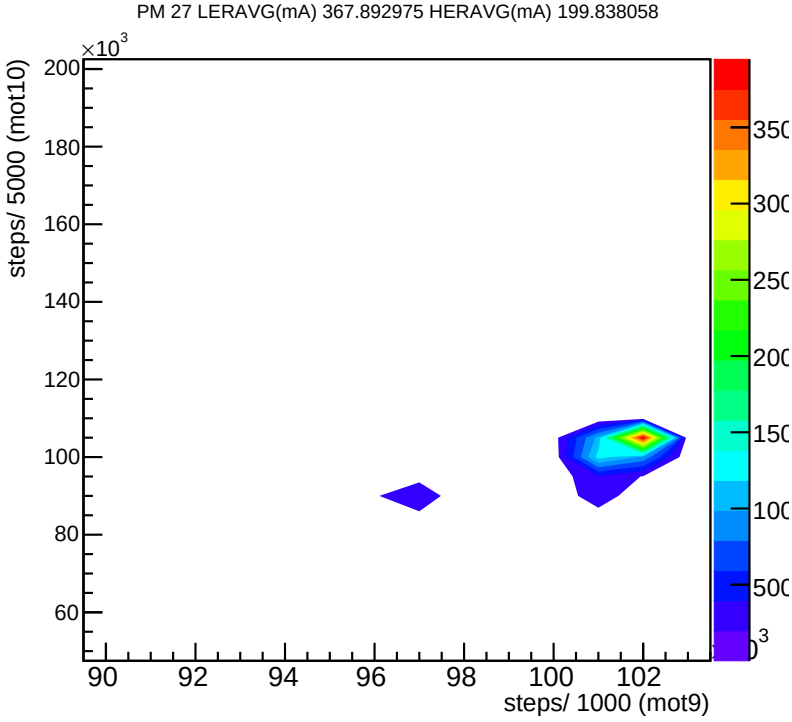
steps/ 1000 (mot9)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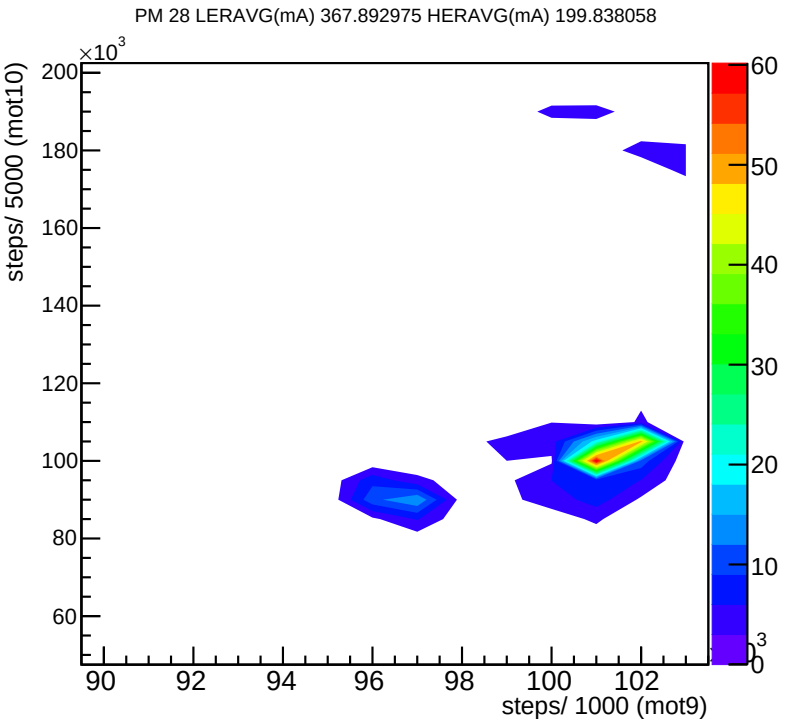
steps/ 1000 (mot9)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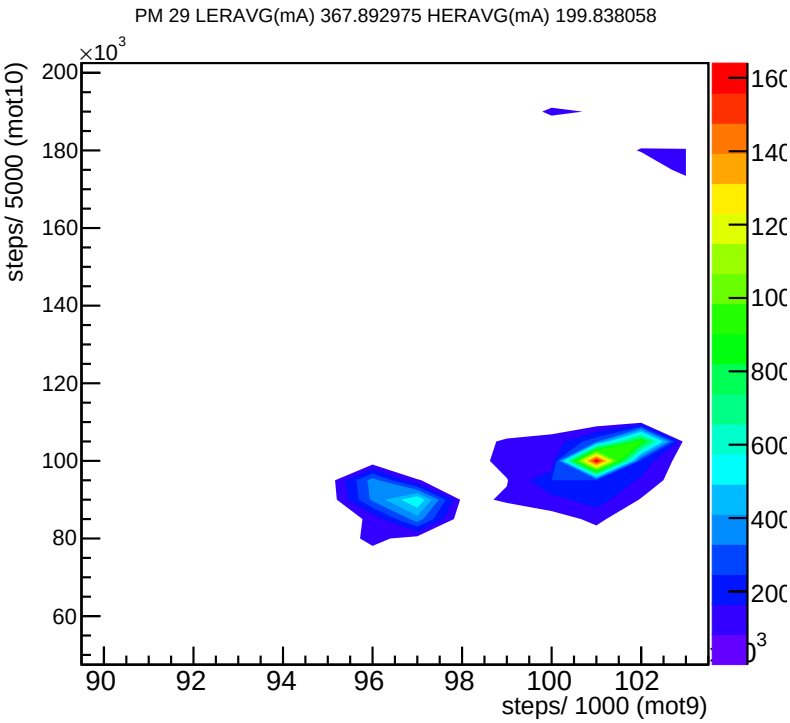
steps/ 5000 (mot10)
steps/ 1000 (mot9)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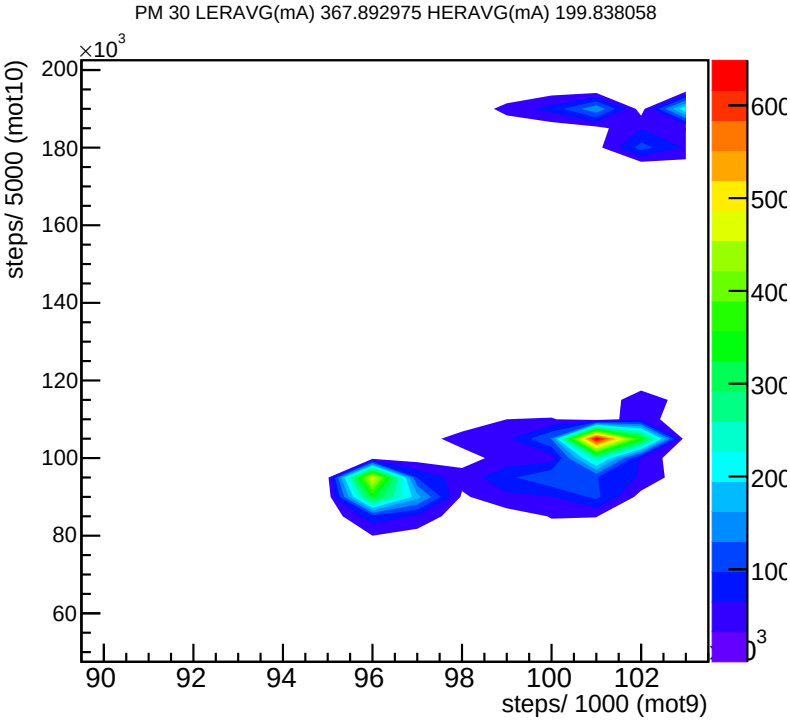
steps/ 1000 (mot9)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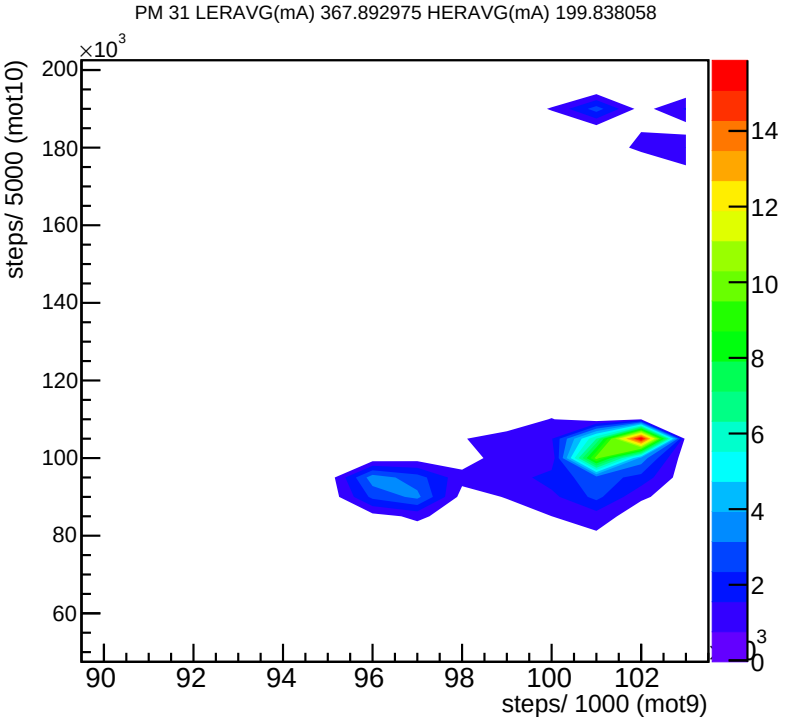
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steps/ 1000 (mot9)