Cornell University
Laboratory for Elementary-Particle Physics

Beam-breakup Calculations for the 1- vs 2-Turn Document

-- Draft of Complete Text and Figures ---

-- Status update since ERL@CESR talk of 23 July 2009 --

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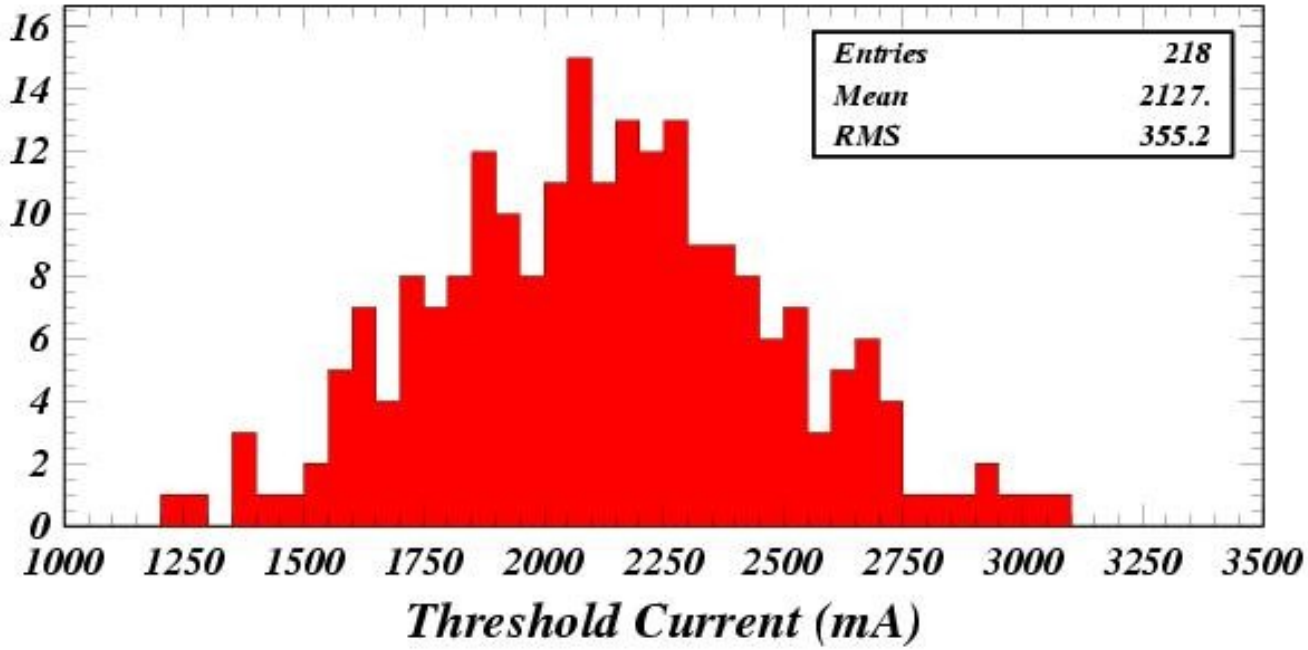
ERL @ CESR Meeting
22 October 2009

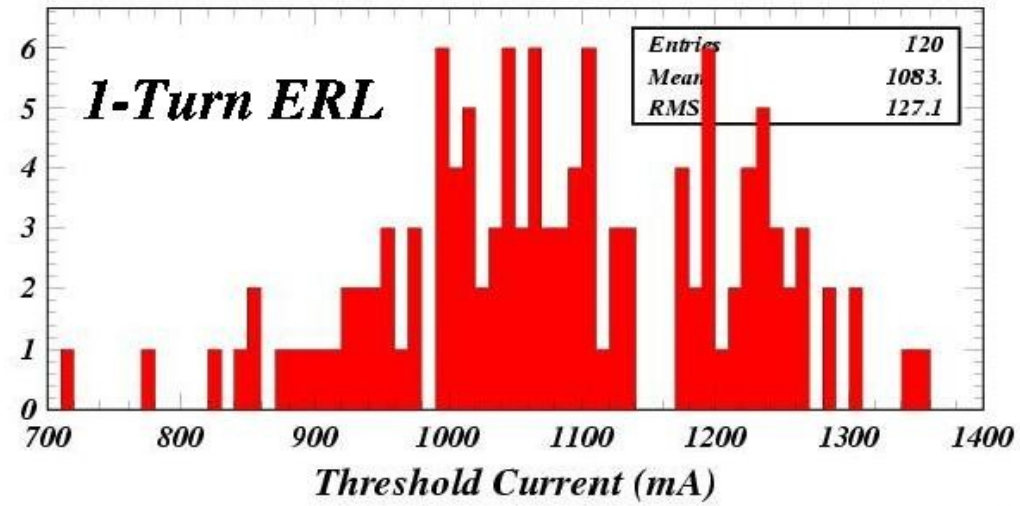
Bmad Validation with Polarized HOMs in the 2007 PRSTAB Coupled Optics

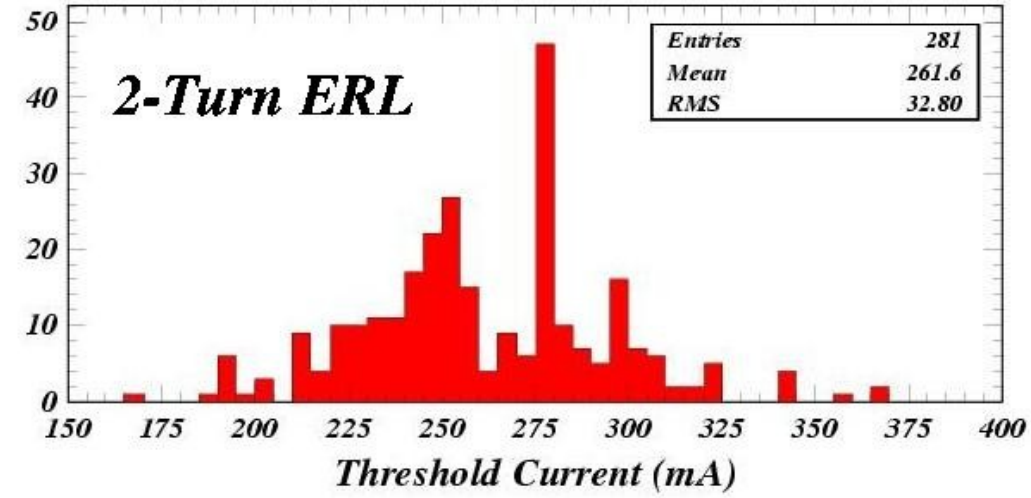


Modelled BBU instability thresholds for the case of a single higher-order mode excited in a single cavity of the fully coupled single-turn ERL optics in Ref. ERL-06-01 with polarized HOMs with 60 MHz frequency splitting and 10 MHz HOM frequency spread.

The resulting average and RMS values of 2127 mA and 355 mA compare well with the values 2076 mA and 341 mA obtained in Ref. ERL-06-01.

Bmad BBU 1 vs 2 Turn Comparison
Updated HOMS (c.f. Matthias), Unpolarized



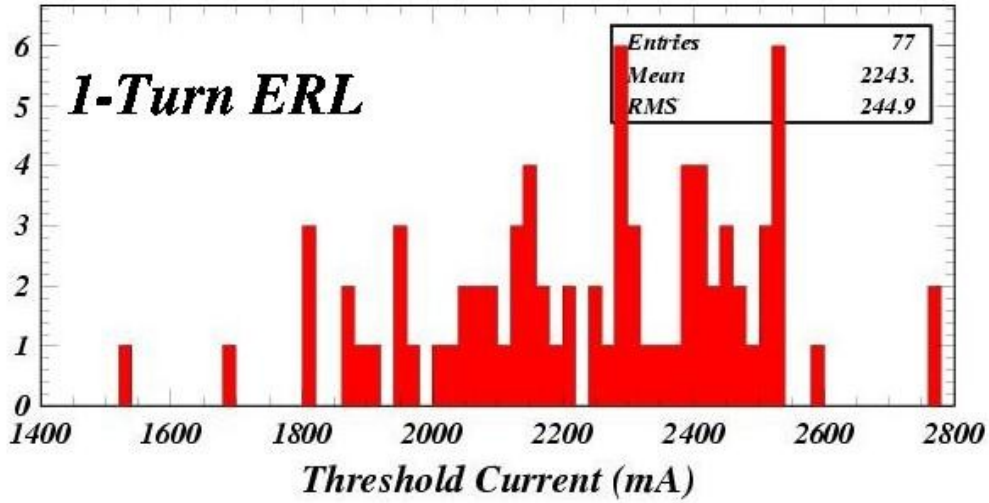


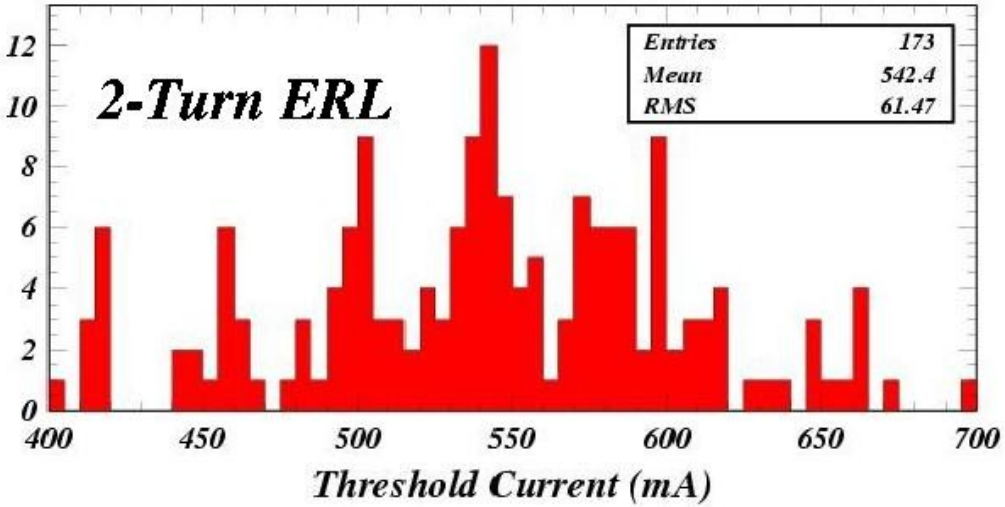
Modelled BBU instability thresholds for the case of the five updated HOMs excited in each cavity of the full 1-turn Cornell ERL optics (upper plot) compared to the threshold currents calculated for the same case in the 2-turn ERL (c.f. Chris, lower plot).

The average 1-turn instability threshold is 1082 mA with an RMS spread of 127 mA. The corresponding values for the 2-turn optics are about a factor of four lower, in rough agreement with the estimate of N(2N-1) = 6 given in PRSTAB 10 (2007).

The worst case found for the 2-turn optics is 160 mA, marginally above the 100 mA design current of the Cornell X-ray ERL.

Bmad BBU 1 vs 2 Turn Comparison
Updated HOMS, Polarized with Coupled Optics





Modelled BBU instability thresholds for the case of polarized HOMs with 50 MHz HOM frequency splitting excited in each cavity of the full 1-turn Cornell ERL optics (upper plot) compared to the threshold currents calculated for the same case in the 2-turn ERL (lower plot).

The improvement is about a factor of two for each of the optics, showing that this means of BBU instability mitigation is as effective in the 2-turn optics as in the 1-turn optics.