Science Impact for MSL RAD for the case of a Missing Medium Gain CsI Channel

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1 This Document

RAD RSH FM1 DM channel is lost. Repair is difficult without schedule constraints, prohibitive with the given schedule contraints. We explain why we do not attempt the fix.

2 RSH Models

- RSH FM1 shall be flight spare, used for calibration after flight instrument delivery.
- RSH FM2 shall fly.
- FM1 and FM2 are built in parallel, each step being performed first on FM1 and then on FM2 subunits. FM2 benefits from experience from FM1 work. The two instruments shall be made identical as much as possible.

3 The CsI detector

- Why we have three diodes, with different gains.
- Performance of the RSH DL DM DH channels
- Redundant VIRNA channels, input gain.

4 Performance loss without the DM channel

- Reduced resolution for intermediate energy deposits.
- Less efficient Si-hit detection for small and intermediate energy deposits.

5 Design Performance Requirements

- RSH preamps exceed design dynamic range expectations.
- VIRENA exceeds dynamic range expectations with non-redundant readout.
- Using the redundant DL VIRENA channel with extra input gain of 8 provides the dynamic range of the original DM channel.
- Three gain scales were introduced before the preamp and VIRENA performance was known.
- The RSH+VIRENA without DM provide what the orginal instrument design called for, plus extra resolution for small signals in the redundant DH channles, but without the extra resolution and background rejection efficiency that a functional DM channel can provide.

6 Proposed Action

- The DM detector and preamp will remain in place.
- The preamp with be powered and operational.
- The broken detector will stay connected to the preamp.
- The detector bias voltage will not be applied to the DM detector to avoid the large noise resulting from appying bias to spead to the other channels.
- Alternatively, the detector could be removed from the CsI crystal, yielding more light in the DH and Dl channels. That would reduce the comparability of calibration results between FM1 and FM2. The removal procedure imposes a substantial risk to the CsI detector subsystem.

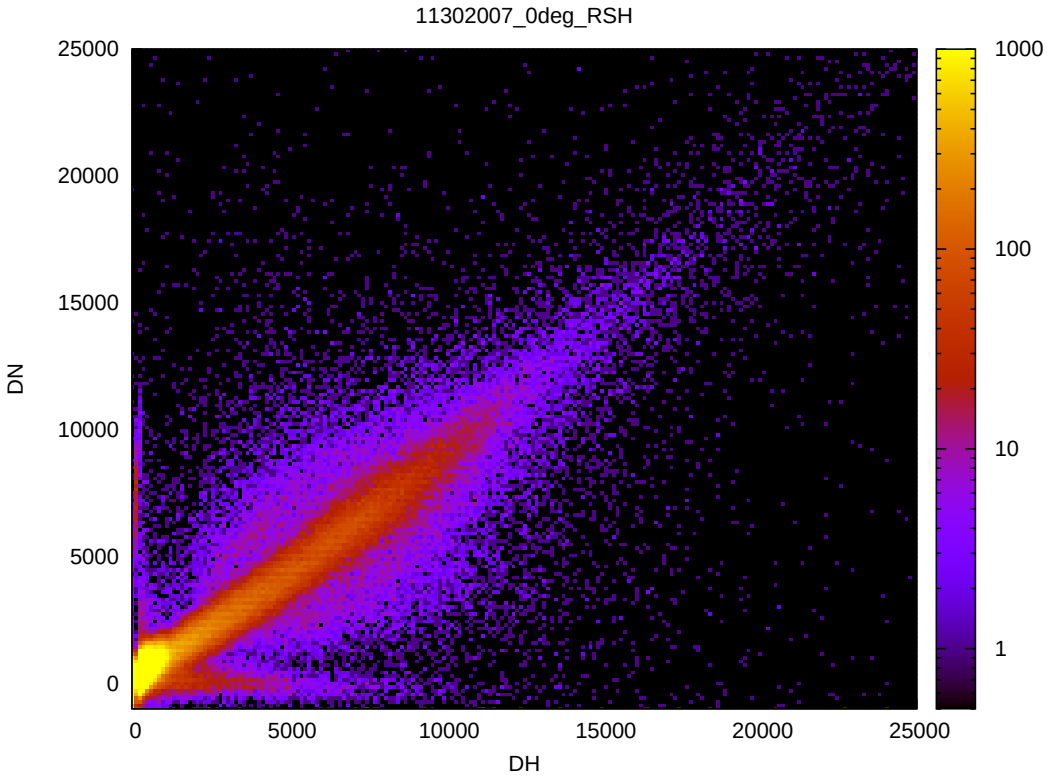

Figure 1: Low-gain vs. high-gain signal amplitude for muons in the CsI crystal.
The low-gain channel was operated with input gain of 4, the high-gain channel with input gain 1. Calibration factors were applied in L2 to bring the number on the same scale. November 2007 muon run in vertical arientation at SwRI.

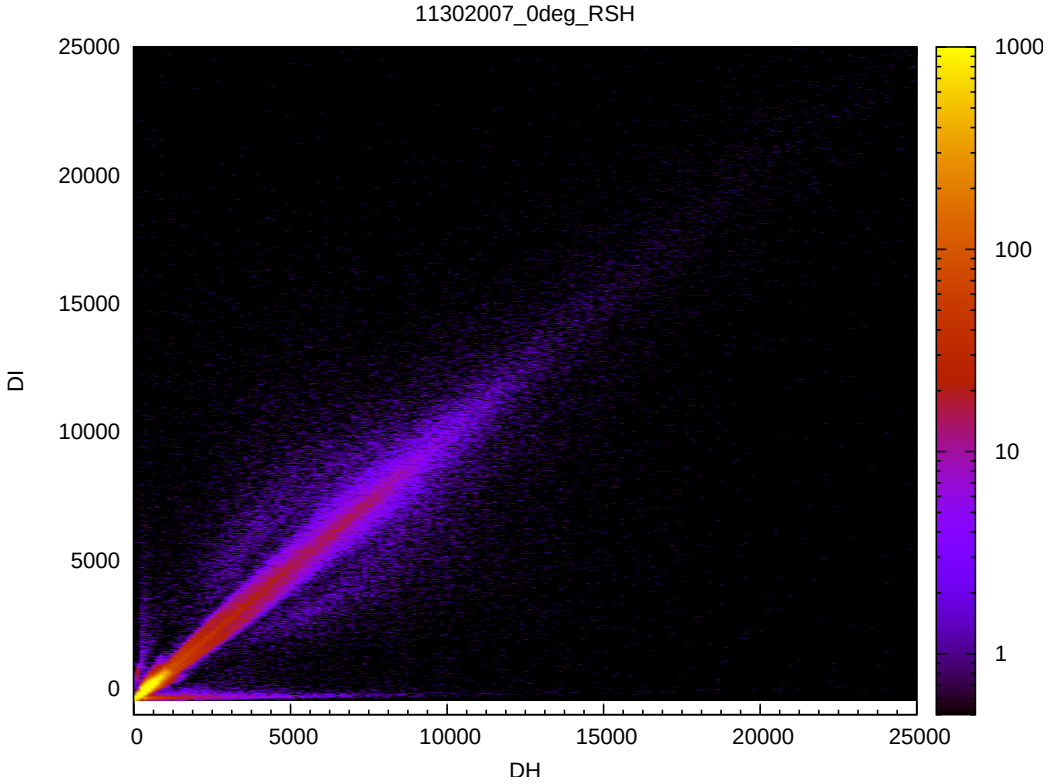

Figure 2: Medium-gain vs. high-gain signal amplitude for muons in the CsI crystal.

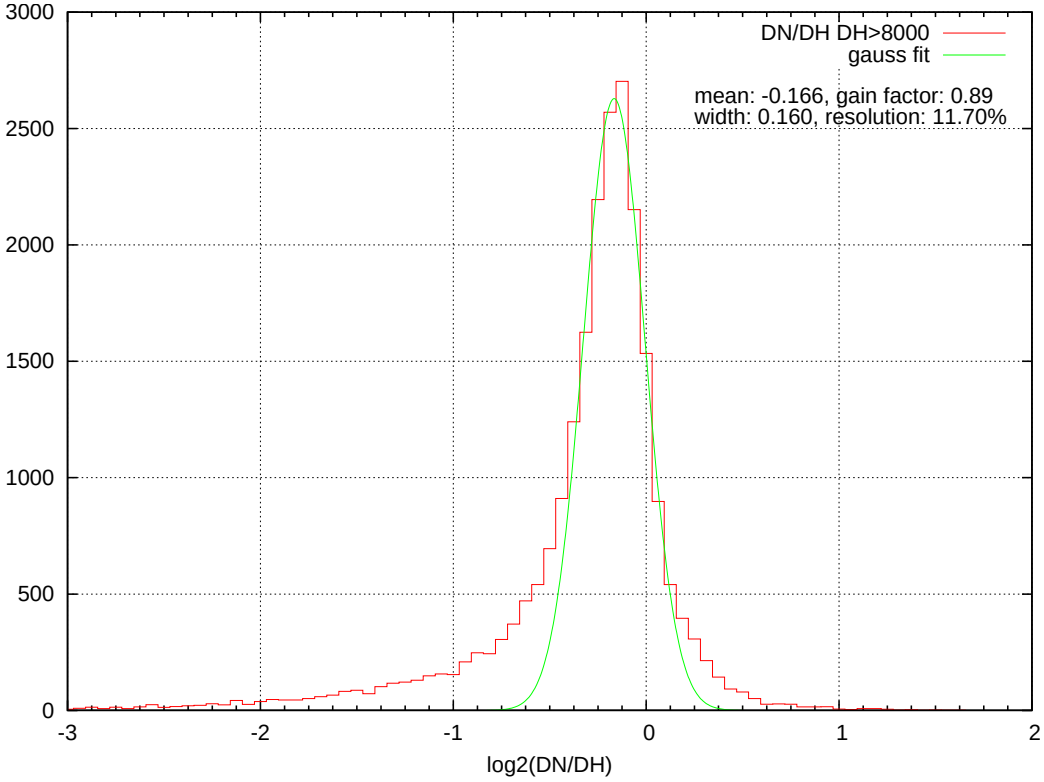

Figure 3: Logarithm base 2 of low-gain devided by high-gain signal amplitude for muons in the CsI crystal.
The low-gain channel was operated with input gain of 4, the high-gain channel with input gain 1. Calibration factors were applied in L2 to bring the number on the same scale. November 2007 muon run in vertical arientation at SwRI.
The calibration factors were off by 11 %, otherwise the peak position should be at zero.
The resolution $r = 11.7\,\%$ is given by $r = 2^w - 1 = 2^{0.160} - 1 = 0.117$ from the width w of the peak.

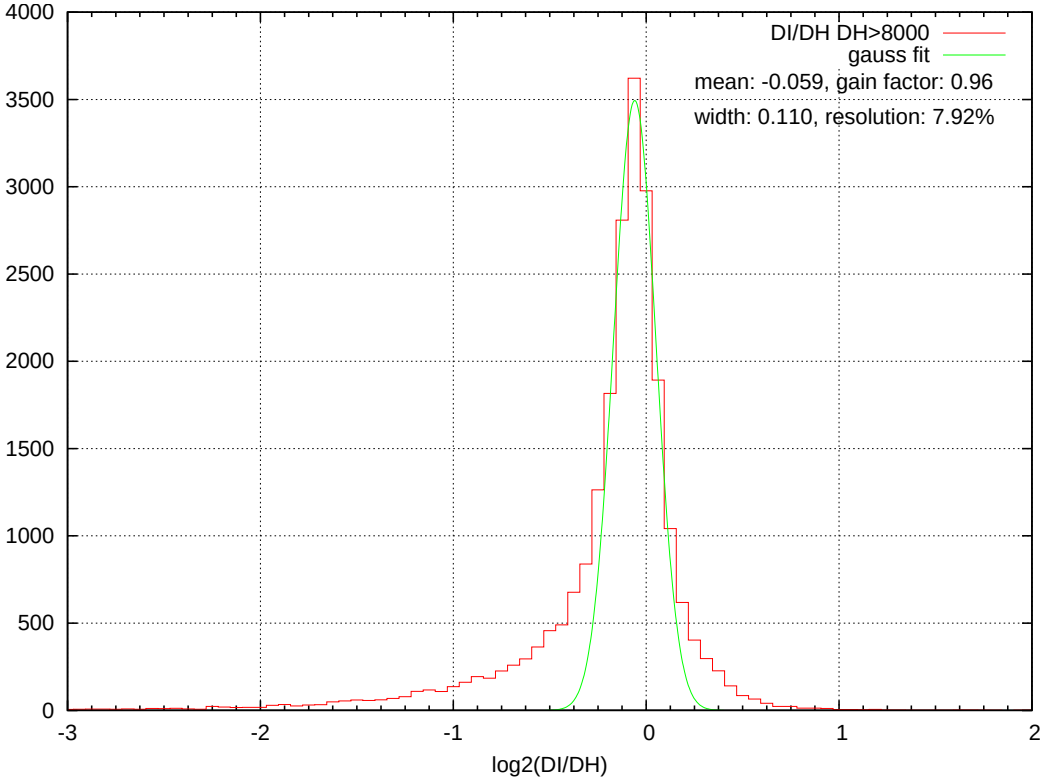

Figure 4: Logarithm base 2 of medium-gain devided by high-gain signal amplitude for muons in the CsI crystal.
The medium-gain channel was operated with input gain of 4, the high-gain channel with input gain 1. Calibration factors were applied in L2 to bring the number on the same scale. November 2007 muon run in vertical arientation at SwRI.
The calibration factors were off by 4 %, otherwise the peak position should be at zero.
The resolution $r = 7.9\,\%$ is given by $r = 2^w - 1 = 2^{0.110} - 1 = 0.079$ from the width w of the peak.