Minimization of IF AM-ing

Filename =
minimize_AMing_2007sep20

References:
A4-IF2 AM-ing Versus LO Drive (filename = A4_IF2_AMing_2007sep10)
Measurement of Phase Switch Effects on AM-ing (revised) (filename = Aming_2007sep7)

Sept 20, 2007
D. Kubo, P. Oshiro

Minimization of IF AM-ing

- Converged VGAs (still only applicable to IF2)
- Checked DC offsets (counts > 10k), correlator in etd 2 & demod modes:
  - TR7 (1L-3L) = -13k counts
  - TR28 (2L-3L) = -8k
  - TR50 (3L-5L) = -13k
  - TR158 (5R-6R) = +8k
  - TR159 (5R-6R) = -8k
- Monitored AM-ing at output of IF/LO using 20 dB pad (to operate in quasi linear regime of detector), Krytar detector, and O-scope.
- Optimized 42 GHz variable attenuator setting to minimize AM-ing
  - Recorded initial and final attenuator micrometer settings (see Table, next page)
  - Sticker on IF/LO did not always match micrometer setting
  - IF output power changed significantly for some antennas
    - Affects IF1 because VGA convergence routine has not been implemented yet
    - IF2 should be unaffected because can converge away difference

Minimization of IF AM-ing (continued)

- "Before" and "After" attenuator micrometer settings:
  - See page 24 for approximate LO power out of variable attenuator
  - There is a ~1ft semi-rigid cable from the attenuator output to the SHM
    - Actual LO power to SHM will be lower

ANTENNA	INITIAL		FINAL	
	LO1 um setting	LO2 um setting	LO1 um setting	LO2 um setting
1	?	65	75	65
2	75	85	80	85
3	115	64	76	66
4	75	75	75	75
5	66	50	66	71
6	88	55	89	76
7	70	65	72	65

- Reconverged VGAs and spot checked DC offsets, there were no longer any that exceeded 10k counts
  - Largest DC offsets:
  - TR5 (1L-3L) = +1.1k counts
  - TR75 (5L-6L) = +1.5k
  - TR76 (5L-6L) = +1.5k

Detailed Look at Correlator Output Data

- Kyle ran 4 sets of data during the evening to check offset as a function of time of day (temperature), see pages 7 through 22
- The test was conducted with the shelter closed and absorbers installed over the receivers
  - ~8:23 PM HST
  - ~10:20 PM HST
  - ~1:00 AM HST
  - ~6:36 AM HST
- Here is an excerpt from his Blog:

(the reduced_rms is just the rms divided by sqrt(number of points)~16).
If the dc offset has no variation, it should fluctuate within the reduced_rms (1 sigma).

Conclusion:

1. 3L and 7L related baselines show largest change in offset level. But this seems to be much better then before already. Their LO drive level can probably be lowered a bit.

2. 2R abnormal pattern is still there, but the LO drive level seems to be pretty good. The dc is jumping around only because of the pattern.

3. Towards later part of night, first row "hair" problem returns? 1R2R and 1R5R show larger offset and associated hairs. But this is not correlated with change in other related baselines. I doubt this sudden change of offset is from the IF AM-ing due to LO drifting.- Kyle

Conclusions & Recommendations

1. I believe that we have identified IF AM-ing as one of the major sources of DC offset
   - The conceptual relation of IF AM-ing to DC offset was already known, Kyle provided a write-up on it's mechanism several years ago
   - This write-up led to a spec limit imposed on the LO phase switch imbalance (I forgot what the limit was)
     - Measured imbalance on the recently installed IF/LO on Antenna 4 indicates an imbalance of 0.2 to 0.3 dB while looking into an RF power sensor.
     - Actual imbalance may be larger when looking into the complex SHM load

2. We've also established earlier that the DC offset increases/decreases with an increase/decrease in IF power delivered to the correlator. Temperature changes affect both the LO power (hence AM-ing) and the IF power.
   - This may explain the inconsistent results for DC offset measurements seen in the past

3. One of the challenges that faces us now is to maintain fairly tight thermal control of the LO being delivered to the SHM
   - Requires tight thermal control of the 21 GHz DRO assembly (only one box)
   - Requires tight thermal control for each of the receiver IF/LO assemblies
   - We should attempt to characterize the 42 GHz LO power variation as a function of assembly temperature

Conclusions & Recommendations (continued)

4. Pablo suggested an alternative to tight thermal control and that is to remove the LO power imbalance at the source of the problem
   - Add a variable attenuator in one of the legs of the phase shifter and tweak for minimum LO power imbalance between the 2 phase switch states
   - Have we already tried this?

5. Each of the 14 SHMs should currently be driven into saturation. As mentioned earlier the adjustment of LO power resulted in some non-trivial changes in IF power. I would like to normalize all 14 IF outputs to produce a relatively consistent level at the IF/LO assembly output
   - Set all VGAs to 0.0V
   - Ambient load on receivers
   - Physically change the pad value (currently 3 dB for most paths) at the input to the Amplifier Plate assembly to achieve a consistent level for all receivers
     - Maybe we will shoot for +6 dBm on all outputs
     - This target will requires some pad changes on IF2 (input to 1st Section)

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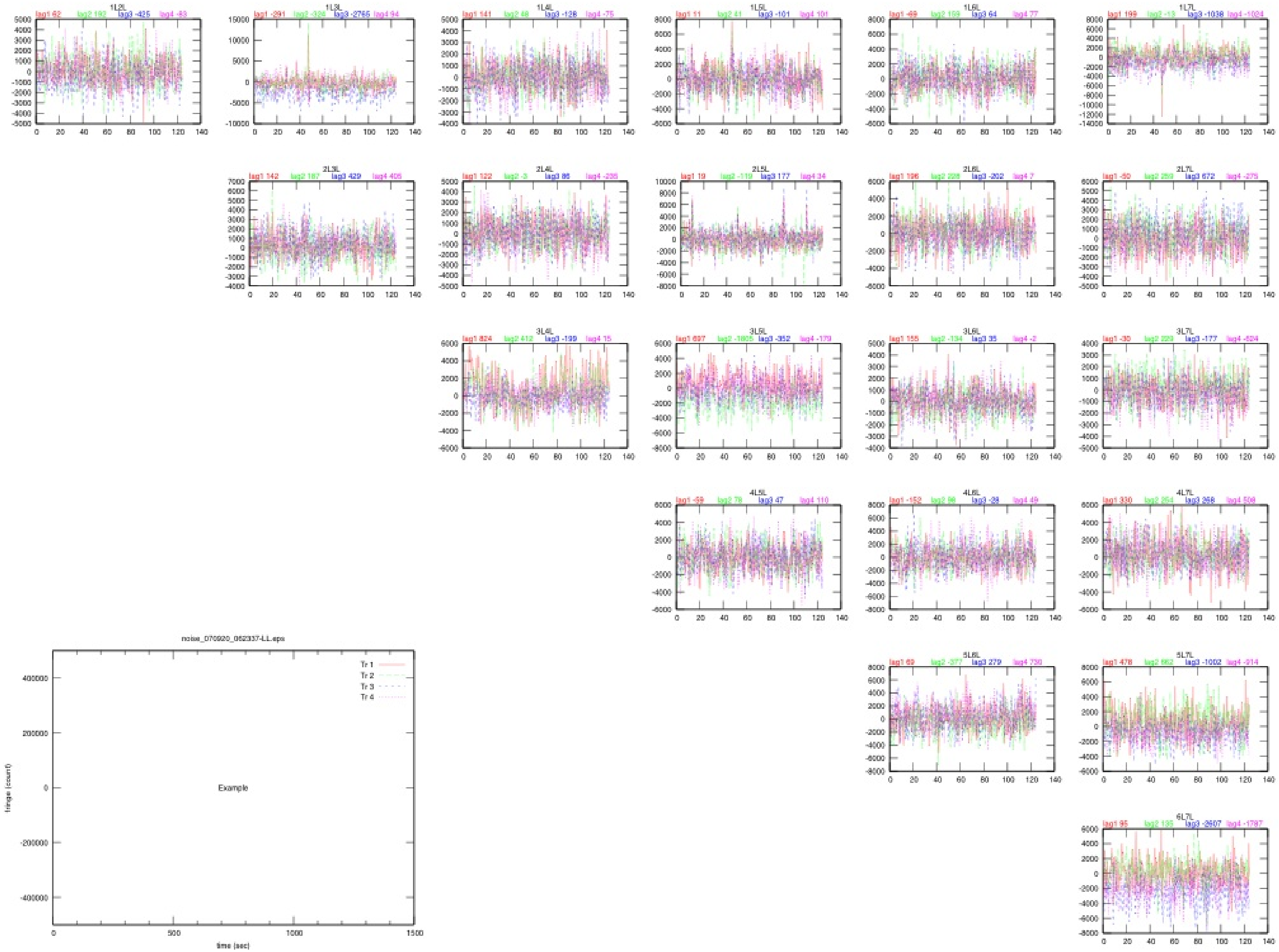

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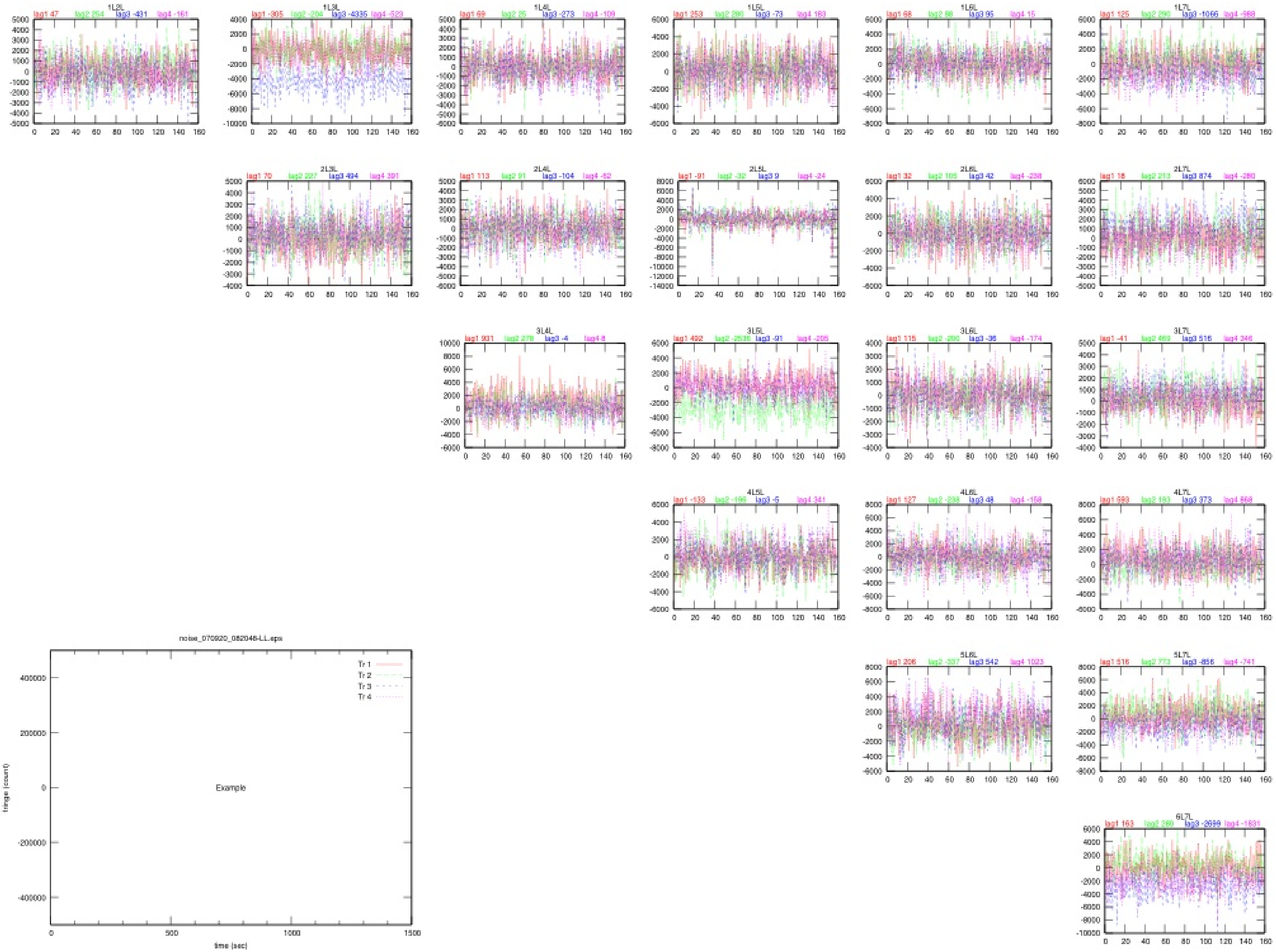

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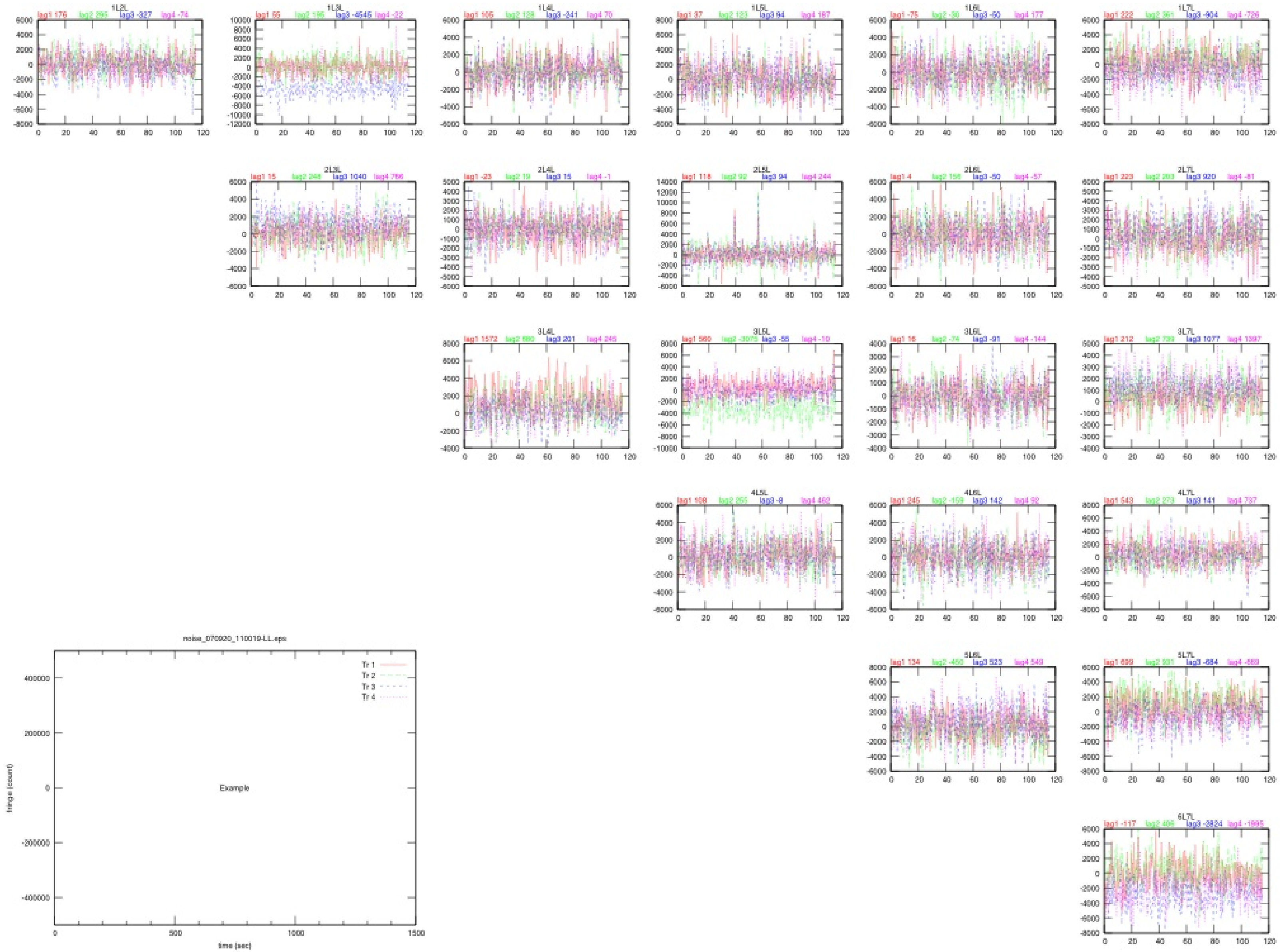

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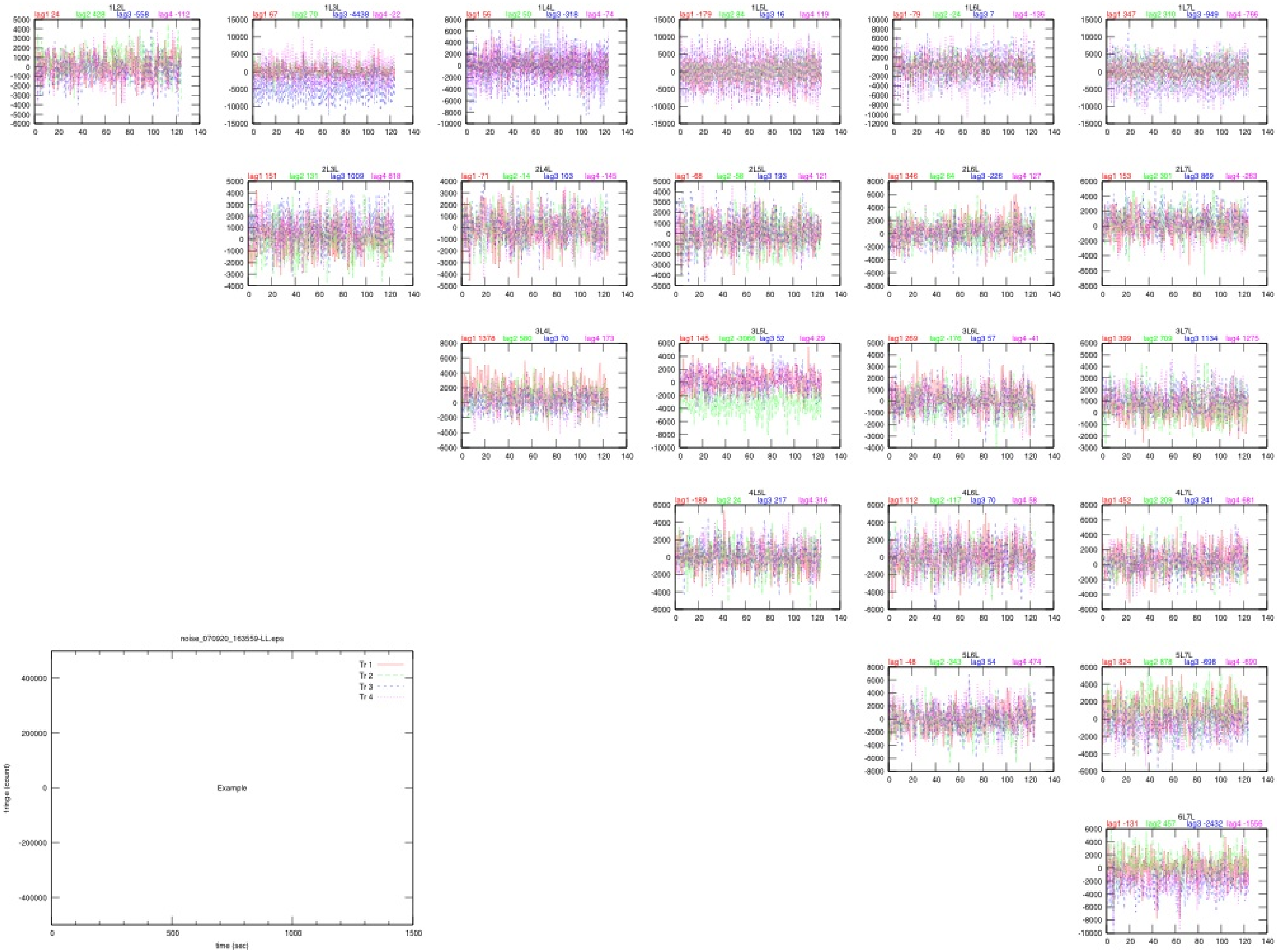

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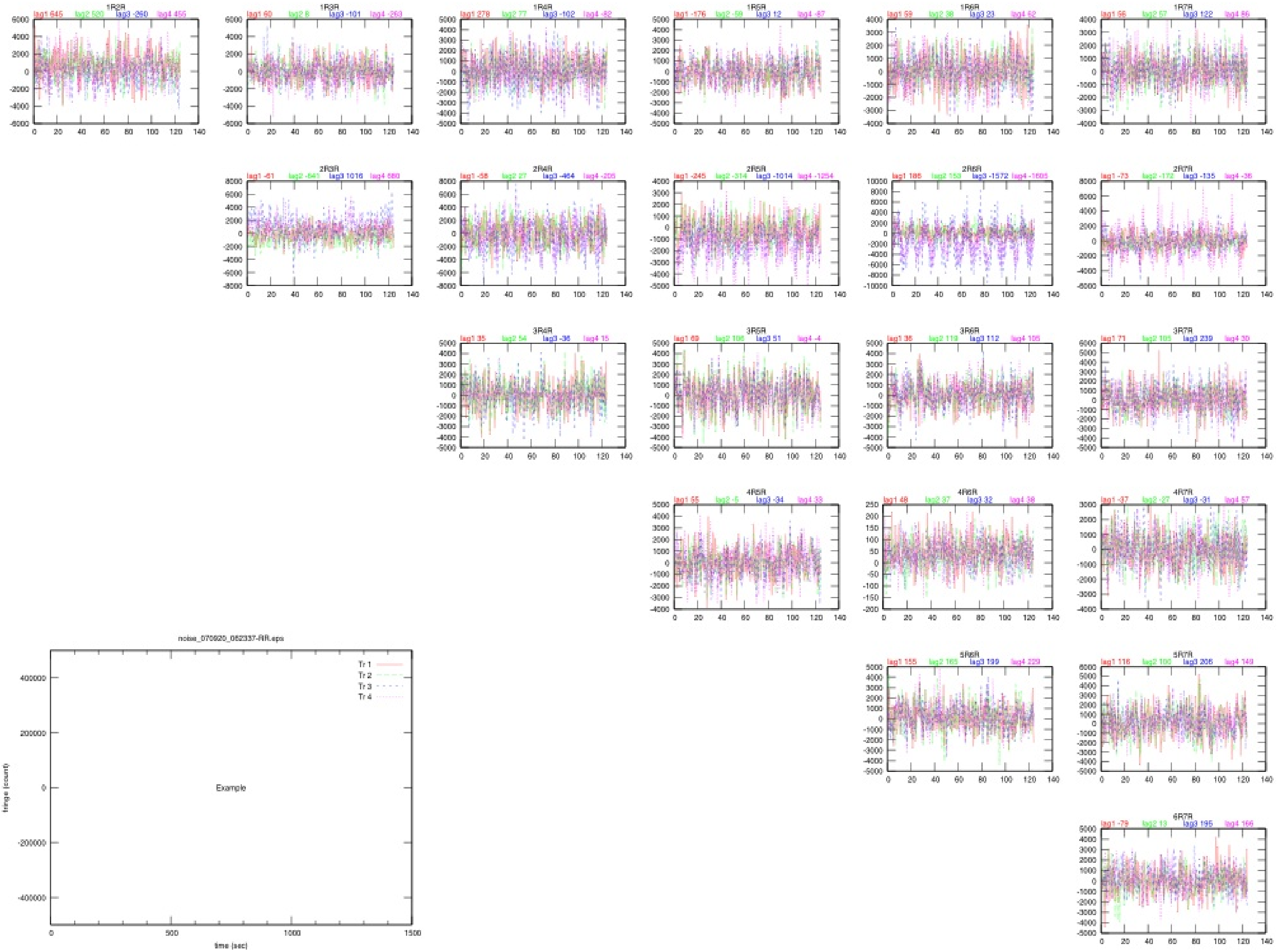

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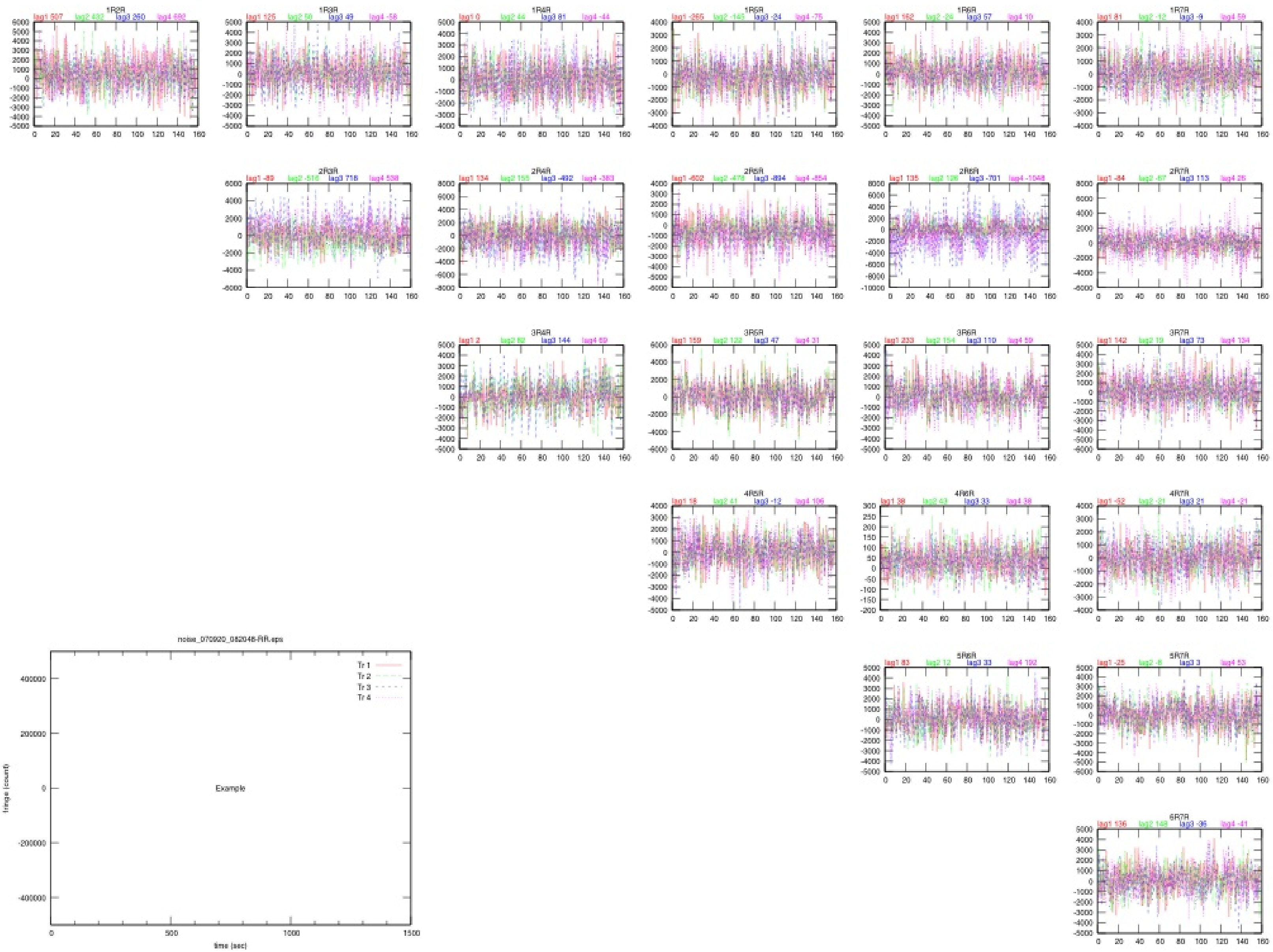

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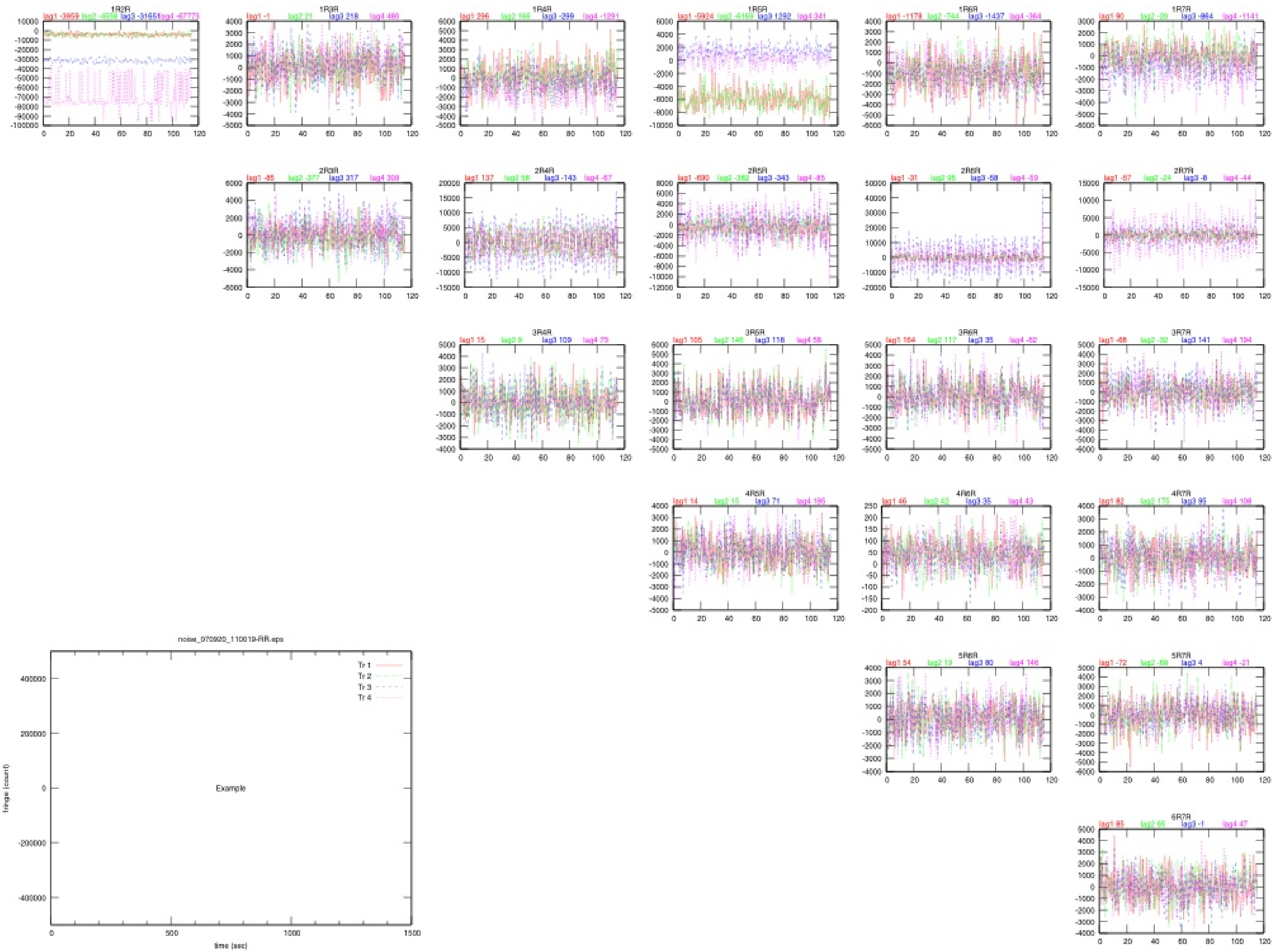

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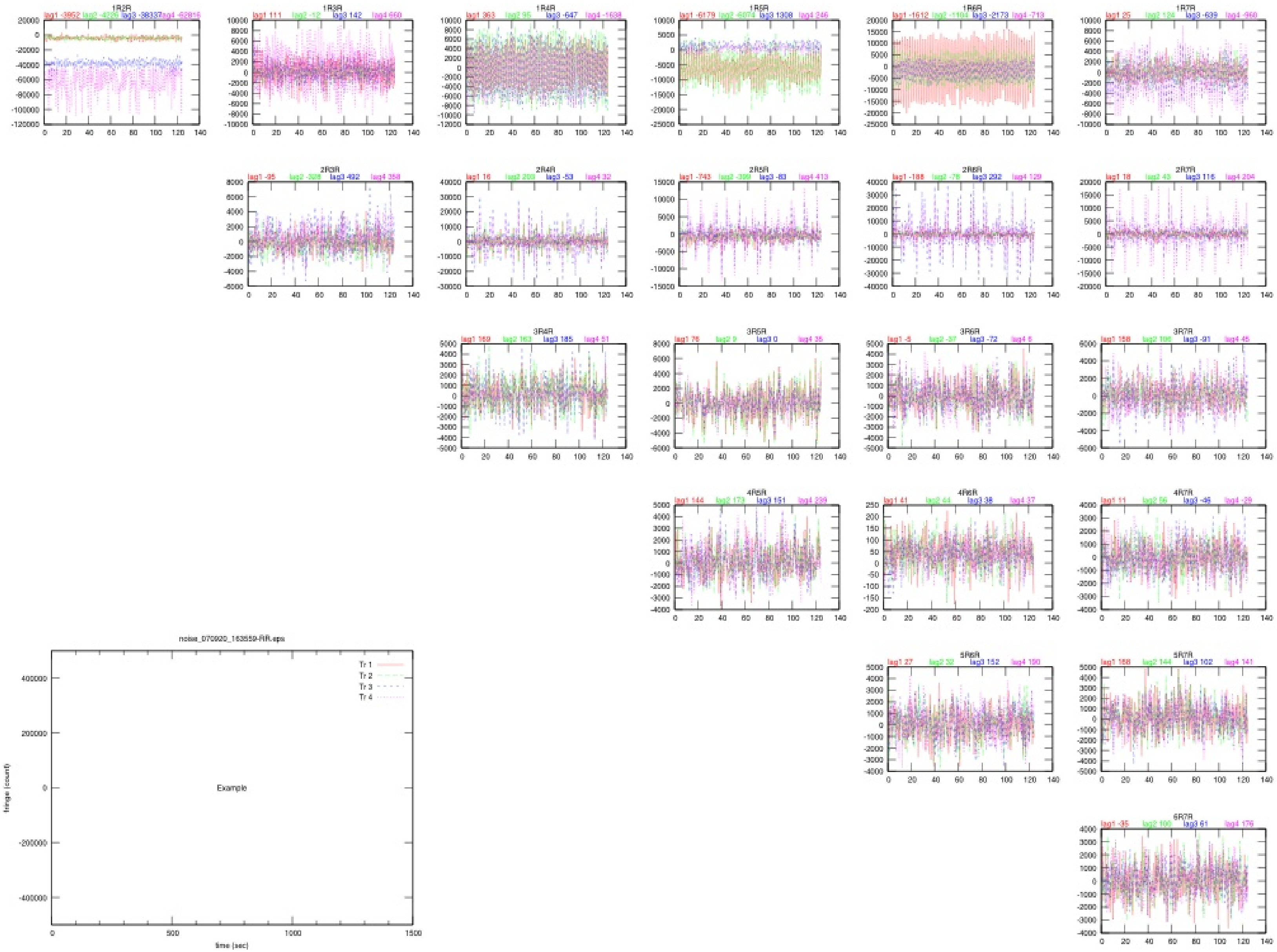

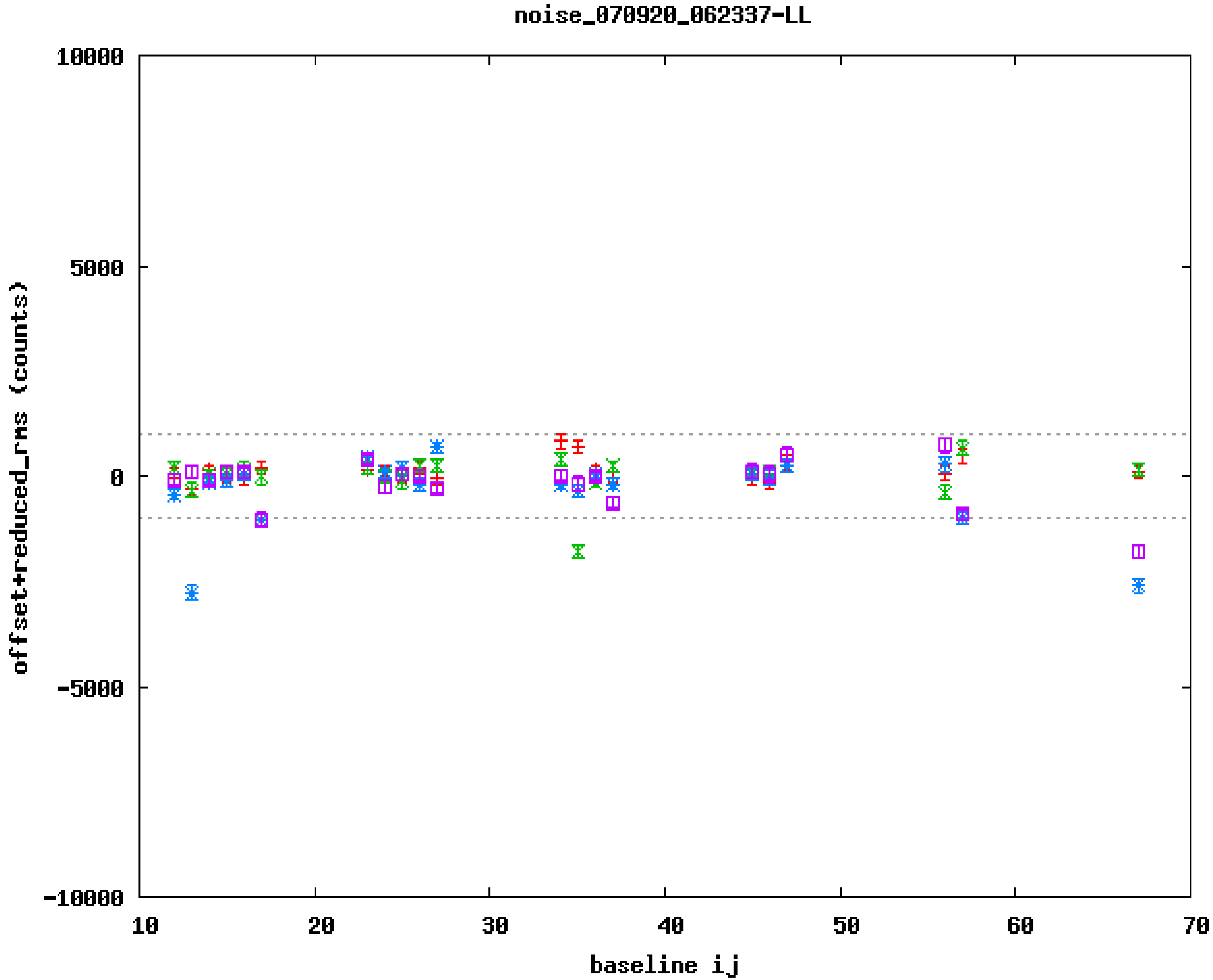
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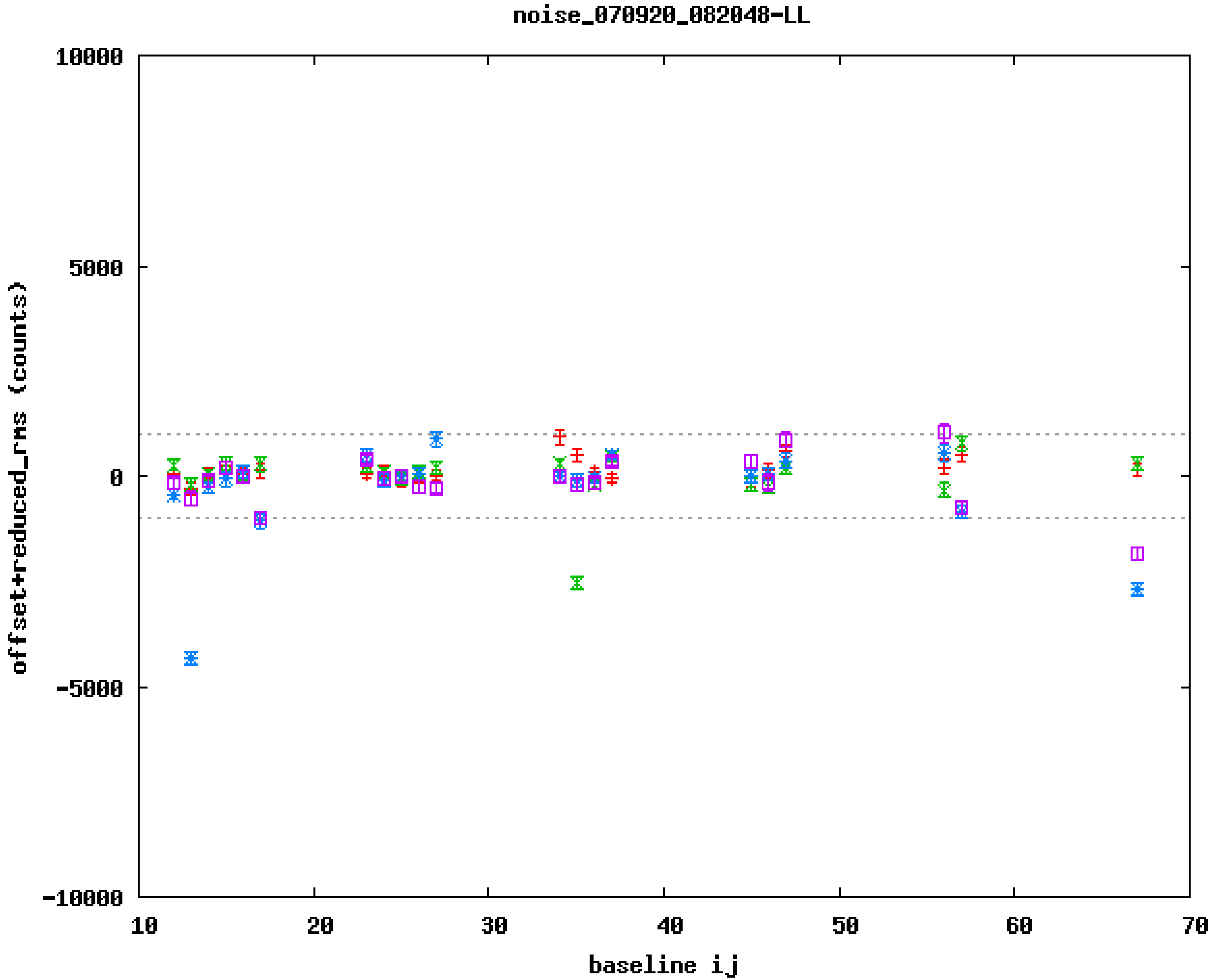
baseline ij
offset+reduced_rms (counts)



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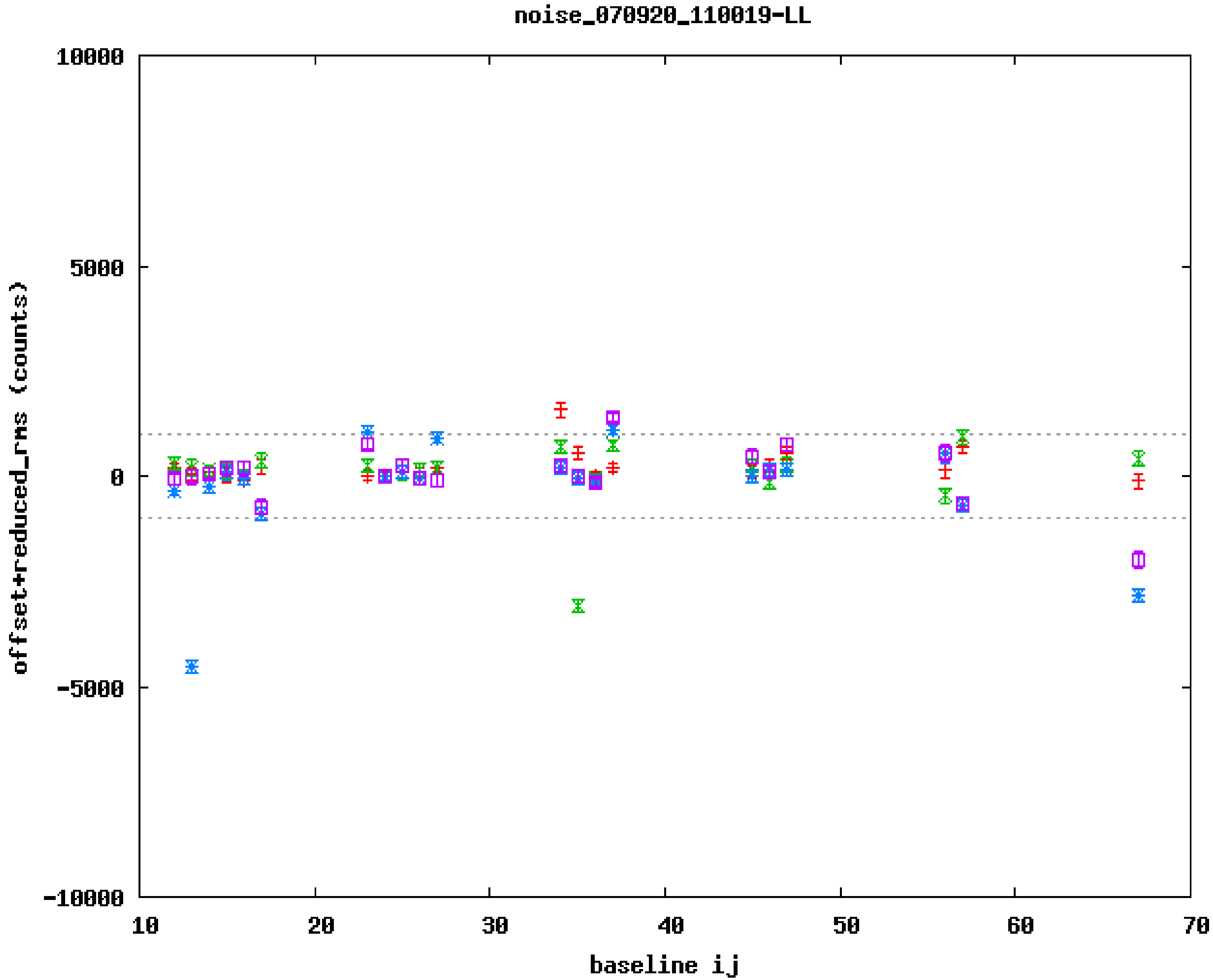
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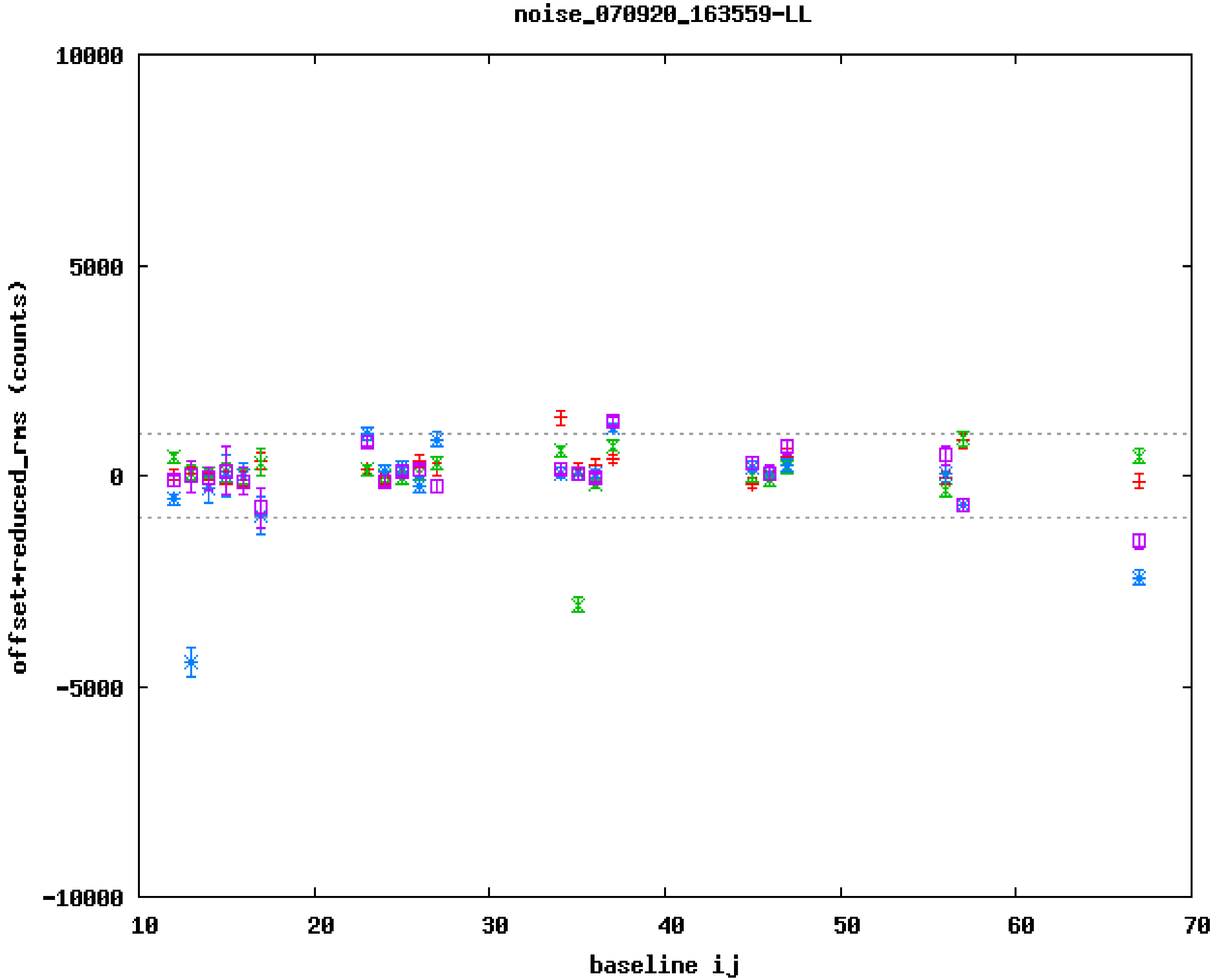

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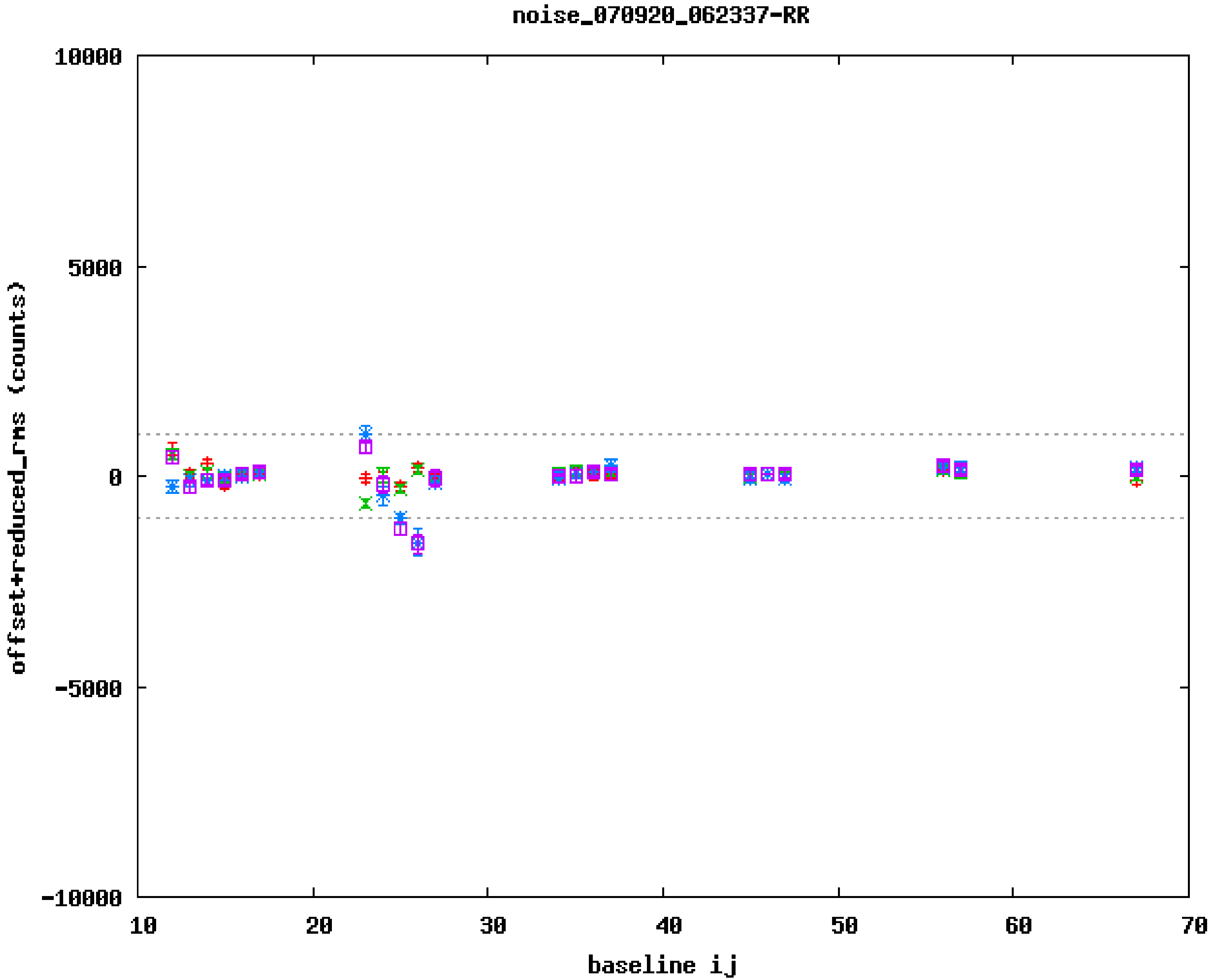
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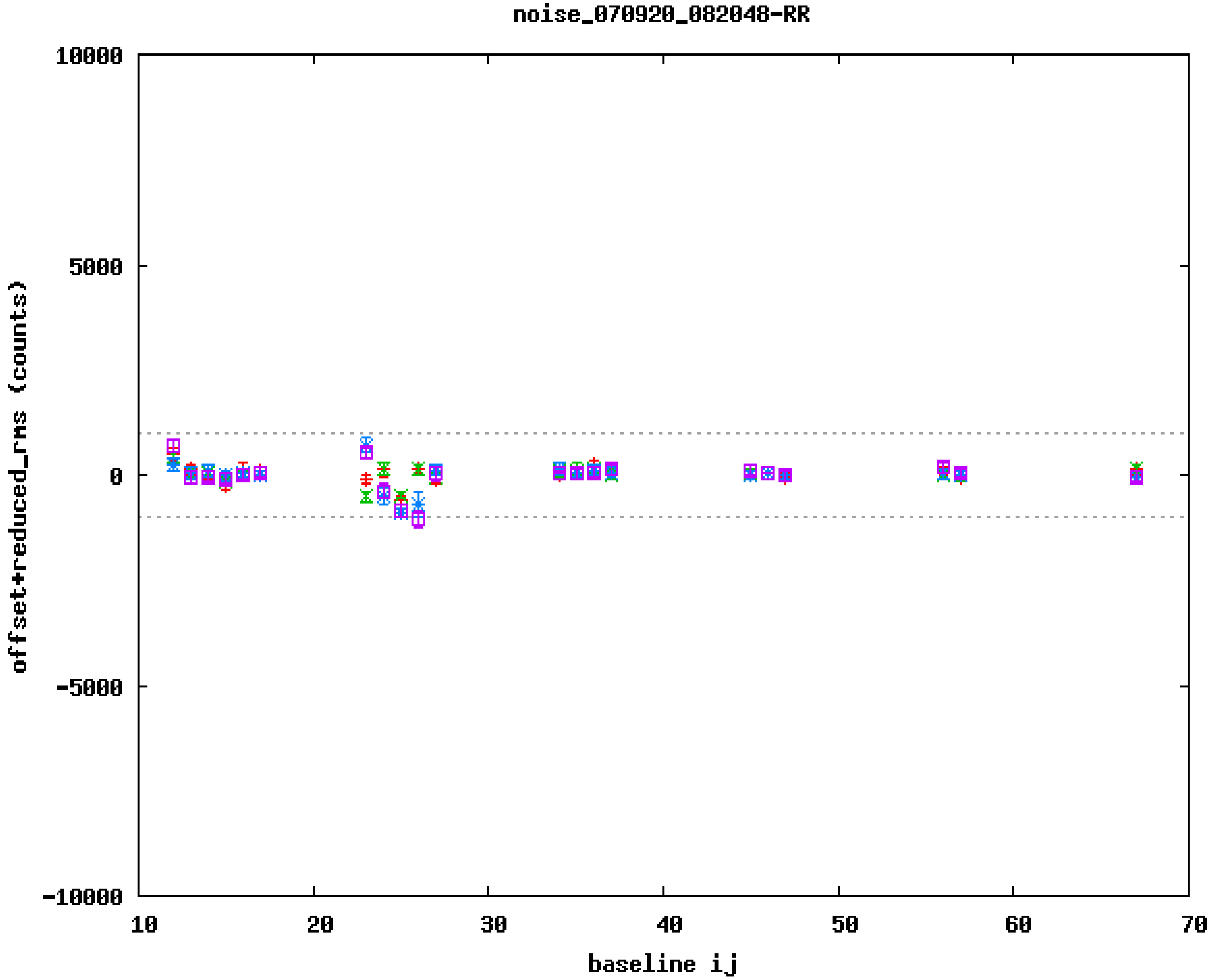
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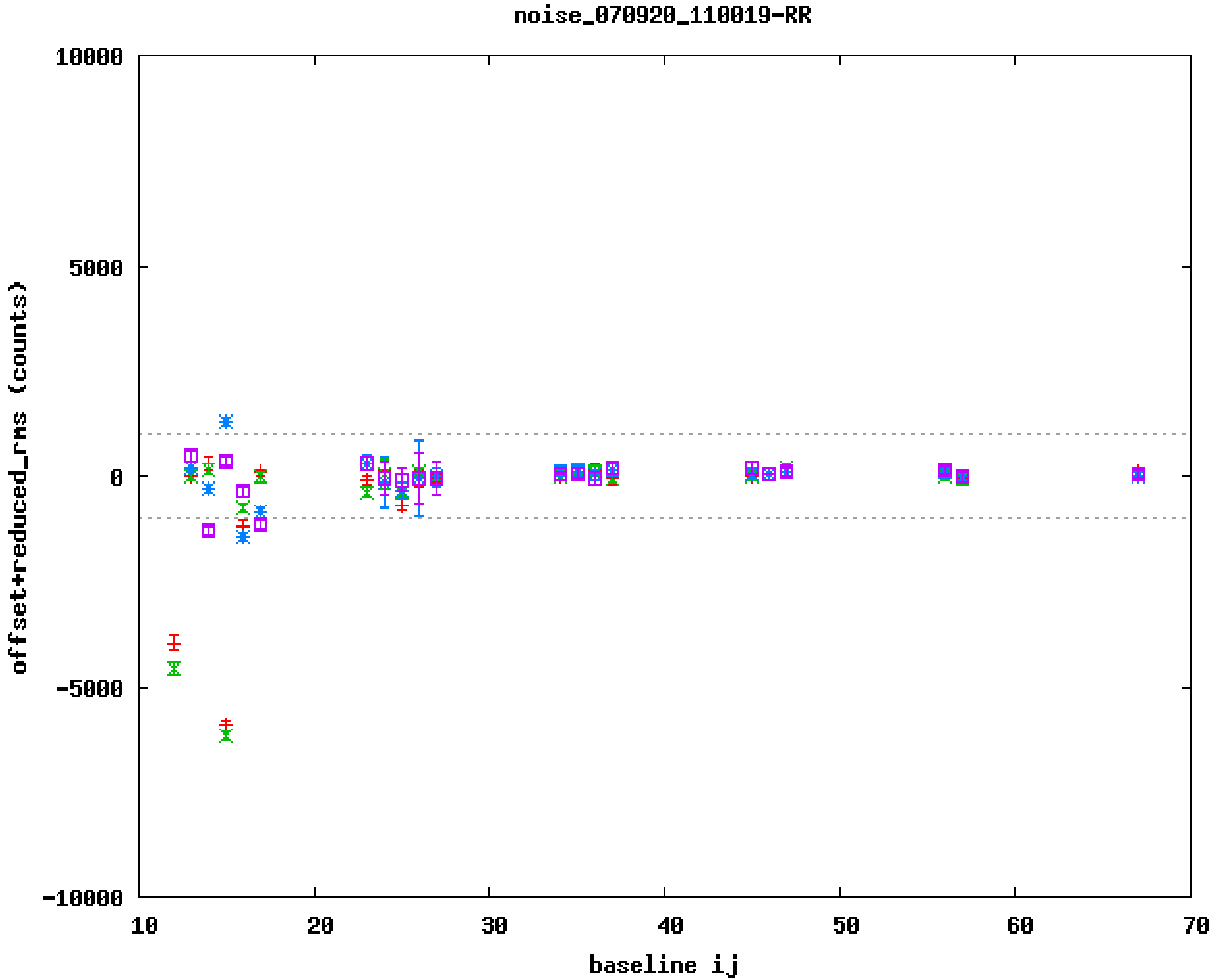
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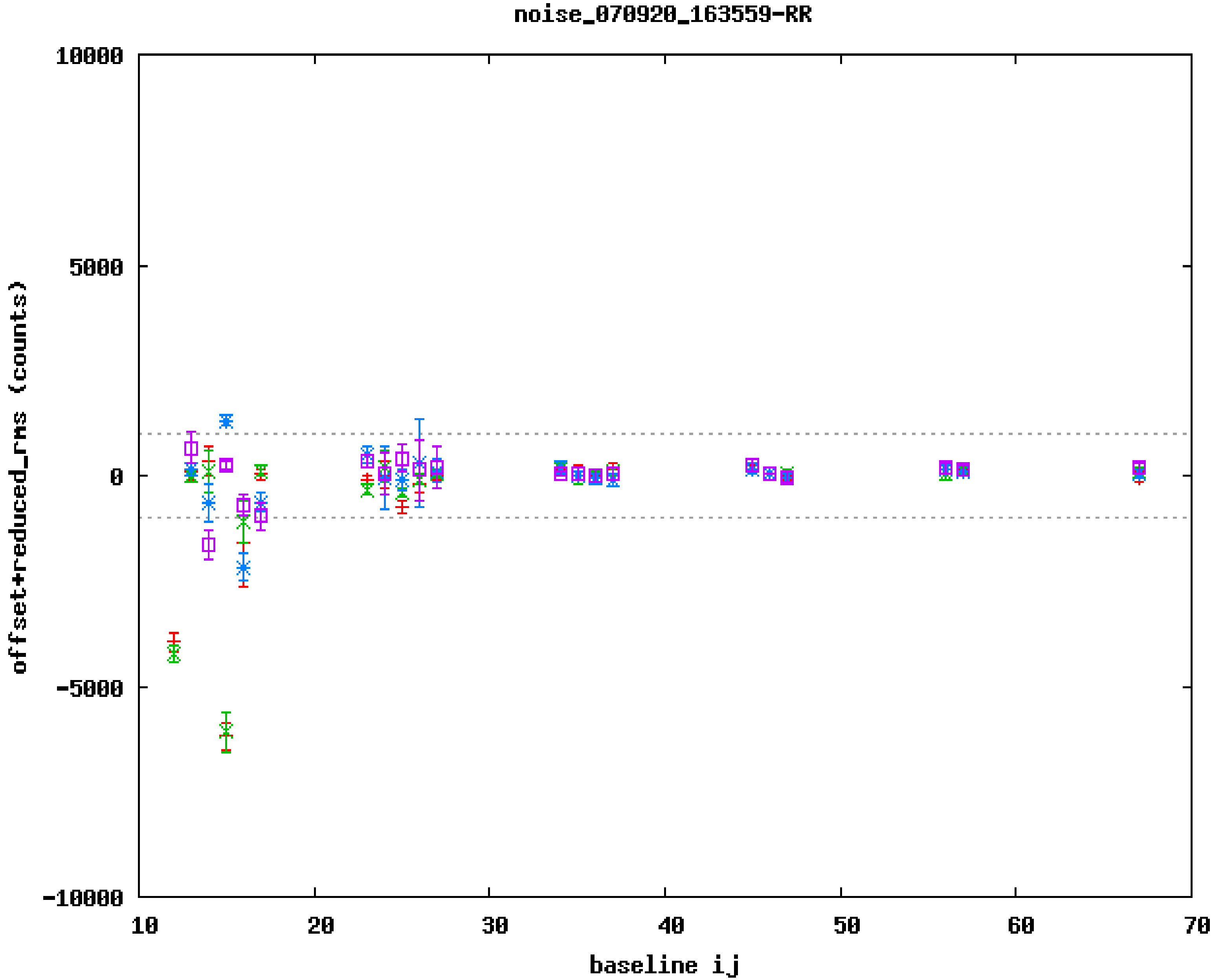
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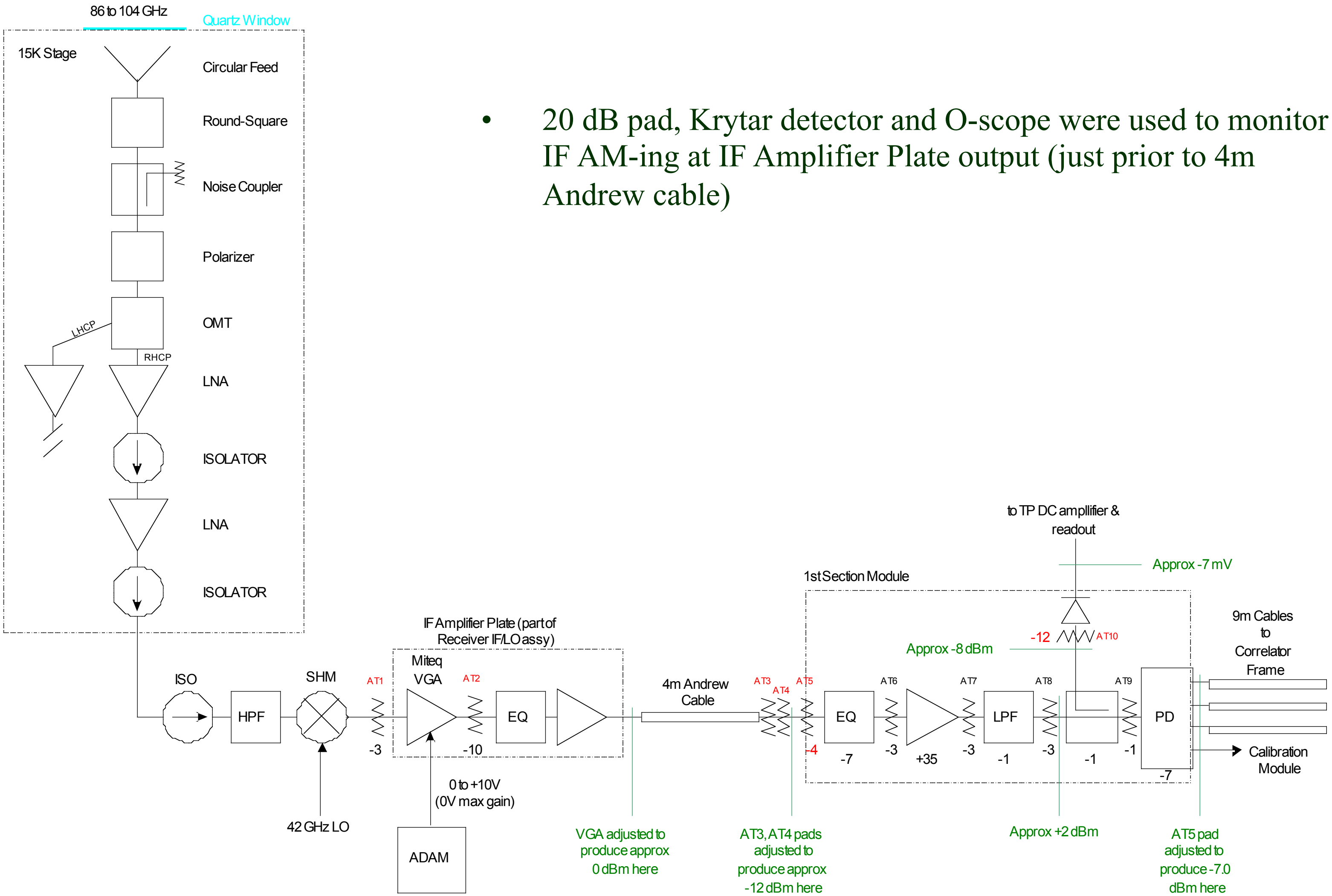
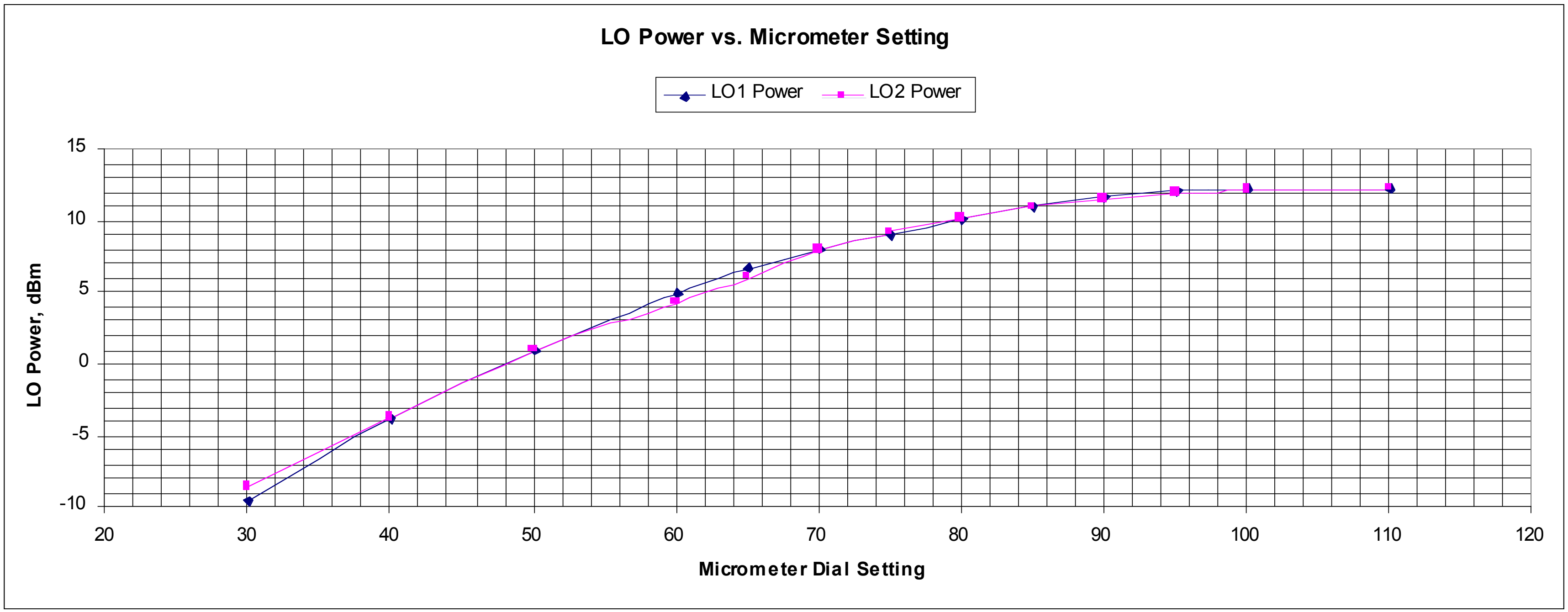
Reference - Block Diagram



- 20 dB pad, Krytar detector and O-scope were used to monitor IF AM-ing at IF Amplifier Plate output (just prior to 4m Andrew cable)

Reference - Antenna 4 LO Variable Attenuator Dial Setting vs. LO Power



Reference - Typical IF Amplifier Plate S21 & P1dBc