RBI Trap Capacity and Impact on Dark Shot Noise & Maximum Practical Exposure Time FLI Proline 3200 Empirical Data

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Summary of Results (FLI Proline 3200)

Operating Temperature (Celsius)	Max Practical Exposure* W/O RBI Mitigation (seconds)	Max Practical Exposure with RBI Mitigation (seconds)
-15	6,600	120
-20	10,500	180
-25	16,000	300
-30	26,100	480
-35	42,000	720
-40	58,000	900

Read Noise = 5.4 e-
Kadc = 0.8668 e-/DN

*Maximum Practical Exposure Time
Defined as that exposure time when the Dark Shot noise matches the Read Noise

Data Collection Procedure

- Collect non-RBI mitigated dark data
  - Start camera from power-off regime with sensor at room temperature
  - Leave cooler off: take 100 bias frames and discard
  - Enable cooler: let temperature stabilize
  - Collect pairs of darks: two each of bias and various timed dark frames (60s, 300s, 600s, 900s, 1200s, 1800s) with out using Light Flood RBI Mitigation Protocol
  - Reduce sensor temperature and let stabilize (data collected at -15C to -40C in 5C steps
  - Repeat the collection of pairs of darks

Data Collection Procedure

- Collect RBI mitigated dark data
  - Start camera from power-off regime with sensor at room temperature
  - Enable cooler: let sensor temperature stabilize at target
  - Collect set of pairs of darks: two each of bias and various timed dark frames (60s, 300s, 600s, 900s, 1200s, 1800s) using Light Flood RBI Mitigation Protocol
  - Reduce sensor temperature and let stabilize (data collected at -15C to -40C in 5C steps
  - Repeat the collection of pairs of darks

Data Reduction: Measuring Total Noise

- Select a pair of identical exposures, add 10,000DN to one frame and subtract the other identical frame from it (you add the 10,000DN offset to prevent clipping the histogram) and save result
- Repeat for set of data
- Using 100 x 100 selection window, record the standard deviation of a low noise portion of each difference frame
- The Standard Deviation = Sqrt 2 * Total Noise

Data Reduction: Determining Dark Shot Noise

$$Total\_noise = \sqrt{Read\_noise^2 + Dark\_shot\_noise^2} \quad (1)$$

$$Dark\_shot\_noise = \sqrt{Total\_noise^2 - Read\_noise^2} \quad (2)$$

$$Dark\_shot\_noise = \sqrt{Total\_dark\_signal} \quad (3)$$

$$Total\_dark\_signal = Thermal\_dark\_signal + Trap\_leakage \quad (4)$$

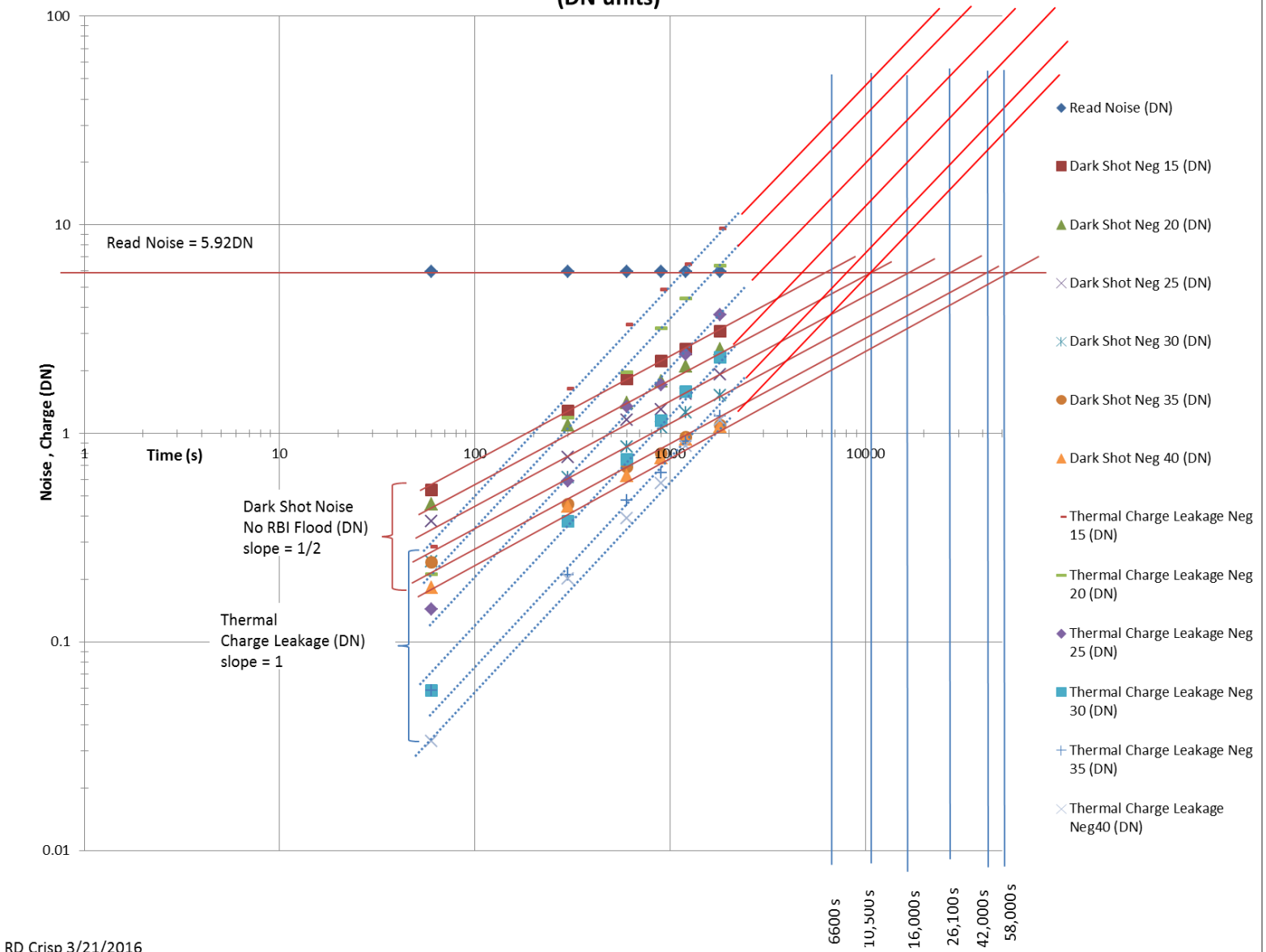
For non-RBI Mitigated case, Trap_leakage is zero

$$Total\_dark\_signal = Thermal\_dark\_signal \quad (5)$$

Calculating Trap Leakage

To determine the RBI trap leakage you use the thermal dark signal data from the non-RBI mitigated case and the Total Noise from the RBI mitigated case

$$Trap\_leakage = Total\_noise^2 - Read\_noise^2 - Thermal\_dark\_signal \quad (6)$$



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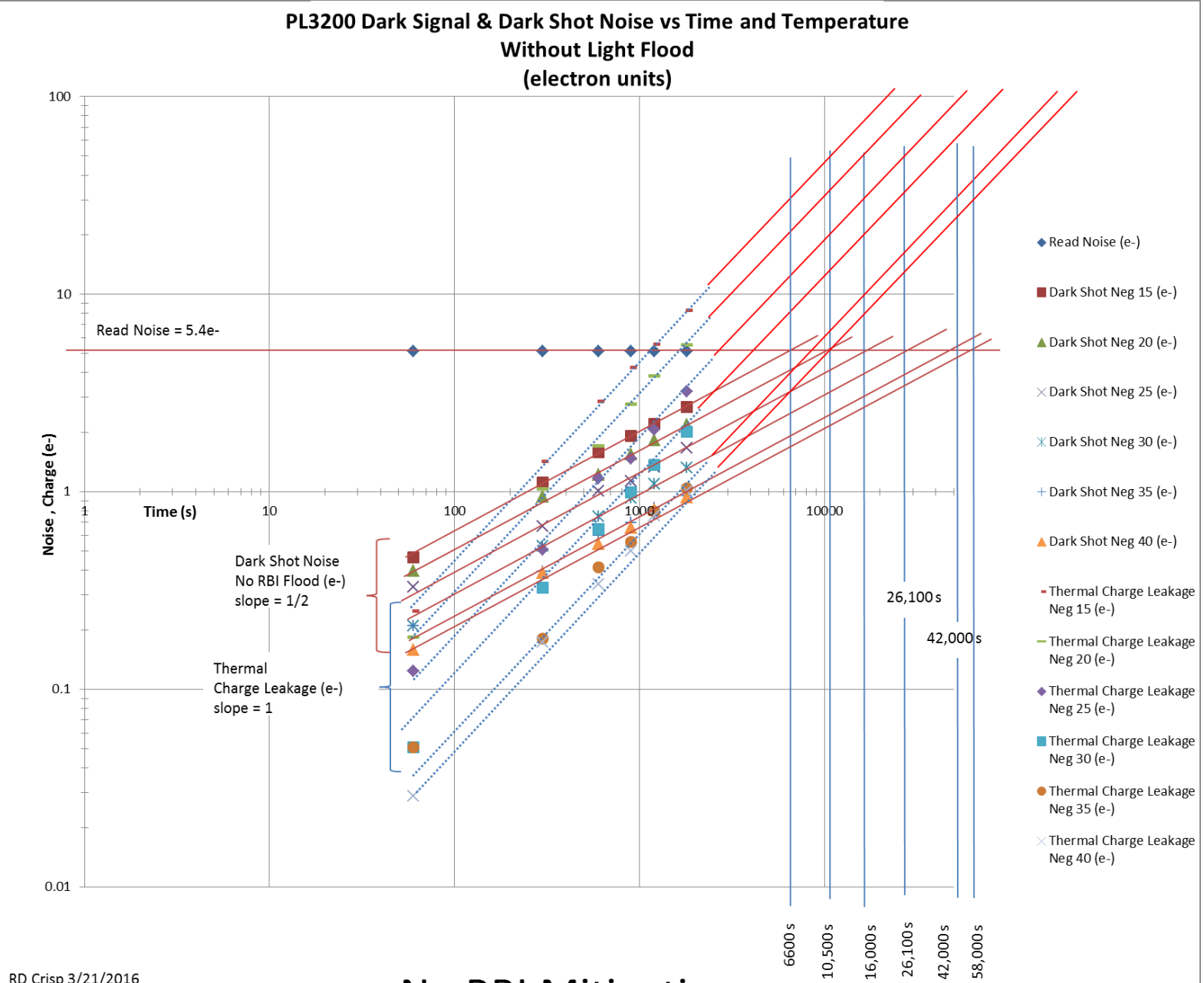
No RBI Mitigation



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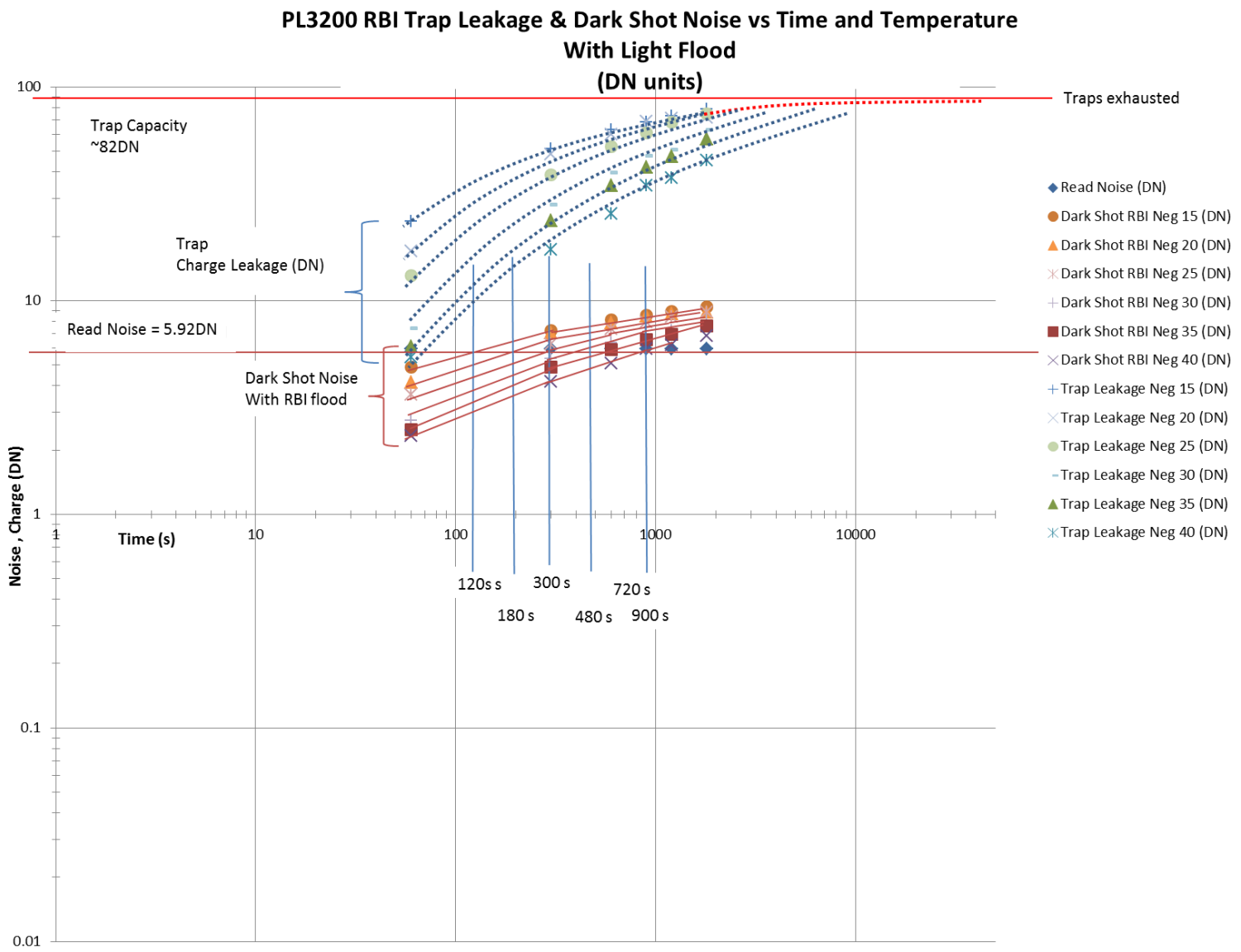
No RBI Mitigation

With RBI Mitigation



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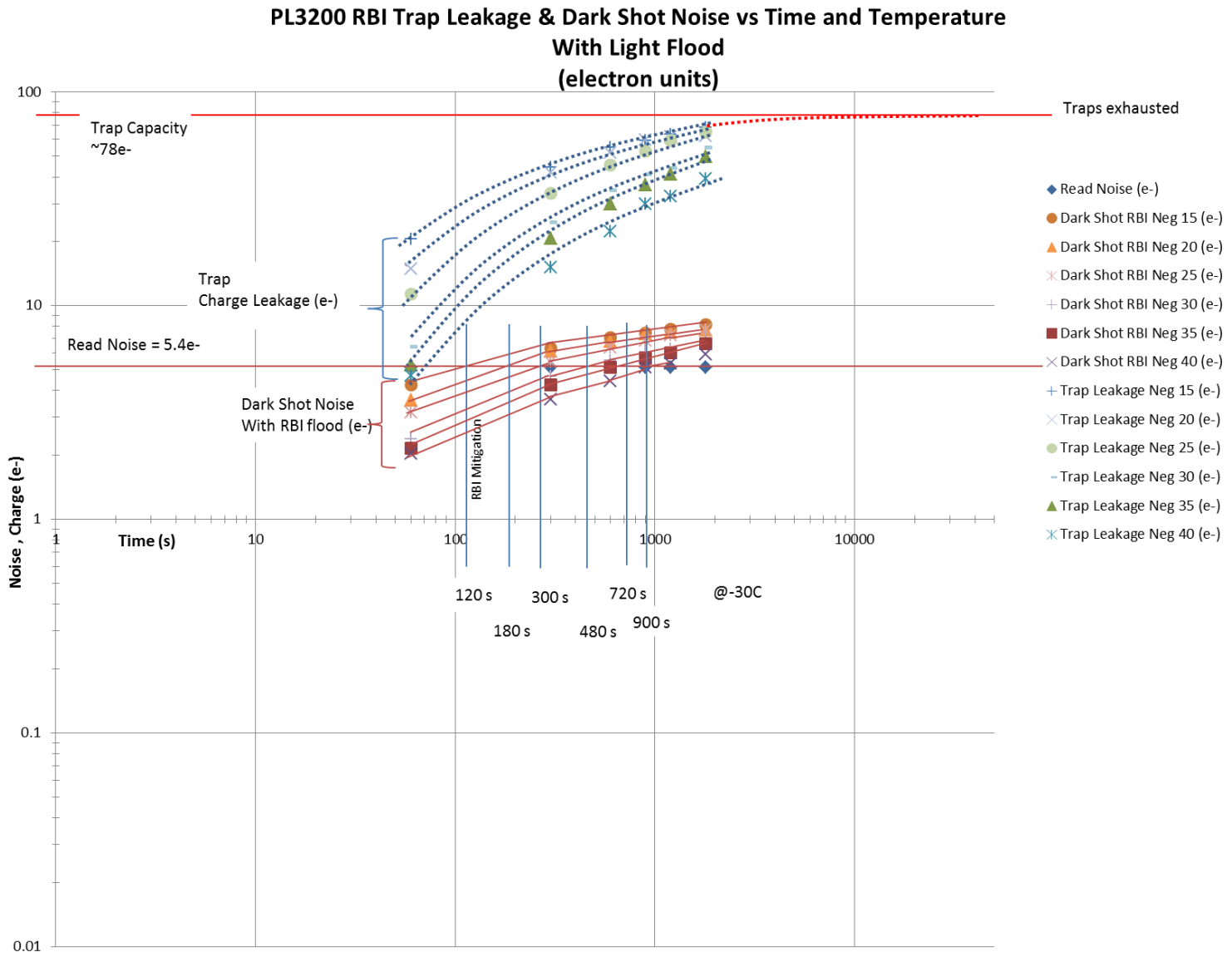
With RBI Mitigation



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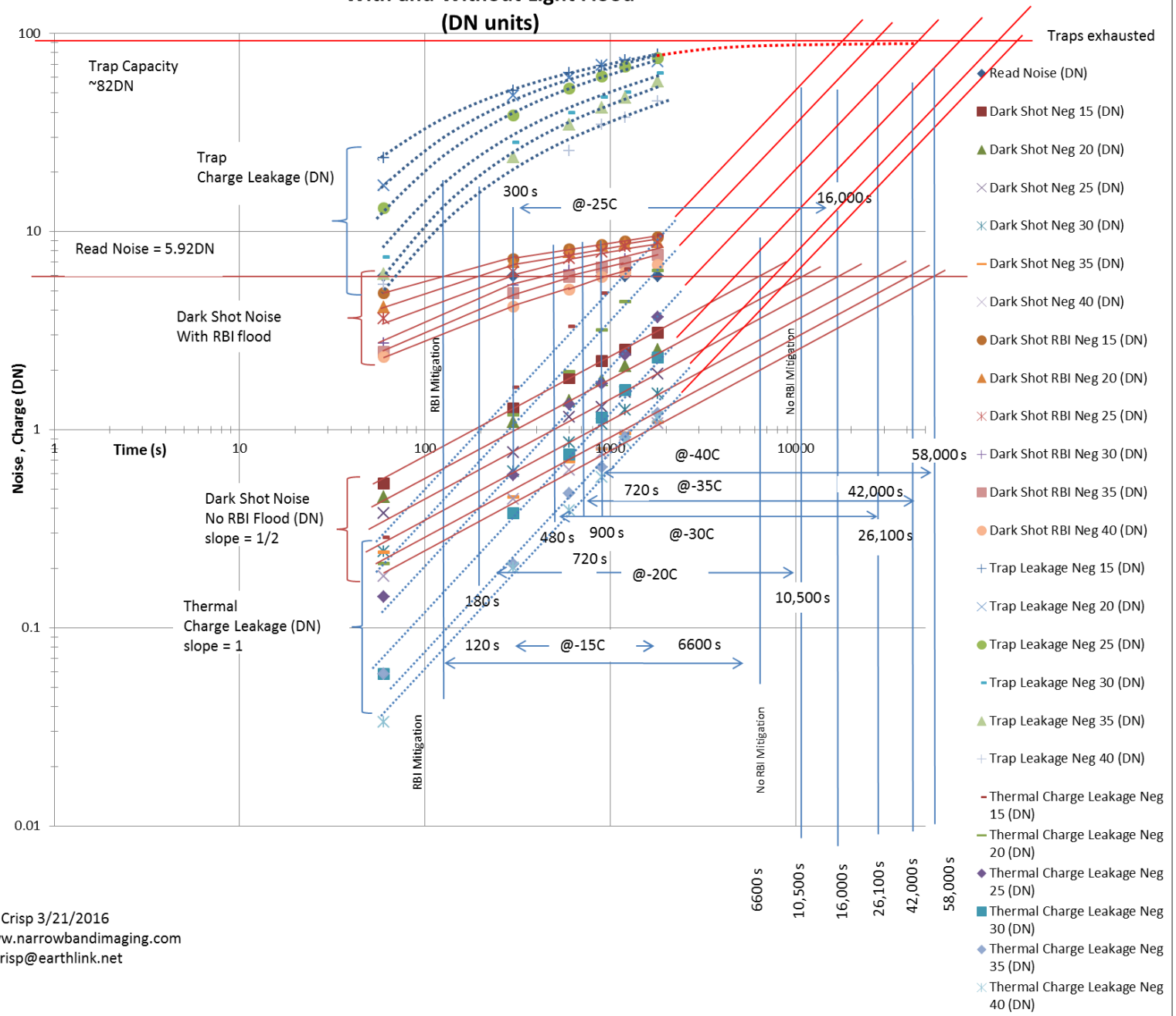
With RBI Mitigation

Both Plotted Together

PL3200 RBI Trap Leakage, Dark Signal, Dark Shot Noise vs Time and Temperature With and Without Light Flood (DN units)



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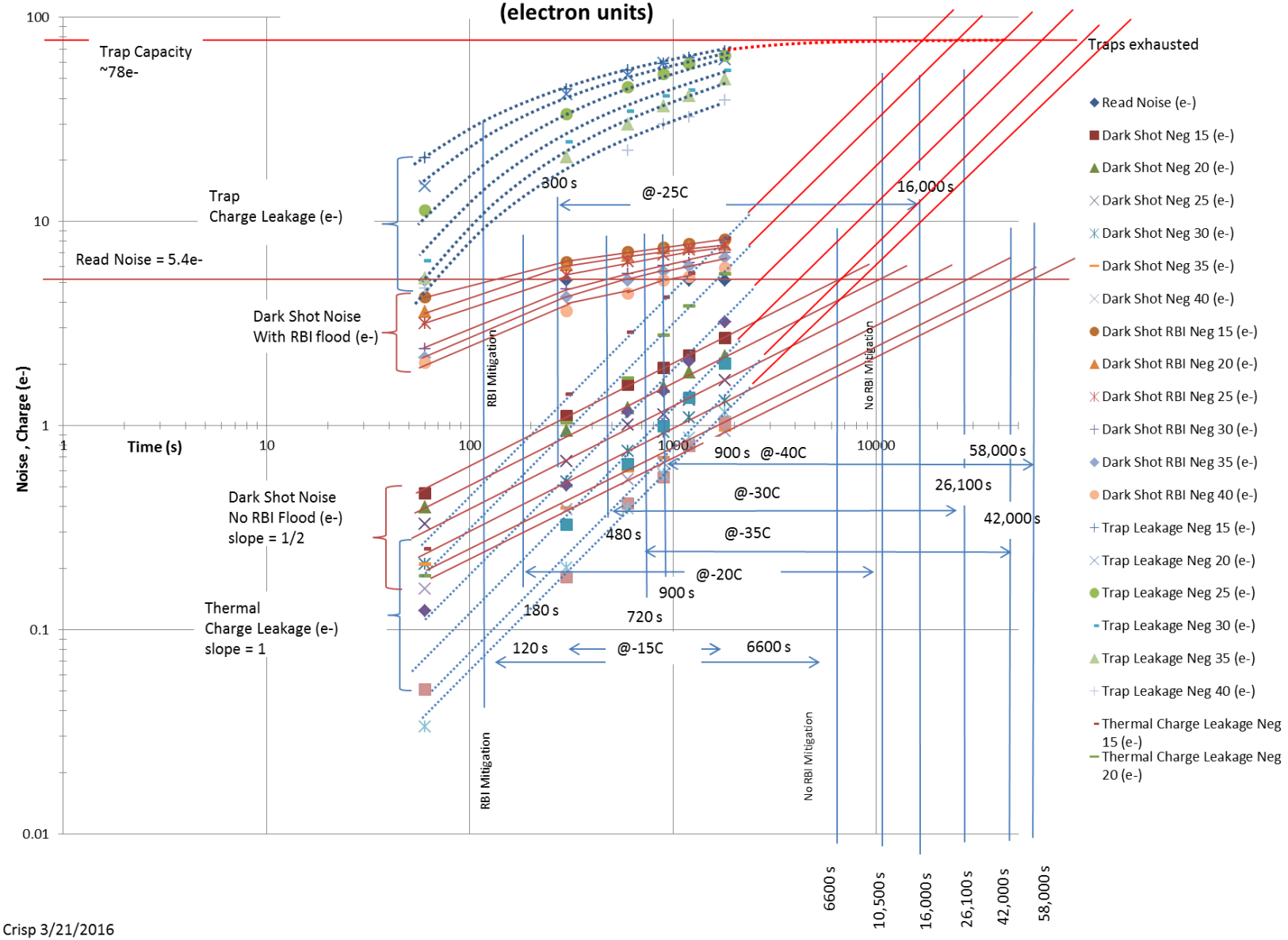
PL3200 RBI Trap Leakage, Dark Signal, Dark Shot Noise vs Time and Temperature With and Without Light Flood (electron units)



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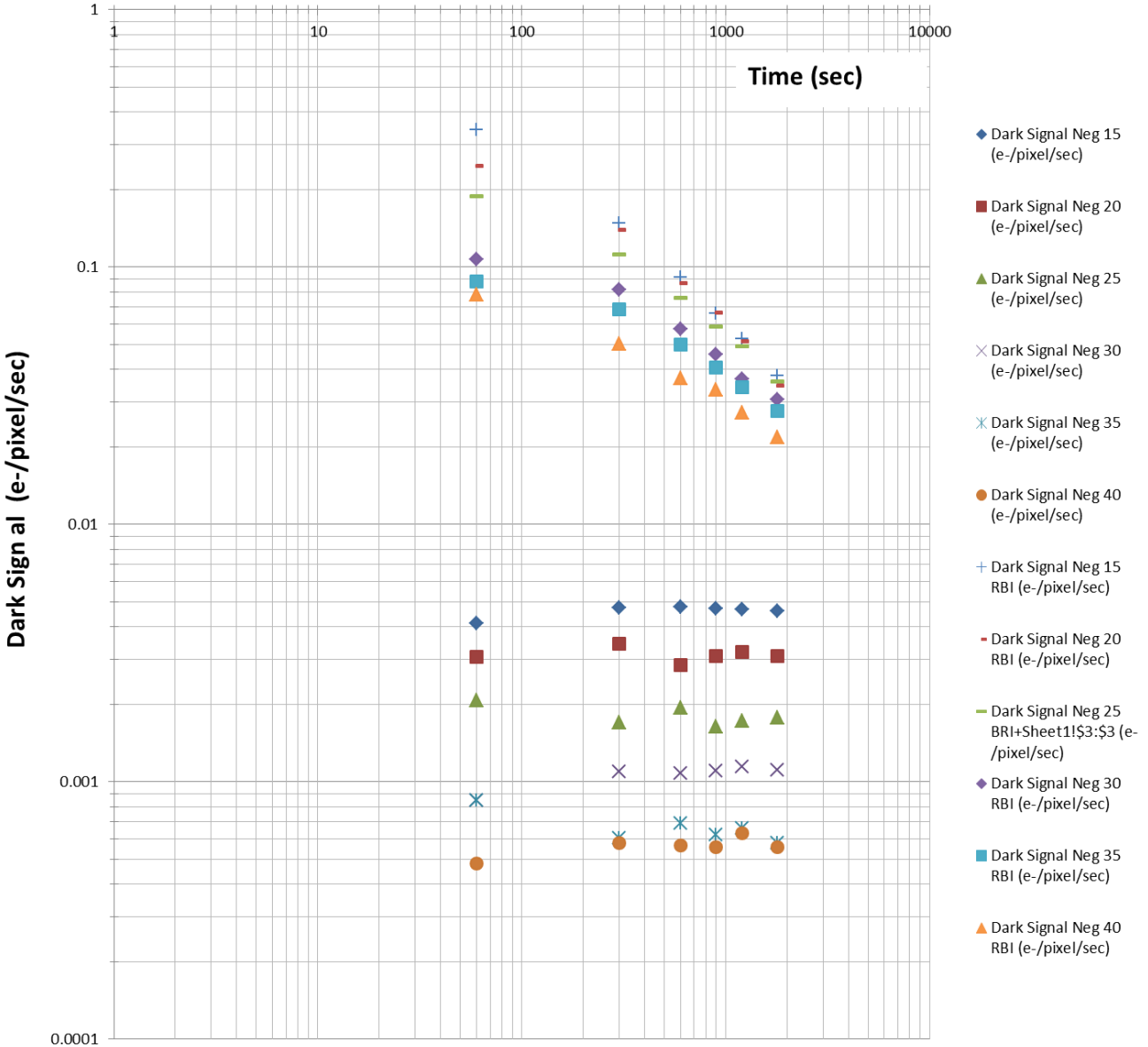
PL3200 Dark Signal vs Time and Temperature With and Without Light Flood (electron units)



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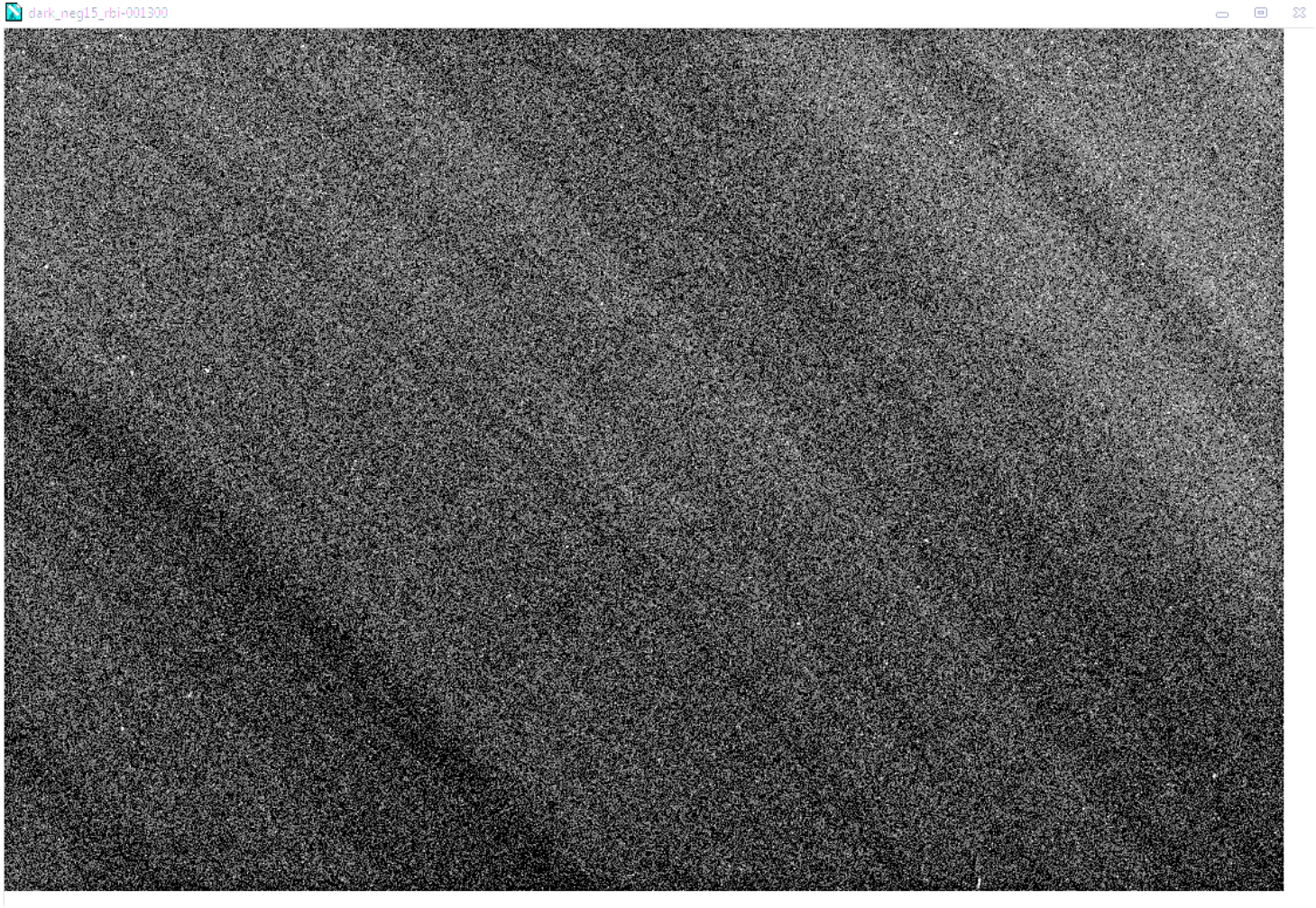
Non-Uniformity of Trap Distribution



300 seconds at -15C after RBI light flood