Hardware Failure Impacts Exercises

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Issues

- Recent results from design reliability analysis (system engineering, Thurston et al.)
- Probabilities aside, no single point failure may cause us not to meet our science requirements.
- There are single failure points that will have an impact on LAT capabilities, most notably loss of a full tower from a non-redundant TEM part failure.

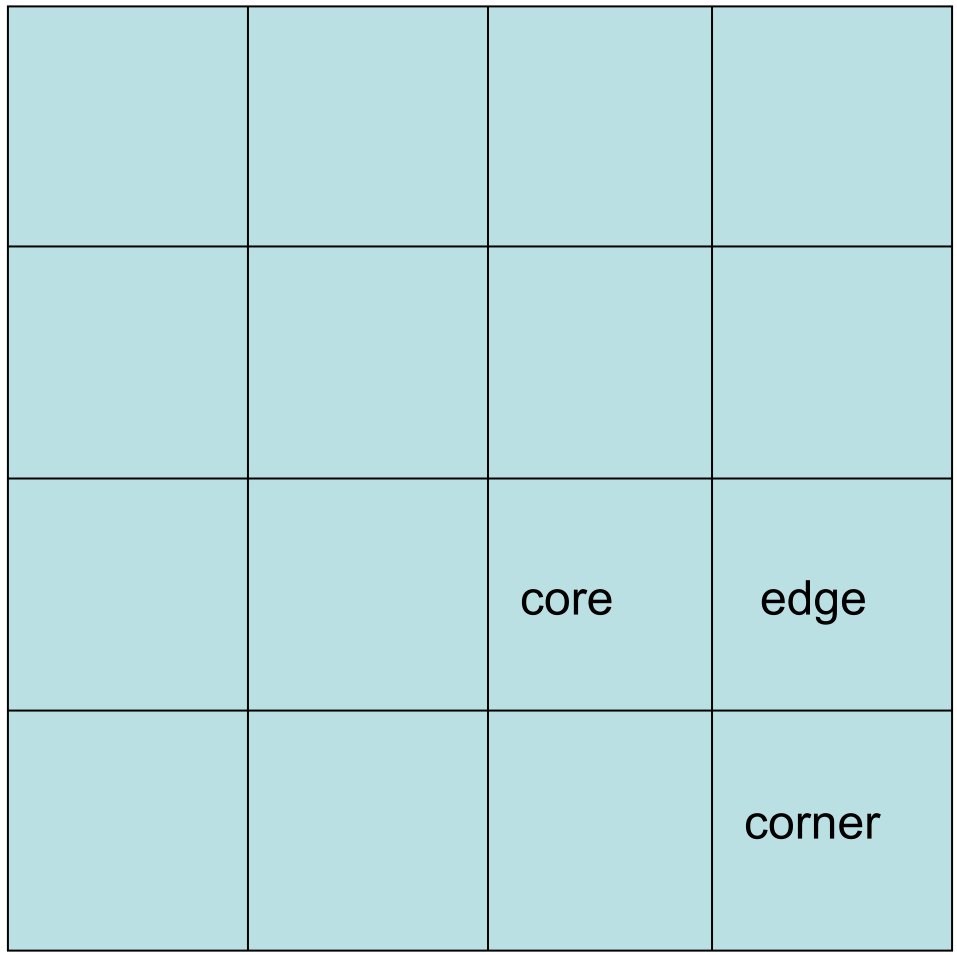
Requirements

- There are requirements on peak effective area (>8000 cm^2), FOV (really Aeff(θ)) >2sr, and lifetime (>5 years with <20% degradation).
  - Other performance parameters (e.g., PSF, energy resolution) can be traded against Aeff.
- Interpret <20% degradation at 5 years as applying to Aeff and FOV, for clarity. We take these degradations relative to the requirements, not to our nominal performance (so, we have additional margin).
- Requirements aside, what is <u>our</u> judgment?

Studies

- Already studied loss of an ACD tile.
- Loss of a TKR layer in one tower on trigger efficiency (D. Wren, thanks to tools provided by Leon), 1 GeV on-axis gammas:
  - thick converter layer (#0): ~0.6% reduction
  - thin converter layer (#8): <0.1% reduction
- Loss of a TKR tower (#6, core) on triggered Aeff:
  - 1 GeV normal incidence: 6% loss
  - 1 GeV 40° off axis: 4% loss
    - **but what about FOV and background rejection?** →

LAT Has Three Tower Locations

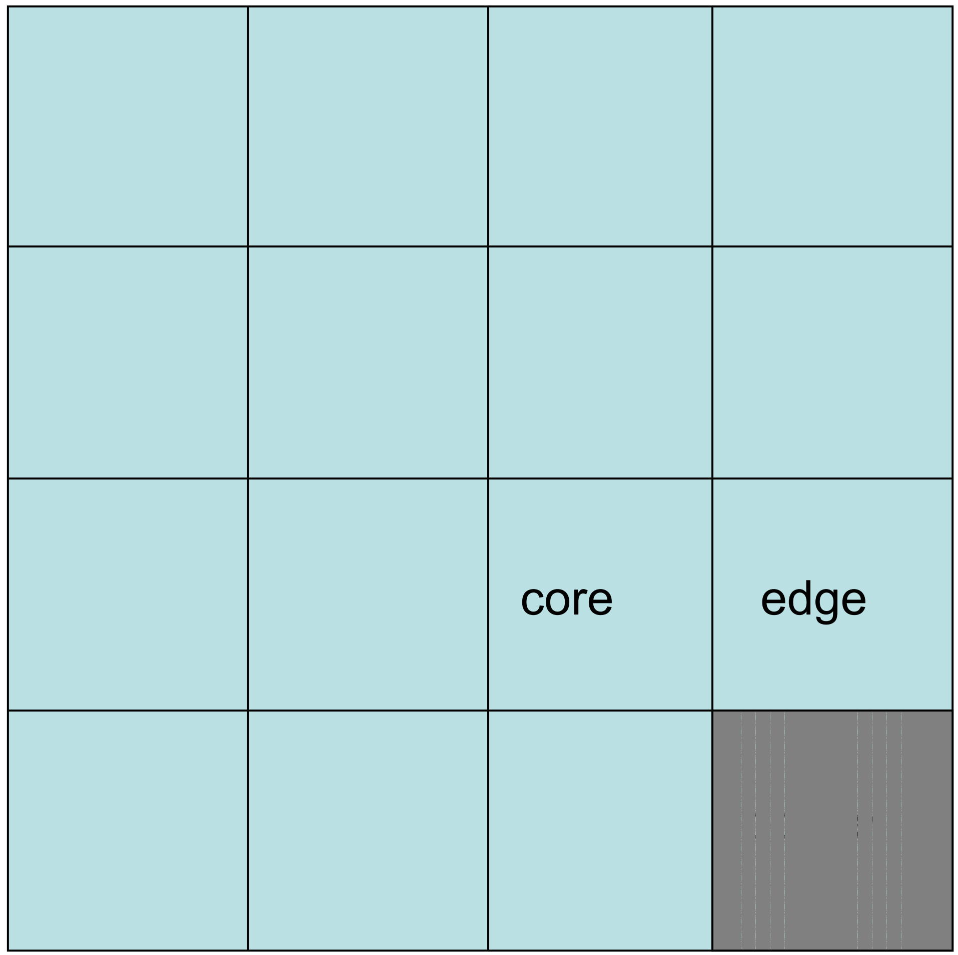


Loss of a corner is not as bad as loss of an edge is not as bad as loss of a core.

Simplifying assumption: “tower loss” means both CAL and TKR. ACD is still intact.

Loss of corner tower

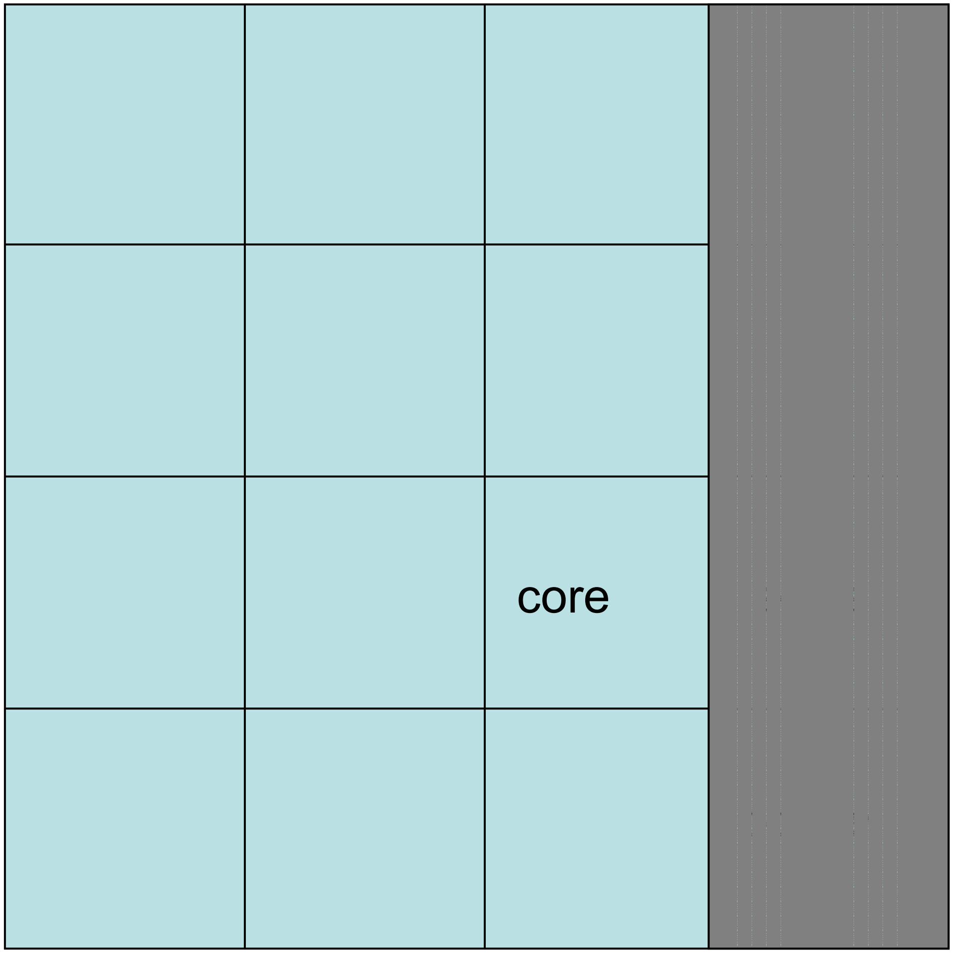
- easiest case to estimate
- Aeff loss ~10%
- FOV loss very small.



good experimental handle on-orbit: can pretend any other working corner tower is off and check for incremental background leakage and other systematic effects.

Loss of single edge tower

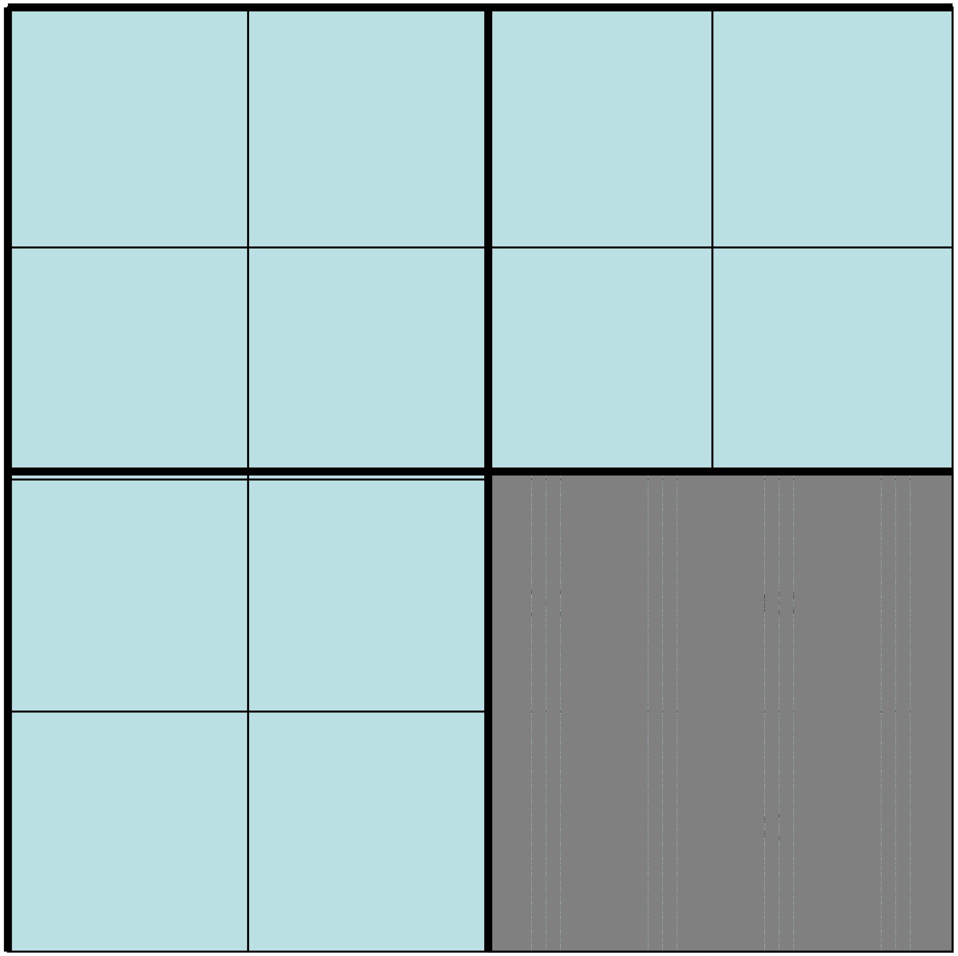
- corner closest to dead edge tower also significantly impacted FOV. For purposes of conservative estimate, assume only 3x4 LAT left.
- Aeff loss ~25%
- FOV loss ~10%.



good experimental handle on-orbit: can pretend any other working edge tower is off and check for incremental background leakage and other systematic effects.

Loss of single core tower

- most difficult (and painful) case. For purposes of conservative estimate, assume whole quadrant compromised. Looks like 2 LATs, each 1x2, with overlap.
- Aeff loss ~25%
- FOV loss ~15%. (~35% loss in 1-dim in the bottom left and top right quadrants)



good experimental handle on-orbit: can pretend any corresponding tower is off and check for incremental background leakage and other systematic effects.

Summary and Next Steps

- Seems OK…but not pleasant!
- Is this estimate sensible?
- Must do full background rejection analysis with core tower off. Can do this as part of the upcoming studies at each stage to get early warning of surprises.
- Think through onboard implications.
- Difficult to predict true impacts, since any real failure will cause all of us to find clever workarounds.