

First test beam insights for ATLAS ITk strip modules with Cold Noise

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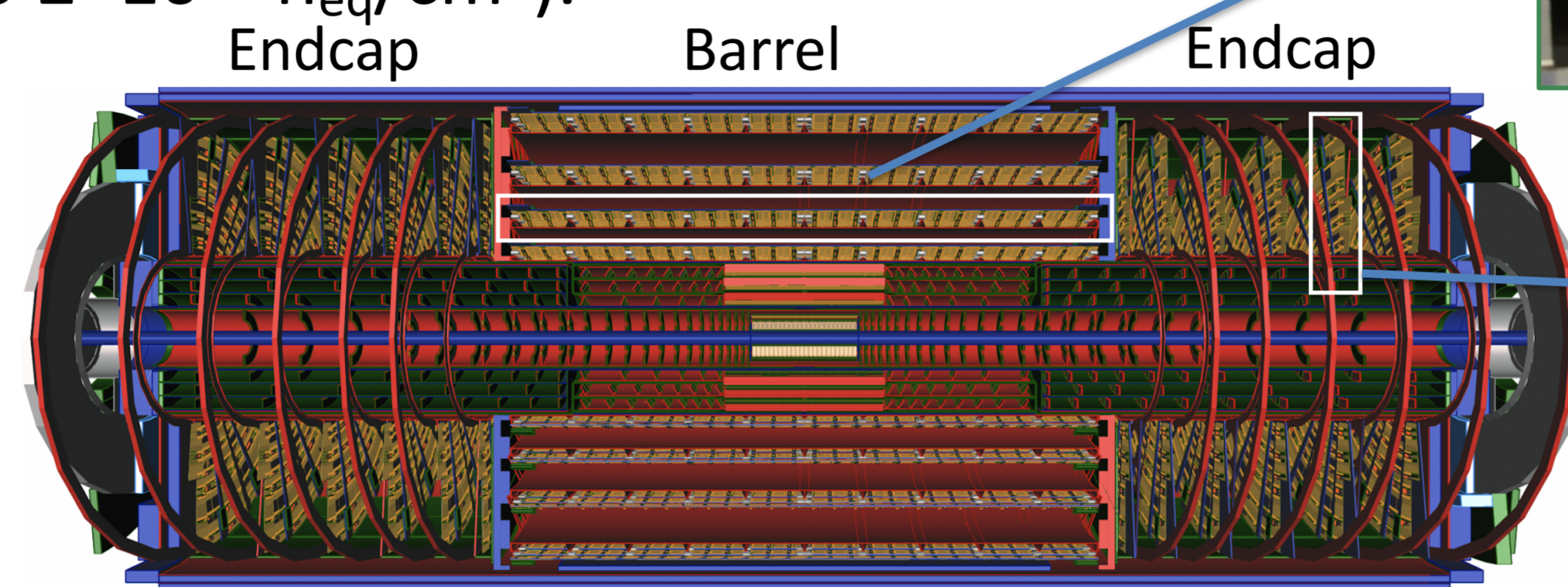
March 2024
Testbeam data

• ATLAS detector for the HL-LHC:

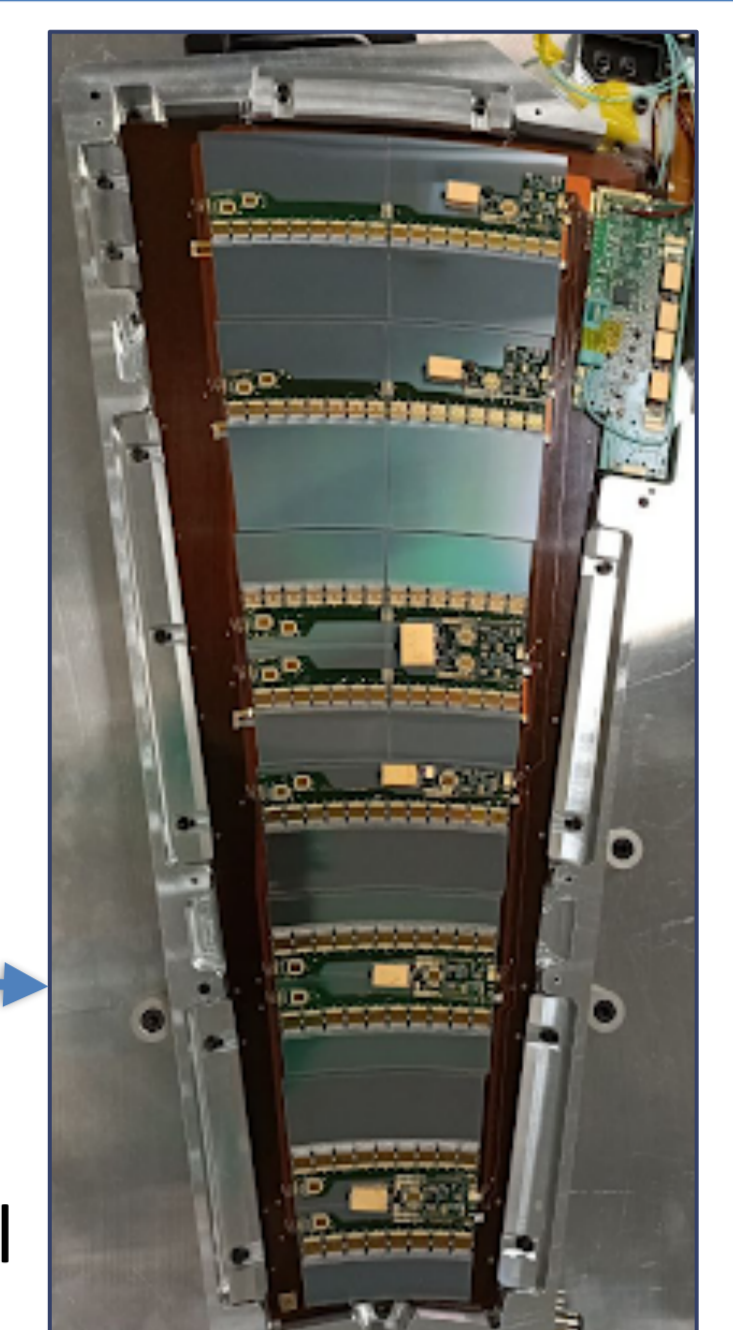
- More interactions per bunch crossing ($\langle \mu \rangle \approx 50 \rightarrow 200$).
- Higher trigger rate (100 kHz \rightarrow 1 MHz).
- Worse radiation damage (up to $2 \times 10^{16} n_{eq}/cm^2$).

• Inner Tracker (ITk):

- 180 m² of n⁺ in p silicon.
- Strip modules in outer layers.
- Pixel layers in inner layers.

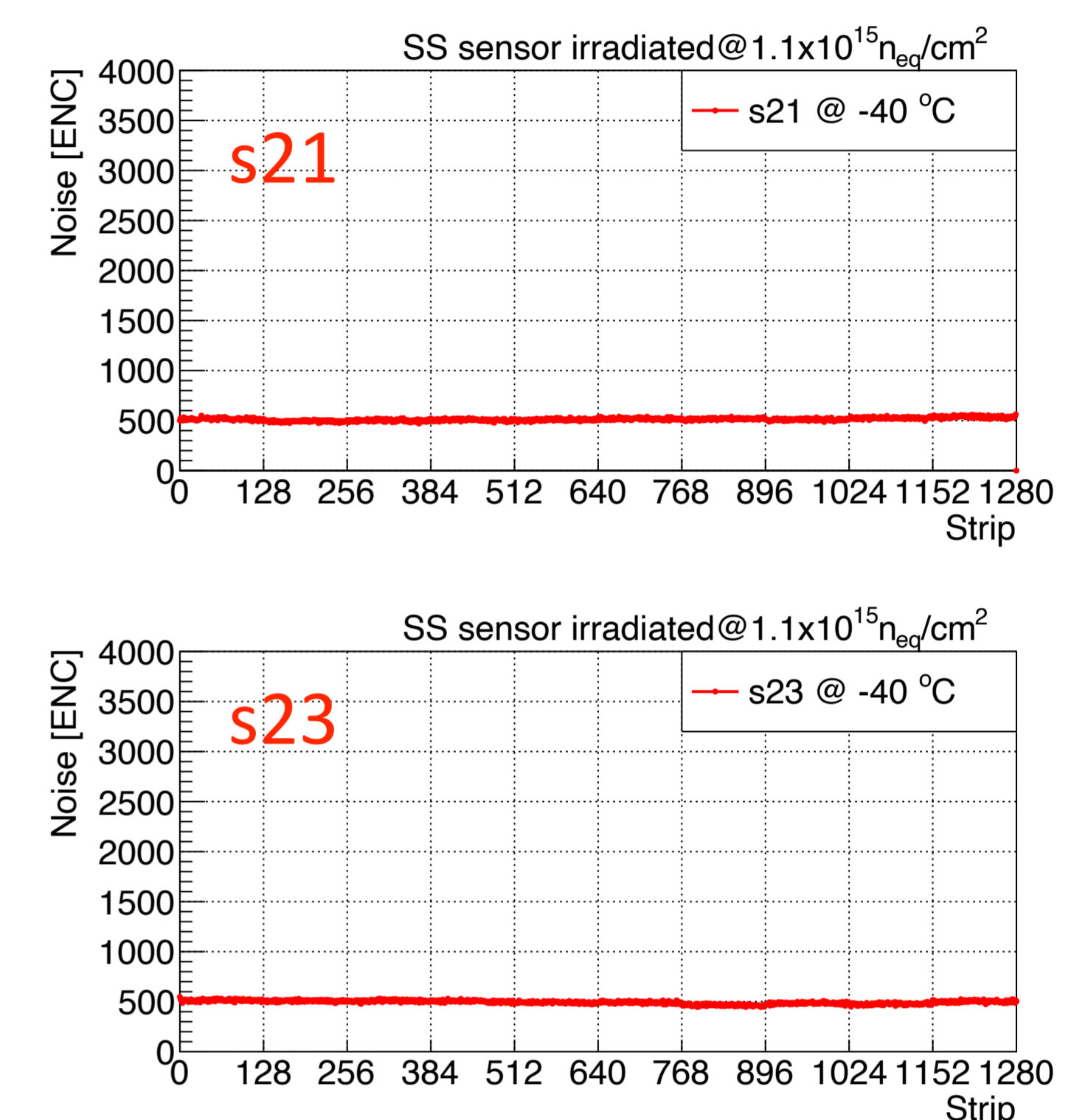
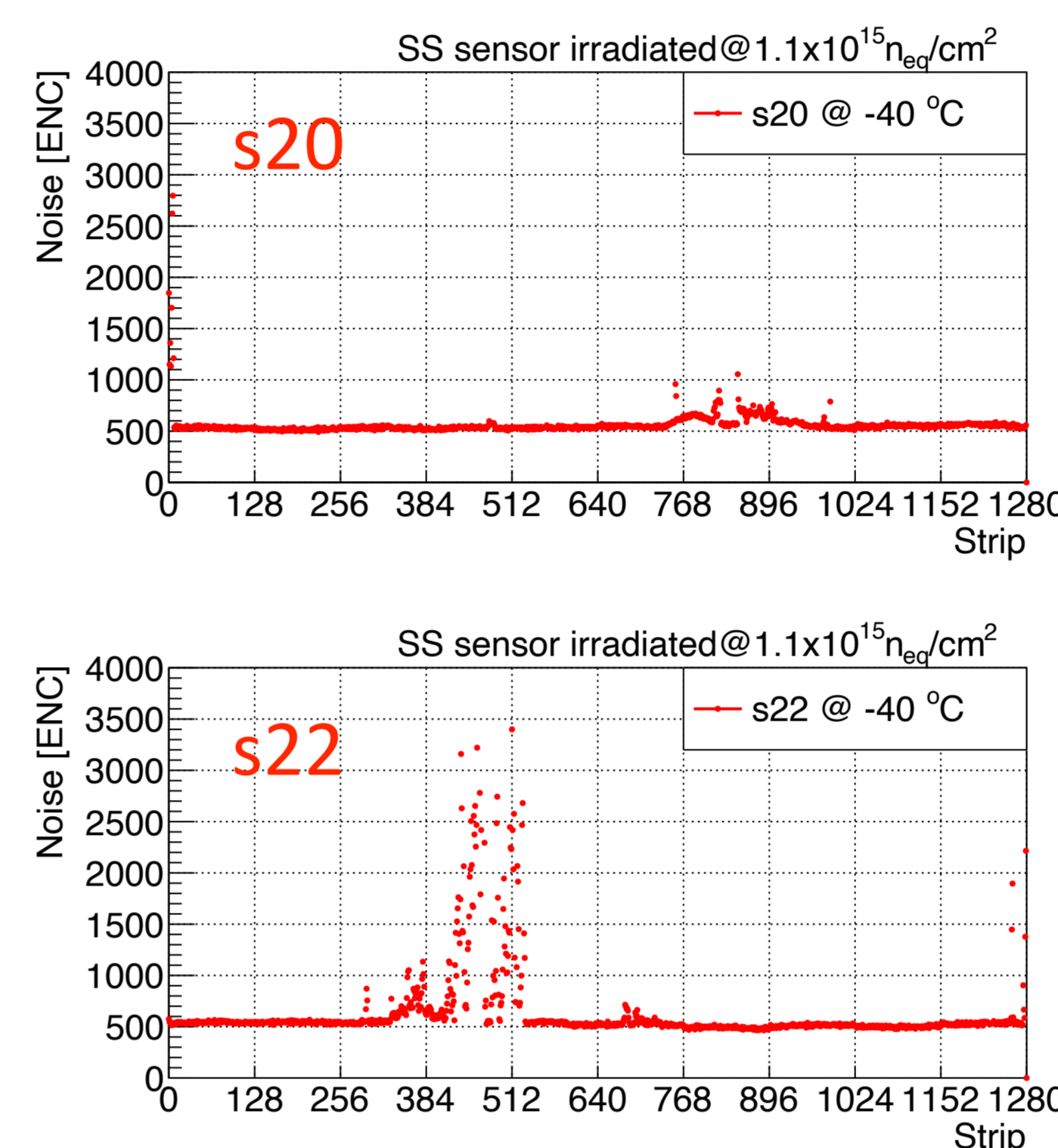
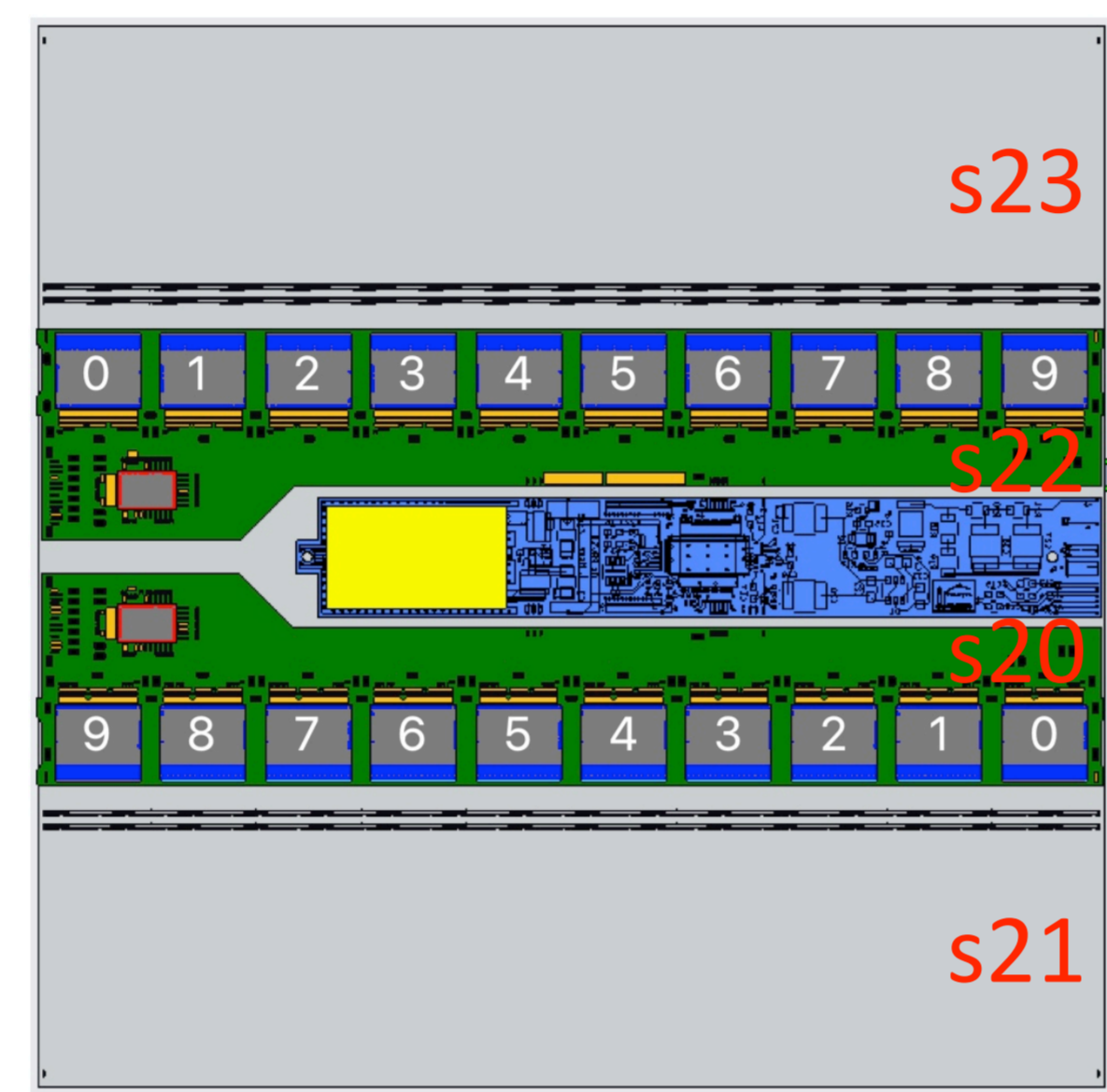
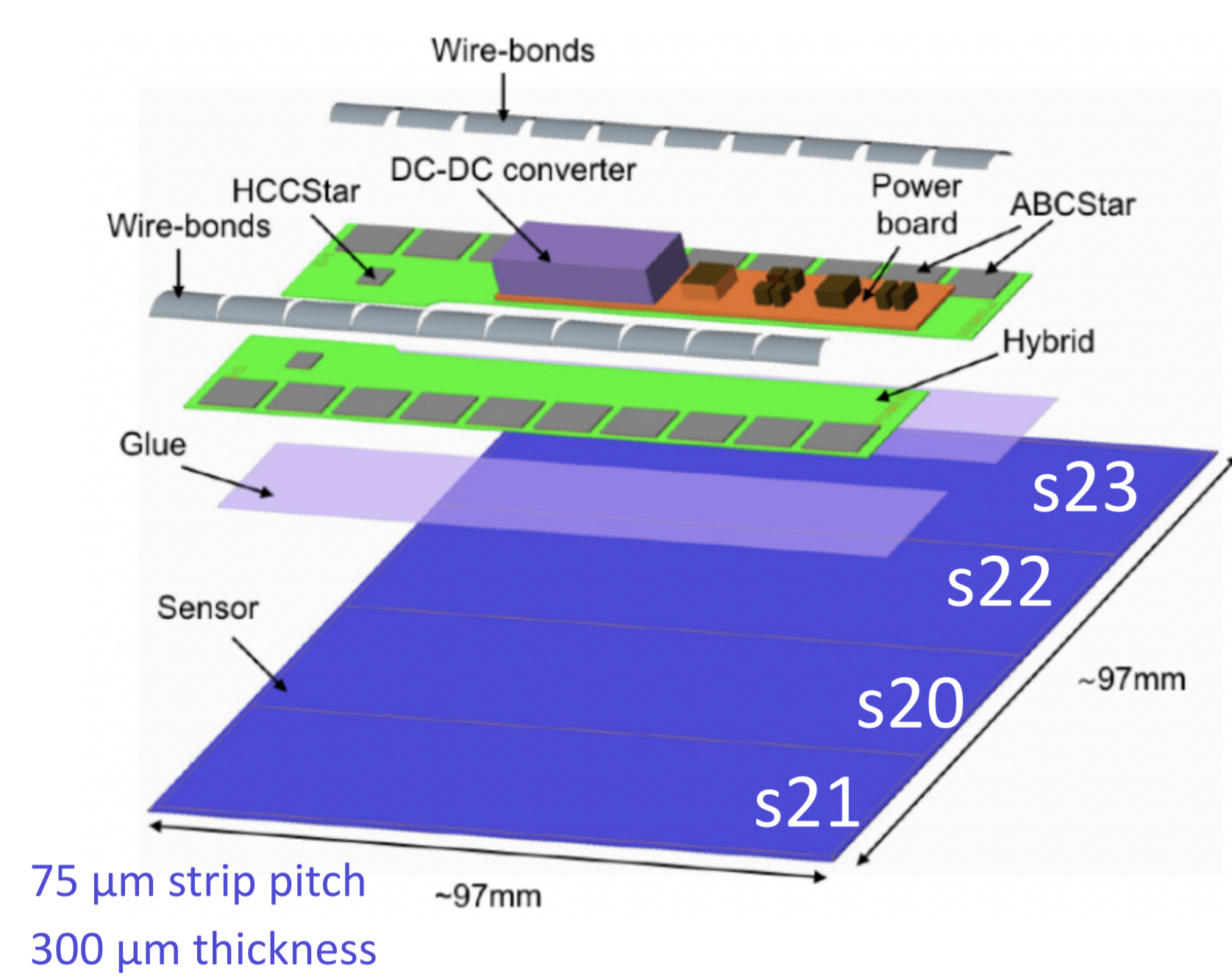


Strip barrel stave



Strip endcap petal

Short strip barrel module and cold noise



Test beam setup @DESY [1]

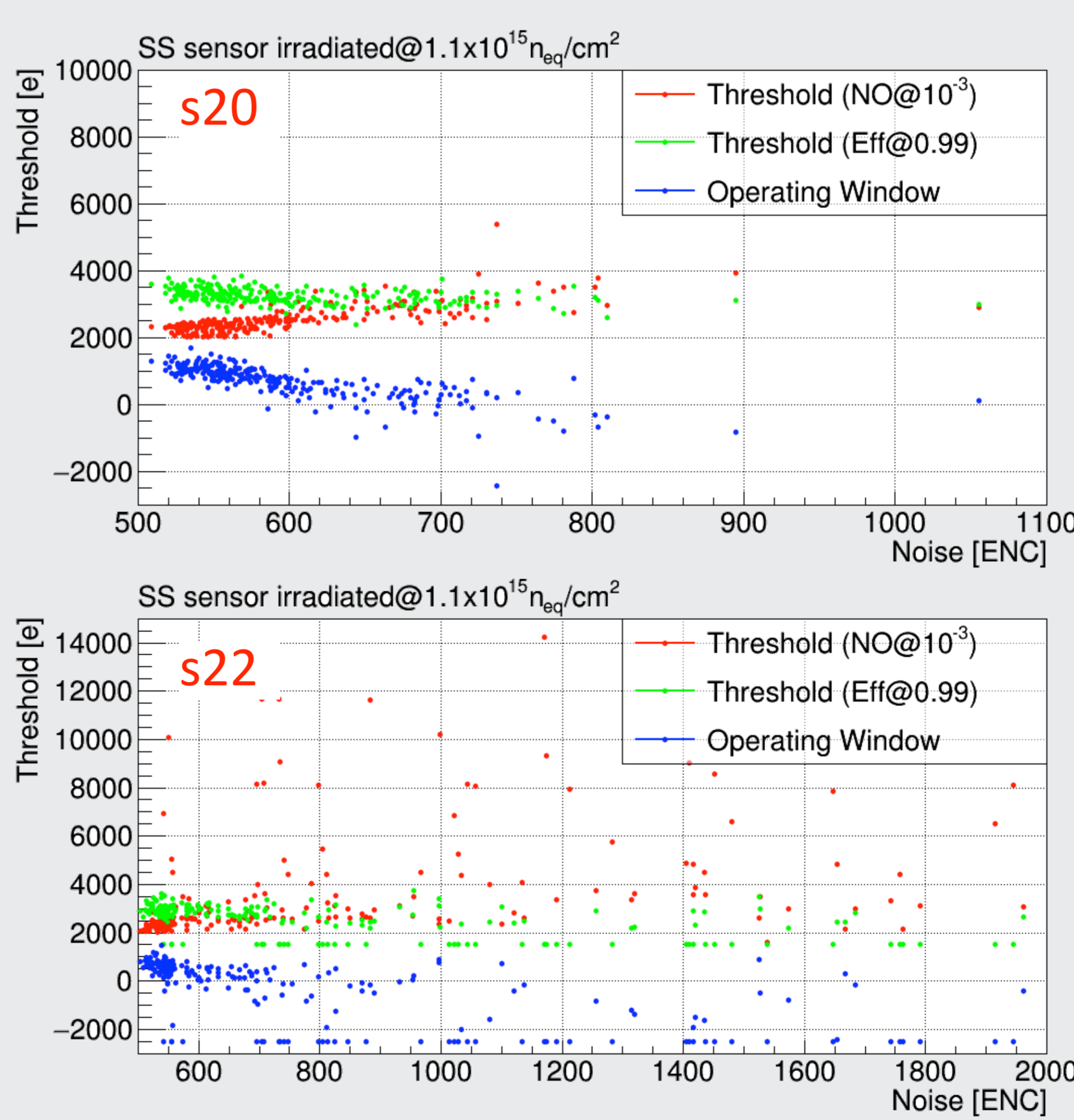
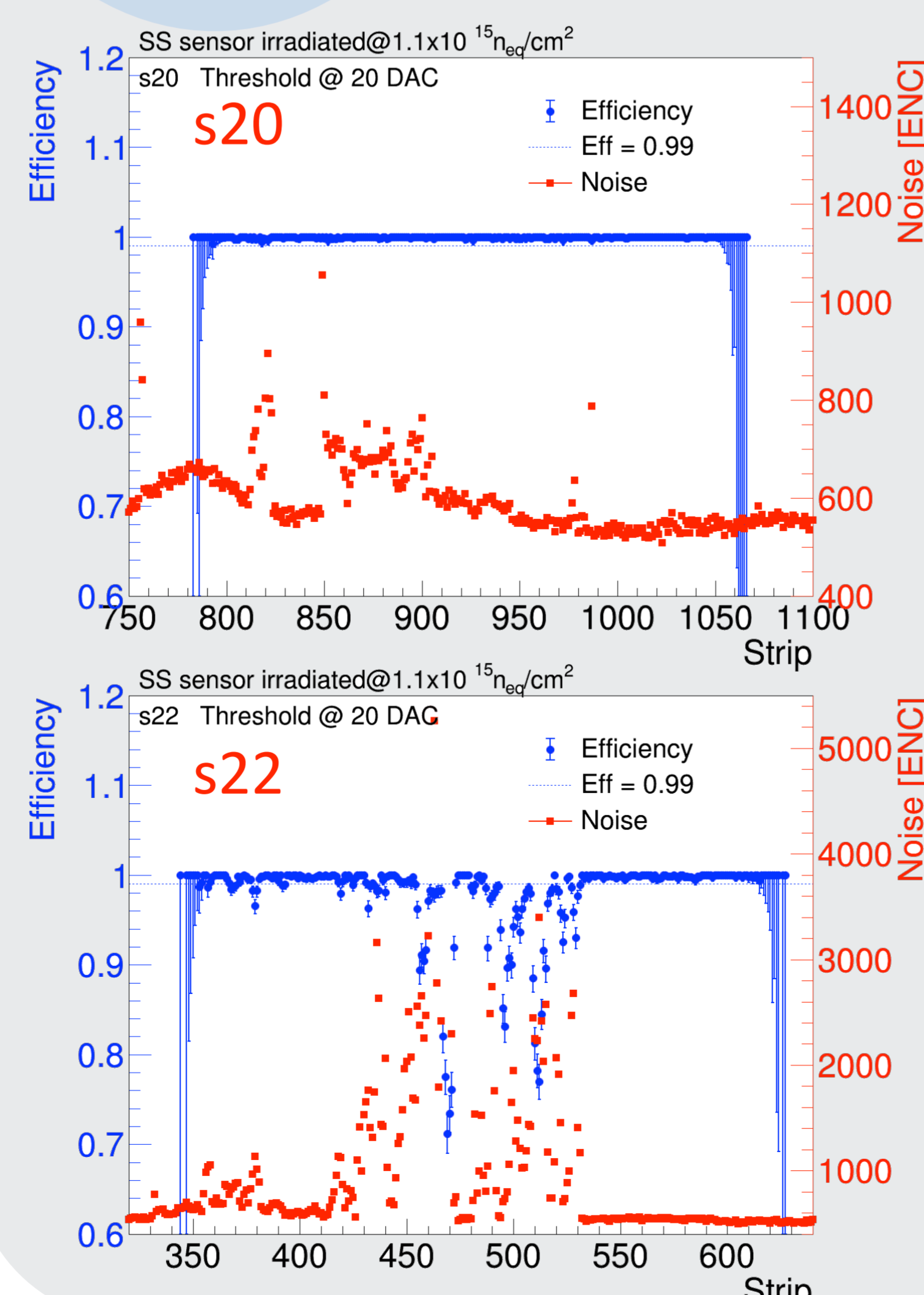
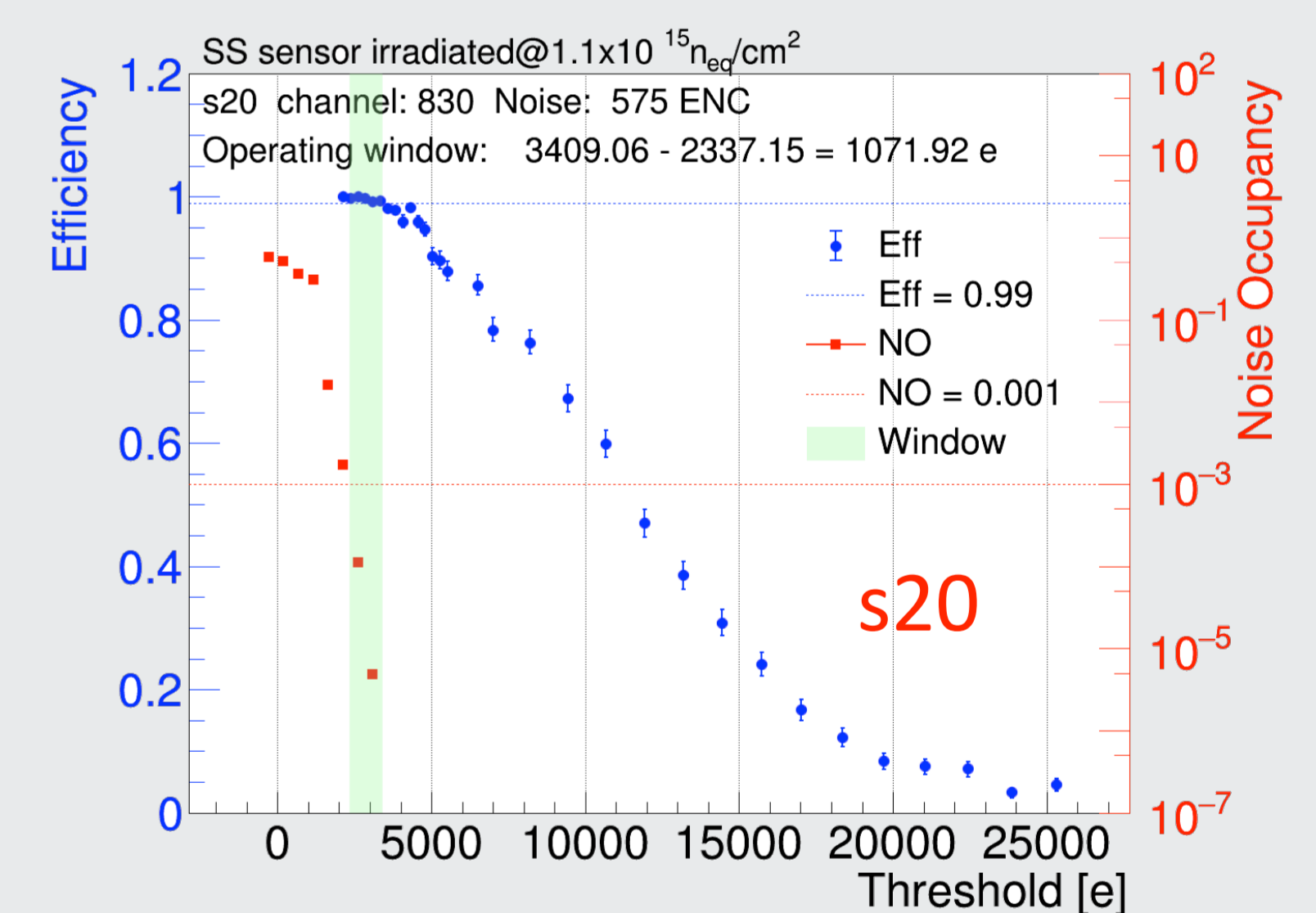
- Adenium telescope [2]
- Telepix timing plane [3]
- Scintillator trigger signal
- DUT cooling box
- DUT

- Noise level growing at low temperature under hybrids & PB.
- Correlated with glue under hybrids.
- Correlated to the DC-DC converter: switching @ 2MHz.
- Mechanical wave couples into sensor (via glue) & travels.

Studies of design modifications to reduce or eliminate cold noise are ongoing.

Test beam results

- Data reconstruction using Corryvreckan [4]
- Operating window = threshold (efficiency@99%) - threshold (noise occupancy@10⁻³)
- If max efficiency < 99%, for plotting use:
 - threshold set as 1500e;
 - operating window set as -2500e.



Summary

These results help us understand how much cold noise must be reduced to have proper tracking at end of lifetime.

More results will also be coming out to have more understandings about cold noise.

References

- [1] [j.nima.2018.11.133](https://arxiv.org/abs/1811.133)
- [2] [2023 JINST 18 P06025](https://arxiv.org/abs/2306.06025)
- [3] [j.nima.2022.167947](https://arxiv.org/abs/2206.167947)
- [4] [2021 JINST 16 P03008](https://arxiv.org/abs/2106.03008)



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