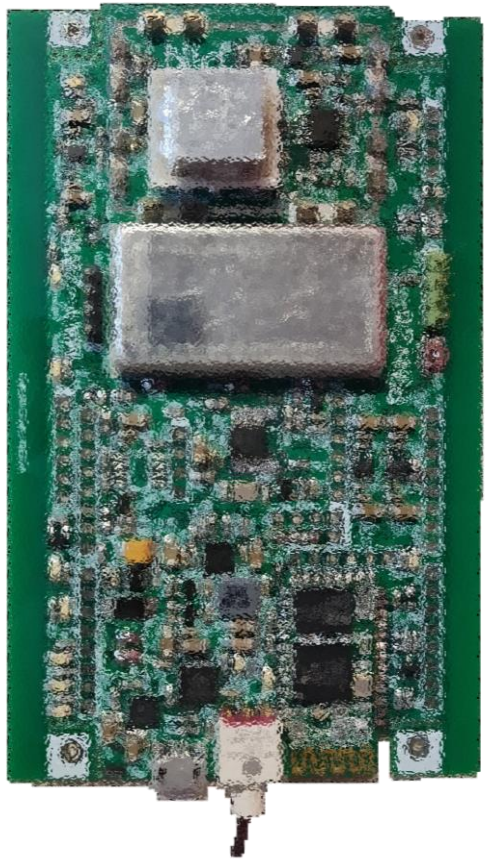
Measuring Background Radiation with a Novel Ionisation Detector Aboard a North Atlantic Voyage

Justin Tabbett

Karen Aplin, Susana Barbosa



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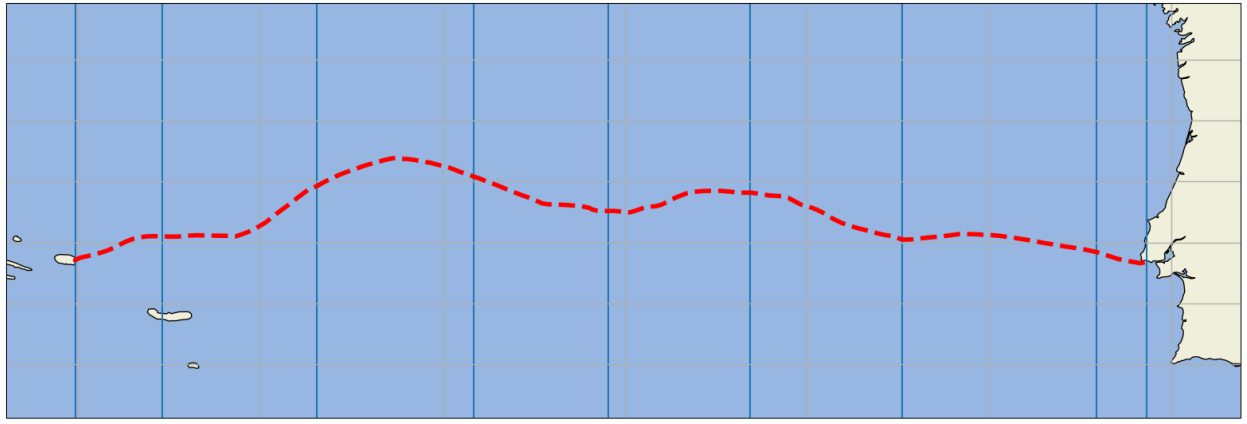
SAIL

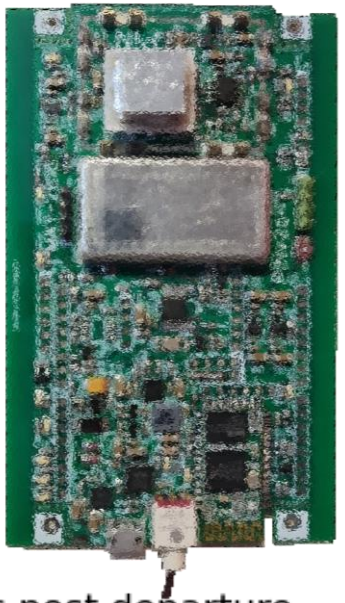
A SQUARED TECHNOLOGIES



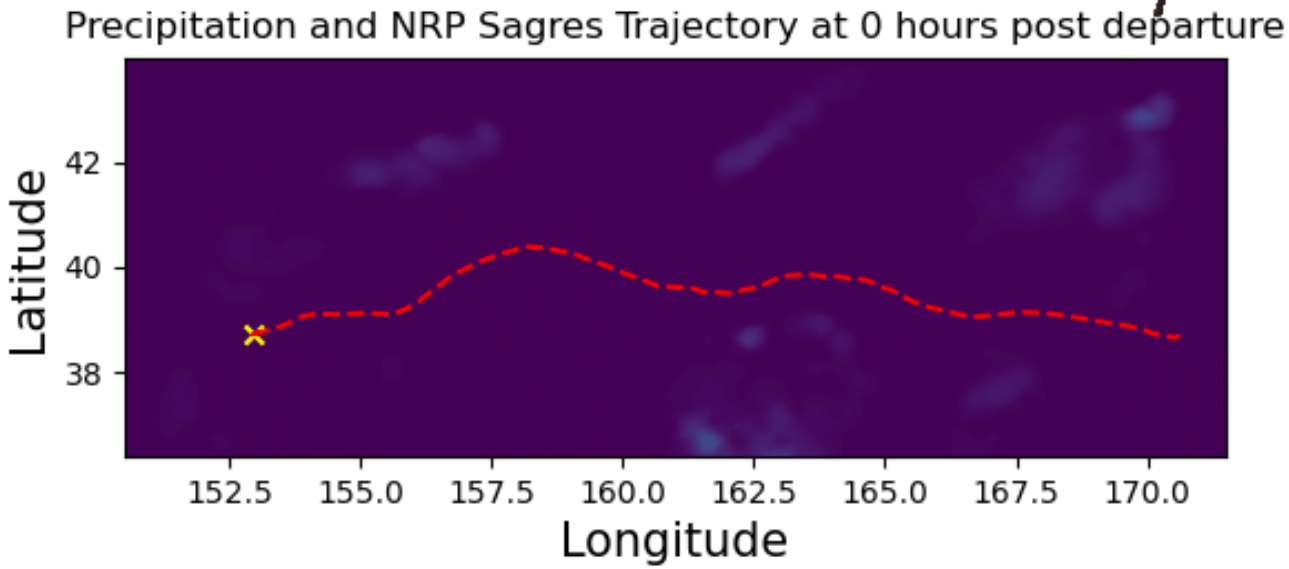
SAIL aboard NRP Sagres

- From Açores to Lisbon 23rd - 31st July 2021
- Instrumentation onboard
  - NaI(Tl) scintillator gamma counter: 0.4-3 MeV
  - Microscintillator PiN detector: 0.4-3 MeV (terrestrially)
  - Biral SWS-050 visibility detector

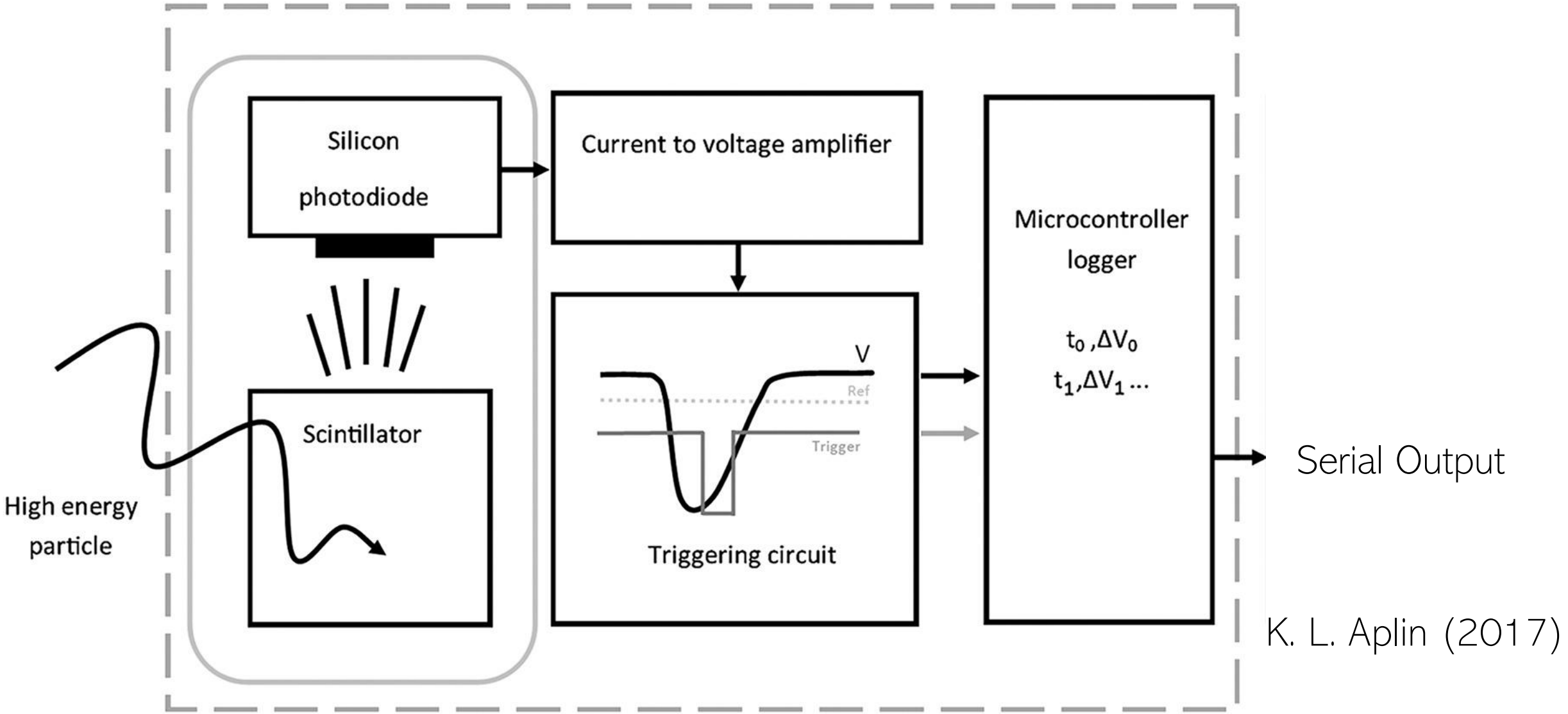
Ionisation detector
1 cm3 CsI(Tl)
PiN photodiode
Low power
Small form factor
~5x11 cm



Wikipedia



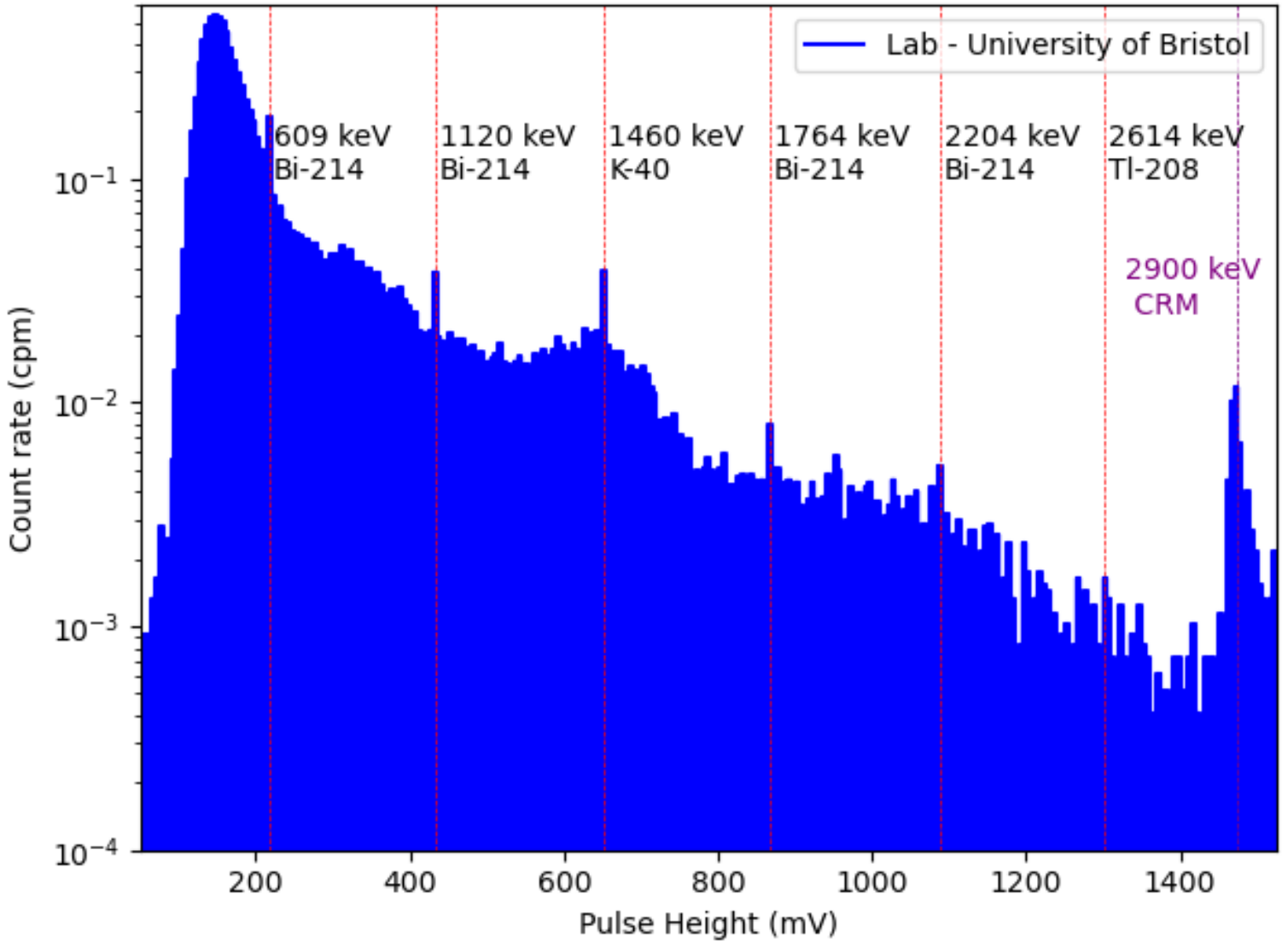
Microscintillator ionisation detector



K. L. Aplin (2017)

Pulse height spectra

- Identified gamma peaks originating from Bi-214, K-40 and Tl-208
- Gamma peaks verified in lab calibration with radioactive sources (Aplin et al, 2017)
- Lab (University of Bristol, 162 hours)
- Normalised by run length



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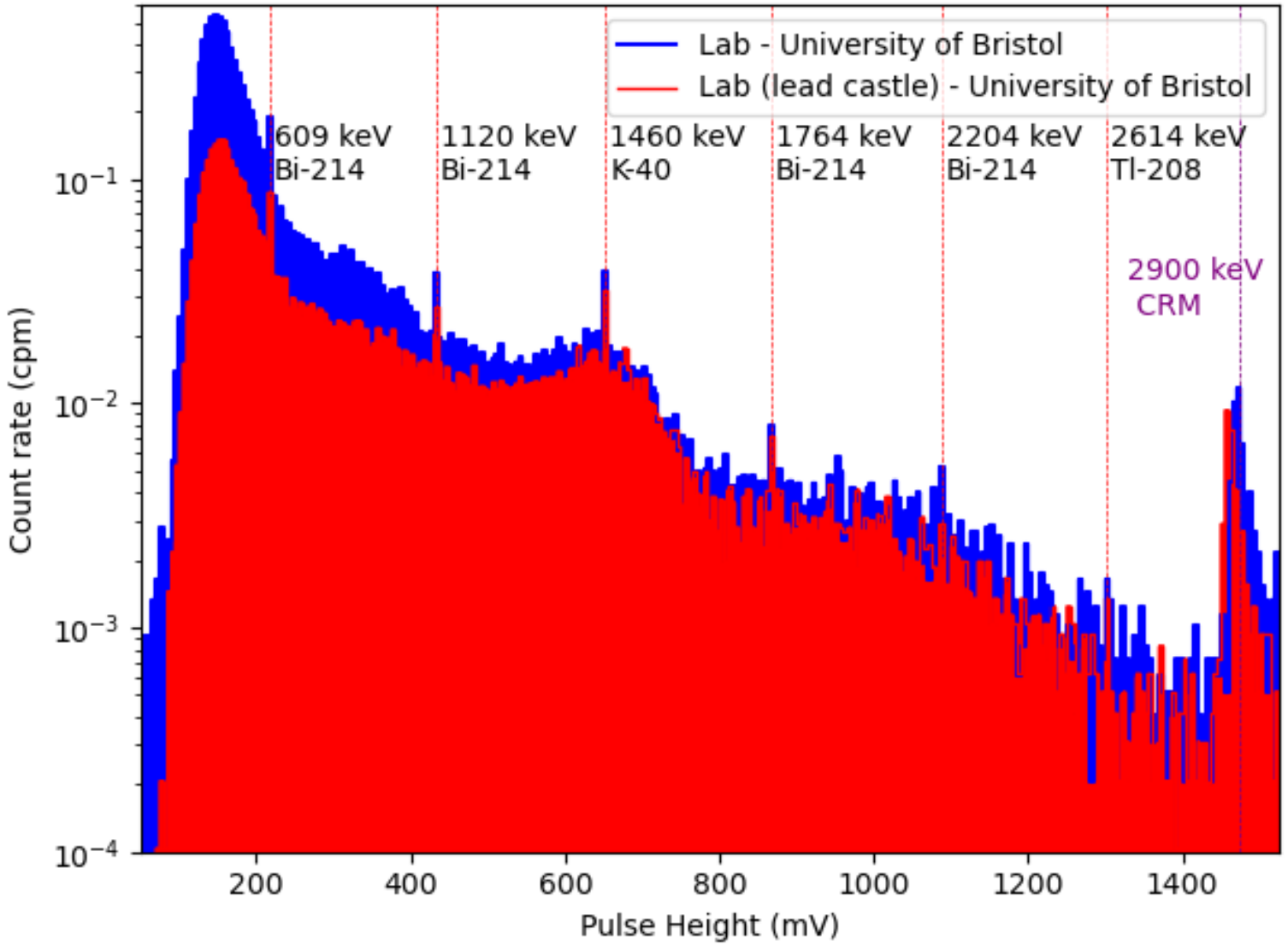

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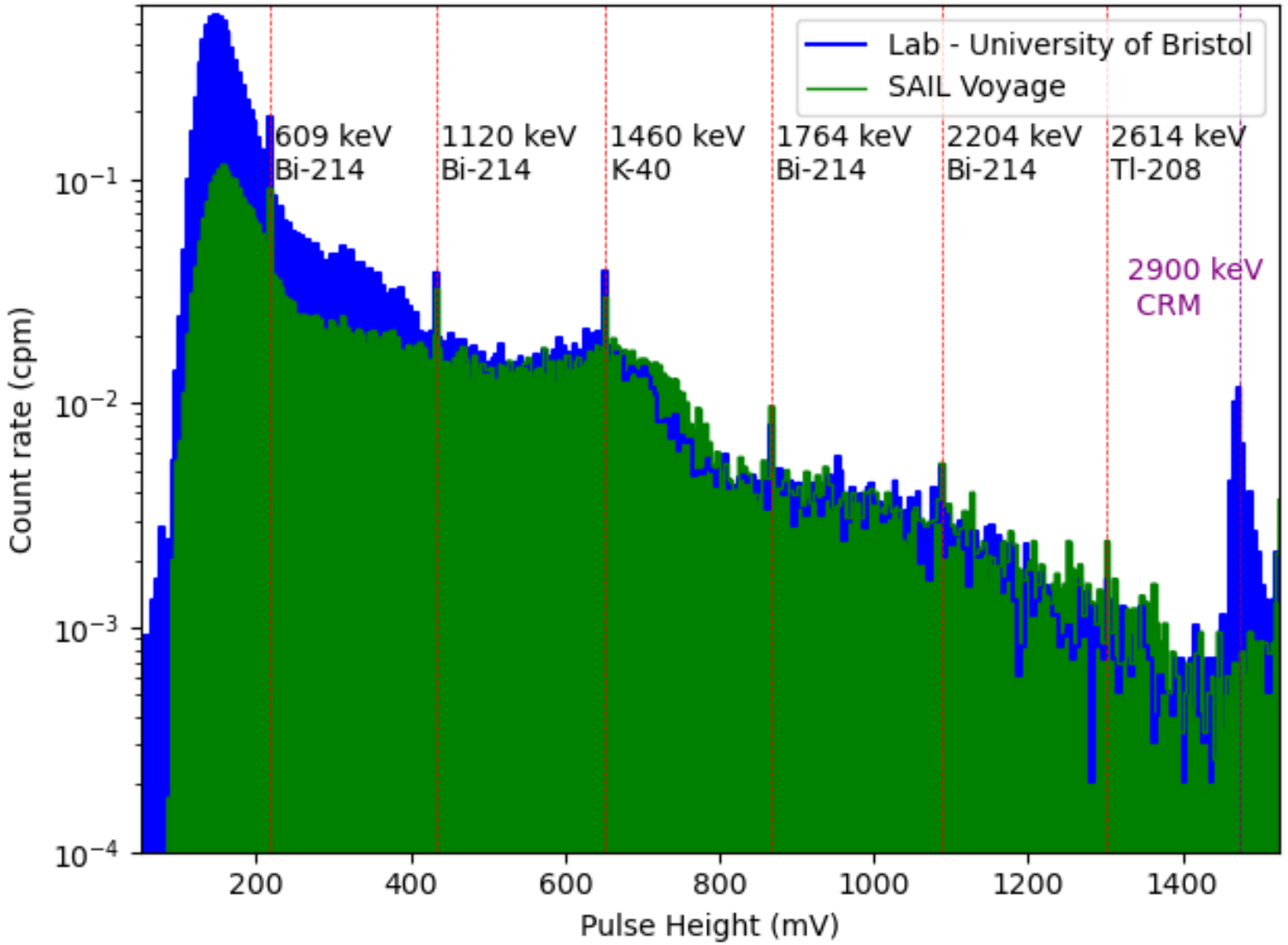

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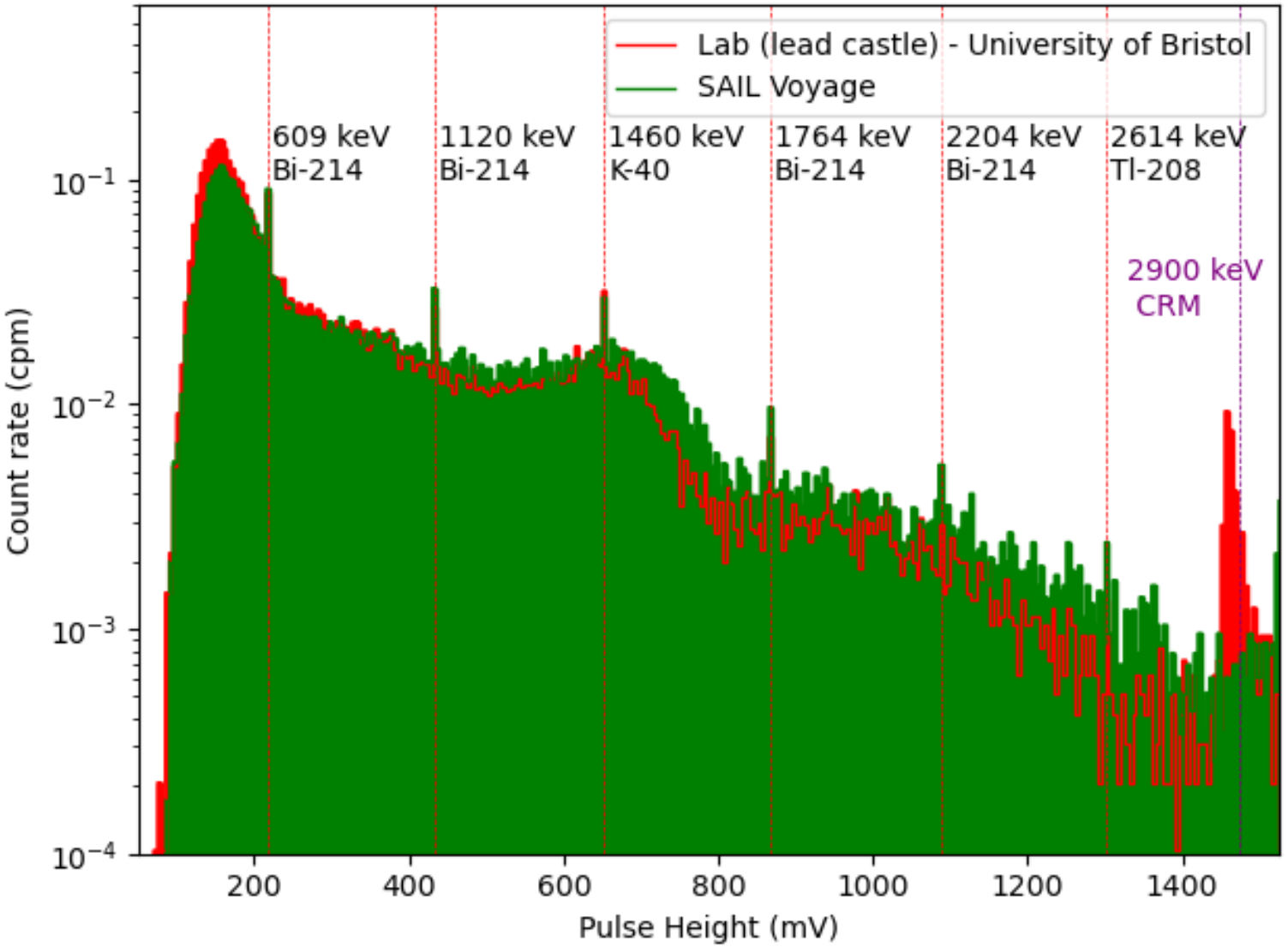
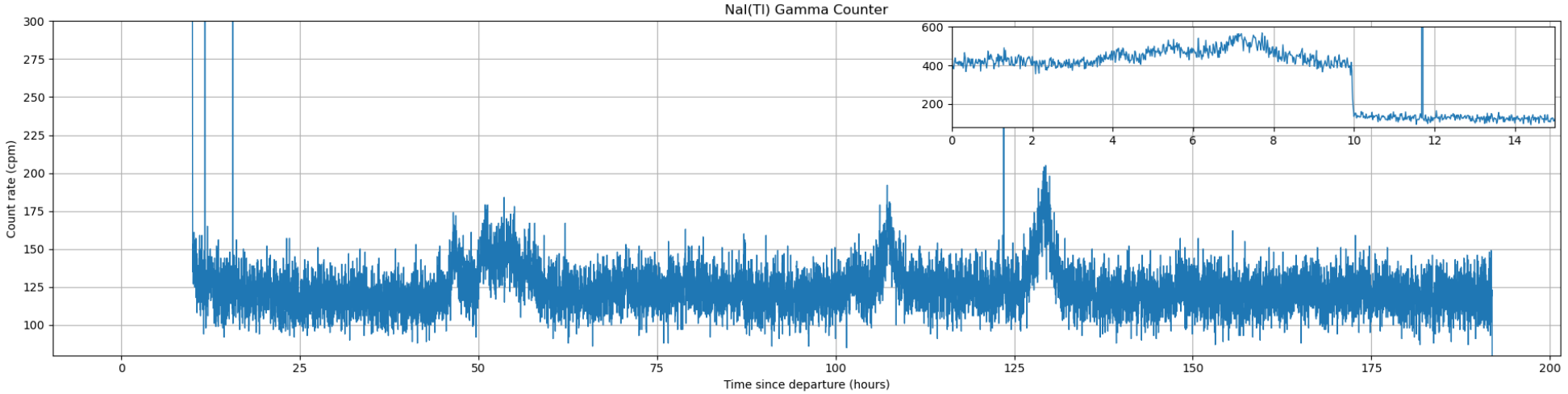
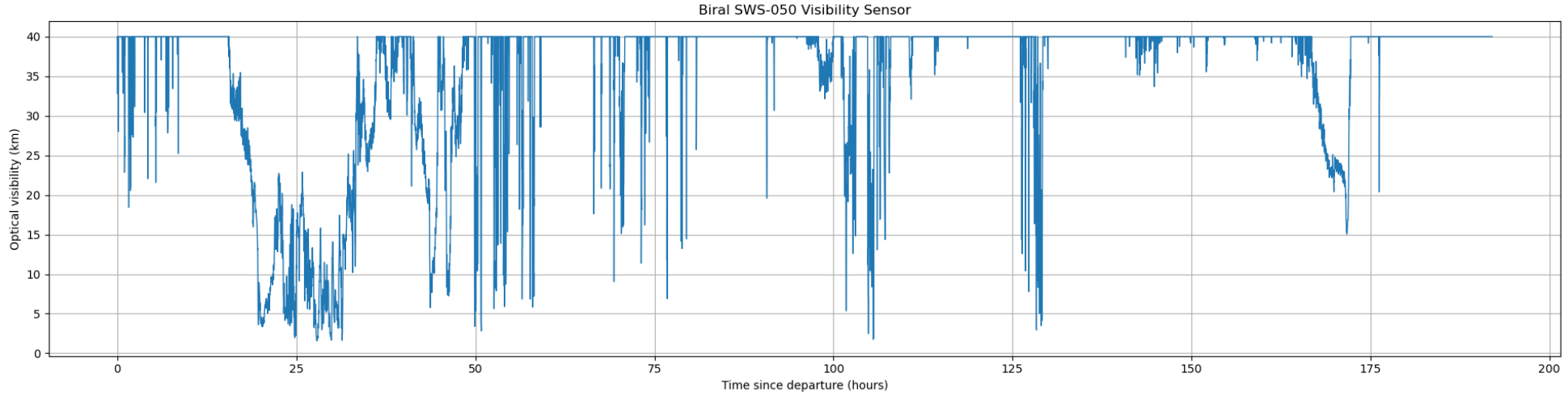
- Lead castle and SAIL spectra both show reduction in low level background
  - Gamma radiation is lower over the ocean
- What about the NaI(Tl) gamma counter?



NaI(Tl) gamma counter & visibility

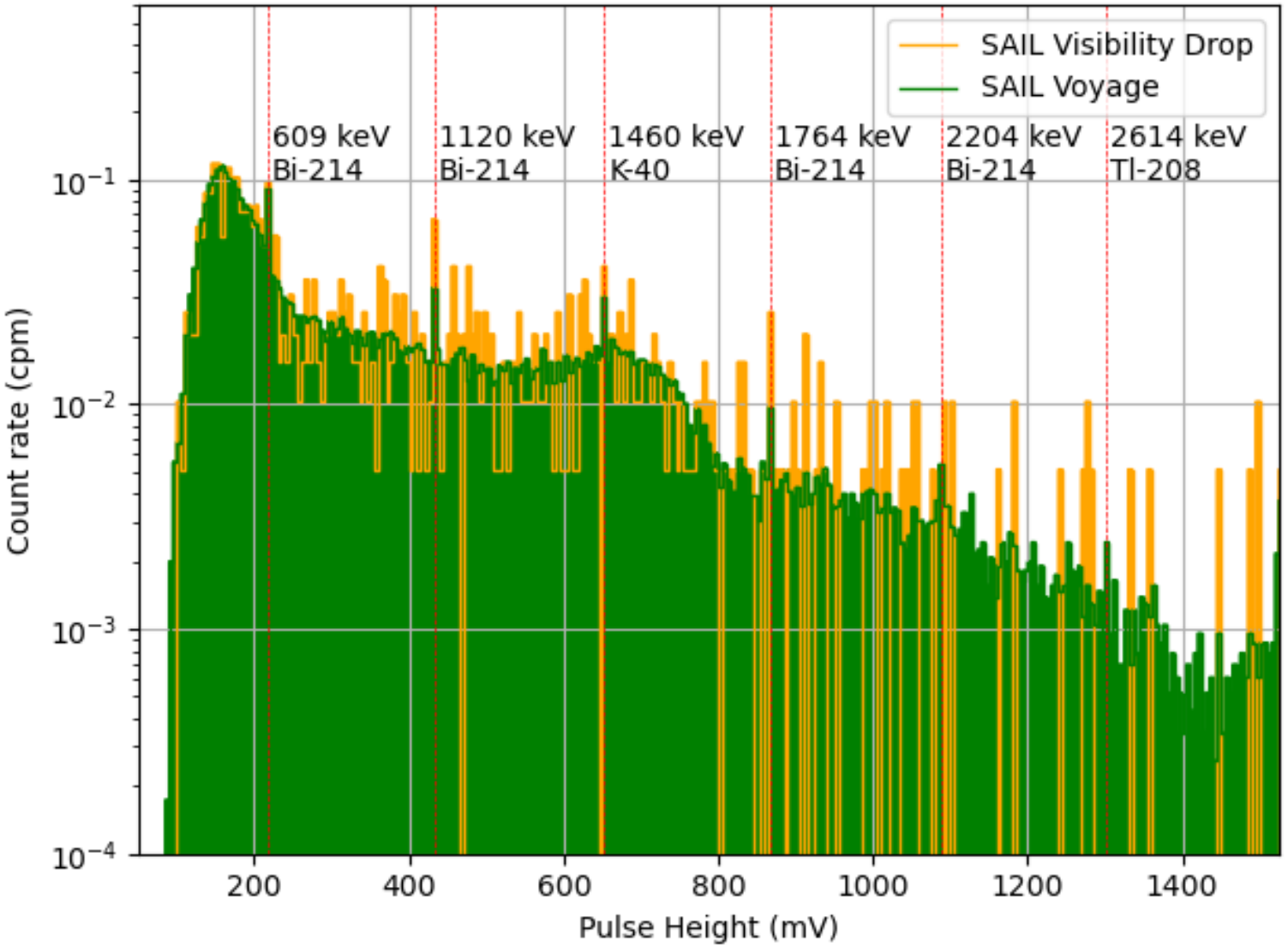
- See a drop in gamma counts over the ocean
- Count rate is not constant
- Precipitation inducing an increase in gamma radiation
- However precipitation data is not available for this part of the voyage.
- Changes in visibility can be an indicator
- Filter by rapid changes in visibility





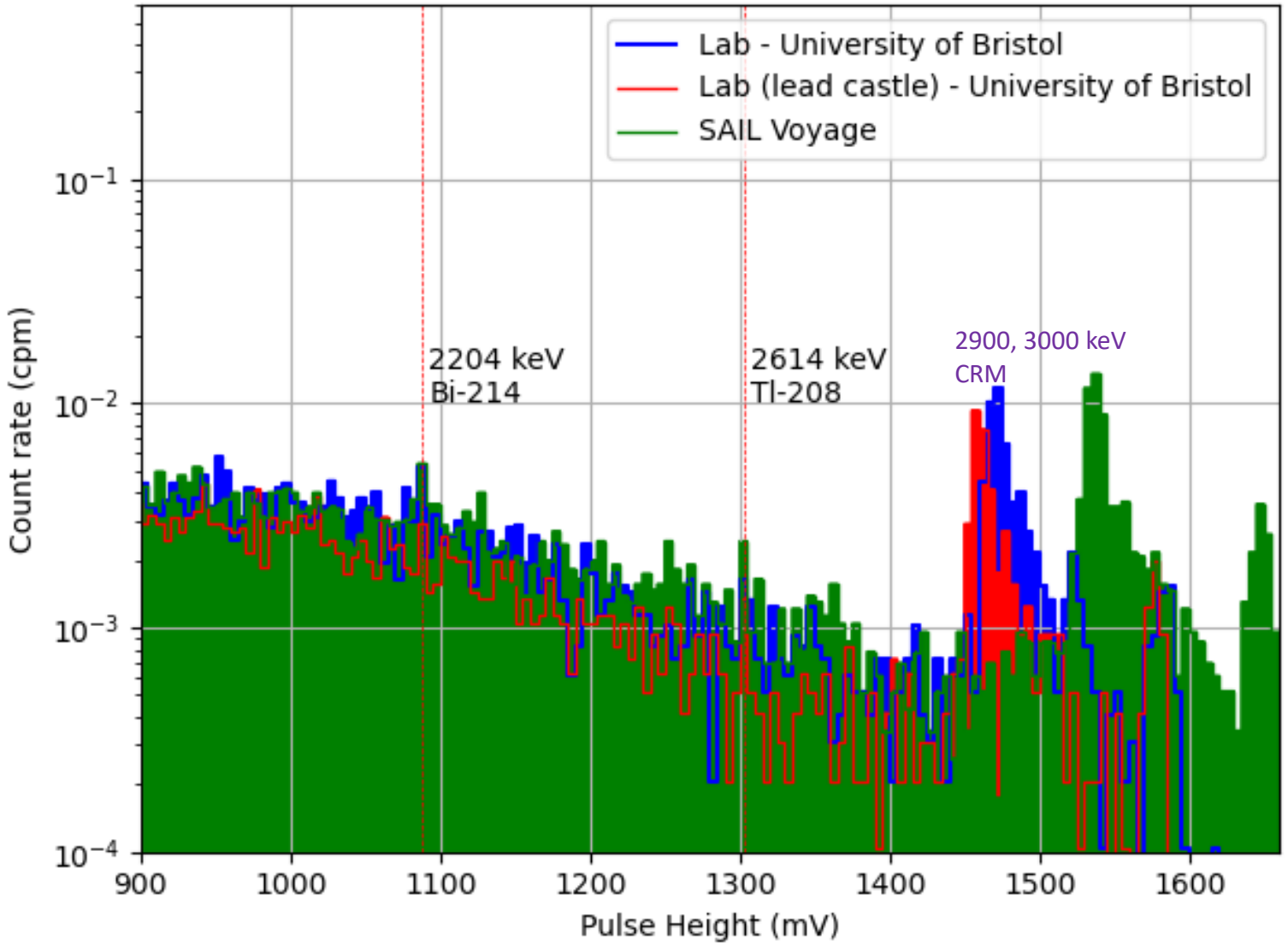
Pulse height spectra

- SAIL (Visibility drop, 3.25 hours)
- Can see a composition of gamma increase
- Looking at response of all Bi-214 peaks as radon progeny
- See a higher count rate from Bi-214 peaks during visibility (precipitation) changes



Cosmic rays

- High energy peak caused by cosmic ray muons (CRM)
- Not a discrete energy since CMRs are minimum ionising particles
- Difference could be due to differences in pressure, temperature, latitude
- Specific cause of response remains unknown



In conclusion

- CsI(Tl) ionisation detector and NaI(Tl) gamma counter able to see a **decrease in counts** over the ocean vs on land
- Correlation between **change in visibility** (caused by rain) **and increased gamma activity**
- Difference in cosmic ray energy deposition

Many thanks to

SAIL team
A-Squared Technologies

Thank you for listening
Are there any questions?

Please contact me at: **jt16596@bristol.ac.uk**

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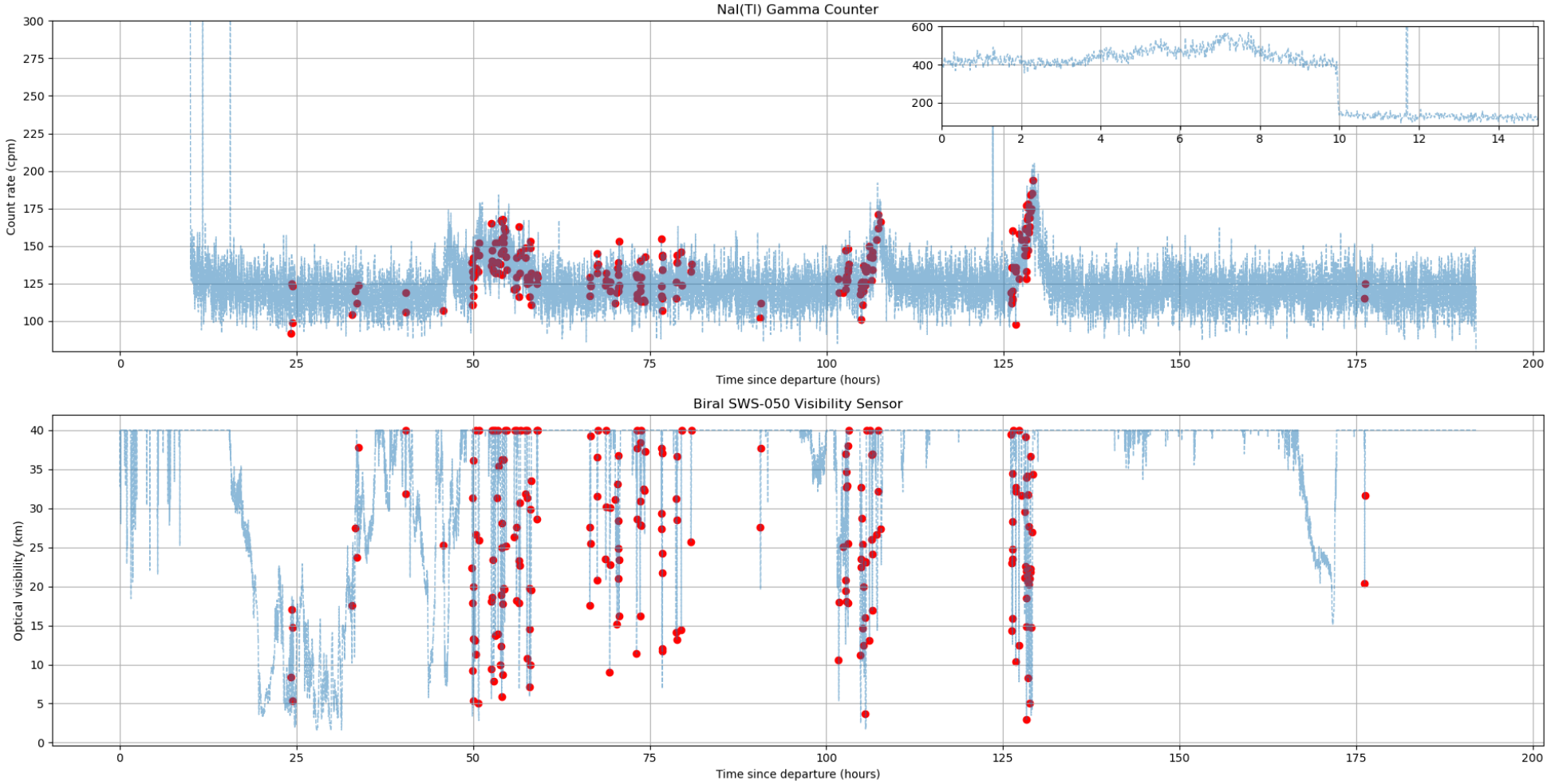
NaI(Tl) gamma counter & visibility

Additional slide

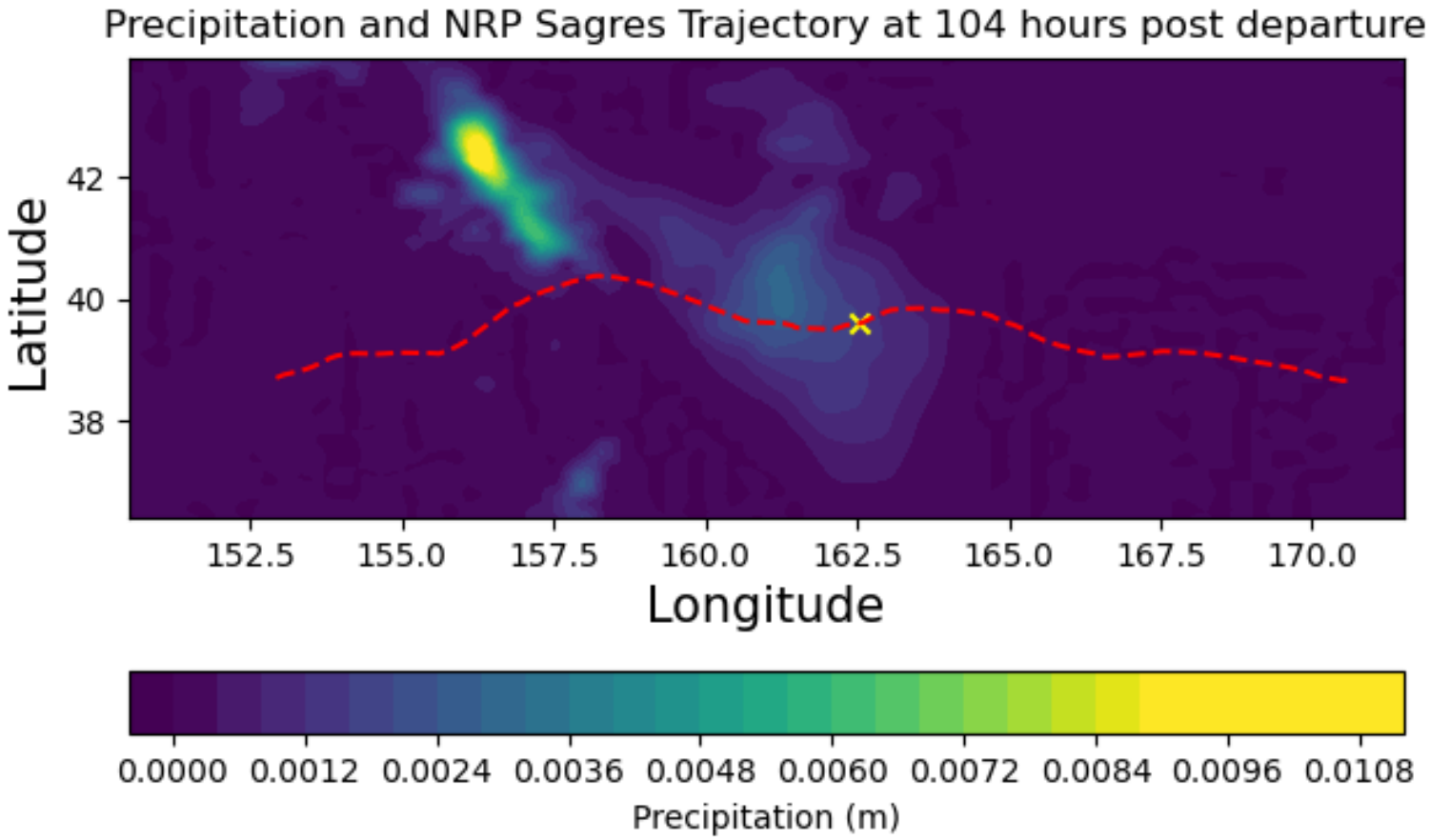
- Find each minute where the visibility changes by **7.5 km**
- Correlation about the leading edges of the features
- Driving force behind the change in visibility also causing the change in gamma activity



Next step: precipitation

Additional slide

- Change in visibility due to precipitation
- Difficult to get high resolution weather data over the ocean
- ECMWF can provide total precipitation over a grid
- However:
  - Data is provided hourly
  - Spatial resolution may not be sufficient
- Next steps:
  - Look at periods where NRP Sagres was in land
  - Establish relationship between ECMWF data, local weather reporting, and visibility



Visibility drop validity

Additional slide

- How can I be sure that the peaks are higher and a not just the noise floor being incomplete?
- Compare a time window of the same length in the lead castle data set
- Find that for the higher energy Bi-214 peaks that the count rate is still higher