ISFRN Workshop

http://ships4sst.org/

SISTeR

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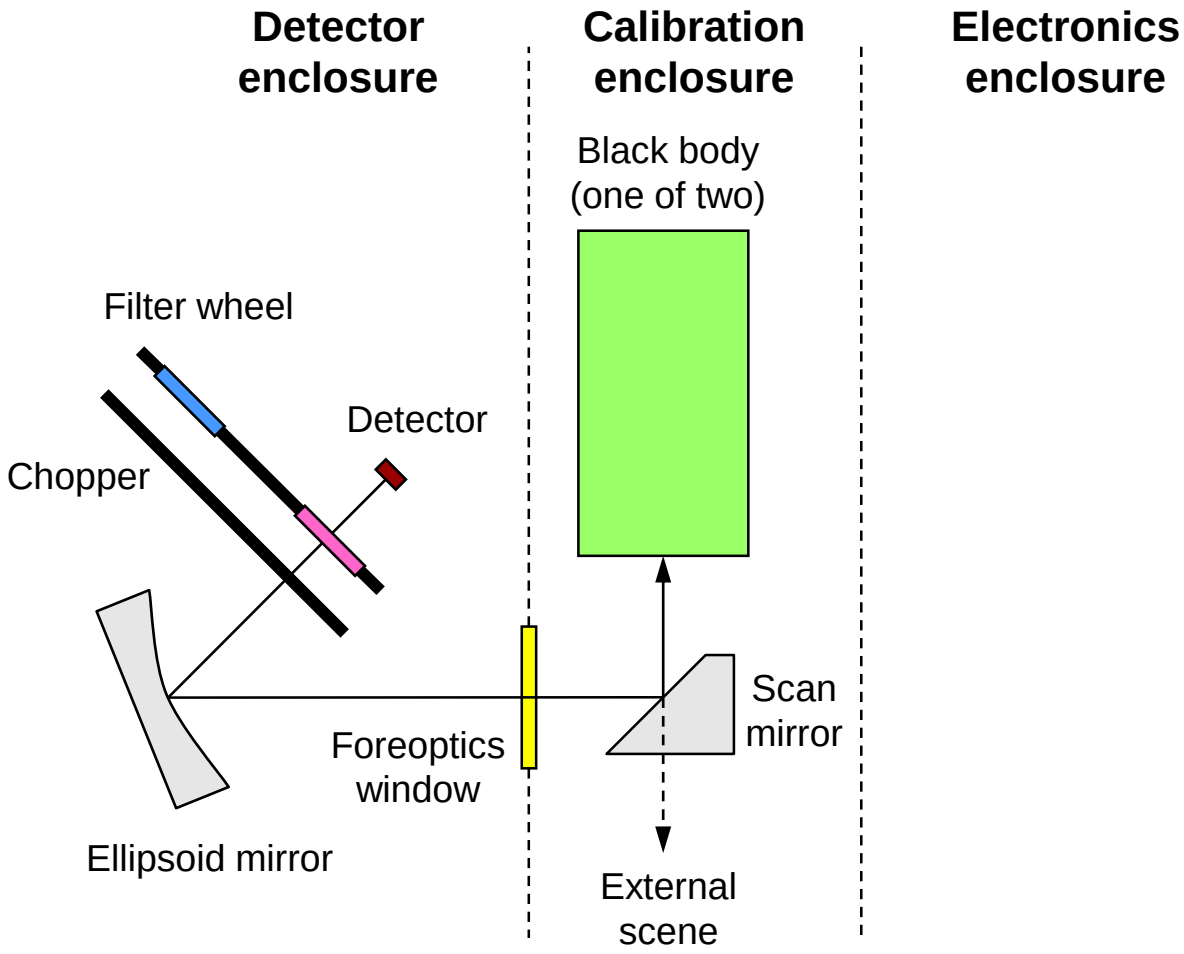
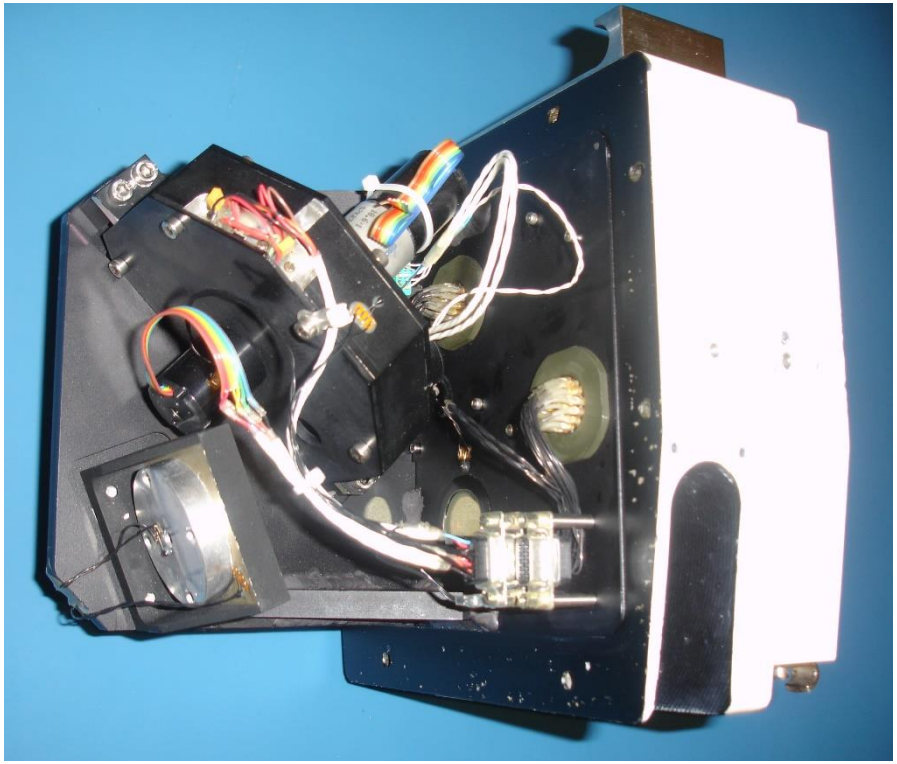
The SISTeR radiometer

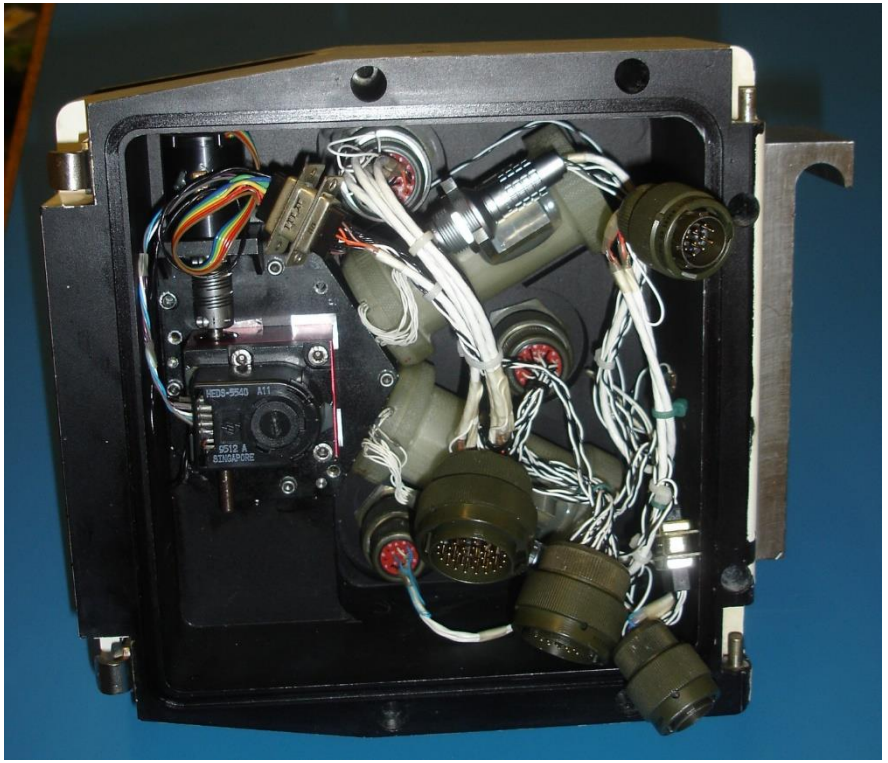
- SISTeR (the Scanning Infrared Sea surface Temperature Radiometer) is a chopped, self-calibrating infrared filter radiometer
  - Capable of measuring infrared brightness temperatures to high accuracy, typically 30 mK or so
  - Black body thermometer calibrations traceable to ITS-90 (NPL)
  - Measurements taken with a 10.8 μm filter matching the (A)ATSR filter shape
  - Measures upwelling radiance from the sea surface and corrects for the reflected sky component with measurements of the downwelling sky radiance
  - Is autonomous – it can operate continuously without supervision and can protect itself against bad weather when required
- SISTeR was designed in 1994, made its first deployment in 1997, and has been deployed regularly from 2006 on the *Color Festival* and *Ragnhild* ferries (Skagerrak) and from 2010 on the Cunard *Queen Mary 2* liner (north Atlantic and annual world cruise).

SISTeR layout



SISTeR





SISTeR black bodies

Traceability

- Scene radiances are referred to two on-board black bodies
  - Great care taken with the choice of thermometer, thermometer calibrations, and readout electronics
  - Thermometers re-calibrated periodically against an SPRT maintained by Oxford University. Re-calibration activities will move to RAL once a new calibration rig has been commissioned
  - Principal traceability route (to NPL realisation of ITS-90)
- Instrument calibration is validated against an external CASOTS black body before and after every deployment
  - Secondary traceability route (to NIST realisation of ITS-90)
- SISTeR participates periodically in radiometer round-robins organised by the national metrology laboratories to validate the calibration chain.
- SISTeR has made direct in-situ intercomparisons with the UoS ISAR. This could potentially be extended to other instruments.

Processor and datasets

- SISTeR generates level 0 data – binary data packets containing snapshots of the complete instrument state which are stored by an external laptop data logger
- The SISTeR processor is coded in IDL
  - Unpacks the data
  - Extracts the appropriate calibration coefficients and other relevant information from a series of XML aux files
  - Applies these to the level 0 data to generate both level 1 (brightness temperature) and level 2 (sea surface temperature) products
  - Propagates random and systematic uncertainties through the instrument and SST equations, in parallel with the core BT and SST quantities
  - Calculates level 2 products directly from level 0 data, not via the level 1 product, to avoid double counting of uncertainties
  - Calculates averaged level 3 summary products from the level 1 and level 2 data
- All higher level products are encoded in netCDF. Level 2 and level 3 SST products follow the L2R in-situ radiometer data format.

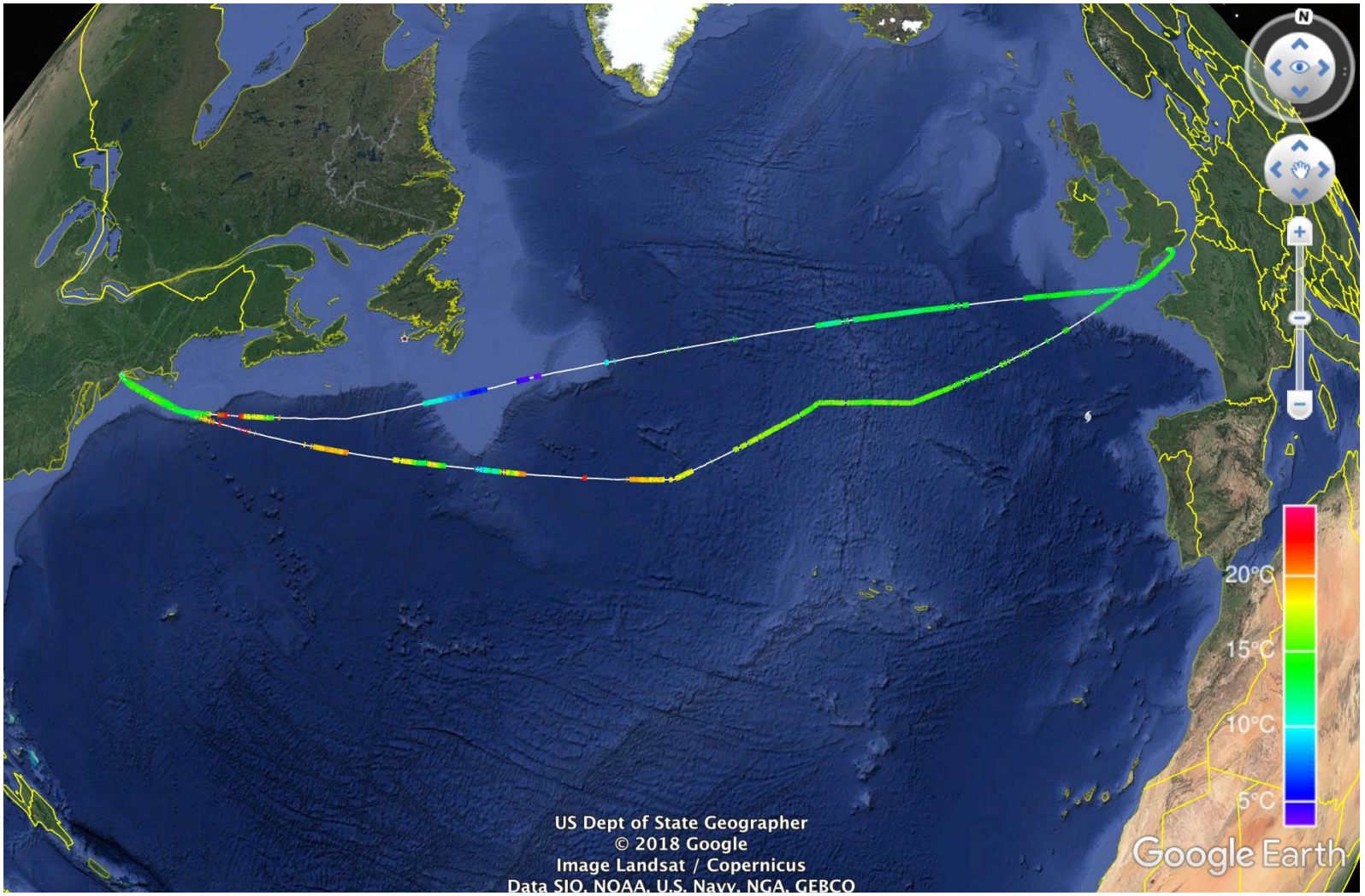
Queen Mary 2 deployments

- SISTeR has been deployed since 2010 on the Cunard Line *Queen Mary 2* liner
- Mounted on a dedicated platform above the starboard bridge wing
- Support equipment (UPS, power supplies, data logger, USB and serial repeaters) installed in an internal cabinet and an external weatherproof box
- Data logger laptop connected to ship's Ethernet network. Emails daily level 0 products back to the UK.
- From May to January, the QM2 operates a regular service between Southampton and New York, with occasional side-trips
- Makes a round-the-world cruise from January to May
- Currently on its 22nd cruise

SISTeR on the Queen Mary 2

SISTeR on the Queen Mary 2

Cruise 15: 05/11/2017 – 19/11/2017



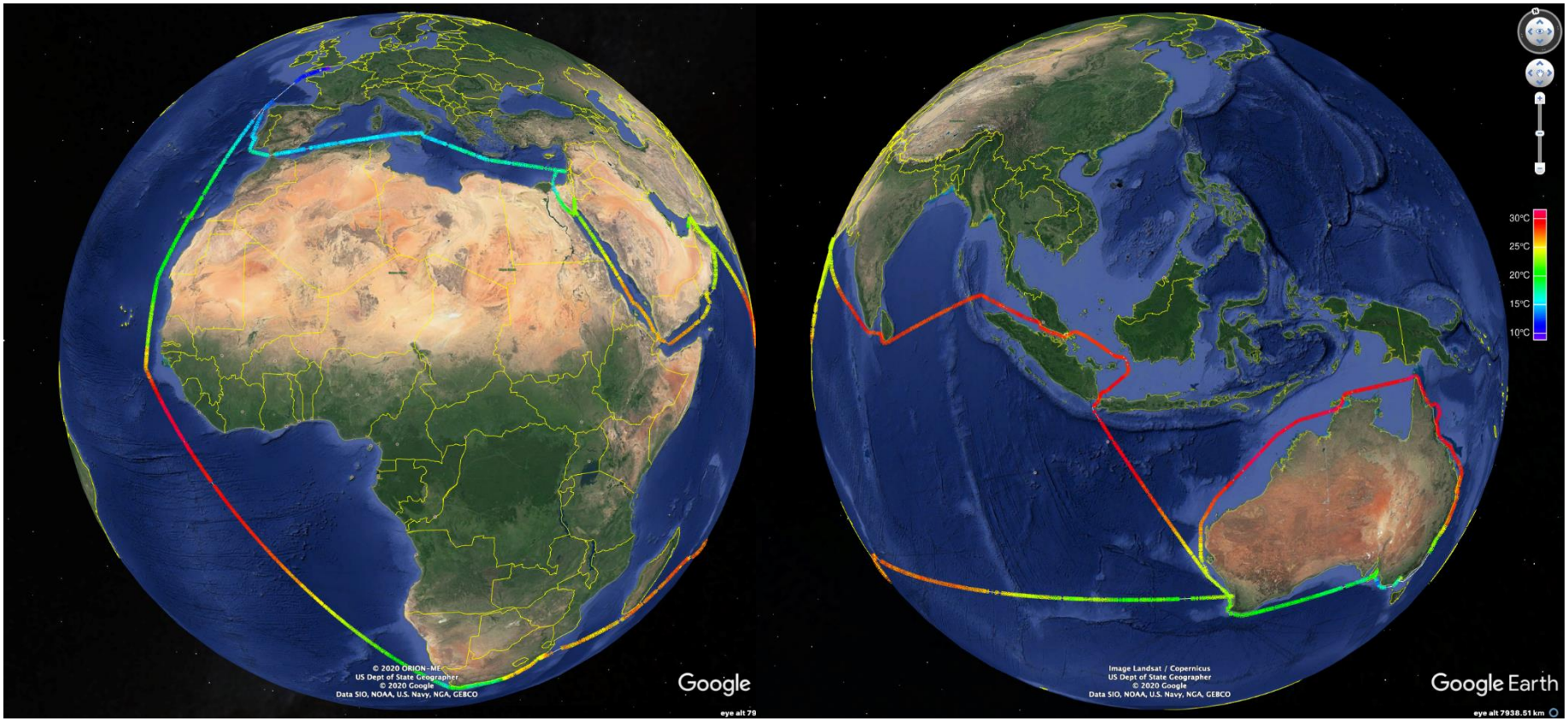
Deployment summary since 2018

Cruise number	Deployment	Retrieval	Route	Notes
16	10 January 2018	10 May 2018	World Cruise	Degraded scan mirror
17	24 June 2018	2 September 2018	North Atlantic	~10 days data lost from loss of ship power
18	16 September 2018	15 December 2018	North Atlantic	Degraded scan mirror
19	10 January 2019	14 April 2019	World Cruise	
20	28 April 2019	14 July 2019	New York/North Sea	
21	26 September 2019	3 November 2019	New York/Nova Scotia	Failed thermometry
22	**10 January 2020**	**18 April 2020**	**World cruise**	

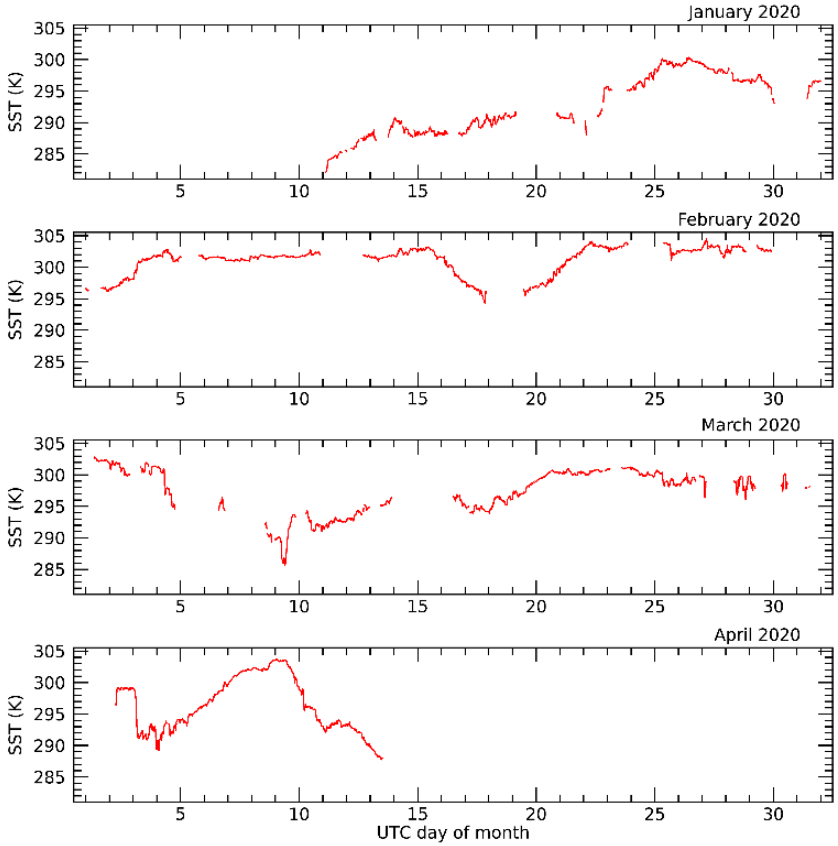
Cruise 22 – “Round the World” 2020

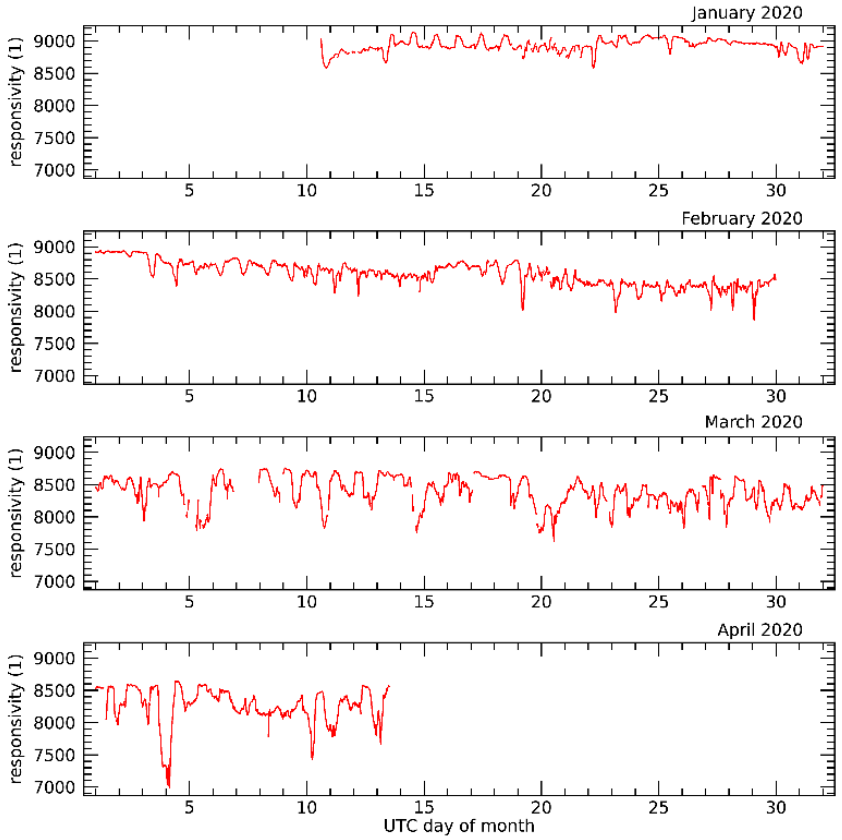
- Deployed on 10th January
- QM2 late into port after multiple incidents and an emergency port call
- QM2 disembarked almost all passengers at Fremantle, but continued close to her original route back to Southampton

Cruise 22 – “Round the World” 2020



Cruise 22 – “Round the World”





Current status

- The QM2 is at the South coast, but currently inaccessible. Cruising is due to restart after a ship refit in Spring 2021
- Currently believed to be in a ‘safe’ state with the weather door closed but the instrument still running – no data collection
- Damage to the door motor drive may have occurred, which could be fixed relatively easily

- Data from this cruise to be released without post-calibration until the instrument can be recovered

Future plans

- Retrieve SISTeR from the ship at the earliest safe opportunity
- Assess current mirror durability and success
  - Nichrome/gold mirror is currently in use, dual-layer titanium/gold mirror is fixed inside the instrument body to measure how it degrades at sea
- Produce next generation of mirror using in-house manufacturing capabilities: diamond-turned solid copper stub with directly-deposited gold

- Continue deployments as soon as possible, hopefully in April 2021