API and Back-End Development for the AuroraCatcher Network for Aurora Borealis Detection

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Introduction & aims

The sun constantly emits charged particles that cause **fluctuations in the Earth's magnetic field**. These emissions are monitored by ground-based observatory networks to study and anticipate the disruptions caused by these fluctuations, which can cause auroras and impact satellites, power grids and telecommunications [1], [2]. These networks, such as the IMAGE network (Figure 1), use fluxgate magnetometers that require regular manual recalibration, which disincentives remote observatories and incurs operating costs. A novel quantum technology using **Nitrogen Vacancy (NV) diamonds** avoids this recalibration need but demands other processing steps.

This thesis aims to design, prototype and test a system that would be able to support a global network of these NV diamond magnetometers.

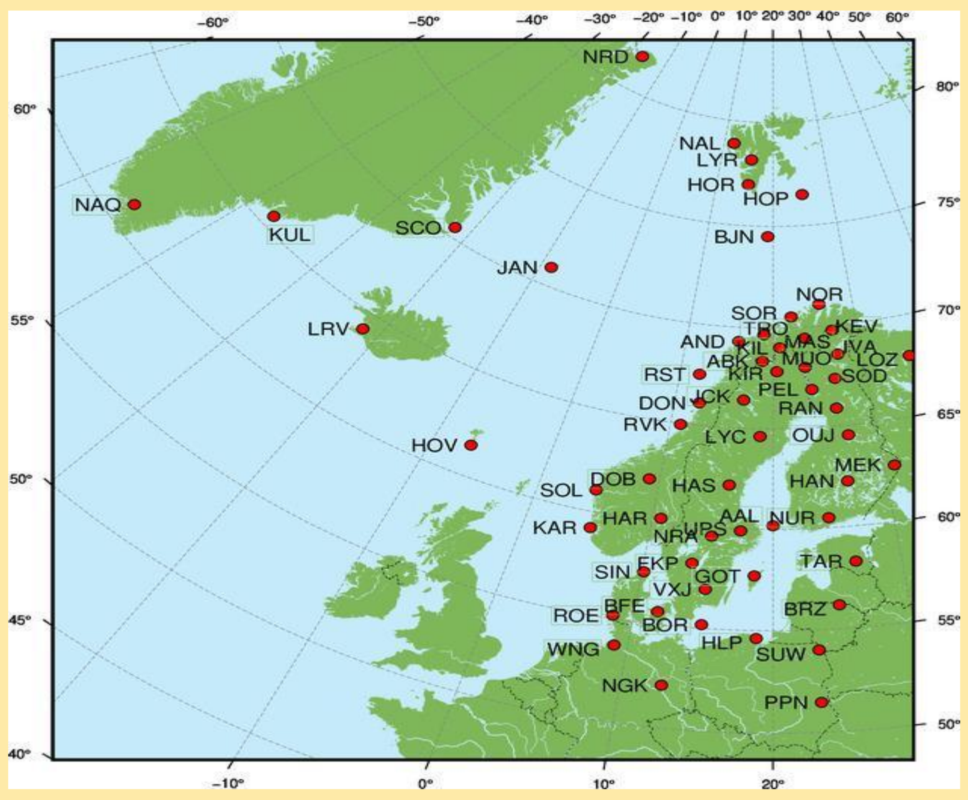
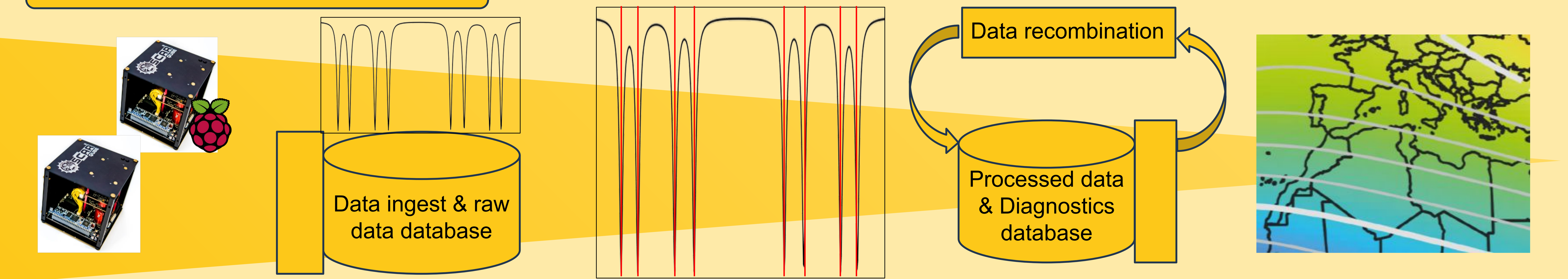


Figure 1: The IMAGE magnetometer network's observatories [3].

Back-end architecture



Data is **collected** by different, remotely configurable NV diamond magnetometers.

The unprocessed ODMR data is **interpreted** and **stored** in the system. This data can be accessed through an API.

The data is **transformed** to magnetic field data through steps like peak detection, and transformed to the correct reference frame.

The processed data is stored in a database, and data from multiple observatories is **recombined.**

The results and diagnostics data are shown in a **web interface.**

Performance testing

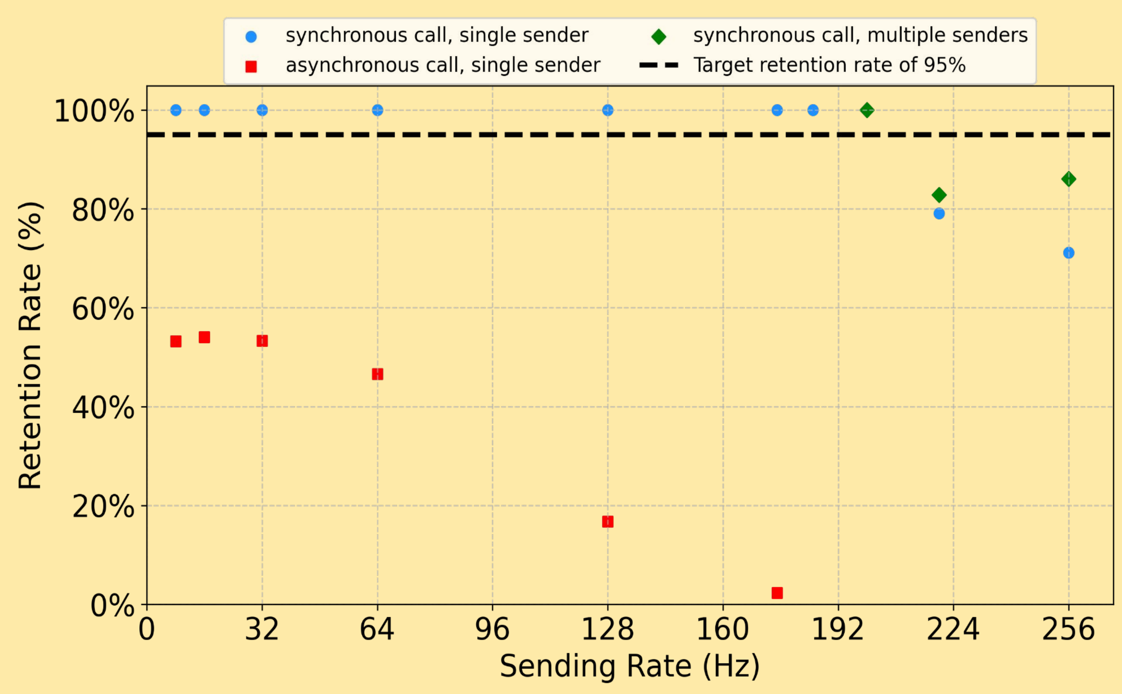


Figure 2: Influence of load on data retention rate

Multiple **iterations of testing** were used to identify the optimal configuration to handle this data load. Figure 2 shows these results, with a clear degradation in performance and a failure of the system's target 90% retention rate when going above 200 Hz.

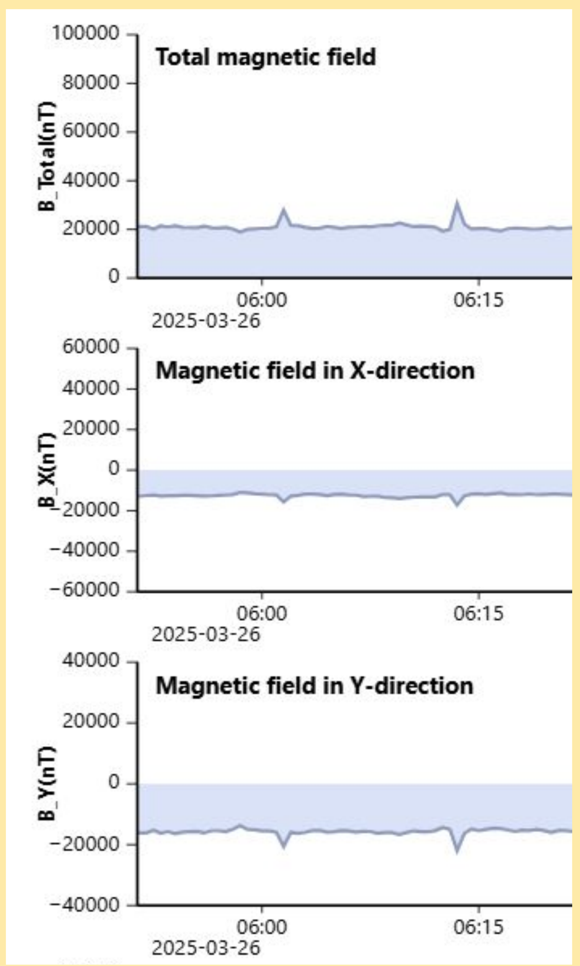


Figure 4: Part of the real-time web interface showing magnetic field data

Prototype & processing

This **prototype**, alongside a physical **mobile observatory** (Figure 3), were tested during an excursion to Tromsø, demonstrating the **technical feasibility** of these processing steps and displaying processed data in a **real-time web interface** (Figure 4).

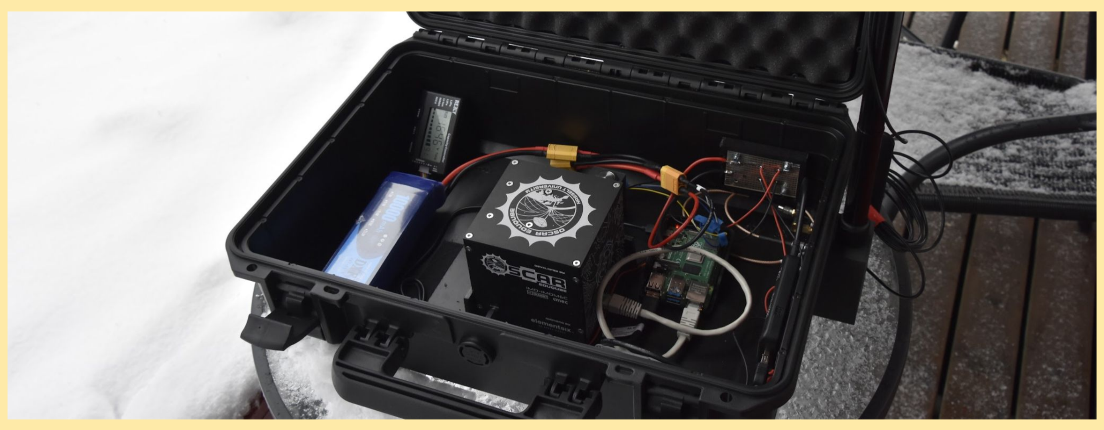


Figure 3: The mobile detector using an NV-magnetometer

Conclusion & future work

The results prove the feasibility of a global, ground-based NV diamond magnetometer network.
The next steps to get there would be further refining the processing steps and deploying a static observatory for a long-term test.

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References: [1] NASA, "NASA Space Weather." Accessed: July 20, 2025. [Online]. Available: https://science.nasa.gov/heliophysics/focus-areas/space-weather/
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