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Fiber-optic gyroscope to catch ground motion: a short review of blueSeis use

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T3.1-666

POSTER

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iXblue for blueSeis Seismology

The highest grade of
Fiber Optic Gyroscope (=FOG)

From navigation
(used for nuclear deterrence) …

… to seismology
(used for nuclear-test-ban control ?)

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ABSTRACT

blueSeis starts the 8th of March 2016
It has been more than 5 years from first prototypes…
…to reference sensor recognition by the community.

To make a long story short, here under is the summary:

- Main past shortcomings
- Present product line
- Two remaining issues
- Top papers released
- Upcoming chapters for blueSeis

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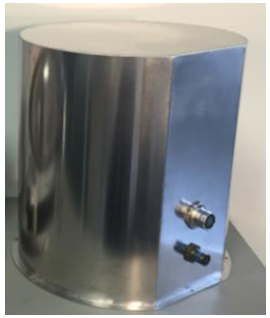
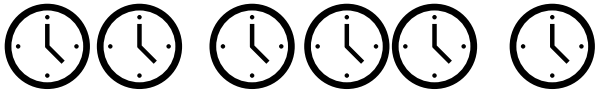
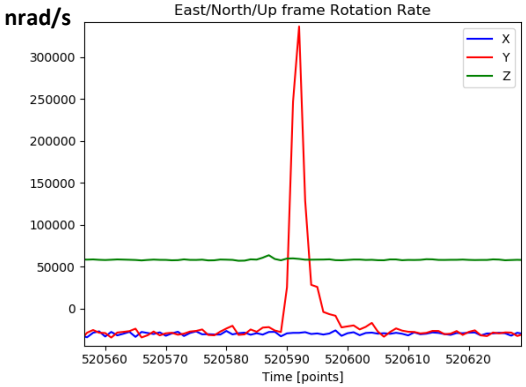
PAST ERRORS



Handles, Robustness and levelling bubble are actually….critical

Each sample was properly time stamped
But the datarate was free to change over time



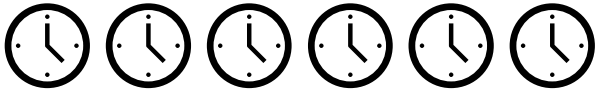


'Spike' issue in transient temperature due to a coil manufacturing issue

Since 2017

Since 2017

Each sample is properly time stamped
And the datarate is GNSS disciplined through an OCXO



Since 2019

Coiling manufacturing is properly defined and controlled to avoid those 'spike'

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PRESENT OFFER

Standard deviation of seismic station orientation installed with a magnetic compass is **~ 5°**

Whereas CTBTO requires < **3°**

(Array Derivative Rotation computation needs < **1°**)

blueSeis-3A Rotational seismometer

- Broadband (DC-50Hz)
- Flat transfer function from 10^{-2} Hz to 50Hz
- Very low self-noise at **20 nrad/s/√Hz**
- No translation sensitivity
- No cross coupling between Axis (=orthogonality)
- Digital output miniSEED streaming TCP/IP
- 20 kg / 18Watt

Seistans Optical gyrocompass

- **0.23°** seclat True North accuracy
- Free of Export
- Dedicated to static use
- GNSS denied environment compatible
- 2.7kg / 9W

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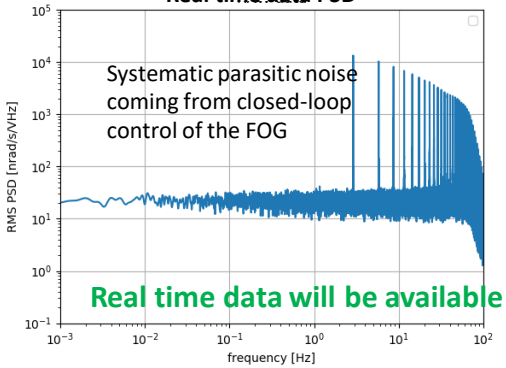
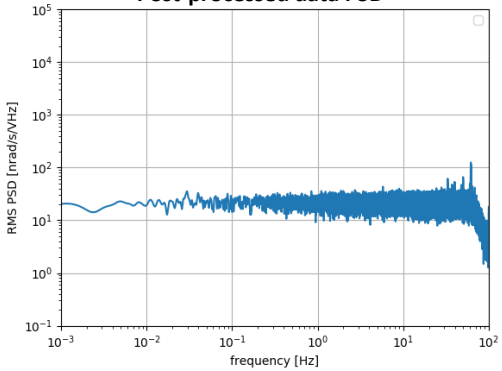
Real time data PSD



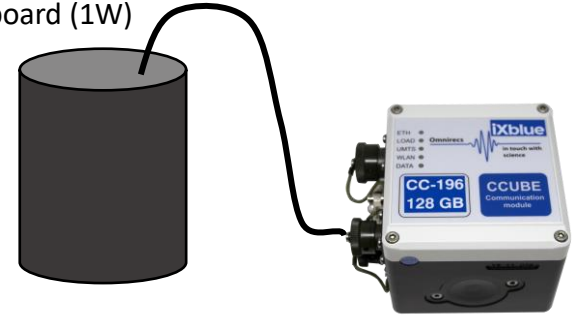
Real time data will be available in 2021 !

Post-processed data PSD



DATA boards (9W)
FOG boards (8W)
IN/OUT board (1W)

Total power consumption : **19 W**



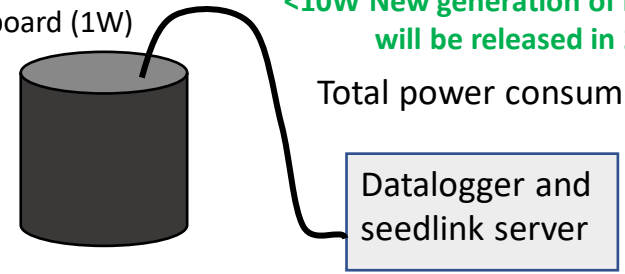
iXcube :
Datalogger and seedlinkserver

Made by DiGOS

FOG boards (8W)
IN/OUT board (1W)

<10W New generation of blueSeis-3A will be released in 2022

Total power consumption : **9 W**



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YUAN, Shihao, SIMONELLI, Andreino, LIN, Chin-Jen, *et al.* **Six Degree-of-Freedom Broadband Ground-Motion Observations with Portable Sensors: Validation, Local Earthquakes, and Signal Processing**. *Bulletin of the Seismological Society of America*, 2020
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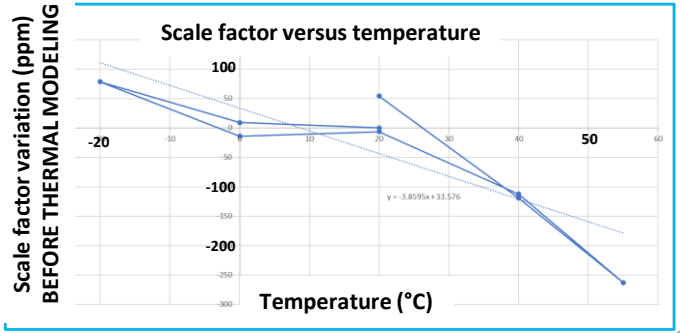
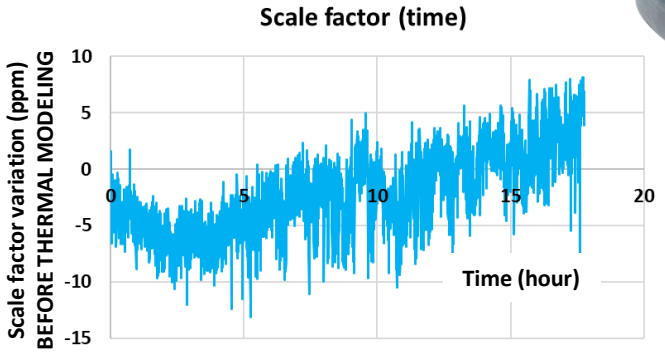
NEXT CHAPTERS



5ppm/°C before thermal modelling
Scale factor residue target is < 100 ppm in [-20°;60°C]

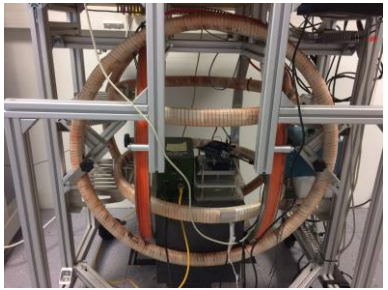


Scale factor stability at constant T°C is <10 ppm

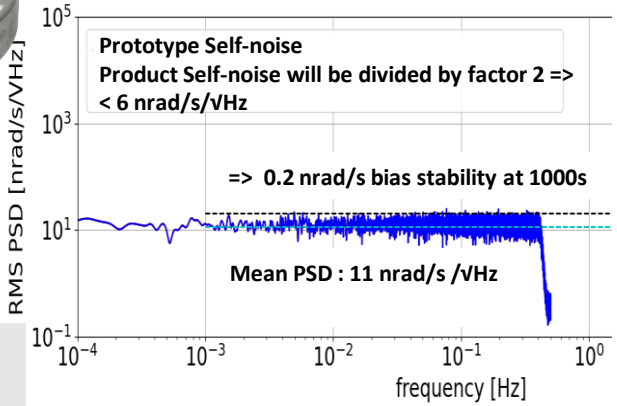
Preliminary test results from Upcoming product : blueSeis-1C

First prototypes with half-length coil to validate manufacturing

40cm diameter / 4kg



Typical magnetic sensitivity : ~100 nrad/s / Gauss



Higher frequencies are not displayed due to filter applied to handle very long duration test at 200Hz datarate

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CONCLUSIONS

- Rotation measurement of the ground brings interesting information for inversion
- blueSeis offers a screened and field proven rotational seismometer
- Scientific community has started to use it with a great interest
- Continuous improvement: Real time and lower Watt available shortly
- A new rotational seismometer is coming with a self-noise decreased four-fold