

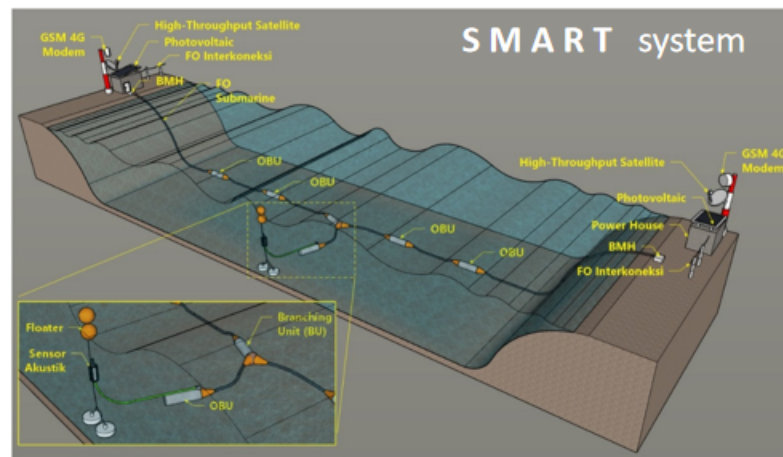
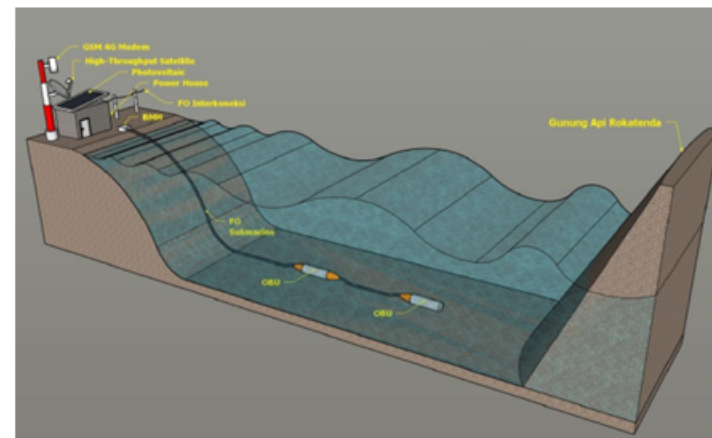
## EQ and Tsunami Monitoring and Warnings using Cable-Based Tsunameter (CBT)

**The PTWS-WG-SCS-XII, UNESCO-IOC**  
**Jakarta, 8 November 2024**

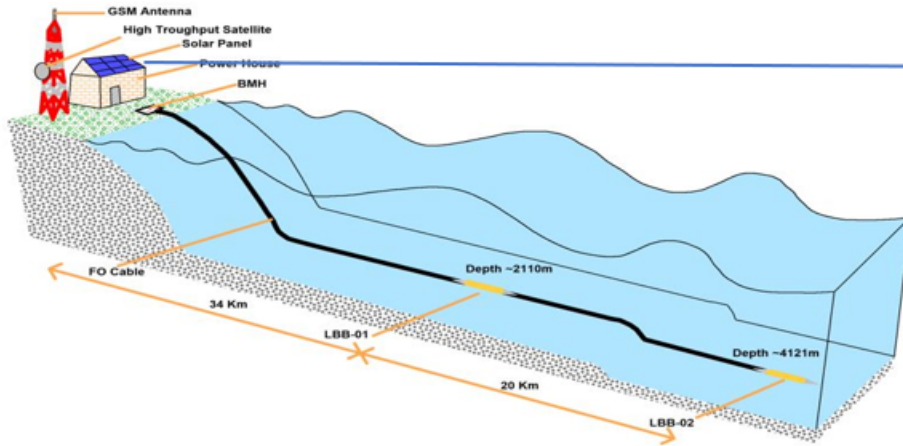
*( was also presented in the 40th Data Buoy Cooperation Panel, Oct 2024)*

**Dr. Wahyu W. Pandoe**  
**Indonesia National Committee of IOC-UNESCO Programme**  
**National Research and Innovation Agency - BRIN**

- Effective for Near Field and Atypical Tsunami
- Can be integrated with ocean bottom seismic sensors (OBS)
- High data sampling rate
- Fast data transmission
- Life time expectation > 20yrs,
- no need yearly regular maintenance except the Landing Station
- NO | vandalisms
- International efforts:
  - SMART Cable System (JTF WMO-IOC-ITU)
  - Japan: S-NET, DONET
  - USA: MARS Landing System
  - **Indonesia: InaCBT**
  - India: .....



# Configuration InaCBT

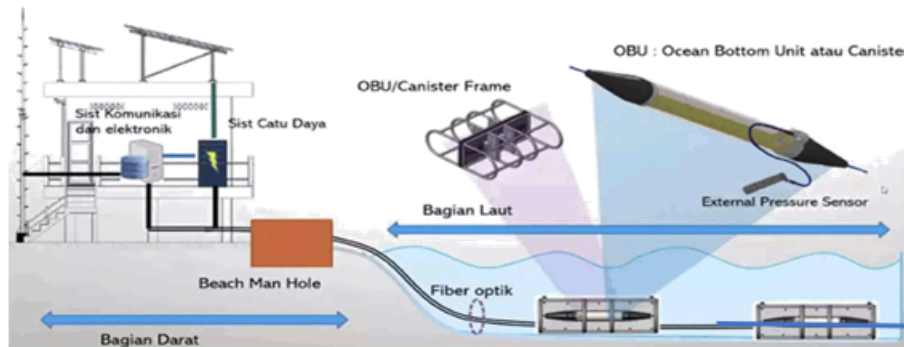


Landing Station (LS)

## Location: Labuan Bajo – Flores Sea.

- Deployment: February 2022
- Operating since: February 2022
- Sensors (now):

- Precise Pressure Gauge (1Hz)
- 3D Accelerometer (125Hz)
- Temperature



extend to  
2nd LS  
(optional)

# Cable-based Tsunami & EQ Detection:

*Ina-CBT (Indonesian Cable - based Tsunameter)*

**Location: Labuan Bajo – L. Flores.**

Length: 54 km (LBB-01 34km + LBB-02 20km)

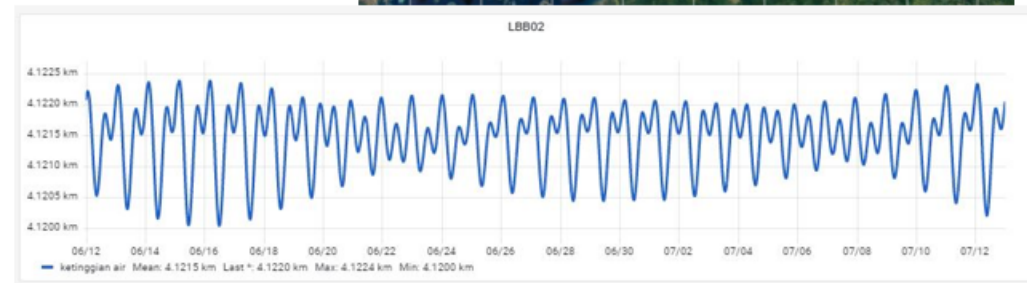
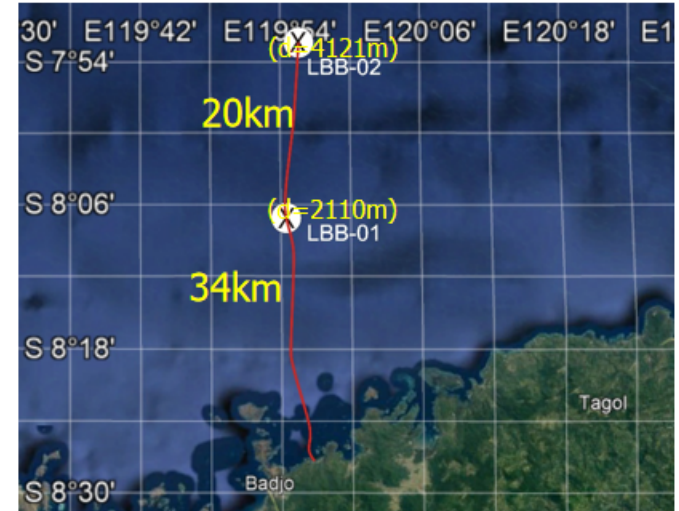
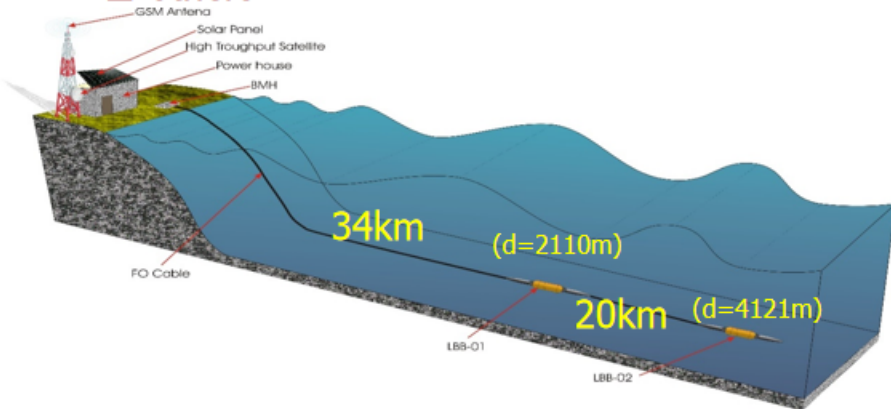
• Operating since: February 2022

• Sensors (InaCBT):

- Precise Pressure Gauge (1Hz)
- 3D Accelerometer (125Hz)
- Temperature

• Add 'optional' Sensors (MHEWS):

- Ocean Bottom Seismometer (OBS)
- Hydrophone
- others

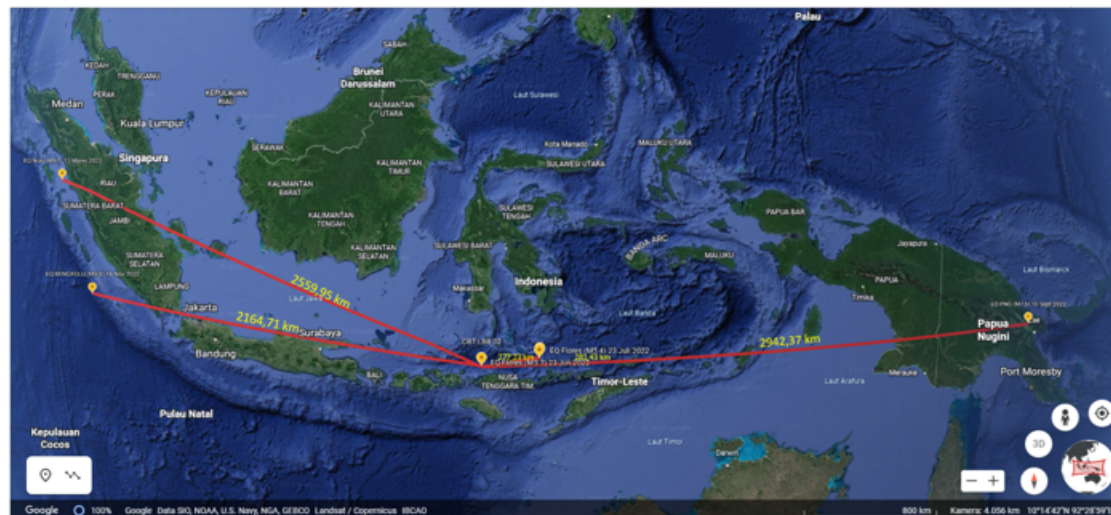
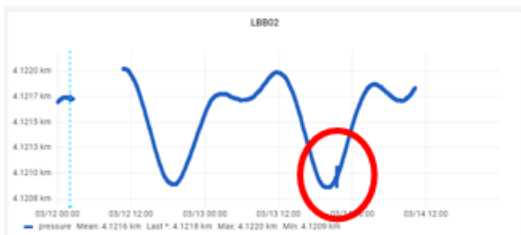


## Jarak Episenter Gempa Terhadap CBT LBB 02

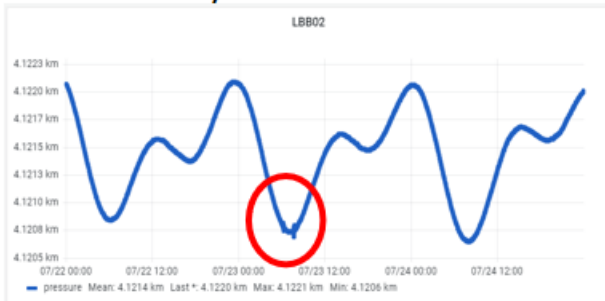
EQ Nias (M6.7)	2559,95 km
EQ Flores (M5.7)	281,43 km
EQ Flores (M5.4)	277,23 km
EQ PNG (M7.6)	2942,37 km
EQ BKG (M6.8)	2164,71 km

# Epicenters of EQs which were detected by InaCBT

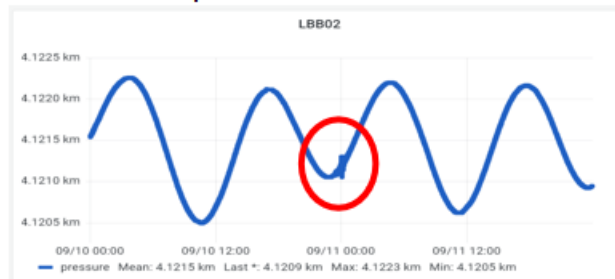
13 March 2022 21.09 UTC



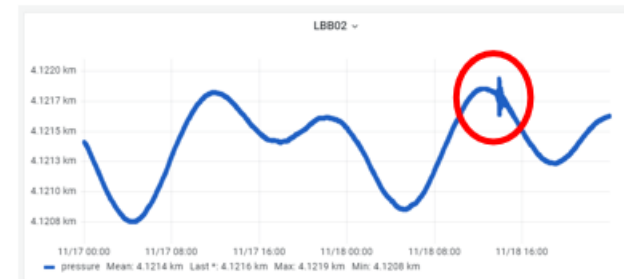
23 July 2022 06.09 UTC



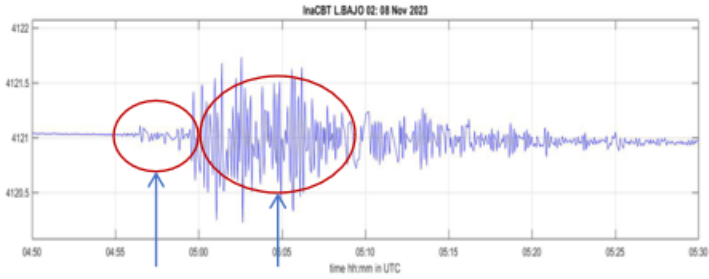
10 September 2022 23.47 UTC



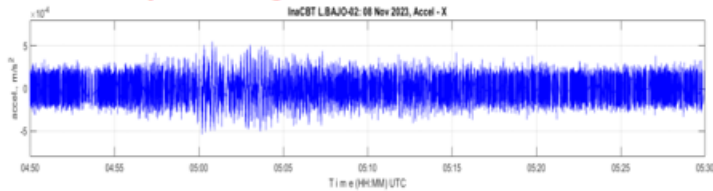
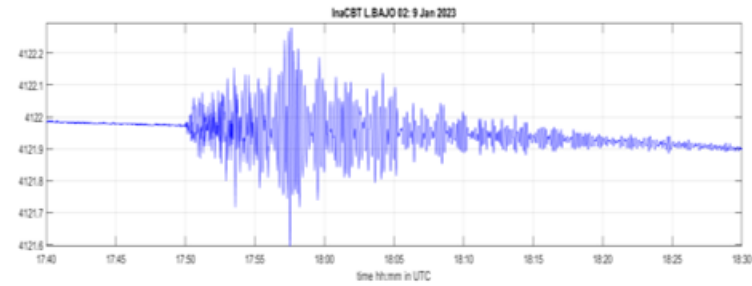
18 November 2022 20:37 UTC



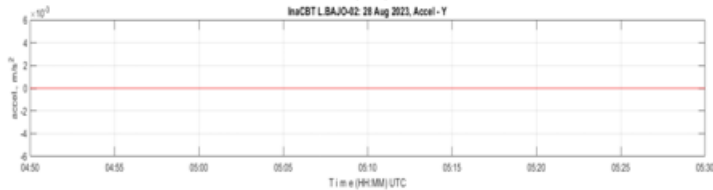
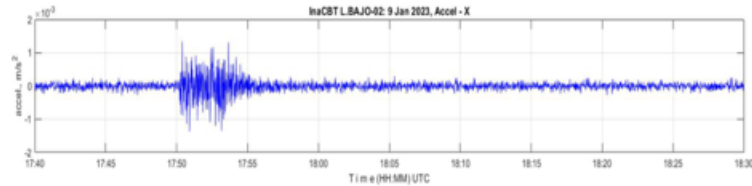
**Vs**



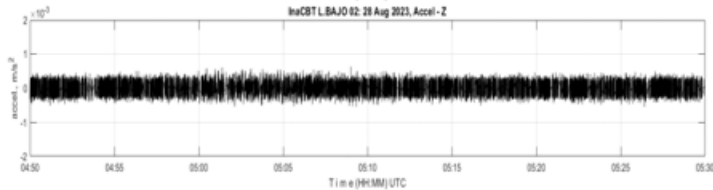
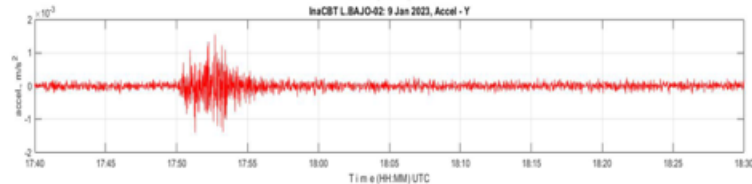
**Pressure**



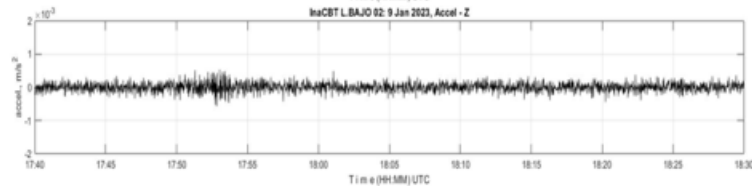
**Accel-x**



**Accel-y**



**Accel-z**



**Q: How to identify P, S, Surface and other Waves ?**

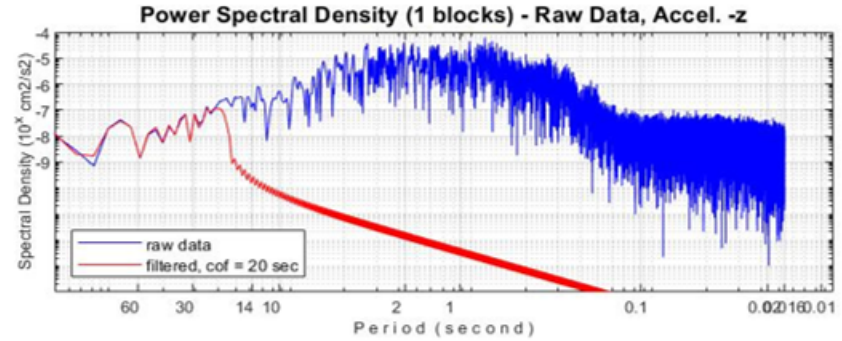
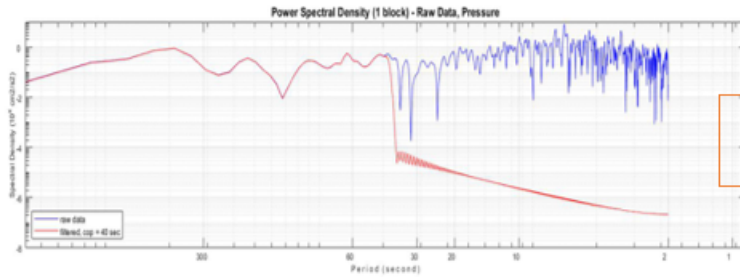
# EQ Aru 08 Nov 2023

Vs

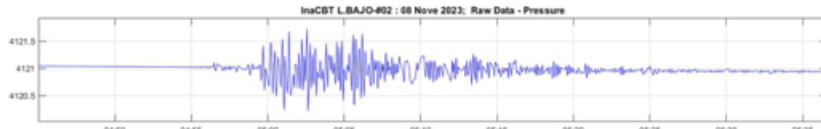
# EQ Maluku 9 Jan 2023

Pressure

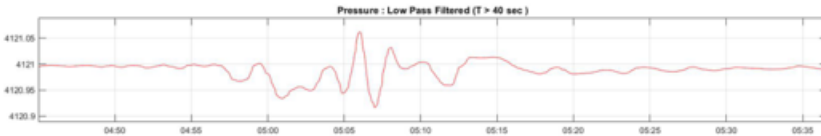
Pressure



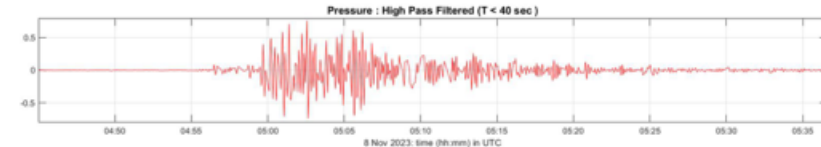
Spectral



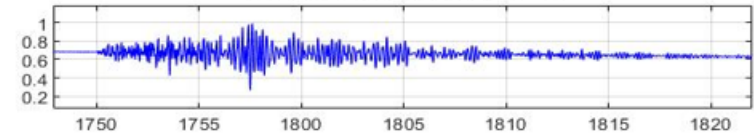
Raw



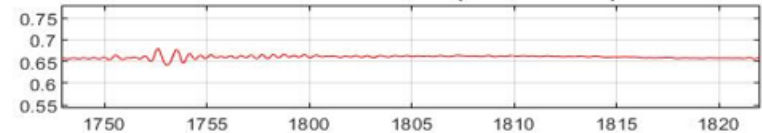
LowF



HighF

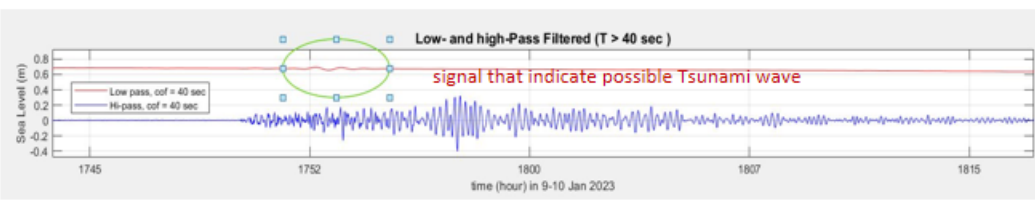
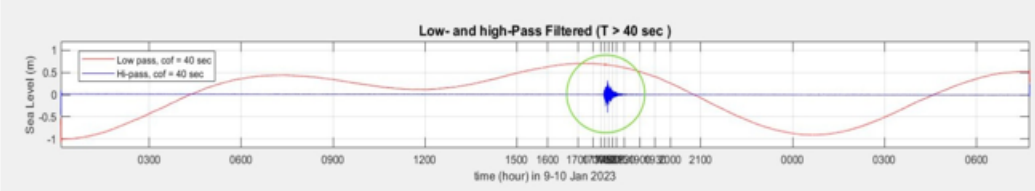
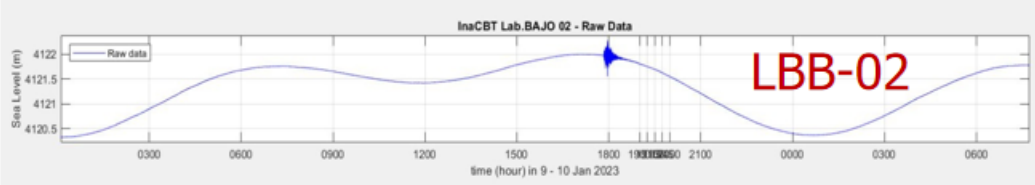
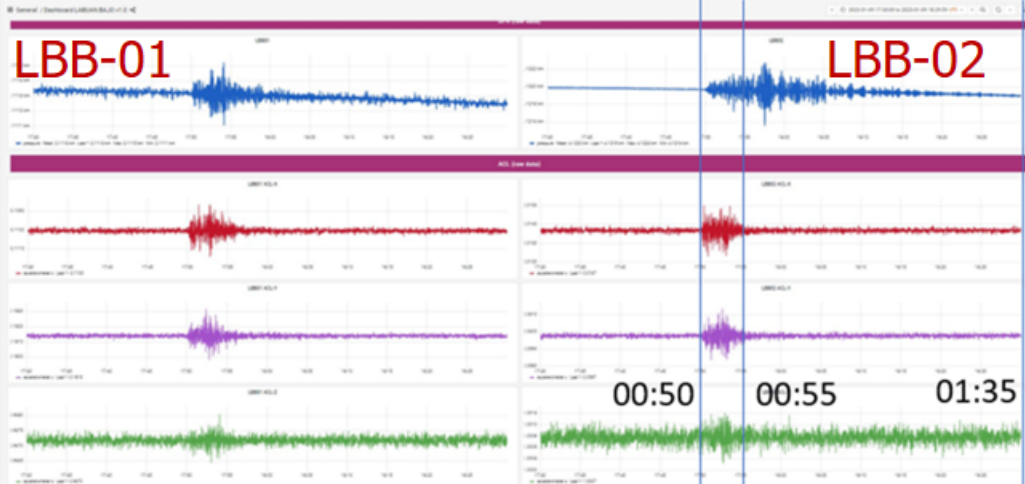


Low Pass Filtered (T > 30 sec)



High Pass Filtered (T < 30 sec)

# Observation on event: Maluku EQ, 9 Jan 2023



**7.9** WARNING TSUNAMI PD-1  
WAKTU GEMPABUMI : 10-01-23 00:47:34 WIB  
Waktu pengiriman : 10/01/2023 00:52:54 WIB  
BMKG

Peta Estimasi Tsunami Berdasarkan Pemodelan  
Tinggi Muka Laut Maksimum [m]  
■ > 3 ■ 0.5-3 ■ 0-0.5



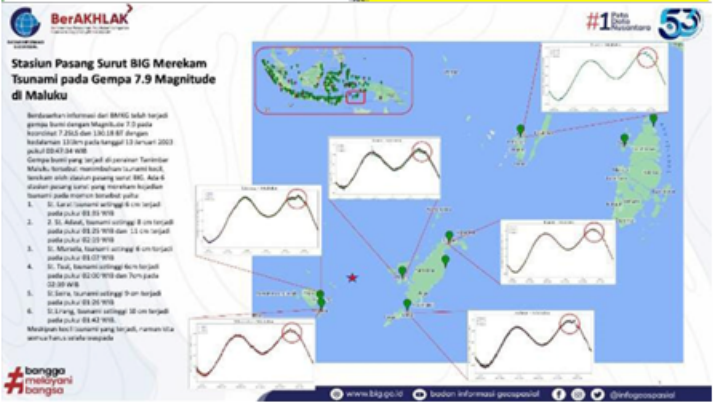
POTENSI TSUNAMI UNTUK DITERUSKAN PADA MASYARAKAT

Daerah yang berpotensi tsunami berdasarkan pemodelan :

PROVINSI	KOTA/KABUPATEN	STATUS PERINGATAN	ESTIMASI WAKTU
MALUKU	MALUKU-TENGAH	SAGA	10-01-2023 00:51:34 WIB
MALUKU	KEPULAGAN MALUKU-TENGGAH	SAGA	10-01-2023 00:55:34 WIB
MALUKU	MALUKU-TENGGAH-SARAT PYAMADENA	SAGA	10-01-2023 01:01:34 WIB
MALUKU	KOTA-AMBON	SAGA	10-01-2023 01:22:34 WIB
MALUKU	MALUKU-TENGGAH	WASPADA	10-01-2023 01:07:34 WIB

- Saran dan Arahan Status Peringatan :
- Perintah Provinsi/Kab/kota yang berada pada status "Awat" diharap memperhatikan dan segera mengarahkan masyarakat untuk melakukan evaluasi masyarakat.
  - Perintah Provinsi/Kab/kota yang berada pada status "SAGA" diharap memperhatikan dan segera mengarahkan masyarakat untuk melakukan evaluasi.
  - Perintah Provinsi/Kab/kota yang berada pada status "Waspada" diharap memperhatikan dan segera mengarahkan masyarakat untuk menjauh pantai dan tepian sungai.

BerAKHLAK  
Stasiun Pasang Surut BIG Merekam Tsunami pada Gempa 7.9 Magnitude di Maluku



berbantuan informasi dari BMKG telah terjadi gempa bumi dengan Magnitude 7.9 pada kedalaman 10 km dan 100 km dari pantai barat Maluku, tanggal 10 Januari 2023 pukul 00:47:34 WIB.

Gempa bumi yang terjadi di perairan Tumbora Maluku, berdampak signifikan ke Sumatera dan sekitarnya, akan berdampak pada gelombang tsunami yang akan pasang surut. ACEH adalah daerah yang sangat rawan terhadap tsunami, maka berikut adalah daftar lokasi:

1. Sarai, tsunami tertinggi 8 cm terjadi pada pukul 01:01 WIB
2. Si. Alab, tsunami tertinggi 8 cm terjadi pada pukul 01:05 WIB dan 11 cm terjadi pada pukul 01:07 WIB
3. Mawata, tsunami tertinggi 8 cm terjadi pada pukul 01:07 WIB
4. Si. Taka, tsunami tertinggi 8 cm terjadi pada pukul 01:09 WIB dan 10 cm terjadi pada pukul 01:09 WIB
5. Si. Bana, tsunami tertinggi 8 cm terjadi pada pukul 01:20 WIB
6. Si. Wang, tsunami tertinggi 10 cm terjadi pada pukul 01:42 WIB


Melihat hasil tsunami yang terjadi, namun kita akan tahu setelah seminggu.

#bangsa melayani bangsa

Increase amplitude at tidal stations : 5-10 cm




**7.9** **WARNING TSUNAMI PD-1**  
WAKTU GEMPABUMI : 10-01-23 00:47:34 WIB  
Waktu pengiriman : 10/01/2023 00:52:54 WIB



**Peta Estimasi Tsunami Berdasarkan Perambatan**

Tinggi Muka Laut Maksimum [m]



POTENSI TSUNAMI UNTUK DITERUSKAN PADA MASYARAKAT

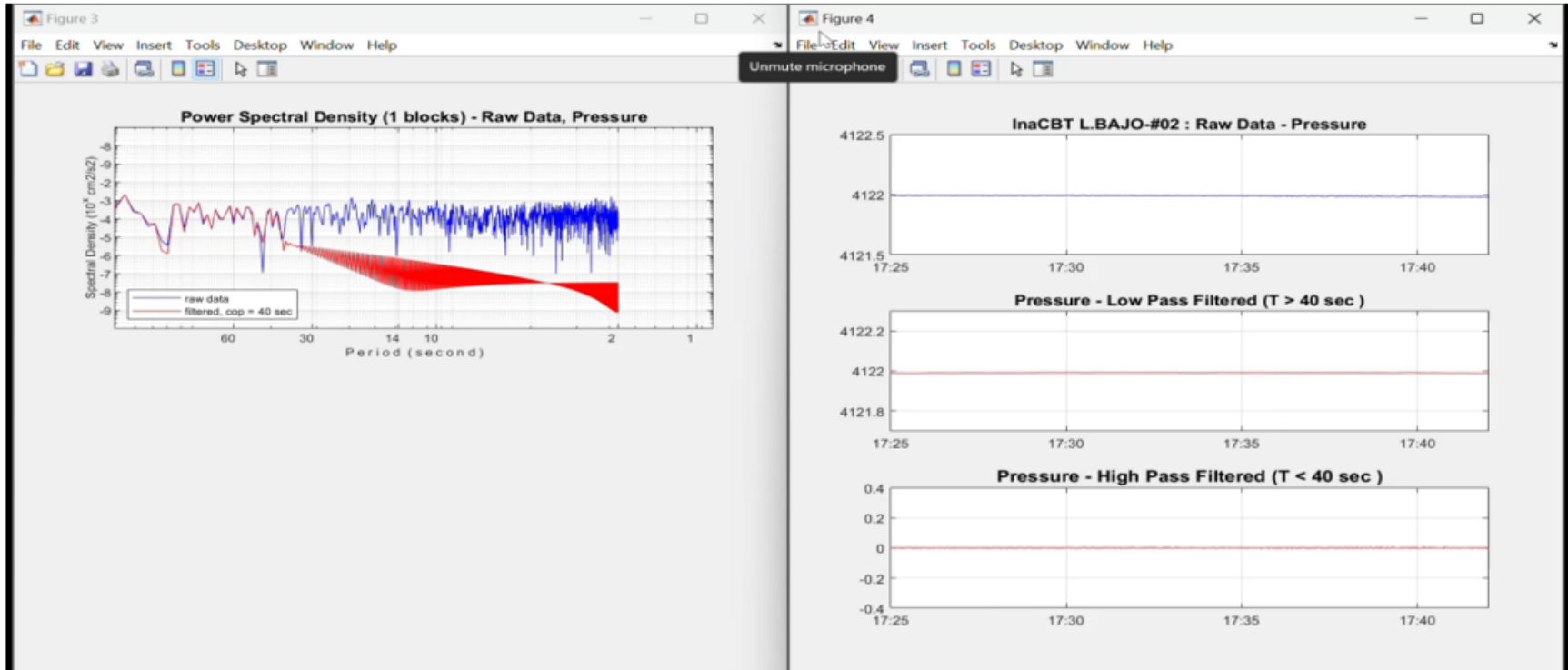
**Daerah yang berpotensi tsunami berdasarkan perambatan:**

PROVINSI	KOTA/KABUPATEN	STATUS	ESTIMASI TMM
MALUKU	MALUKU TENGAH	SIKUT	15:00:00 00:51:34 WIB
MALUKU	KEPULAUAN MALUKU-TENGARA	SIKUT	15:00:00 00:50:34 WIB
MALUKU	MALUKU TENGGARAH BARAT	SAGA	15:00:00 01:01:34 WIB
MALUKU	KOTA AMBON	SAGA	15:00:00 01:22:34 WIB
MALUKU	MALUKU TENGGARA	SIKUT	15:00:00 01:07:34 WIB

Sumber: Data Status Peringatan

- ! Perambatan: Perambatan/kuhita yang berada pada status "Siakut" yang memperhatikan dan segera mengaktifkan masyarakat untuk melakukan evakuasi
- ! Perambatan: Perambatan/kuhita yang berada pada status "Siaga" yang memperhatikan dan segera mengaktifkan masyarakat untuk melakukan evakuasi
- ! Perambatan: Perambatan/kuhita yang berada pada status "Siapaada" yang memperhatikan dan segera mengaktifkan masyarakat untuk menjadi janta dan benar-benar

- ❑ EQ event 9 Jan 2023 gives a good example how the InaCBT works well
- ❑ moving spectral (video) 9 Jan 2023 EQ event



- ❑ InaCBT is still in the research / experimental stage
- ❑ How to distinguish EQ source: seismic vs non seismic Tsunami ?
- ❑ How to distinguish Primary, Secondary, Surface and other waves ?
- ❑ Consider:
  - Each type of wave can be classified by range of frequency, period and duration of the wave generation
  - Input/feeding for the numerical model
  - Requires high sampling rates sea level monitoring

## Related Publications

- Privadi, A., Damara, D. R., Widati, P. L. & Triputra, F. R. 2021. Indonesia's Cable Based Tsunameter (CBT) System as an Earthquake Disaster Mitigation System in East Nusa Tenggara. Proceeding - 2021 IEEE Ocean Engineering Technology and Innovation Conference: Ocean Observation, Technology and Innovation in Support of Ocean Decade of Science, OETIC 2021 (pp. 63-67), Jakarta. DOI: <https://doi.org/10.1109/OETIC53770.2021.9733734>
- Purwoadi, M. A., Anantasena, Y., Pandoe, W. W., Widodo, J. & Sakya, A. E. 2023. Introduction to Indonesian Cable-based Subsea Tsunameter. 2023 IEEE International Symposium on Underwater Technology, UT 2023, March (pp. 1-6), Tokyo. DOI: <https://doi.org/10.1109/UT49729.2023.10103368>
- Shinohara, M., Yamada, T., Sakai, S., Shiobara, H. & Kanazawa, T. 2015. New ocean bottom cabled seismic and tsunami observation system enhanced by ICT. 2014 Oceans - St. John's, OCEANS 2014, St. John's. DOI: <https://doi.org/10.1109/OCEANS.2014.7003045>
- Wahyu W. Pandoe, Michael A. Purwoadi, Zulfa Qonita, Alfi Rusdiansyah, Aris Suwarjono. 2024. Indonesia Cable-Based Tsunameter (InaCBT): Tsunami Detection and Identification on Other Seismic Wave Signals. Ocean and Coastal Research, *accepted*.

A blue and white research vessel is sailing on the ocean. The vessel has a white superstructure and a blue hull. It is positioned in the center-left of the frame. The background features a dark, forested coastline under a blue sky with light clouds. The water is a deep blue with gentle ripples.

**TERIMA KASIH**

KR.Baruna Jaya IV-BPPT  
Perairan Gunung Anak Krakatau  
12 April 2019