
# DONNÉES D'IMAGERIE MARINE

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REM/BEEP/LEP

ODATIS

ATELIER TECHNIQUE #13 – 9 JUIN 2022

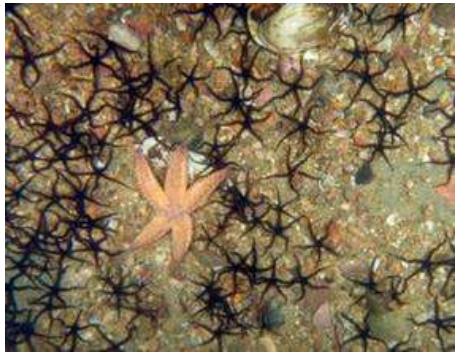
# Imagery is a widely used tool

Coastal zones & lagoons

Fisheries

Deep sea

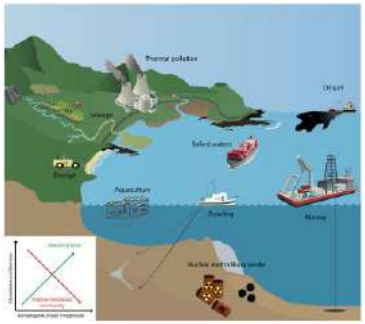
Benthos
Plankton
Nekton



# Underwater imagery data

**Imaging data**
=
images + extracted information

| Images | Metadata | Image-derived data |
|---|---|---|
| Still images 2D/3D | Origin of acquisition/sampling | Taxa occurrence |
| Video | Cruise/Dive/Observatory | Positioning in the image (in pixels) |
| Video stereo | Position | Organism's size/volume |
| 2D Mosaïcs | Date - Time | Density |
| 3D Models | Environmental parameters | Abundance |
| | | Substrate type and cover |
| … | … | … |



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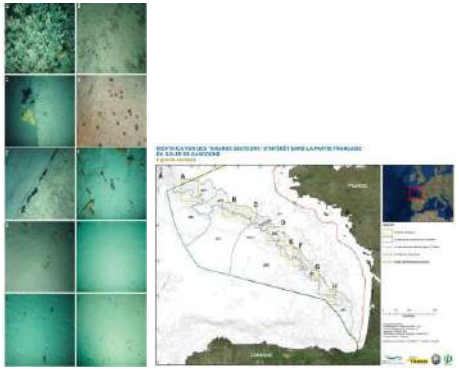
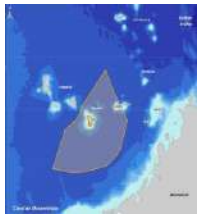


Ecological/biodiversity studies

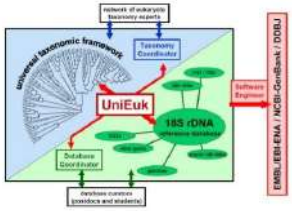
Proposition and management of conservation areas (MPA)



Monitoring of ecosystems

Build reference (curated) training datasets for machine learning

Make the link between morphology and genes

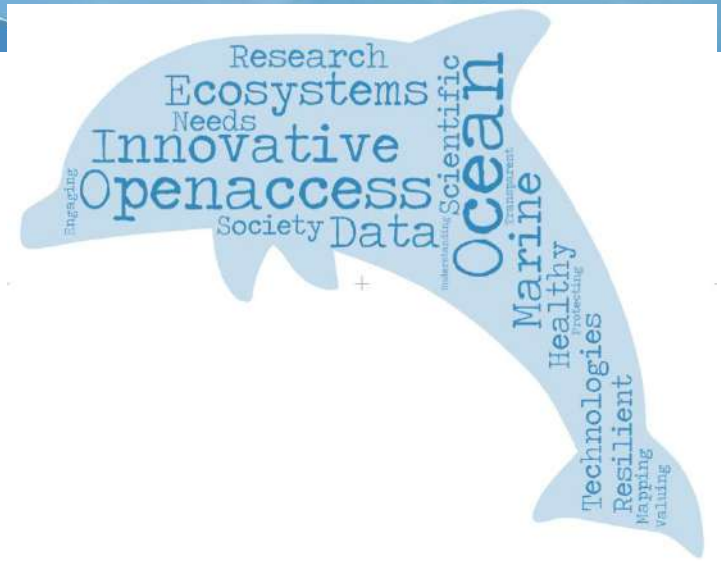



Share with the scientific community,
make data available to any end-user

These applications are generally based on standardized and open access depositories with morphology, functional and genetic information

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

A unifying framework for achieving ocean-related 2030 priorities




## Priority variables are Essential Biodiversity Variables (EBV)

### Documenting EBVs: information needs

- ecologically relevant and for all facets of biodiversity
- locally-relevant & scalable
- non-impacting
- Findable, Accessible, Interoperable & Reproducible (FAIR)

**Imagery and particularly optical imagery provides a wealth of ecological data that can be shared and understood by the society**

# The CAMERA project example

**ZooCAM**

Classification & counting of zooplankton

**PAGURE**

Classification & counting of benthos

**STAVIRO**

Identification & counting of fishes
Description of habitats

**HoloSea camera**

Identification & counting of meiofauna

**DEEP-SEEDS**

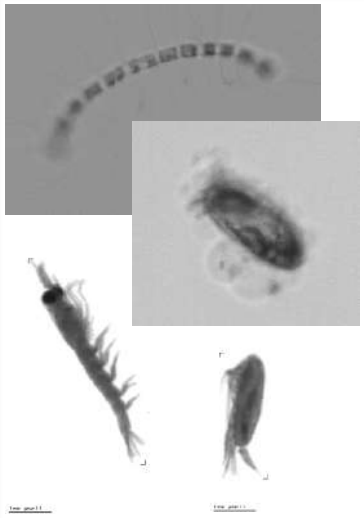
Collect rare and unknown colonizating life-stages

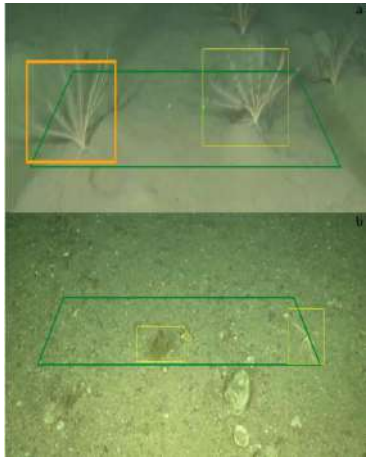
## Scientific challenges

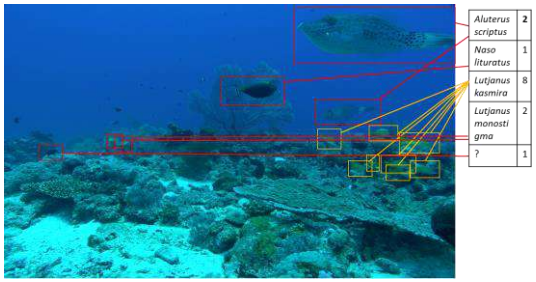
| | | | | |
|---|---|---|---|---|
| Enhancing the system capability to distinguish species | Develop capability to distinguish & identify objects | Efficient fish detection and counting<br>Fish measurements | Accelerate meiofauna biodiversity assessment | Characterize colonization processes of the deep-sea |

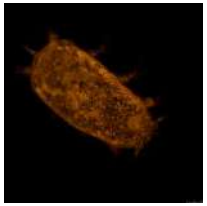
## Technological innovations

| | | | | |
|---|---|---|---|---|
| Multispectral & multiangle imaging | Low cost and modular tools | Low cost-high quality compatible system<br>Stereo version for size information | Meiofauna extraction from sediment before injection through holographic camera | Design a multiparameter and versatile platform |





**Diversity of practices, tools and information extracted from images**

*Taxonomic groups, position, location, count, size & size-related traits, behaviour, benthic categories, fluorescence,...*

**Detection and contouring** | **Identification/classification** | **Measurements**

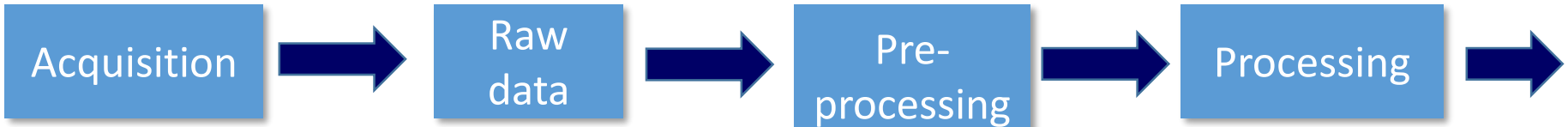
**of organisms/habitats/objects**

**Standardization** of methods, tools and annotated datasets

**A.I. algorithms-based tools optimized** for powerful results in interdisciplinary work on imagery

Serving **ecosystemic approaches & scientific questions on marine biodiversity**

# General imaging data workflow




- Different sources & Formats
- Transect video
- Stereo video, rotative, 3D
- Still images
- Images micro/mesoplankton/ meiofauna

- Mass storage
- Shared « raw » data base
- Standard format including metadata & georeferencing
- To build on existing data infrastructures

- Correction (color, illumination… )
- Image extraction from videos
- Transcoding

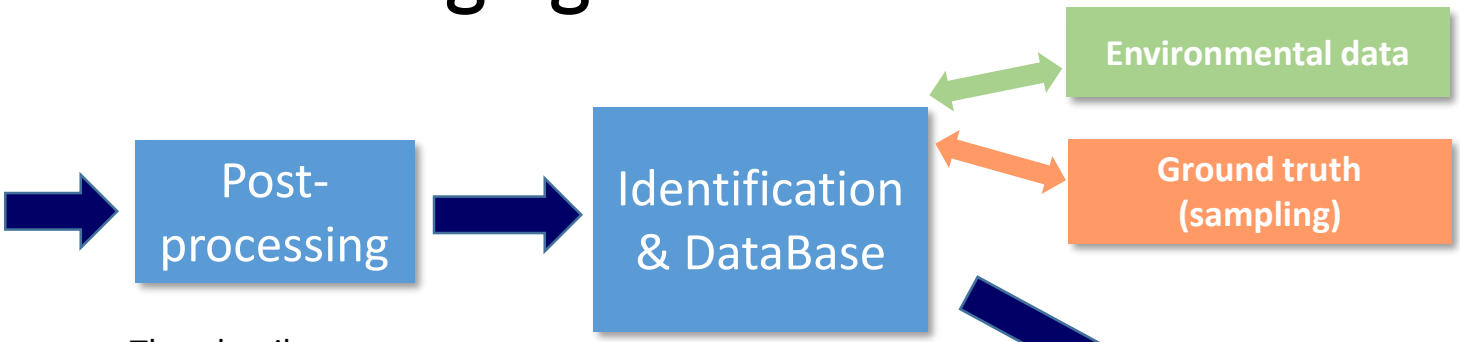
- Mosaicks/ reconstruction (2D/3D)

**- Pas complètement résolu pour les approches temporelles**
**- Pas de solution opérationnelle pour l'étude de certains compartiments (par exemple les larves)**

**- Volumes de données difficilement manipulables et générés de façon exponentielle (espaces de stockage à organiser)**
**- Formats divers**

**- Nécessite des espaces de travail et des ressources en calcul conséquentes, encore difficilement disponibles**

# General imaging data workflow




- Thumbnails extraction algorithms/ segmentation
- Open access reference libraries (basis for the image qualification/identification process)

- Objects identification
- Variable extraction: size, volume, etc.
- Libraries of analysis/identification algorithms
- Shared datasets platform

Products

- Maps
- Chronology
- Catalogs of imaging data

Automation & Modelisation

- **Processus encore très manuels et chronophages**
- **Données non centralisées (donc difficilement partagées)**
- **Manque de standardisation des méthodes**

# An association of ecologists and computer scientists

- Digital images are **data for scientific research**
- Quantitative imaging yields **huge datasets** which processing is long and still largely manual
- The data generated is often **scattered**, not interoperable (variety of annotation tools)
- Quantitative imaging can help if current efforts are made **interoperable** and the increasing amount of data can be efficiently used
- **Machine learning can accelerate image classification** in particular deep-learning
- In ecological images, the information is often **taxonomical**

# Structuring communities

## National level

**IMEV**

**Station Biologique de Roscoff/UPMC**

**MNHN**

**ex-ALLOHa** (Ifremer, LabSTICC, ISEN)

**GDR Ecostat** (workshop « ImaginEcology » )

…

## International level

**Germany** (Bielefeld Univ., GEOMAR)

**UK** (NOCS)

**Australia** (CSIRO, UTAS)

**USA** (MBARI)

**Canada** (ONC)

**Japon** (JAMSTEC)

**Marine Imaging Workshop**

…

**European Infrastructures & Ocean Networks Canada**

Context for integrated and innovative developments

**GEOBON – MBON**

# Ifremer projects

## Interdisciplinary projects

***Citizen sciences***
Extended platform of citizen image analyses: multi-ecosystems

***Quatre A***
Sharing image-derived biodiversity data between Australian and French researchers

***CAMERA****
Cross-cutting imagery project from acquisition to identification

***Imagery working group***
Animation and communication throughout the institute

## A.I. & 3D

***BLUE REVOLUTION***
Biodiversity underestimation in our bLUe planEt: artificial intelligence REVOLUTION in benthic taxonomy

***DeeSCoVR****
Deep Sea Collaborative Virtual Reality

***TIAMAT*****
Bilateral project for BIIGLE co-development

***Game of Trawls***
Giving Artificial Monitoring intElligence tO Fishing TRAWLS

***Recif 3D***
Coral reef characterization using 3D multi and hyperspectral images

## Acquisition technologies

***Observatories***
Bay of Biscay, Mayotte, New-Caledonia

***Deep'Seannovation***
ROV innovative imagery tools

***KOSMOS***

## Integrated approaches

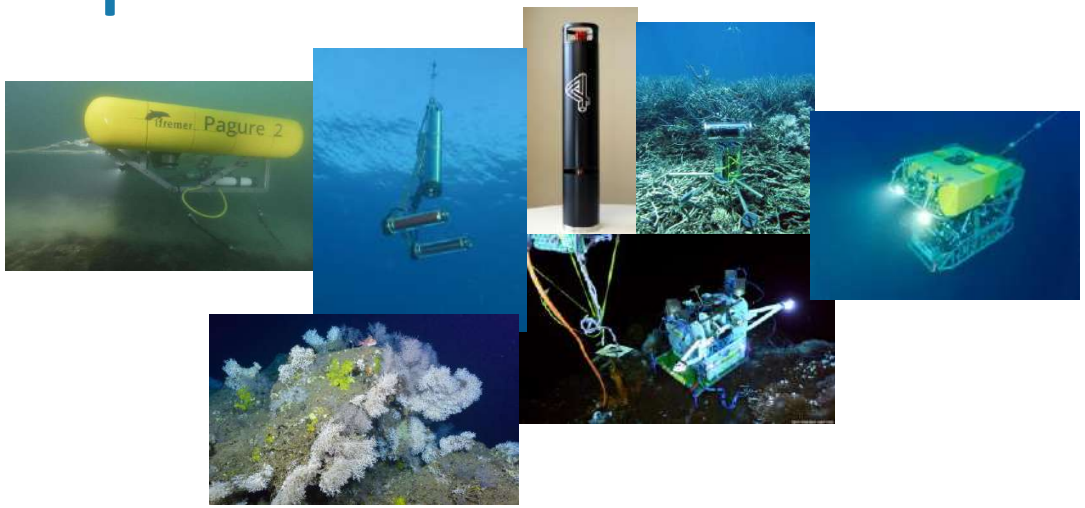
***INTESEAM****
INTegrated approaches in SEAMount ecology research

**not funded; ***submitted*

# Merci pour votre attention

# Acquisition

Underwater imagery




Laboratory imagery

Satellite & Aerial imagery

# Acquisition : technical specificities

Different acquisition systems (cameras, microscopes,…)

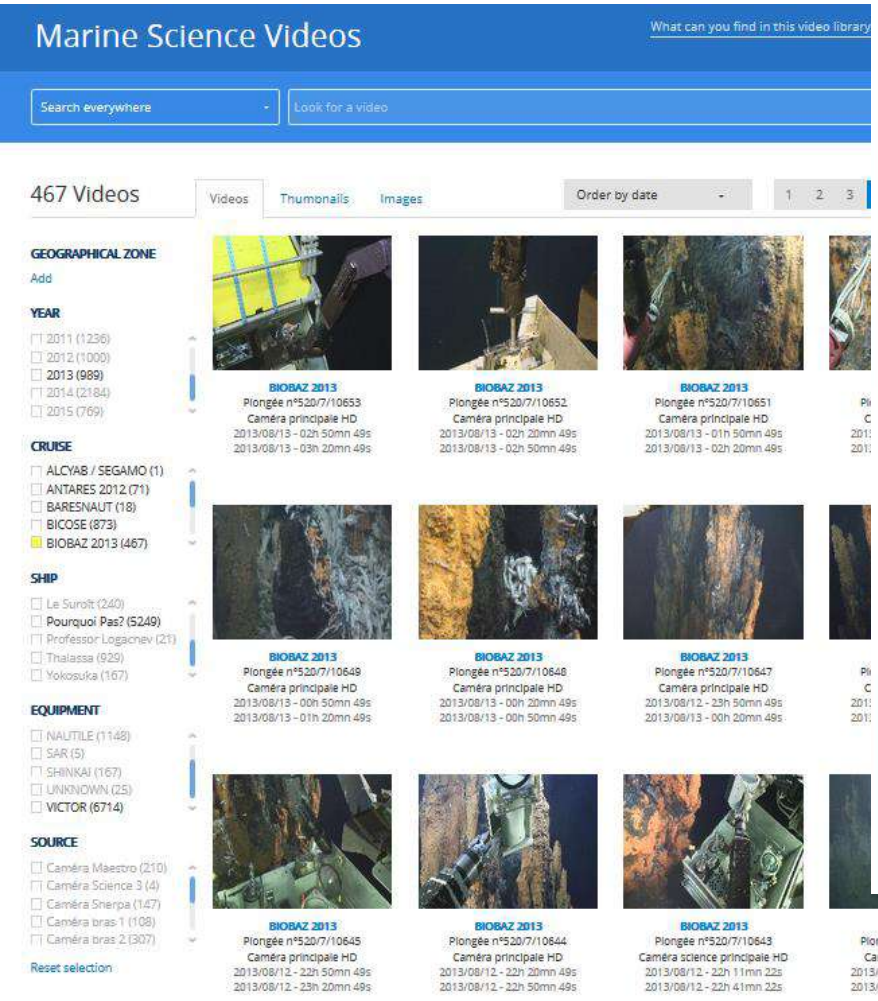
Different formats : mpeg4, PAL, avi, mkv, lif…

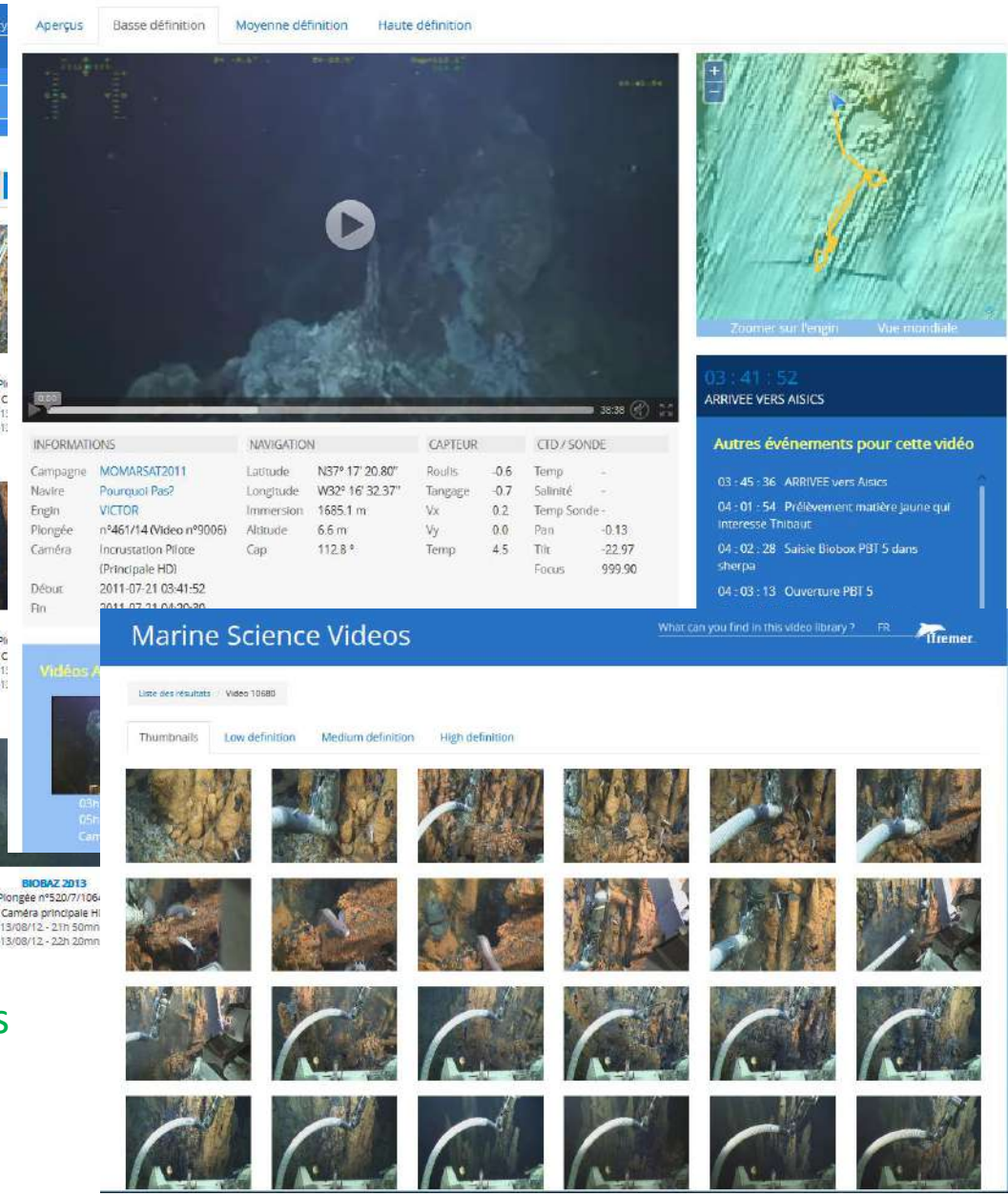
Different storage, energy and triggering systems

Different equipment : Laser, LED lighting…

2D/3D

# Accès aux données




Images et vidéos des engins sous-marins

Métadonnées associées

PAS les données extraites

# Les logiciels d'analyse

3DMetrics

ADELIE

ImageJ

Image Processing & Analysis in Java

DEEP SEA Spy

Avinote

BIIGLE

EventMeasure

# Imaging data are science data

- **Growing popularity** of optical imagery for marine observation of biodiversity

- Flow of raw images **to be processed and managed** to produce meaningful scientific evidence and disseminate it

- **Proliferation of protocols** and sharp increase in **data volumes**

- Considerable time, effort, and expertise is needed to create annotations. The **value of these annotations**, beyond their initial intended purpose, is lost if they cannot be **shared and archived**

# Objectives of the CAMERA project

1. Innovative improvements for existing imaging systems
2. Automation of image annotation for marine biodiversity
3. Standardized/consistent procedures and data workflows
4. Methods to facilitate data & knowledge sharing
5. Innovative integrated data analyses enabled by standardization

# WP4 - Demonstration, *dissemination & data sharing*

ZooCAM

PAGURE

STAVIRO

HoloSea camera

DEEP-SEEDS

## Test of the WorkFlow

**Pelgas** : planktonic communities

**Evhoe** : benthic communities & habitats

**Kosmos-Staviro** : bentho-demersal habitats & fish communities

**Marha + EMSO-Açores** : deep-sea larvae, recruits and meiofauna & environmental variables

**Elaboration of a multidisciplinary data portal : images & data**