



Photogrammétrie libre open source avec MICMAC

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Qu'est-ce que la photogrammétrie ?

*The science/art/technique of doing
geometric measurements (3D model)
from photos*

Un objet que l'on veut mesurer :



Prendre beaucoup de (bonnes) photos de l'objet

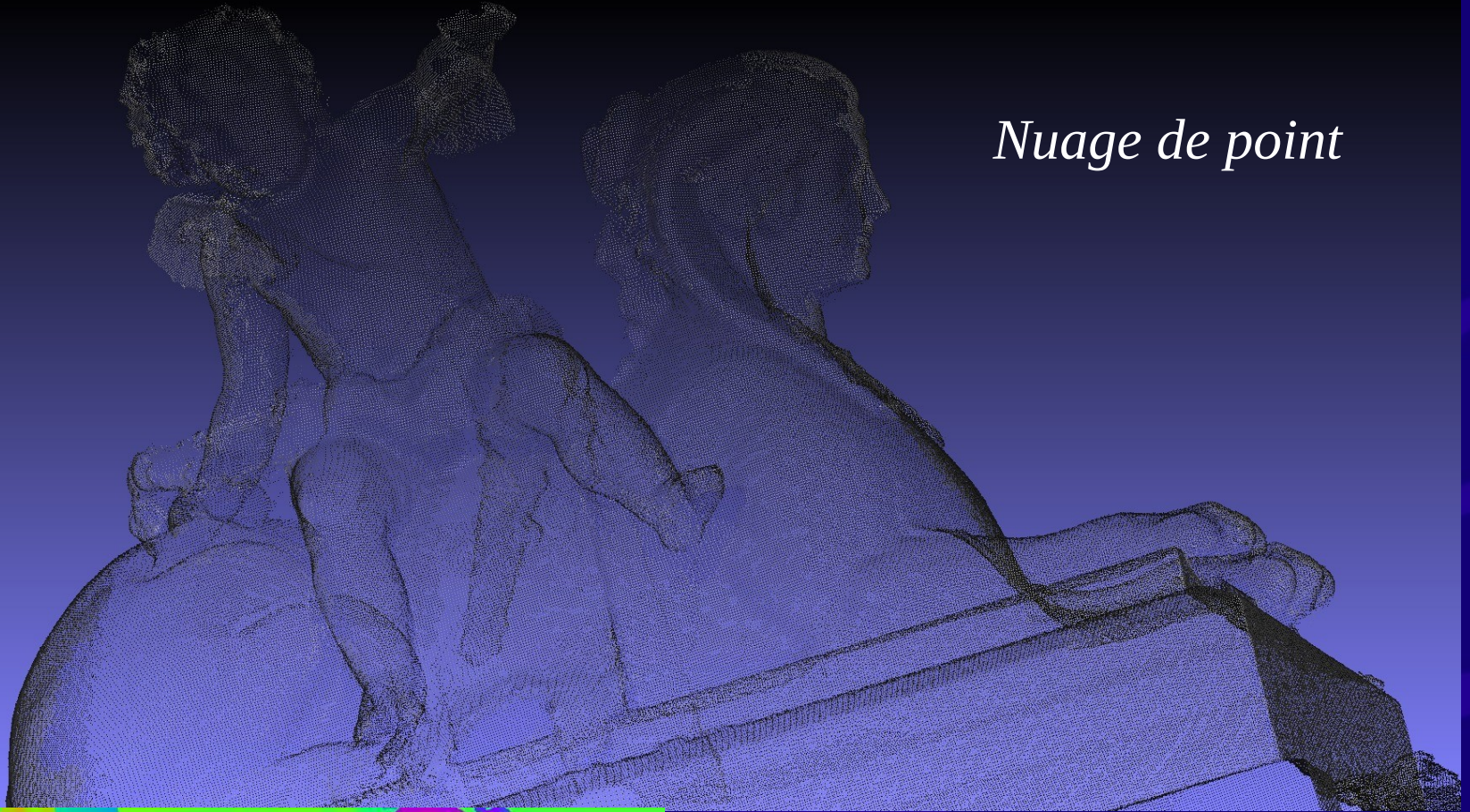


Traiter les données .

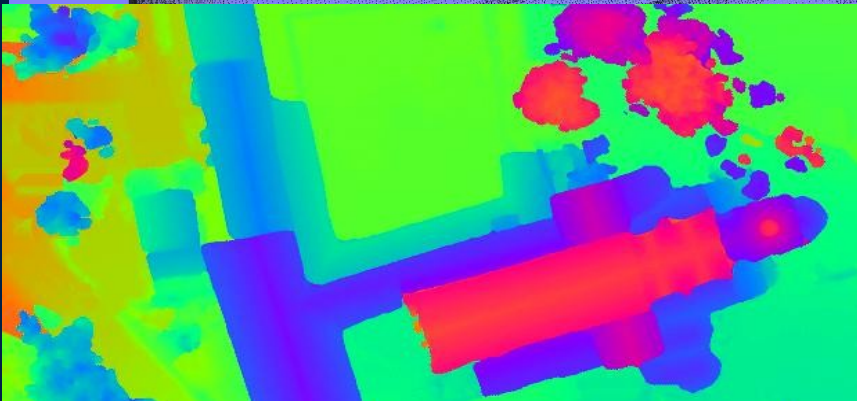


On obtient le modèle 3D

Nuage de point



*Modèle numérique
de terrain*



Nuage de point coloré



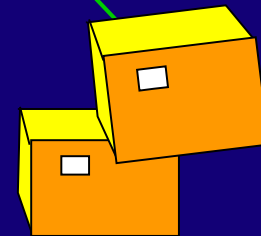
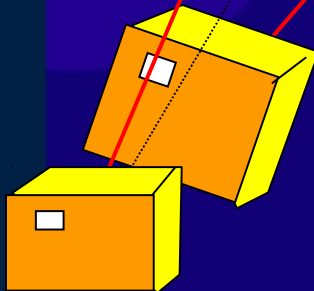
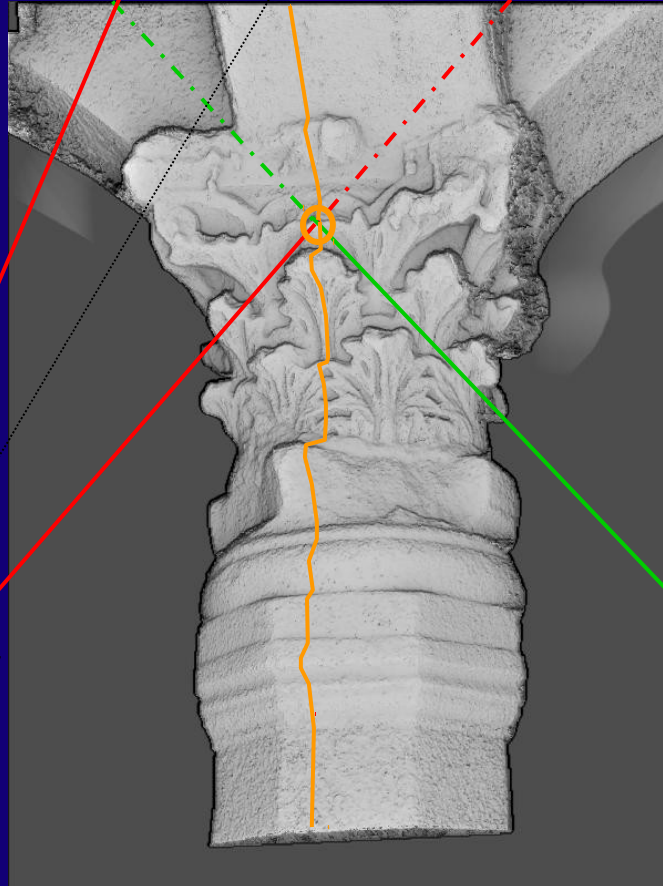
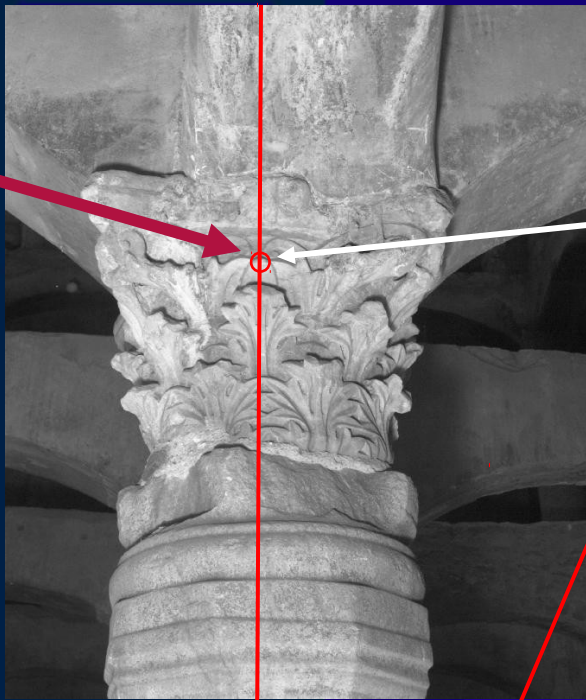
*Ortho
photographie*

Nuage de point coloré



*Ortho
photographie*

Modélisation photogrammétrique

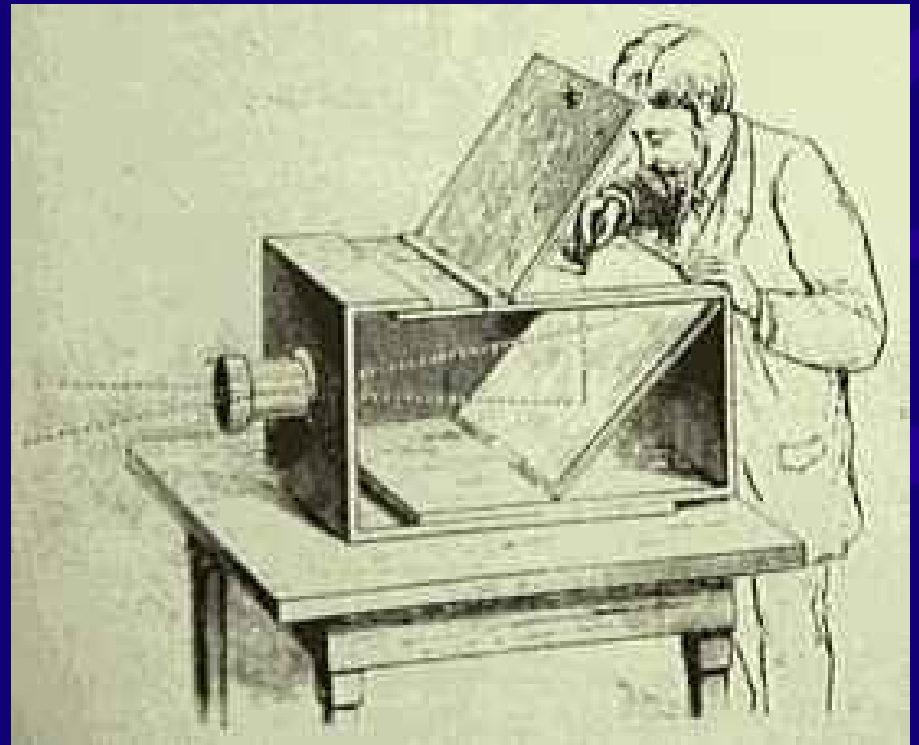


La mesure géométrique à partir d'images:

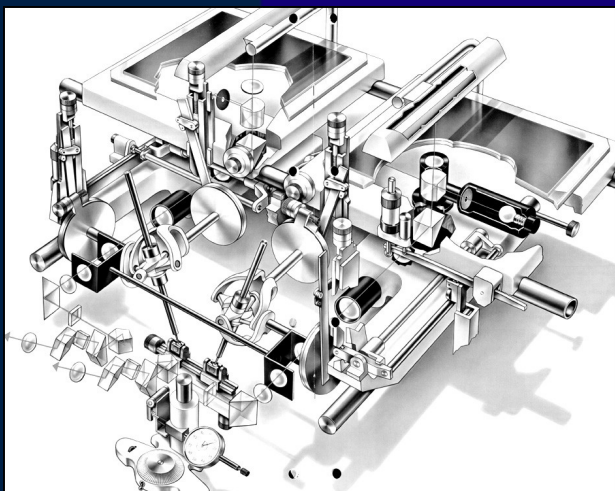
Une technique ancienne
(plus de 150 ans)



Aymé Laussedat
(1819-1907)



Up until 2000,
photogrammetry was seen **as**



An old technique



**Requiring specialized hardware
and operator**

Less accurate, automatic and complete than LIDAR
Une courte explication du lidar ?

Rupture totale depuis 5-10 ans

Contexte technologique (capteur, porteur, traitement)
en pleine mutation:

Photo numérique ;

Drone et satellites d'observation de la terre ;

Puissance de calcul (CPU-GPU-Cloud computing);

Progrès méthodes et algorithmes (photogramétrie-vision
par ordinateur-traitement d'image).

⇒ *Moyen puissant et économique de mesure géométrique*

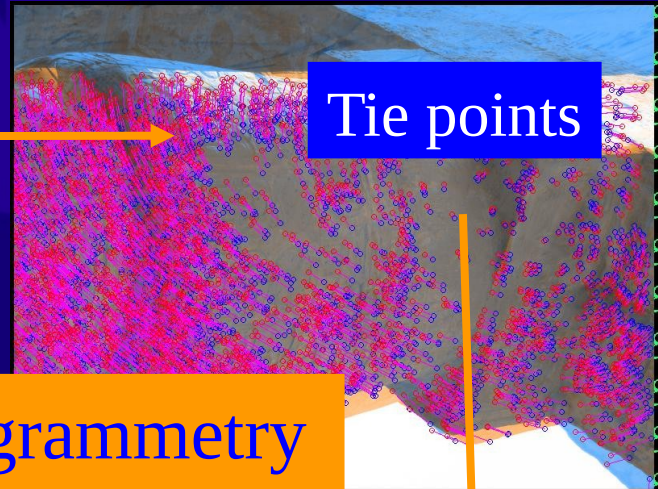
Standard processing flow for image based 3D modelization

Images processing

Images



Tie points



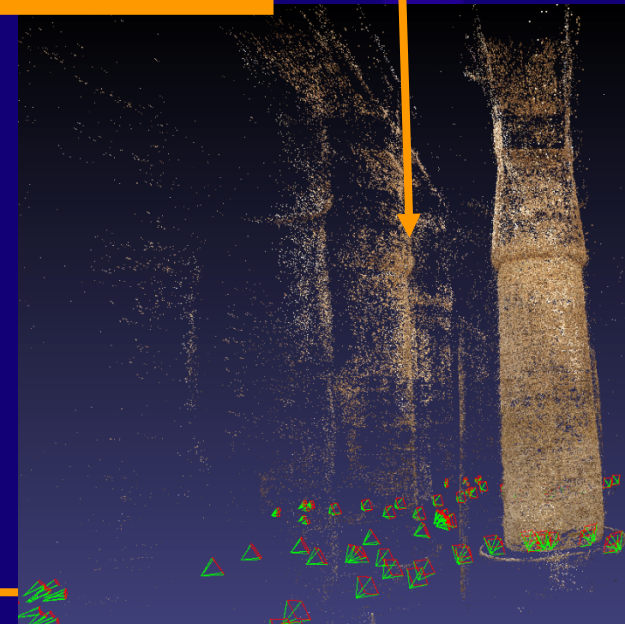
Photogrammetry
Computer vision

Dense matching

3D Model



Orientation, calibration

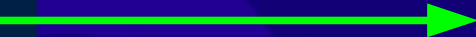
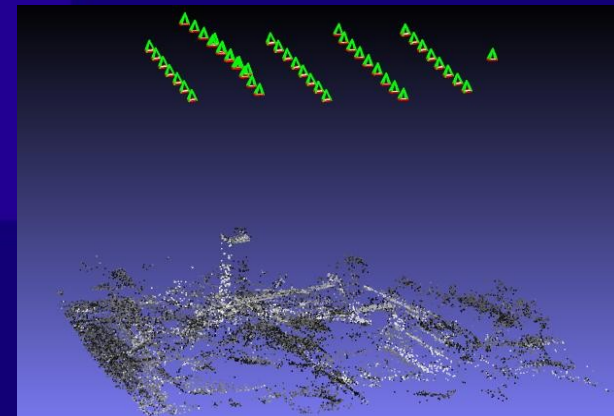
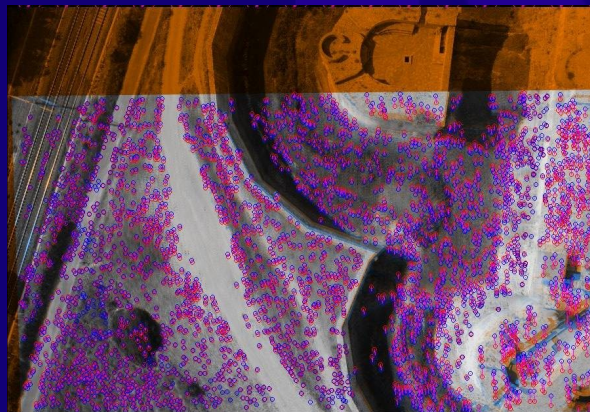




Cas aérien



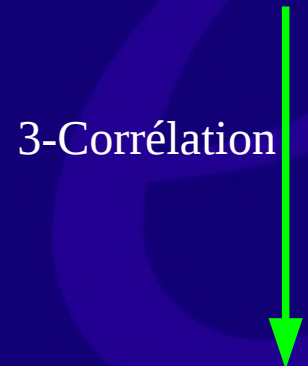




1-Points homologues



2-Orientation/Calibration



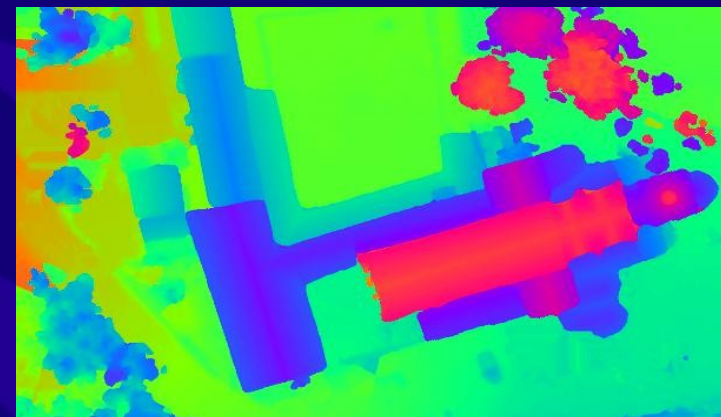
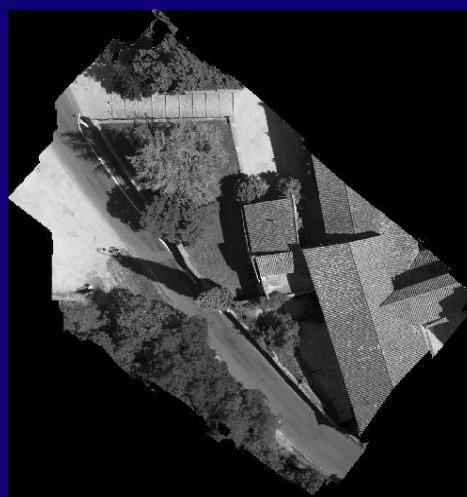
3-Corrélation

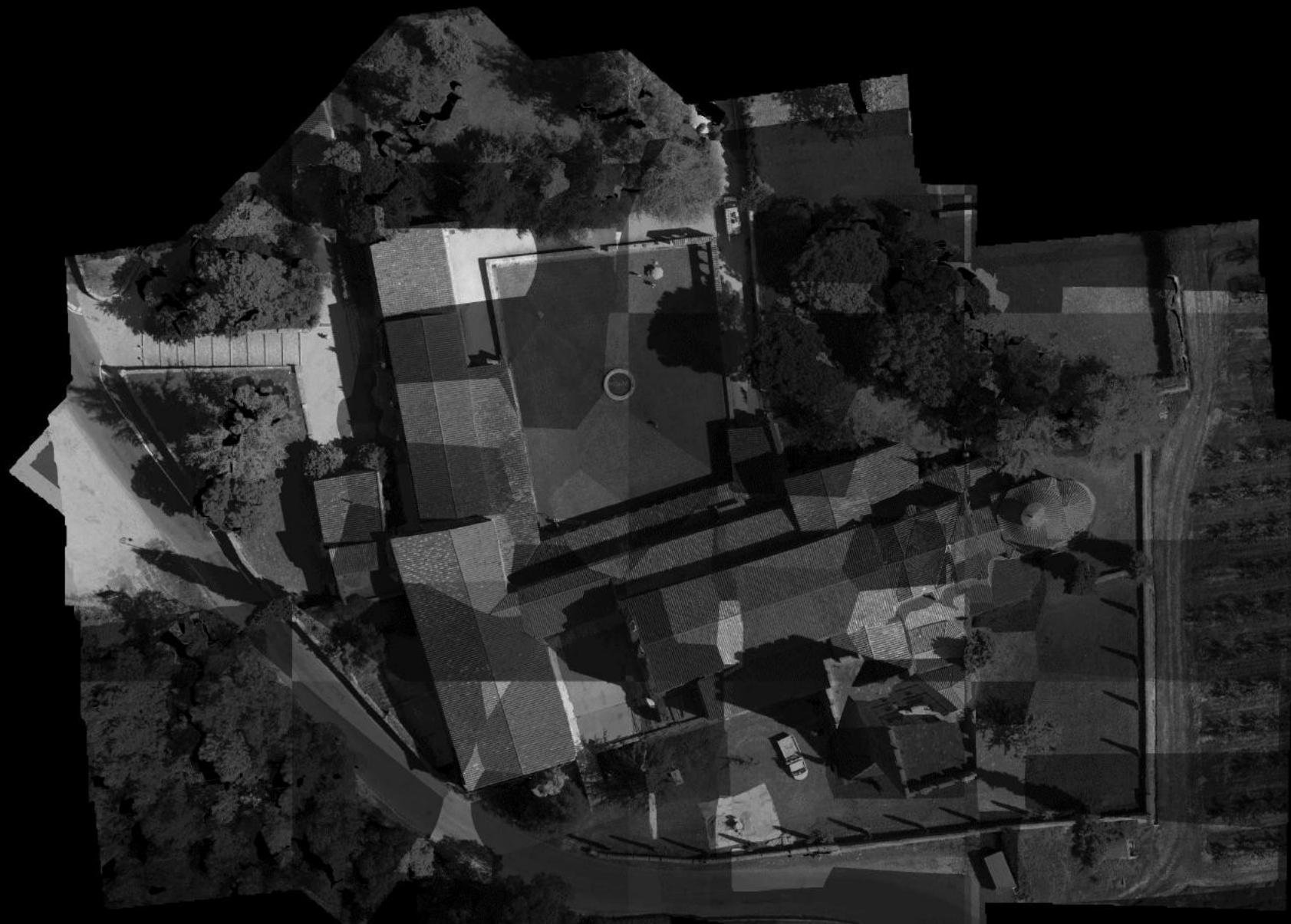


4-Ortho-rectification



5-Mosaïquage





Avec égalisation.





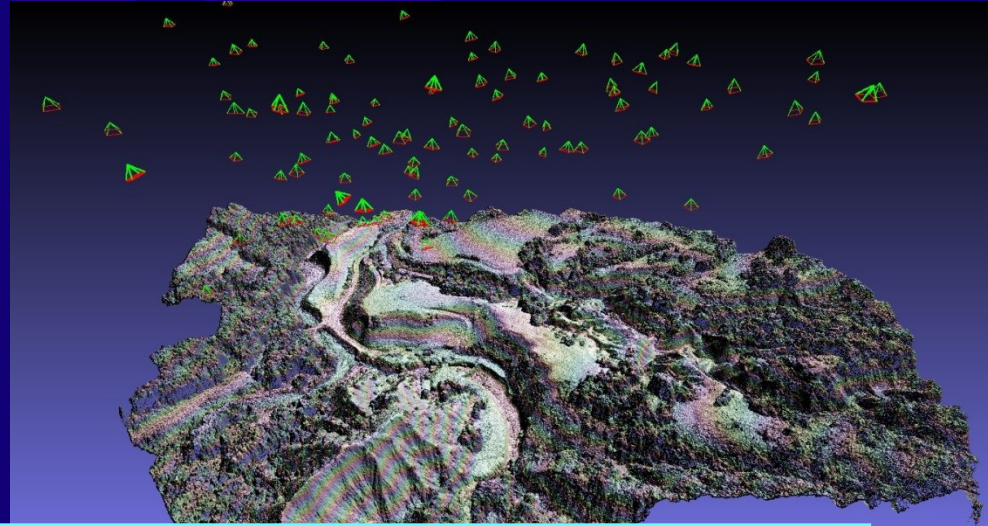
Domaines d'applications variés pour les ingénieurs, scientifiques ...

Environnement

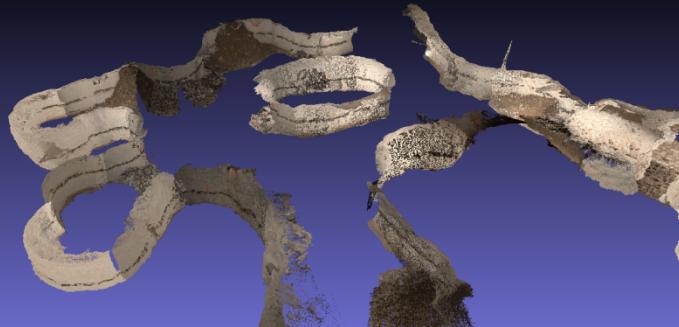
Patrimoine

Industrie

Foresterie



Surveillance de l'érosion des sols

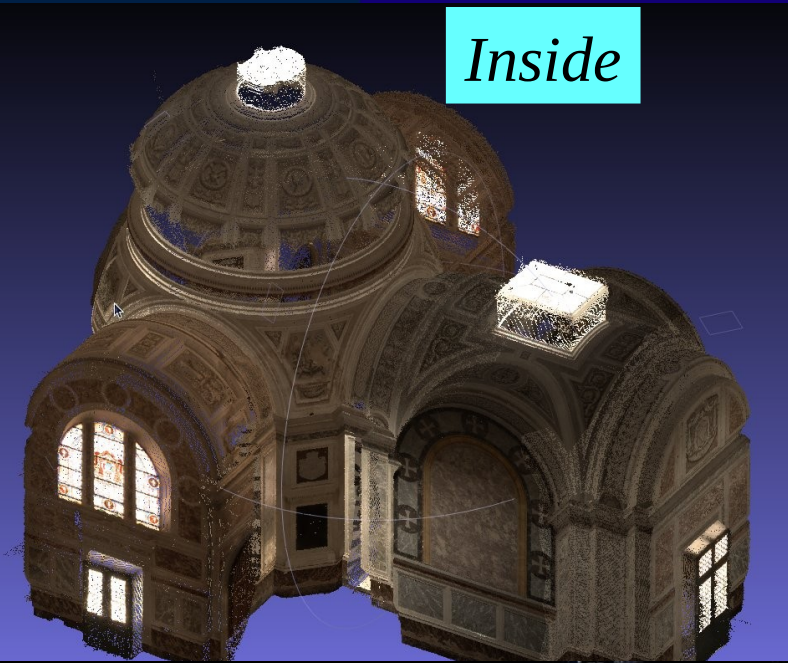


Modèles 3d de grotte



Mesure de rugosité de placettes

Inside



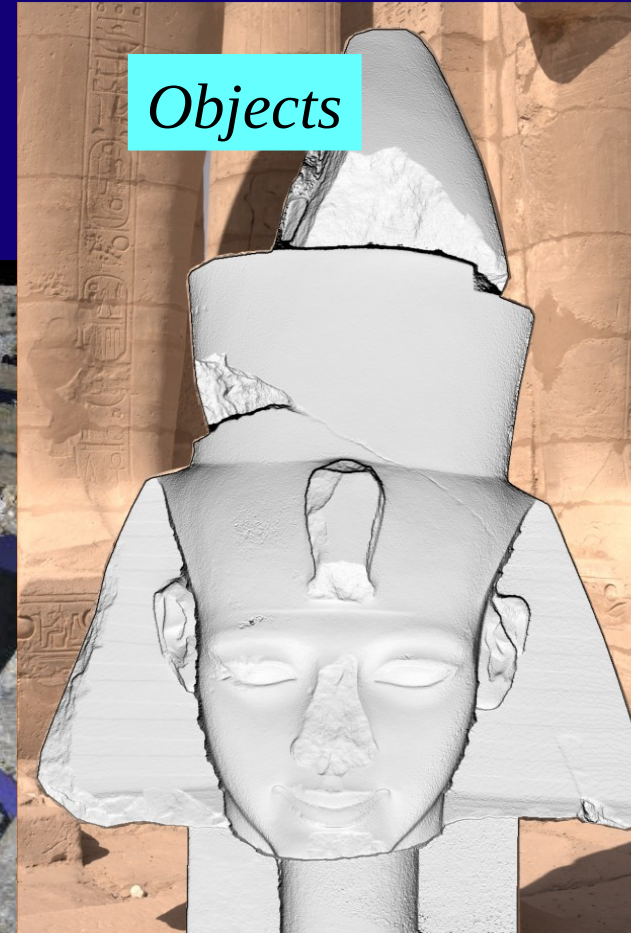
Cultural Heritage

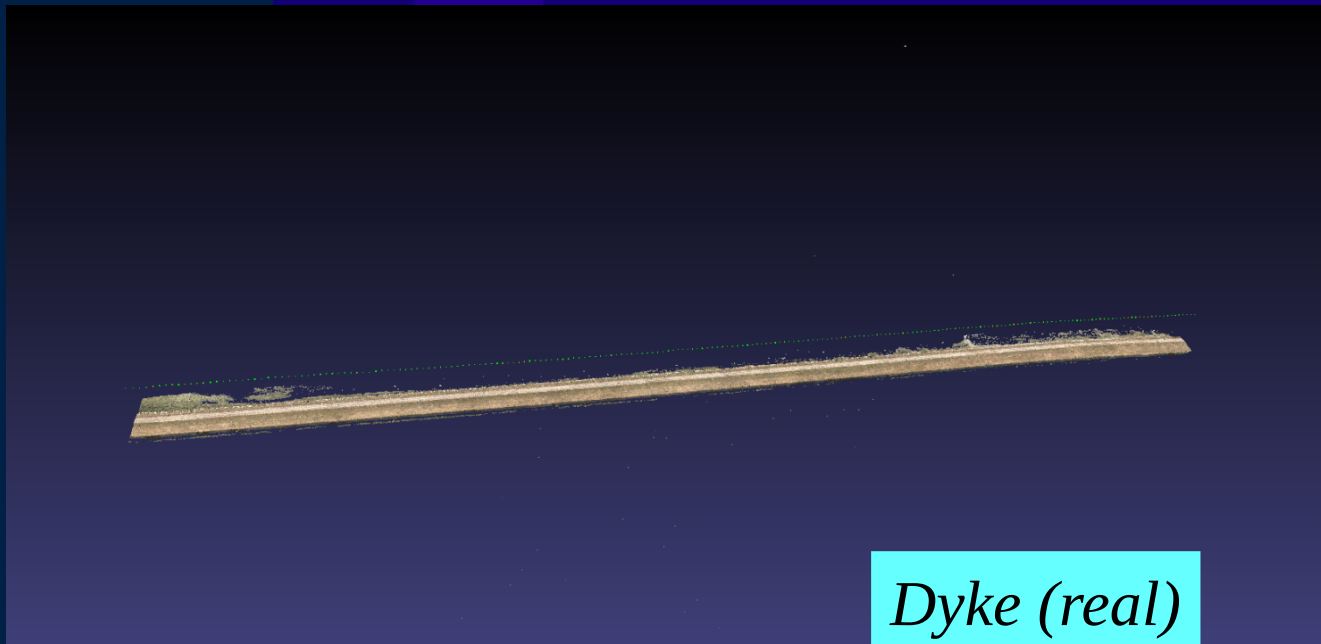
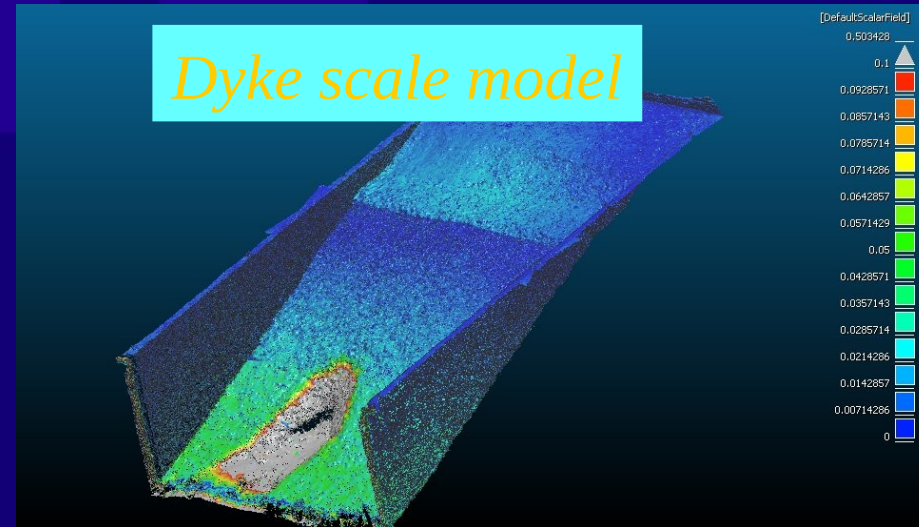
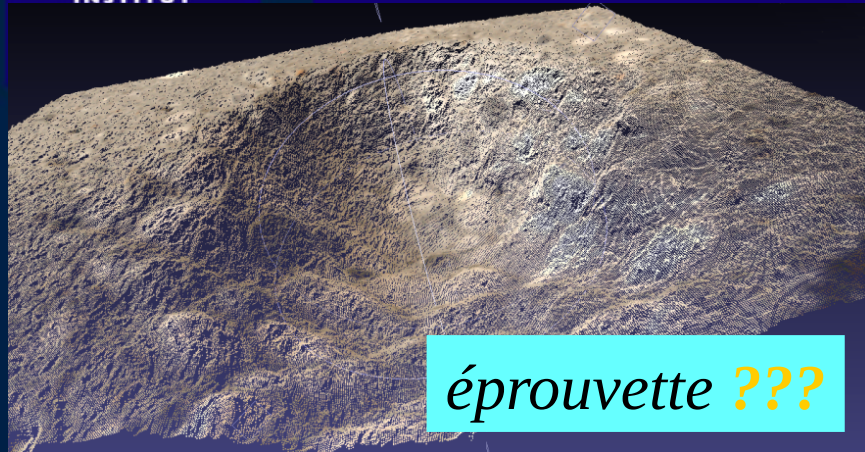
*Scientific measurements.
Communication tools.*

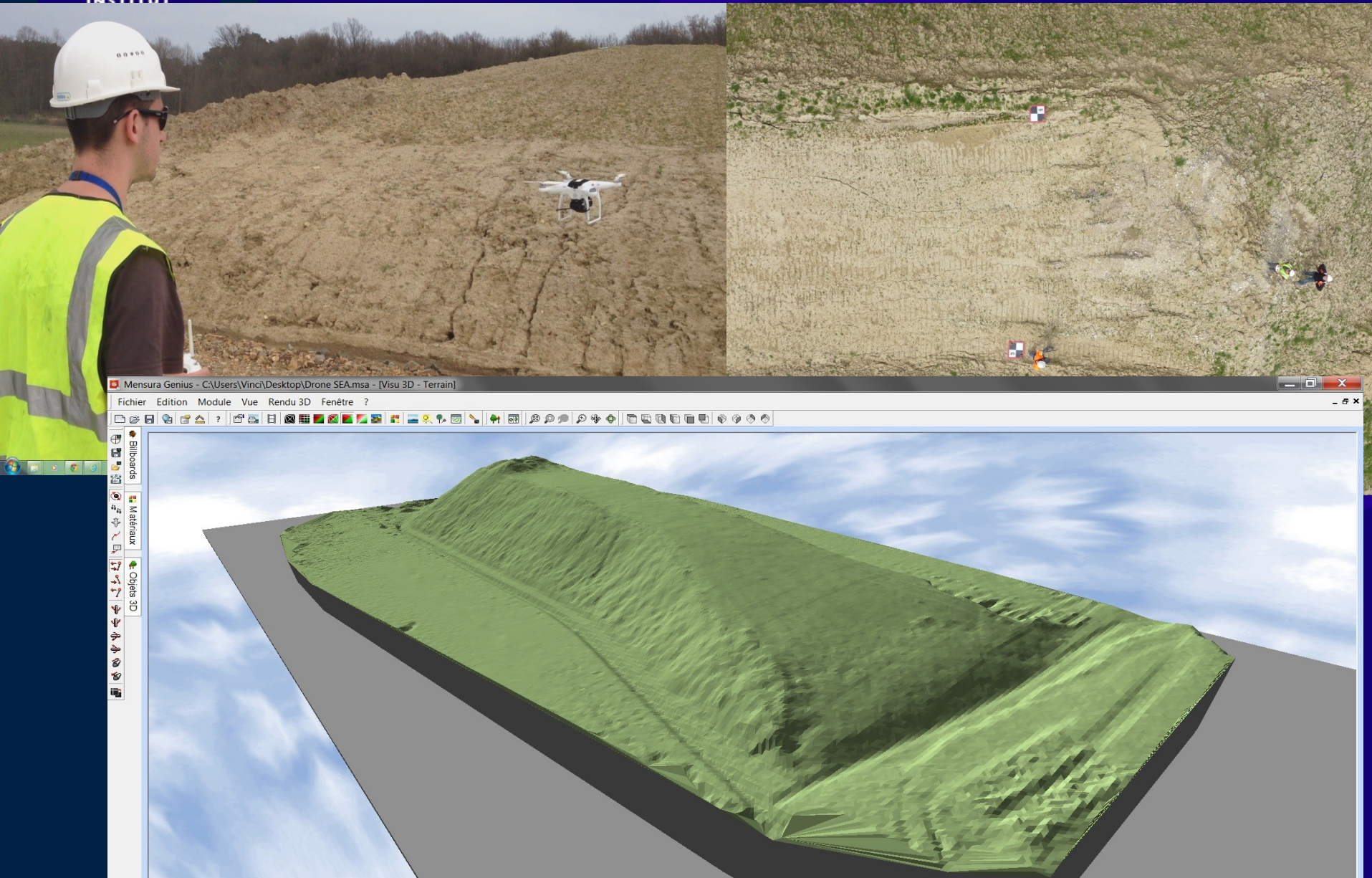
Outside (UAV)

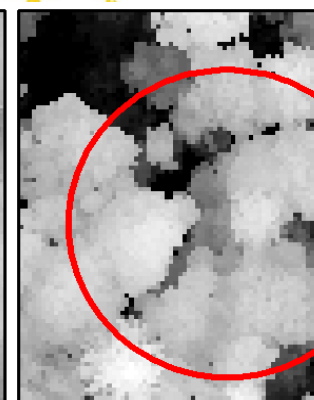
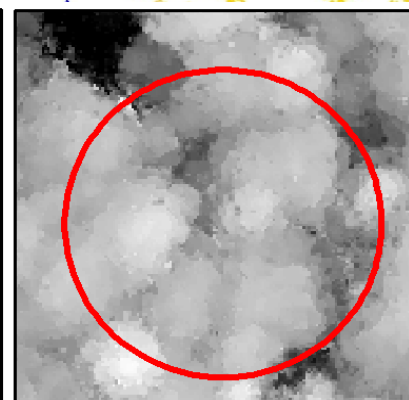
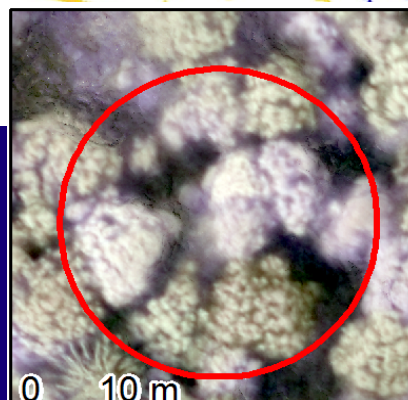
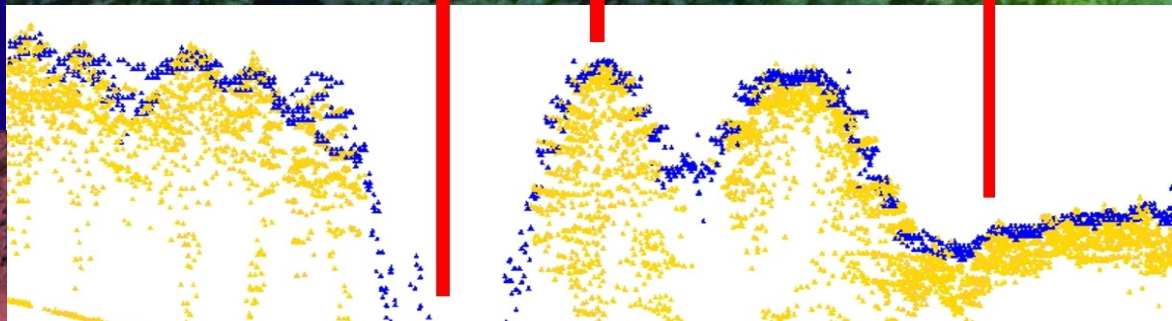
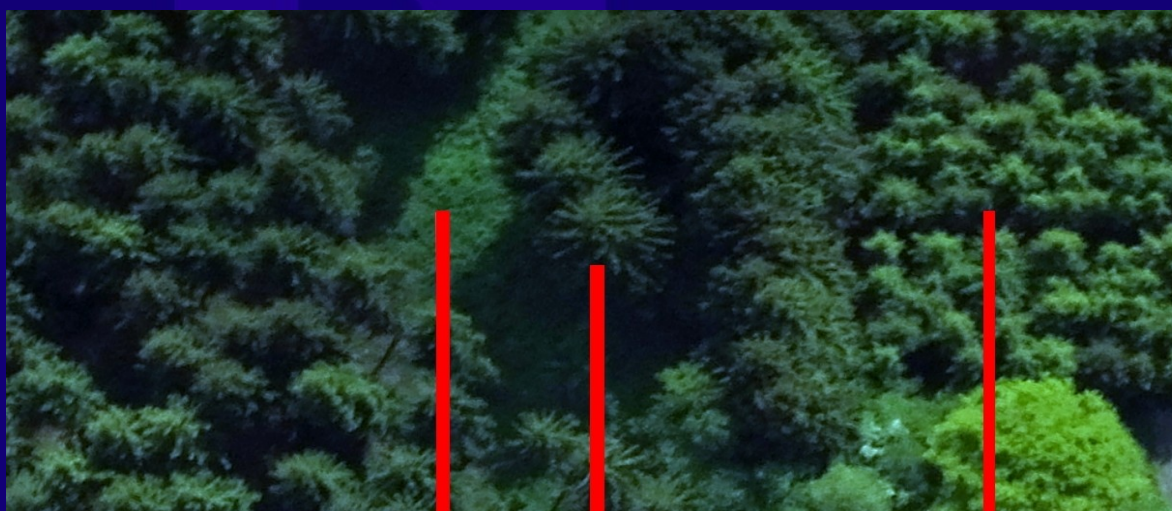


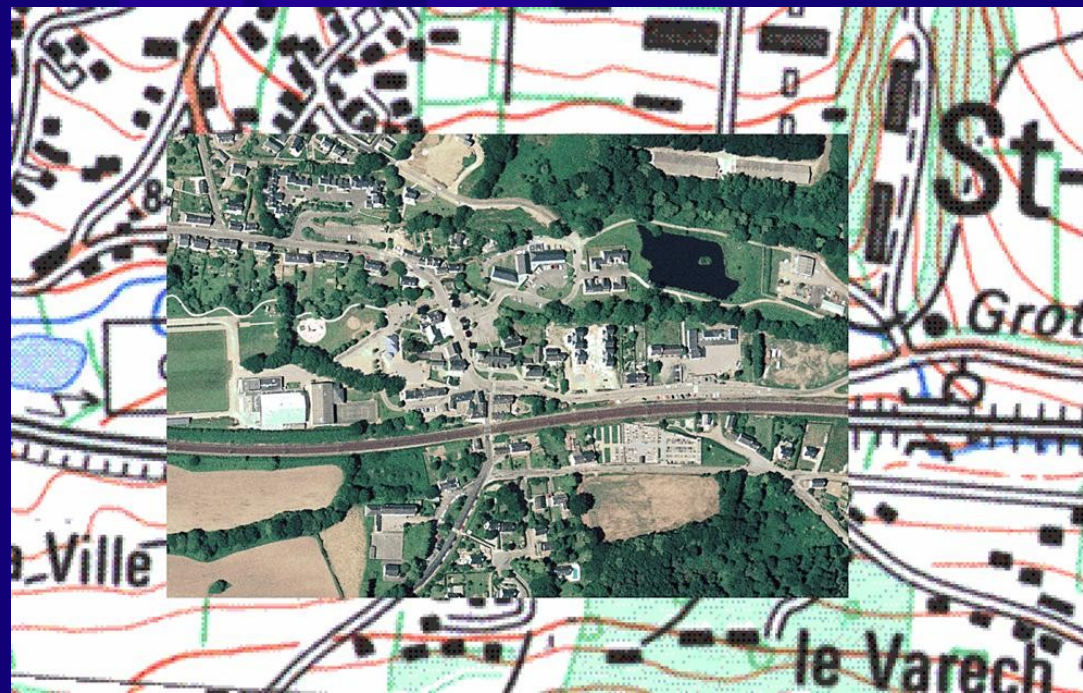
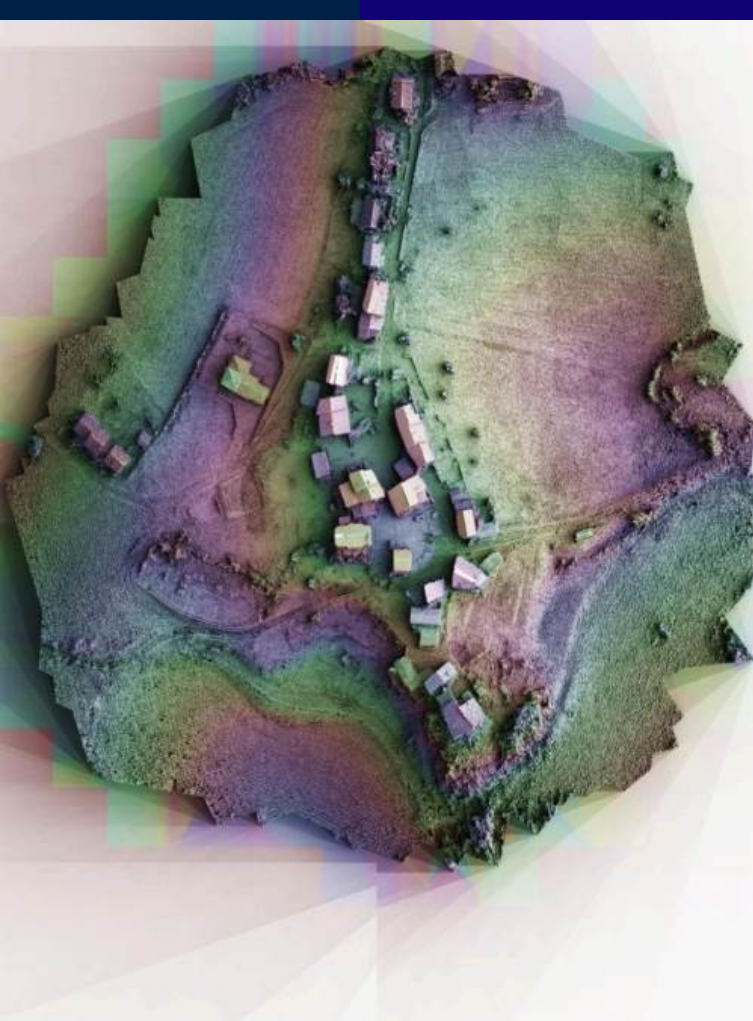
Objects







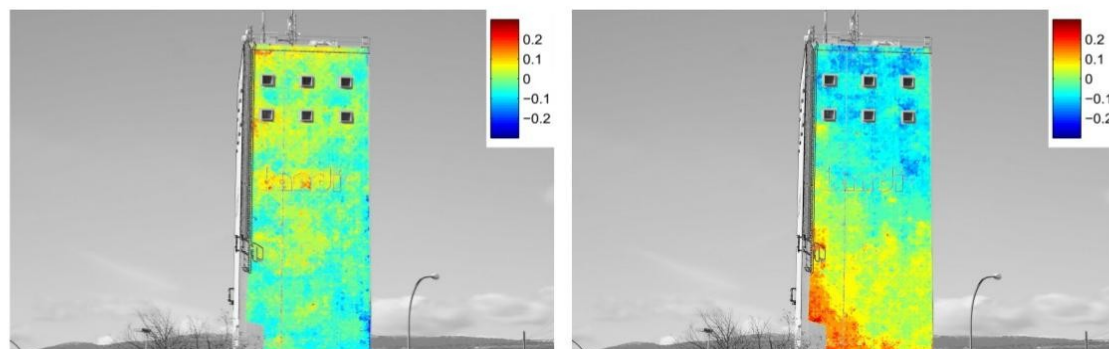




*And of course
cartography....*



Deformation (« optical correlation ») , using a fixed camera on a pod:



(a) Disparités horizontales [px].

(b) Disparités verticales [px].

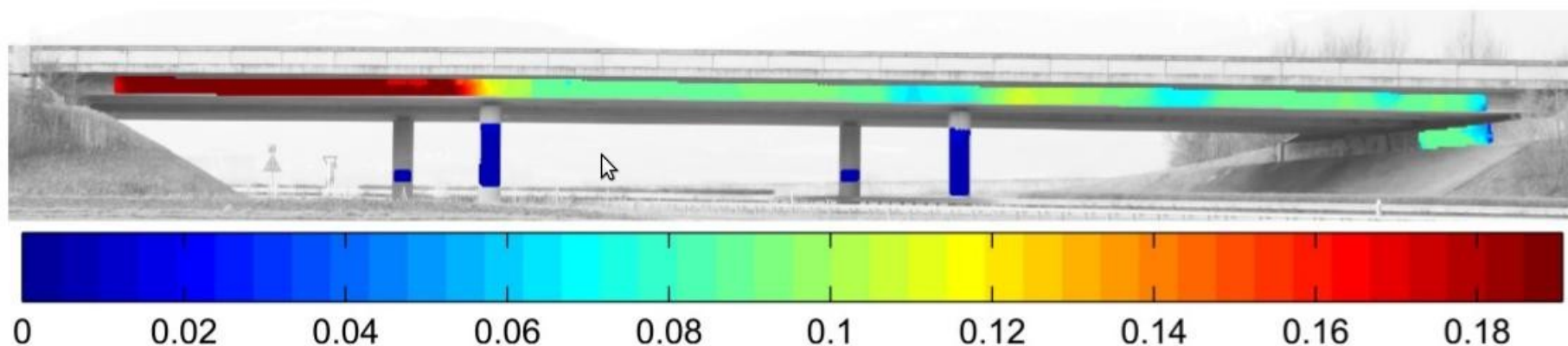
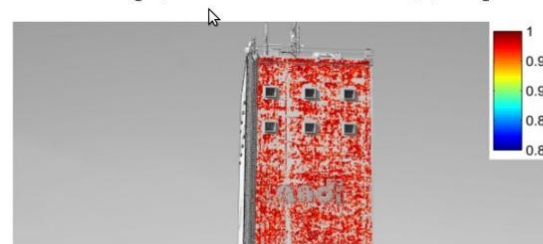
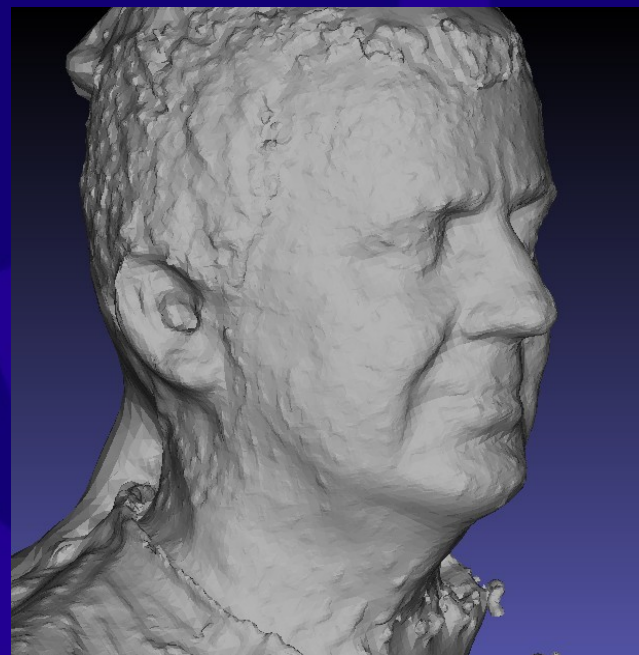
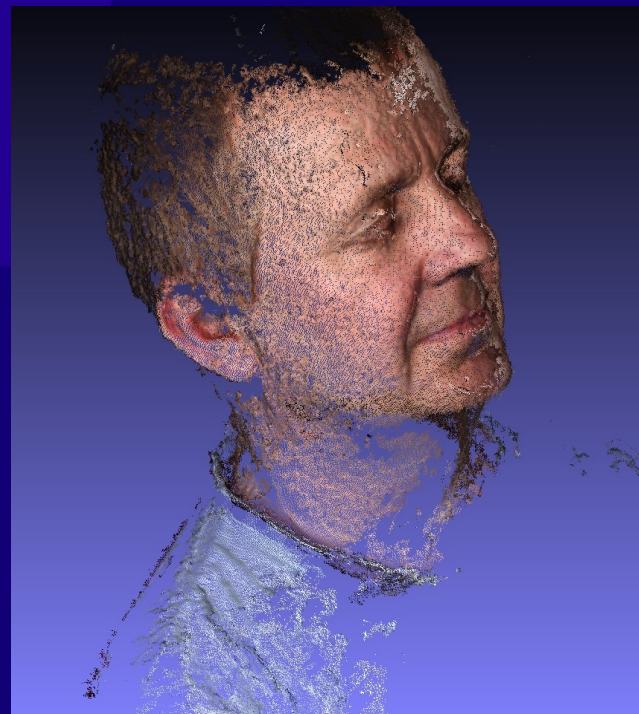


FIGURE 7.6 – Images 75-89 : Disparités verticales [px].

Aujourd'hui un outil pour scientifique

Demain un outil grand public ?

Un outil pour tous, pour s'amuser ?



Soon, used by **all**? for :
3D printing

*3D printing,
requires 3D model :*



*Photogrammetry :
a cost effective tool to input 3D models in 3D printers.*

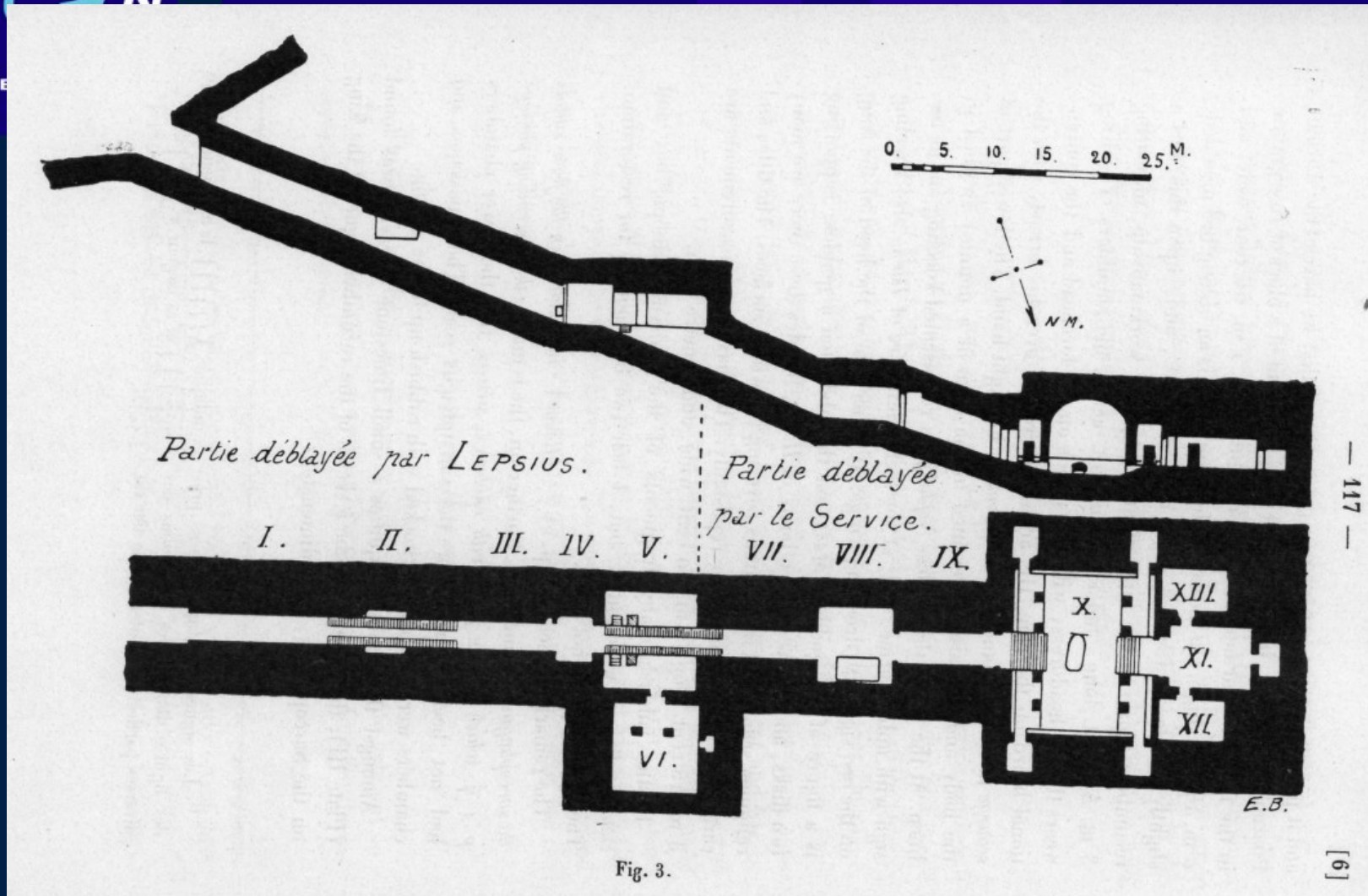
Soon, used by **all** for :

3D measuring
tool for DIY



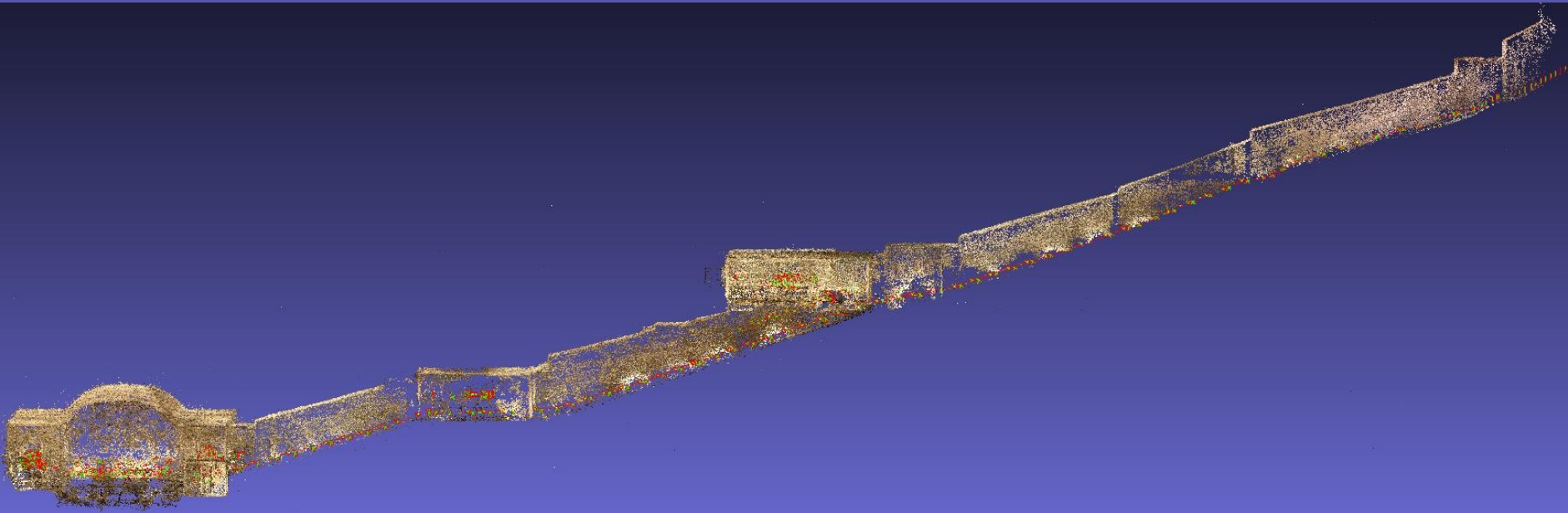
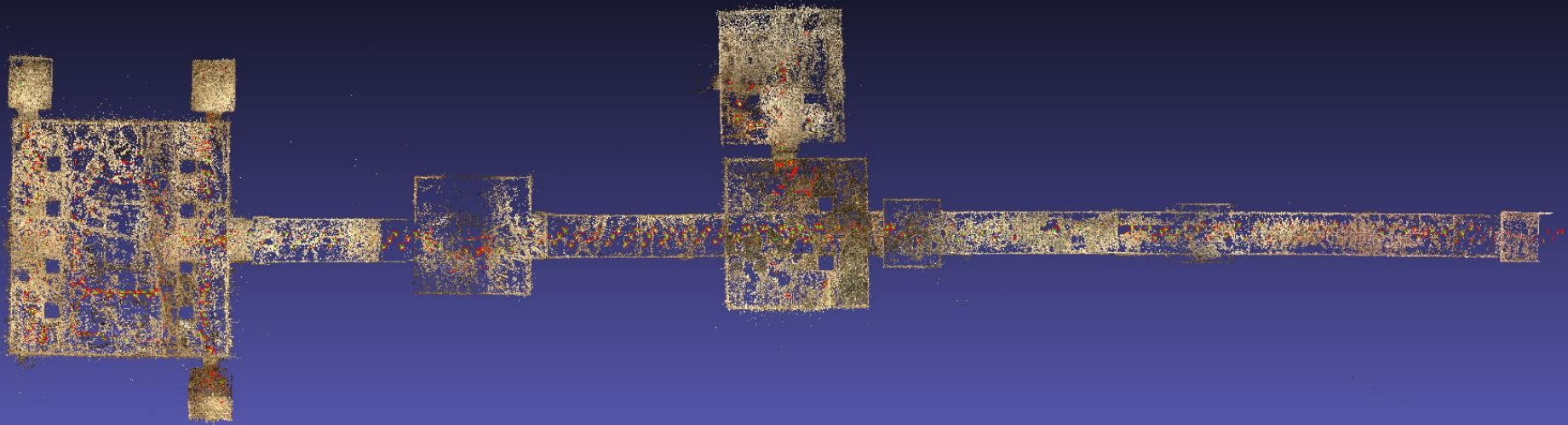
*Photogrammetry & 3D model,
a cost effective tool to **m**ake any quotation.*

DIY, need **of** a 3D plan of your flat



Example of a « very big flat », 1000 m², 100 m long.
(Meremphthah's tomb, **Valley of the Kings**).

...photogrammetry



*Photogrammetric « plan » of the tomb, accuracy
2-3 cm (on 100 meter length).*

*MICMAC : une chaîne libre open source de
photogrammétrie développée à l'IGN.*

Many existing softwares:

Free and open-source	Bundler PMVS
	Visual SFM MicMac-Apero (Cecill B)
Cheap	Agisoft
Free upload	Arc3D
	123DCatch
Paying software	Acute3D (Now Bentley)
	Pix4D (Now Parrot)

Characteristics of the IGN's software:

Meant for experts (cartographers, archeologists, architects...)

Quite complex, no “push-button” mode;

Every step may be controlled;

It can deal with BIG data.

It produces intermediate (and final) results in open formats: it can be used as “spare parts”

Principales fonctionnalités :

- * pipeline « classique » de création de nuage de point (points de liaisons, calibration, appariement);
- * géo-référencement des données (systèmes de projection via proj4)
- * génération d'ortho photo mosaiquée égalisée (et MNT);
- * gestion des caméra sténopé et push-broom (appareil photos classiques et images satellites) pour tout le pipeline;
- * calcul de cartes de déformation.

History

2003: development of an image matching software to produce urban DTE and self-calibration

2005: creation of an XML interface; the name of the software is “MicMac”

2007: open source version of MicMac;

2008: development of the “Apero” software to orientate the images

2010: training sessions;
development of simplified interfaces (without XML);

2012: “culture 3d” project ; MicMac available on Windows,
Binaries distributions;

Organization of the software

mm3d

mm3d : Allowed commands

AperiCloud Visualisation of camera in ply file

Apero Compute external and internal orientations

AperoChImSecMM Select secondary images for MicMac

Bascule Generate orientations coherent with some physical information on the scene

BatchFDC Tool for batching a set of commands

Campari Interface to Apero, for compensation of heterogenous measures

ChgSysCo Chang coordinate system of orientation

CmpCalib Do some stuff

cod Do some stuff

CreateEpip Tool create epipolar images

Dequant Tool for dequantifying an image

Devlop Do some stuff

ELDcraw Do some stuff

GCPBascule Relative to absolute using GCP

CenterBascule Realtime to absolute using embedded GPS

GCPCConvert Convert GCP from Txt 2 XML

OriConvert Convert Orientation from Txt 2 XML

GenXML2Cpp Do some stuff

GrShade Compute shading from depth image

Gri2Bin Do some stuff

MakeGrid Generate orientations in a grid format

Malt Simplified matching (interface to MicMac)

MapCmd Transforms a command working on a single file in a command working on a set of files

Mascarpone Automatic mask tests

.....

Help to remember a command from a sub-expression:

mm3d Ap
Suggest by Prefix Match
AperiCloud
Apero
AperoChImSecMM

mm3d asc
Suggest by Subex Match
Bascule
GCPBascule
CenterBascule
Mascarpone
NuageBascule
RepLocBascule
SBGlobBascule
SaisieBasc

For all the commands, use « -help » to know the proper syntax :

```
mm3d SaisieAppuisPredic -help
*****
*   Help for Elise Arg main   *
*****

Unnamed args :
* string :: {Full Name (Dir+Pattern)}
* string :: {Orientation}
* string :: {File for Ground Control Points}
* string :: {File for Image Measurements}

Named args :
* [Name=SzW] Pt2di :: {Size of global window (Def 800 800)}
* [Name=NbF] Pt2di :: {Number of Sub Window (Def 2 2)}
* [Name=WBlur] REAL :: {Size IN GROUND GEOMETRY of blurring for target}
* [Name=Type] string :: {in [MaxLoc,MinLoc,GeoCube]}
```

Here, for instance, 4 compulsory arguments (all « strings »)
+ optional arguments called by their names

```
mm3d TestKey "IMG_.*tif" Nb=1000
```

```
0 IMG_5564-RGB.tif
1 IMG_5564.tif
2 IMG_5564_Masq.tif
3 IMG_5565.tif
4 IMG_5566.tif
5 IMG_5567.tif
6 IMG_5568.tif
7 IMG_5569.tif
8 IMG_5570.tif
9 IMG_5571.tif
10 IMG_5572.tif
11 IMG_5573.tif
12 IMG_5574.tif
13 IMG_5574_Masq.tif
14 IMG_5575.tif
15 IMG_5576.tif
16 IMG_5577.tif
17 IMG_5578.tif
18 IMG_5579.tif
19 IMG_5580.tif
```

... ■

```
mm3d TestKey "IMG_.*8.tif" Nb=1000
```

```
0 IMG_5568.tif
1 IMG_5578.tif
2 IMG_5588.tif
```

```
mm3d TestKey "IMG_.*[68][6-9].tif" Nb=1000
```

```
0 IMG_5566.tif
1 IMG_5567.tif
2 IMG_5568.tif
3 IMG_5569.tif
4 IMG_5588.tif
5 IMG_5589.tif
```

MicMac/Apero tools « think » that there is only one project in a directory.

A log file remembers all the commands:

```
cat mm3d-LogFile.txt
```

```
=====
```

```
/home/marc/MMM/culture3d/bin/mm3d Malt Ortho Abbey.*.jpg L93 SzW=1 AffineLast=false DefCor=0.0
```

```
[Beginning at ] Fri Feb 1 18:15:17 2013
```

```
[Failing with code 2 at ] Fri Feb 1 18:15:24 2013
```

```
=====
```

```
/home/marc/MMM/culture3d/bin/mm3d Malt Ortho Abbey.*.jpg L93 SzW=1 AffineLast=false DefCor=0.0
```

```
[Beginning at ] Fri Feb 1 18:15:37 2013
```

```
[Failing with code 2 at ] Fri Feb 1 18:15:44 2013
```

```
=====
```

```
....
```

```
=====
```

```
/home/marc/MMM/culture3d/bin/mm3d GCPBascule Abbey-*.*.jpg All-Rel RTL-Init AppRTL.xml Measure-BUG-S2D.xml
```

```
[Beginning at ] Fri Feb 1 22:17:40 2013
```

```
[Failing with code 2 at ] Fri Feb 1 22:18:05 2013
```

exif data gives information about the images.

Missing or wrong information in the exif data can be given through the MicMac-LocalChantierDescipteur.xml file.

```
<Global>
  <ChantierDescipteur >
    <KeyedNamesAssociations>
      <Calcs>
        <Arrite> 1 1 </Arrite>
        <Direct>
          <PatternTransform> .* </PatternTransform>
          <CalcName> Canon EOS 5D Mark II </CalcName>
        </Direct>
      </Calcs>
      <Key> NKS-Assoc-STD-CAM </Key>
    </KeyedNamesAssociations>
    <KeyedNamesAssociations>
      <Calcs>
        <Arrite> 1 1 </Arrite>
        <Direct>
          <PatternTransform> .* </PatternTransform>
          <CalcName> 50.0 </CalcName>
        </Direct>
      </Calcs>
      <Key> NKS-Assoc-STD-FOC </Key>
    </KeyedNamesAssociations>
  </ChantierDescipteur>
</Global>
```

There exists a camera global database, which can be updated.

```
<MMCameraDataBase>
  <CameraEntry>
    <Name> PENTAX K-5 </Name> <!-- 4.807 micron -->
    <SzCaptMm> 16.0 24.0 </SzCaptMm>
    <ShortName> PK5 </ShortName>
  </CameraEntry>
  <CameraEntry>
    <Name> Canon EOS 60D </Name>
    <SzCaptMm> 14.9 22.3 </SzCaptMm>
    <ShortName> C60D </ShortName>
  </CameraEntry>
  <CameraEntry>
    <Name> Canon EOS 7D </Name>
    <SzCaptMm> 16.0 24.0 </SzCaptMm>
    <ShortName> C7D </ShortName>
  </CameraEntry>
.....amera.xml
```

Conclusion - Perspectives

MicMac a tool for all ?



A powerful and accurate tool (all the results of this presentation done with MicMac)



Free open source (Cecill-B), open format



Documented (300 pages), a forum of users (enter « *forum micmac* » on your research engine).



Long term support by IGN and several funding (CNES, FUI, ANR, CNR, Vinci).



Used by many scientists, engineers



Now fully automatic in many contexts

BUT

Complex, no fully satisfying GUI



Some GUI were developed ... but :

A development made at IGN in 2009-2010 .. **but** it was too soon (kernel not stabilized).

Several tests using student projects, good for prototypical ideas ... **but** no long time support

Development made by private companies ... **but** none free open source.

=> It's probably the **right** time to begin a free open source development project of “photogrammetry for people”, based on MicMac kernel.

=> **Contact for interested developers:**
marc.pierrot-deseilligny@ensg.eu

**Merci pour votre
attention.**



Ecole d'été “Logiciels libres pour le traitement d'images satellites” (SFPT/CNES/IGN):

- 4 jours : 4 au 8 juillet
- à l'ENSG
- OTB+MicMac
- prix 150/250/800

=> www.sfpt.fr

Pour en savoir plus :

=> micmac + forum

=> micmac + ign

=> marc.pierrot-deseilligny@ensg.eu