Shipborne Laser Scanning

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Präsentation auf dem
4. Hamburger Anwenderforum Terrestrisches Laserscanning
HCU, Hamburg; 23.06.2011

Gliederung

- Einführung
- Systembeschreibung
- Projekte in Hamburg
- Projekt Hoch-Rhein
- Zusammenfassung

Definition of Hydrography

IHO-Extraordinary International Hydrographic Conference EIHC, 4 June 2009

- Erfassung und Beschreibung der physikalischen Eigenschaften der
  - Ozeane, Meere, Küstenzonen, Seen und Flüsse
- Prädiktion der temporalen Veränderungen

für die Zwecke

- Sicherheit der Schifffahrt
- Ökonomische Entwicklung
- Sicherheit und Verteidigung
- Wissenschaftliche Forschung
- Umweltschutz

Equipment

- ***GNSS - Positioning and Attitude Determination***
  - SAPOS - RTK
  - Javad: JAVAD 4 Gyro (GNSS Positioning and Attitude)
  - Geo++ GNSS-Software GNATTI
  - IXSEA: OCTANS III (fiberoptic IMU)
- ***IMU - Attitude Determination***
  - IXSEA: OCTANS III (fiberoptic IMU)

- ***Single Beam Echosounder Fahrentholz Lithugraph***
- ***Multibeam Echosounder Reson SeaBat***
  - ***141 beams x 40 Hz***
- ***Side Scan Sonar***
- ***Innomar Sediment Echosounder***
- ***Magnetometer***
- ***Acoustic Doppler Current Profiler (ADCP)***

- ***Terrestrial Laser Scanner (Riegl VZ400)***
- ***…***

Photo: P. Andree

“Bringing Land and Sea Together”- BLASTER - sensorwise

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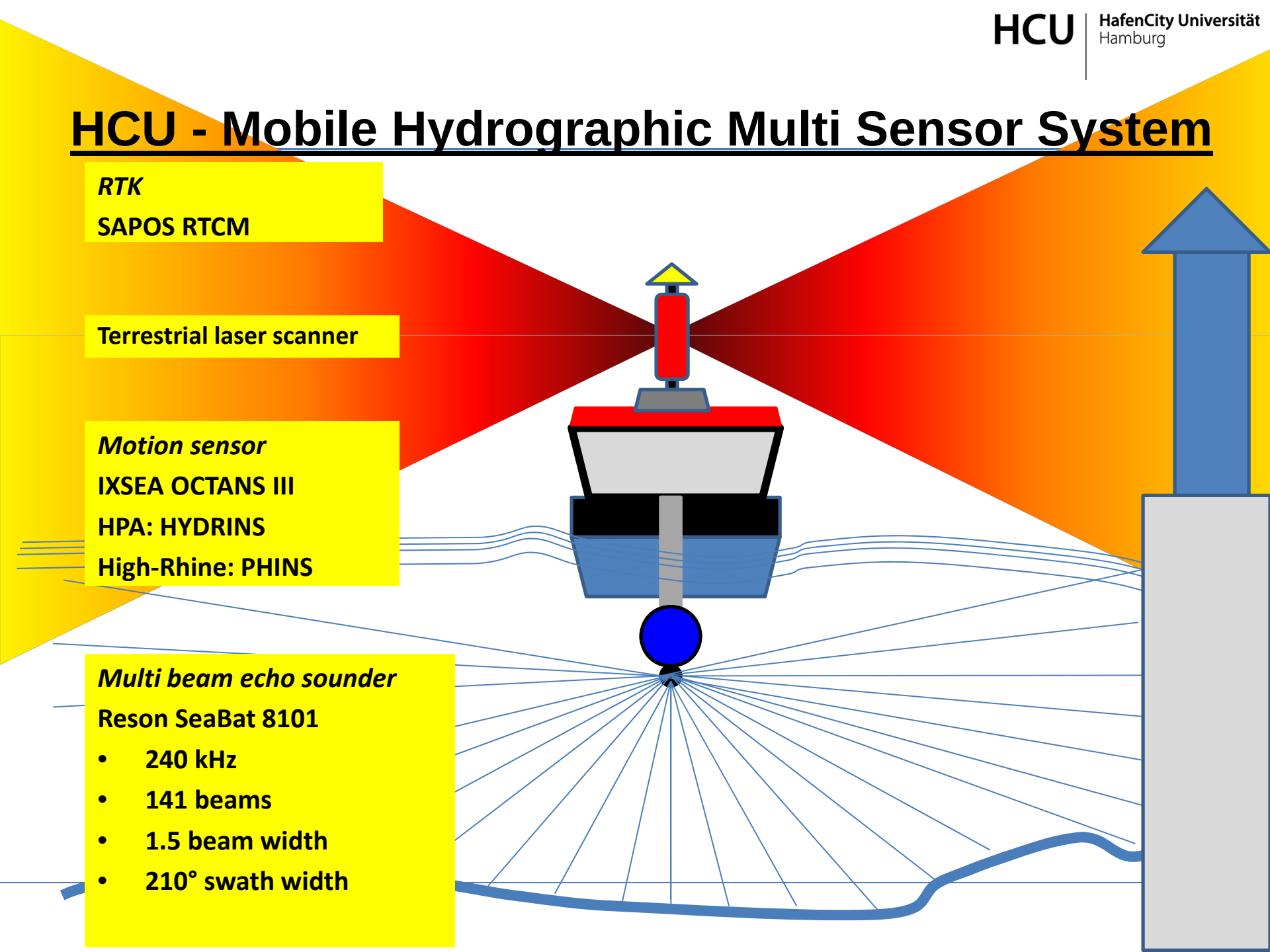
- Using hydrographic sensors to detect the underwater world

- Using terrestrial laser scanner to determine objects above the water line
  - Quay walls
  - Buildings and constructions
  - Banks and beaches (erosion)
  - Dikes

HCU - Mobile Hydrographic Multi Sensor System



RTK

SAPOS RTCM

Terrestrial laser scanner

Motion sensor

IXSEA OCTANS III

HPA: HYDRINS

High-Rhine: PHINS

Multi beam echo sounder

Reson SeaBat 8101

- **240 kHz**
- **141 beams**
- **1.5 beam width**
- **210° swath width**

Project Power Plant Wedel
Terrestrial Laserscanner on Board

- First investigations with laser scanner from Zoller & Froehlich (owner: Dr. Hesse and Partner Ingenieure, Hamburg (DHPI))

Project Grasbrookhafen
Hamburg Port Authority (HPA): Master thesis Thomas Thies

- Survey Vessel “Deepenschriewer III”
  - Length 17,20 m
  - Width 4,90 m
  - Draught 1,40 m

Pilot study – Riegl VZ-400
Master thesis Thomas Thies (2011), HPA

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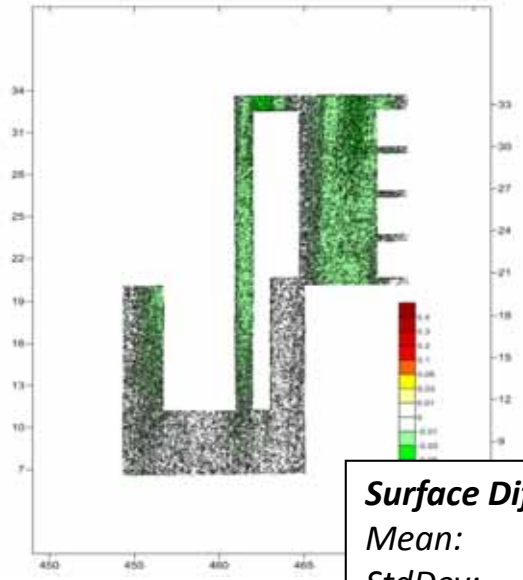
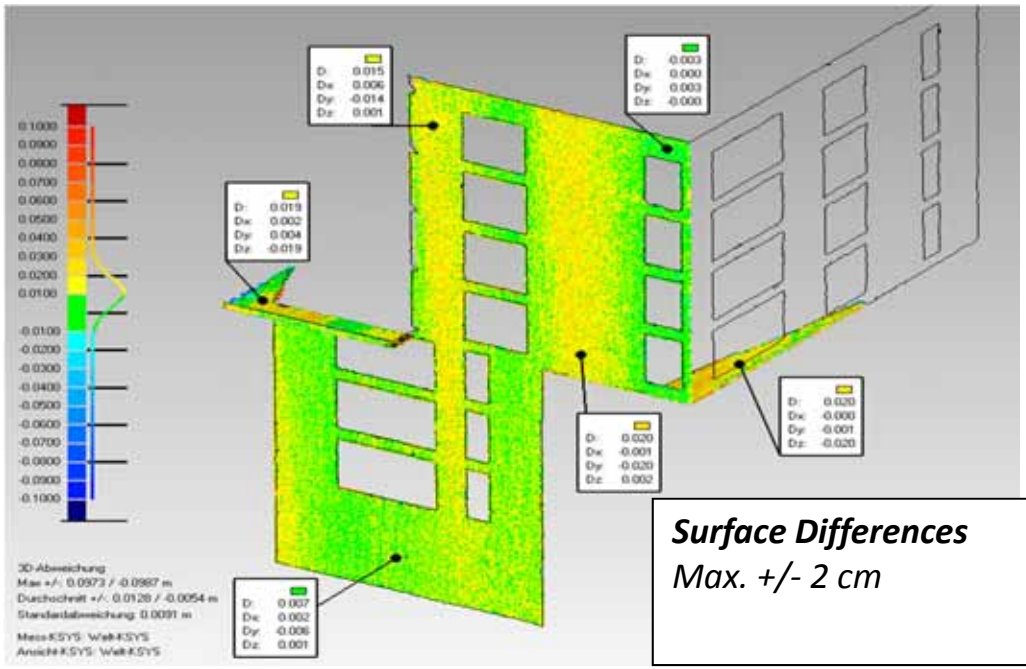
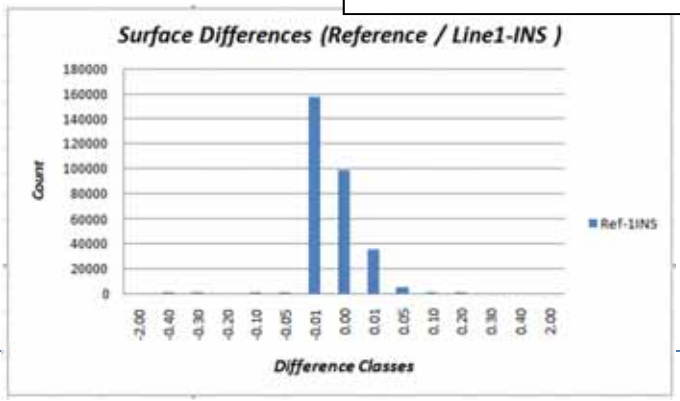
- **Precision analysis – Surface Differences (Reference - Survey Line)**



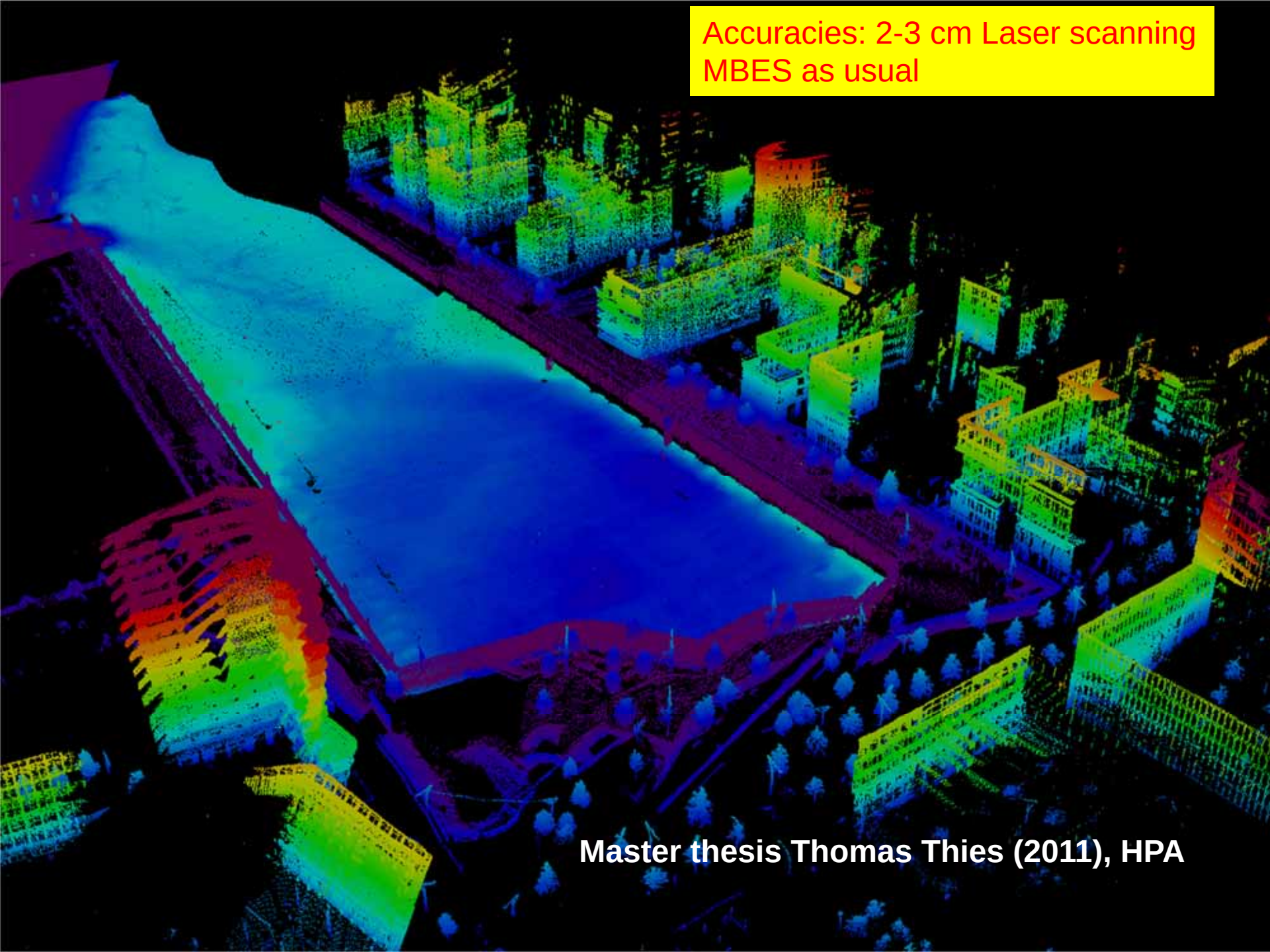
Surface Differences
Mean: *-0.011m*
StdDev: *±0.011m*



Surface Differences
Max. +/- 2 cm

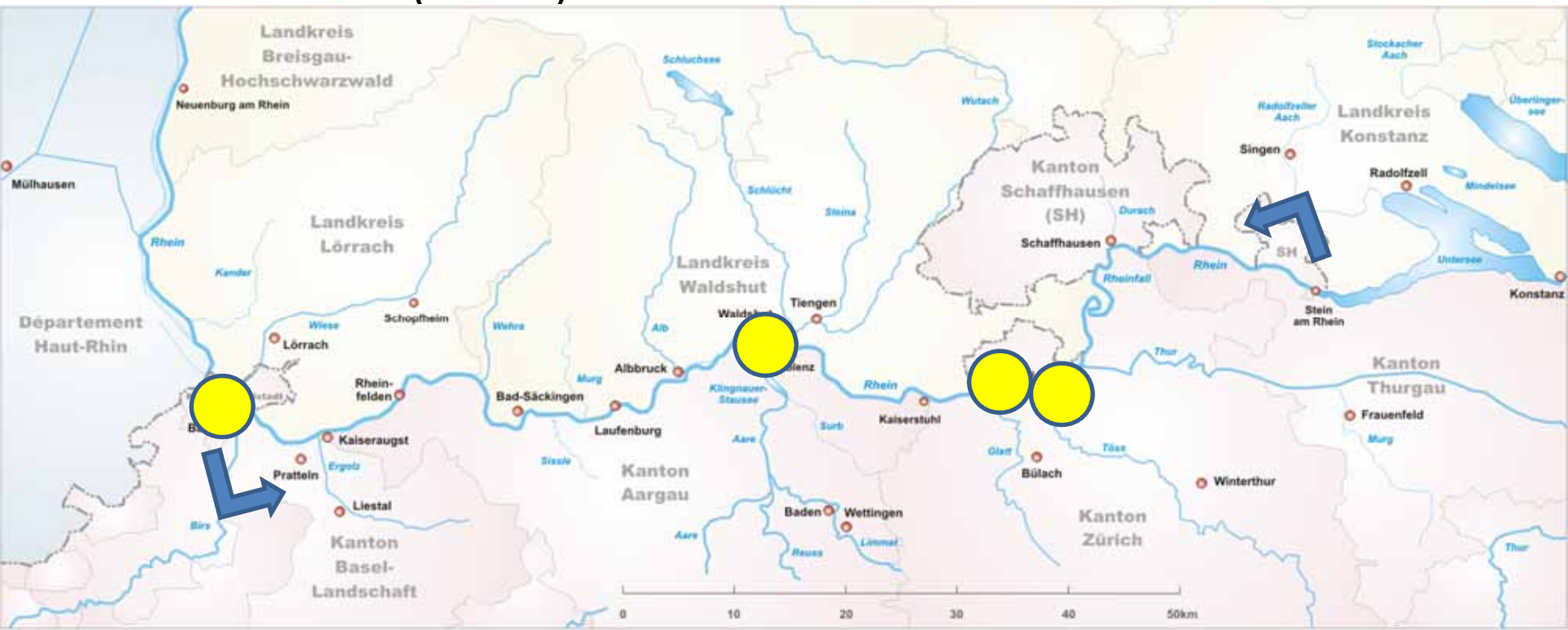


- ➔ **Computation only with plane facade surfaces without windows etc.**
- ➔ **Small height dependent systematic artefacts have to be investigated in more detail**


Accuracies: 2-3 cm Laser scanning
MBES as usual
Master thesis Thomas Thies (2011), HPA

Project High-Rhine: Motivation

- High-Rhine: from Stein am Rhein (Lake Constance) to Basel, around 160 km
- Depth measurement only around hydroelectric power plants
- No open depth information for shipping (ask the “natives”!)
- 4 test areas (17 km)

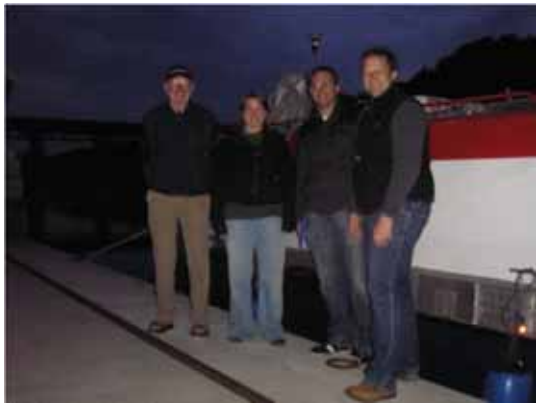


Leica GNSS 1200

Laser scanner Riegl VZ400

IMU IXSEA PHINS

Team at Night



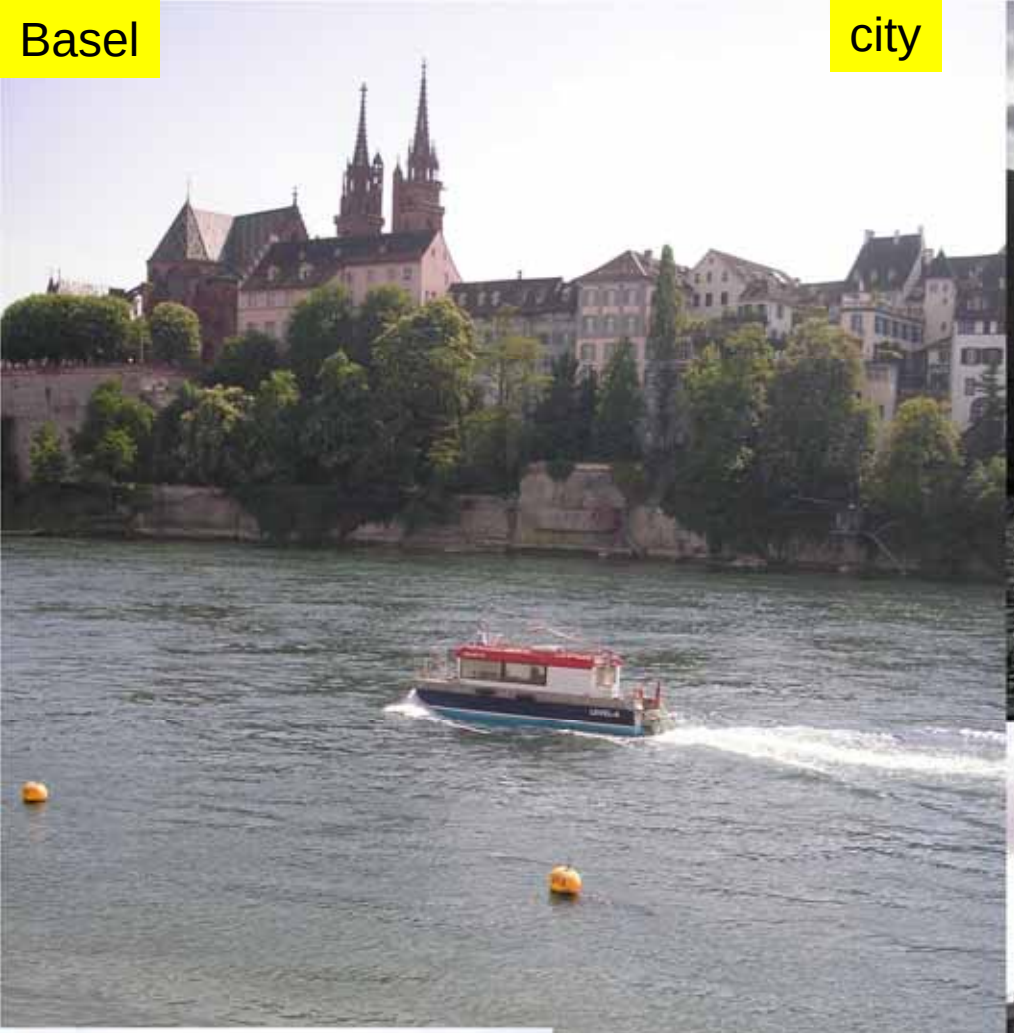
RESON SeaBat 8101

Equipment

- RTK-Positioning: Leica GNSS 1200
  - SWISSPOS RTCM corrections
- Inertial Measurement Unit: IXSEA PHINS
  - Heading 0.034° (HH), Roll/Pitch 0.01°
- Multibeam Echosounder: Reson Seabat 8101
  - 141 beams, 210° fan, measuring rate 40 Hz, range 300 m
  - 1.5° opening angle, point distance: 1.31m @ 50 m
- Terrestrial Laser Scanner Riegl VZ400
  - Range up to 500 m @ Laser Class 1
  - Repeatability 5 mm
  - Measurement rate
    - High speed: 125.000 / s max. 300 m
    - Long range: 42.000 / s max. 500 m
  - Connector for external GPS PPS

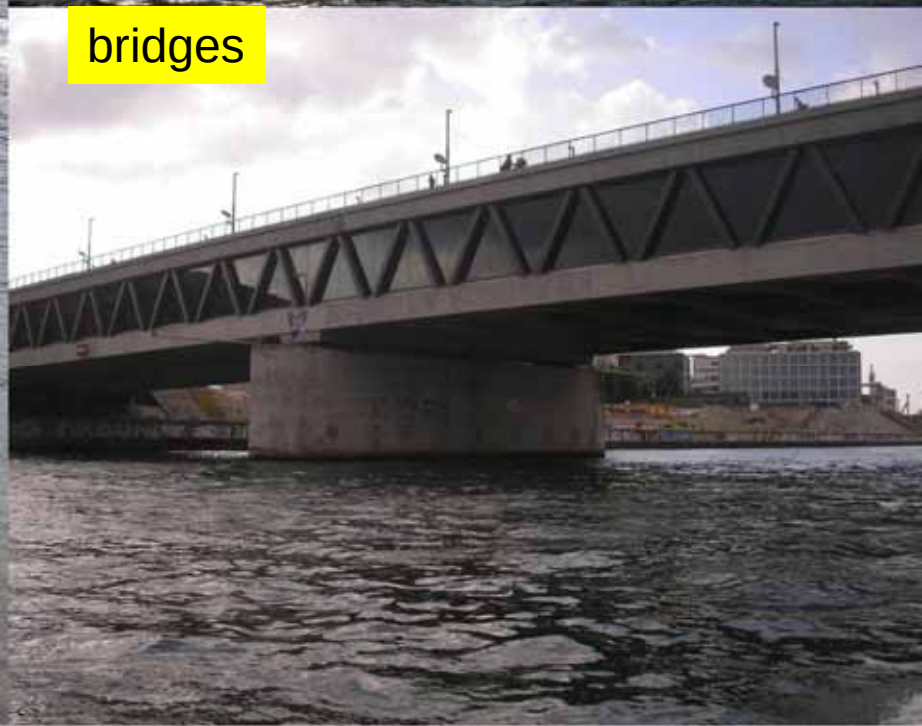
Basel

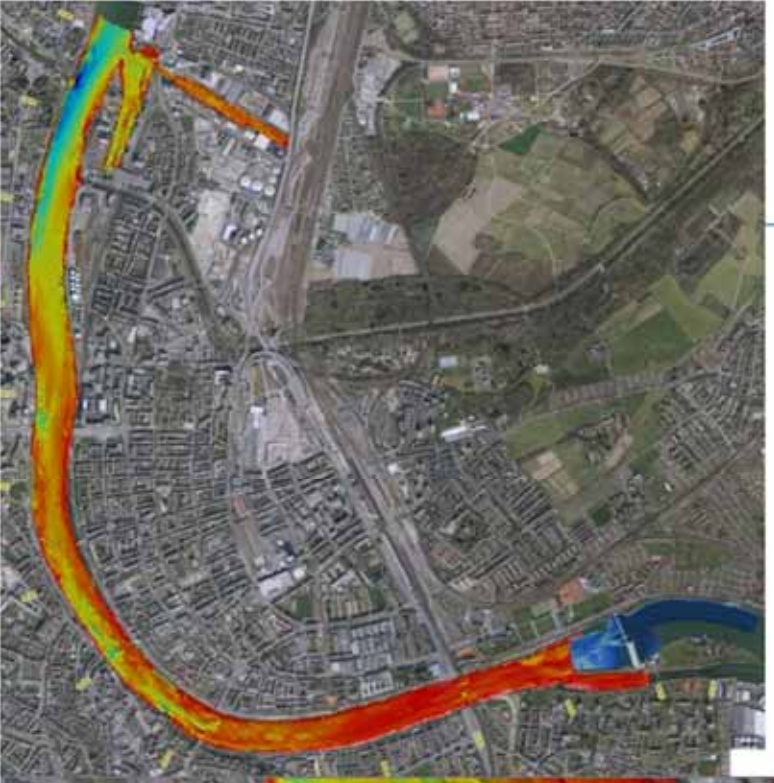
city



industry

bridges

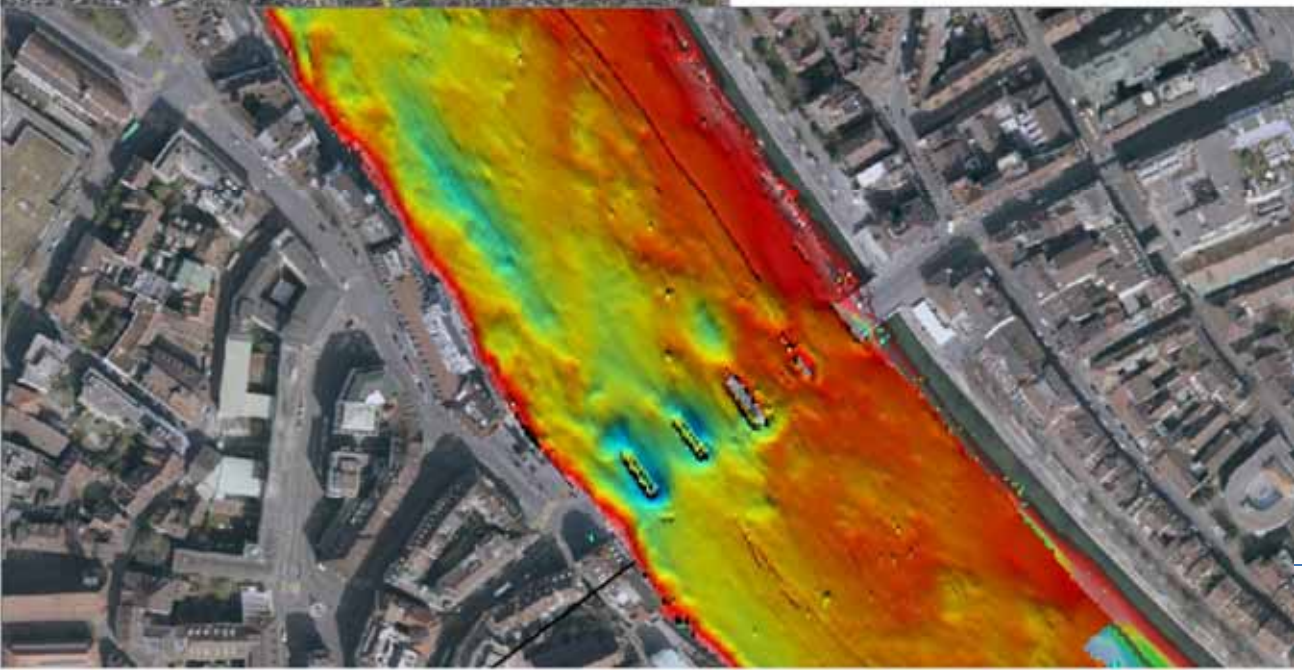




Basel

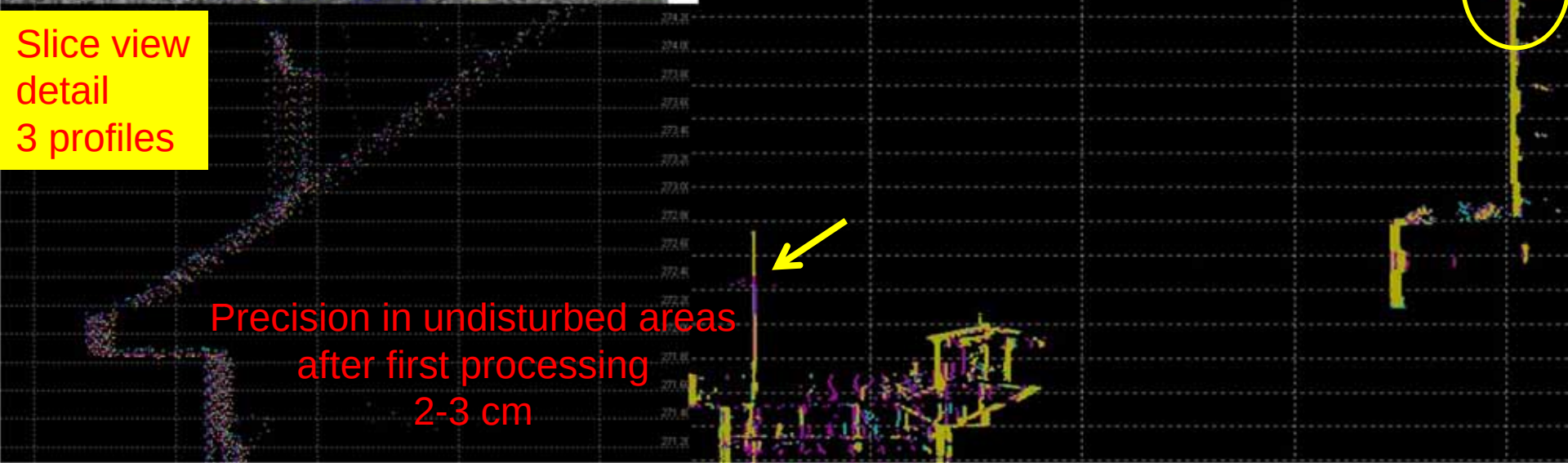
MBES data

-real time processed-

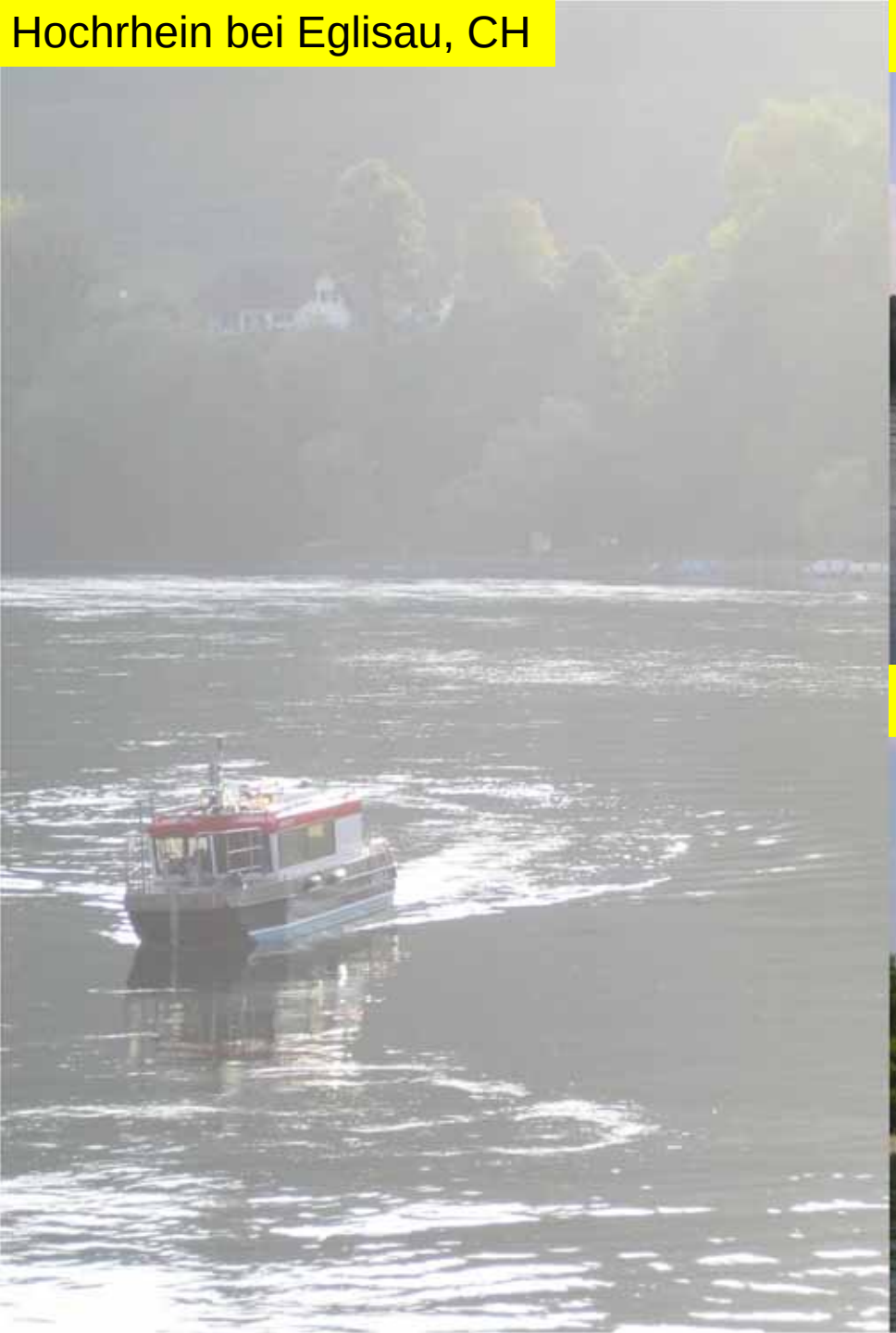


Slice view

Slice view
detail
3 profiles

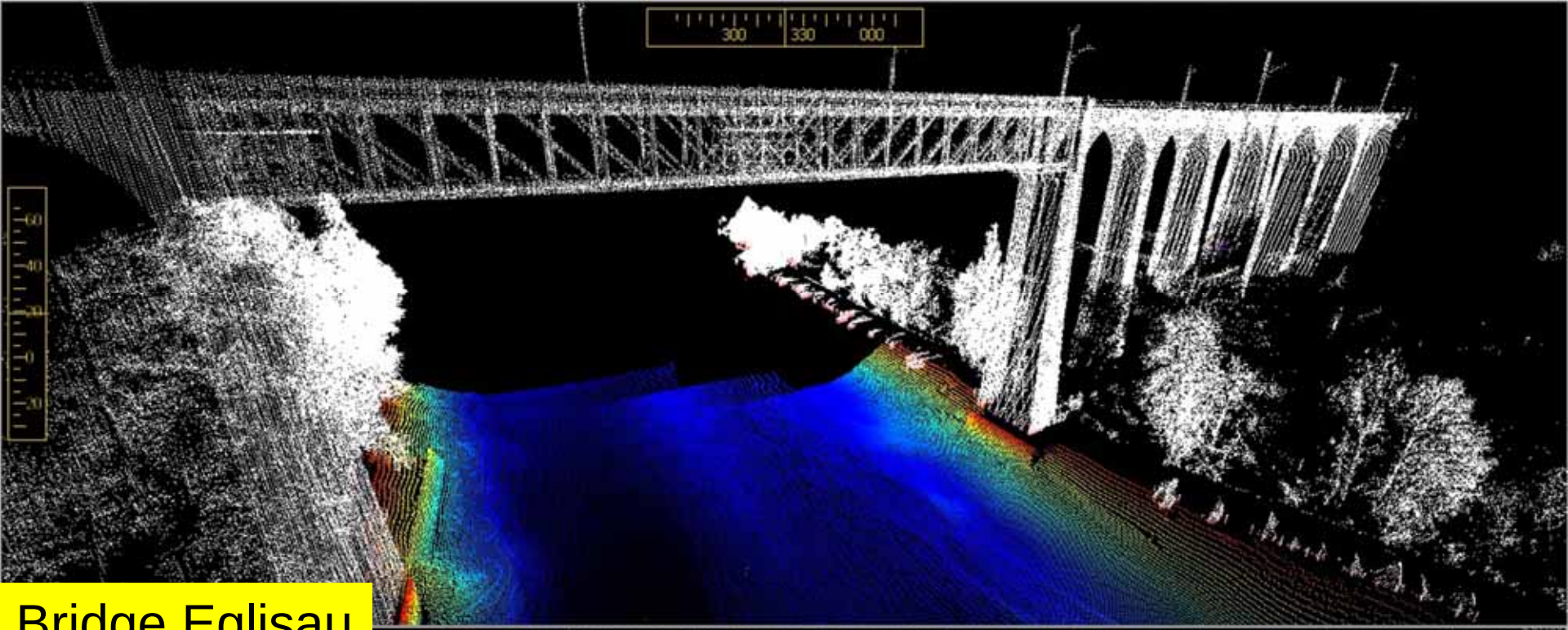


Hochrhein bei Eglisau, CH

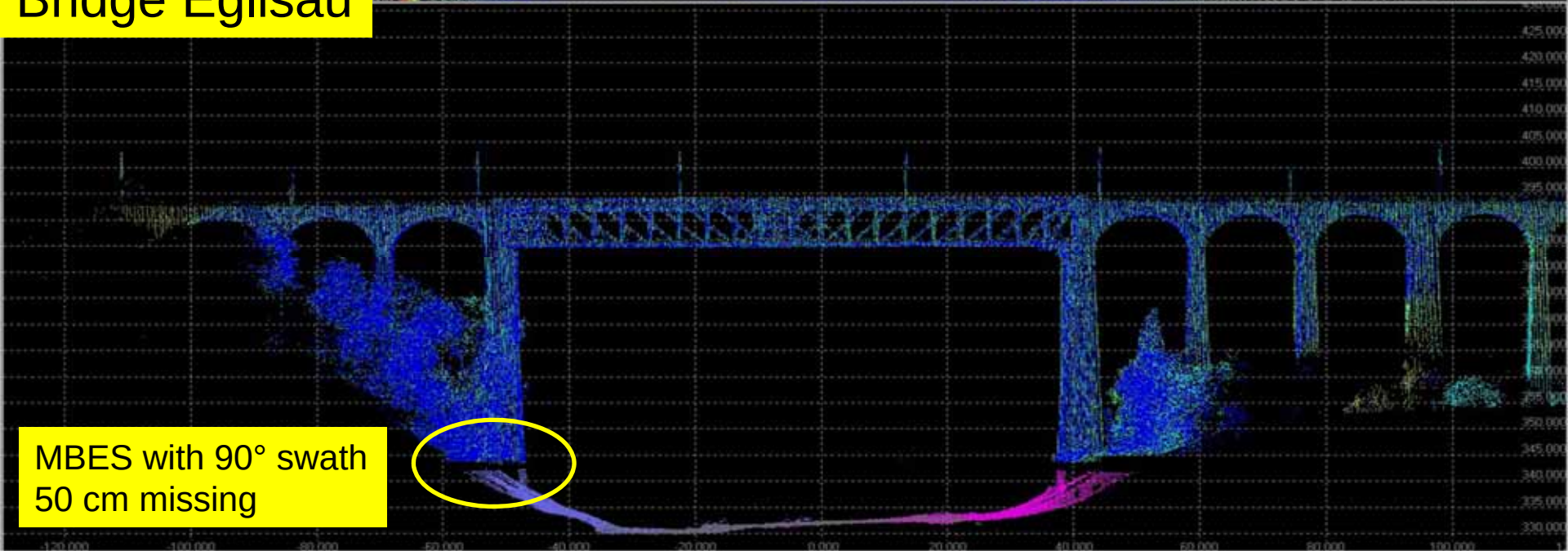


Nature

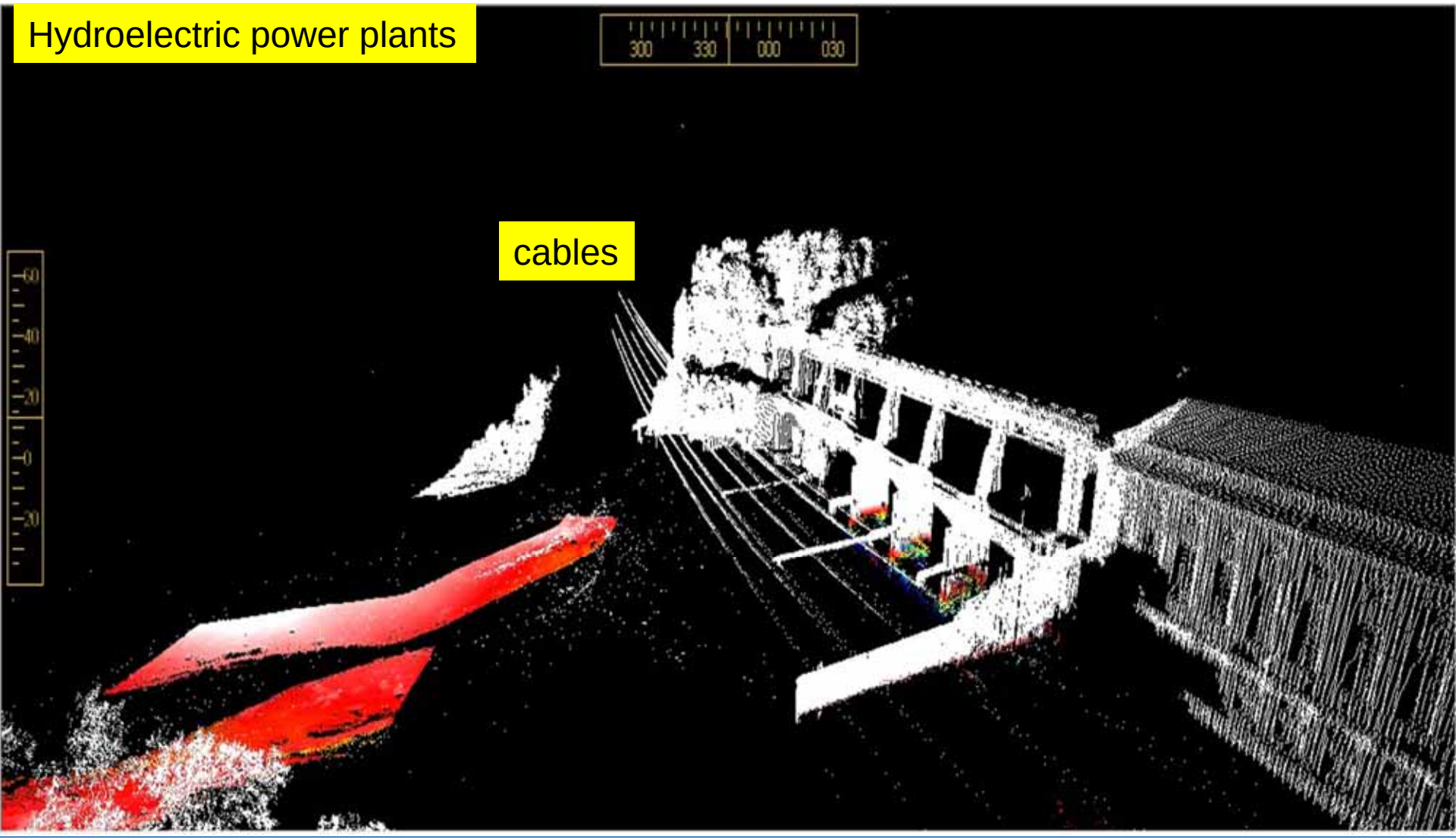
Hydroelectric power plants



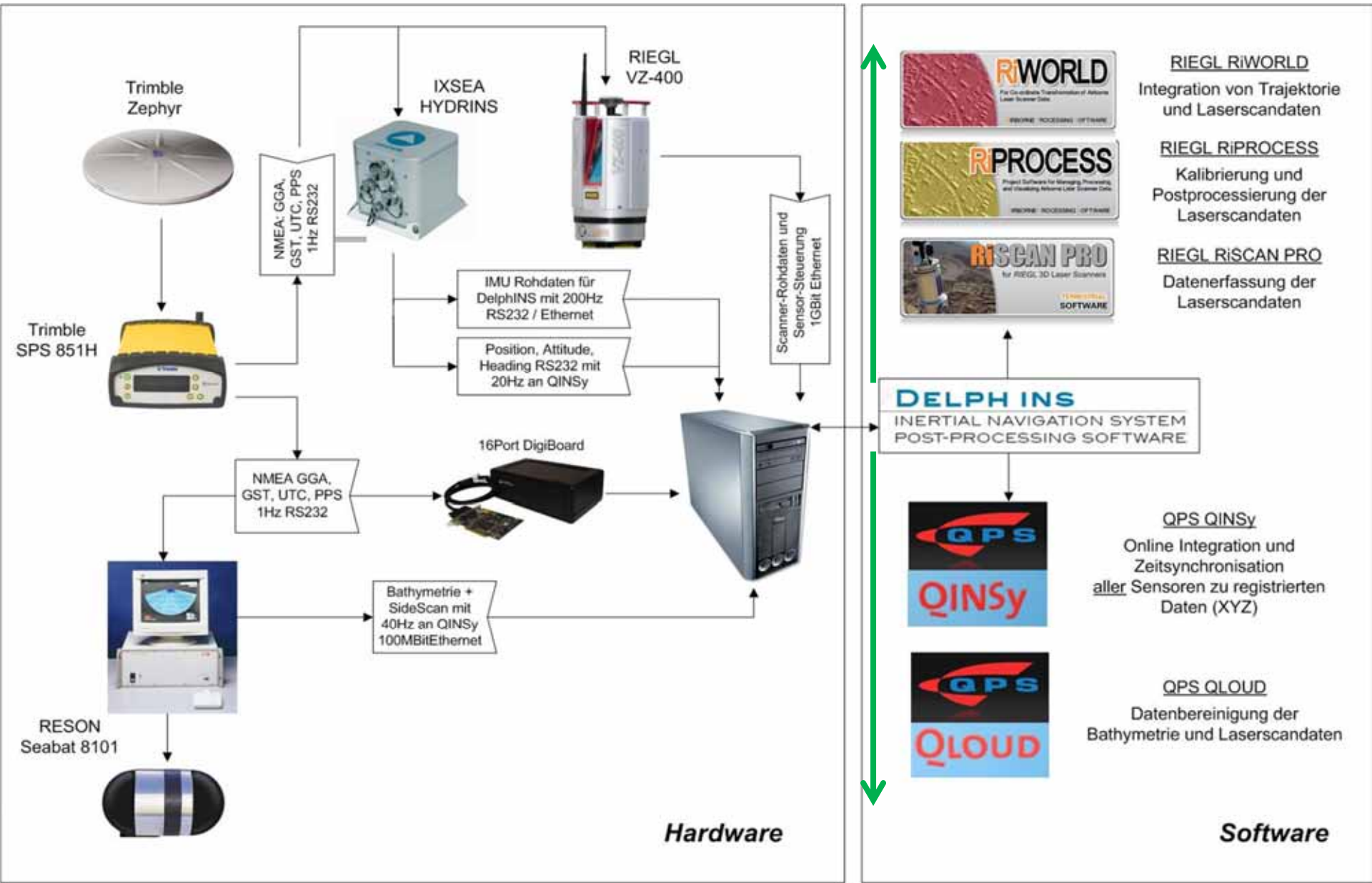
Bridge Eglisau



MBES with 90° swath
50 cm missing


Hydroelectric power plants
cables

Sensor Integration of GNSS/IMU, echo sounder and terrestrial laser scanner



Real time Impressions Post Processing

- Real time solution / QPS Qinsy/Qloud
  - Low resolution (data rate 10 Hz for positioning)
  - Real time: deviations between profiles: partly around 2-4 cm, mean solution around 10 cm

- Improvement of positioning and attitude with DelphINS (post processing)
  - Applanix SBET-format
  - ASCII-formats
  - up to now 50 Hz, because of computional limitations

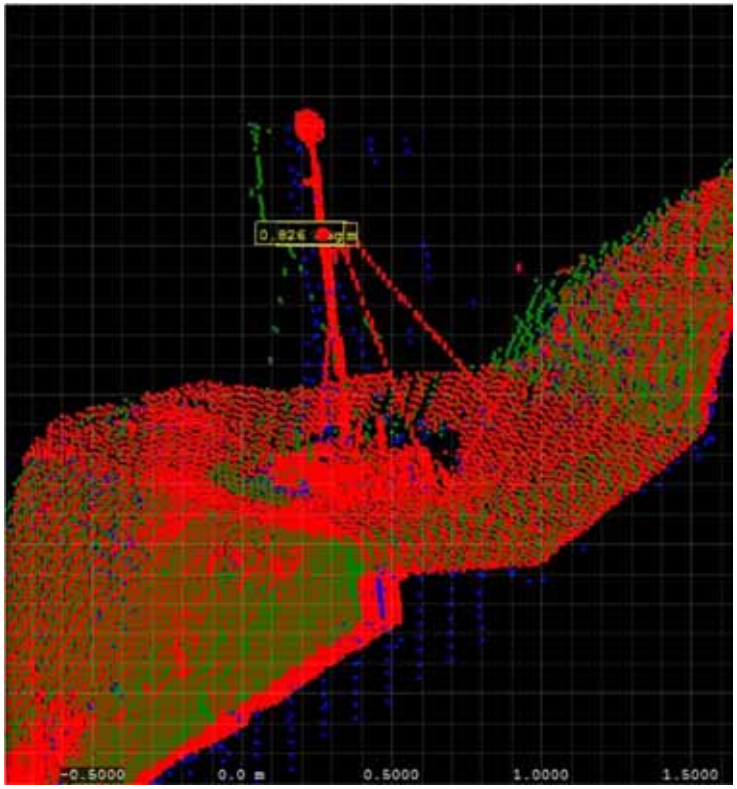
- Post processing solutions
  - QPS / Qinsy and Qloud and RiProcess
  - full data rate
  - Improved accuracies (re-calibration)

To be discussed with RIEGL / IXSEA and/or to be investigated by HCU:

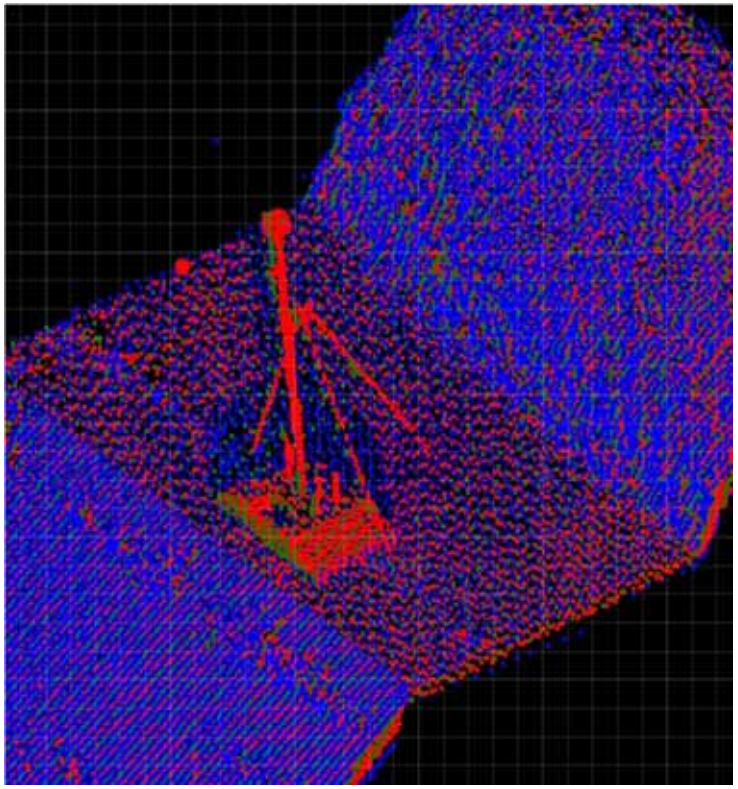
in GNSS disturbed areas advanced filtering / rejecting methods

Real time Impressions Post Processing

- Latency in post processing



Post Processing in Software X
Latency of 150 ms ?



Post Processing in Software Y
No latency

Same data input

Potentielle Anwendungen

- 3D-Mapping in Hafengebieten, Wohngebiete, Industrieanlagen (Überwachung von Kaimauern, ...)
- 3D-corridor mapping an Flüsse und Seen, Habitatskartierung
- Topographische Aufnahmen an Flüssen, Seen, Küsten (Wattenmeer)
- Überwachung von Schifffahrtswegen und Deichen
- Durchfahrtshöhen von Brücken
- Analyse von Schiffsbewegungen
- ... to be continued ...

Zusammenfassung

- Erfolgreiche Integration mehrerer TLS in das Multi Sensor System an Bord der Level-A
- Hohe Genauigkeiten in Echtzeit (2-3 cm – dm)
- Große Abhängigkeit von Positions- und Lagewinkelbestimmung (GNSS, aber besonders inertiale Sensoren)
- Voraussetzung: bestmöglich optimierte und kalibrierte Sensoren
- Zu untersuchende/diskutierende Probleme:
  - Schnittstellen zwischen den Sensoren und den Softwareprodukten
  - Aufnahmen in stark GNSS-abgeschatteten Gebieten (gute INS notwendig)

Großes Potential für Forschung, Entwicklung und Anwendungen

Zusammenarbeit mit / Dank an

QPS
IXSEA
Riegl

Dr. Hesse & Partner Ingenieure dhp:i
Thomas Thies, M.Sc. (HPA)
TBA Basel (Frank Schmidt), BAFU
FH Muttenz (Prof. Gottwald, Dr. Stiebler)
Prof. Kersten und Mitarbeiter (HCU)
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Danke für Ihre Aufmerksamkeit !