

JOANNEUM RESEARCH

Natural Risks

Terrestrial Laser Steaming

for Georisk Monitoring. Methods and Practice

Digital Image Processing

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 Rock Slide Monitoring
 Snow Cover Monitoring
 Glaci Mo

 Monitoring
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Glacier Change Monitoring

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Georisk Monitoring

Overview



Rock Slide Monitoring Danger of a Rock Fall



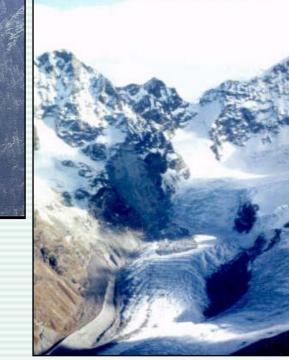
Vorarlberg, 2002



Eiblschrofen, Schwaz, Tyrol, 1999

Reasons: >

- Climate change: global warming
- Extreme weather conditions
- Removal of protection forest
 - Dense settlement



Piz Morteratsch, Switzerland, 1988

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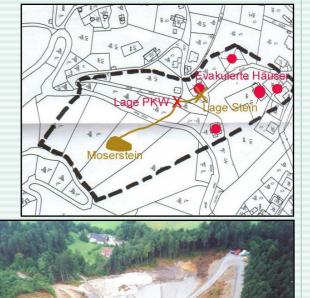


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Rock Slide Monitoring Appropriate Measures

- Evacuation of buildings
- Road closure
- Disaster alert plans
- Protection buildings: protective barrier, retaining wall, retention capacity, rock anchor
- Restoration of protection forests
- Observation of potentially insecure regions



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Riegl LPM98-2k

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Laserscanner

DIBIT Geoscanner

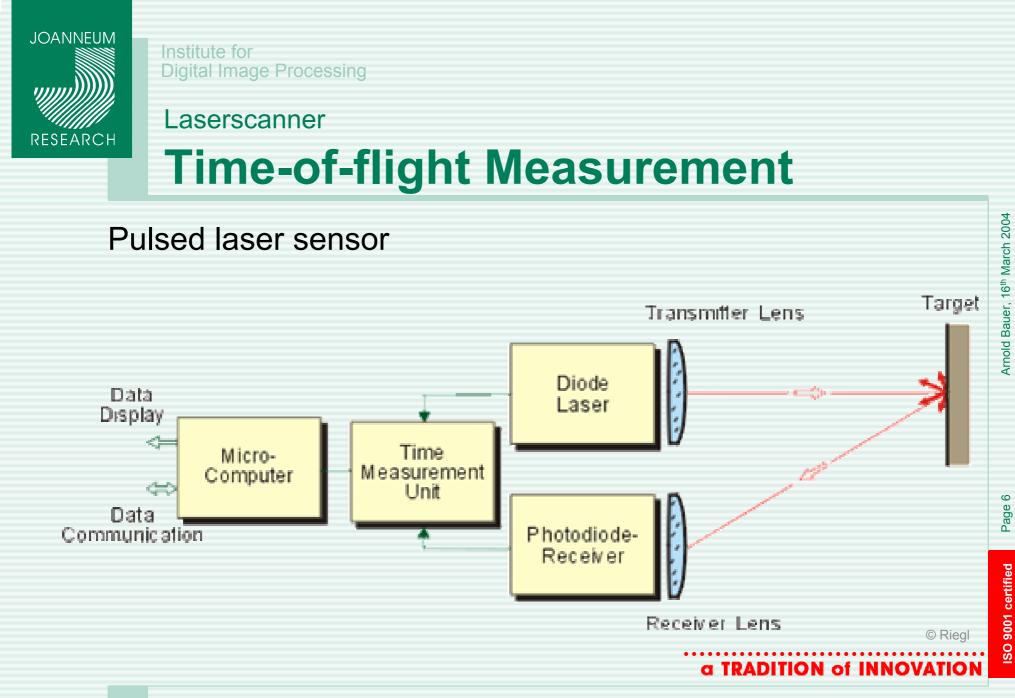


Terrestrial

long range laser scanner (up to 2km)

- Pan & tilt mount for positioning Regular grid of spherical angles
- Laser wavelength: near-infrared, 900 nm Eye safety: class 1M (3B) Beam divergence: 1.2 mrad
- Measures distance, reflectivity, SDev
- High accuracy (distance: typ. ± 50 mm) Measuring time: 0.25 - 1 sec / point
- See <u>www.riegl.co.at</u>

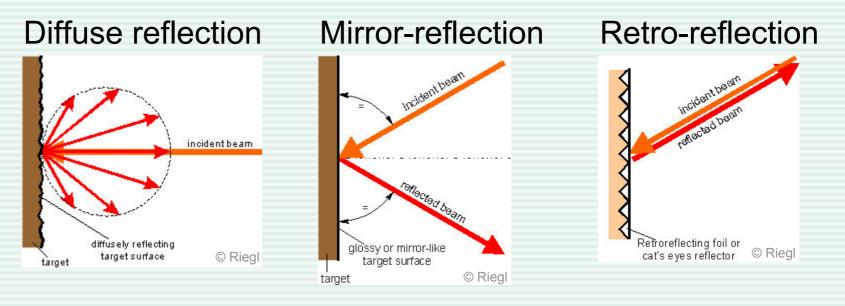






Laserscanner

Reflecitity of Surfaces / Materials



Reflectivity:

 Snow: ~ 85 %
 Sand: ~ 50 %

 Rock: ~ 75 %
 Trees: ~ 30 %

Reflecting foil 3M: ~ 1250 %

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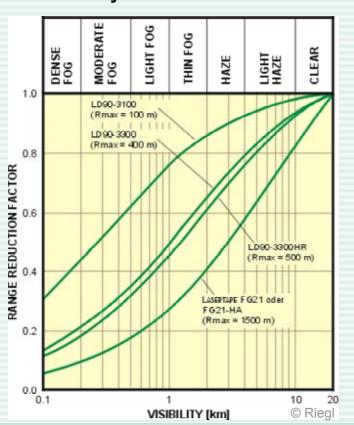


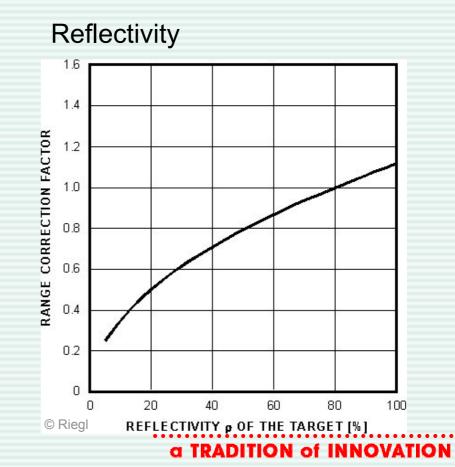
Laserscanner

Maximum Range

Depends on:

Visability





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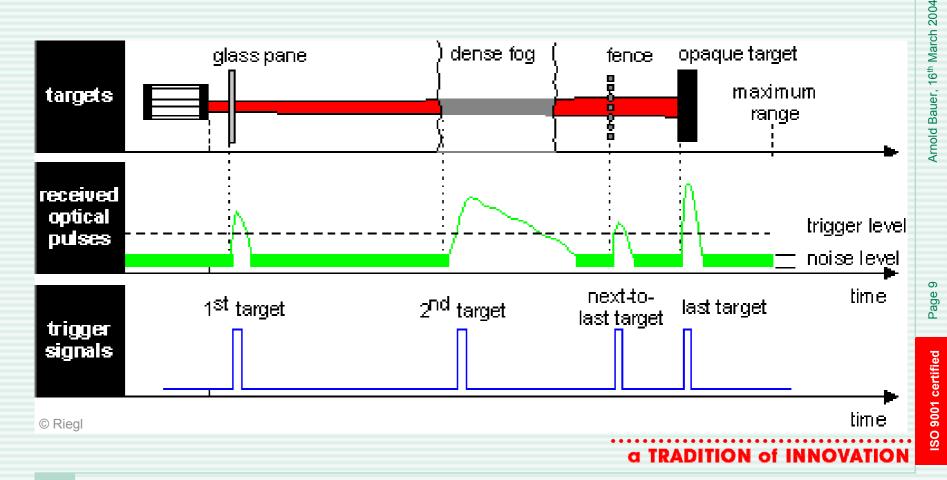
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Laserscanner

First / Last / Strongest Pulse



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Laserscanner Software

LaserServer

Fully automated data acquisition and analysis

LaserServer (D:\Laser\ArlbergGalzig2004ForPaper)	
Meßstrategie	Log : IDL Version 5.4 (Win32 x86). (c) 2000, Research Systems, Inc. Log : Initialisierung der seriellen Schnittstelle mit 9600 Baud
Standard-Meßprogramm Einzelmessung	Log : Initialisierung des Laserscanners Log : Erfolgreiche Initialisierung (0.000 sec)
Not-Meßprogramm	Log : Ausführen der Aufgabe Log : Einlesen der ROI 1/1 <pleisen> Log : Einlesen von <pleisen 020103.3dd="" 20030304=""></pleisen></pleisen>
Kalibration Auswertung	Log : Einlesen von <pleisen_20030304_020103.3dd> Log : >> Vorverarbeitung</pleisen_20030304_020103.3dd>
Aufgabenliste: TaskListAnalysisPleisen.cfg	Log : Definierte Einzelmessungen: 271273 (78.31%) Log : Verwerfe Einzelmessungen mit Reflektivität < 0.015: 1049 (0.30%) Log : >> Zuordnen der Orientierung
Messung	Log : Gültigkeit der Kalibration: 0 00:42:40 Log : Zuordnen von <trafo_20030304_011823.sop></trafo_20030304_011823.sop>
De-Initialisierung Start	Log : Speichern von <pleisen_20030304_020103.sop> Log : >> Berechnung des Höhenmodells Log : Lade Parameter <dempleisen.cfg></dempleisen.cfg></pleisen_20030304_020103.sop>
Status	Log : Direkte Rekonstruktionsmethode: 1900 x 1100 DEM Log : Erfolgreich berechnete Punkte: 210770 (60.85%) Log : Undefinierte Messpunkte: 76176 (21.99%)
Region:	Log : Ausserhalb des DEM-Bereichs: 59454 (17.16%)
Messung: Status: Scanner initialisiert. Bereit für Messung.	Log : Statistik: Minimum Maximum Mittelwert Log : X -8260.687 -6769.044 Log : Y 221626.533 224055.491
Definition	Log : Z 1814.224 2597.764 2058.299 Log : Interpoliere DEM Log : Speichere <d:\laser\arlberggalzig2004forpaper\results\dem\pleisen 20030304020<="" th=""></d:\laser\arlberggalzig2004forpaper\results\dem\pleisen>
Erogramm	Log : >> Berechne absolute Schneehöhe Log : Lade Referenz <d:\laser\arlberggalzig2004forpaper\commondata\dem_zero.tif> Log : Speichere <d:\laser\arlberggalzig2004forpaper\results\demdiff\pleisen_0000000< th=""></d:\laser\arlberggalzig2004forpaper\results\demdiff\pleisen_0000000<></d:\laser\arlberggalzig2004forpaper\commondata\dem_zero.tif>
🔬 Auswertung i Hilfe 🔀 Schließen	Log : Speichere <d:\laser\arlberggalzig2004forpaper\results\demdiff\pleisen_0000000 Log : >> Konturplot des Höhenmodells</d:\laser\arlberggalzig2004forpaper\results\demdiff\pleisen_0000000

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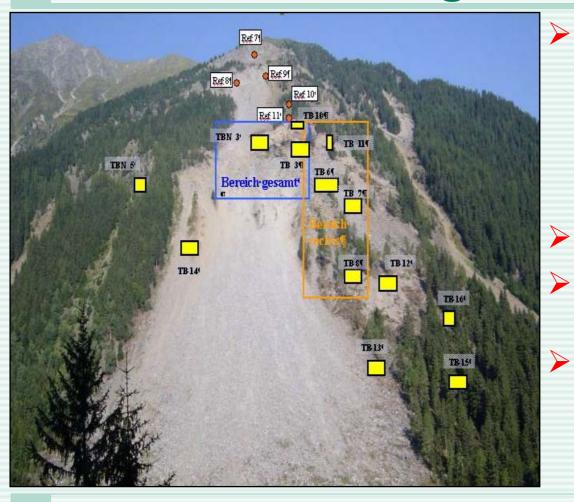
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Project Definition Define Measuring Process



Areas to be surveyed:

- Area ROI
- Point ROI
- Reflective Target
- Natural Target
- Measuring Sequence
- Starting time & Repetitions
- Strategy for acquisition and evaluation

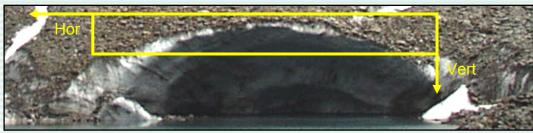
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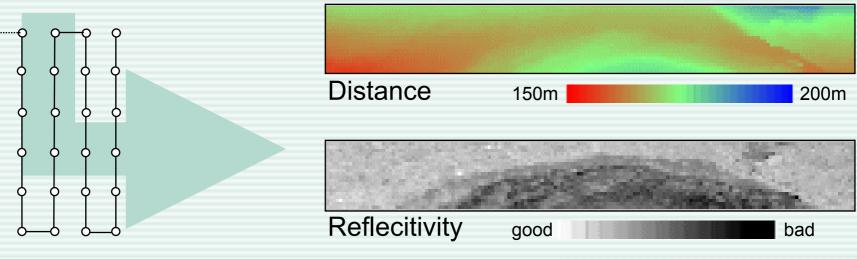
Laserscanner Software

Data Acquisition



Continuously scan rectangular regions-ofinterest with dense grid of distance measurements

Regular grid of sperical angles



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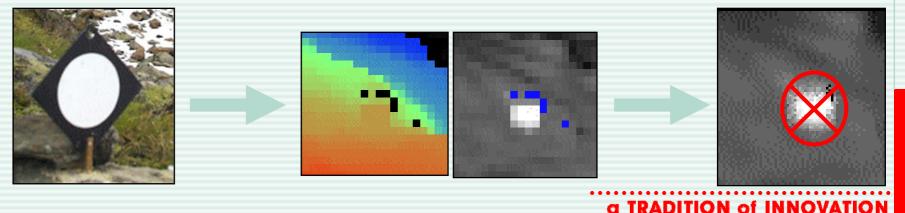
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Laserscanner Software

Measurement Compensation

- To guarantee comparability of measurements
 - Compensate orientation (due to misalignment)
 - Compensate distance measures (due to atmospheric influences)
- Use circular reflecting point targets
- Method: Reflectivity-weighted centroid determination



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Rock Slide Monitoring Monitoring of Mass Movements

- Objective:
 - Online monitoring of instable slopes and rock faces
 - Detection of instable slopes and movements
 - Low-speed motions of rock surface
 - Lateral distribution of deformations
 - Measure volume loss
 - Global trends
 - Change detection and classification
 - Risk assessment

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Rock Slide Monitoring

Monitoring of Mass Movements

Strategy:

- Distance measurement
- Point / ROI tracking
- Volume / deformation model

Projects:

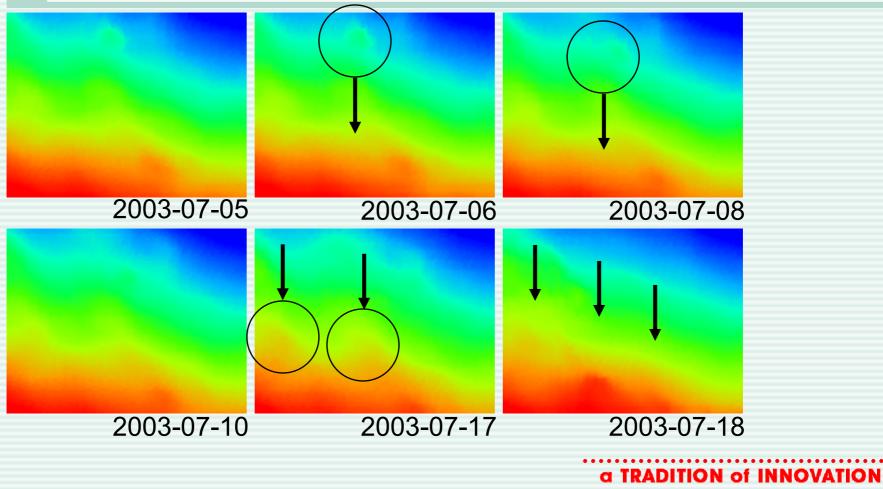
- Eiblschrofen, 1999
- Innertkirchen, 2001
- Gries, 2003

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Rock Slide Monitoring

Series of Measurements



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Rock Slide Monitoring **ROI Tracking**

- Derive deformation from 3D surface structure & reflectivity & RGB image
- Point tracking on ROIs
- Evaluation of the changes
- Classification of the changes
- Knowledge based system
- Automatic selection of ROIs



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Rock Slide Monitoring
Change Analysis

- Detect changes and motion
 - Change classification using expert system
- Develop a set of rules to categorize changes: use statistical parameters of ROI tracking use expert decisions
- Semantic classification of the kind and relevance of the change event
- Risk assessment
 When exceeding thresholds \rightarrow give an alarm



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Rock Slide Monitoring

Change Analysis

- Statistical evaluation of the matching results: plausibility, estimated accuracy, average displacement
- Straightforward set of rules for decisions:
 - Unusable measurement
 - Irrelevant / Significant displacement
 - Structure changed (rock slip, heap)

Prototype software

078 TB8_20030721_054935 TB8_20030720_234921 0.86 0.13 0.0013 ROI_M_IrrelevantDisplacement 079 TB8_20030720_234921 TB8_20030720_174926 0.10 0.24 0.1860 ROI_M_StructureChanged 080 TB8_20030720_174926 TB8_20030720_114934 0.61 0.19 0.0200 ROI_M_LargeDisplacement 081 TB8_20030720_114934 TB8_20030720_054929 0.64 0.20 0.0023 ROI_M_IrrelevantDisplacement 082 TB8_20030720_054929 TB8_20030719_234942 0.81 0.16 0.0019 ROI_M_IrrelevantDisplacement 083 TB8_20030719_234942 TB8_20030719_174933 0.64 0.20 0.0188 ROI_M_LargeDisplacement 084 TB8_20030719_174933 TB8_20030719_114919 0.64 0.20 0.0194 ROI_M_LargeDisplacement 085 TB8_20030719_114919 TB8_20030718_235057 0.76 0.18 0.0006 ROI_M_IrrelevantDisplacement 086 TB8_20030718_235057 TB8_20030719_054929 0.76 0.17 0.0014 ROI_M_IrrelevantDisplacement

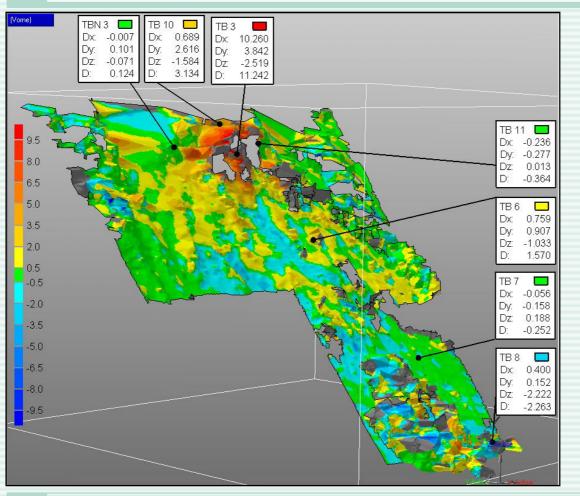
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Rock Slide Monitoring

Volume / Deformation Model



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Point Tracking



Epoche 81 2003-07-24, 01:49:38

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Snow Cover Monitoring

Basics for avalanche prognosis:

- Meteorological Data: precipitation, atmospheric pressure, atmospheric humidity, temperature, wind speed, ...
- Digital terrain model
- Depth of snow

not only on few point locations and weekly, but on whole area and continuously (several times a day)

Redistribution of snow

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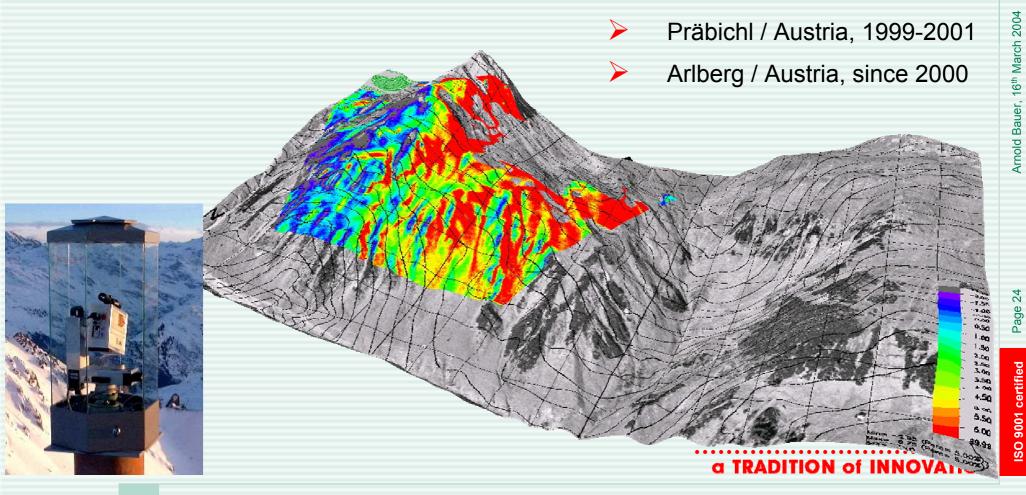
Snow Cover Monitoring

- Preprocessing: Measurement usability
- Compensate orientation and range measurements
- Geo-reference
- Digital Elevation Model (DEM)
- Difference-DEM:
 - Absolute snow cover
 - Increase of snow cover





Snow Cover Monitoring

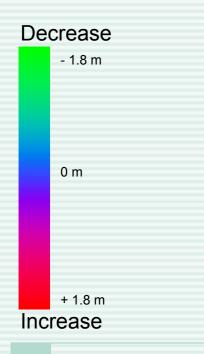


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Snow Cover Monitoring

Avalanche Präbichl / Austria 12.03.2001

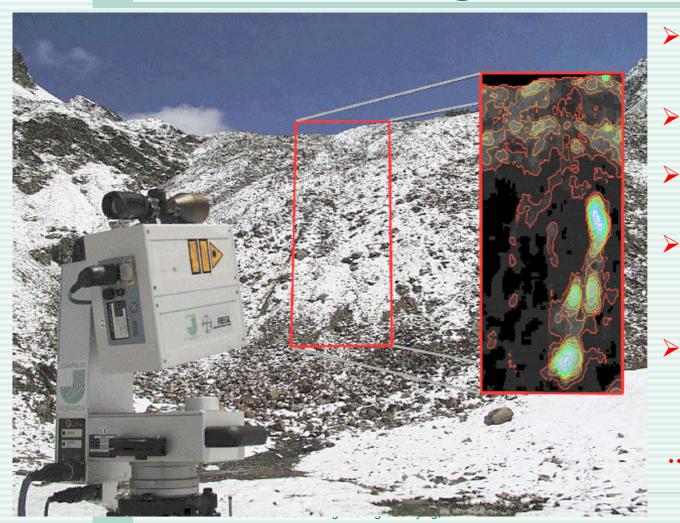


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Glacier Change Monitoring

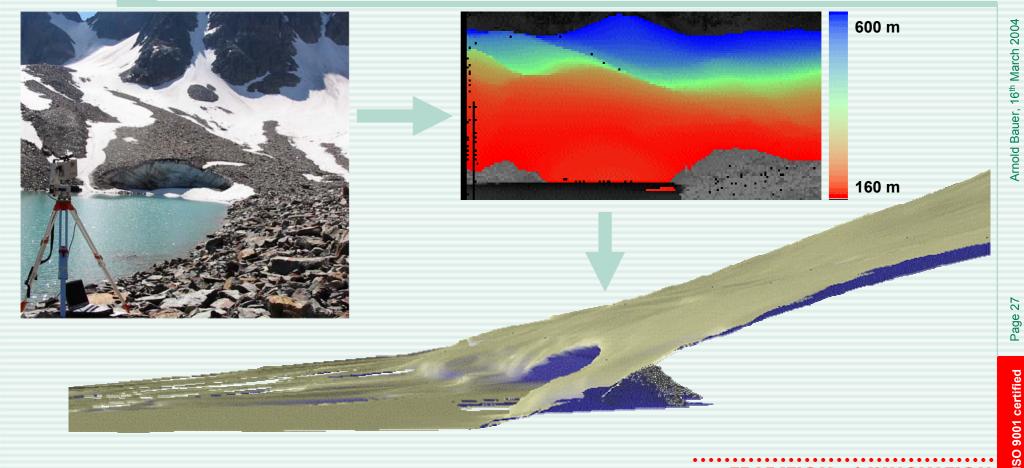


- Area-wide documentation of the dynamic trend of glacier surfaces
- Increase / decrease of glaciers
- Measure volume change
- Cooperation with TU Graz, Institute for Applied Geodesy and Photogrammetry
- Test site: Gößnitzkees, Langtalsee, Pasterze (Nationalpark Hohe Tauern)

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Glacier Change Monitoring



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