

# Hydrostatic Leveling Systems: Measuring at the System Limits

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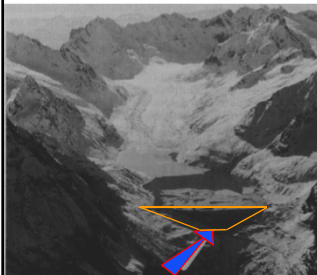
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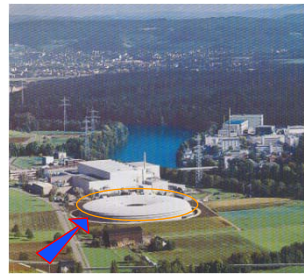
**Roger ZWYSSIG**  
Emch + Berger WSB, Cham, Switzerland

## 3 Applications at the system limits



Hydropower Dam

*differential  
pressure*



Accelerator

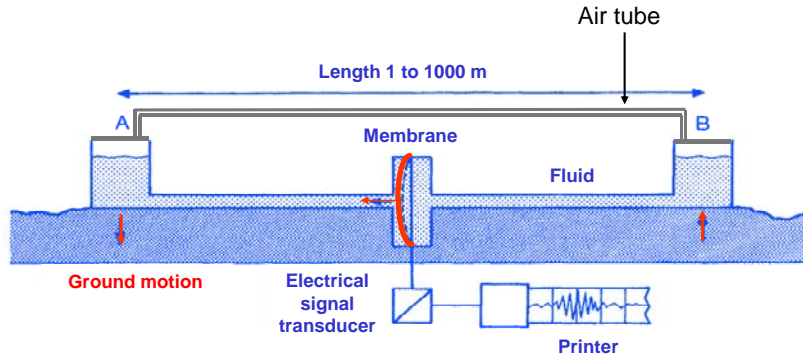
*half-filled pipe*



Highway Bridge

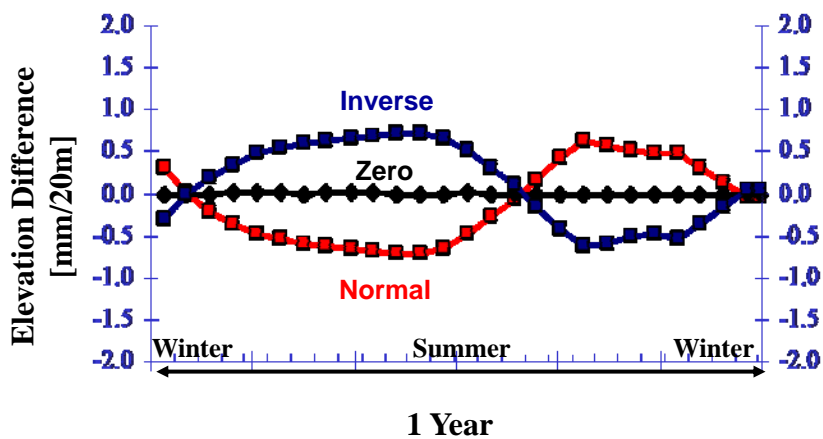
*differential  
pressure*

# LAS-meter: Large Area Settlement



- hydrostatic pressure
- membrane deformation
- autocalibration

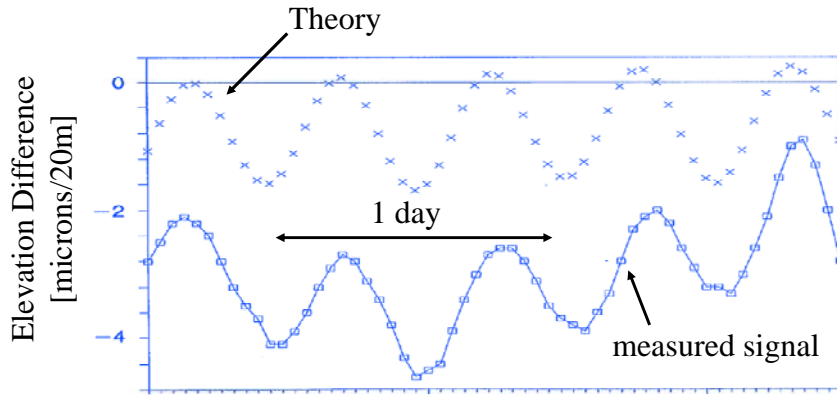
# Albigna Dam: Calibration Data



## Albigna Dam: *High resolution*

e m e r partner

### Earth-Tides



ETH  
Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zürich

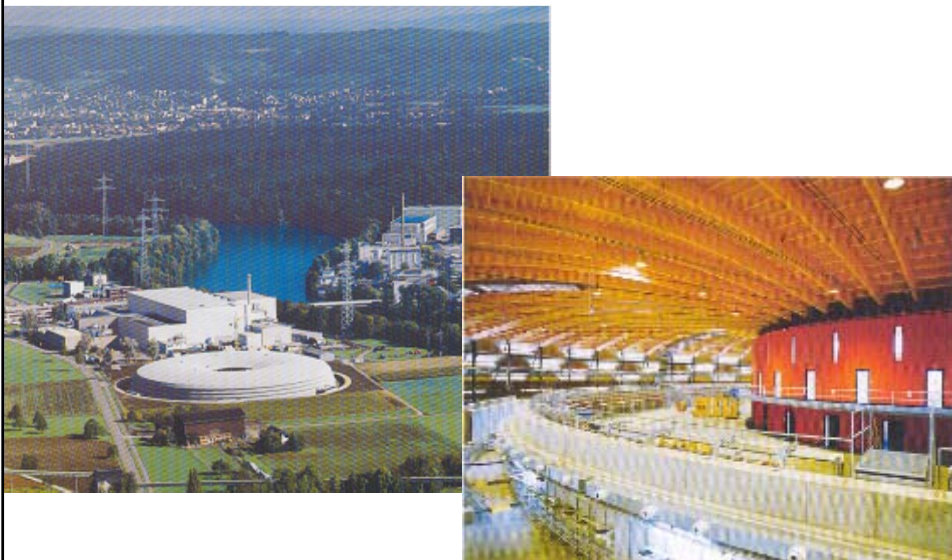
geomETH

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## Accelerator SLS : Paul Scherrer Institut

e m e r partner



ETH  
Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zürich

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# Girder SLS

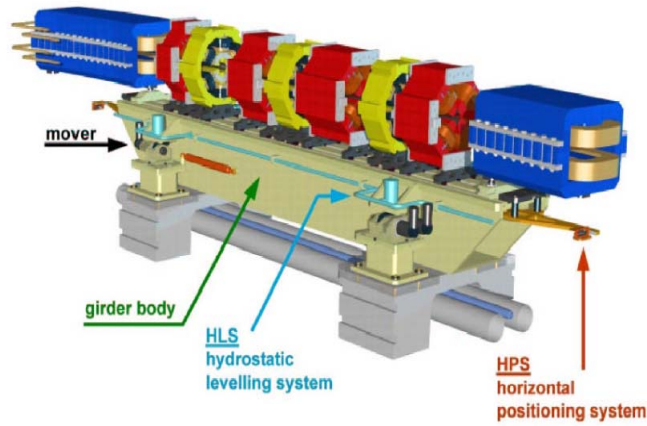


figure 1: SLS girder assembly

Schlott et al. 2000

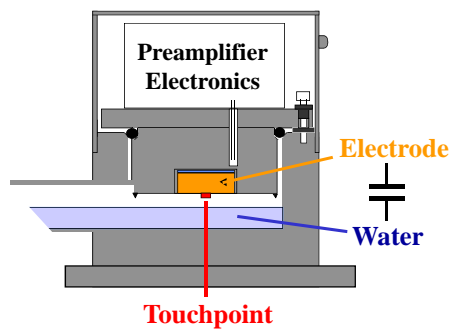
## 1 DYNAMIC ALIGNMENT

# Hydrostatic Leveling System HLS

Collaboration of EMP, geomETH, Winterthur, Stanford Linear Accelerator Center,  
Paul Scherrer Institute



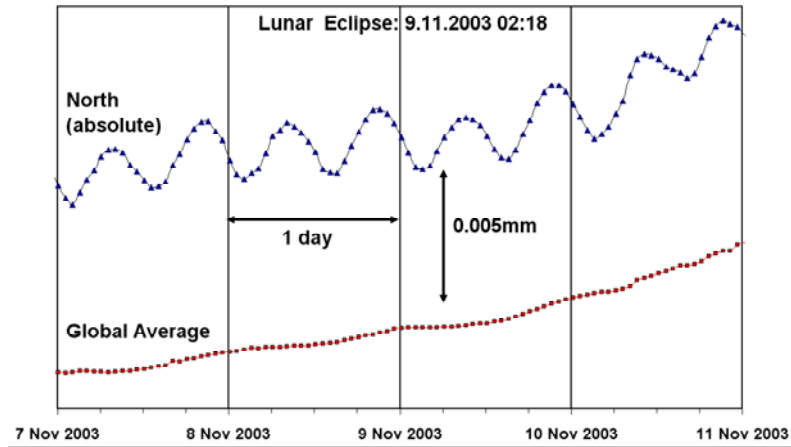
Levelsensor: Installation on girder



Section of the Levelsensor

## Liquid Loss -> No Error

e m e r t partner



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## Automatic Filling Station

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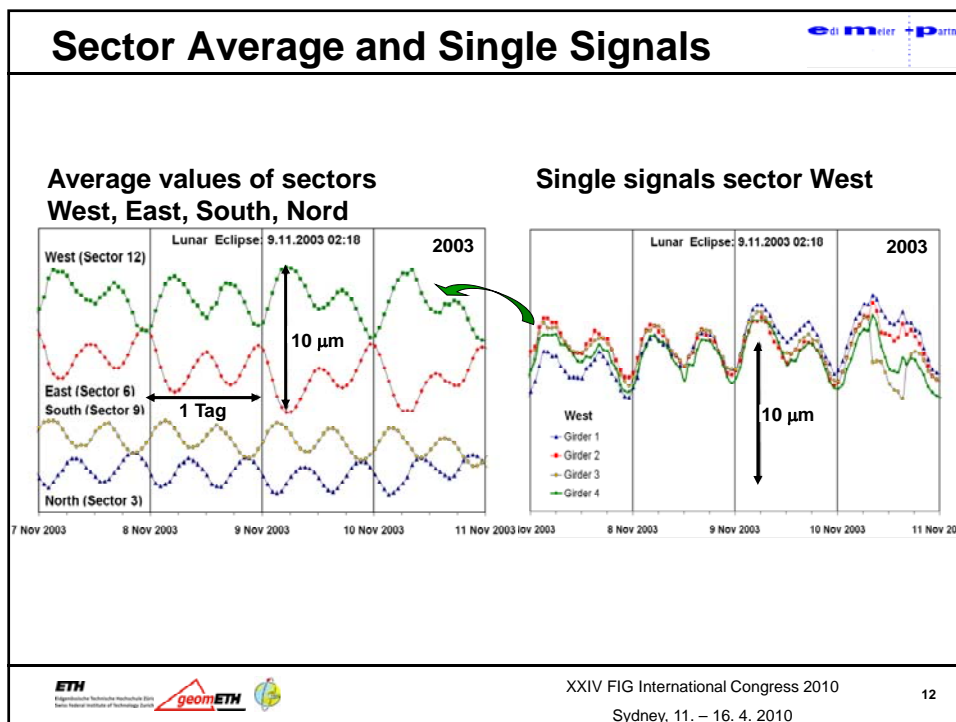
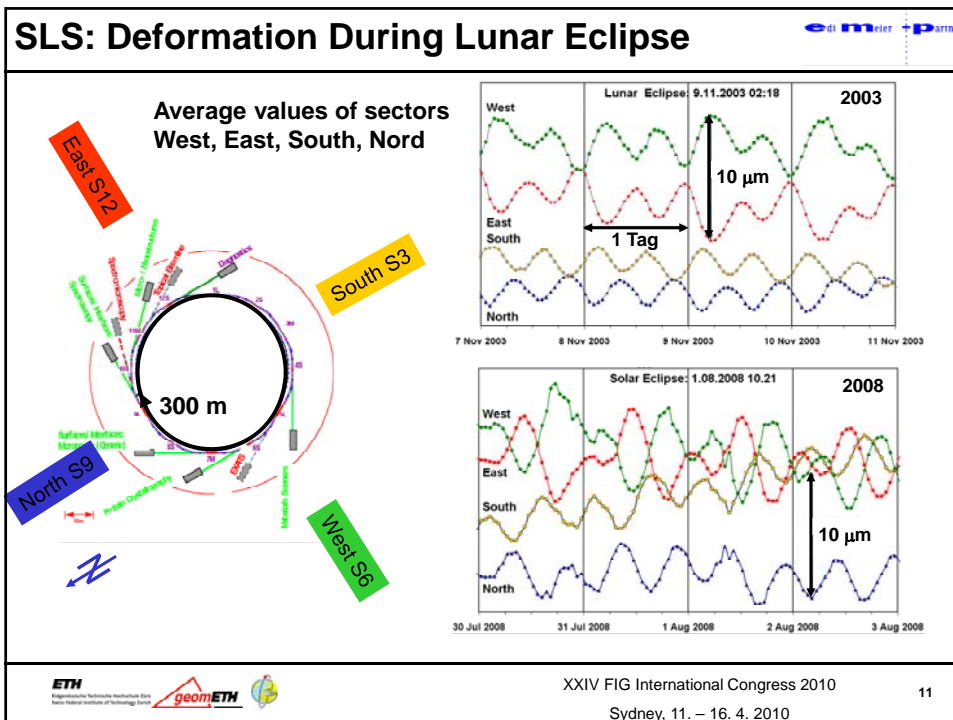
PSI SLS  
Remote Access

ETH  
Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zürich

geomETH

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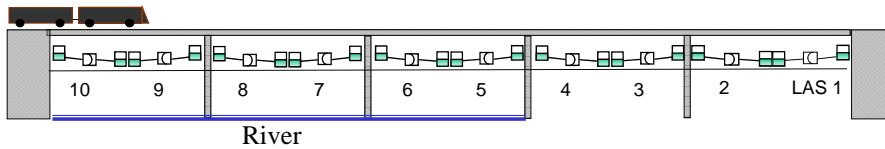


# Dynamic Bridge Monitoring with LAS

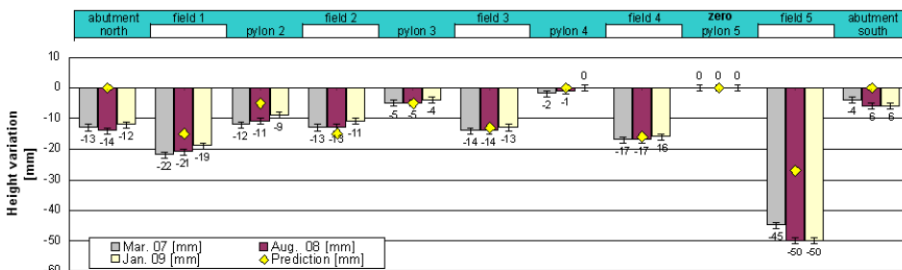
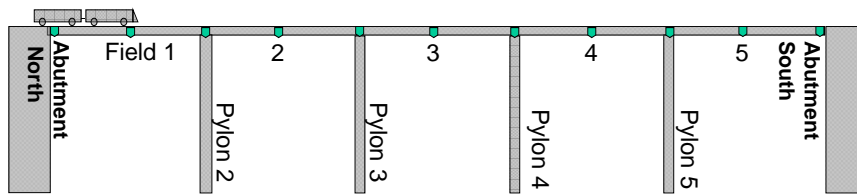


Broadening of a highway bridge near Lucerne  
*5 years security monitoring!*

- Verification of model assumption
- Recording of long-term settlements
- Recording of Dynamic displacements due to heavy trucks

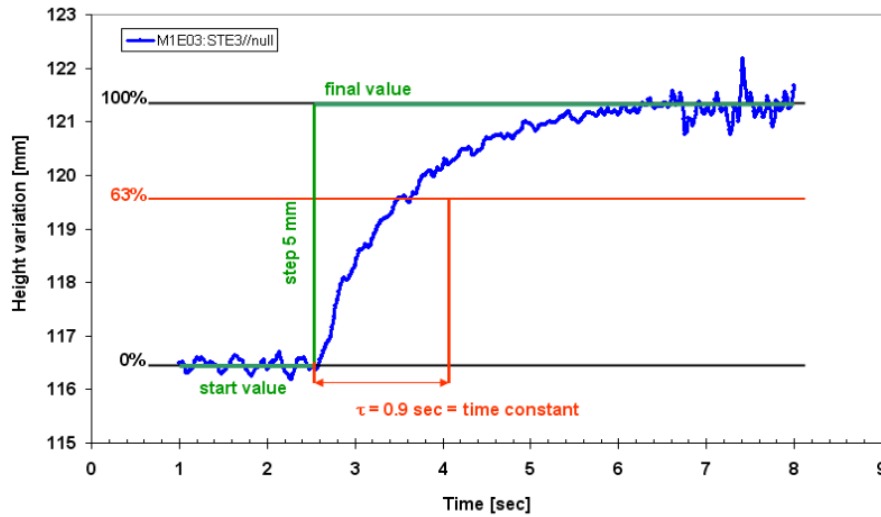


# Bridge: Long-Term Deformations



# Response Time

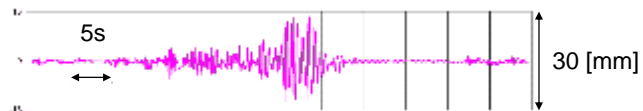
## In-situ control of the time constant



# Limits of differential pressure systems

LAS Signal  
Nr. 3

*not possible!*



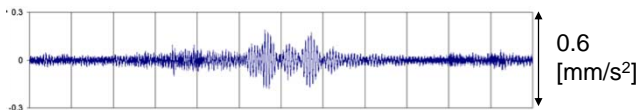
Magnetic Signal

*for detecting cars*



Horizontal -  
Acceleration

*interference with „g“*



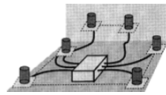
LAS Signal  
filtered





## When LAS and when HLS?

- LAS will be used, when:
  - the measuring spots are not accessible
  - long electrical cables are vulnerable to lightning
  - the power input has to be small
- HLS is used, when:
  - long-term stability has priority
  - all sensors lie on one level
  - angular measuring lines can be installed staircase-shaped



## Summary and conclusion

- Hydrostatic leveling systems have always to be adapted to the environmental conditions.
- In the field of dynamic systems further research is still needed.
- The bridge near Lucerne offers the possibility. Who is interested, is cordially invited!

**Thank you for listening!**