FP 6

EU Proposal SALMAPS

Safety Assessment and Lifetime Management of Piping Systems

by Klaus Kerkhof, MPA Stuttgart

Core Partners:

VCE, Vienna

MPA, Stuttgart

WBI, Höchberg

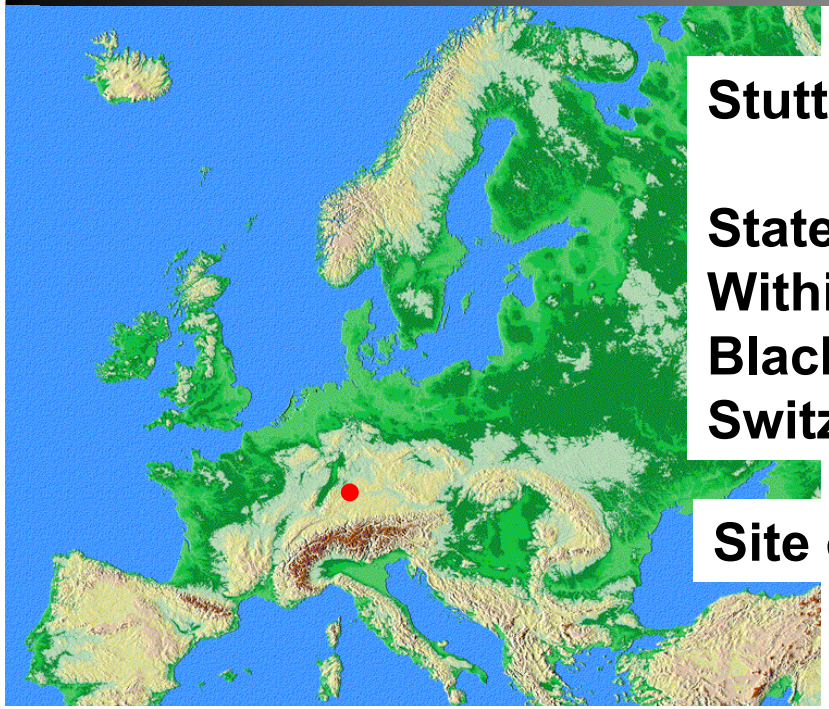
MPA STUTTGART

Research
Testing
Teaching
since 1884

Materialprüfungsanstalt
Material testing institute

Location
Some Historical Data
Legal Status - What is MPA ?
Scope of Activities - Equipment
Specific Research Activities
International Contacts

Location



Stuttgart - in the heart of Europe

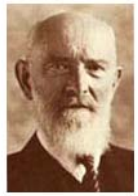
State Capital of Baden Wurttemberg
Within a short distance to
Black Forest, Swabian Albs, Lake of Constance
Switzerland, Austria, France

Site of Porsche, Mercedes, Bosch

Famous people of Stuttgart:

Georg Friedrich Wilhelm Hegel
Philosopher, born 1770 in Stuttgart

Friedrich Schiller
studied at the former Hohen Carlsschule (University)



Robert Bosch
developped in 1902 the high-speed, high-tension magneto ignition

Gottlieb Daimler
invented in 1883 the first fast-running petrol engine in his test workshop in Bad Cannstatt

Mercedes-Benz

BOSCH

PORSCHE

Some Historical Data

Founded in 1884 by Carl von Bach

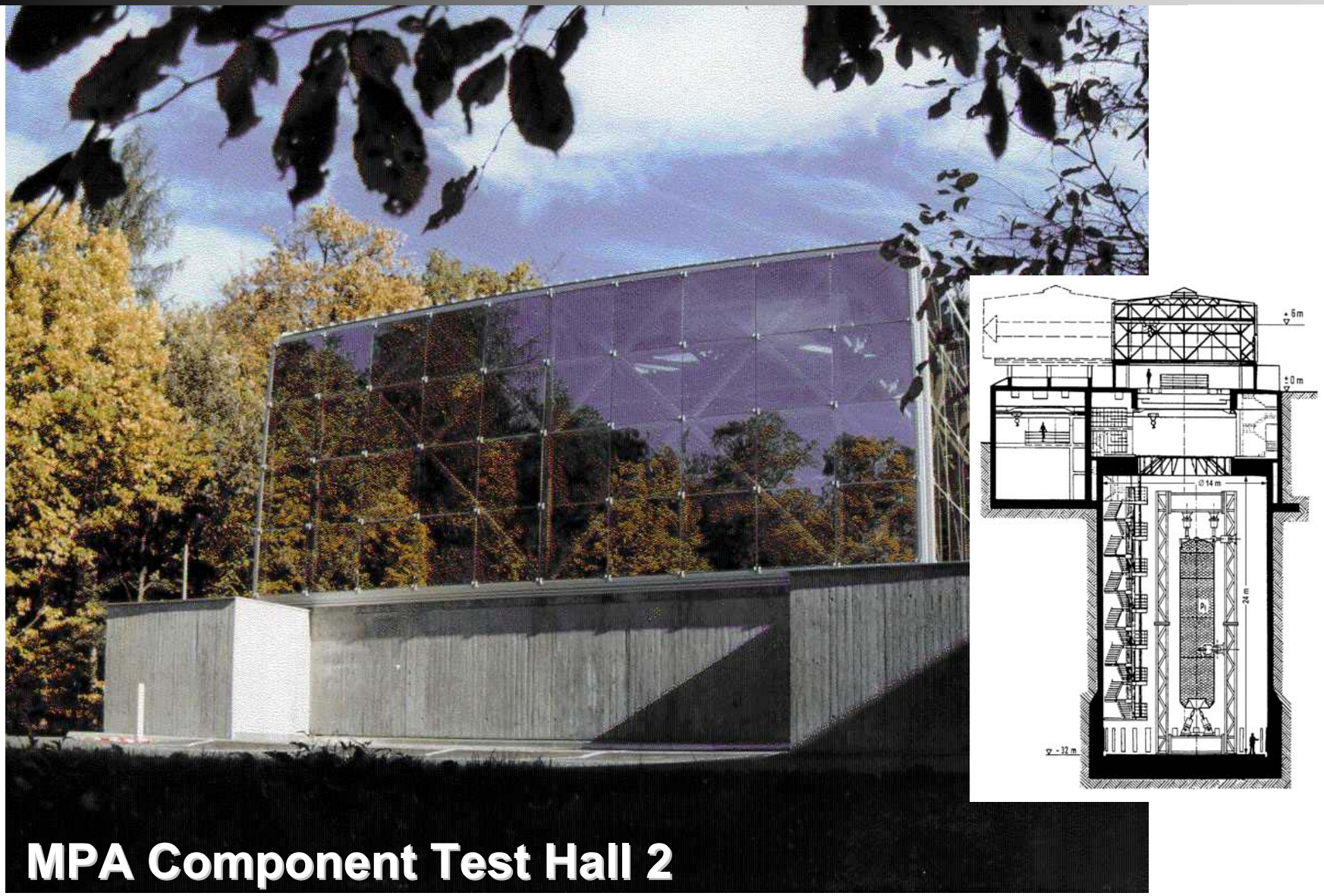
Establisher of modern elastic-plastic strength calculation, stress analysis and material testing in Germany

Contemporary of Bosch and Daimler - influencing their engineering work

Ennobled by the King of Wuerttemberg

Foundation

Location



Legal Status - What is MPA ?

Independent research organisation

Affiliated to the University of Stuttgart

MPA
STUTTGART

Research Activities until 6/2003

Materials - Science
- Basic Characterisation
- Qualification
- Material Laws
- Development

Manufacturing Technologies
- Heat treatment
- Joining Technologies
- Surface Engineering

Integrity Analysis
- Strength Analysis
- Lifetime Analysis
- Transferability of Material Laws to Structures

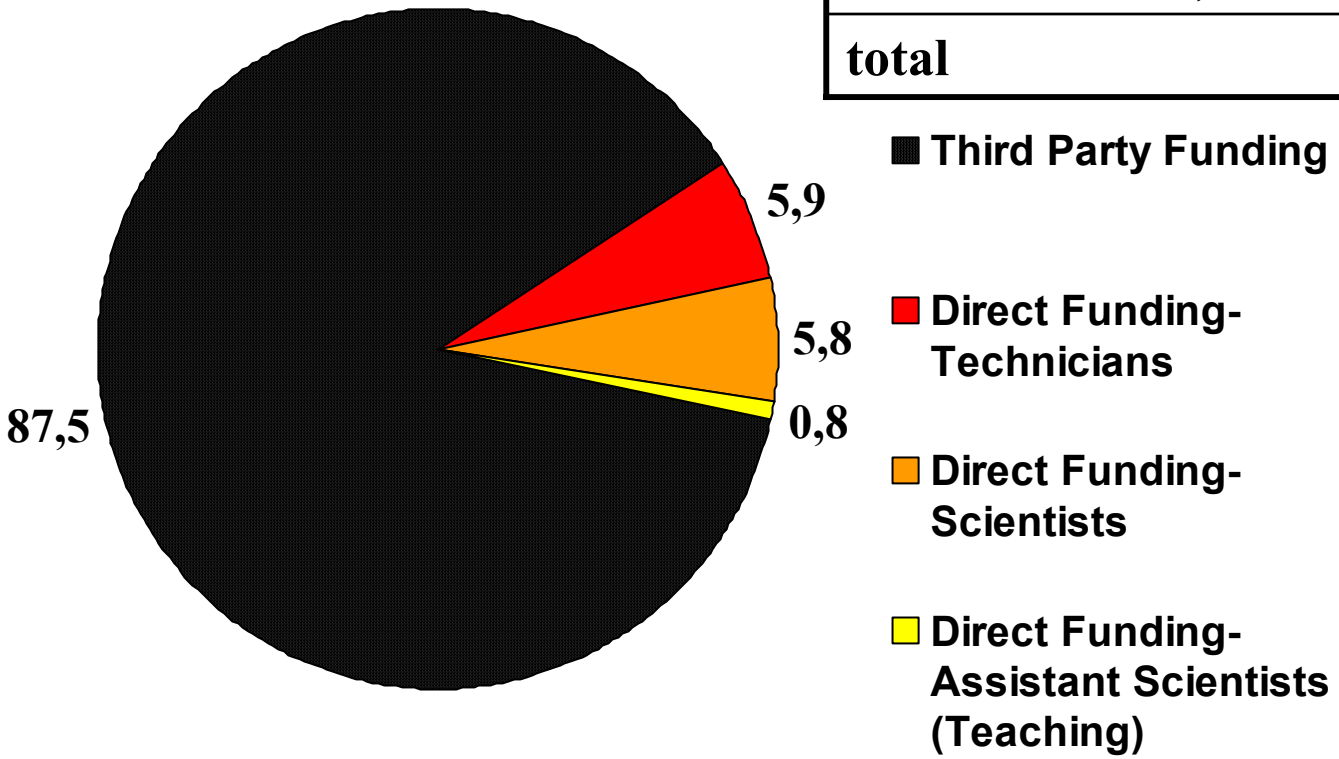
Quality Assurance

Maintenance Strategies

Materials
- Steels
- Lightweight Metals
- Ceramics
- Composite Materials

Status until 6/2003

Scientists	112	50%
Technicians.	73	33%
Administration, Services	37	17%
total	222	100%



Financing - Personnel Costs

Status

Decision of the University of Stuttgart to merge with 01st July 2003

Forschungs- und Materialprüfungsanstalt für das Bauwesen (FMPA)
- Otto-Graf-Institut -
(Research & Material Testing Institute for Civil Engineering)

and

Staatliche Materialprüfungsanstalt (MPA)
(State Material Testing Institute)

to

Materialprüfungsanstalt (Material Testing Institute)
MPA Stuttgart • Otto-Graf-Institut
University of Stuttgart

to be a Central Institut of the University of Stuttgart

Scope of Activities Modern Materials Testing

Scientists	188
Techniciens	174
Admini-stration	62
total	424

MPA

Institut für Materialprüfung, Werkstoffkunde und Festigkeitslehre

FMPA

IWB

Institut für Werkstoffe im Bauwesen

Material Testing Institute
University of Stuttgart

Competence of MPA Stuttgart

- Accredited by DAP German Accreditation System for Testing Ltd. under the terms of DIN EN ISO/IEC 17025
- for tests in the fields specified in the accreditation certificates (DAP-PL-2907.0).
- Additional accreditation and certification by DKD/PTB, KBA, ZLS and TÜV

- Nominated Body
  according to Pressure Equipment Directive (PED)

Motivation

Health Monitoring and Safety Assessment in Plant Engineering

In-service inspection and operational monitoring

- **improves availability of plants and components and**
- **reduces costs of maintenance**

Superior objectives are

- **to identify best practices specifically applicable to revamp projects and the effect of maintenance and operational availability**
- **to increase economy and to reduce emissions of European engineering structures**
- **to avoid unnecessary conservative stress analysis procedures and to achieve higher safety**

Motivation in reactor-technology, end-users need

For the end-user the economic benefit of diagnostics by reduction of failures, by extending life time of components, by precise planning of inspections intervals etc. is estimated up to 400 M€ per year depending on the size of the power generation unit. The assumptions made are:

Outages can cost the utilities up to 200.000 € per day in terms of lost revenue.

The replacement of the complete pipe work is up to 12 M€.

The replacement of a single component (hanger construction) is up to 50.000 €.

Increasing the period for inspections could save around 170.000 € per year for one power station unit.

Motivation in chemical plant industry, end-users need

For the **end-user** the economic benefit of health monitoring by reduction of failures e.g. in the field of PO-production may be

- freight cost savings of 37,000 US$ per year
- lost sales 350,000 € per year
- production cost 222,000 € per year

Motivation in chemical plant industry, end-users need

This realistic calculation is based on lost product due to equipment failures such as

- transmitter failure
- nozzle crack due to vibration
- propylene leakage instrument nozzle
- leakage due to vibration
- thermo-element failure due to vibration
- outlet line broken due to vibration
- crack in instrument nozzle

Motivation in chemical plant industry, end-users need

If the possibility of fatigue of safety relevant piping material is taken into account and one production plant would go out of operation the

production loss would be

20, 000 € / hour

480, 000 € / day

3 360, 000 € / week

Workpackages (WP)

The following themes in Plant Engineering were identified with a great potential of improvement (WP1: current practice…, WP11: Management)

WP 2

- **Sensor and Component Development:** Nonlinear Vibrations, Waves, Investigations regarding the wave propagation in piping systems, Design and fabrication of the PZT-fibre actuator, Electronic signal processing, System-conform application of the actuator
- **Sealing Technology:** Optimisation of sealing technology in plant engineering, development of a design method for bolted flange connections under vibrational loading

WP 2, Sealing Technology

- Optimisation of sealing technology in plant engineering (bolted flange connections in piping and valves), development of a design method for bolted flange connections under vibrational loading, monitoring and reduction of emissions from bolted flange connections and valves.

- Testing under vibrational loading, monitoring of bolt load and leakage rate

- Development of measures in order to optimise bolted flange connections in view of emission reduction

- Development of new or extension of existing design methods, development of a strategy for maintenance, emission control and emission reduction

Workpackages (WP)

WP 3

- **Selection of Test Cases, Monitoring of various systems in practice:**
  Collection of data (periodic insp.), Classification and database, Assessment of cases and ranking, Risk assessment and management, Selection of the best cases

WP 4

- **Monitoring System:** Check of existing components and systems,
  Determination of development requirements, Waves, Communication-network
  Selection of sensors from existing technology (acceleration, distance, velocity, strain, pressure, temperature)
  Derivation of requirements for investigated and demonstrator system
  Specifications in co-operation with end-users (which damages shall be found)

Workpackages (WP)

WP 5

In-situ Investigations under operational conditions → "Best Praxis“ in a chemical plant with pilot case characteristics

- **Vibration Analysis, Ambient vibration monitoring**

  Structural control (Reducing Vibration in Plug Flow and Reactor Piping, Damping), Safety Assessment, Fatigue

- **System identification: Development on model-updating features regarding piping analysis, Damage detection, structural model with actual conditions**

- **Damage allocation**

- **Data storage and transfer to → Decision support systems (WP6)**