

- **The Architecture of scientific data acquisition in the lysimeter research facility at GSF-Neuherberg, Germany**
 - ➔ **Introduction**
 - ➔ **Technical Structure**
 - ➔ **Intentions and Requirements**
 - ➔ **Common Methods of Resolution**
 - ➔ **Database Architecture**
 - ➔ **Software - Data Acquisition**
 - ➔ **Software - Data Visualisation**
 - ➔ **Software - Facility Controlling**
 - ➔ **Software - Protocol and Database Administration**
 - ➔ **Summary**

• Personal Profile

■ Georg Janker, Munich

- ➔ Consultant for Software Engineering
- ➔ Involved in GSF Department EUS since 1990

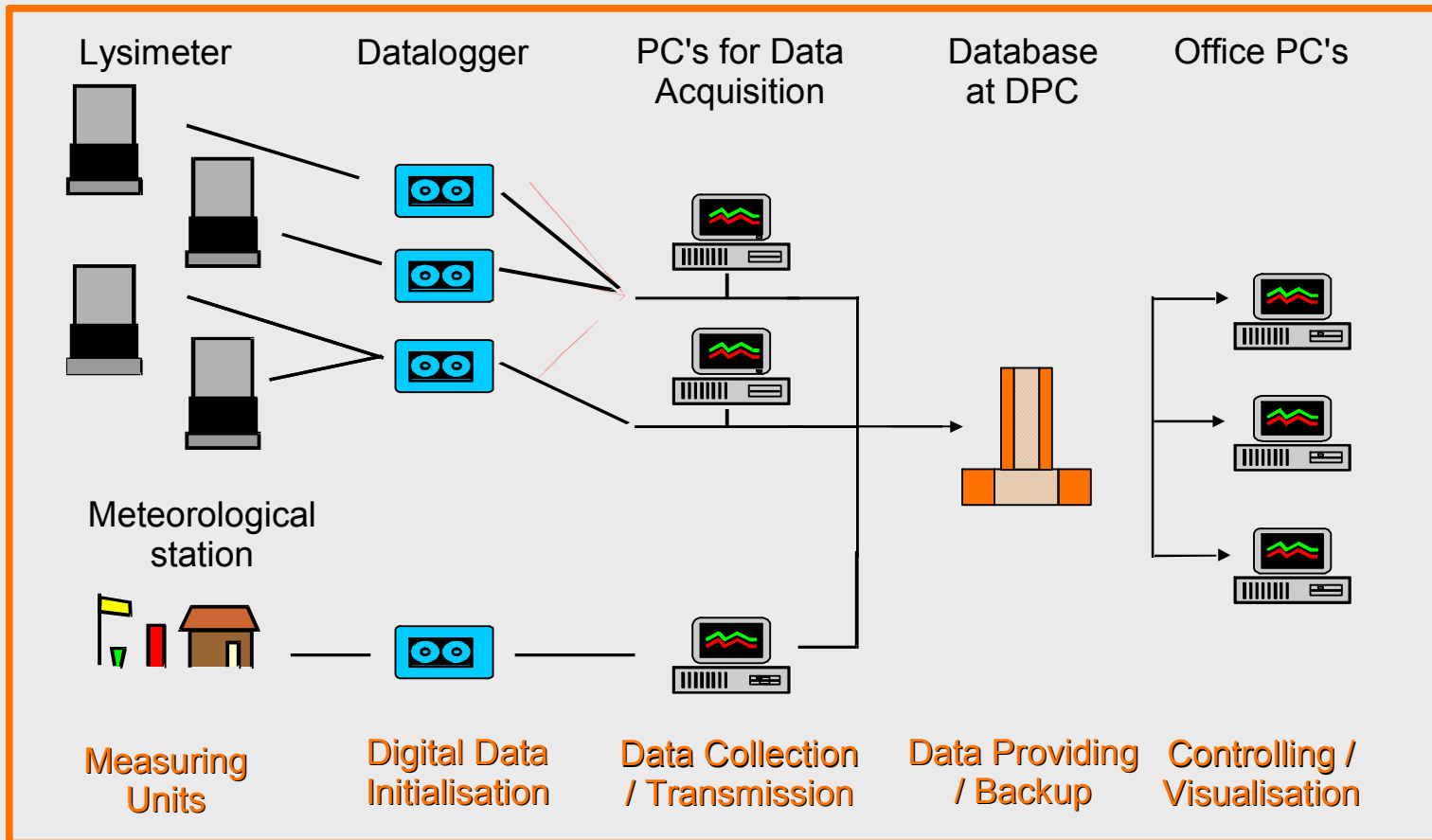
■ Dirk Römermann, Munich

- ➔ System- and Software Engineering
- ➔ Consulting and Software Engineering since 1992

• Activitiy Focus

- Consulting and software engineering for research facilities
- Since 2001 consulting the GSF lysimeter facility and
- Development of a most efficient data acquisition architecture
- Development of an integrated software system for research facilities, in particular for the GSF lysimeter facility.

Technical Structure



- Up to 48 lysimeters with measuring units connected to different types of datalogger
- 2 PC for data collection and data transmission
- One meteorological station nearby the lysimeter field
- Database Management System (DBMS) at the GSF Data Processing Centre (DPC)
- All components connected via LAN

- Scientific User and Operator

- Data Availability

- ➔ immediately after acquisition
- ➔ for different users like scientists and operators
- ➔ Continuous data flow ???
- ➔ long time storage, especially for lysimeter research projects

- Data Access !

- ➔ Data transparency : distinct data allocation
- ➔ Verifiable data : distinct data origin
- ➔ Interpretable data : saving available measuring circumstances

- All this qualities should be available after years independent from active scientist or operator

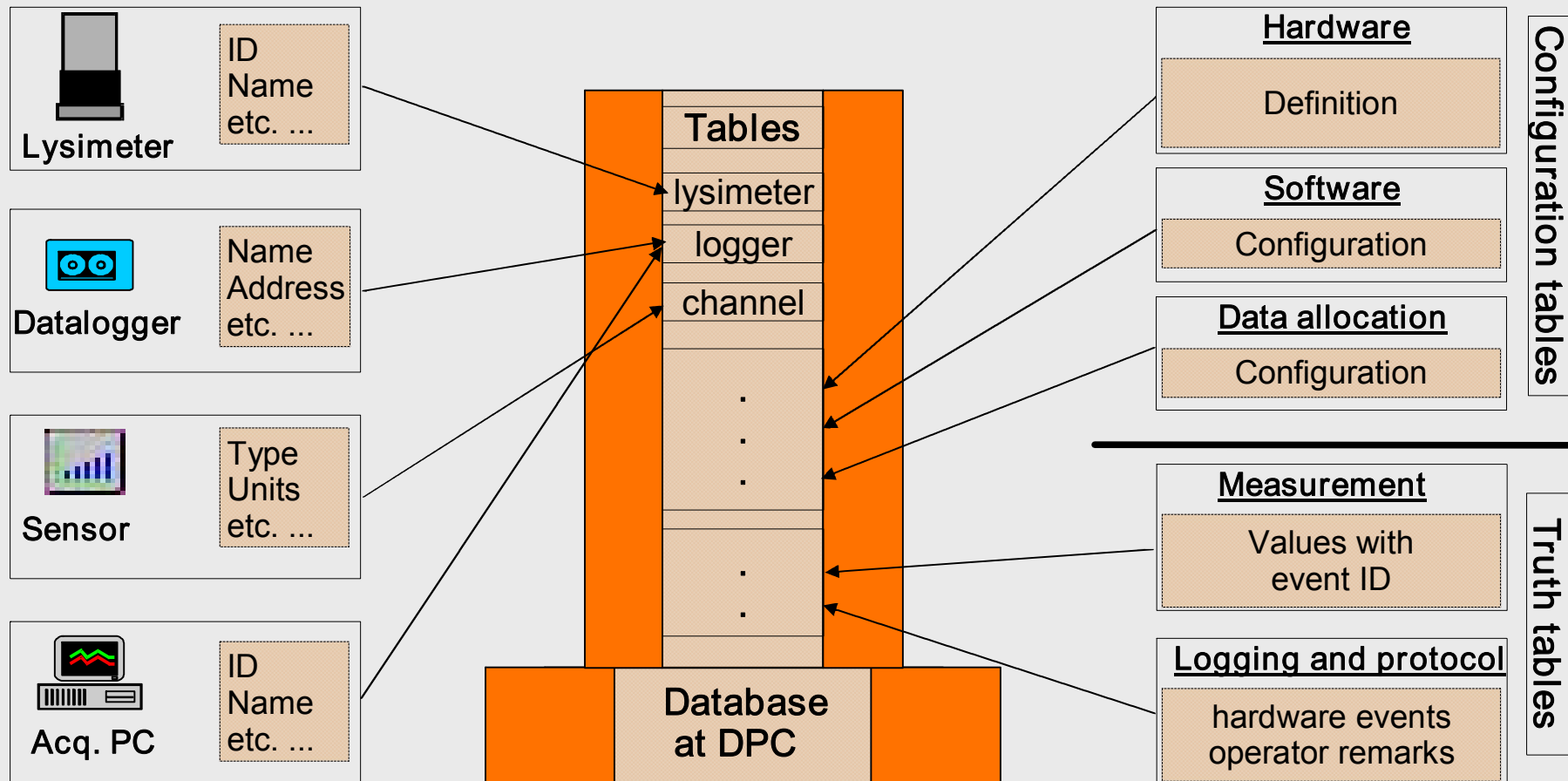
- **Common Software Requirements**

- Continuous data acquisition and storage from different datalogger types
- Easy data access, visualisation and export with standardised user interfaces
- Efficient operating and controlling of the whole facility
- Automation of administrative database jobs

- **Methods of Resolution**

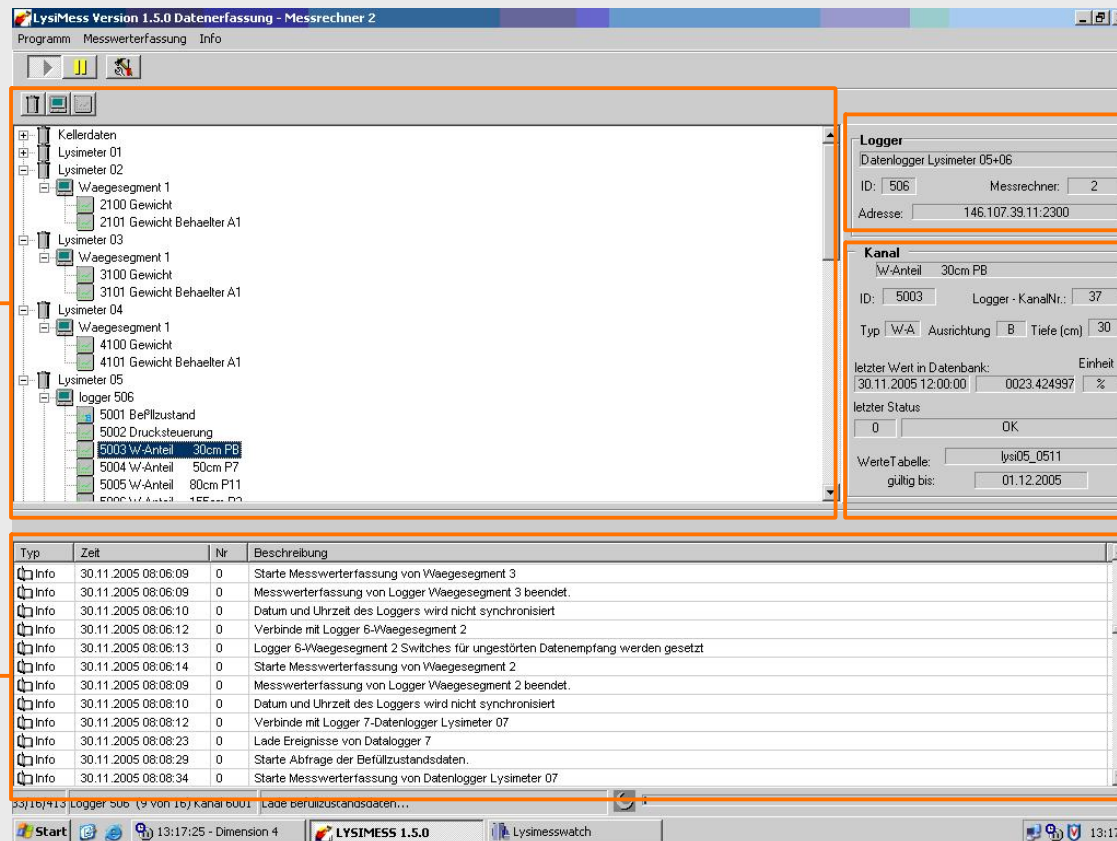
- **Constructing the database architecture !!**
 - maintains all infrastructure information
 - central configuration of sensors, datalogger, etc.
 - Global software configuration
- **Developing independent software modules for**
 - ➔ Data collection and transmission
 - ➔ Data Visualisation
 - ➔ Facility controlling
 - ➔ Database administration
 - ➔ Manual event logging and data mining

Database Architecture



- Each measuring unit property is mapped to configuration tables
- Each definition and configuration is registered
- Logging and protocol tables for advanced data interpretation

Program Overview



The screenshot displays the LysiMess software interface with several key components highlighted by orange boxes:

- Structured tree view of connected units:** A hierarchical tree on the left side of the window showing the connection structure. It includes folders for 'Kellerdaten', 'Lysimeter 01' through '05', and 'logger 506'. Under 'Lysimeter 05', a specific channel '5003 W-Anteil 30cm PB' is selected.
- Active datalogger details:** A panel on the right showing configuration for 'Datenlogger Lysimeter 05+06', including ID (506), Messrechner (2), and Adresse (146.107.39.11:2300).
- Active sensor details + last Value + last State:** A panel below the datalogger details showing configuration for 'W-Anteil 30cm PB', including ID (5003), Logger-KanalNr. (37), Typ (W-A), Ausrichtung (B), and Tiefe (cm) (30). It also displays the 'letzter Wert in Datenbank' (30.11.2005 12:00:00, 0023.424997, %) and 'letzter Status' (0, OK).
- Runtime activity protocol:** A table at the bottom of the window showing a log of events with columns for Typ, Zeit, Nr, and Beschreibung.

Typ	Zeit	Nr	Beschreibung
Info	30.11.2005 08:06:09	0	Starte Messwerterfassung von Waegesegment 3
Info	30.11.2005 08:06:09	0	Messwerterfassung von Logger Waegesegment 3 beendet.
Info	30.11.2005 08:06:10	0	Datum und Uhrzeit des Loggers wird nicht synchronisiert
Info	30.11.2005 08:06:12	0	Verbinde mit Logger 6-Waegesegment 2
Info	30.11.2005 08:06:13	0	Logger 6-Waegesegment 2 Switches für ungestörten Datenempfang werden gesetzt
Info	30.11.2005 08:06:14	0	Starte Messwerterfassung von Waegesegment 2
Info	30.11.2005 08:08:09	0	Messwerterfassung von Logger Waegesegment 2 beendet.
Info	30.11.2005 08:08:10	0	Datum und Uhrzeit des Loggers wird nicht synchronisiert
Info	30.11.2005 08:08:12	0	Verbinde mit Logger 7-Datenlogger Lysimeter 07
Info	30.11.2005 08:08:23	0	Lade Ereignisse von Datalogger 7
Info	30.11.2005 08:08:29	0	Starte Abfrage der Befüllzustandsdaten.
Info	30.11.2005 08:08:34	0	Starte Messwerterfassung von Datenlogger Lysimeter 07

Structured tree view of connected units

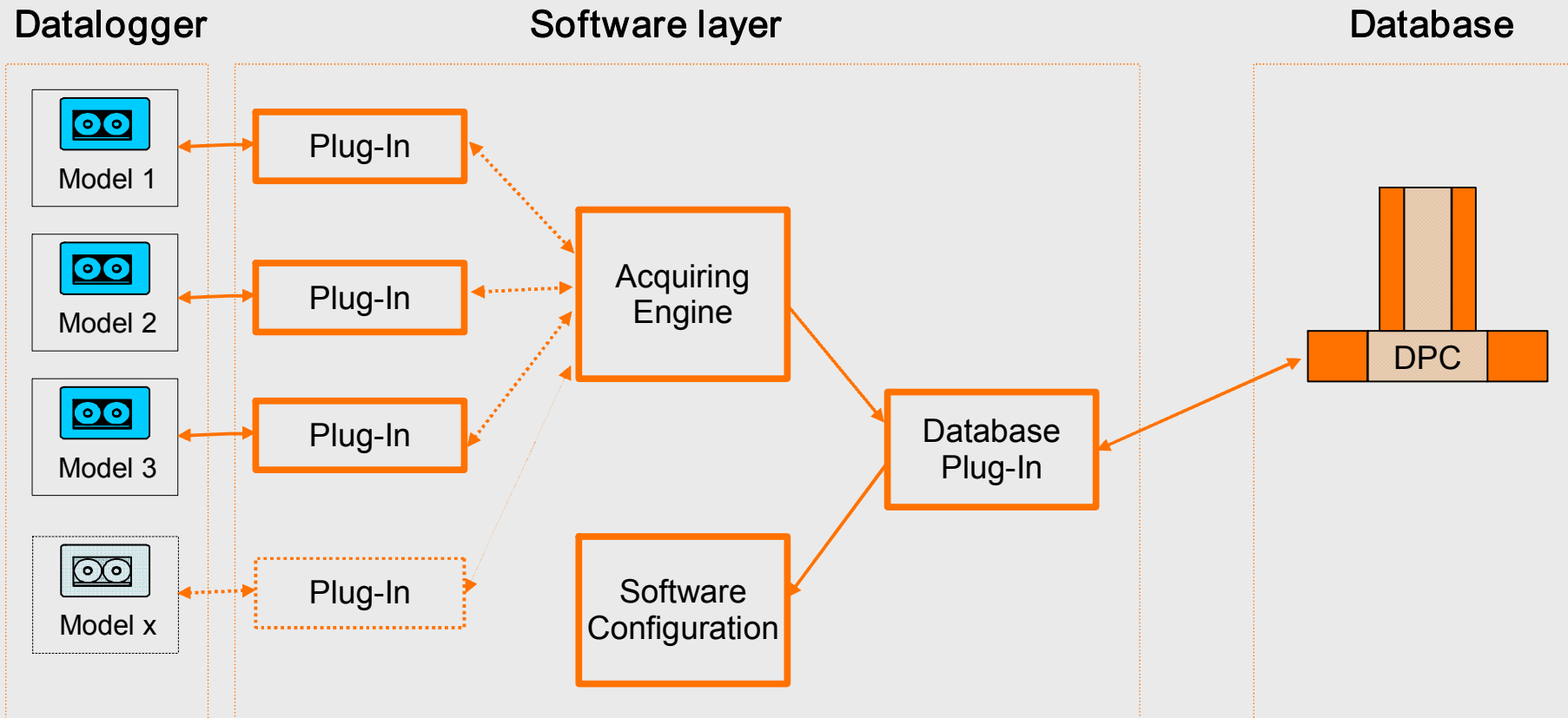
Active datalogger details

Active sensor details + last Value + last State

Runtime activity protocol

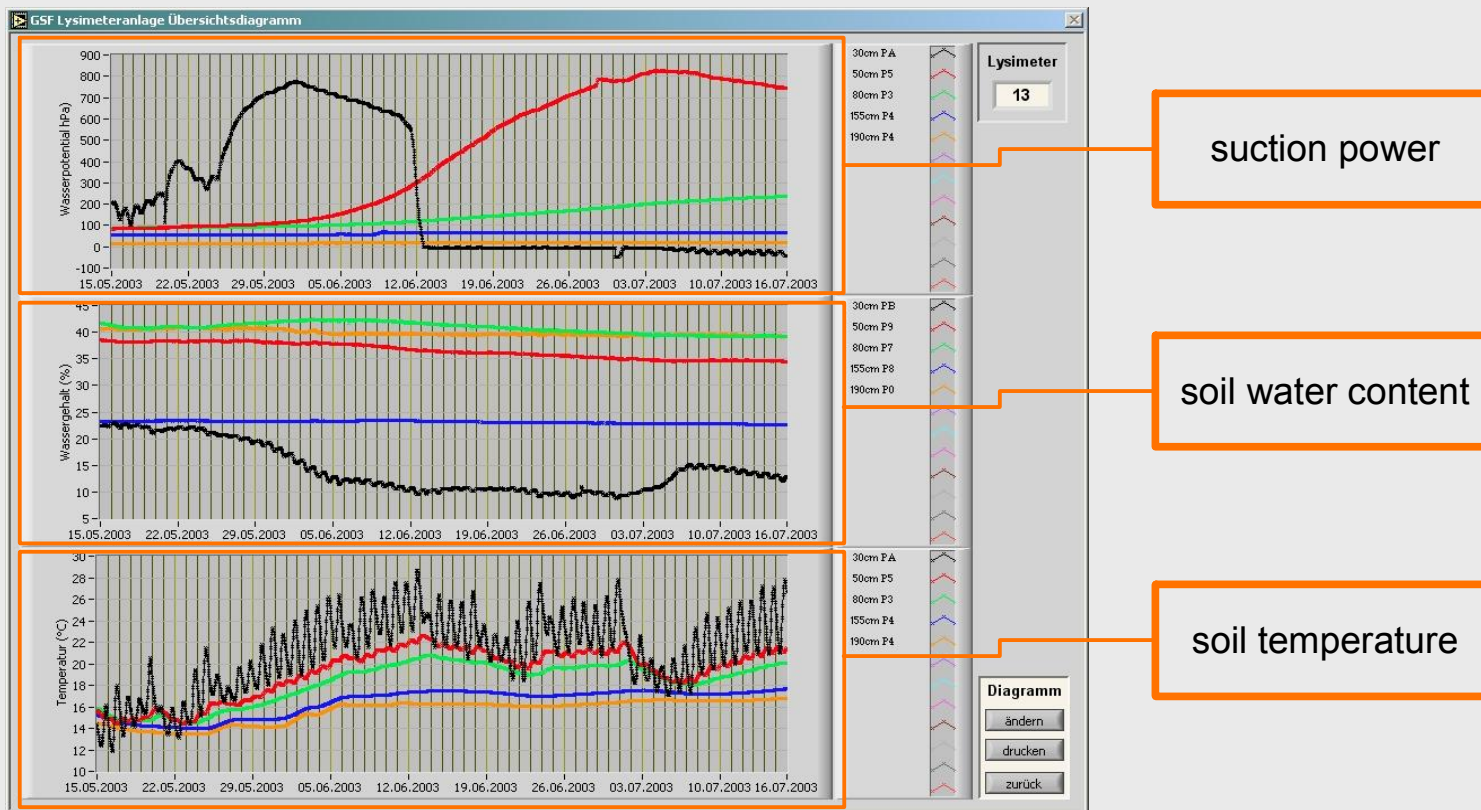
- free scaleable acquisition cycles
- special module to collect soil water drain values and to tare weighing units
- integrated runtime watchdog

Acquisition software model



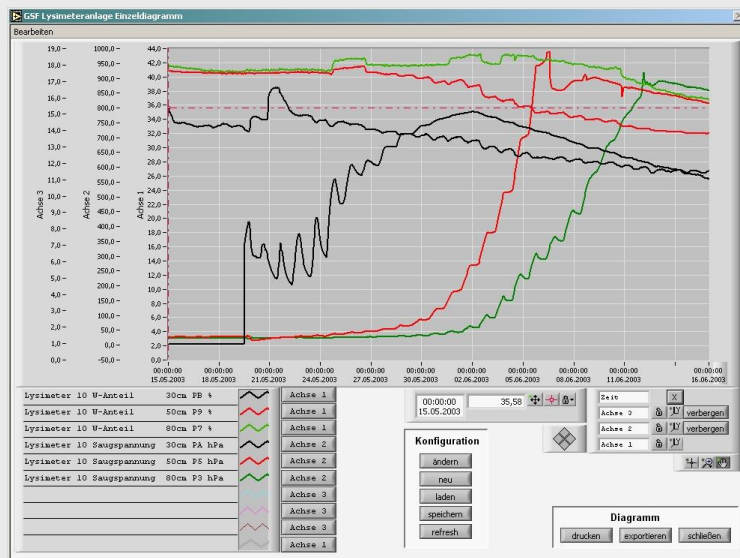
- Changing datalogger model only needs changing configuration
- Adding datalogger model only needs integrating new plug-in
- Changing database-system only needs changing database plug-in

Overview diagram

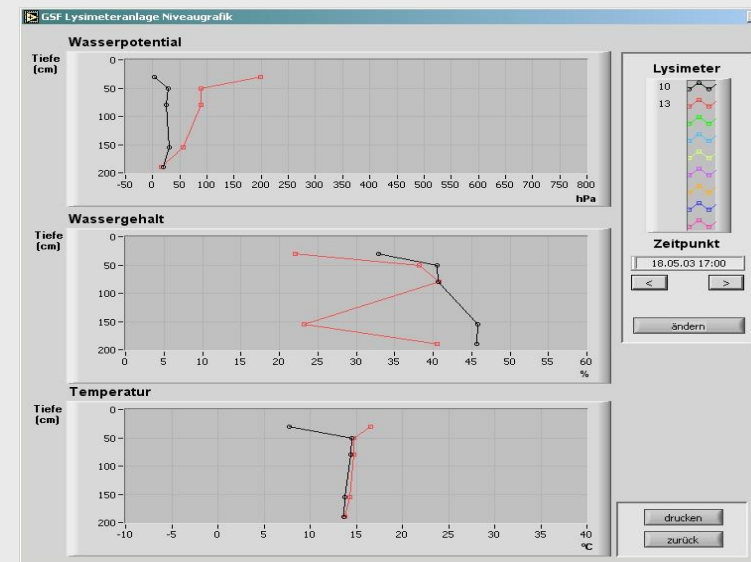


- Ergonomic overview
- Quick determination of actual lysimeter state
- Easy sensor failure detection

Individual view



Level diagram



Visualisation benefits

- Standardised Interface
- Create, save and reuse of individual views
 - Useful for scientific analysis as well as daily service and maintenance
- Data export
- Adjusts automatically to new facility configuration

LysiControl - Facility Controlling

Main Program view

The screenshot displays the LysiControl main program interface. It features a hierarchical tree view of sensors and loggers. The tree is organized into folders for different sensors (e.g., Lysimeter 13, 14, 15) and loggers (e.g., Datenlogger Lysimeter 07, 08, 09). Each folder contains a list of sensor channels with their respective IDs and classes. The interface includes a menu bar (Programm, Bearbeiten), a toolbar, and a status bar at the bottom showing the current date and time.

Structured
sensor event
tree view

Structured
logger event
tree view

Edit sensor event mask

The screenshot shows the 'Kanalereignis bearbeiten' dialog box. It has tabs for 'Detail', 'Ereignisliste', 'Bearbeiten', and 'Gesamt-Statistik'. The 'Detail' tab is active, showing a table with columns for 'Lysimeter', 'Kanal', 'ID', 'Ereignis', and 'seit'. Below the table, there are options to change the event class (Fehler, Warnung, Information) and a section for 'Ereignis zurückstellen bis' with a date selector. At the bottom, there are buttons for 'Änderungen übernehmen', 'Ereignis entfernen', 'Übertragen', and 'Schließen'. A status bar at the very bottom shows 'Ereignisse: 0', 'Bearbeitet: 0', and 'Änderungen: 0'.

Controlling benefits

- Quick facility state overview for operators just in time
- Advanced hardware event interpretation and annotation
- Considering event classification



• LysiProtokoll

- Logbook for Operators
- Search engine for events and remarks
- Creating facility reports over time periods and units


• LysiDBAdmin

- Realise database administration jobs without system knowledge
 - ⇒ Creating new truth tables and data allocation entries
 - ⇒ Handling user access

- Conclusion

einführungssatz

- Using the universal database architecture guarantees
 - ➔ most reliability in data availability and accessibility
 - ➔ independence from different users data models and storage format
 - ➔ comparable measurement results
- Using integrated software models gives
 - ➔ standardised interfaces for each field of activity
 - ➔ most flexibility in hardware modification
 - ➔ highest standard in facility operating



- Thank you for your attention

