SysML for Telescope System Modeling
- Requirements Modeling -

by the

INCOSE MBSE Challenge Team SE^2

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SysML for Telescope System Modeling

Speaker

Rudolf is principal consultant and responsible for aerospace and defense at HOOD Group Germany's leading requirements management consulting company.

He takes care for all requirements modeling activities at HOOD Group.

Rudolf has over 15 years of experience in modeling in many large projects, trained SysML and UML methods and published many articles and conference presentations.

He is OCSMP certified system modeling professional.

Agenda

- **What is the SE^2 Challenge project about?**
- Requirements Engineering and Modeling - Motivation
- Examples for Specification by Modeling
- Summary

About SE^2

- Collaboration between European Southern Observatory (ESO) and German Chapter of INCOSE (GfSE)
- Access to high-tech project: Active Phasing Experiment (APE).
- The team members are:
  - Robert Karban (ESO)
  - Tim Weilkiens (oose GmbH)
  - Dr. Rudolf Hauber (HOOD Group)
  - Rainer Diekmann
  - Michele Zamparelli (ESO)
  - Andreas Hein (TU Munich)
- Former members:
  - Andreas Peukert (TU Munich)

ESO

Non-profit Intergovernmental European Organisation for Astronomical Research in the Southern Hemisphere

http://www.eso.org

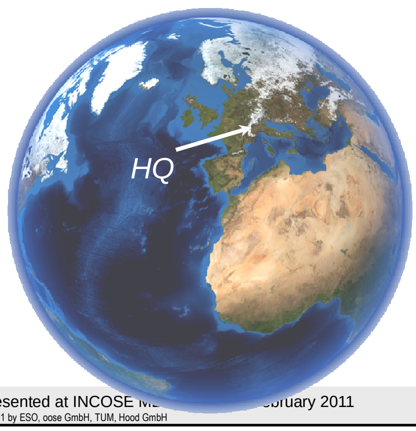
Headquarters in Munich, Germany, 3 Observatories in Chile

Mission statement

Build and operate world class ground based astronomical facilities

ESO's sites

- Paranal (2600 m)
- La Silla (2400 m)
- Chajnantor (5000 m)



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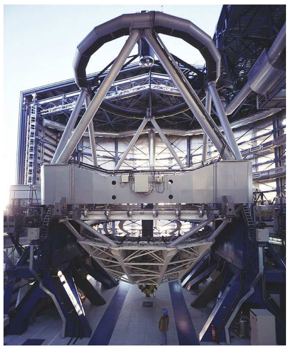
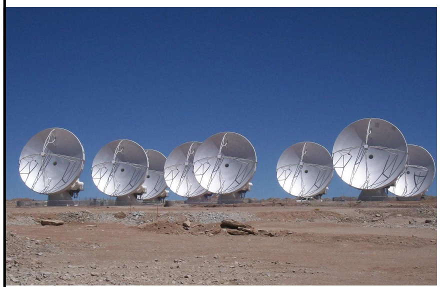
ESO major projects

Very Large Telescope (VLT)
Started 1988, in operation since 1999





Atacama Large Millimeter Array (ALMA)
Europe-US-Japan
Started 1998, installation starting now

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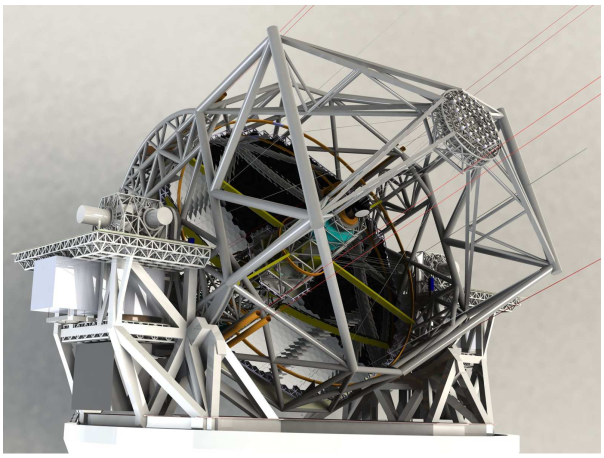
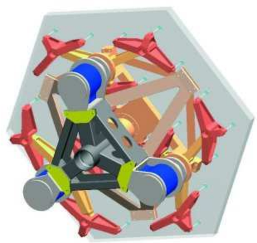
E-ELT





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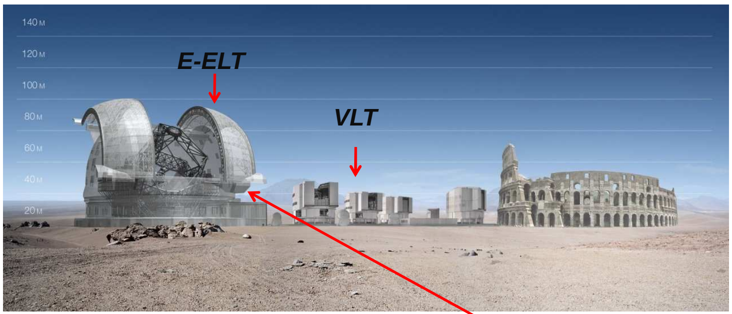
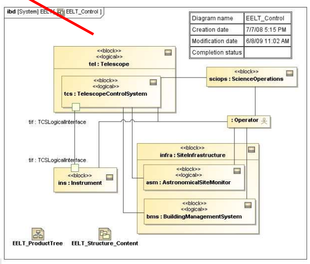


- 10000 tons of steel and glass
- 42m segmented primary mirror
- 20000 actuators, 1000 mirrors
- 50000 I/O points, 700Gflops/s, 17Gbyte/s
- Many distributed control loops
- Use MBSE/SysML to model the control system since 2008



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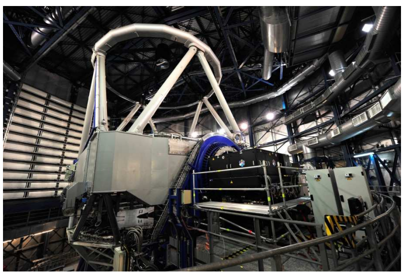
What is the challenge project about?



- System case study (since 2007)
  - APE technology demonstrator for future Extremely Large Telescope (ELT)
  - High-Tech interdisciplinary opto-mechatronical system in operation at Paranal observatory
- Goals
  - Create modeling guidelines and conventions for all system aspects, hierarchy levels, and views
  - Create fully fledged SysML model
  - **Documented at http://mbse.gfse.de**

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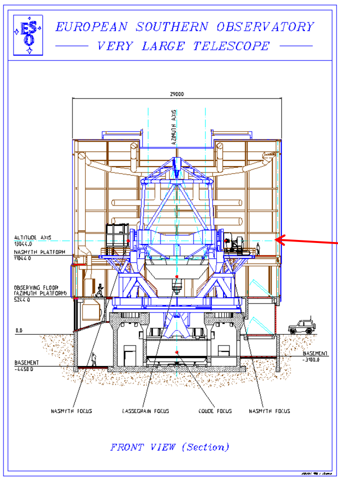

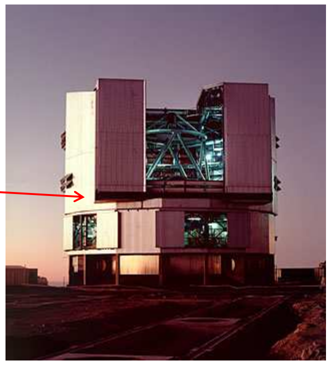

APE was installed at telescope in Atacama desert, Chile.

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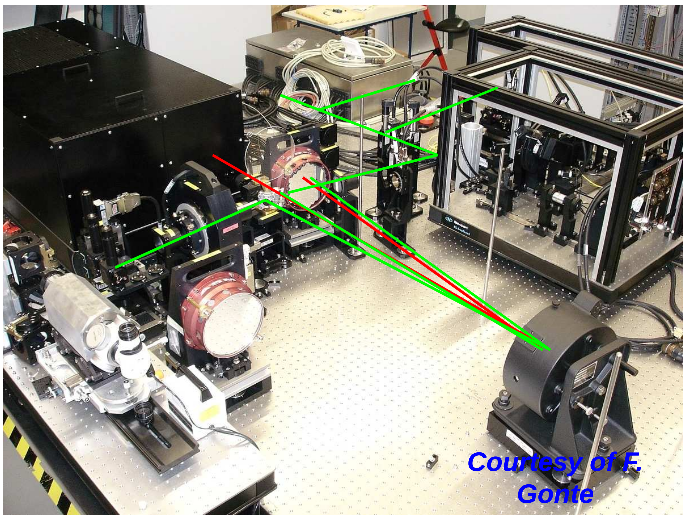

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Installation on the platform of the telescope

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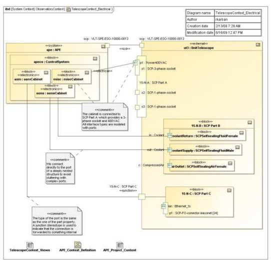
What have we achieved?

- APE model (re-engineering)
- Guidelines and best practices: MBSE Cookbook
  - Model structure and overview
  - Objectives and Requirements
  - Context, System Structure
  - Behavior and Data
  - Verification
  - Model library and SE Profile
- Plug-in for modeling tool
- Input for tool vendor and SysML RTF



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Agenda

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- **Requirements Engineering and Modeling - Motivation**
- Examples for Specification by Modeling
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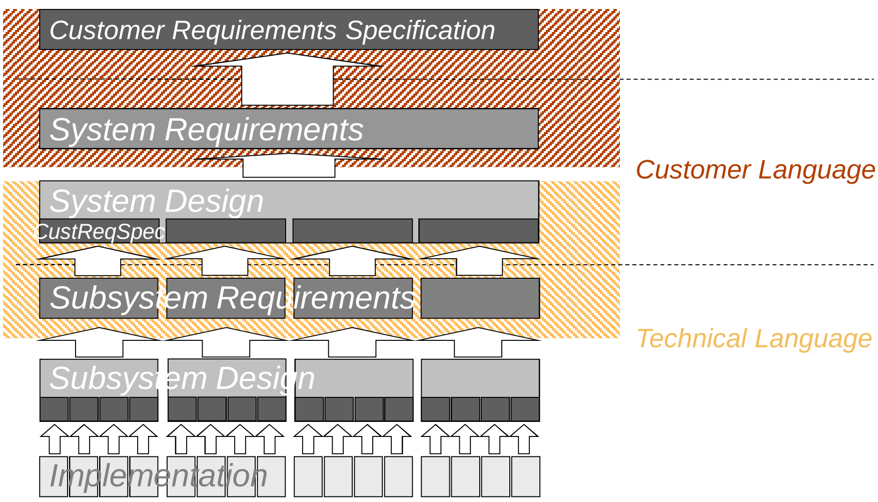
The difference between Design and System Requirements:



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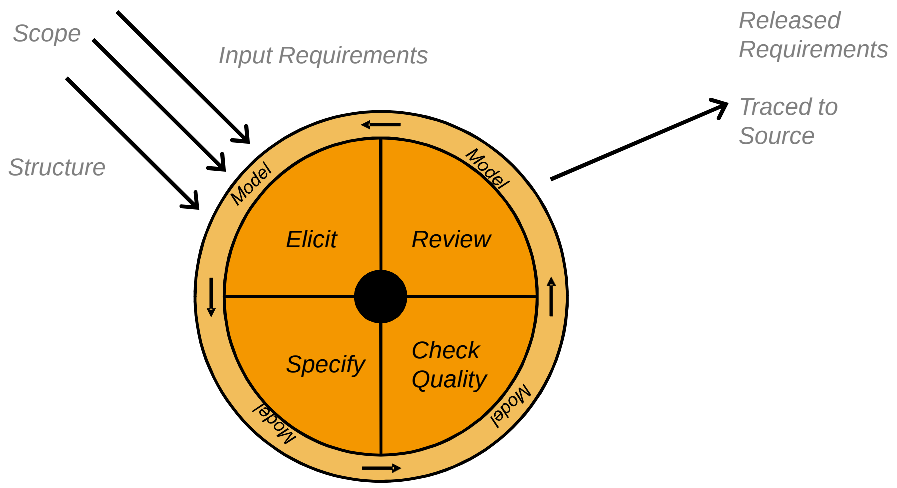
Requirements Definition - Process



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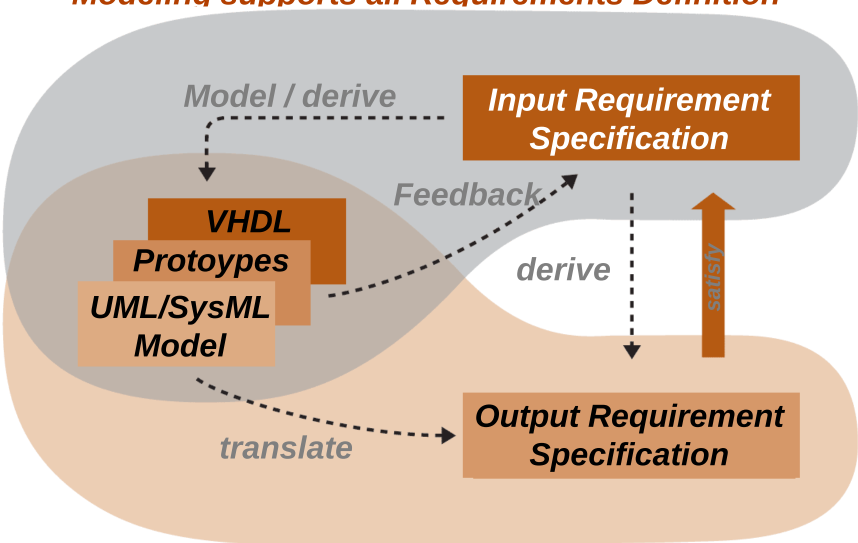
Modeling supports all Requirements Definition



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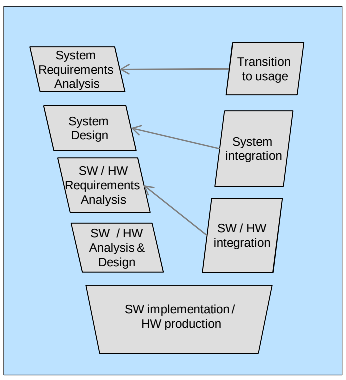
Why Modeling requirements?

- 100s of textual requirements and their dependencies are hard to understand
- Abstract representation can un-cover hidden inconsistencies/problems
- Formulating precise, context-free, and understandable textual requirements is hard
- Modeling is well-tried to specify specific aspects (formal language, intuitive notation)
- Different aspects can be consistently related in the model

System Specification, Test Specification

- What has To Be Specified?
  - Organizational context
  - System functions
  - System quality
  - System interfaces
  - System data
  - System behavior
  - System communication
  - HW elements
- Impact on
  - Test Concept
  - Test Cases



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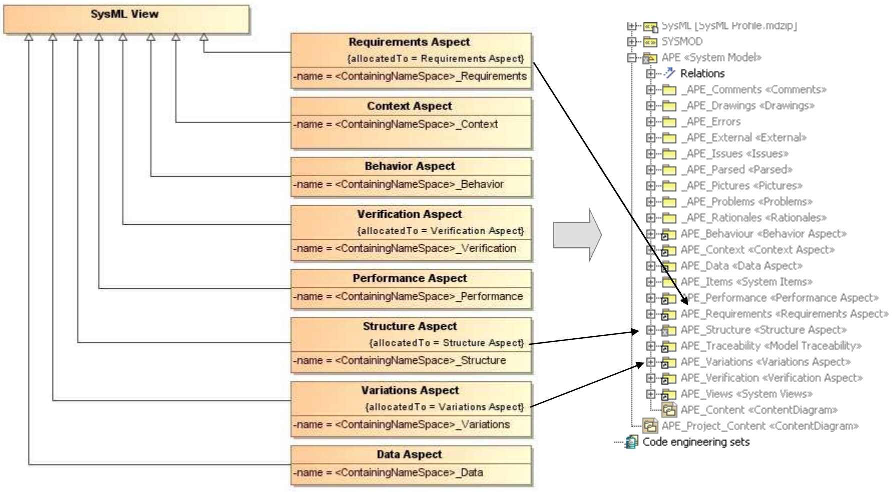
1. Clear defined terms - Ontology



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Agenda

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- **Examples for Specification by Modeling**
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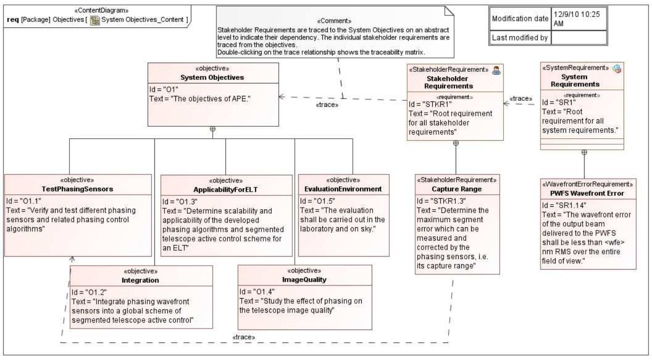
Project Goals

- Which organizational benefit shall be achieved?
- What are the objectives for the project?
- Which capabilities shall be available?
- Which business use cases exists?
- <<objective>> Requirements



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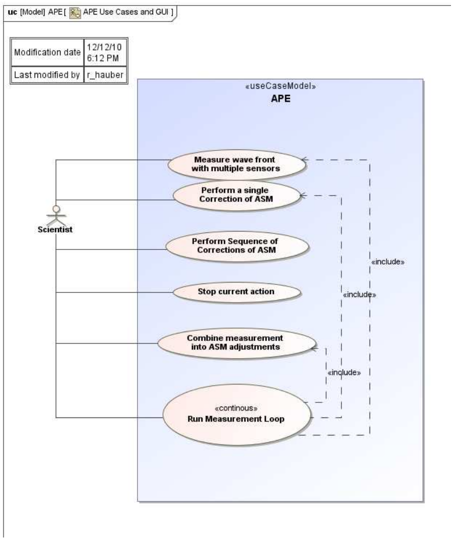
System Use Case Identification

- Who interacts with the system?
  - *Identify actors*
- What he wants from the system?
  - *identify* system use cases based on business processes
- System use cases very good suited for
  - specifying how actors benefit from using the system
  - deriving system test cases



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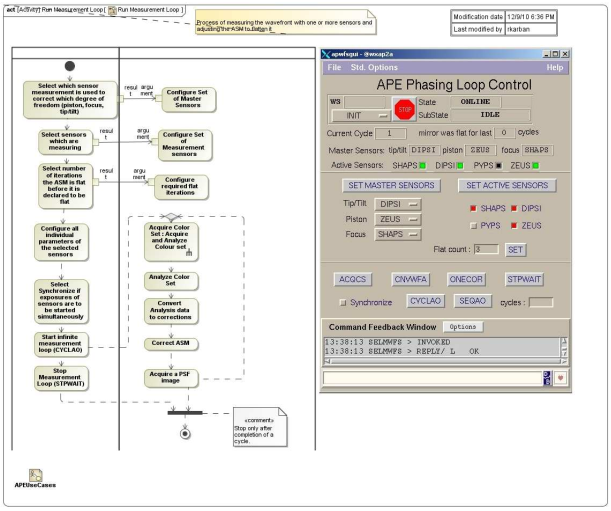
System Use Case Specification

- What is the workflow of a use case?
- Activities are perfectly suited for specification of use cases!



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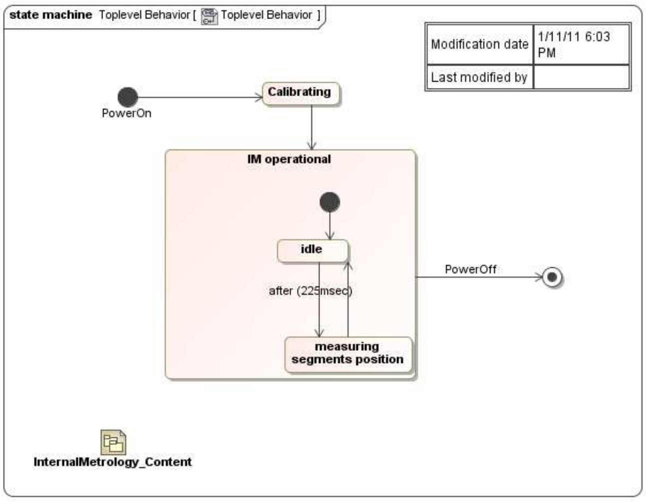
System Use Case Relations

- What are the system states and modes?
- State machines are perfectly suited for specification!



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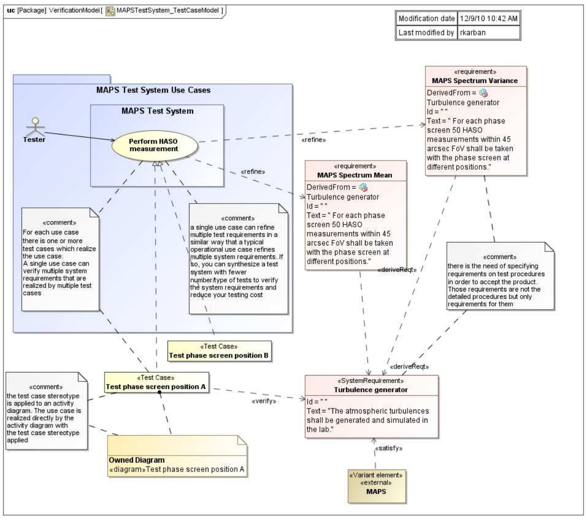
System Verification

- How shall the use cases be verified?
- E.g. show how the system test concepts is affected
- SysML test cases for test case overview / identification



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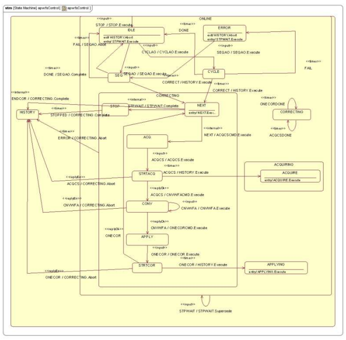
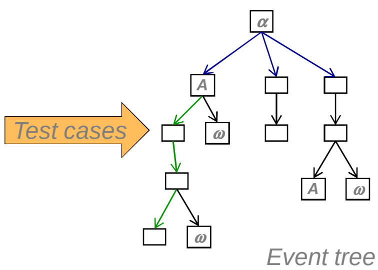
System Use Case Verification





- All test cases can be generated from activities/state machines
- Event chain tree containing all test cases

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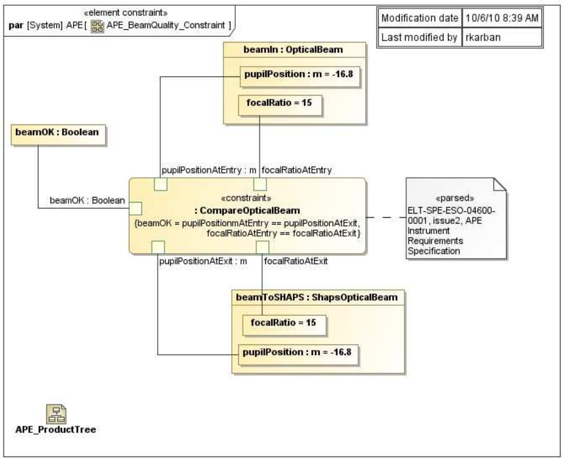
System Use Cases: Non-Functional Aspects

- Quality
- Performance
- Security
- Usability

- Tagged values and parametrics



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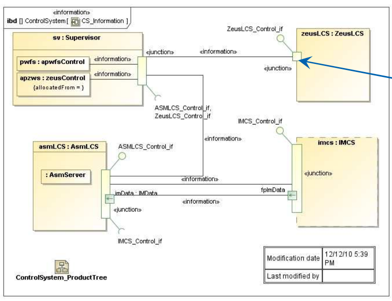
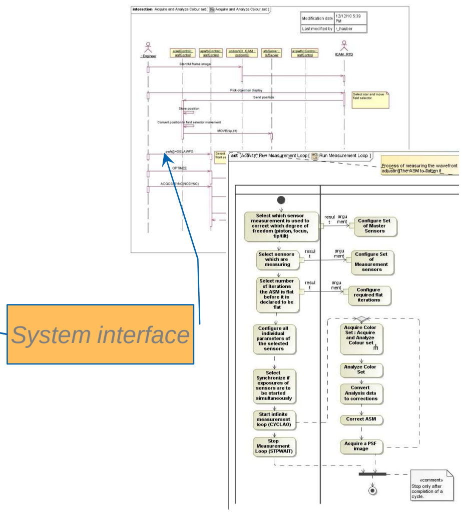
System Interface Identification

- Identification of services using black-box sequence diagrams for use case scenarios
- Identification of interfaces
- Context diagram with interfaces





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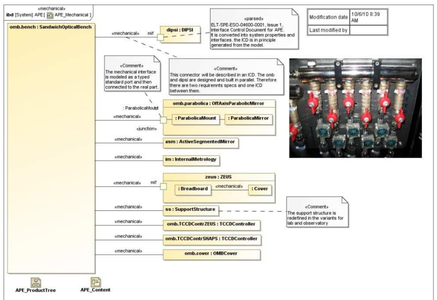
System Interface Specification

- Specify interfaces from different aspects
  - Mechanical
  - Electrical
  - Optical
- Internal Block Definition diagrams can be used to specify ICD



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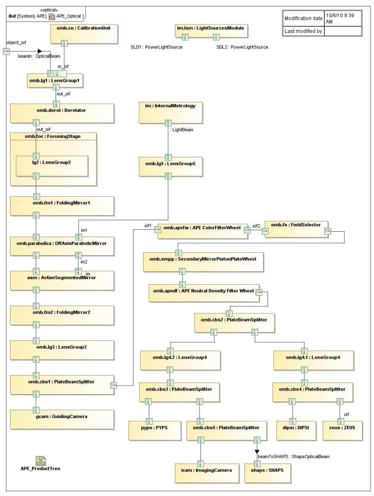
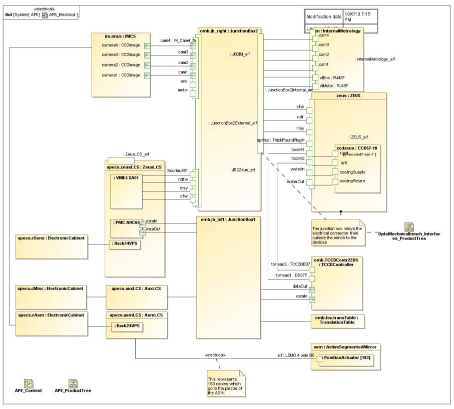
System Interface Specification



optical interfaces



electrical interfaces

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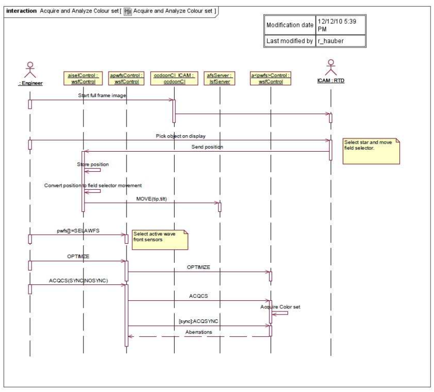
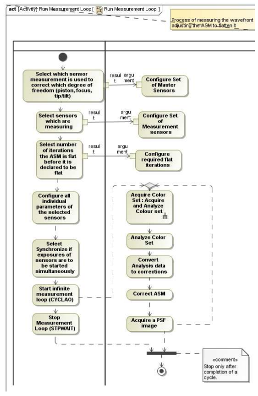
System Interface and Service Verificaton

- Black-box sequence diagrams can be directly used for system verification



actual flow



Specified

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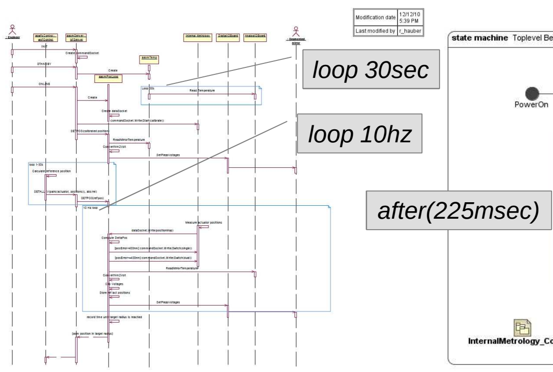
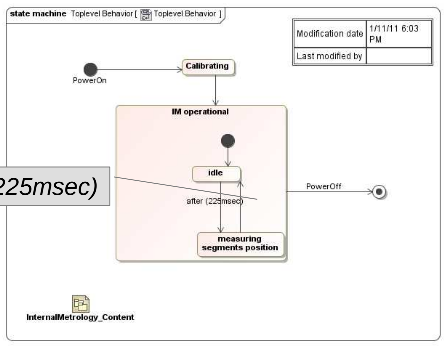
Performance Specification

- Performance criteria can be specified, e.g.
  - by time constraints in sequence diagrams
  - Time event in state charts





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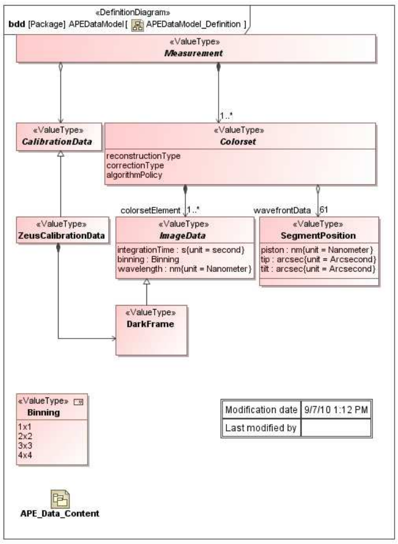
System Data Specification

- Which data must be provided, handled and processed by use cases / services?
  - Block Definition Diagram



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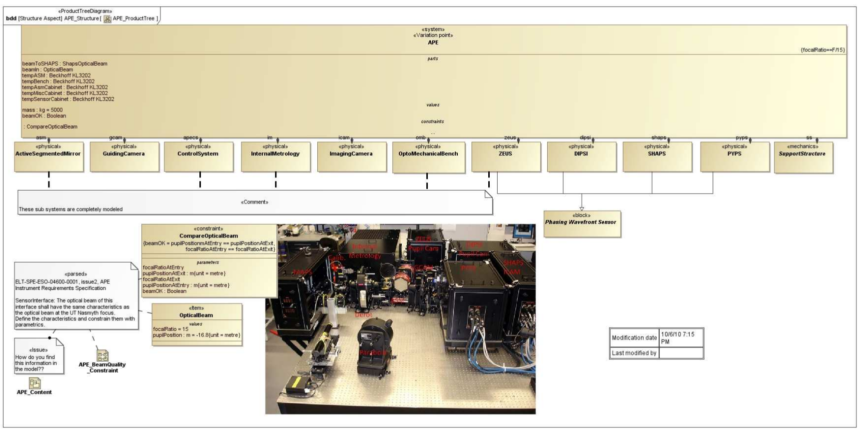
Physical properties

- Which physical properties are required?
  - Tagged values can be used for non-functional requirements: weight, size, etc.



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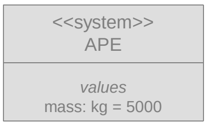
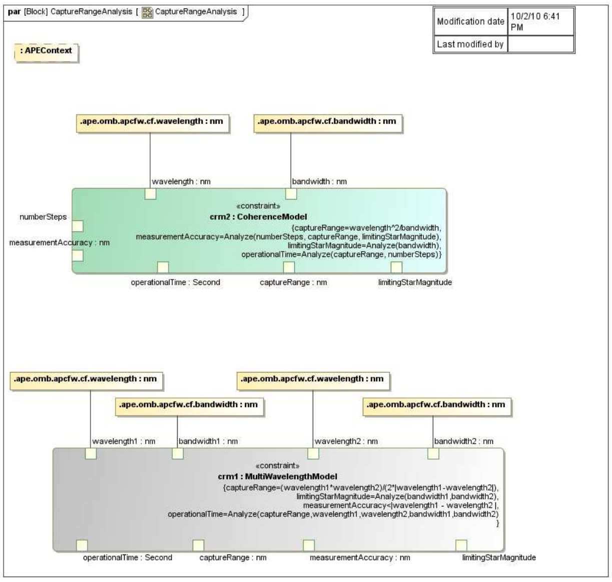
Constraints

- Which physical constraints must be ensured?
  - Parametric diagrams





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Model based Specification – Best Practices

- Define purpose of model
  - Only specification vs development
  - Partial vs complete
- Consider who shall read the model
  - Use appropriate model elements
- Define the deliverable of specification: Document vs model
  - Test the acceptance of deliverable early
- Use model as communication platform with stakeholders
  - Integrate all stakeholders
- Simplicity is key!
  - Use easy to understand elements
  - Use text-based requirement if there is no simple modelling construct
- Training
  - Train stakeholders in understanding the model
  - ➢ 10 minutes usually enough for every diagram type

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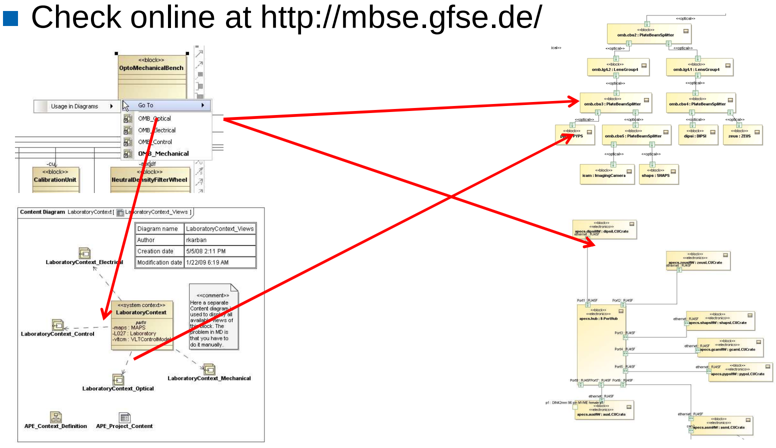
Live Demo of the Model

- Please fasten seatbelts - setting up the system…
- Check online at http://mbse.gfse.de/



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