STATUS OF THE ULTRA FAST TOMOGRAPHY EXPERIMENTS CONTROL AT ANKA (THCA06)

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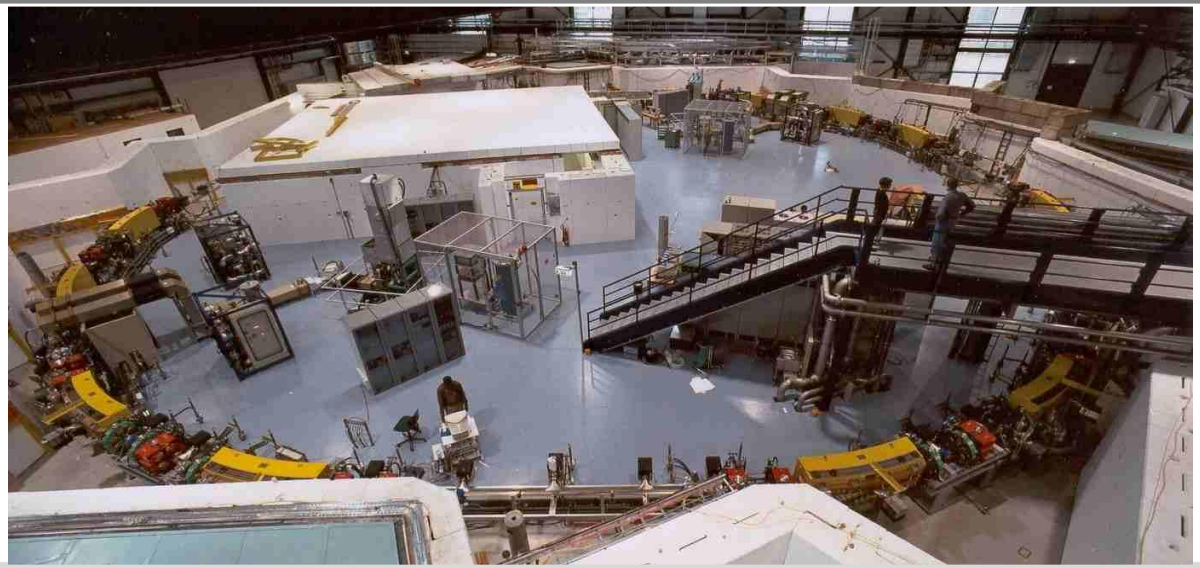

Content

- ANKA - Synchrotron Light Source
- Tomography and its control system
- The reconstruction framework “UFO”
- Results
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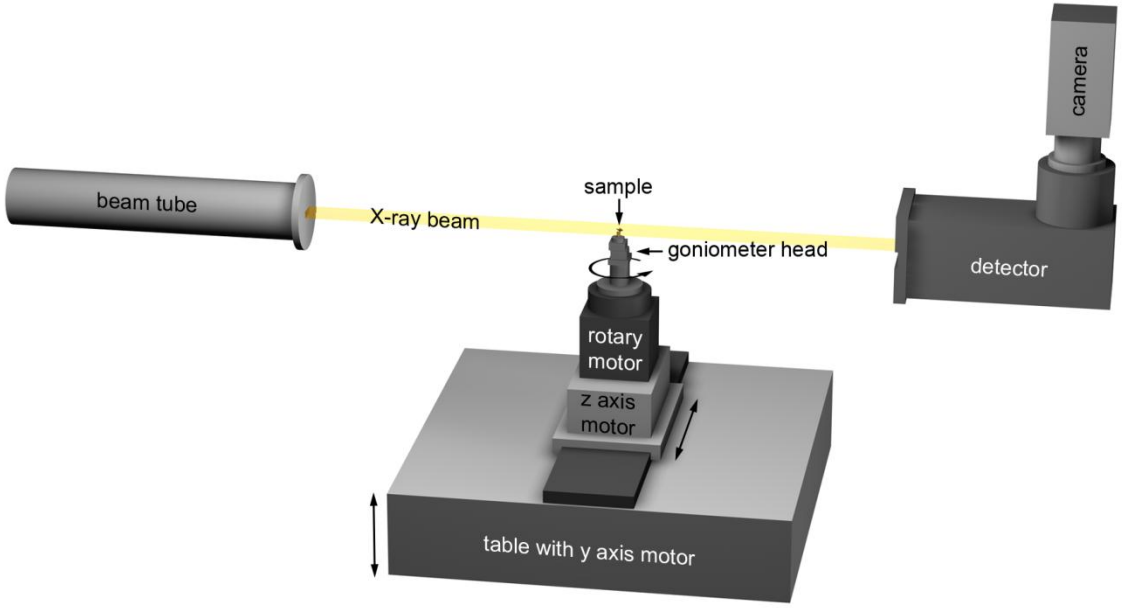
ANKA – Synchrotron Light Source

- ANKA at KIT
- First light in year 2000
- research methods
  - Fluorescence
  - Scattering
  - Spectroscopy
  - Lithography
  - Imaging
  - Synchrotron research

Technical data of the storage ring

- Storage ring diameter 35m
- Energy 2.5 GeV
- Current up to 200 mA
- 17 Beamlines (15 productive, 1 commissioning, 1 construction)

Tomography and it‘s challenges



Simple schematics of an tomography experiment

Microtomography in the past

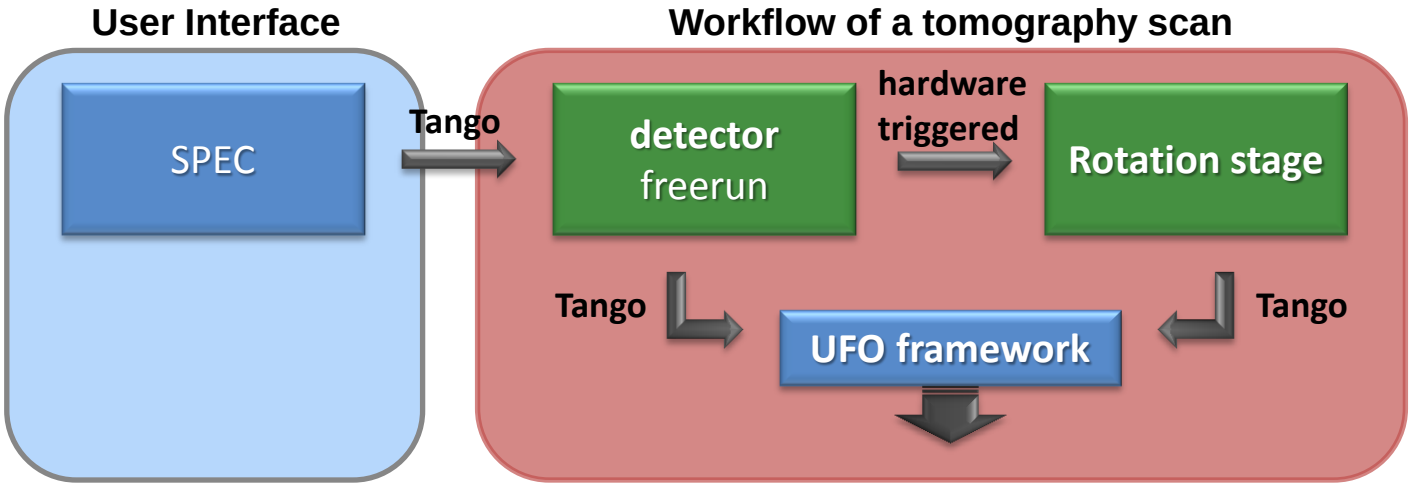
- ~1000 projections
- Slow computing machines
- Slow detectors
- Acquisitiontime ~1hour
- Reconstructiontime ~half a day

- ✓ Efficient use of flux and new CMOS detectors offers new imaging techniques
- ✓ GPU-based tomography reconstruction make online processing available
- ✓ Handling experimental data up to several TByte/day

➡ **Possibility to implement an ultra fast tomography scan with a total duration less than a minute → 4D resolution**

Tomography experimental control

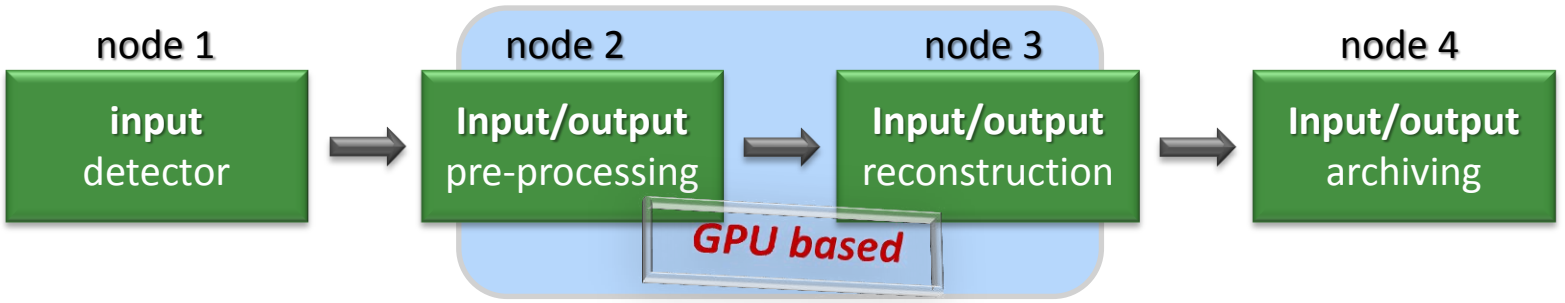
- Macro User Interface, connected via Tango software bus
  - Tomography experiment is started by Tango
  - Tango is too slow for handling the whole experiment, latencies ~ms
- *Detector is the "Master" of the experimental workflow*
  - The detector triggers all components on hardware level
  - Latencies ~µs



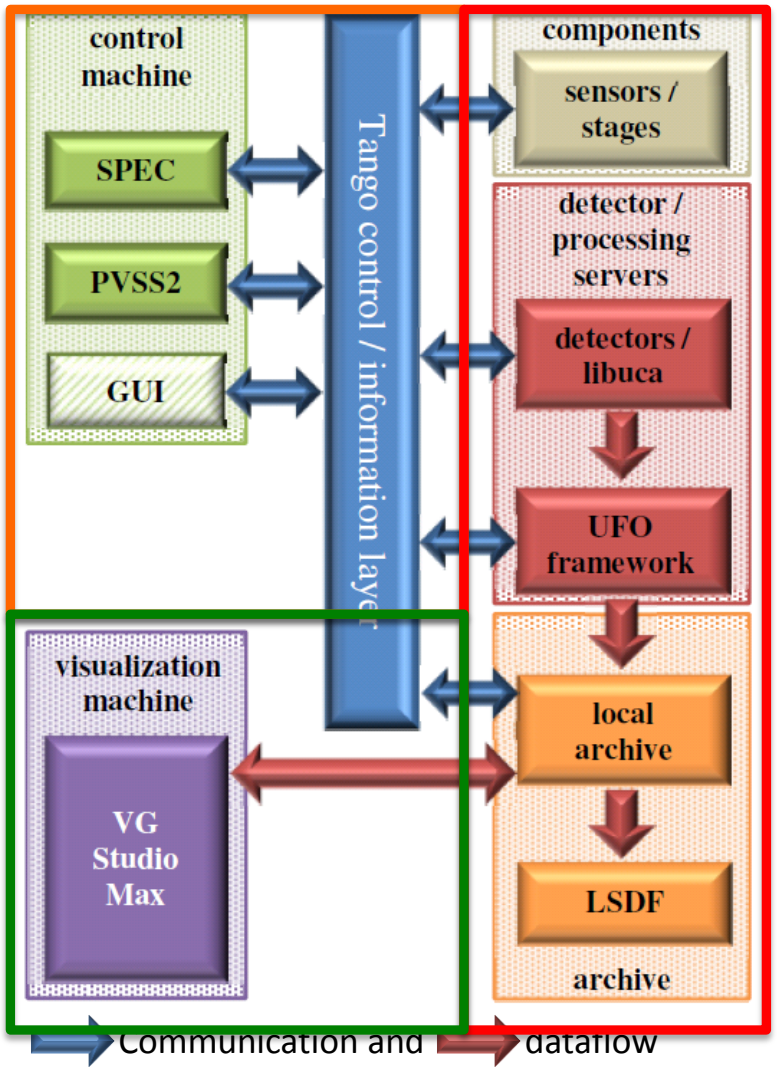
The reconstruction framework “UFO“

(Ultra fast X-Ray imaging of scientific processes with on-line assessment and data-driven process control)

- A *GPU based framework* reconstructing tomography data
  - Using back-projection algorithm
  - GPU based for fasten up the overall reconstruction time
- Implemented in C and uses GLib, GObject and OpenCL
- Includes highly optimized image algorithms
- *Data is streamed in a processing chain* (pre-processing, reconstruction etc)
  - Each step is realized as a input/output node
  - Other processing steps can easily added



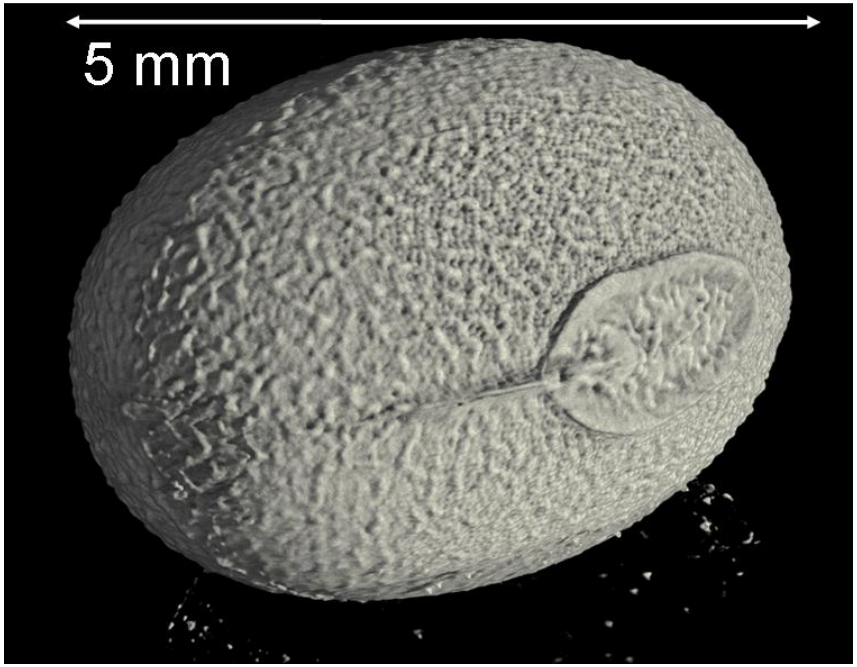
Overall beamline control system



- Tango coordinating workflow of control system
- All hardware components can be seen as Tango-Servers
- Tango client SPEC is starting tomography scan
- The workflow of the tomography scan is coordinated by the UFO framework
- Visualization is separeted from the whole workflow

Results (Experiment of Cecilia A. from ANKA)

Volume rendering of an egg of the stick insect *Peruphasma schultei*



Algorithm	Overall reconstruction time
PyHST	31.3 s
UFO-Framework	12.5 s

- Used optics
  - 74µm thick LSO:Tb scintillator
  - Eyepiece with *f*=180mm
  - Objective with *f*=50mm
  - Results in total magnification of 3.6x and a pixel size of 5.5µm
- CMOS detector *Photron SA-1*(5400 frames/s in full-frame mode, 12bit)
- frequency of the detector of 2000 frames/s
- Rotation stage speed 450 °/s
- **Results in a tomography scan with 800 projections taken in 0.4s**

Outlook

- Automatization of the whole workflow
- Implementation of data life-cycle management
- Implementing NEXUS format for Meta-data handling
- Developing a graphical user interface

- **Final concept realization at upcoming IMAGE beamline, starting next year!**

Acknowledgements and References

Acknowledgements

- Thanks to all people of the imaging and IT group at ANKA
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References

- High Data Rate Initiative, http://www.pni-hdri.de
- Ultra-fast X-ray Imaging, ufo.kit.edu
- Large Scale Data Facility, http://www.scc.kit.edu/forschung/lsdf.php

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