Elettra Sincrotrone Trieste

Control and Data Acquisition System for the MicroTomo2@STAR imaging station

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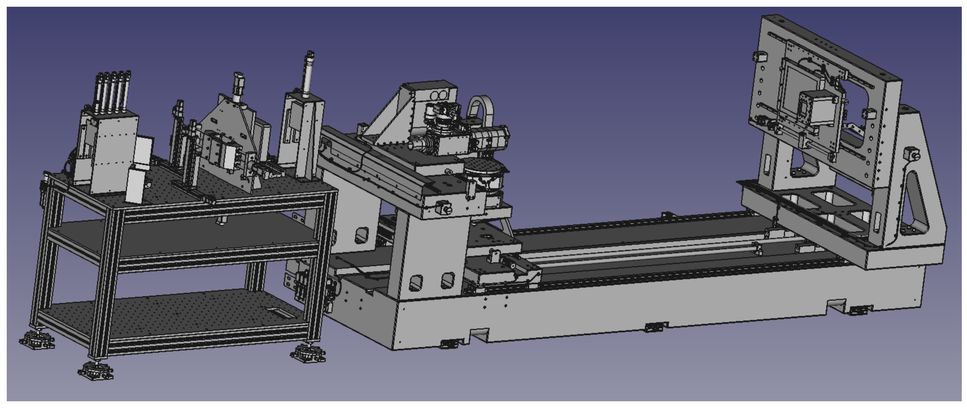
MicroTomo2 is an X-ray imaging station installed at the STAR accelerator facility of the University of Calabria. The STAR accelerator, currently under construction, will produce photons with energies up to 350 keV generated by the laser light-electron collisions using the Thomson back-scattering phenomenon. The MicroTomo2 experimental station will provide full-field X-ray radiography and tomography for 3D imaging and analysis of a large variety of samples and materials. The experimental setup is composed of a six axes sample manipulator and two distinct X-ray imaging detectors that will allow to cover a wide range of scientific cases spanning from high resolution investigations to large scale sample tomography. The focus of this work is the MicroTomo2 control system, developed using the TANGO framework, that is in charge of managing all the elements of the station from the photon transport to the experiment management and data visualization.

Microtomo2 Description

Microtomo2 is a x-ray tomographic imaging station designed for the **High Energy branch (STAR-HE-Linac)** of the **Southern Europe Thomson Backscattering Source for Applied Research (STAR)** [1-4], a Thomson source of monochromatic tunable, polarized X-ray beams, ranging from 20 to 350 keV installed at the university of Calabria. The Microtomo2 station will allow Phase Contrast Tomography (PCT) and microtomography mapping experiments.
The setup is composed by a **Beam Transport System**, for the geometric control and the diagnostic of the beam, and an **Experimental Imaging Station**, for acquiring radiography images and tomographies even of large scale objects.

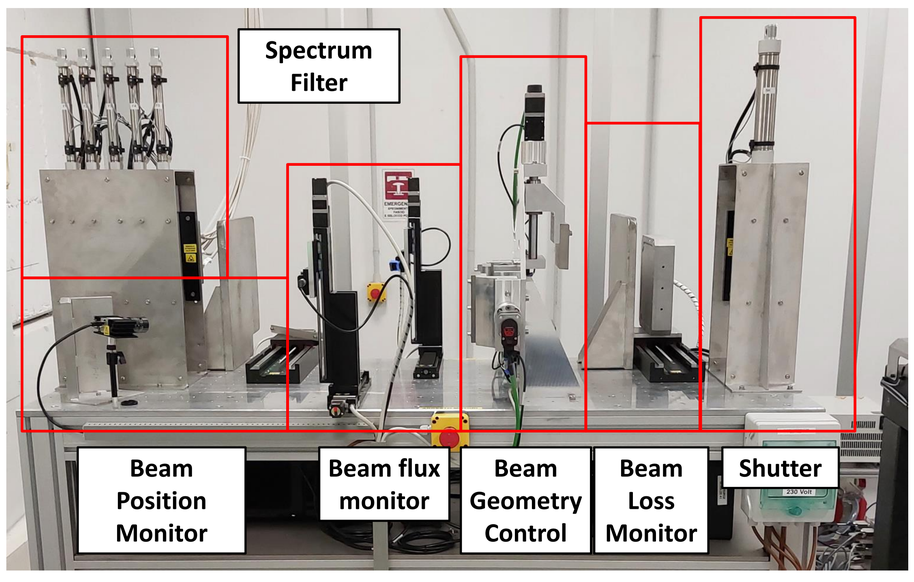


3D layout of Microtomo2

Beam Transport System

The beam transport system is composed by:

- **Spectrum Filter**: A set of PMMA and aluminium filters, pneumatically controlled.
- **Beam Position Monitor**: A movable photosensitive screen using phosphors P20 or P43, coupled with a Basler camera acA2440-20gm.
- **Beam flux monitor**: two Si photodiodes HAMAMATSU S8193 acquired via AH501B Elettra - Sincrotrone picoammeter, mounted on PI linear guides.
- **Beam Geometry Control**: A four slit 95%W-5%NiFe system controlled by Nanotec N5 motion controllers.
- **Beam Loss Monitor**: A movable ionization chamber acquired via XPI Elettra - Sincrotrone picoammeter.
- **Shutter** (**95%W-5%NiFe**) controlled pneumatically.



Microtomo2 Beam Transport System

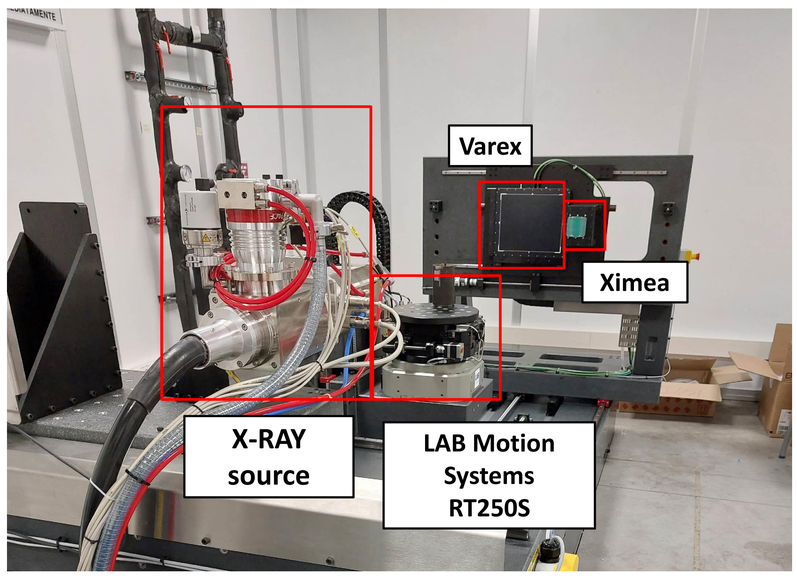
Experimental Imaging Station

The tomographic station can use the photon beam coming from the STAR source or an independent **X-RAY WorX Microfocus X-ray tube XWT-190-TCNF Plus** source. The acquiring system is composed by:

Custom Ximea MX377: radiation resistive fiber optics with CsI scintillator on a water cooled sCMOS sensor with 6144x6144 pixel on 61x61 mm (pixel pitch 10µm).

Varex XRD 3025 G45 C: a high efficiency CsI scintillator on single substrate of a amorphous Silicon active (a-Si) TFT diode array with 2512x3008 pixel on 248mmx298mm (pixel pitch 100µm).

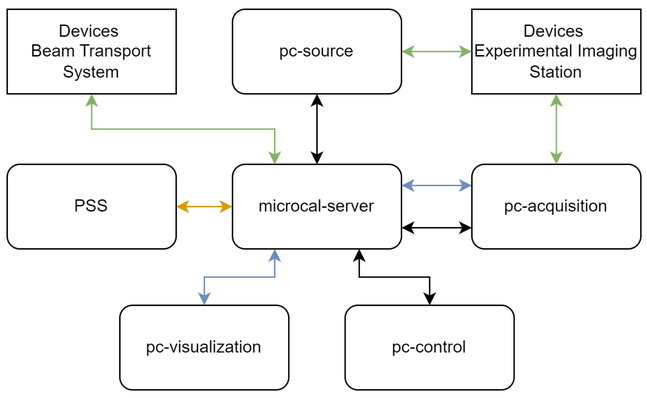
Sample manipulator, detectors and sources position are controlled via a set of Elmo controllers (**CANopen over EtherCAT**): 8 stepper motors and a rotatory RT250S air levitation BLDC.



Microtomo2 Experimental Imaging Station

Control System

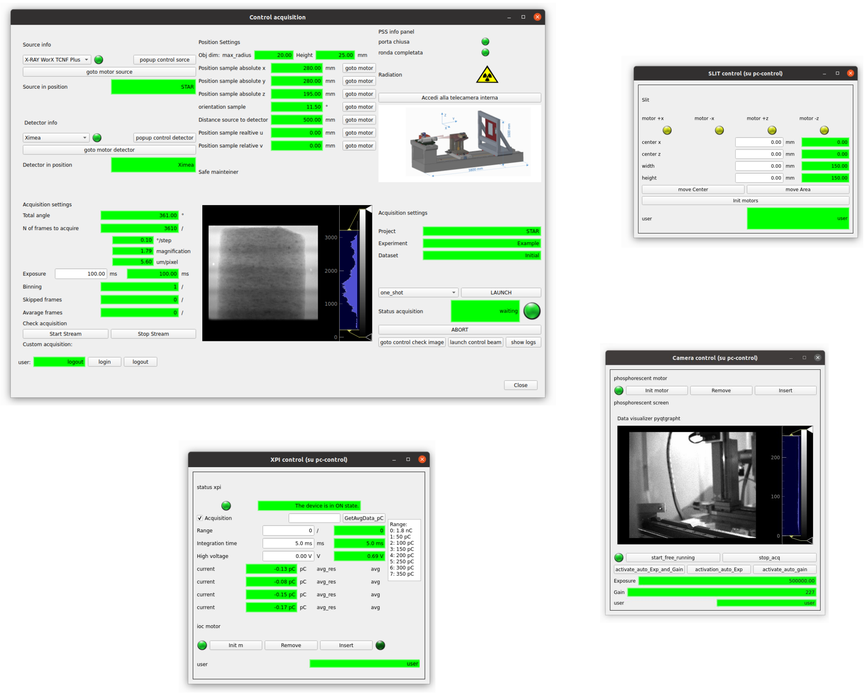
The Microtomo2 control system has been designed by Elettra Sincrotrone Trieste as a turnkey solution. It comprises a Person Safety System (PSS), PILZ PLC based, along with a distributed Tango Control System for experiment management.
Each instrument is controlled by a Tango device server, the high level operations are coordinated by two primary servers named “executers”. One executer is dedicated to the beam diagnostic system and the other to the experimental imaging station. Each system is designed to ensure secure motion movements taking into account the presence of operators in the hutch.



Microtomo2 Network structure

User Interfaces

User interfaces are built using **Taurus** framework, that allows a transparent access to the **TANGO structure**.



User interfaces for controlling the experiments
displayed are the control acquisition of the Experimental Imaging Station, Beam Geometry Control, Beam Loss Monitor and Beam Position Monitor

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[1] A. Bacci et al., The Star project, Proceedings of IPAC2014, Dresden, Germany [2] A. Bacci et al., Status of the Star project, Proceedings of IPAC2016, Busan, Korea
[3] A. Bacci et al., Photoinjector Emittance Measurement at STAR”, Proceedings of IPAC2017, Copenhagen, Denmark [4] A. Bacci et al., STAR HE-Linac Complete Detailed Design Report, 2021 arXiv:2109.10351