Commissioning the STAR Inverse Thomson Scattering X-ray source: progress report

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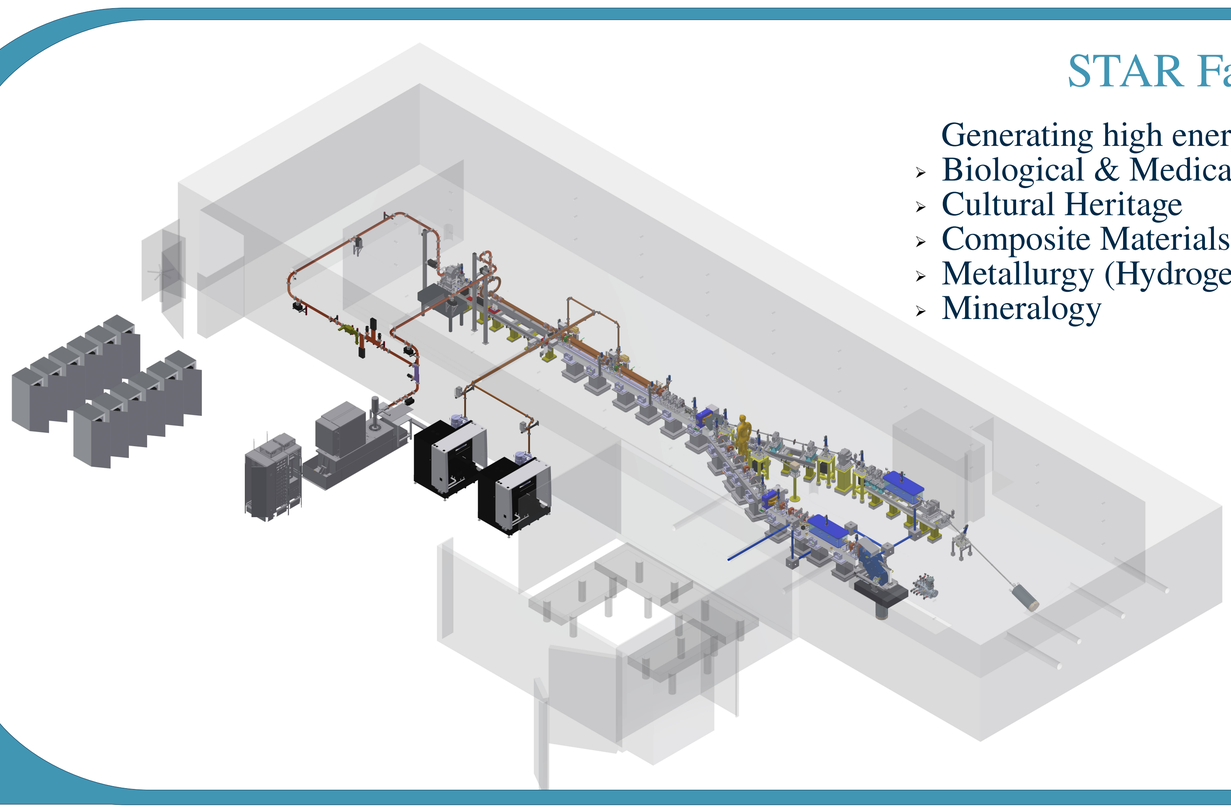
Abstract

The Southern European Thomson back-scattering source for Applied Research (STAR) is a high energy photon facility located on the campus of the University of Calabria (UniCal). The facility was designed for its first phase to operate with an electron and photon energy up to 85MeV and 140keV respectively. For the second phase of the project the energy of the electrons, and thereby the photons, would be increased up to 150MeV and 300keV respectively. The Italian Institute for Nuclear Physics (INFN) was awarded the project for installing, testing and commissioning the energy upgrade of the electron beamline. Here we will outline the progress made regarding the RF system and the Control System Software (CSS). The former consists out of two C-band linacs connected to their individual RF power stations for which the site acceptence test has recently been performed. For the latter the network of the STAR site has been extended to allow the EPICS based CSS to be further developed, including top level GUIs and IT security infrastructure.

Upgrade to High Energy Line

Upgrade to High Energy line (HE-line) consist out of:

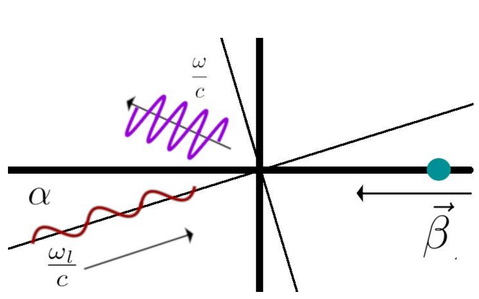
- Installation of soilenoid (8 cm) in front of S-band cavity for emittance control
- Installation of two C-band RF cavities incl. powerstations, for higher beam energy
- Cooling system upgrade
- Electric system upgrade, incl. backup power, power supplies and cabeling
- IT infrastructure & control system software

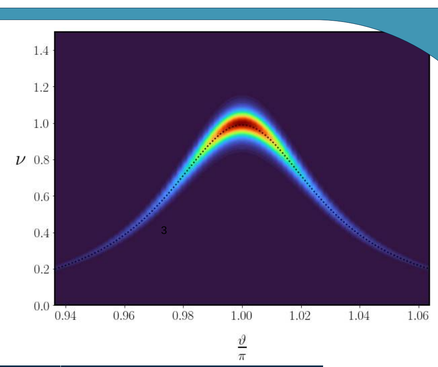


STAR Facility

Generating high energy radiation for

- Biological & Medical Imaging
- Cultural Heritage
- Composite Materials
- Metallurgy (Hydrogen embrittlement)
- Mineralogy





	Electron [Mev]	Photon [keV]
LE – line	23 -65	40 - 150
HE – line	40-150	25 - 350

Electrons

- Emittance : 1 [mm mrad]
- Charge : 100 – 500 [pC]
- Bunch length : < 0.7 [mm]
- Energy spread : 0.1 %, 0.05%

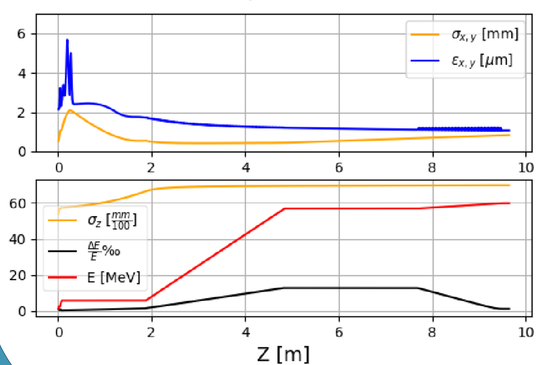
(CPA) Laser

- Energy : > 0.5 [Joule]
- Wavelength : 1030 [nm]
- Bandwidth : 1 [nm]

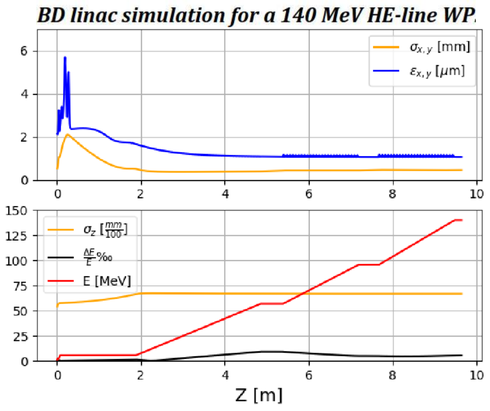
LINAC upgrade

Previously a single S-band (SLAC-type, 2.856 GHz) cavity was used to accelerate the electron bunch. In the upgrade two additional C-band (5.712 GHz) cavities are installed. By using different phases of the three cavities the energy spread of the electron bunch is under control, and in fact the entrance energy spread is recovered.
Plus a solenoid is installed before the first accelerating cavity that permits for a better control of the beam divergence.

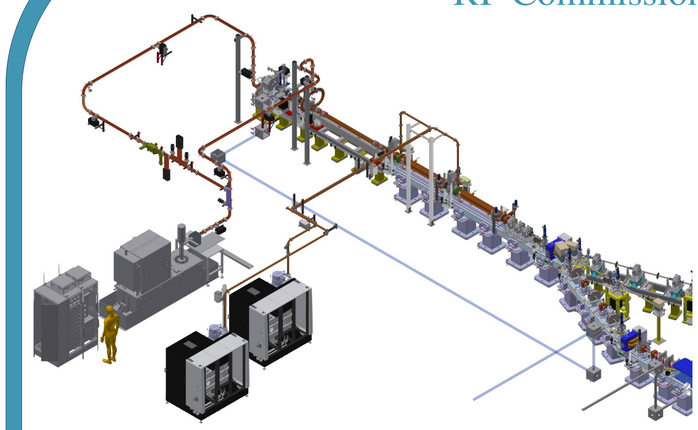
BD linac simulation for the 60 MeV LE-line WP.



BD linac simulation for a 140 MeV HE-line WP.



RF Commissioning

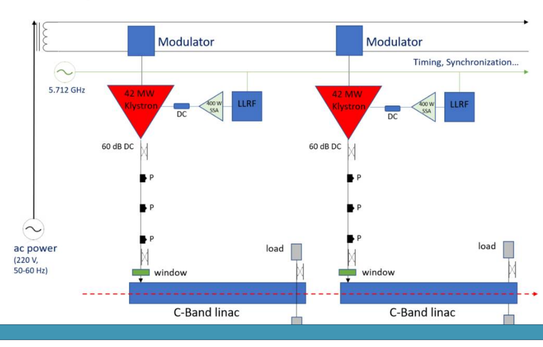


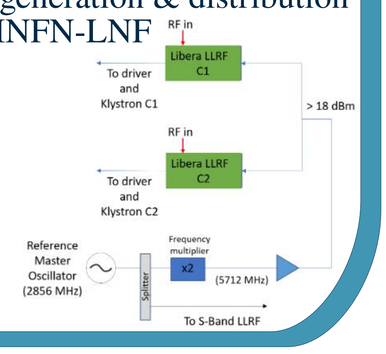
C-Band power units for Scandinova's Modulator (K300) and Klystron (E37212)

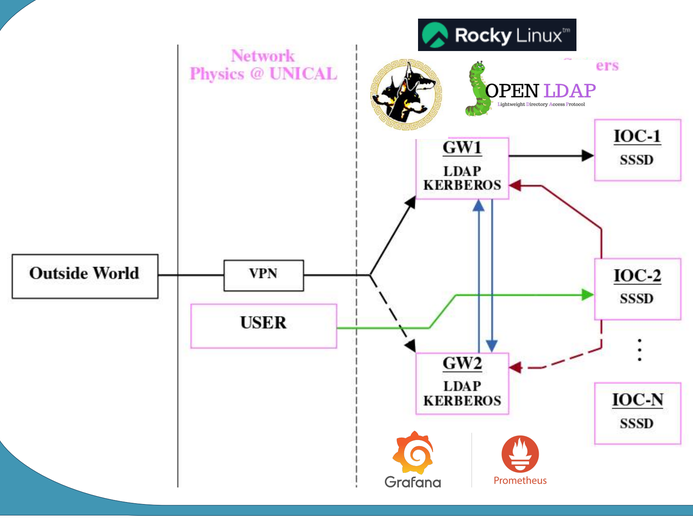
- Factory Acceptance Test
  Novermber 2022
- Site Acceptance Test
  May 2023

Low Lever RF
operation control through:

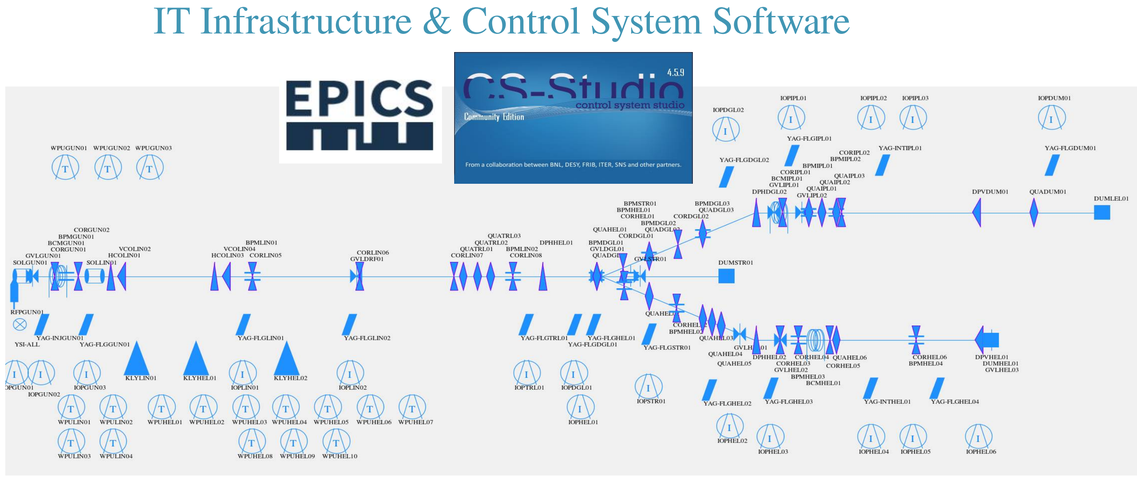
- I-Tech Libera LLRF
- RF reference generation & distribution developed by INFN-LNF







IT Infrastructure & Control System Software



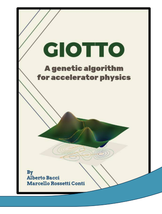
New Equipment:

- Servers
- Switches 10 GB/s

High available server with high level of security and extensive monitoring. Devices are implemented in EPICS and controlled with GUI's in CS-Studio.

Planned:

- Integrating LLRF
- Integrating GIOTTO
- Upgrade to PHOEBUS



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