EUROPEAN SPALLATION SOURCE

ESS Linac Integration Stand Update

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TAC12

https://ess-ics.atlassian.net/wiki/display/AITS/AD+Integration+Test+Stand+Home

Motivation:
Bootstrapping From a Green Field Site

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- Over 50% of the ESS Accelerator components will be built by in-kind partners from over 25 different institutions.
- The main task of ESS Accelerator staff in Lund will be integrating these separate components into a single complex system.
  - ESS is a green field site with no logistical infrastructure in place
  - The installation schedule is extremely tight and does have any contingency for logistical mis-fires.
- ESS Staff in Lund must be ready for integrating complex accelerator systems well before installation begins in 2018
- “Vertical” System integration tests can provide an avenue
  - for bootstrapping a green field site
  - to a functioning laboratory is a short amount of time
  - different from component test stands (FREIA, CEA,...)

Motivation:
Vertical System Integration Tests

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- Vertical tests encompass all aspects of the system
  - Total System performance
  - Safety
  - Shipping & receiving
  - Utilities (Cooling and Power)
  - Controls
  - etc
- The goal of a vertical system integration test is:
  - Working out unforeseen logistical issues
  - Measurement of complex system performance
- By-products of a a vertical system integration test:
  - Staff recruitment
  - Staff training

Motivation:
RF Integration Stand

- Initially, for a green field site, logistical issues will dominate the vertical system tests.
- To solve logistical issues quickly, the initial technical goals should be simple (but not too simple…)
- As logistical issues become solvable, the complexity of the test stand should increase.
- For a linac, a large majority of the integration issues arise at the RF source
  - power conversion, controls, cooling, grounding, interlocks, small signal processing, high power, etc…
- A good choice for an test stand would be single high power RF source
  - **Goal is not to just produce RF Power - that can be done anywhere**
  - **The goal is for ESS to transform itself into a functioning laboratory**

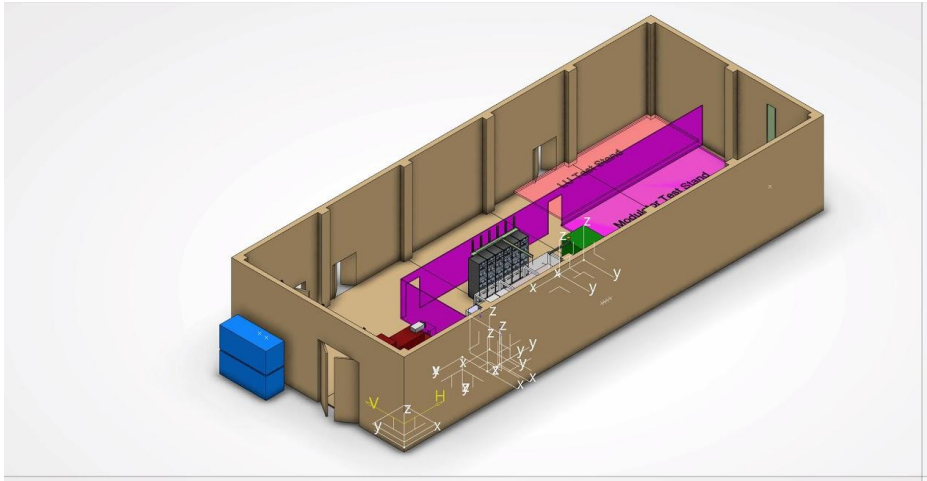
RF Source Requirements

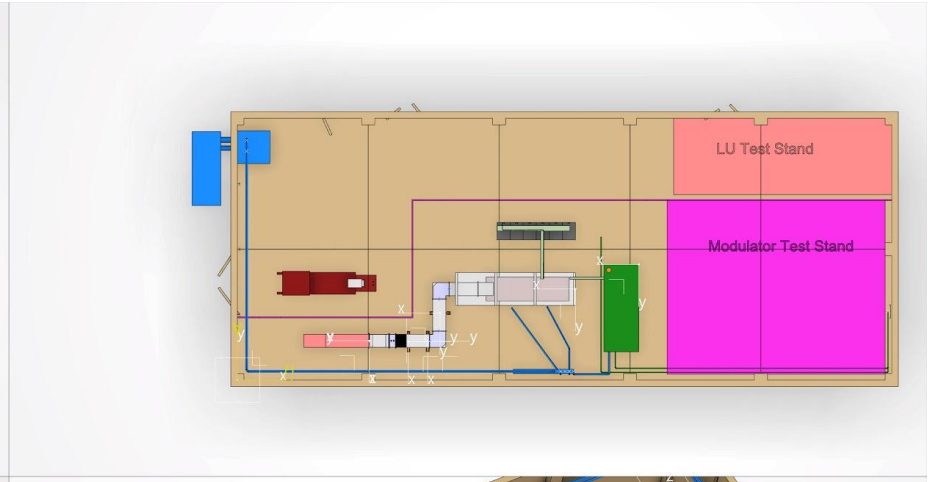
- Frequency: 352-704 MHz
- Peak RF Output Power: 1.0 - 1.5 MW
- RF Pulse length: 1 - 3 mS
- Duty cycle: 1 - 5%
- AC Power consumption: < 180 kVA
  - Cathode Voltage 120kV
  - Cathode Current 25A
  - Modulator efficiency > 85%
- 10kV AC input
- Floor Space < 100 m^2

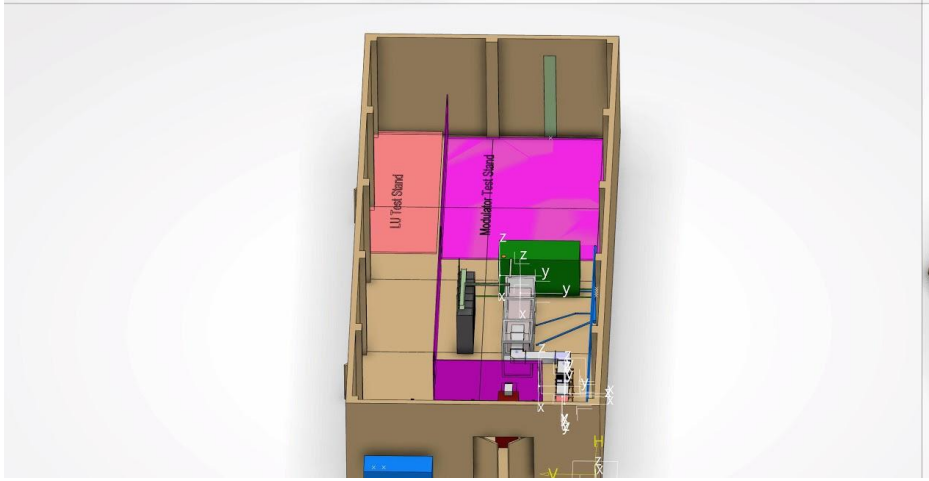
Location: LTH M Building South Hall

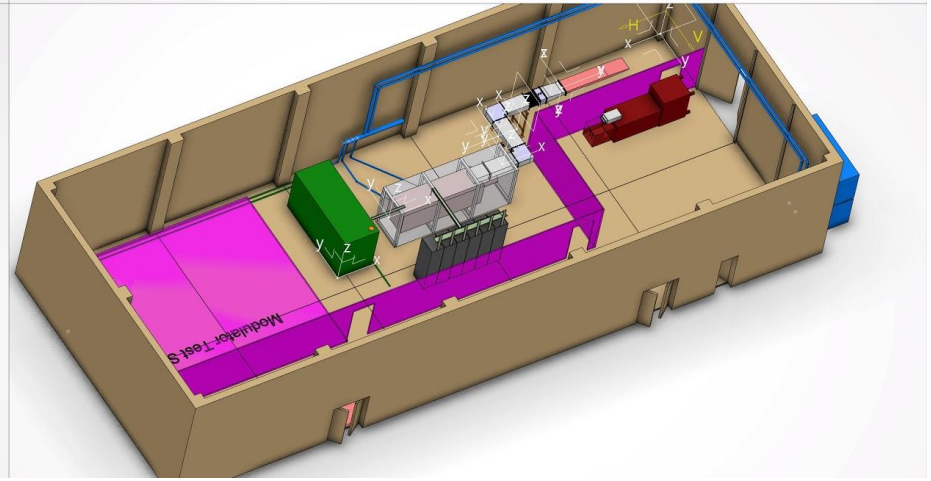
- It is available now
- We are already there and have a good working relationship with LTH
- It is close to ESS offices
- It is at LTH
  - Technical advice
  - Students
  - LTH infrastructure (machine shops, canteens,etc..)
- It has a crane.
- Large entry door
- Thick floor
- It has a stiff power source (10kV)

Possible Layout









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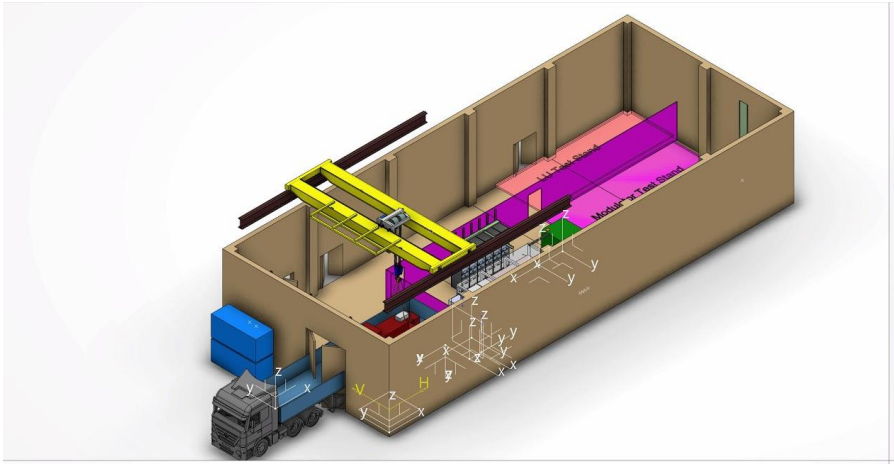

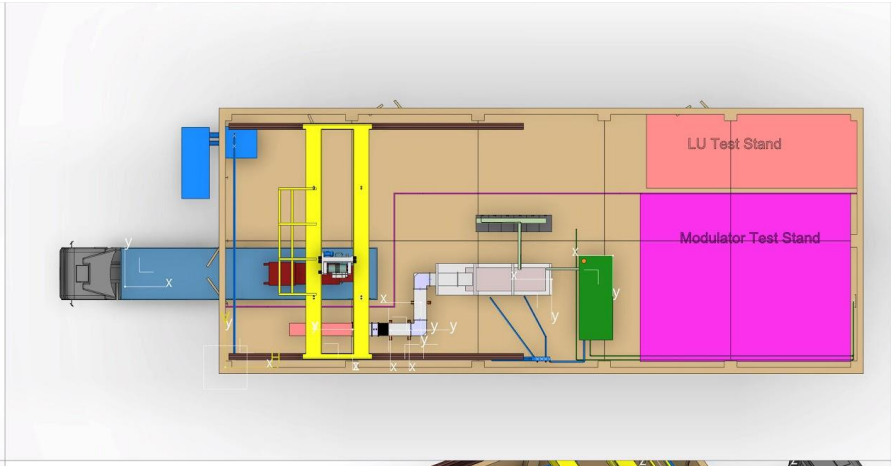

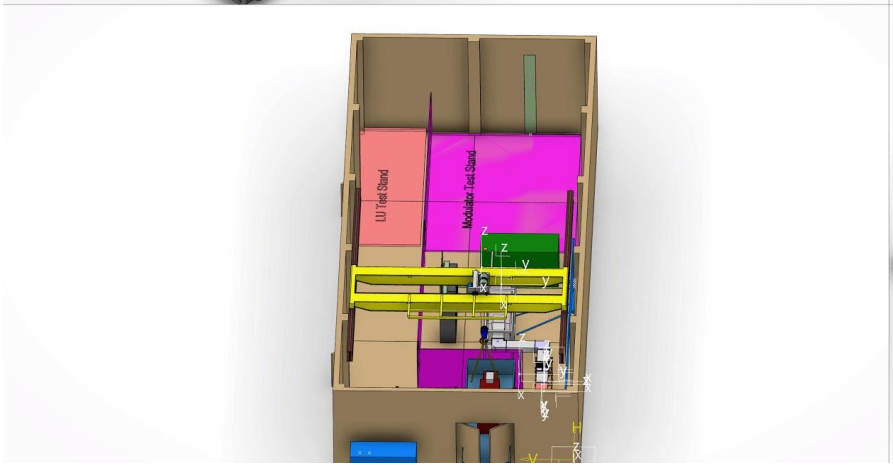

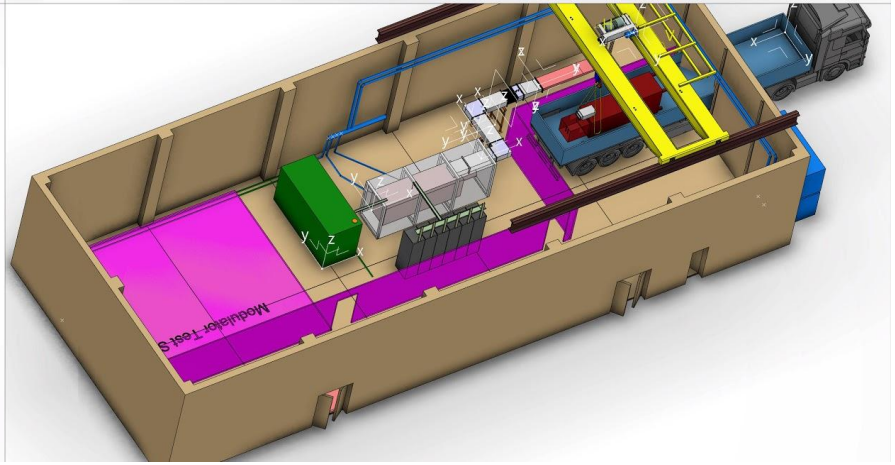

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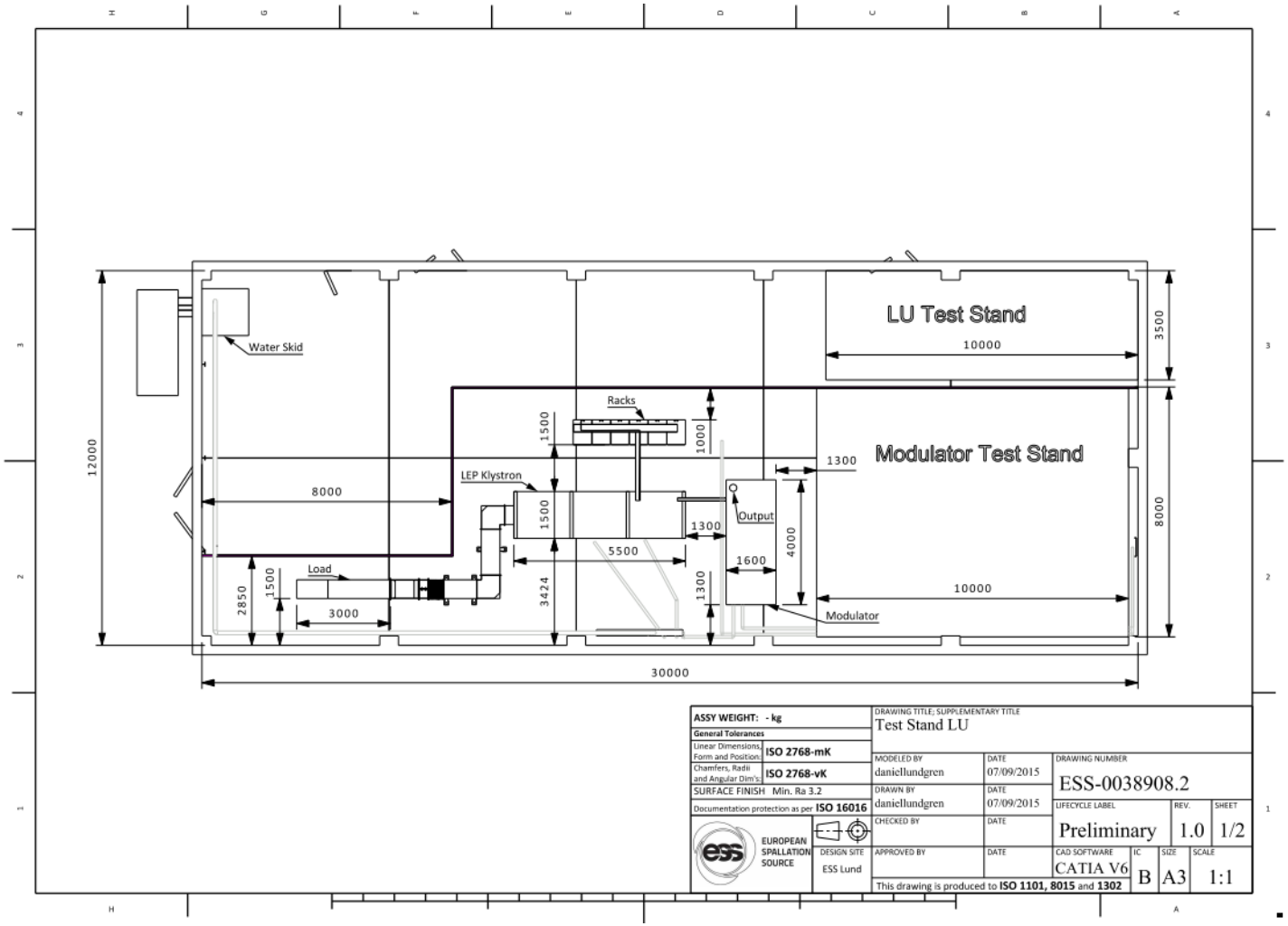

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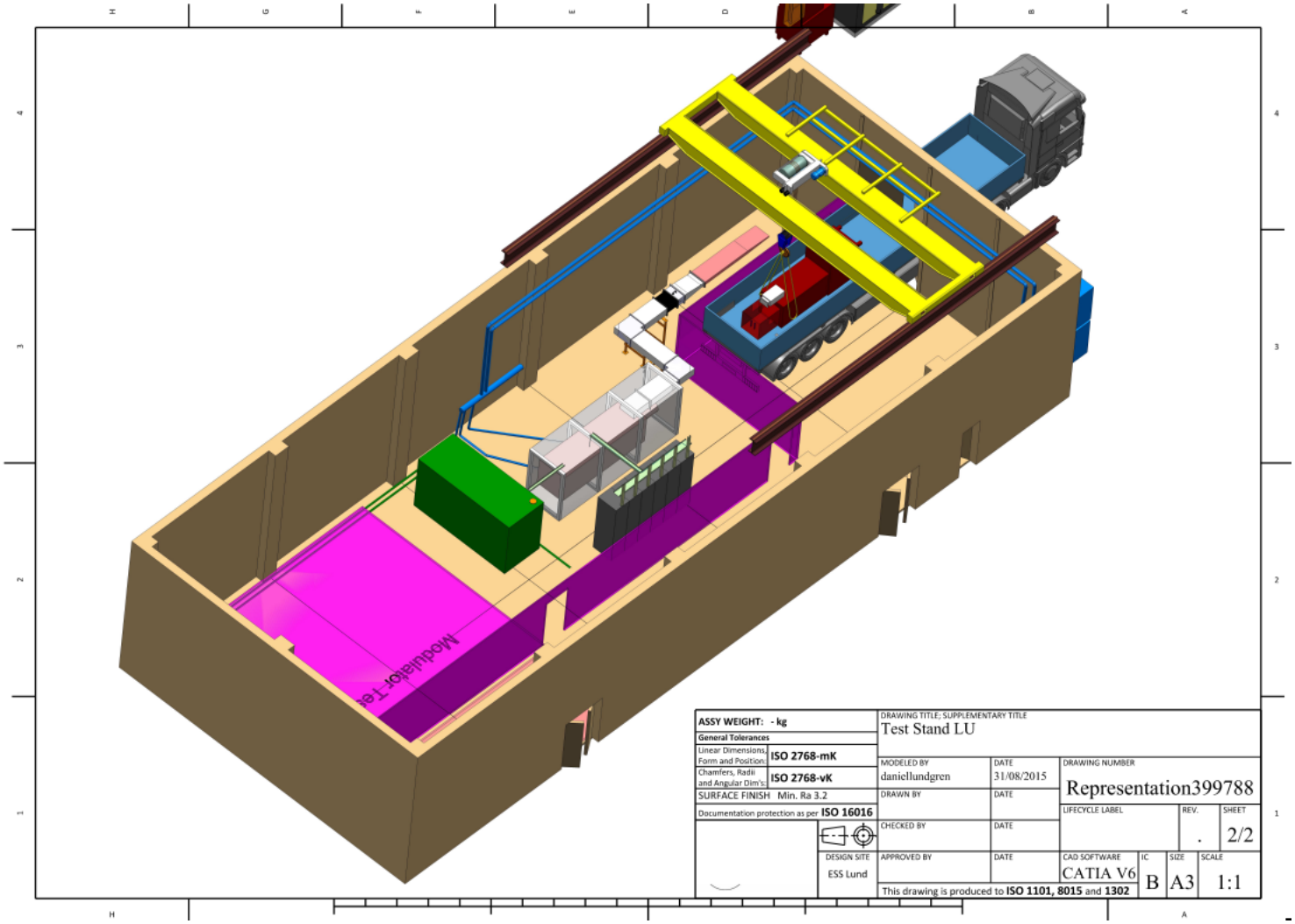

Equipment Configurations

- Configuration 1 (November 2015)
  - CERN Modulator powering CERN klystron protected by CERN interlock system
  - Borrowing already tested and working equipment allows ESS staff to focus on developing integration skills
  - CERN equipment could arrive in Lund by late September 2015
  - Possible to have a functioning test stand by November 2015
- Configuration 2a (March 2016)
  - Stacked Modulator powering CERN klystron protected by CERN interlock system
  - Stacked Modulator prototype available early 2016.

Equipment Configurations

- Configuration 2b (in case of delays in Stacked Modulator) (June 2016)
  - CERN modulator powering ESS klystron protected by CERN interlock system
  - ESS 704 MHz Klystron arrives Q1-Q2 2016.
- Configuration 3 (June 2016)
  - Stacked modulator powering ESS klystron protected by CERN interlock system
- Configuration 4 (Q4 2016)
  - Stacked modulator powering ESS klystron protected by ESS interlock system

Safety Precautions

- **Will have a safety readiness review before each configuration is energized.**
  - **LTH and Academiska Hus will be invited to participate in the review**
- All klystrons are shielded and shielding is interlocked and shielding actively verified
- Non-ionizing radiation will be continuously monitored and interlocked
- All high voltage equipment to be placed behind locked fence
  - No exposed bus bars
  - High voltage fencing
  - Follow lockout tagout during repairs
  - All modulators are encased in oil containment tubs

The Team (Key holders)

- Coordination
  - Dave McGinnis (Leader)
  - Nick Gazis (Mechanical Engineer)
- RF
  - Morten Jensen (Leader)
  - Stevo Calic (RF Engineer)
  - Chiarra Marelli (RF Engineer)
  - Staffan Ekström (RF Technician)
- Power Convertors
  - Carlos Martins (Leader)
  - Göran Göransson (Electrical Engineer)
  - Marko Kalafatic (Electrical Technician)

Timeline

- 1-April-2015
  - Integration Test Stand proposed ATAC11 (https://indico.esss.lu.se/indico/event/298/)
  - Proposed borrowing ESS-CERN modulator and CERN SPL 704 MHz Klystron
- 23-April-2015
  - Integration Test Stand proposed again at Annual Review (https://indico.esss.lu.se/indico/event/316/)
  - Annual Review Recommendation: Get your hands dirty! -- The ESS/AD should start establishing some technical credibility and developing the technical workforce by getting their hands on relevant hardware systems as soon as possible. We endorse the so-called "Blinky Light Test", the RF test stand and the opportunity of early integration of the ion source, its control system and the beam diagnostics. Also, the Uppsala test stand should be used as an opportunity to train staff.

Timeline

- 8-July-2015
  - First CERN Meeting (https://ess-ics.atlassian.net/wiki/display/AITS/Meeting+at+CERN+8-July-2015)
  - Equipment List Agreement: CERN has agreed to loan ESS the following equipment from September 2015 until January 2017
    - The CERN-ESS long pulse klystron modulator
    - A LEP-Linac4 352 MHz 1 MW klystron
    - The shielding garage for the klystron
    - The filament and solenoid power supplies
    - A Linac4 Interlock rack including driver amplifier but excluding cables
    - A "minimal" set of WR2300 waveguide components (no circulator) to connect the klystron output to an RF load
    - A 352 MHz, WR2300 waveguide load capable of handling a maximum average power of 50 kW.

Timeline

- 8-July-2015
  - Resource Agreement: Subject to approval by CERN management, CERN staff will:
    - Pack and ship the equipment (ESS will pay for the shipping costs)
    - Review at ESS the test stand configuration before powering at ESS
      1. 1 day review with a CERN RF expert, Modulator expert, and Controls expert
      2. ESS pays for travel costs
    - Provide guidance and advice to ESS staff at a level of best effort not to exceed 1 man-day per month via email, teleconference, and visits to CERN.
  - ESS and CERN will modify the current agreement so that at the end of the loan, CERN keeps the CERN-ESS long pulse modulator indefinitely.

Timeline

- 12-August-2015 - 2nd CERN Meeting
  - Finalize the details to the updated MOU
  - Understand the operations of the ESS-CERN modulator and LEP/Linac 4 klystron
  - Understand the dimensions of the equipment
  - Discuss the shipping logistics
- 2-October-2015
  - Klystron equipment packed and shipped from CERN
- 5-October-2015
  - Klystron equipment delivered to ESS

Klystron Delivered to LTH M Building