# Metrology for integration and installation activities at the PRIMA Test Facility

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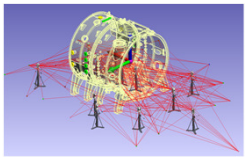
**ABSTRACT** The ITER project requires at least two Neutral Beam Injectors, each accelerating up to 1MV a 40A beam of negative deuterium ions, so as to deliver to the plasma a power of about 33 MW for one hour. Since these requirements have never been experimentally met, it was recognized necessary to build-up a test facility, named PRIMA, that is in an advanced state of realization and which includes both a full-size negative ion source (SPIDER) and a prototype of the whole ITER injector (MITICA).
The poster describes the main metrology activities performed in the last four years devoted to the integration and installation of the large number of items and plant units composing the facility. Particular emphasis is given to the propaedeutic activities consisting mainly in the definition of the metrology network (the so called Unified Spatial Metrology Network - USMN) by using technologically advanced laser trackers. The USMN is a feature of the Spatial Analyzer software (SA) compliant with the ISO standard that using the Monte Carlo method is capable to reduce the global measurement uncertainty. The method is based on the installation and measurement of a large number of fiducial points (approximately two hundreds targets). For PRIMA, some local USMN networks have been built up at different locations resulting eventually in the definition of the PRIMA USMN network. This approach allowed the definition of the global reference frame to be used for the positioning of all items, while respecting the uncertainty requirements of each component. In the poster some instances will be given like the positioning of the transmission line (uncertainty of 0.2 mm over more than 100 m between first and last tank) and the high voltage bushing support structure for MITICA, the vacuum vessel and the beam source for SPIDER (uncertainty better than 0.01 mm of the grid apertures).

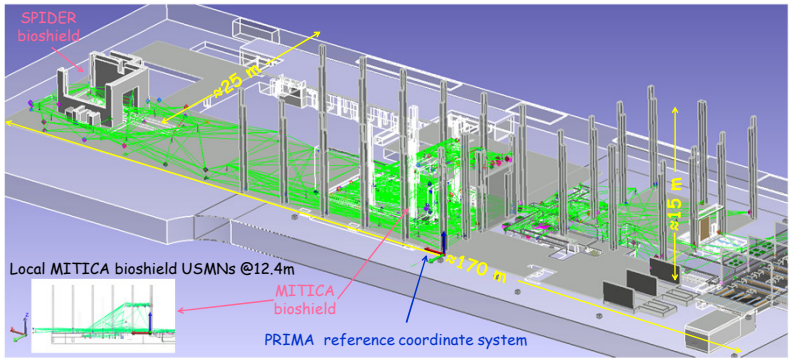
## The PRIMA USMN network (Unified Spatial Metrology Network)


Typical Fiducial Point installed on building pillars and floor


SMR and it support pointed by the laser beam

Local SPIDER USMNs (bioshield and vessel connected) with the SPIDER reference coordinate system



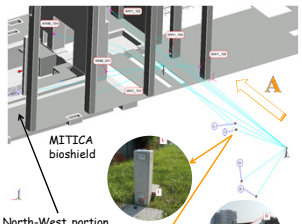


PRIMA Neutral Beam Test Facility – Padova - Italy

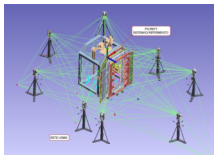

Laser Tracker «Leica AT403»

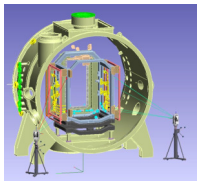

Laser Tracker «Faro Vantage»


Laser Tracker «Leica AT960»




## SPIDER Beam Assembly and Installation inside the Vacuum Vessel

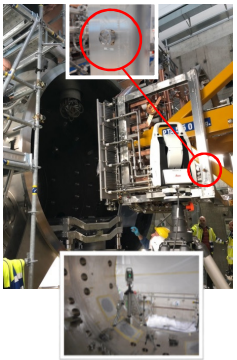

Definition of the local USMN for SPIDER Beam Source assembly and installation (with BS reference frame)


Simulation of SPIDER Beam Source installation/positioning inside the vacuum vessel


Measuring/check activities with the BS inside the clean room (in assembly area) before it installation in the vessel


Two specific tools for apertures position and adjacent grid distance measurements has been designed, manufactured and successfully used

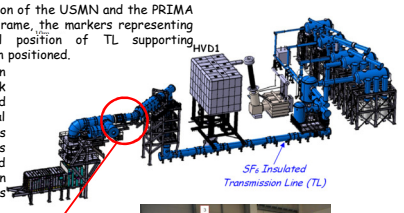

Uncertainty better than 0.05 mm for the grid apertures position measurements

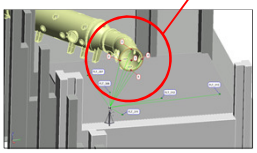

The laser tracker inside the SPIDER vacuum vessel during the installation of the Fiducial Points (for the in-vessel USMN)

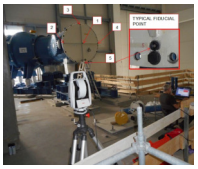
## MITICA 1MV transmission line and transformers positioning

Following the definition of the USMN and the PRIMA absolute reference frame, the markers representing the correct/nominal position of TL supporting rails/frame have been positioned.

After the installation of almost each tank of the TL (performed by an external Company) the cross check measurements have been performed to assess the position of the thanks themselves.

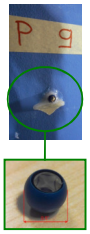


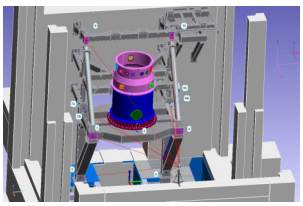




Measurements of the flange of the bent tank following the core snubber @12.5m

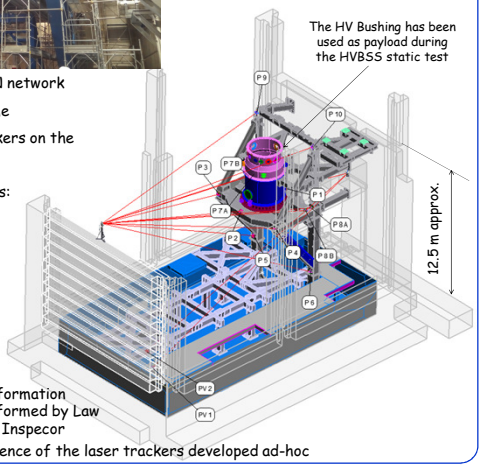
Positioning of the last TL flange with an uncertainty of 0.2mm over more than 100m

## MITICA High Voltage Bushing Support Structure (HVBSS): installation and test



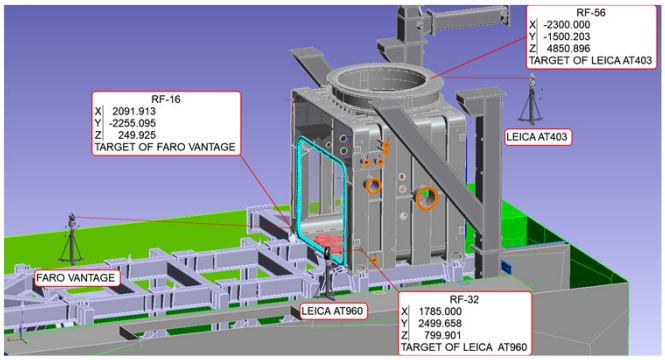


- Definition of the MITICA USMN network
- Definition of the reference frame
- Positioning of the main axes markers on the bioshield wall
- Simulation in SA to define/assess:
  - The position of the laser trackers during the HVSS installation (forged ring)
  - the position of the temporary fiducial points to be fixed to the HVBSS
- Measurement for the structure Site Acceptance Test
- Measurements of the HVBSS deformation during the Static Load Test, performed by Law at the presence of the Qualified Inspecor
  - automatic positioning sequence of the laser trackers developed ad-hoc




## MITICA Beam Source Vessel (BSV):installation with Trans-Track routine

For the alignment of BSV three points have been used in three different positions.
A point has been associated with a laser, for the continuous measurement of the position and it's relative shift from the nominal. For the alignment of the BSV three laser have been used: the Faro Vantage, the Leica AT403 and the Leica AT960. For this measure a precise routine of SA, called Trans-Track, was used. With this routine you can check the position of the BSV and, in a live mode, the possible mechanical structure deformation.







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