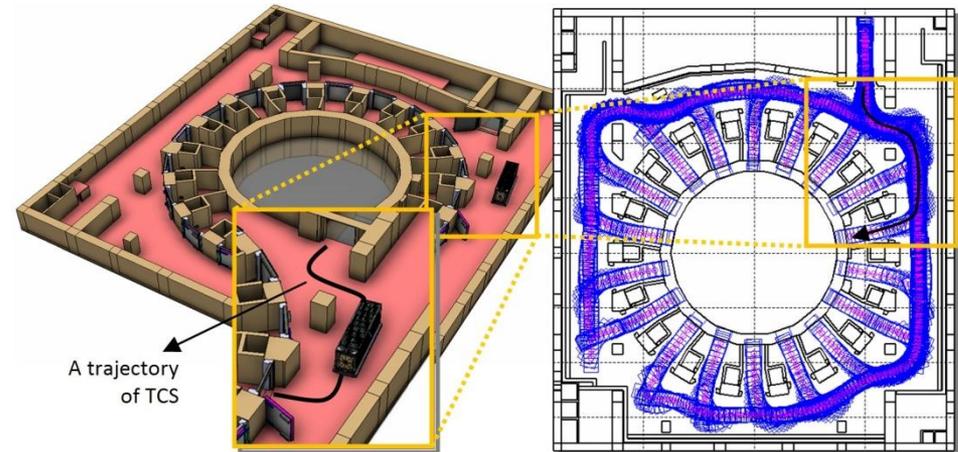


Activities related to the development of an Air Transfer System prototype and Cask Transfer System Virtual Mockup

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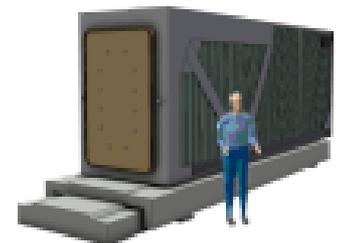
Partners:

- Instituto Superior Técnico (IST), Portugal – Coordinator
- CIEMAT - Spain
- ASTRIUM ST (France) – subcontractor



Tasks

- **Task 1** – Definition of optimized CPRHS paths between all vessel ports on all levels and the hot cell ports (IST)
- **Task 2** – Definition, development and operation of a comprehensive Virtual Model of the ITER buildings, ATS and TCS (ASTRIUM ST)
- **Task 3** – Definition of a test facility for ATS prototyping testing (IST + CIEMAT)
- **Task 4** – Technical support in the task areas A and B (IST)

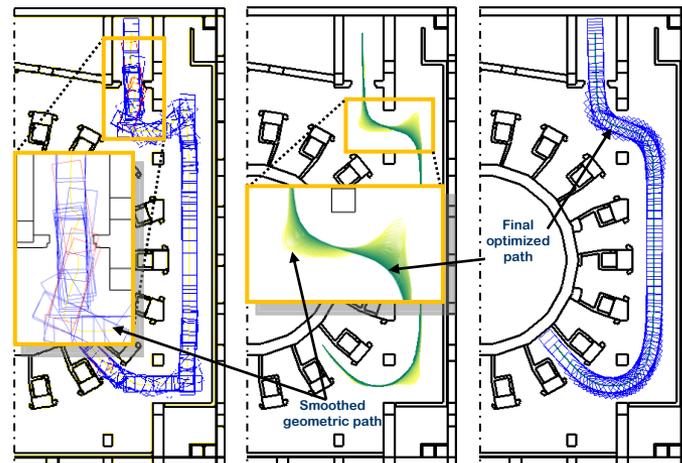


Activities related to the development of an Air Transfer System prototype and Cask Transfer System Virtual Mockup

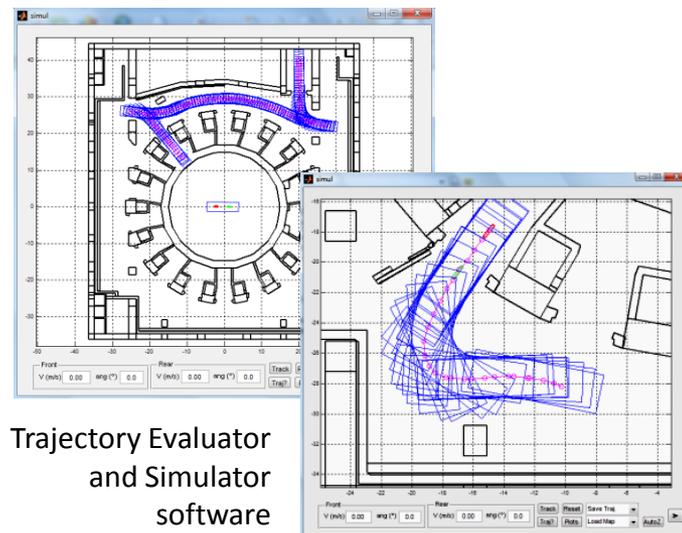
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Results from Task 1 (IST):

- Development of **TES (Trajectory Evaluator and Simulator)**. MATLAB tool for:
 - Load, edit and save maps.
 - Evaluate, load, and save trajectories.
 - For the grant, TES was developed considering **that both wheels of the CTS follow the same path**. A different approach with both wheels following different trajectories can be developed in the future.
 - Simulate the CPRHS/CTS following the optimized paths.
 - Estimate the space occupied by the CPRHS/CT along the entire trajectory.
 - Drive manually the CPRHS/CTS with its rhombic capabilities.
 - Identify the nearest obstacle in each point of the trajectory.
 - Generate plots with velocities, orientations, minimum distances, etc.



Trajectory optimization algorithm



Trajectory Evaluator and Simulator software

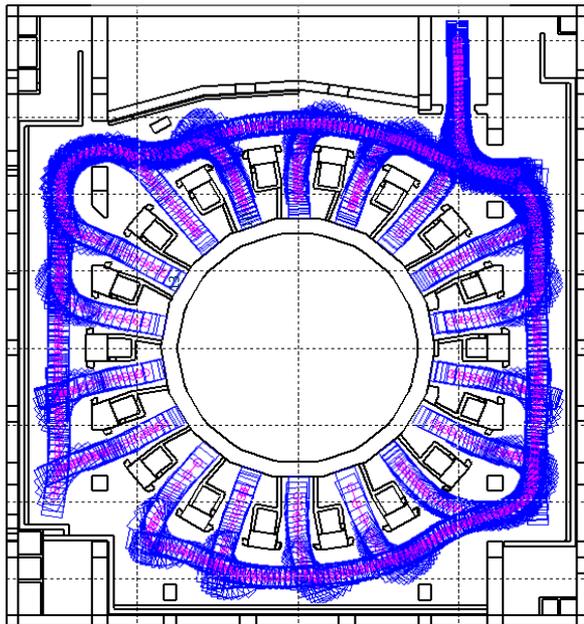
Activities related to the development of an Air Transfer System prototype and Cask Transfer System Virtual Mockup

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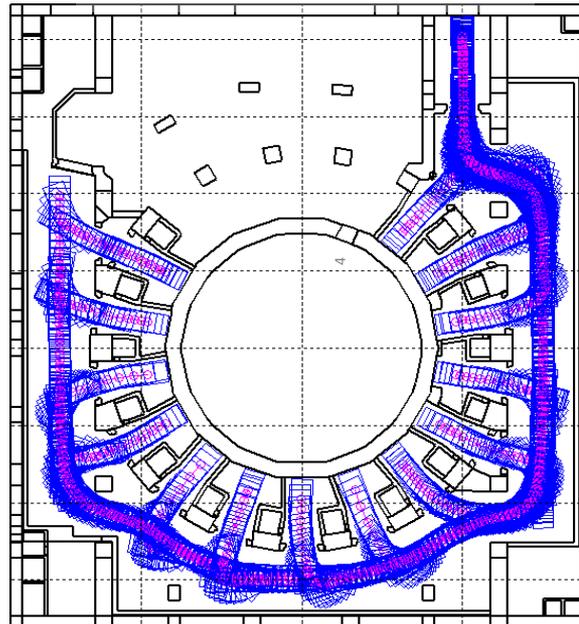
○ Results from Task 1 (IST):

- **Generation of Optimized Trajectories** (60 trajectories more than 4.5 km of length in ITER buildings (TB and HCB), some with 1 or 2 maneuvers for docking and parking). Some of the trajectories required one or two maneuvers.

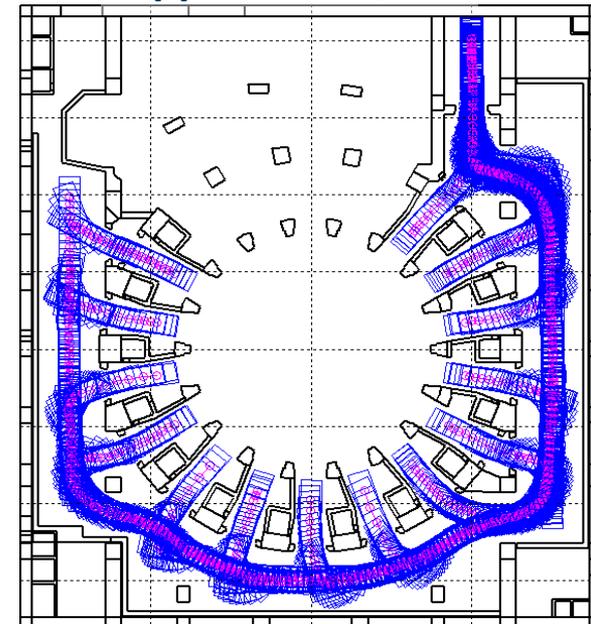
Divertor level @TB



Equatorial level @TB



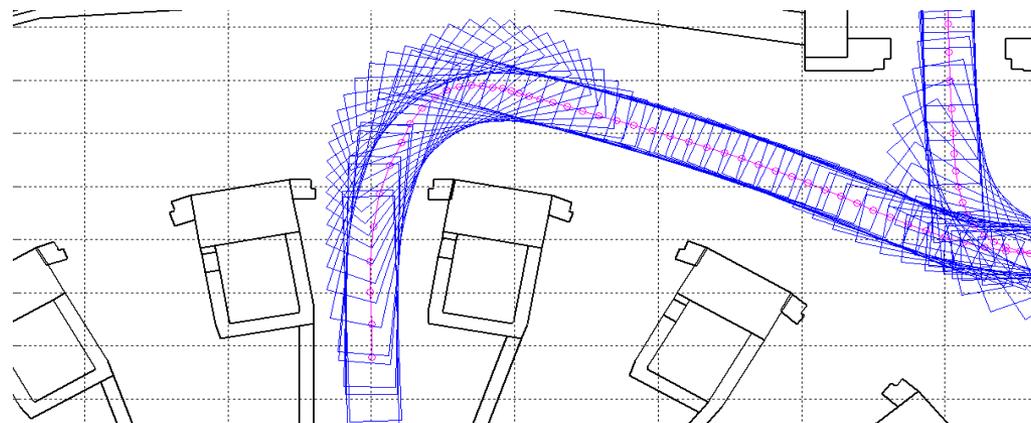
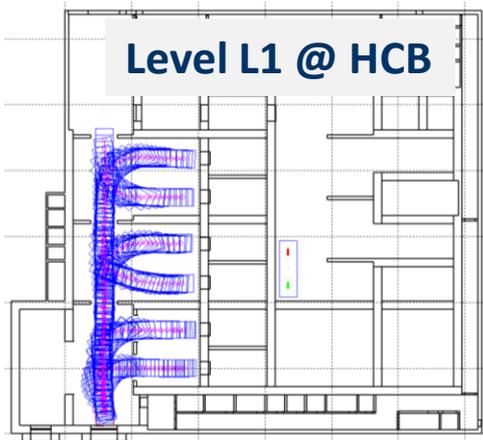
Upper level @TB



Activities related to the development of an Air Transfer System prototype and Cask Transfer System Virtual Mockup

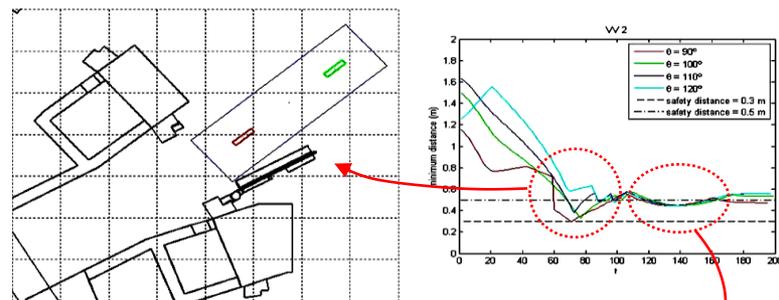
Fusion for Energy Grant: F4E-2008-GRT-016 | March.2009-July 2010

Results from Task 1 (IST):

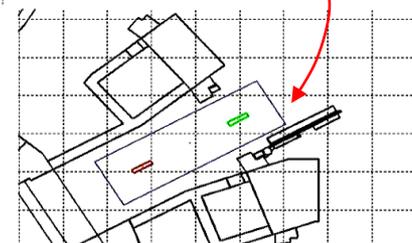


Trajectory for VV 5 (level B1), for a narrower CPRHS (8500 mm x 2000 mm)

- Buildings CAD models analysis and proposal modifications (e.g., VV port cell doors modifications were proposed (door width, aperture angle, aperture direction) to guarantee a safety margin of 300mm in all trajectories



Distance to the closest obstacles

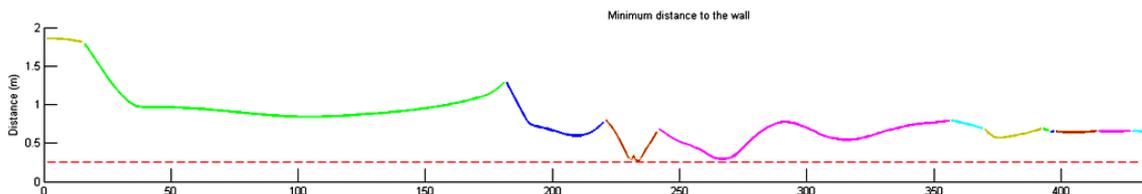


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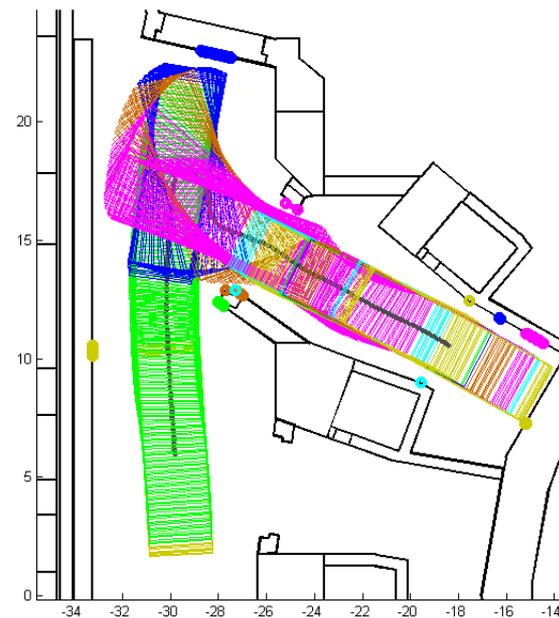
○ Results from Task 1 (IST):

- Extension of VV ports 8 and 17 in level L1 of the TB were proposed and included in all studies where this modification becomes relevant.



Evolution of the minimum distance to the obstacles

- Study on the **parking locations** in Hot Cell Building



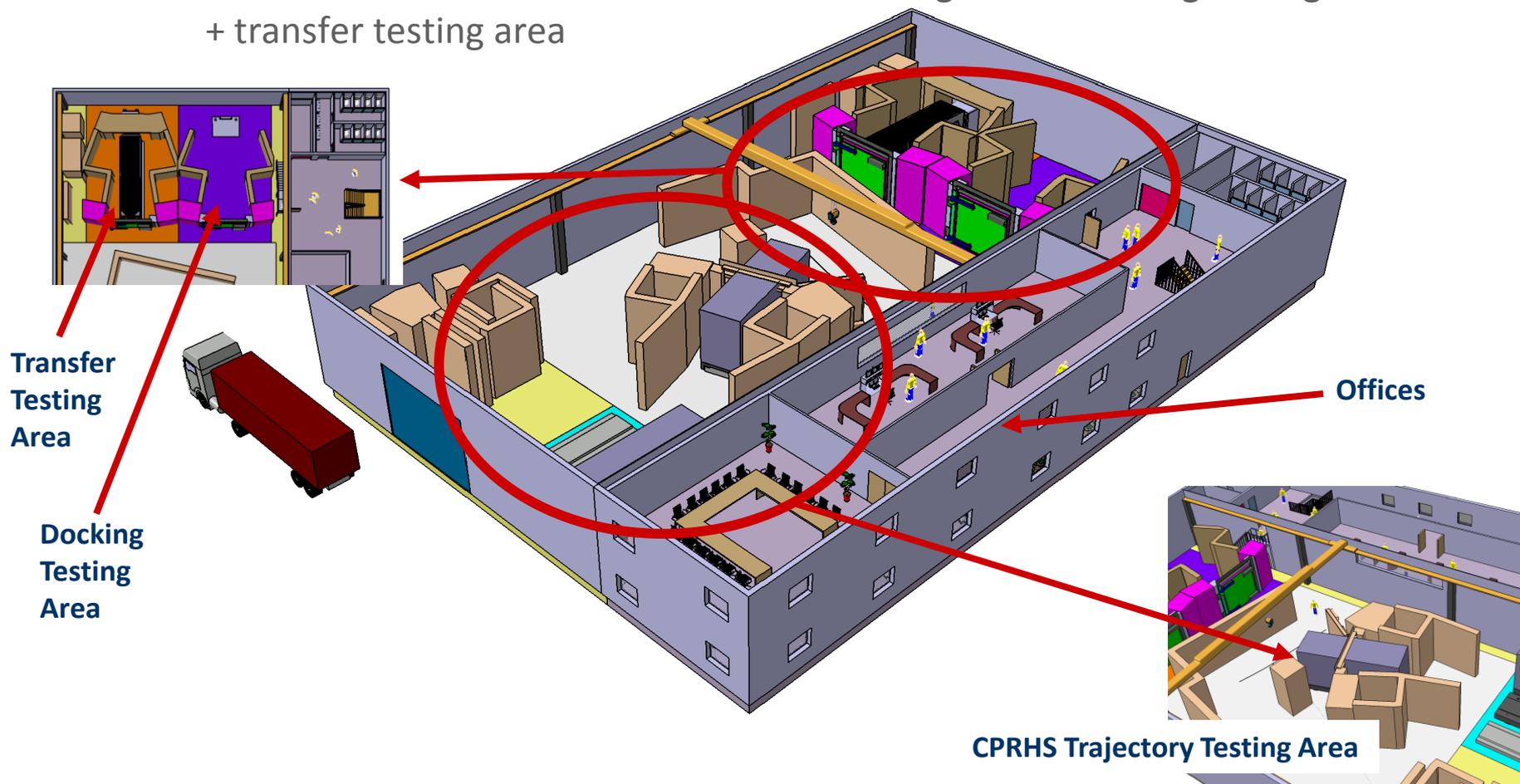
Extension of VV port cell 8 in level L1 of TB and closest obstacles associated to each part of the trajectory

Activities related to the development of an Air Transfer System prototype and Cask Transfer System Virtual Mockup

Fusion for Energy Grant: F4E-2008-GRT-016 | March.2009-July 2010

○ Results from Task 3 (IST + CIEMAT)

- Specification of a **Test Facility for the CPRHS/CTS**
- 1200m² with three main areas: CPRHS testing area + docking testing area + transfer testing area





Activities related to the development of an Air Transfer System prototype and Cask Transfer System Virtual Mockup

Fusion for Energy Grant: **F4E-2008-GRT-016** | March.2009-July 2010

○ Results from Task 4 (IST):

- Technical consultancy support to F4E for CPRHS/CTS design. Main addressed topics: the CPRHS/CTS dimensions, CPRHS docking procedures, interfaces between the three components of the CPRHS, surveys on air-cushion, navigation (line-guidance vs free-roaming) and localization systems.

○ Publications from IST team:

- Isabel Ribeiro, Carlo Damiani, Alessandro Tesini, Satoshi Kakudate, Mikko Siuko, Carlo Neri, “The Remote Handling Systems in ITER”, Fusion Engineering and Design, Elsevier, in press, March 2011, <http://dx.doi.org/10.1016/j.fusengdes.2011.01.138>
- Filipe Valente, Alberto Vale, Daniel Fonte, Isabel Ribeiro, “Optimized Trajectories of the Transfer Cask System in ITER”, Fusion Engineering and Design, Elsevier, in press, December 2010, <http://dx.doi.org/10.1016/j.fusengdes.2010.12.027>
- C. González Gutiérrez, C. Damiani, M. Irving, J-P. Friconneau, A. Tesini, I. Ribeiro, A. Vale, “ITER Transfer cask System: status of design, issues and future developments”, Fusion Engineering and Design, Elsevier, Vol. 85, issues 10-12, December 2010, pps. 2295-2299.
- D. Fonte, F. Valente, A. Vale, I. Ribeiro, “A motion planning methodology for rhombic-like vehicles for ITER remote handling operations”, Proceedings do 7th IFAC Symposium on Intelligent Autonomous Vehicles, IAV2010, Lecce, Italy, September 2010.