TOC

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Why Remote Handling in ITER?

ITER has no critical negative concerns like fission reactors: no risk of uncontrolled energy release, greatly reduced quantity of high level waste and greatly reduced threat to non-proliferation of weapons material. Please see the differences between *fusion* and *fission*.

However, human beings are not allowed o enter in Tokamak Building as soon as the operation starts. A Transfer Cask System (TCS) for the transportation of components during maintenance operations is required. The TCS consists of an unshielded (with respect to gamma radiation) mobile vehicle with dimensions similar to an autobus with a maximum load of 100 tons and moved by air-cushion, provided with autonomous guidance and docking.

TCS dimensions

Which are the mobile robotics challenges in Remote Handling?

This TCS must be able to travel between different pre-defined start/goals locations in different levels of the Tokamak building. There are several challenges:

- Path planning: optimized set of trajectories from all pairs of start/goal locations in the building (see the examples in the following images). The optimization criteria will consider collision free and smooth paths with the minimization of steering maneuvers and the preservation of a safe area around the vehicle and to accomplish the mission as fast as possible. Additionally it will maximize the length of the commons paths to be followed in different tasks, i.e., different pairs of start/goal locations.
- Path Following: since path planning is accomplished, a control system must drive the TCS through the trajectories, which can be represented by wired system, painted on the floor or simple virtual trajectories.
- Localization: while following the computed trajectories, it is necessary to permanently estimate the position of the TCS for path planning, monitoring and synchronization with the entire system (e.g. vacuum-vessels doors, lift doors, additional TCS or other vehicles).
- Sensor procurement: the particular issue inside the Tokamak building is the radioactive level, which constraints to a reduce spectrum of electronic sensors.

- Experimental results combining several challenges together: develop and test a prototype with similar and huge dimensions, a very unusual motion system (Air-Cushion System) with particular kinematics (Rhombic vehicle).
- Export trajectories from MATLAB environment and simulate using real CAD model scenarios of ITER.

Path Planning

CAD model	Matlab

Who has started?

Instituto Superior Técnico

IST (Instituto Superior Técnico) is recognized for its high quality education and R&D, in a growing synergy with the economic sector. IST is considered, in Portugal, and abroad, as a High Quality Engineering, Science and Technology School, which is able to rival with the best Schools worldwide, in their areas of competence. R&D at IST is carried out essentially in excellent Research Institutes, which integrate teachers and researchers linked to the several departments of IST. In particular IPFN and ISR are leading units on the fields of physics and robotics.

Instituto de Plasmas de Fusão Nuclear

IPFN (Instituto de Plasmas e Fusão Nuclear provides a unique setting for world-class research, fostering scientific and technological excellence in an internationalized context. Leveraging on our wide range of expertise, in our vision IPFN promotes a culture of ambition and leadership, in a permanent pursuit of the most far reaching and intellectually demanding scientific and technological problems, attracting the best talents in our areas to work in an exciting environment, strongly networked with other world leading institutions. Our global position allows us to act as a central hub for research, advanced formation and training, and technological transfer in Plasma Physics and Engineering, Controlled Nuclear Fusion, Laser and Photonics and Advanced Computing. The IPFN high expertise permits to have an important participation in the landmark EU large-scale research projects (e.g. JET, ITER, HIPER, ELI) through the collaboration in the scientific and technical activities of these projects, and the active presence on their governing boards.

Instituto de Sistemas e Robótica

ISR-Lisbon (Instituto de Sistemas e Robótica is a university based R&D institution where multidisciplinary advanced research activities are developed in the areas of Robotics and Information Processing, including Systems and Control Theory, Signal Processing, Computer Vision, Optimization, AI and Intelligent Systems, Biomedical Engineering. Applications include Autonomous Ocean Robotics, Search and Rescue, Mobile Communications, Multimedia, Satellite Formation, Robotic Aids. Since 1996, ISR-Lisbon is periodically subject to evaluation, by international panels of independent scientists organized by the Ministry of Science, Technology and Higher Education. In the two evaluation exercises organized in 1996 and 2000 ISR has been rated as excellent. ISR-Lisbon is engaged in several international R&D and collaborative projects in conjunction with universities and research centres of excellence, as well as European businesses with recognized competence, under the auspices of programs funded by the Portuguese Science and Technology Foundation, European Community and other agencies.