

# **Collimator alignment in high radiation environment**

**Remote controlled  
alignment verification system  
for LHC collimators at IP7**

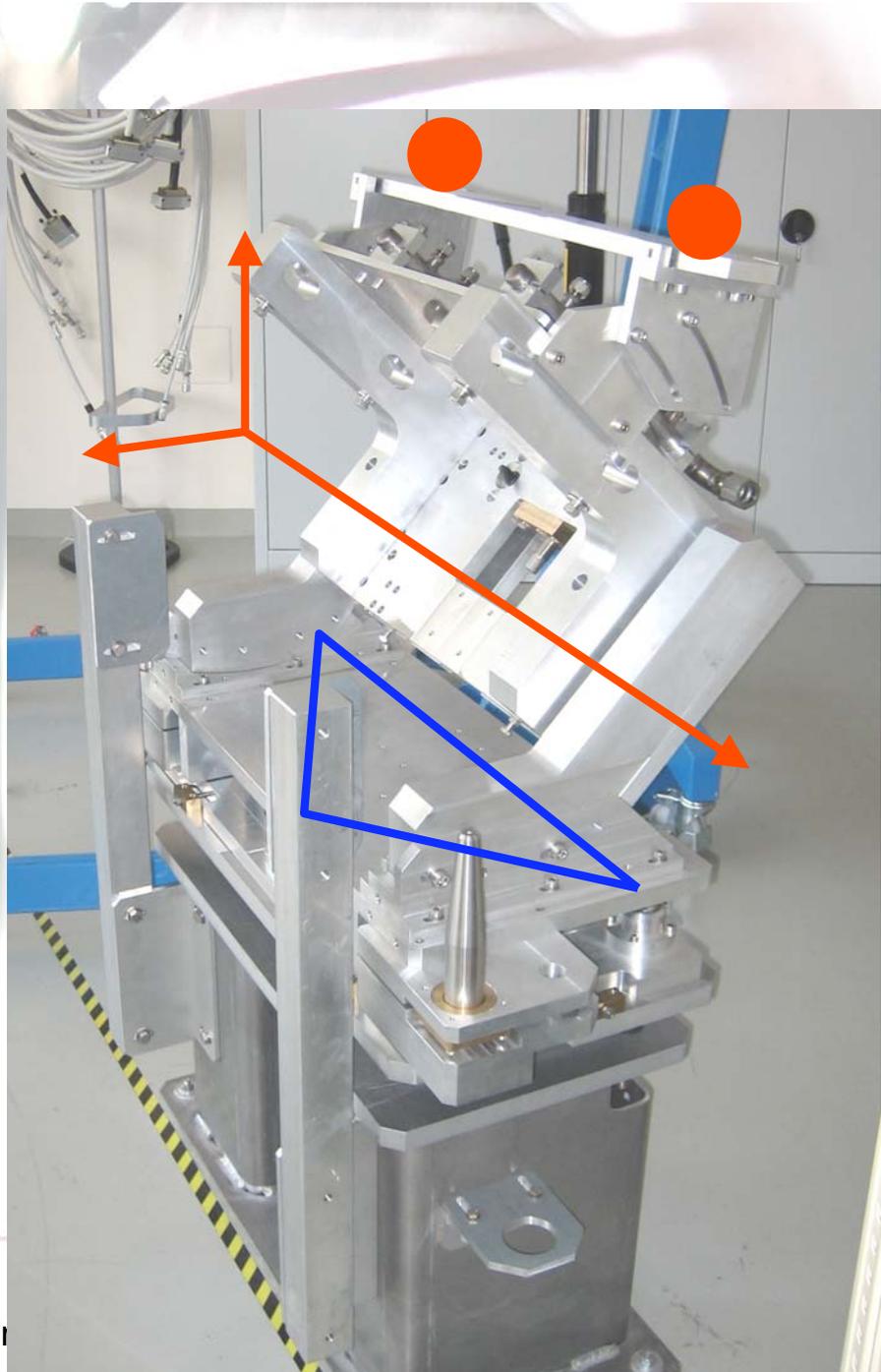
# Overview

- Introduction
- Metrology
- Initial alignment
- The train concept
- Measurement concept and references
- Sensors and configuration
- Measurement Results



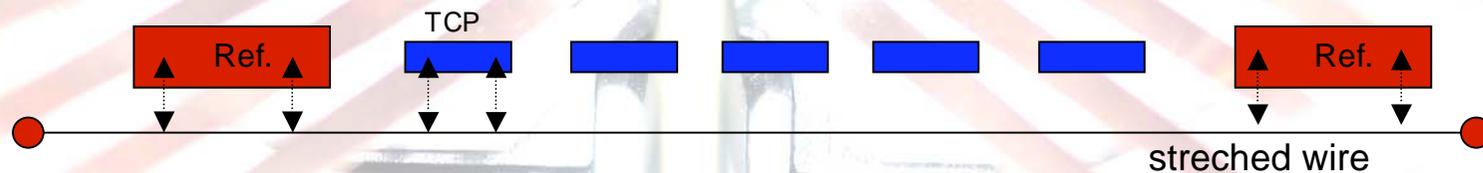
# Collimator metrology

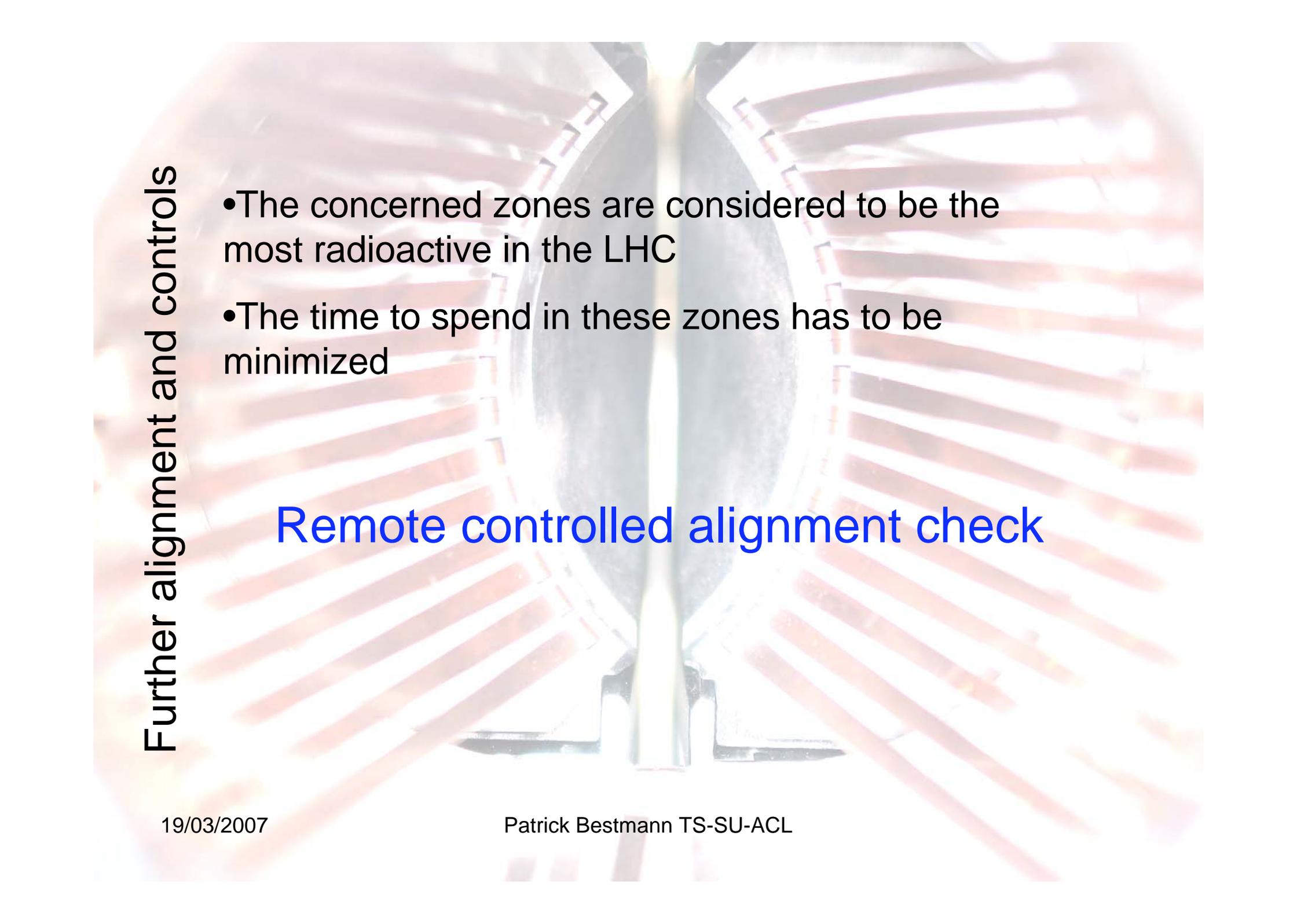
- Alignment of Collimator w.r.t. plug in support
- Alignment of fiducials w.r.t. Collimator coordinate system
- ✓ All collimators are at the same position w.r.t. the plug in
- ✓ All collimators have equal parameters for the fiducials.



# Initial alignment

- 2D alignment using TDA5005
- Vertical alignment using digital level
- Smoothing with neighbour magnets using wire offsets





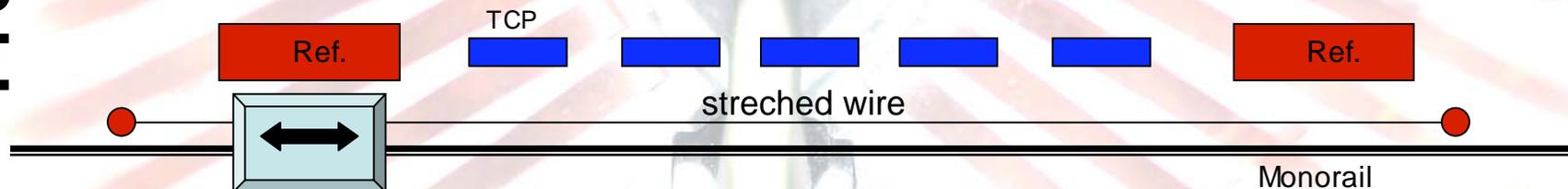
## Further alignment and controls

- The concerned zones are considered to be the most radioactive in the LHC
- The time to spend in these zones has to be minimized

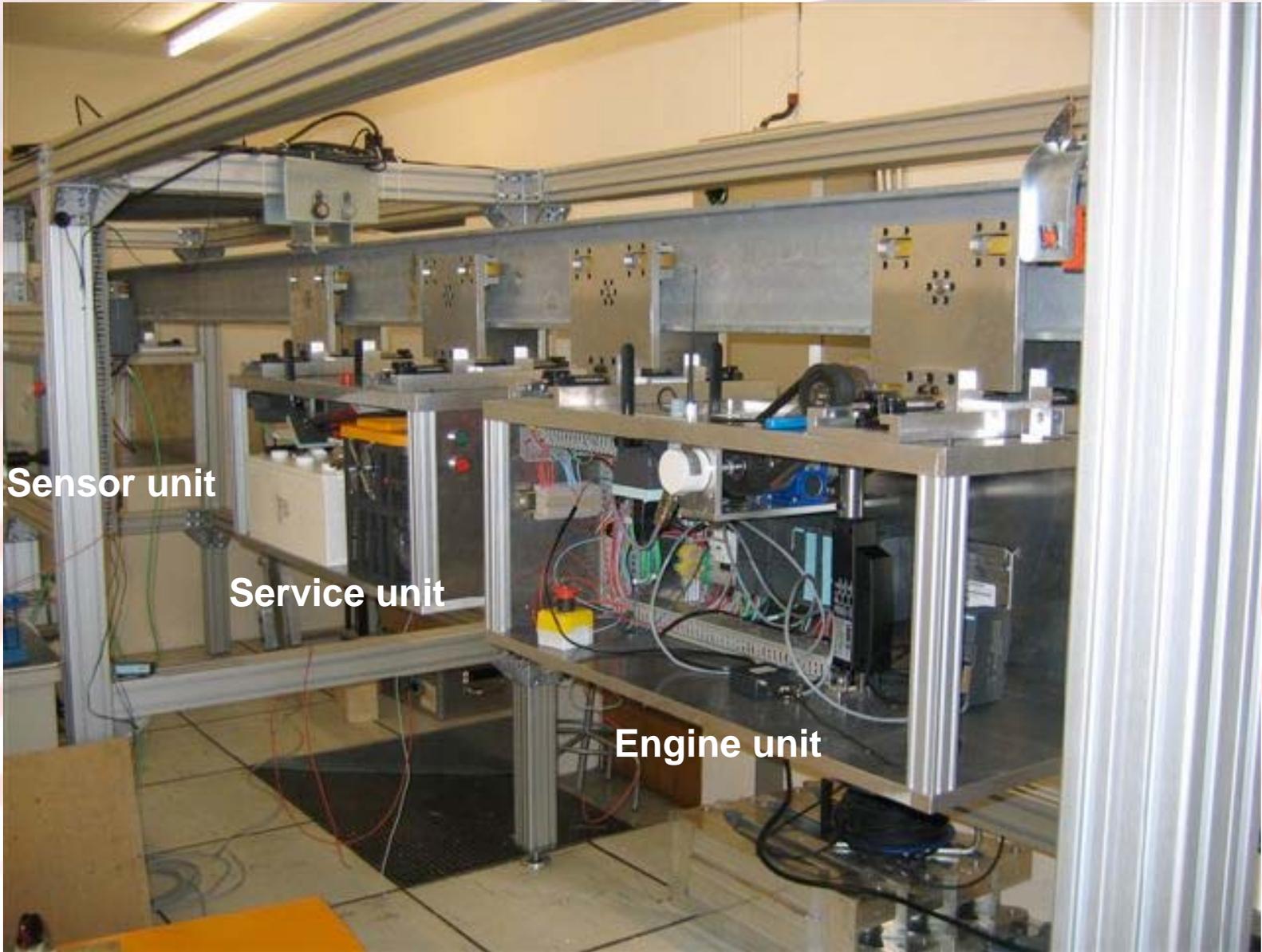
Remote controlled alignment check

# Train concept

- Train attached to the monorail (collaboration with TS-IC-IS)
- Wire offset measurements to determine the transversal train position
- Digital photogrammetry to link the position of the train and the collimators / reference magnets



# Train concept

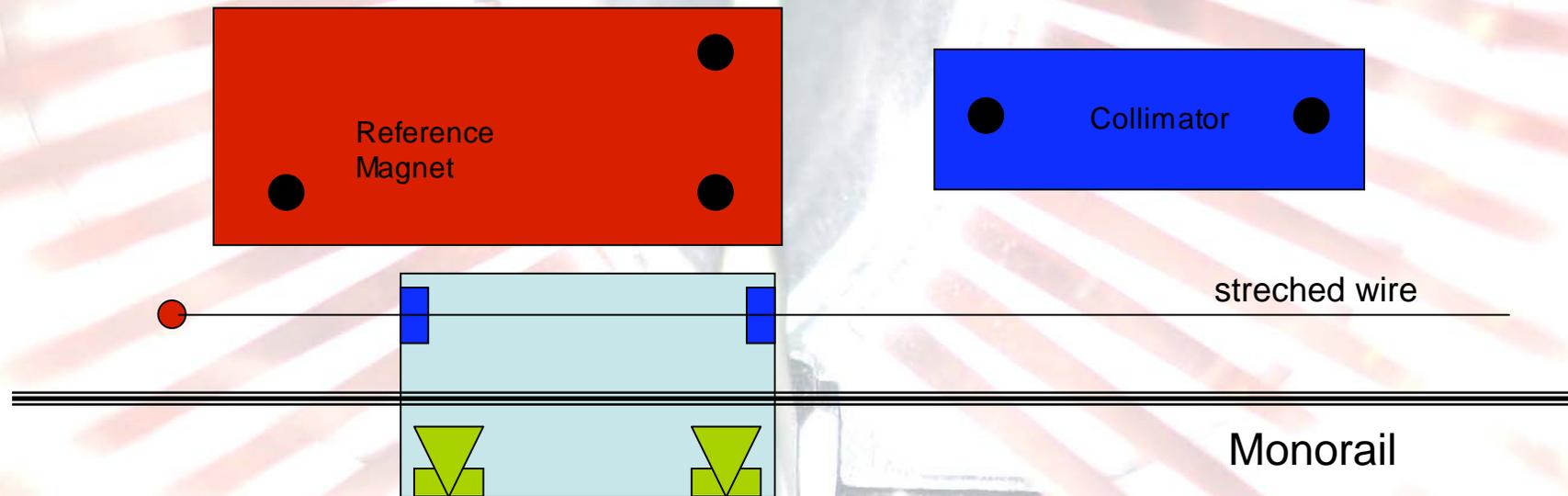


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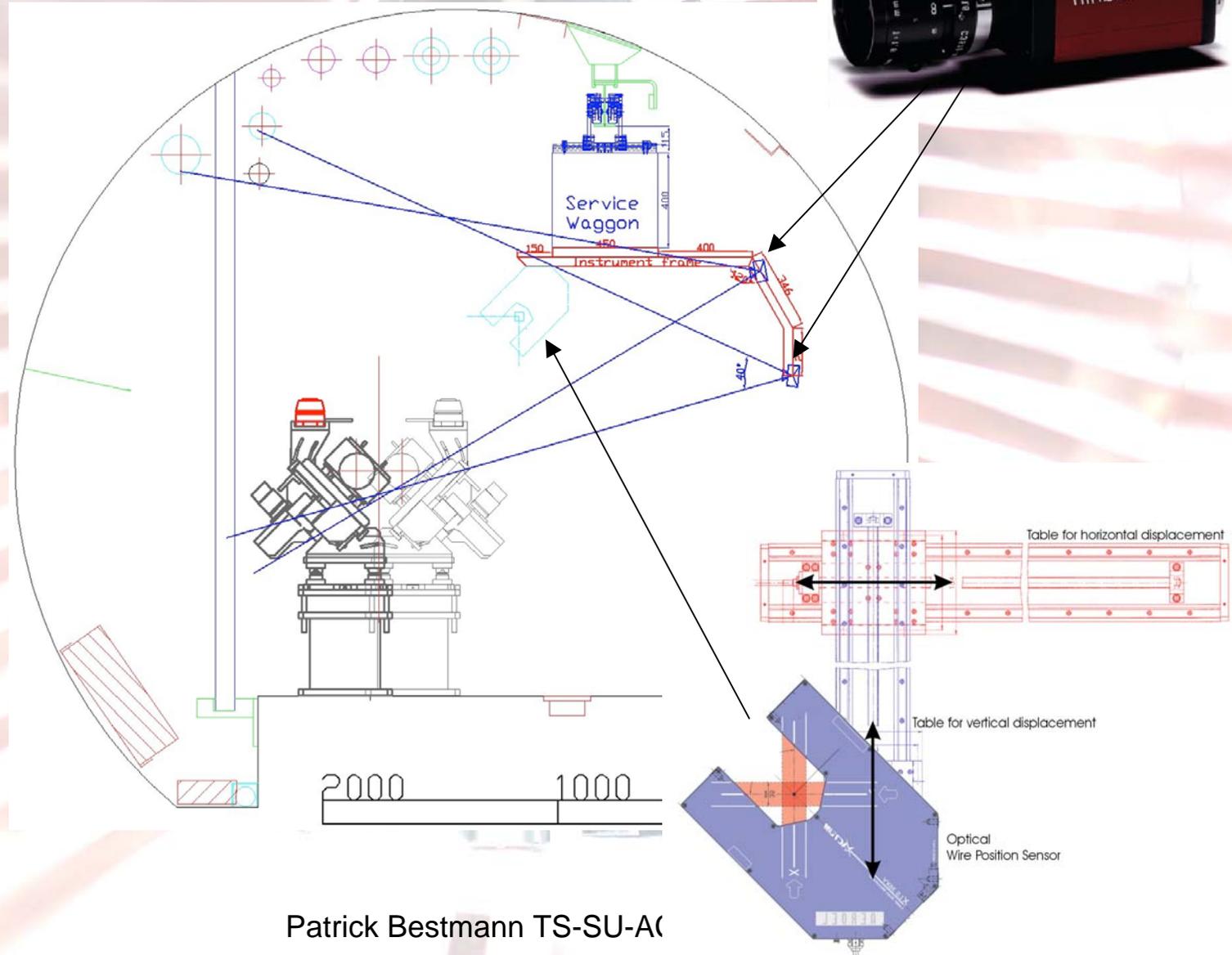
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# Train concept

- Measurement of the wire position w.r.t. the reference magnets
- Measurement of the different collimators w.r.t. the wire



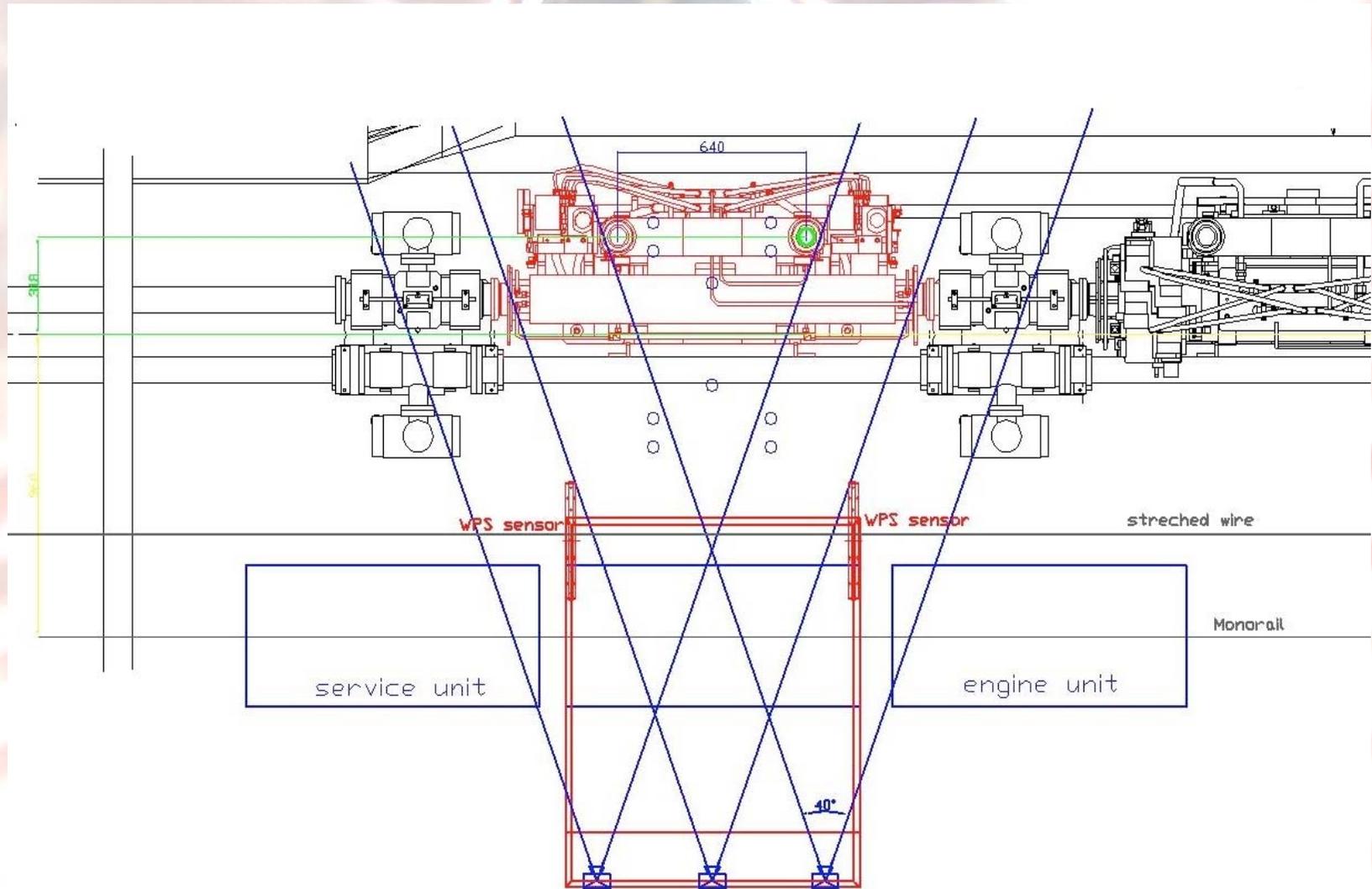
# Principle crosssection



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# Principle Topview

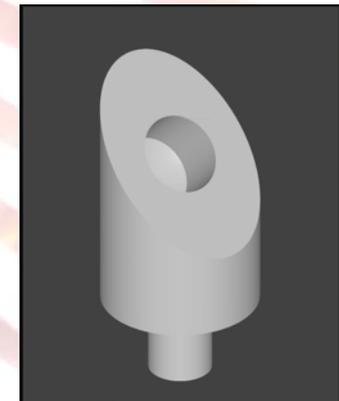


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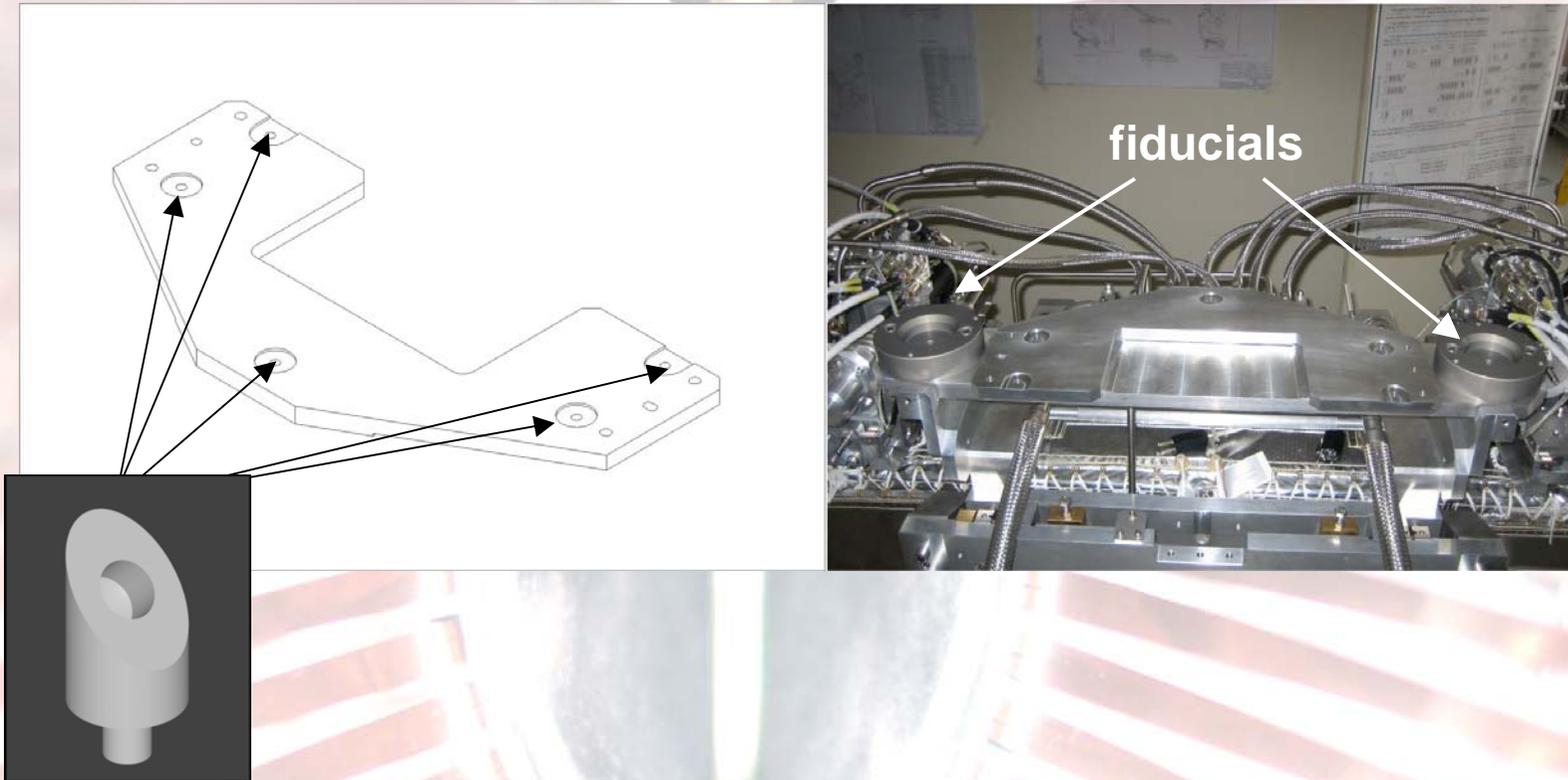
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# Photogrammetry Targets

- Normal retroreflecting targets are optimized for contrast and visibility and not radiation hard
- Aluminium targets have to be produced in order to resist under radiation (prototypes ready)
- 5 targets/collimator are needed to represent the position and orientation of the collimators



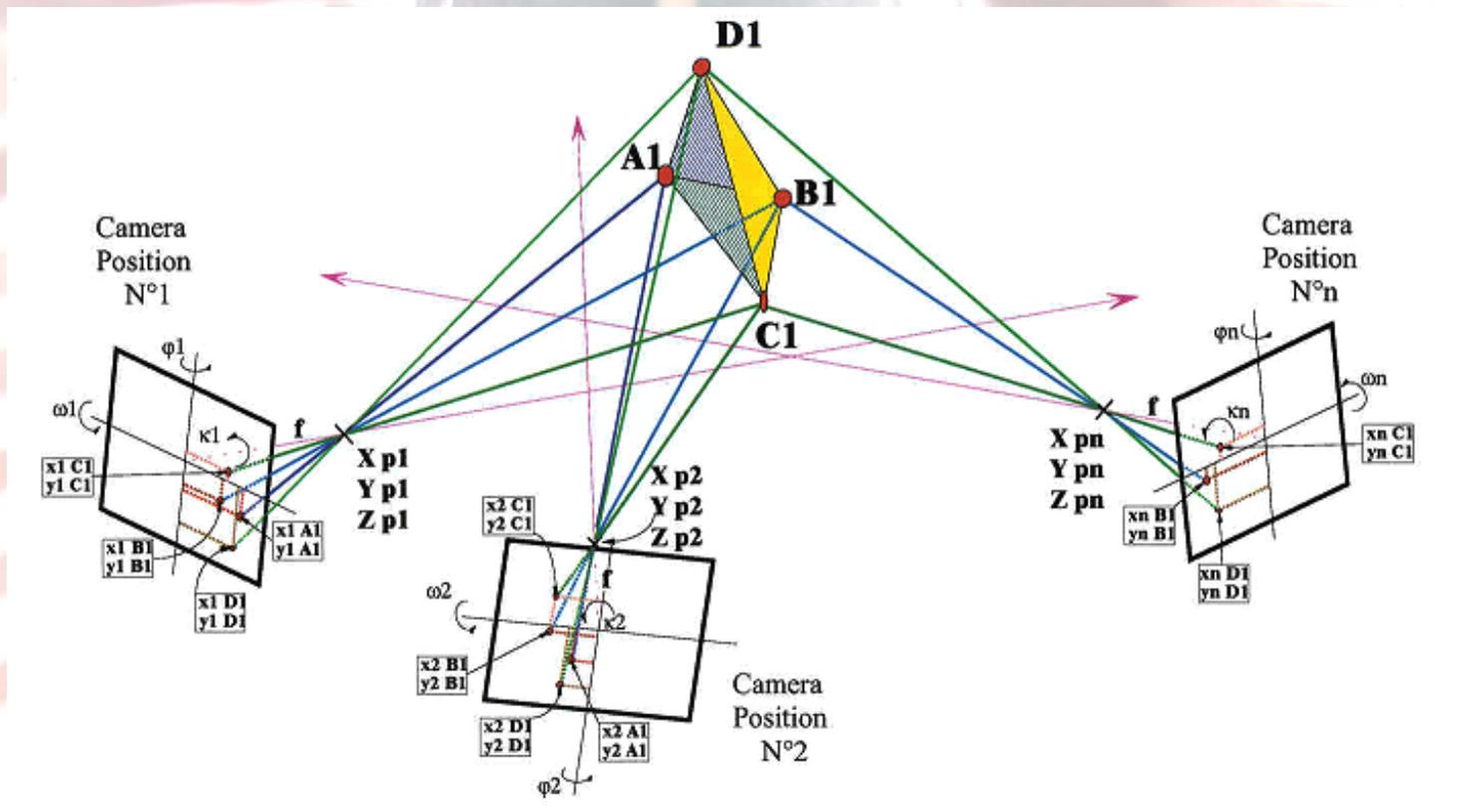
# Photogrammetry Targets



- Fiducials are adjusted to nominal coordinates
- Additional targets will be attached to fiducials

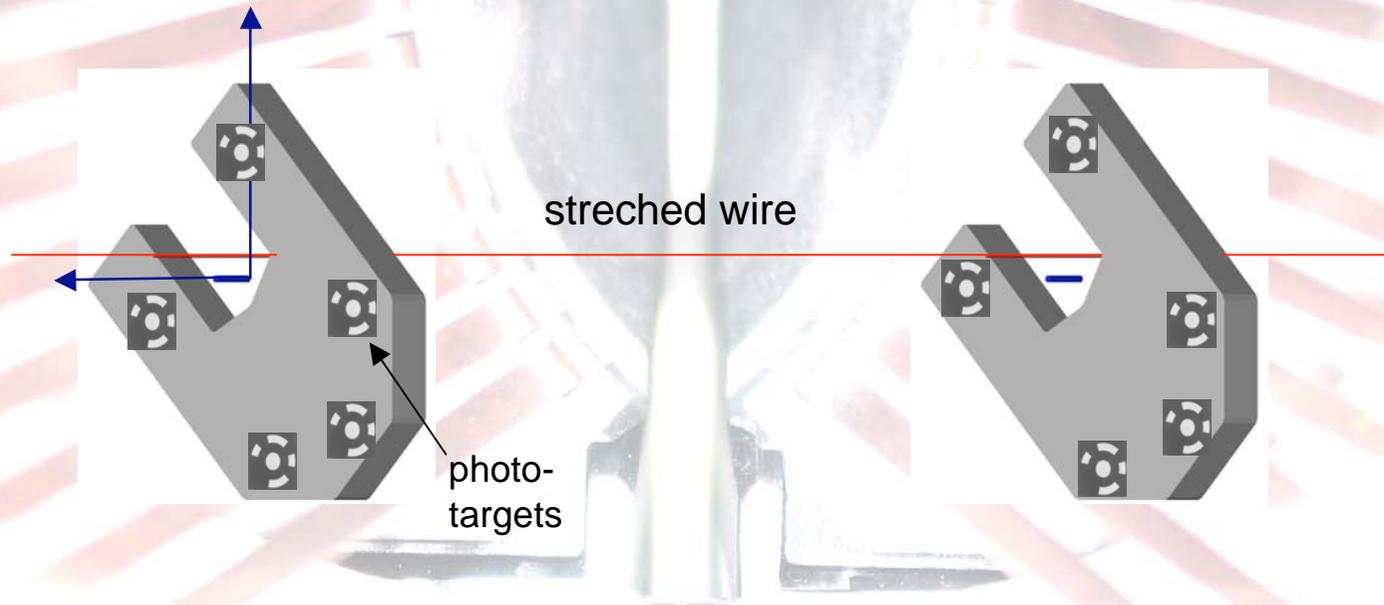
# Photogrammetry

- 3 to 4 cameras will deliver synchronized images of the collimator targets
- Using these images the system can calculate 3D coordinates of the collimators in the train coordinate system using triangulation
- But where is the train?



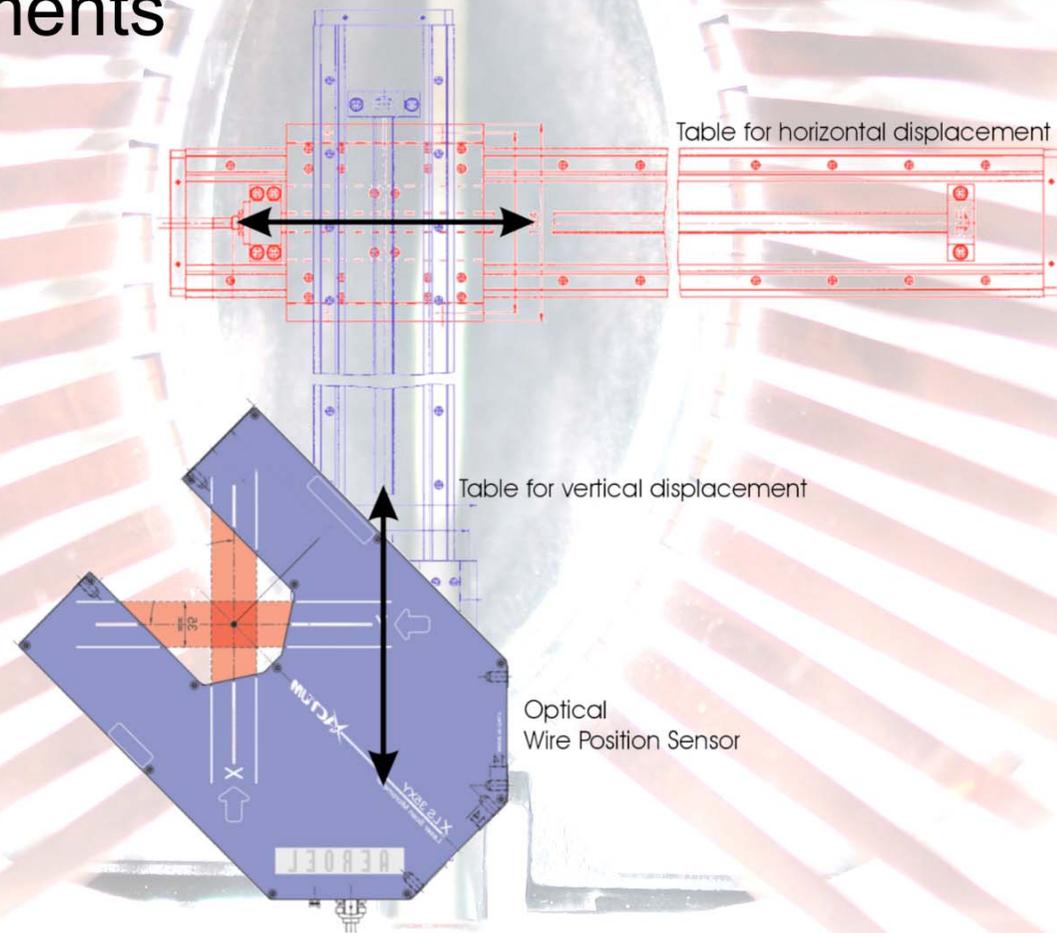
# Wire sensor

- The train will get its position from the stretched wire
- The wire sensors are two additional objects to be measured in the same images.
- Self calibrating system as the sensors are measured in each image



# Wire sensor

- Online displacement of the wire sensors to compensate Monorail defaults and train movements



# Recapitulation

- Transversal position of the collimator targets and reference magnets w.r.t. the wire.
- The rotation around the wire will be measured using electronic inclination sensors
- The longitudinal position will be measured relative to the reference magnet using a laser distometer



# Schedule

12/06	Layout Target prototypes, Wire sensor comparison
01/07	Finalizing simulations for fixing camera parameters, order of target prototypes
02/07	Starting of train construction, Order for wire sensors
03/07	Camera system: call for tender, Layout and construction for instrument frame
05/07	Software and interfaces for the system
06/07	Assembling of train and wire sensors, tests for interfaces and software
08/07	Integration of cameras, Tests and calibrations
.....	Assembling, Tests and modifications
.....	.....
05/08	Operational system