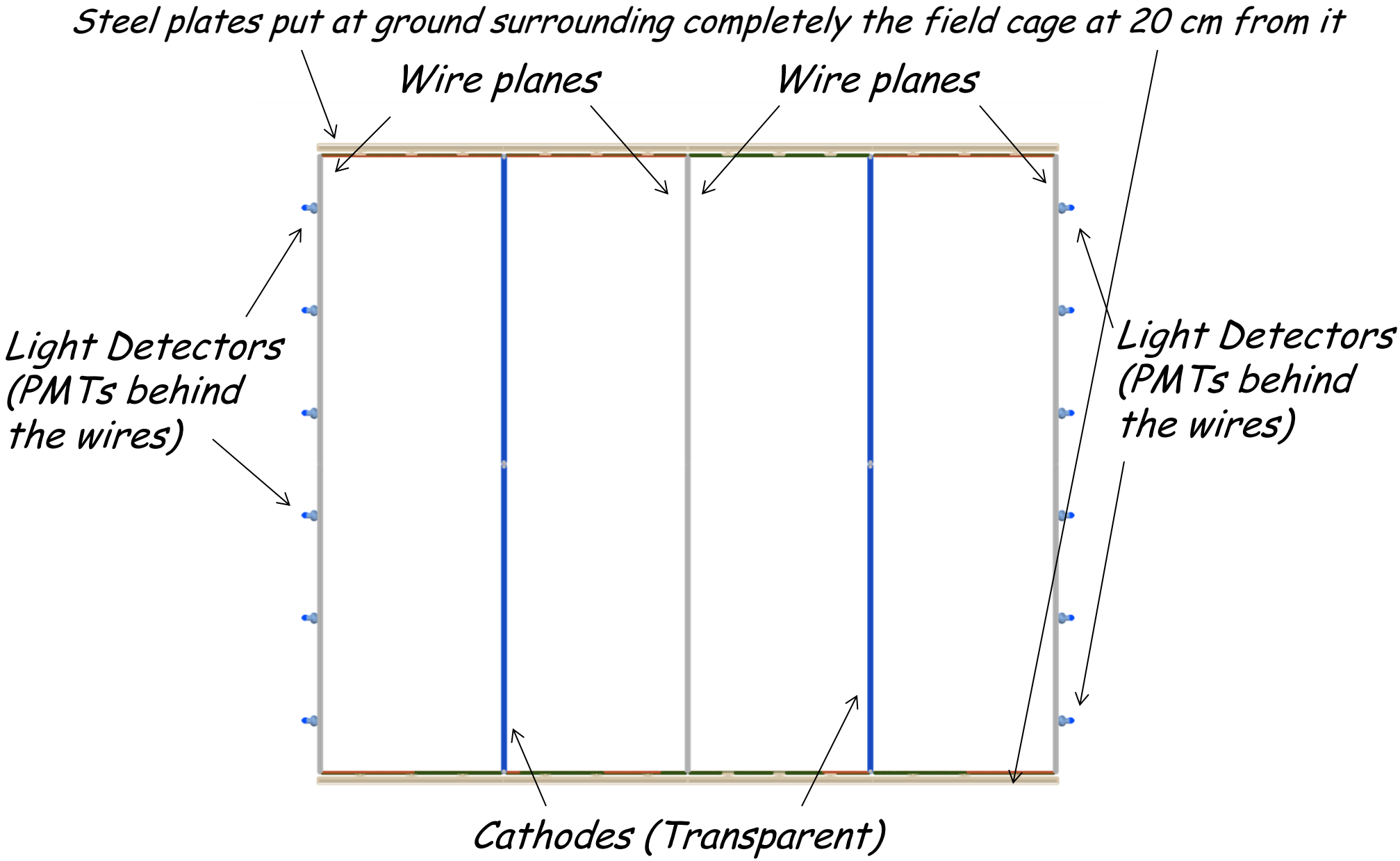
Concept Design for LBNF Far detector (LAr single phase)

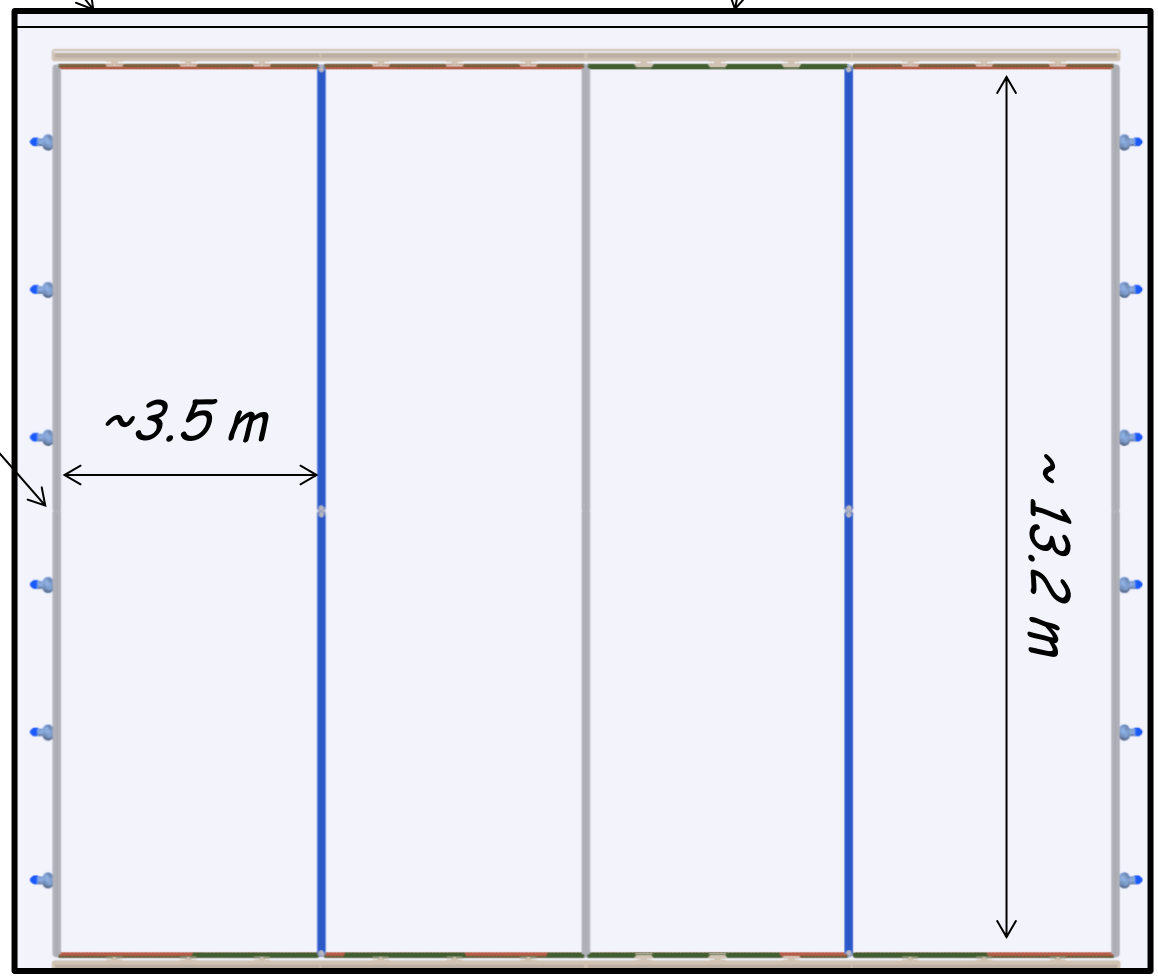
Main goals

- ✓ *Build on the pass experience (ICARUS, Microboone, LBNE studies, …)*
- ✓ *Maximize the effective use of the LAr mass available*
- ✓ *Avoid any possible HV problem*
- ✓ *Take into account the characteristics of the membrane cryostat concept (no vacuum, corrugated surface, …)*
- ✓ *Simplify installation, avoid problems of transport*
- ✓ *Maximise the purity of the LAr*
- ✓ *Relay on acquired and tested technology for the first detector*

Basic concept



Dimensions

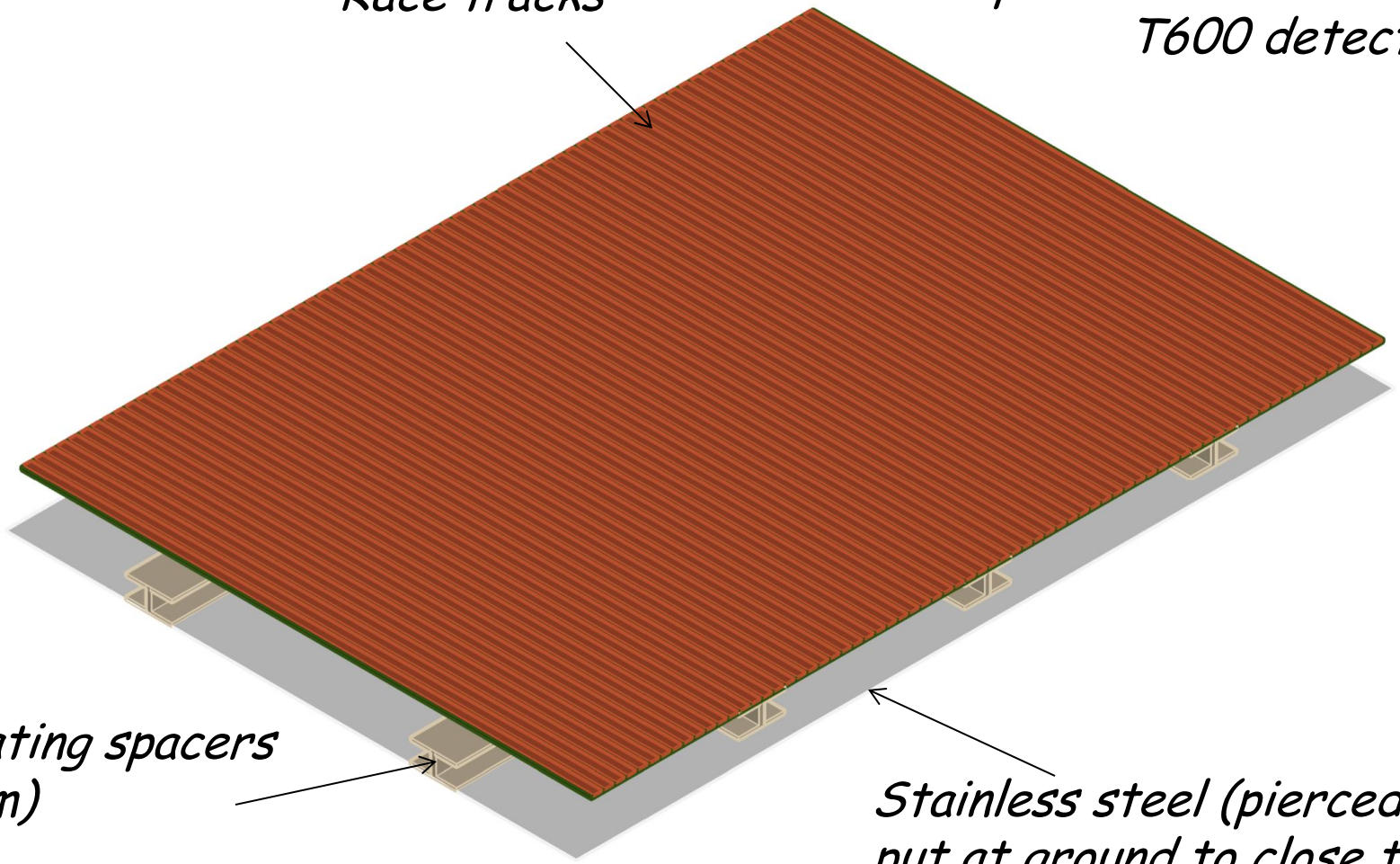


Active volume
14 x 13.2 x 60 m³
11088 m³

Total LAr Volume
15.1 x 13.7 x 62 m³
12845 m³

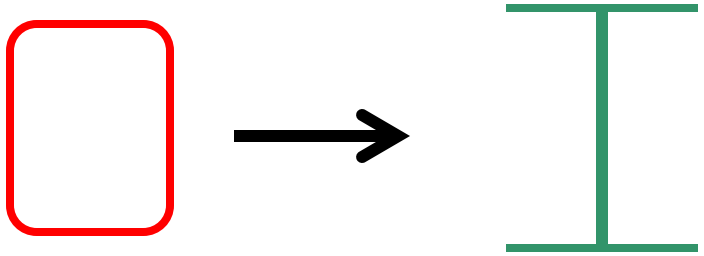
Field cage

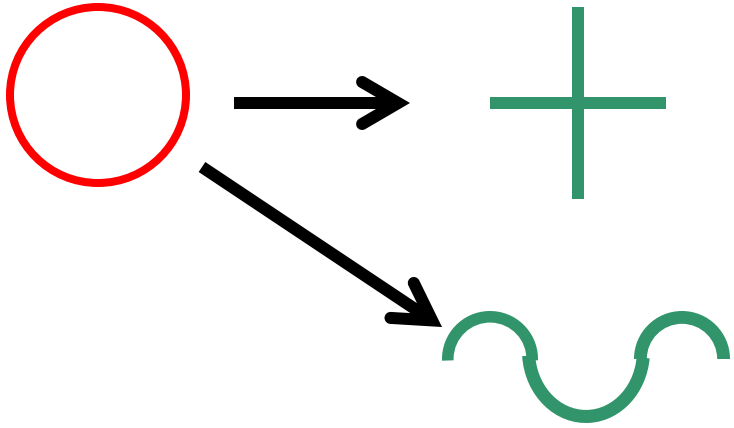
Max external field < 10 kV / cm
Up to 15 kV/cm tested in the T600 detector



Designing for no vacuum

Avoid closed or trapped volumes



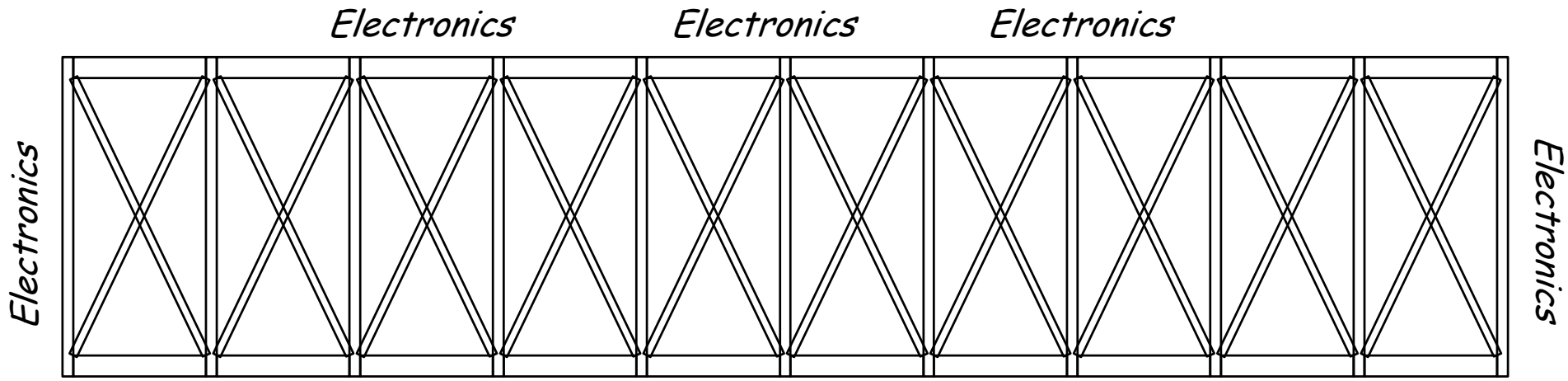


Minimize contact surfaces.

Know and optimize argon flow.

Self-supporting structure

- *Basic philosophy: make the TPC structure as much independent as possible from the cryostat.*
- *"Meccano" approach: highly repetitive and simmetrical structure made of many lightweight easy to assemble components.*
- *Components built by several industries in parallel.*
- *Overcomes the shaft limitations*
- *Many preassemblies can be done outside the gallery and outside the cryostat.*
- *Wires, produced outside an taken inside with convenient packaging, plugged on the supporting frame in groups (32, 64, ...). Very fast and safe operation.*
- *Weight of the structure depends on the requested mechanical precision.*



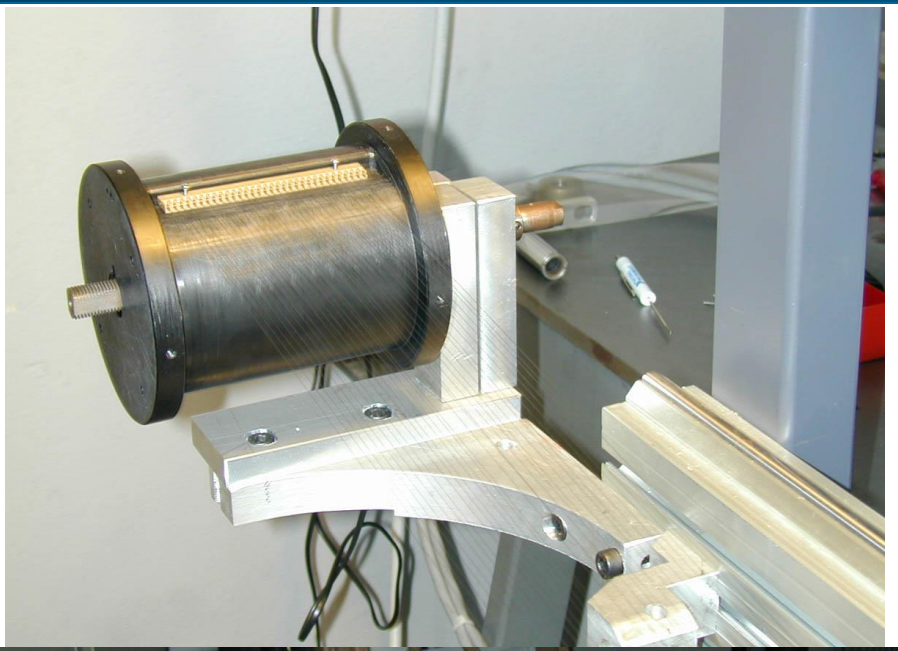
Wiring

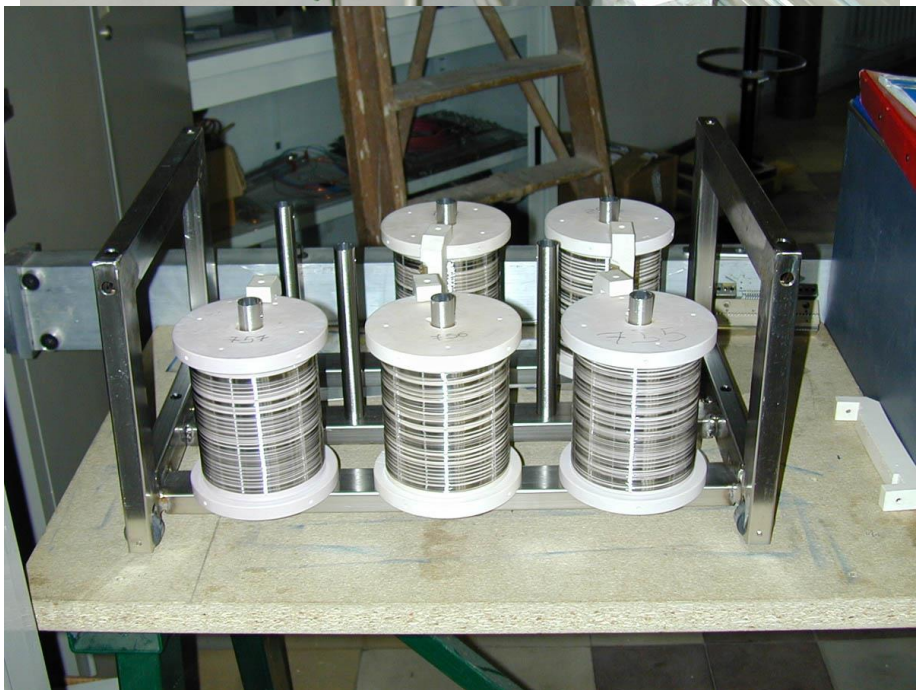
Wires production made with dedicated machines (wiring tables) in highly controlled conditions.
It can be done in parallel in several production sites: speed for the T600 was about 1 wire/minute → 6 months were required for one T600 module (27000 wires) with one wiring table.

Wires handling

Wires are grouped in modules (32 wires for the T600) and then coiled around a plastic cylinder for cleaning, transport and handling).

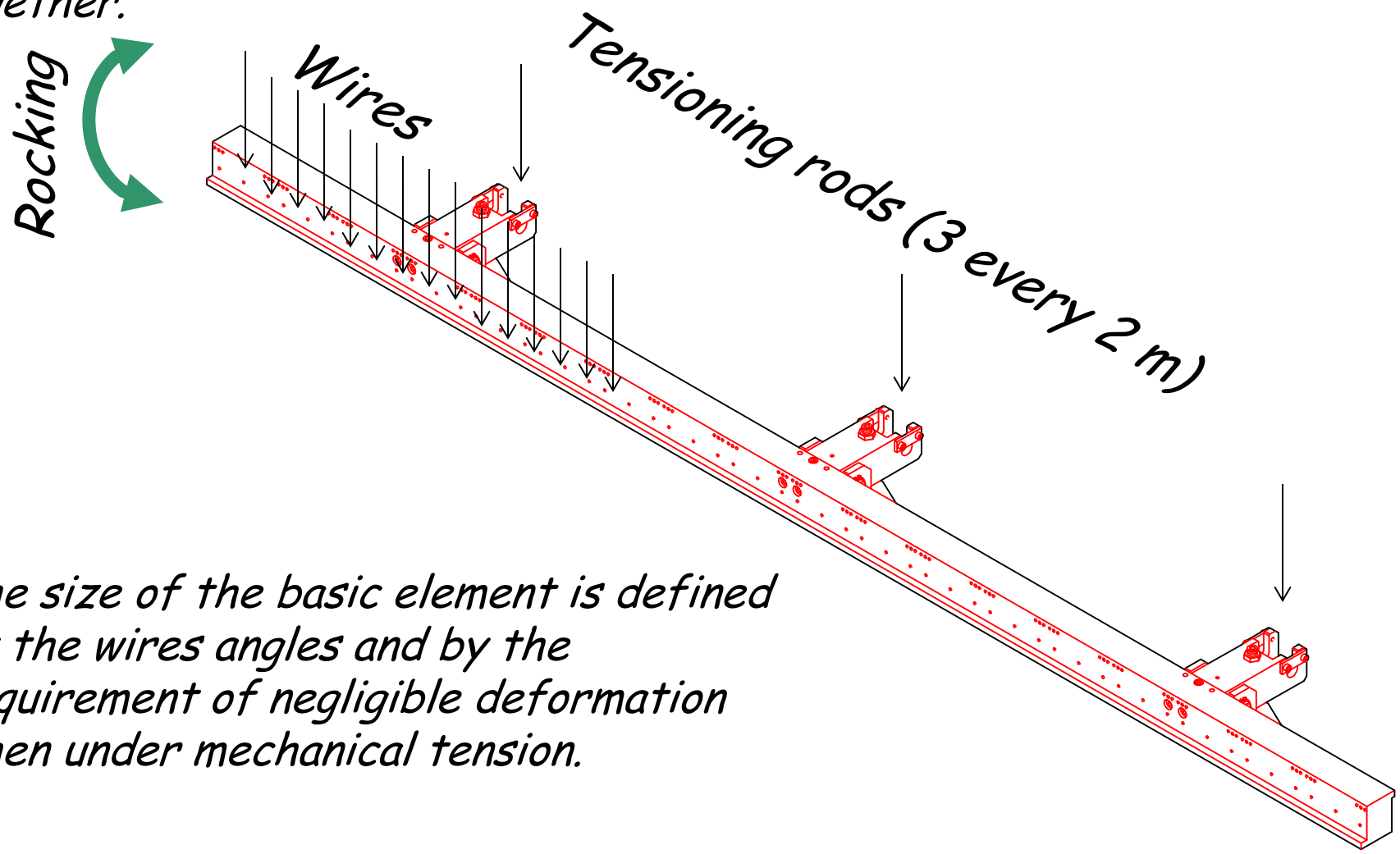
Prior to installation the coils were unrolled and, by two persons, plugged on the wires chamber supports. This procedure is very easy and fast and, again, can be highly parallelized.





Rocking frames

Use of movable frames allows the easy installation of wires. The wires are installed in de-tensioned conditions and then tensioned all together.



The size of the basic element is defined by the wires angles and by the requirement of negligible deformation when under mechanical tension.

Race tracks

Several solutions can be adopted for the field cage and some of them have already been successfully tested in LAr:

1) *St. Steel profiles with G10 or PEEK insulators (ICARUS T600, MicroBooNE):*
    1) *Pipes have to be substituted with smooth open geometry profiles;*
2) *Copper strips on G10 support (LBNE, several prototypes):*
    1) *Current leakage between the strips at high voltages has to be carefully studied;*
    2) *The G10 support has to be pierced to allow free circulation of LAr.*
3) *Continuous resistive paint on G10 (only small prototypes);*
    1) *Support has to be pierced to allow free circulation of LAr;*
    2) *Very high resistive paint has to be found, given the large surface of the field cage;*
    3) *Local field distortions due to the very low local currents (point 2) have to be understood.*

At present, the best proven and studied solution is the first one. A careful cost comparison should be performed.

Use of G10 or other glass reinforced materials should be carefully analyzed due to the relatively large presence of radioactive contaminants.

Electronics and feedthrough

All cables and electronics in the cold

All cables in the liquid

Minimize length of cables (no cables from the bottom of the TPC)

Cold electronics inside the cold feedthrough to allow for an easy access is necessary