Tecnica di costruzione di una camera a deriva stereo ad alta trasparenza

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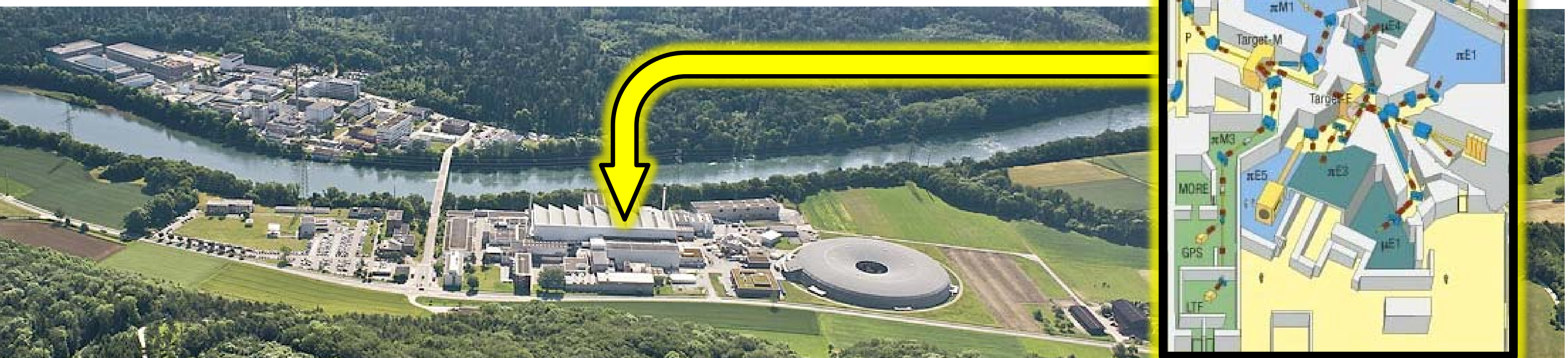
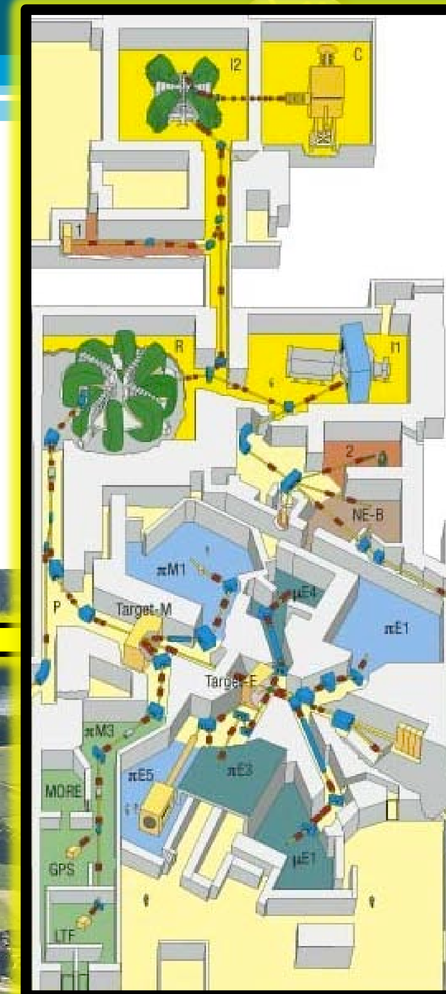
Summary

- MEG experiment
- MEG II vs MEG
- MEG Drift Chamber
- Wiring robot
  - Wiring system
  - Soldering system
  - Automatic handling system
- Assembly station
- Conclusion

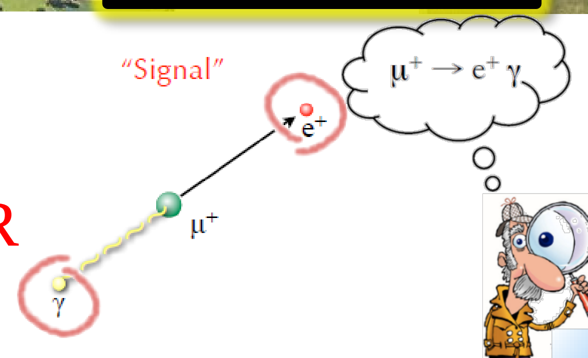
The MEG experiment

- The MEG Collaboration: 60 physicists, 12 institutes, from 
- Detector location is at the *Paul Scherrer Institut* near Zürich, Switzerland



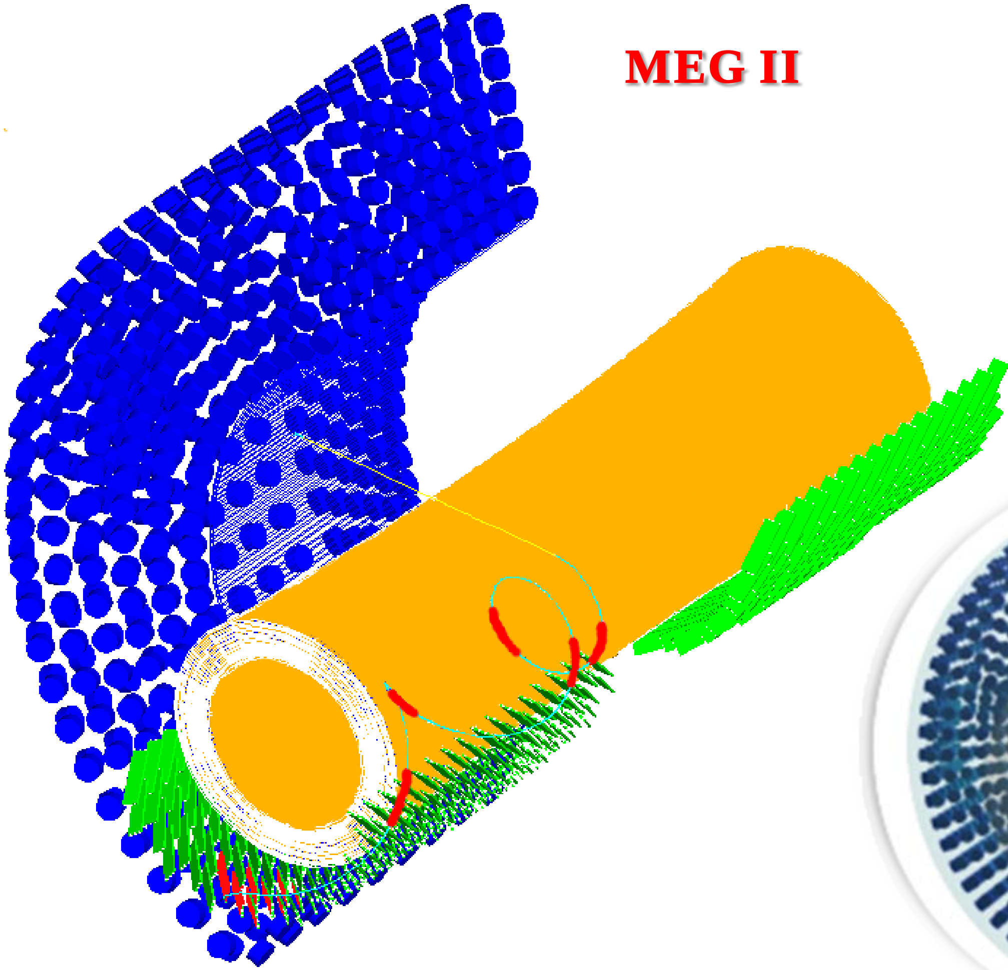


- The MEG experiment, at the PSI searches $\mu \rightarrow e\gamma$ decay with the most intense muon beam available, the actually limit of the BR is $5{,}7 \times 10^{-13}$

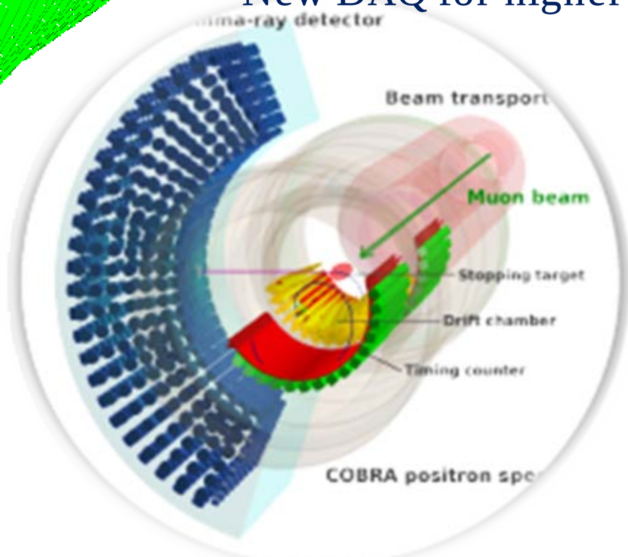


MEG II vs MEG

- Increase the number of stopped muons on target
- Reduce the target thickness
- Improve on granularity, resolution and efficiency of DC (Resolution x-y 120 µm, resolution z: 300 µm (210µm and (800µm for MEG))
- Improve timing counters granularity
- Extend calorimeter acceptance
- Improve photon energy, position and timing resolution for shallow events
- New DAQ for higher bandwidth

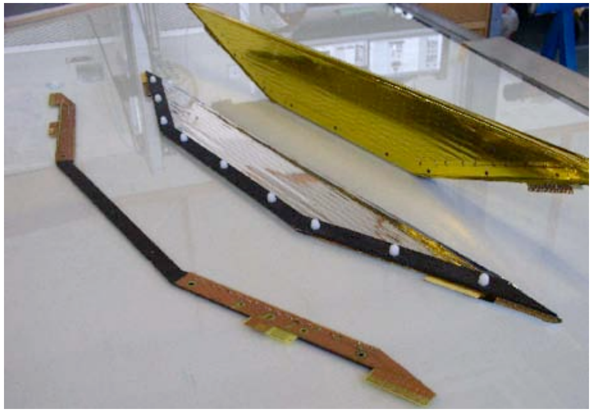


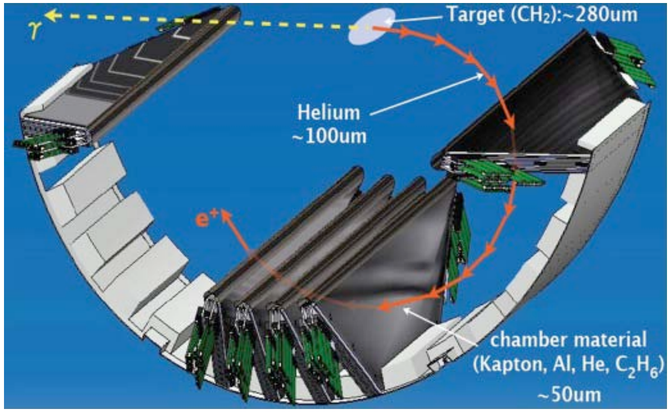
MEG II

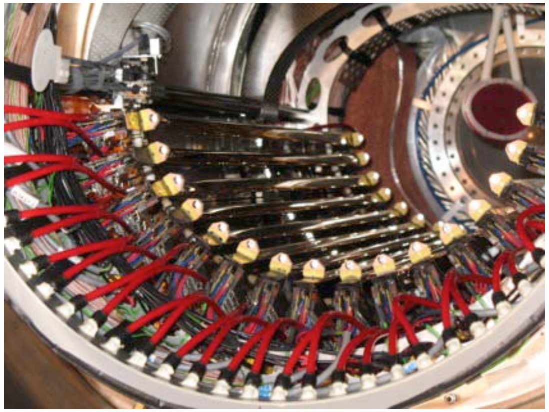


MEG

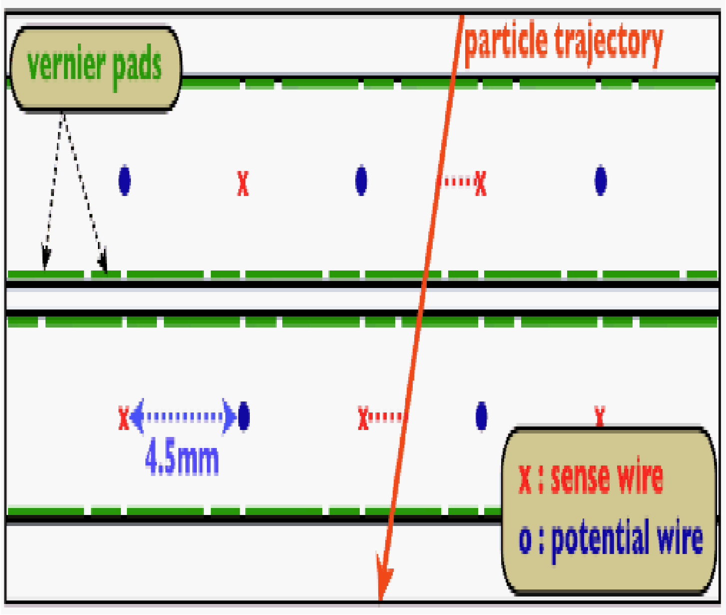
MEG: Drift Chambers



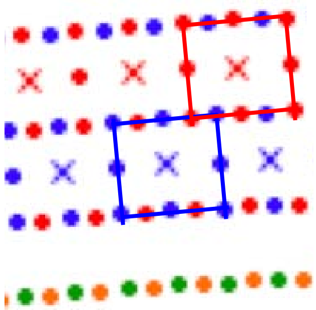




- 16 chambers
- Each chamber is composed of
  - 4 x12 mm of kapton (cathodes)
  - 50 mm BeCu cathode wires
  - 25 mm NiCr anode wires
  - 2 x 7 +3 mm He:C2H6 (50/50)
- Single chamber ~ 2.3 10-4 X0
- Full e+ turn : ~ 1.7 10-3 X0



MEG II: Drift chamber Upgrade



stereo angle +

stereo angle –

guard layer

field to sense wires ratio **5 : 1**

Active length L	1960	mm
N. of layers	10	
N. of stereo sectors	12	
N. of cells per layer	192	
N. of cells per sector	16	
Cell size (at z=0)	5.8 ÷ 7.8	mm
Twist angle	±60°	
Stereo angle	102 ÷ 147	mrad
Stereo drop	35.7 ÷ 51.4	mm

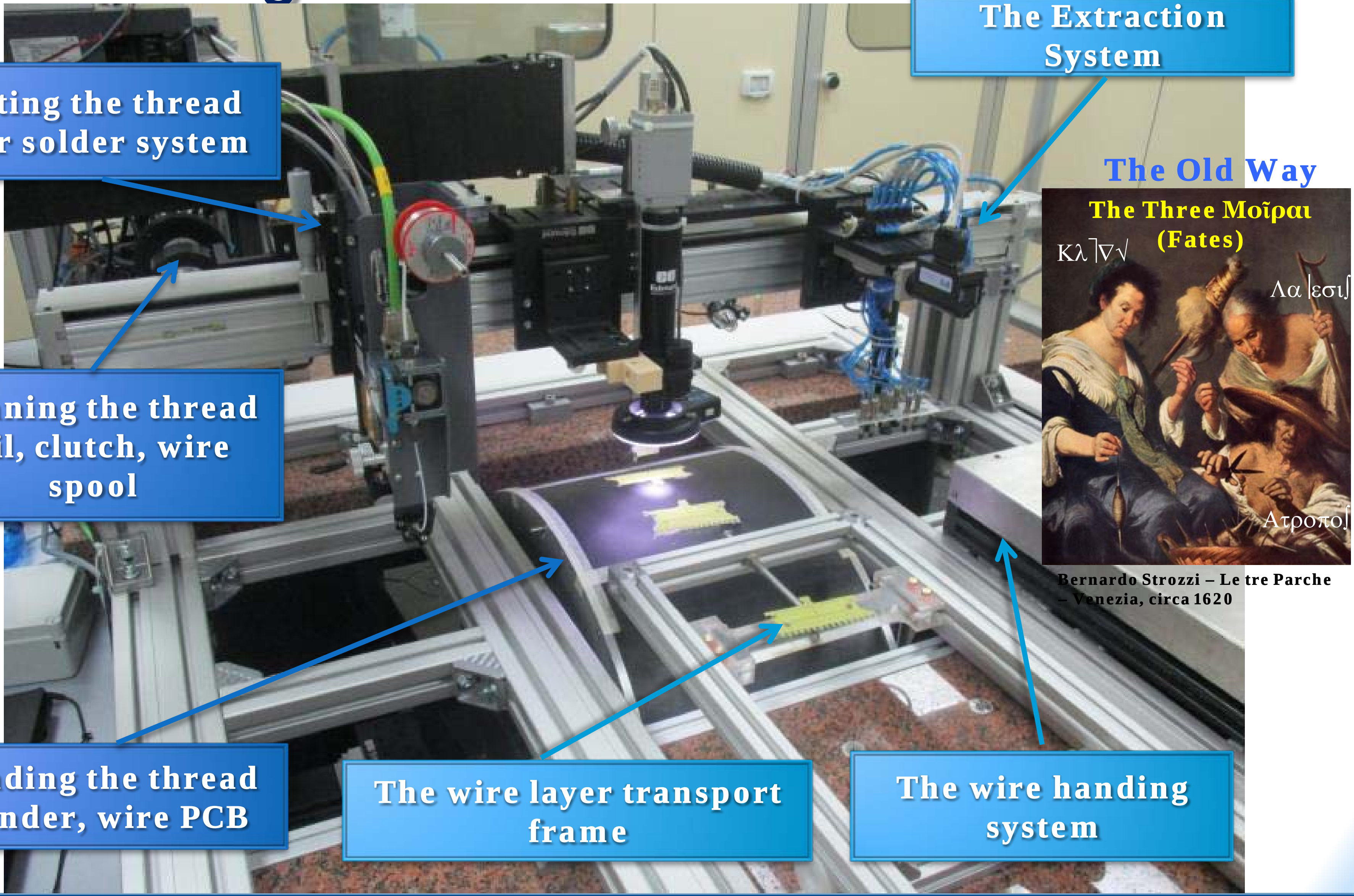
- Full stereo cylindrical DC with large stereo angles **(102÷147 mrad)**
- Small square cells **(5.8÷7.8 mm at z=0, 6.7÷9.0 at z=±L/2)**

sense wires:	20 μm diameter W(Au)	=> 1920 wires
field and guard wires:	40 μm diameter Al(Ag)	=> 7680 wires
potential wires:	50 μm diameter Al(Ag)	=> 2688 wires

12,288 wires in total

- **Large number of wires, anyway, require complicated and time consuming assembly procedures and, therefore, they need a novel approach of wiring(without wire feed-through**

The wiring robot

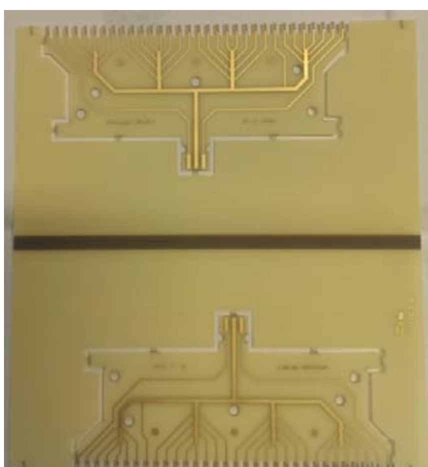


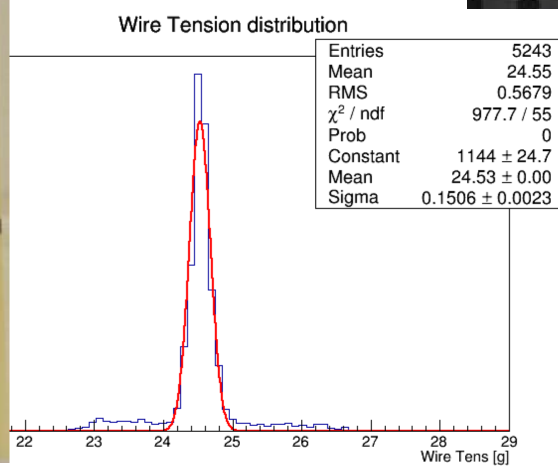
The Old Way

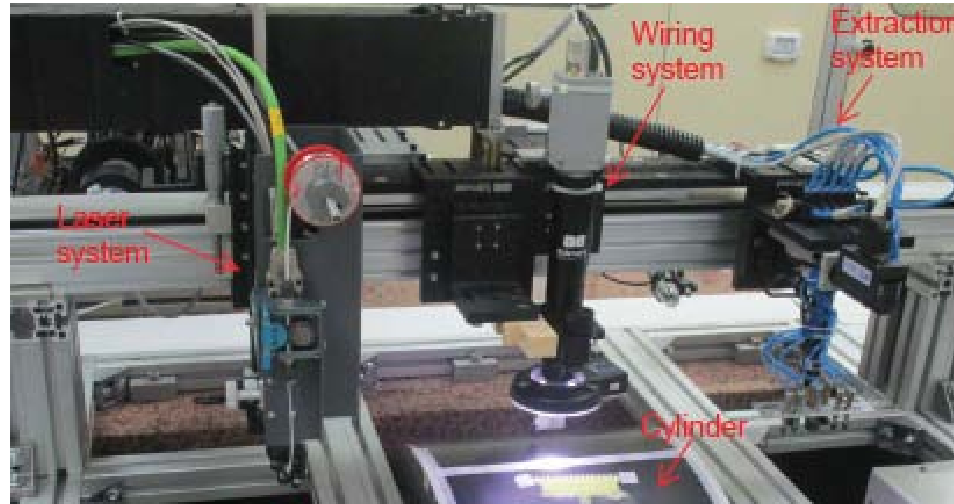
Bernardo Strozzi – Le tre Parche – Venezia, circa 1620

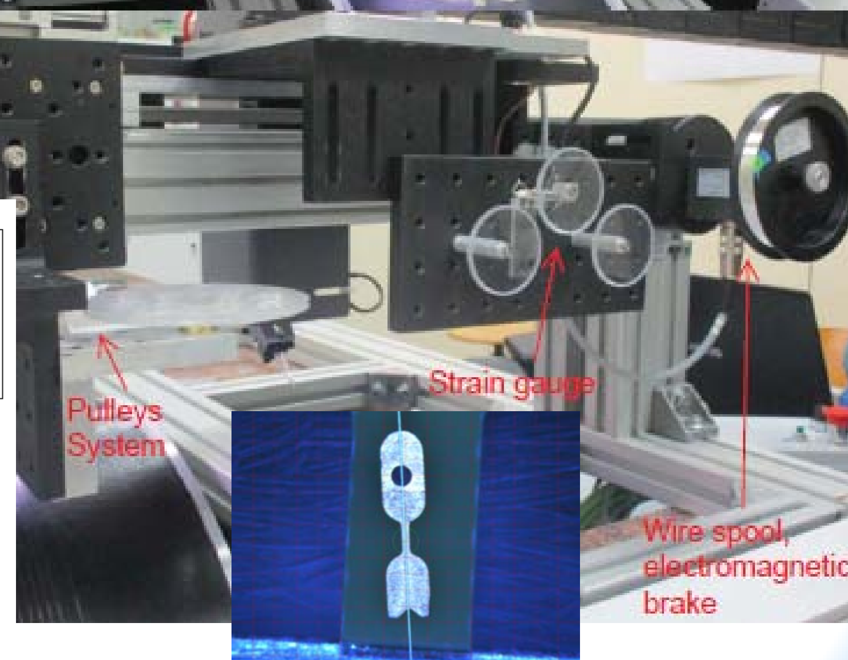
WIRING SYSTEM

- The purpose of the wiring system is the winding of a multiwire layer made up of 32 parallel wires.
- The wire mechanical tension is monitored by a high precision strain gauge and corrected with a real-time feedback system.
- The wire position is precise about 20 μm



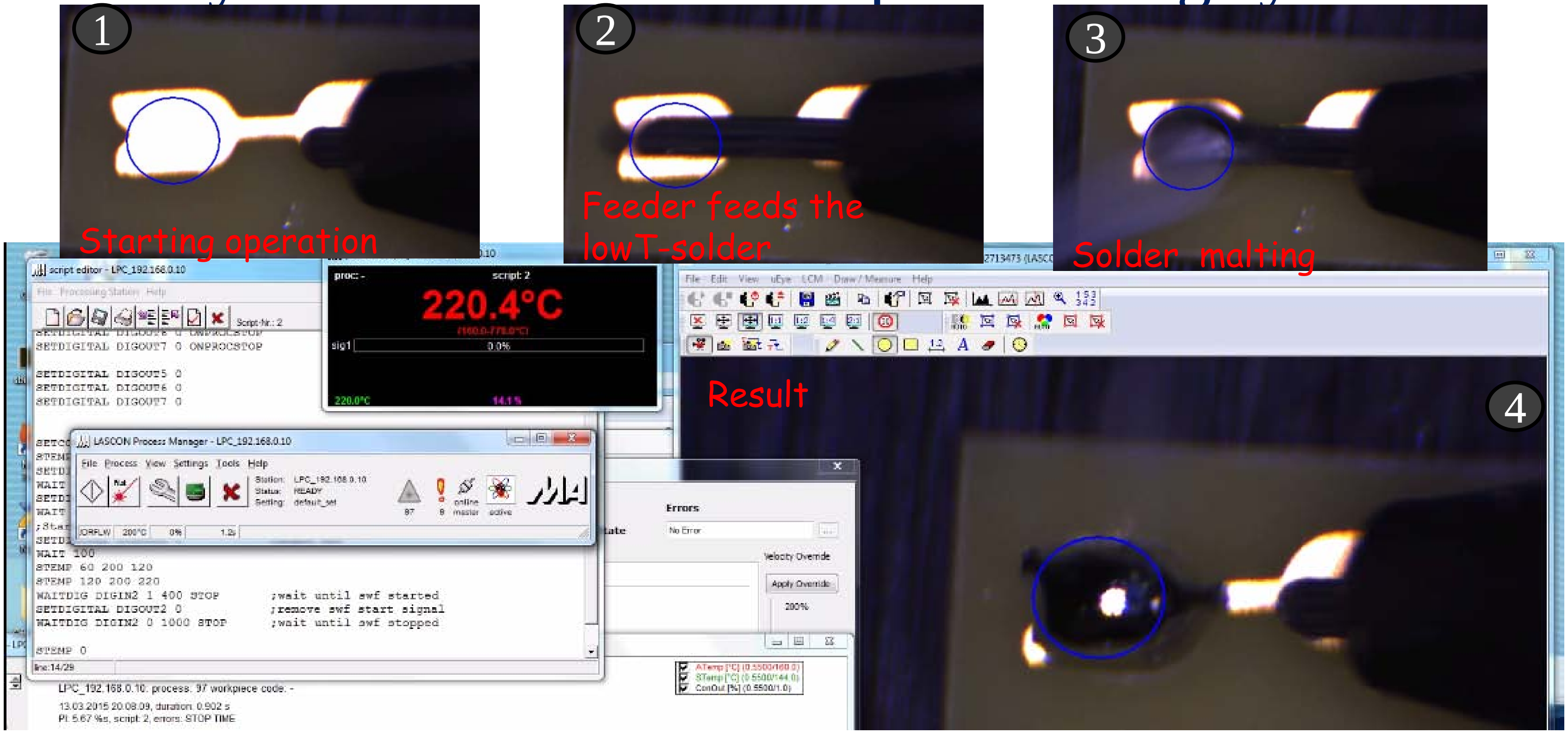






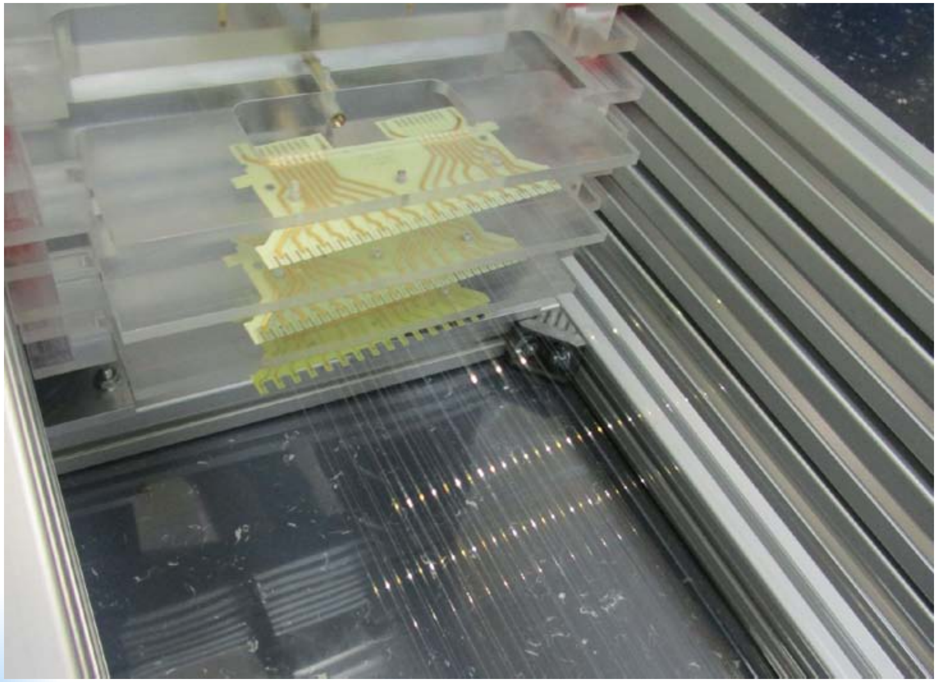
SOLDERING SYSTEM

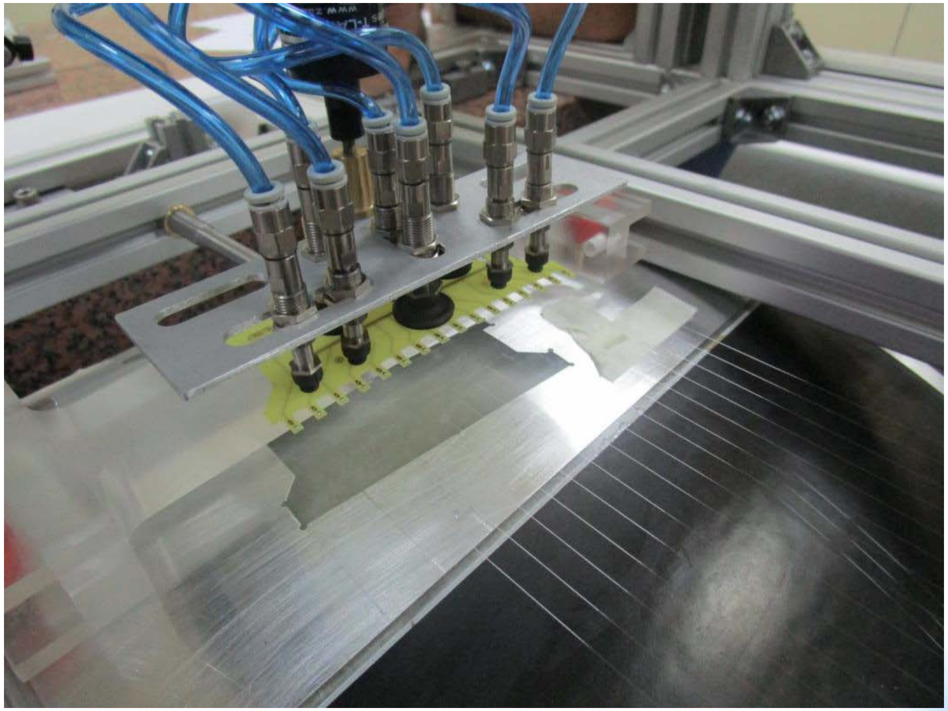
- The soldering phase is accomplished by an IR laser soldering System.
- The laser system is controlled by the Compact RIO and is synchronized with the positioning system



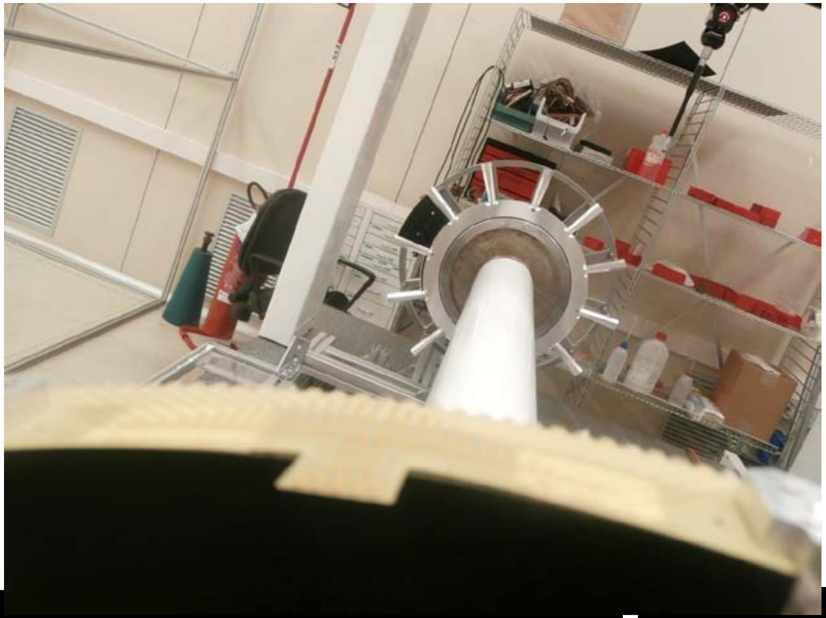
AUTOMATIC HANDLING SYSTEM

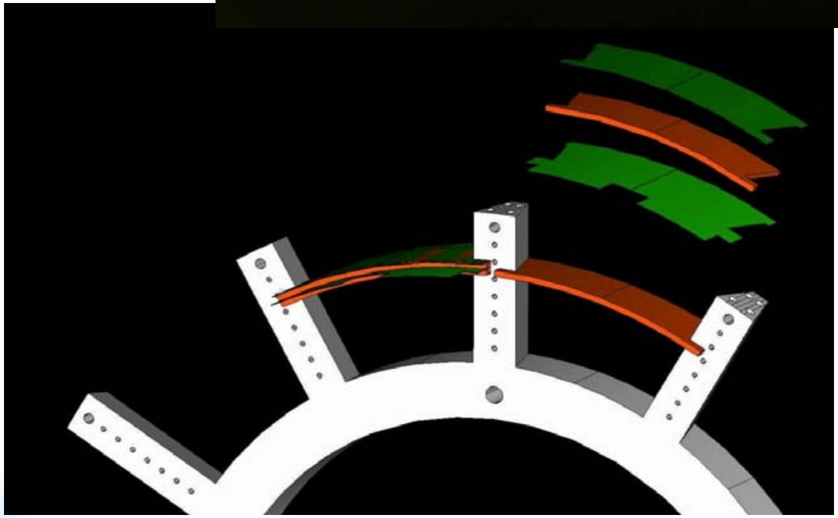
- The wound layer of soldered wires around the cylinder must be unrolled and de-tensioned for storage and transport frame, to be sent to the assembly station at the INFN Pisa.
- The wire PCBs are lifted off from the cylinder surface with a linear actuator connected to a set of vacuum operated suction cups.





ASSEMBLY STATION@ INFN Pisa





CONCLUSIONs

- Strong motivations for an upgraded MEG experiment aiming at setting an upper limit $\mathcal{B}(\mu^+ \rightarrow e^+ + \gamma) < 6 \times 10^{-14}$.
- The upgrade of the positron tracker consists in a a full stereo and high transparency Drift Chamber
- The design and the performance of the new tracking system, among the other subsystems, are crucial to reaching this goal.
- For the huge number of wires constituting the DC has been a novel approach of wiring.
- For the accuracy of positioning of the wires and not to ruin them has been designed and realized a robot semiautomatic.
- The wiring robot is ready for the production of the MEG DC layer

References

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4. M. Adinolfi et at al ”**The tracking detector of the KLOE experiment**” Nucl. Instr. and Meth. A, 448:51, 2002
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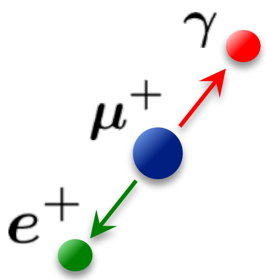
Thank you

MEG

Mu-E-Gamma Collaboration

Detection principle

Signal:

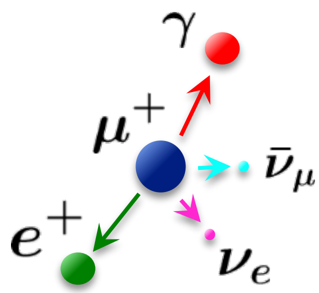


$E_\gamma = 52.8$ MeV
$E_e = 52.8$ MeV
$\Theta_{e\gamma} = 180^\circ$
$T_{e\gamma} = 0$ s

$$N_{\text{sig}} = R_\mu \cdot T \cdot \text{Br}(\mu^+ \rightarrow e^+ \gamma)$$

Backgrounds:

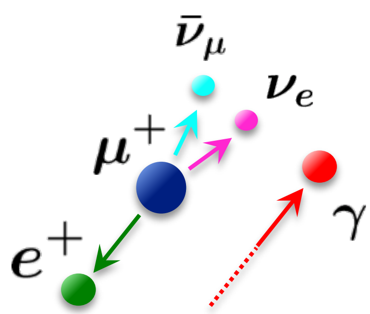
1) Radiative muon decay ($\text{Br}_{\text{RMD}} \approx 1.4\%$)



$E_\gamma < 52.8$ MeV
$E_e < 52.8$ MeV
$\Theta_{e\gamma} < 180^\circ$
$T_{e\gamma} = 0$ s

$$N_{\text{RMD}} = R_\mu \cdot T \cdot \text{Br}(\mu^+ \rightarrow e^+ \gamma\, \bar{\nu}_\mu\, \nu_e)$$

2) Accidental overlap



Photon can come from:
1. Radiative muon decay
2. Positron annihilation in flight
3. Brehmstralung

$E_\gamma < 52.8$ MeV
$E_e < 52.8$ MeV
$\Theta_{e\gamma} < 180^\circ$
$T_{e\gamma} \sim$ flat

$$N_{\text{acc}} \propto R_\mu^2 \cdot T \cdot (\Delta E_\gamma)^2 \cdot \Delta E_e \cdot (\Delta \Theta_{e\gamma})^2 \cdot \Delta T_{e\gamma}$$

$\Longrightarrow$ Acc. background dominant, detector resolutions crucial!