Analysis of Field Homogeneity and Magnetic Measurement Points in the PTOLEMY SC Magnet

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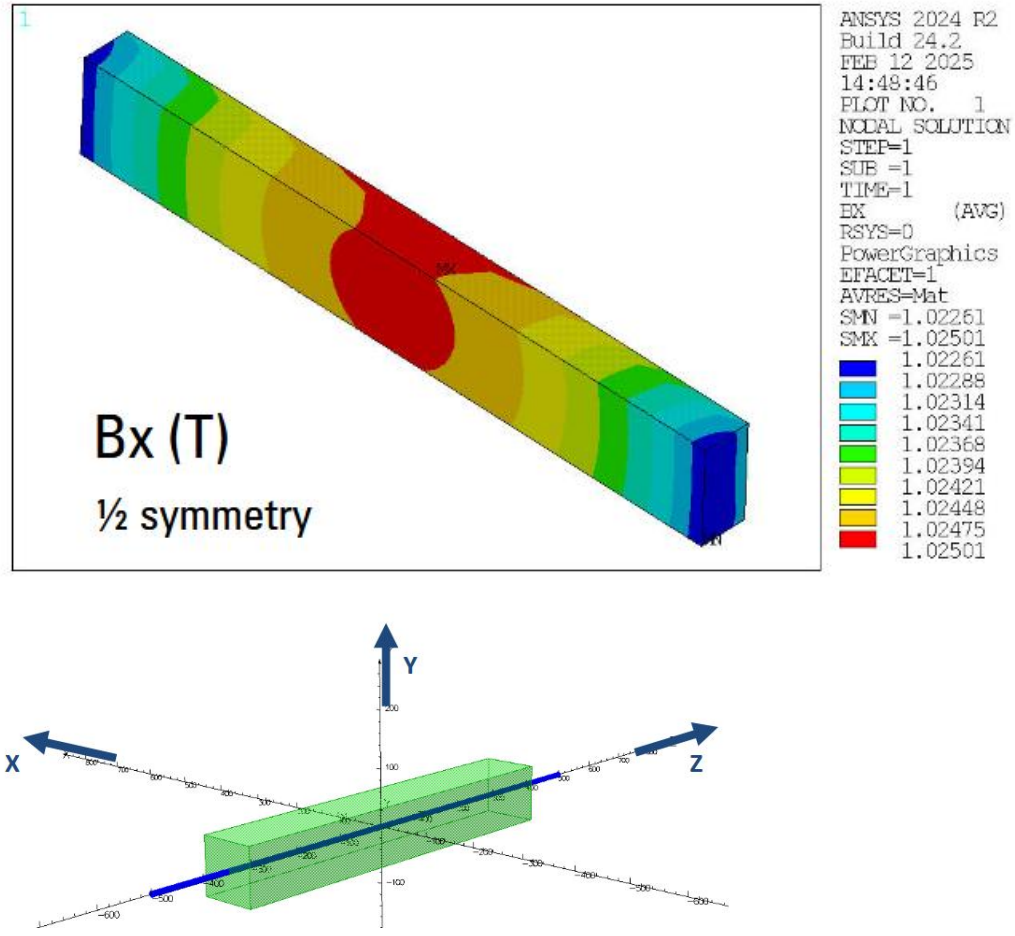
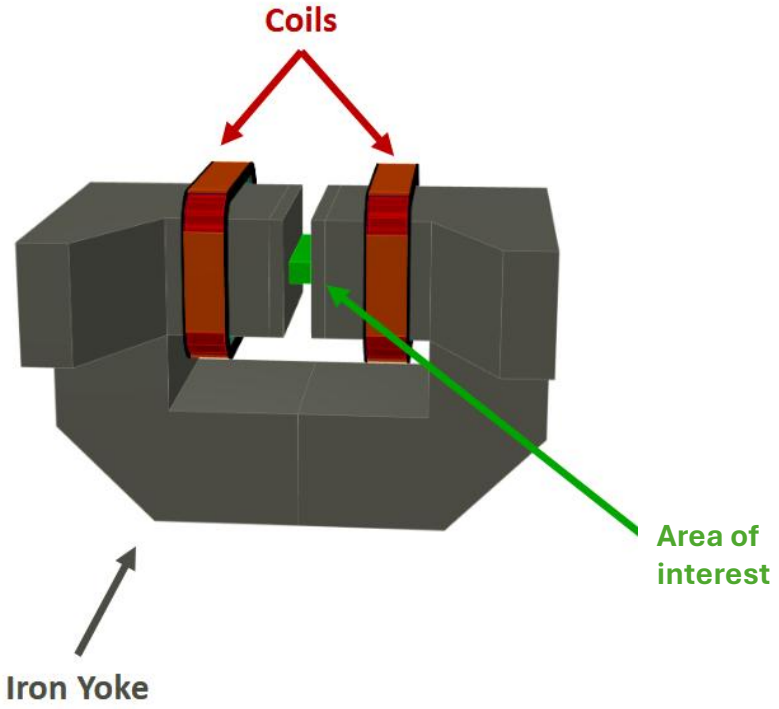
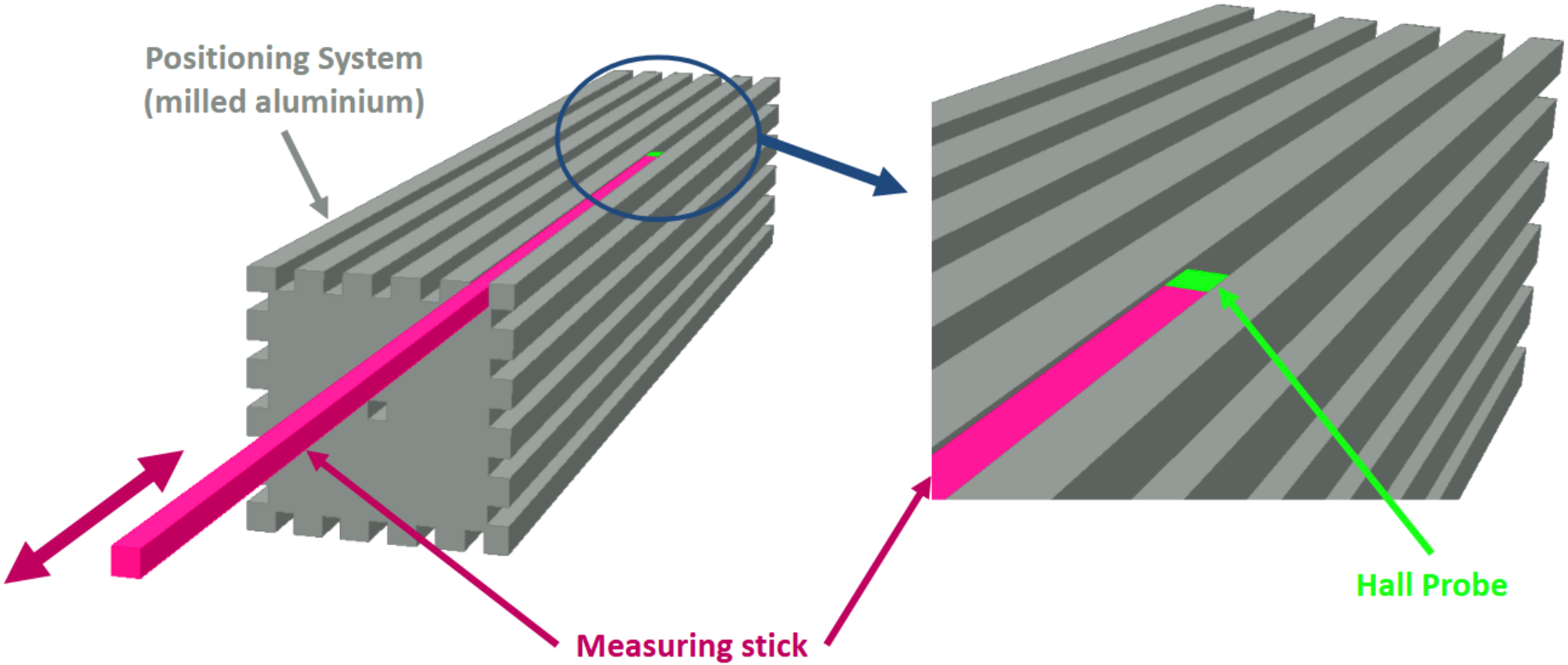
ANSYS model of the area of interest



- 4686 total nodes
- ½ simmetry

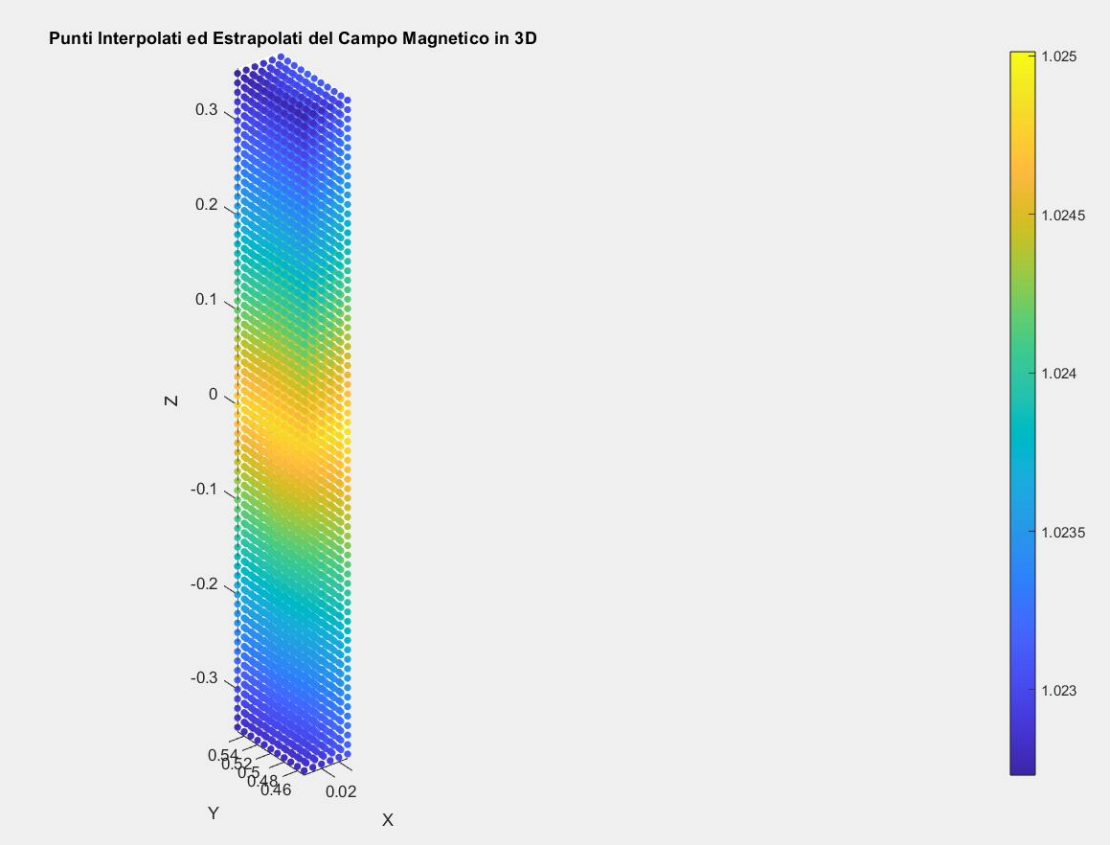


Data collection system



Interpolation

- I performed a tetrahedral interpolation in MATLAB, creating a spatial grid of 4686 points, analogous to the one generated by ANSYS in the simulation.
- The points selected for the interpolation were taken from the three possible surfaces of the parallelepiped and along the central line.
- I compared the interpolation results with those of the simulation, both by calculating the mean of the residuals and the root mean square error



Interpolation

- I performed several interpolations using progressively fewer points, down to a minimum of 4 points
- In all the interpolations, the error found was very small

Number of points	Mean of residuals	Root mean square error
36	0.000305900	0.000344000
20	0.000412900	0.000541800
14	0.000342410	0.000419740
12	0.000309990	0.000349920
4	0.000428160	0.000553690

Translation of the area of interest

- The translations were made in the y and z directions, the only ones allowed by the structure of the magnet
- New simulations were carried out, this time by translating the area of interest
- In this way, the interpolated points did not include the maximum and minimum of the field
- Also in this case, the measurement error is on the order of 10^{-3}

R.M.S error with different translations

Number of points	No shift	Shift Y+0.05, Z+0.05	Shift Y+0.005 Z+0.005	Shift Y+0.0005 Z+0.0005	Shift Y+0.025 Z-0.025
36	0.000344000	0.00054078	0.00034166	0.00033717	0.00035925
20	0.000541800	0.00076286	0.00048906	0.00056198	0.00042083
14	0.000419740	0.00113650	0.00033489	0.00051287	0.00041677
12	0.000349920	0.00104490	0.00033150	0.00040391	0.00041801
4	0.000553690	0.00181890	0.00138430	0.00136920	0.00341360

Homogeneity

- Different simulations, shifting the coils every time
- 0.5 mm in X, Y, Z directions
- The homogeneity is substantially unchanged, with a value of $1{,}5 \times 10^{-3}$

$$H \equiv \max\left(\frac{B_x - < B_x >}{< B_x >}\right)$$

Shift (m)	<B> (T)	Min (T)	Max (T)	H
//	1.0242	1.0226	1.0250	1.5e-03
X'=X+0.0005	1.0240	1.0225	1.0249	1.5e-03
X'=X-0.0005	1.0243	1.0227	1.0251	1.5e-03
Y'=Y+0.0005	1.0242	1.0226	1.0250	1.5e-03
Y'=Y-0.0005	1.0242	1.0226	1.0250	1.5e-03
Z'=Z+0.0005	1.0242	1.0226	1.0250	1.5e-03
Z'=Z-0.0005	1.0242	1.0226	1.0250	1.5e-03

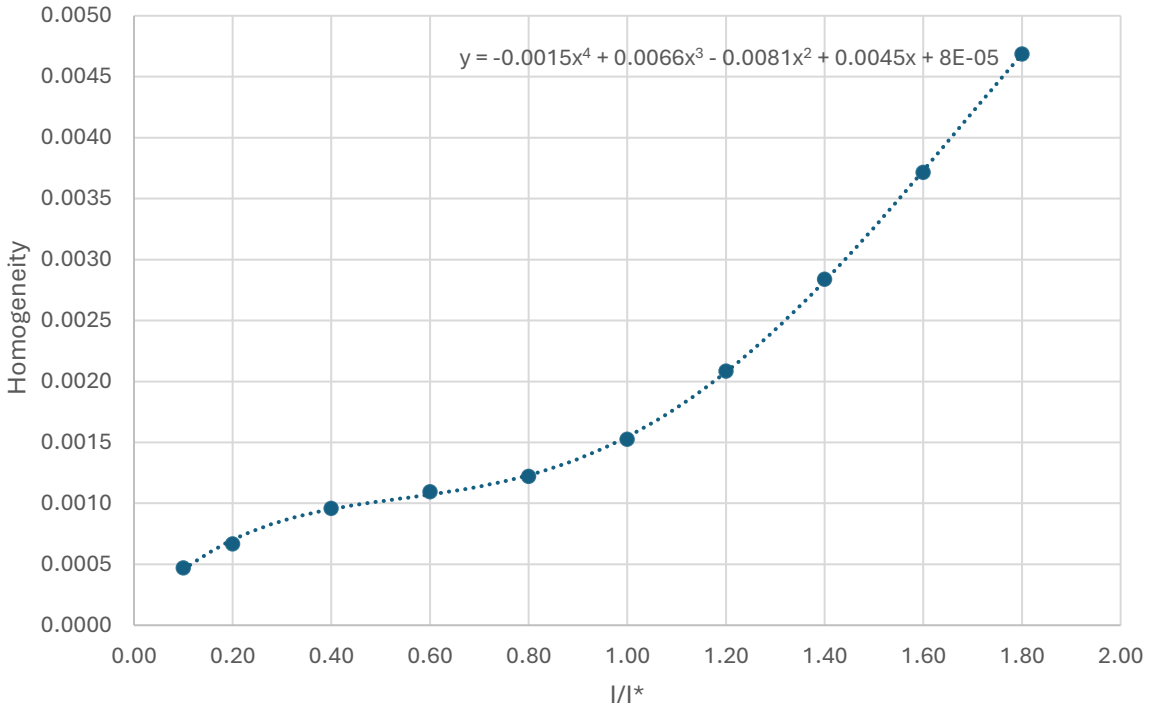
Analysis of homogeneity changing the gap

An analysis was carried out by modifying the air gap dimensions; the homogeneity remains almost unchanged even with a 1 mm error

Shift (mm)	Field (T)	Min (T)	Max (T)	H
+0.1	1.0232399E+00	1.0217313E+00	1.0240375E+00	1.4743067E-03
-0.1	1.0253039E+00	1.0237398E+00	1.0261462E+00	1.5255449E-03
+0.2	1.0221863E+00	1.0206790E+00	1.0206790E+00	1.4745539E-03
-0.2	1.0264374E+00	1.0248727E+00	1.0272809E+00	1.5244312E-03
+0.3	1.0209256E+00	1.0194192E+00	1.0217204E+00	1.4755497E-03
-0.3	1.0274244E+00	1.0258671E+00	1.0282639E+00	1.5157566E-03
+0.4	1.0198028E+00	1.0182974E+00	1.0205960E+00	1.4761508E-03
-0.4	1.0287111E+00	1.0271448E+00	1.0295569E+00	1.5225382E-03
+1	1.0137604E+00	1.0122620E+00	1.0145432E+00	1.4780125E-03
-1	1.0355816E+00	1.0340102E+00	1.0364344E+00	1.5174107E-03

Analysis of homogeneity changing the current I

- I* is the current required to obtain a magnetic field of 1 tesla
- The inflection point is at I/I*=0.543



Status update on the winding process at ASG

The winding process has started and is currently ongoing at the San Desiderio site in Genoa

Next activities

- Continuing the analysis of homogeneity with oblique displacements of the air gap
- Following the winding and the construction of the magnet
- Take part in cold testing campaigns at CERN