Cost calculation procedure for normal conducting magnets

C. Will, C. Mühle

GSI, Darmstadt, Germany

Previous procedure

In the past cost calculations for normal conducting magnets were usually done by using "cost per kilogram" assumptions. This method based upon a tight observation of production prices over the years.

During the process of ongoing planning for the production of components for the FAIR-Project a detailed price estimation became necessary.

Especially for normal conducting magnets as one of the biggest systems of the project cost estimations and production time estimations have been asked.

Figure 1 shows the distribution for costs per kilogram for dipole magnets, quadrupole magnets and steering magnets of the HICAT project [1].

This fast method of generating a cost estimation cannot consider the amount of magnets in one production cycle. In addition a reliable forecast about production duration is not possible.

Only in a double logarithmic representation the overall dependence is visible. If one examines magnets with similar weights a factor of 2 or more can be easily observed.

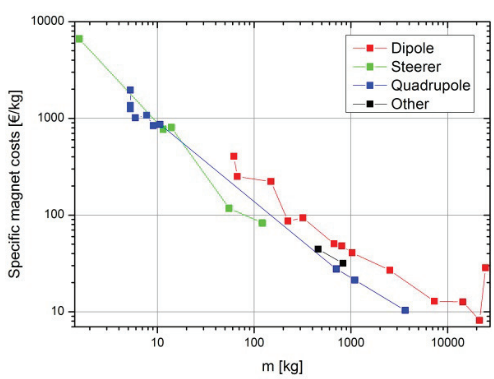

Figure 1: Specific costs (€/kg) for magnets built for HICAT [1].

New calculation procedure

Ambitions of a new procedure for calculation for normal conducting magnets were:

- Cost calculation on the basis of parameter tables given by magnetic calculation
- Consideration of the amount of magnets which have to be produced
- Generation of a pattern for time scheduling considering the amount of possible production lines
- Generation of an error analysis on basis of the calculated items

Parts of the calculations are mechanical design, tools for production, production of components for the magnets, assembly, mechanical, electrical and magnetic acceptance.

The method was developed for dipole magnets and quadrupole magnets. By using indicators the dipole calculation schema can be adopted for steering magnets, as well as the quadrupole schema for sextupoles.

Following the new method it is possible to generate price estimations with better accuracy in combination with a time table for the production of the magnets.

In addition a "design to cost" procedure is possible. The influence of magnetic and mechanical design options on the price of the components can be checked.

Additional factors for risk based on the error analysis and common commercial factors [2] also are included.

Analysis of deviances between offers by suppliers and calculated costs show that the error of calculation is higher for magnets with less weight.

This finding can be proven by separating the costs for materials and design. Table 1 shows the influence of the total magnet weight on the portions of costs for materials (steel, copper) and design for different magnet sizes and types calculated with the new schema. The error of material costs can be minimized by observing market prices. So the influence of uncertain information about working time decreases with increasing weight of the component. All calculations listed in table 1 were done for the production of a single magnet. The influence of the costs for design and for tooling decreases with increasing quantity of magnets.

Table 1: Portion of costs in reference to the weight of the component

Magnet	Weight	portion of costs		
	[kg]	% Steel	% Copper	% Design
Dipole	4331	4,44	6,91	13,16
Dipole	5907	6,02	8,18	9,64
Dipole	8612	5,98	7,12	6,47
Dipole	42468	15,36	12,45	5,31
Quadrupole	1262	2,14	4,39	26,19
Quadrupole	1944	2,25	8,34	24,45

References

[1] C. Muehle, B. Langenbeck, A. Kalimov, F. Klos, G. Moritz, B. Schlitt; Magnets for the Heavy-Ion Cancer Therapy Accelerator Facility (HICAT) for the Clinic in Heidelberg; IEEE Trans. on Appl. Supercon., vol. 14, no. 2, pp. 461-464, June 2004

[2] U. Fischer et al., Tabellenbuch Metall, Verlag Europa Lehrmittel, Haan-Gruiten, 2006