# FINITE-ELEMENT ANALYSIS OF A BRUSHLESS PM DC LINEAR MOTOR

## MAIN FEATURES OF THE LINEAR ACTUATOR

- Traditional DC actuators employ two field windings, one mounted on a slotted iron stator and the second on the sliding rotor.
- The trailing leads can be avoided by replacing the moving winding with a set of high-field permanent magnets
- In this way a very simple and low cost PM DC linear actuator with slotless armature and permanent magnet slider is obtained.
- In addition to the winding distributed over the working length, two coils are placed at the ends of the actuator.

# THE PM DC LINEAR ACTUATOR

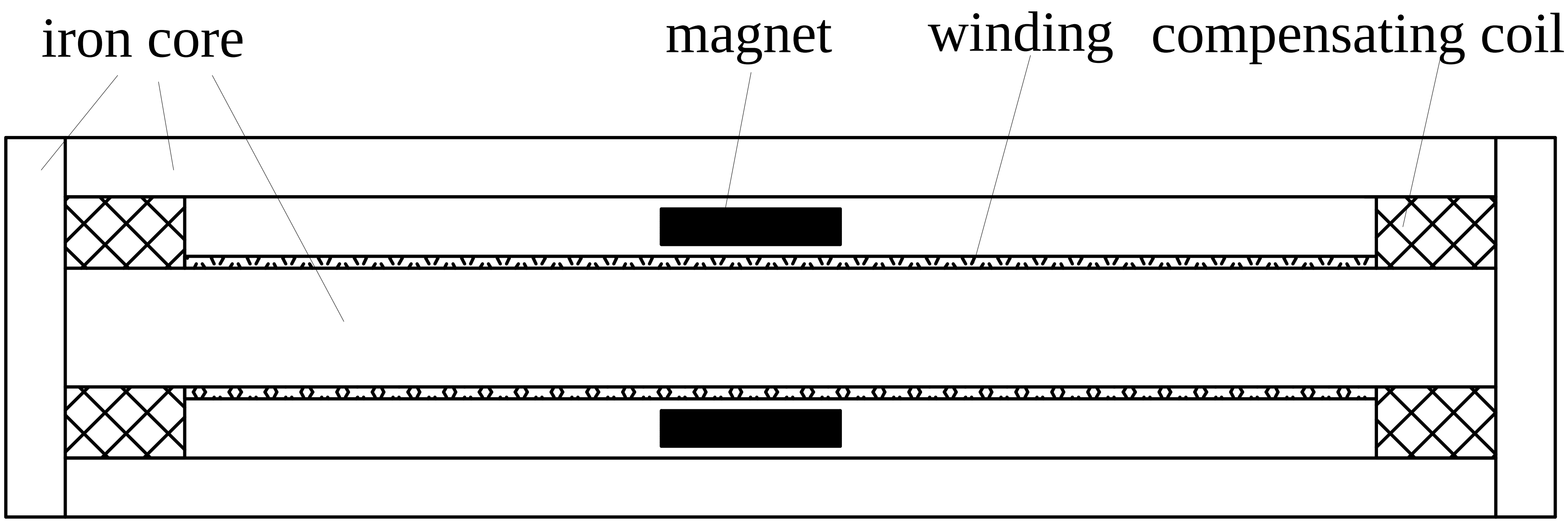


Fig. 1- Schematic drawing of the PM DC linear actuator.

# SIMPLIFIED MODEL OF THE ACTUATOR

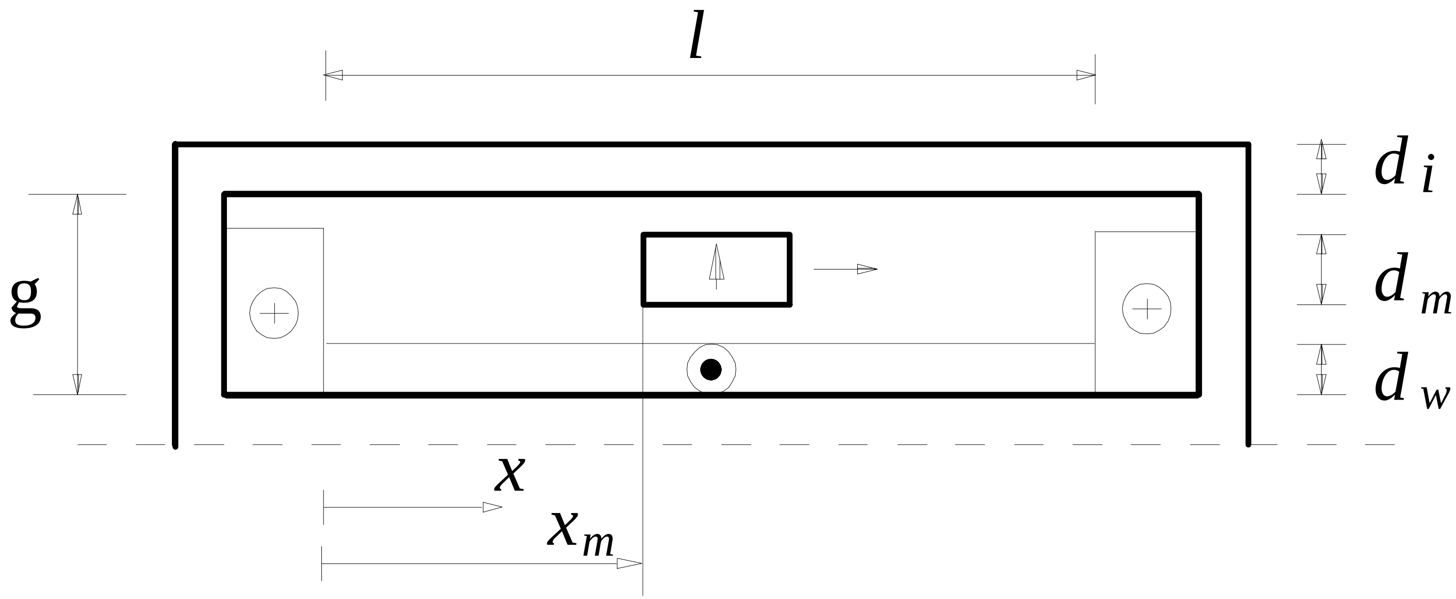


Fig. 2. Model of the PM DC linear actuator.

# FINITE-ELEMENT ANALYSIS

TABLE I - ACTUATOR DIMENSIONS

| | | |
|---|---|---|
| $l = 0.4$ m | $L = 0.05$ m | $l_m = 0.055$ m |
| $d_i = 0.02$ m | $d_w = 0.004$ m | $d_m = 0.006$ m |

Rated current 3 A, corresponding to $J_l = 13.3$ kA/m.

Samarium-cobalt magnets
remanent flux density 1.06 T
coercive force 750 kA/m

A straight-line demagnetisation curve was assumed with a relative recoil permeability of 1.1.

# PLOT OF FLUX DISTRIBUTION

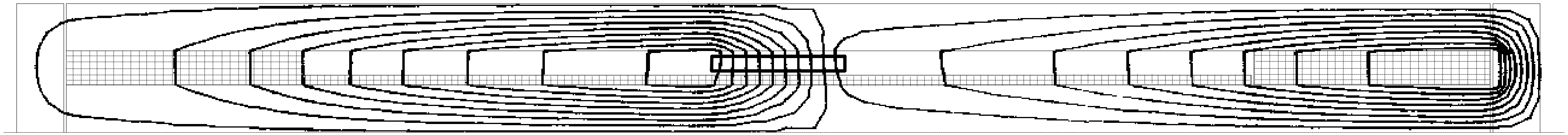

Fig. 3 - Plot of the flux density distribution for a winding current of 3 A.

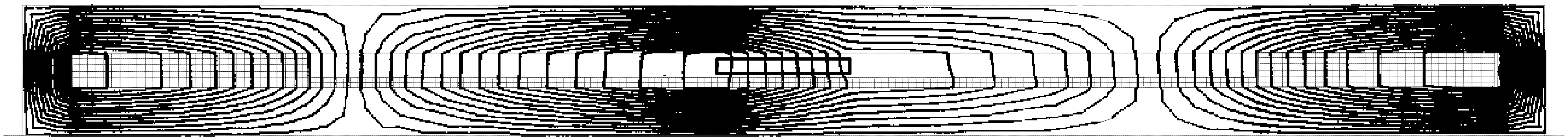

Fig. 3 - Plot of the flux density distribution for a winding current of 6 A.

The thrust acting on the slider is
27 N for $i$ = 3 A and 40 N for $i$ = 6 A.

# NUMERICAL RESULTS

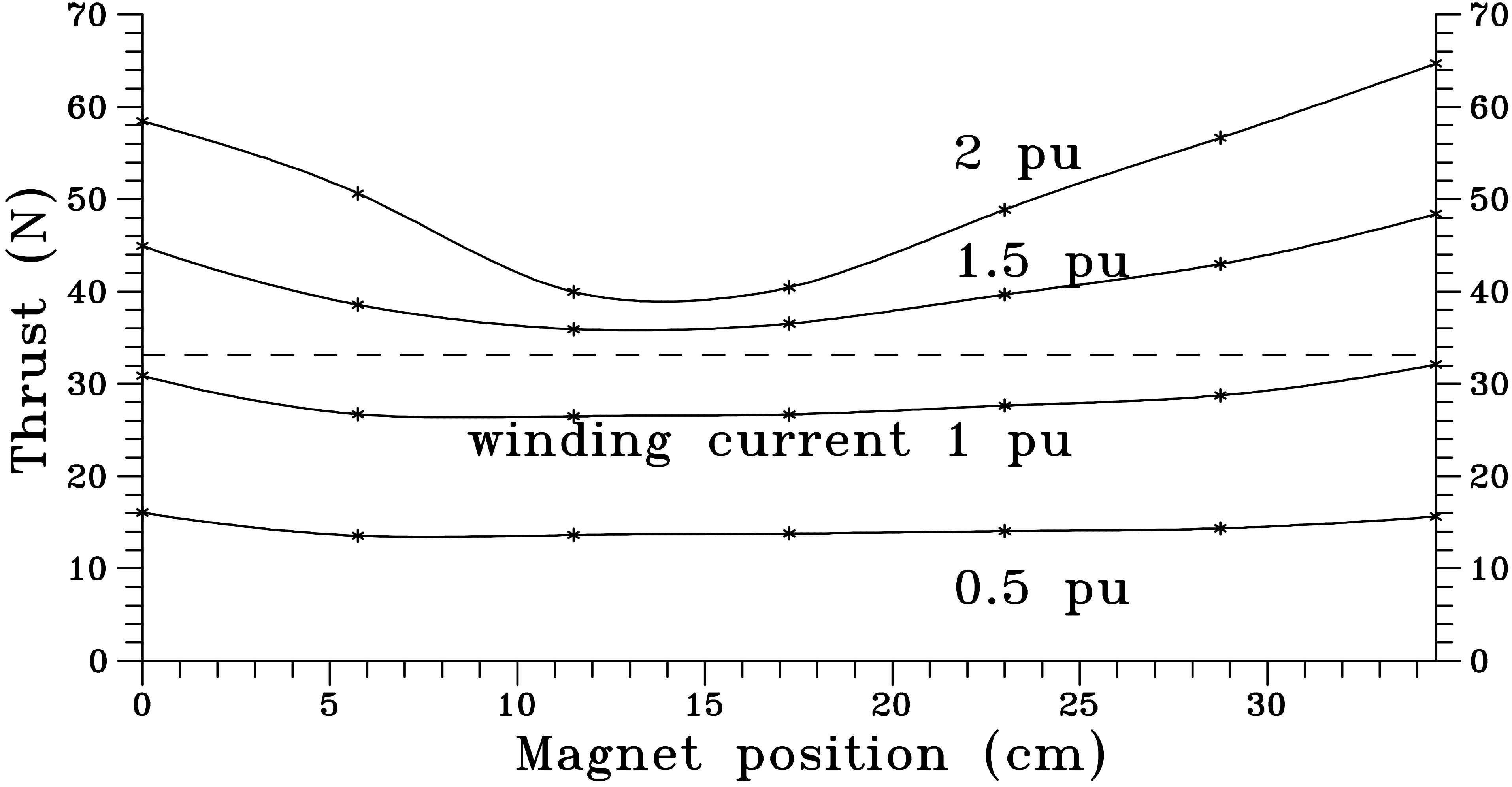


Fig. 4 - Thrust versus magnet position for fixed current values (l=0.4 m).

# *Influence of the iron saturation*

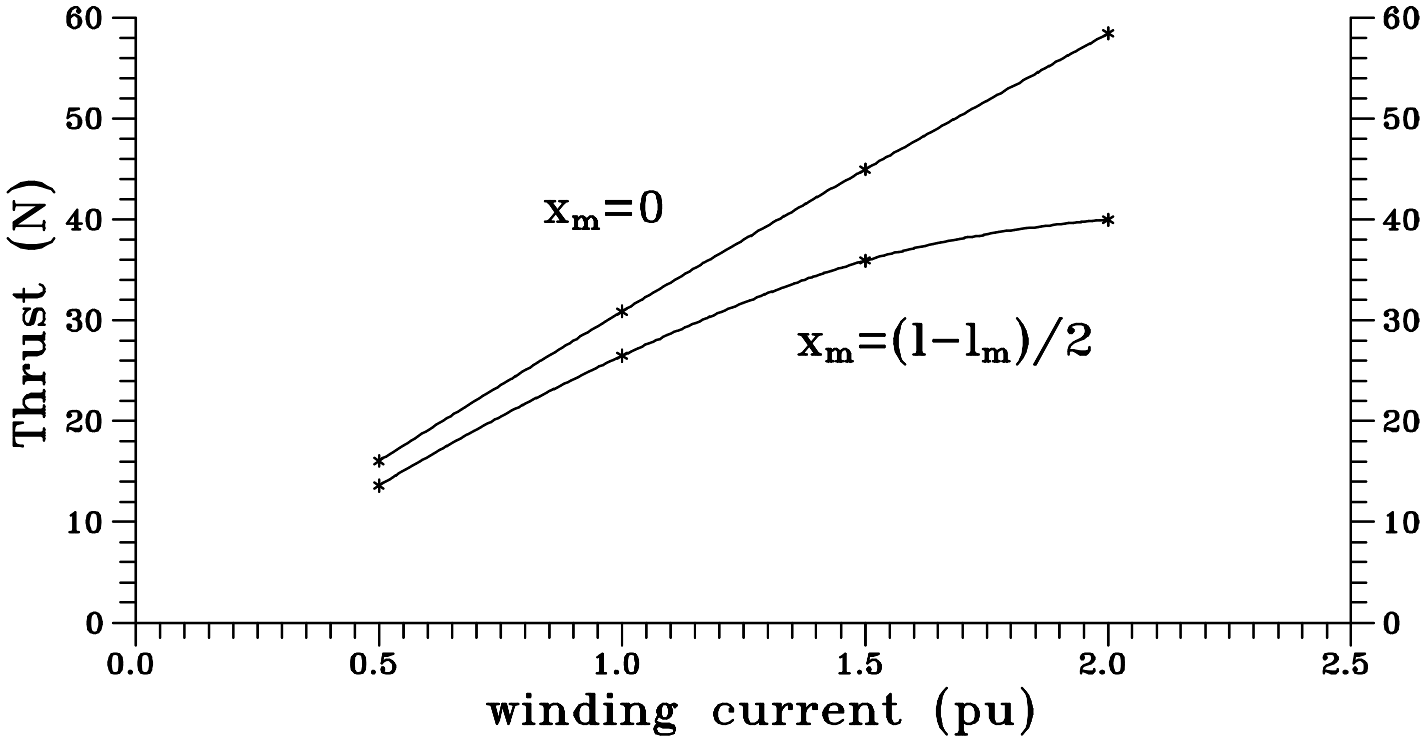


Fig. 5 - Thrust at the beginning and at the middle of the stroke versus armature current.

## *Influence of the working length*

PM DC linear actuator with working length of
**0.6 m instead of 0.4 m**.

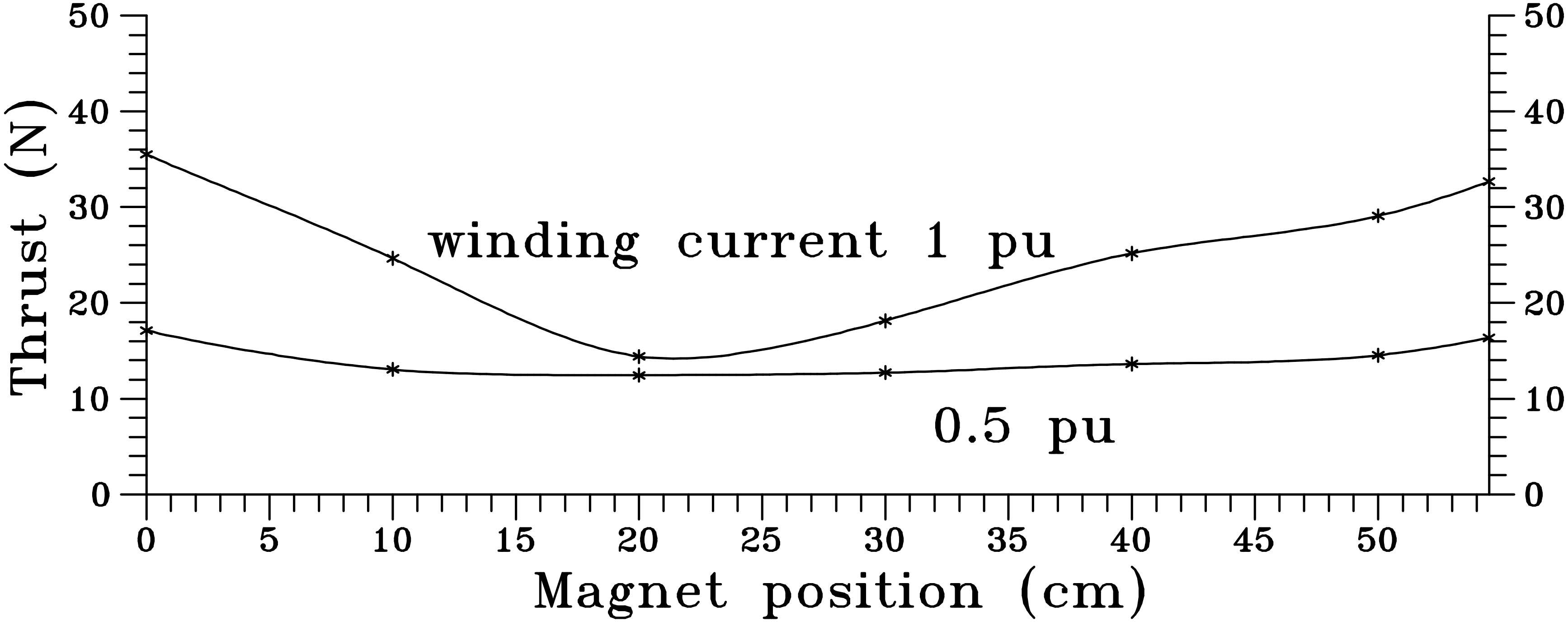


Fig. 6 - Thrust versus magnet position for fixed current values (*l*=0.6 m).