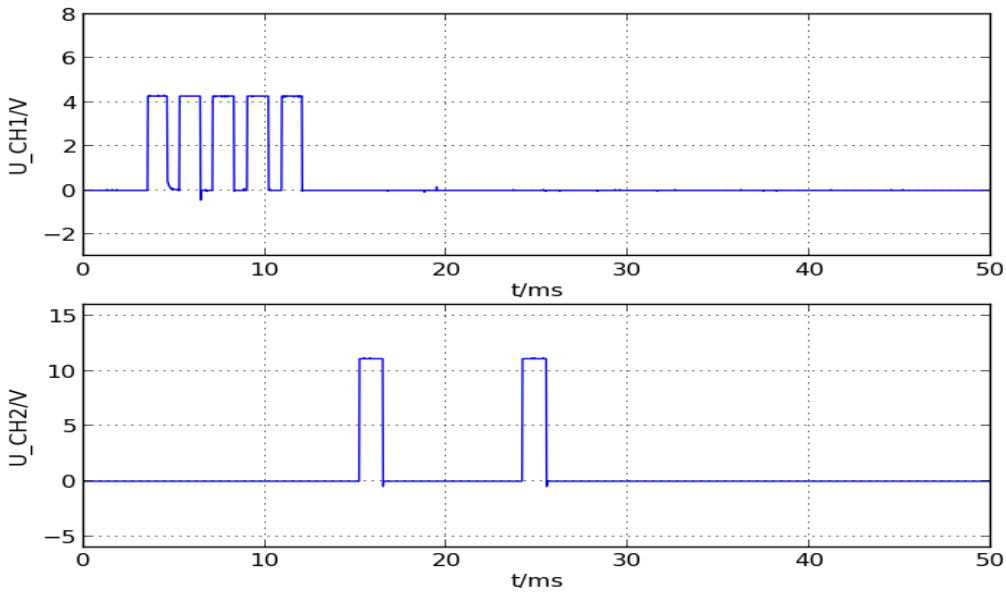
Coilgun measurements

All measures done with coilgun version 1.0:

http://staff.ltam.lu/feljc/electronics/coilgun/Coilgun_technical_data.pdf

Velocity was measured with an optical barrier, behind the last coil (CH2 in the oscillograms).
The photo transistors have a distance of 190mm.
CH1 displays the triggering pulses of the thyristors.

Sample oscillogram:



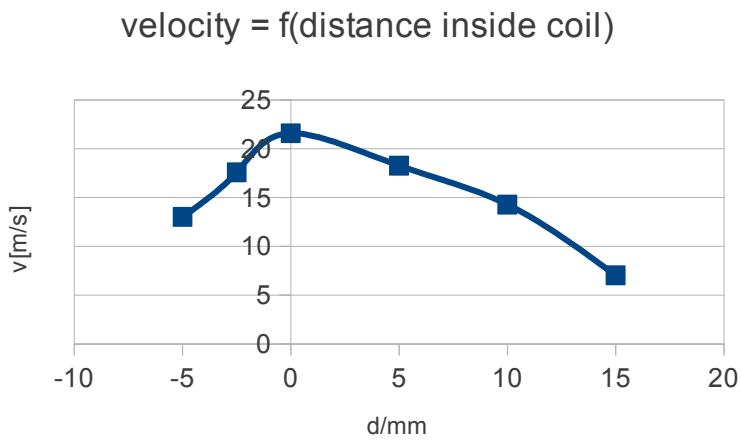
1. Single coil measurements

With 1 coil:
U = 400V
Projectile: m = 6.2g, diameter = 6mm, length = 30mm

Variation of distance to coil

Results:

	d/mm	dt/ms	v[m/s]
outside	-10		
outside	-5	14,6	13,01
outside	-2,5	10,8	17,59
at the edge	0	8,8	21,59
inside	5	10,4	18,27
inside	10	13,3	14,29
inside	15	27	7,04

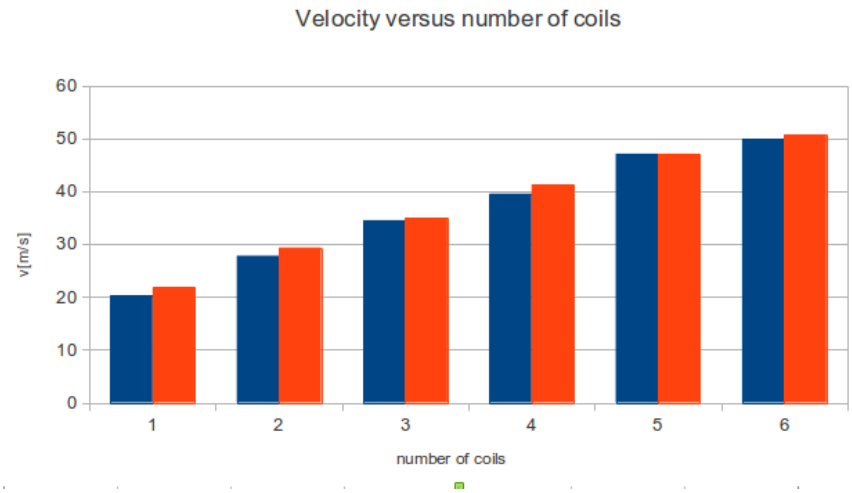


(negative d = outside, positive d = inside)

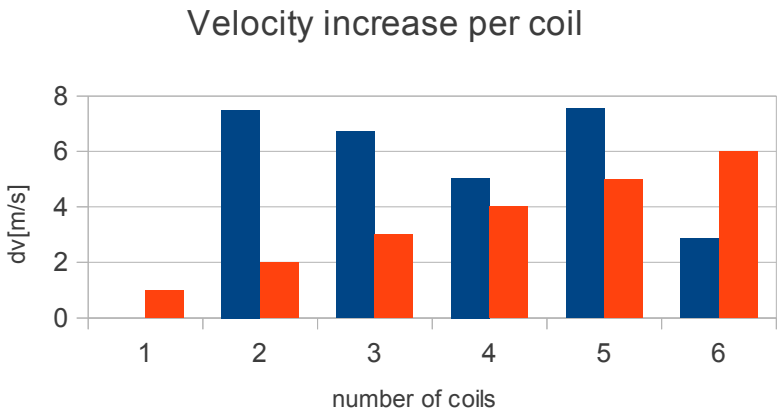
Conclusion: Optimal position: projectile just before coil

2 Multiple coil measurements

U = 400V



blue: 25mm projectile
red: 30mm projectile



3. Effects of voltage variation

U/V	dt/ms	v[m/s]		Ekin/J	Eel/J	eta
20	63,3	3,00		0,03	1,128	2,52
50	15,8	12,03		0,46	7,05	6,46
100	6,08	31,25		3,08	28,2	10,91
150	5,63	33,75		3,59	63,45	5,65
200	4,88	38,93		4,78	112,8	4,23
250	4,39	43,28		5,90	176,25	3,35
300	4,1	46,34		6,76	253,8	2,67
350	3,85	49,35		7,67	345,45	2,22
400	3,8	50,00		7,88	451,2	1,75

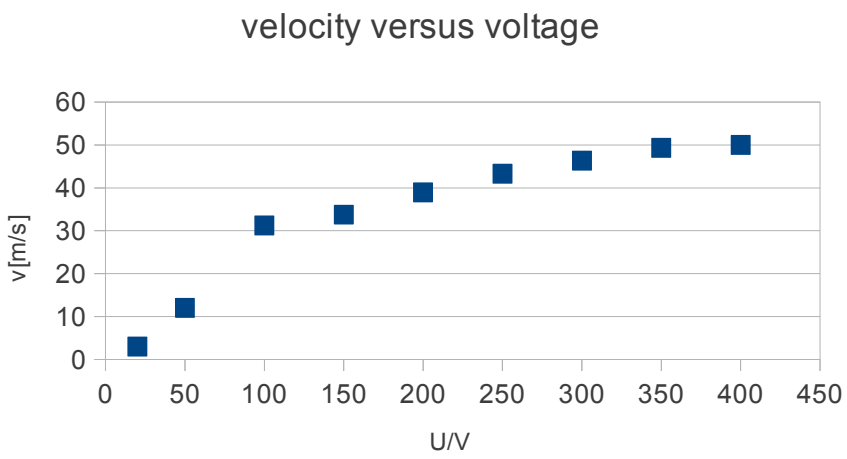
dt is the time interval between the optical barrier pulses, thus $v = \frac{190\text{mm}}{dt}$

E_{kin} is the kinetical energy of the projectile: $E_{kin} = \frac{1}{2} m v^2$

E_{el} is the electrical energy stored in the total capacity C=5.64mF : $E_{el} = \frac{1}{2} C U^2$

eta is the efficiency calculated as $\eta = \frac{E_{kin}}{E_{el}}$

As it is easy to beleive, there is an increase of velocity versus voltage:



This diagram tells us that efficiency is far from being constant, otherwise velocity and voltage should be proportional one to the other, as

$$E_{kin} = \eta E_{el}$$
$$\frac{1}{2} m v^2 = \frac{1}{2} C U^2$$
$$v = \sqrt{\eta} \cdot \sqrt{\frac{C}{m}} \cdot U$$

In fact, efficiency seams to have a maximum at U=100V: