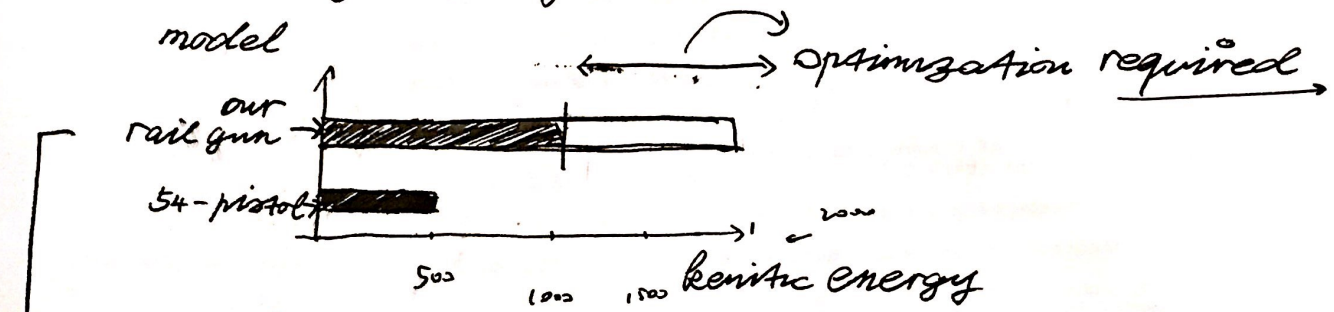
Rail gun Project.

~~Linear Approximation~~

Abstract - This project is aim to produce a rail gun model that can shoot a projectile with about 1000 - 2000 Js kenitic energy.

Reference: 54-Pistol has about 500 J KE ~~da~~ directly after the bullet out of the gun body.



(10 - 40 %)

coil gun efficiency

→ Calculation: $\Sigma_k = \frac{1}{2} \cdot C \cdot U^2 \cdot \sigma$

C → 550 Volts / 2200 uf as a single unit

10 x C = 550V / 22000 uf

This might be a good starting position!

A → ≈ 3300 J · σ , ≈ 330 - 1390 J.

↓ x3 x3 ‖ primary

≈ 10000 J · σ 4000 J → 4000 J

↓

10x 550V/2200 uf Capacitors

↓

x2 - x8 (54-pistol)

~~In this page, this~~

The power / kenitic energy of a rail gun functioning at 12 kV will be discussed.

12 kV v.s. 550 V

Function environment

Standard of two different type of capacitor.

① C = 550 V / 2200 uf · 30 - 40 RMB per 1

② C = 12 kV / $\frac{1200}{1000}$ nF · 80 - 150 RMB per 1

~~12 kV~~ 1 kV 30 uf 45 RMB

Calculation ($E = \frac{1}{2} \cdot C \cdot U^2 \cdot \sigma$)

↳ rail gun efficiency range from 10 → 40 %.

① $\sum_{10} \times C_1 = 10 \times 2200 \times 550^2 \times 0.5 \times 10^{-6} \times \sigma$ ⊕

different votage equal stored energy = $3327 \times \sigma$

$= 330 - 1330$ J

② $\sum_{10} \times C_2 =$ ~~$10000 \times 10^{-}$~~

$300 \times 10^{-6} \times 1000^2 \times 0.5 \times \sigma$

$= 150 \times \sigma$ (useless!)

Abandent!

③ 5.5 kV / 220 uf

$E = 220 \times 10^{-6} \times 0.5 \times 5500^2 \times \sigma$

$= 3327 \times \sigma$

Rail gun schematic

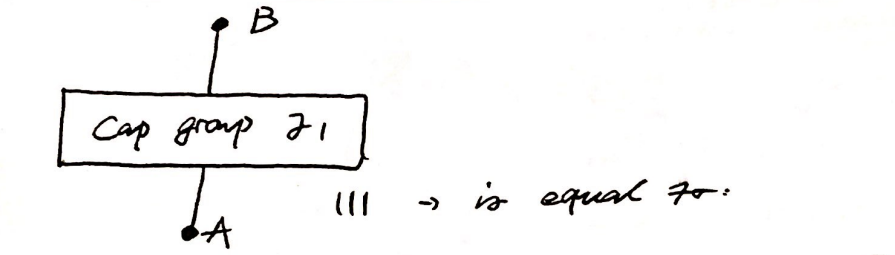
BOM List:

① 550V / 2200 uF Capacitor

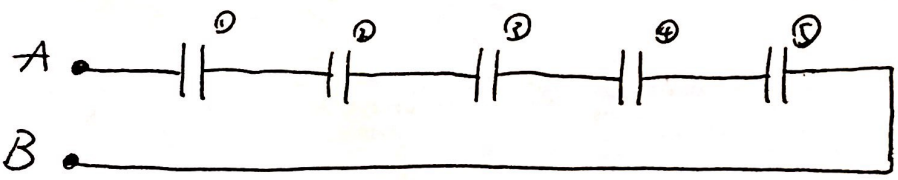
Target Voltage: 5500 kV

Target stored energy: 6000+ J

Target landing kenitic energy: 600 - 2400 J ← 0.1-0.4



||| → is equal to:

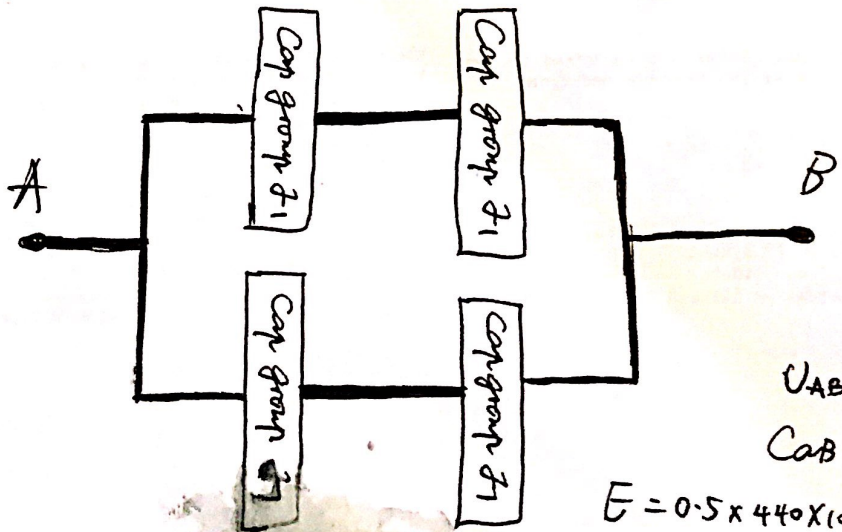


→ 550V / 2200 uF

Voltage of Cap group J1 = 550 x 5 = 2750V

Capacitance of Cap group J1 = $\frac{1}{\frac{1}{2200} \times 5}$ = 440uF = 4.4×10^{-4} F

Schematic:



6655 x 1

U_{AB} = 5500V

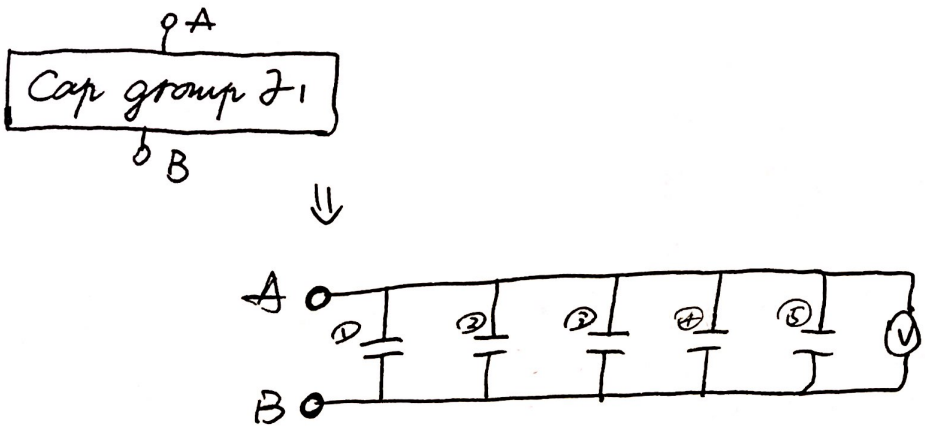
C_{AB} = 440 uF

$E = 0.5 \times 440 \times 10^{-6} \times 5500^2 \times 1 =$ 6655J

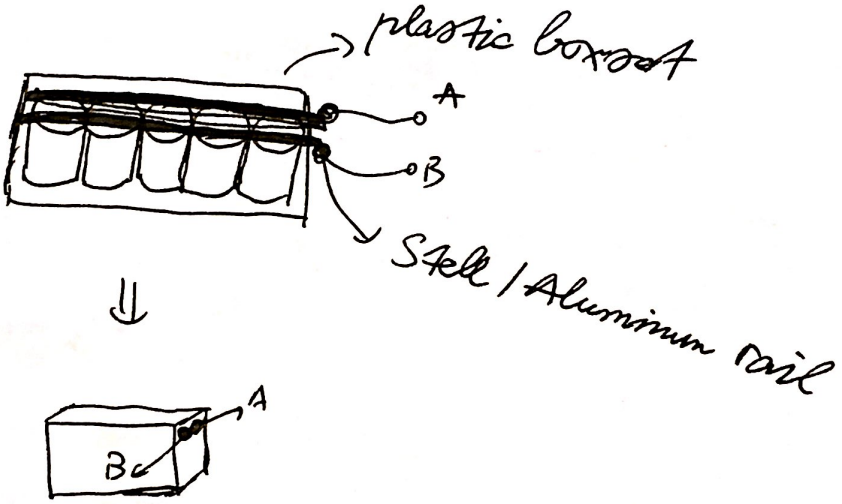
Layout of rail gun.

Schematic

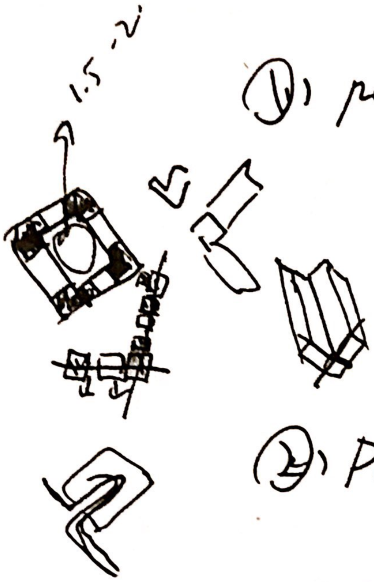
Jonathan's ~~Layout~~ Version 1.0



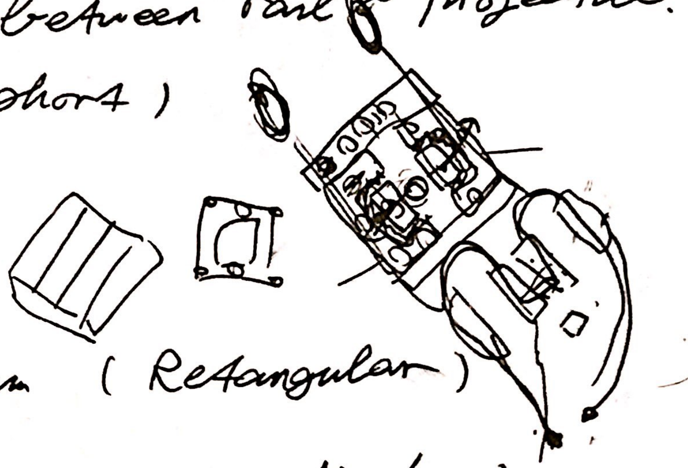
layout:



Issue waiting to be solved: ①



(1) powder of graphite produced be the friction between rail & projectile.
(may caused short)



(2) Projectiles:

1) Aluminium (Retangular)

2) Iron (conic + cylinder)

60×40, 30
6×6×10
4×4×20
6×60
4×25 from cgshop

what might the enlarged contact surface area between rail & projectile gonna affect the whole system?

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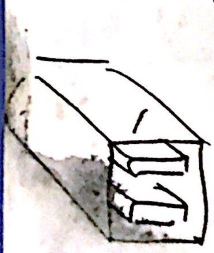
③ dimension profile of four-ways rail system
and
projectile of 4-ways system.



possible solutions - cut the project by ourself

dead line of first practical model:
in 4-week!

Issues waiting to be solved : ②

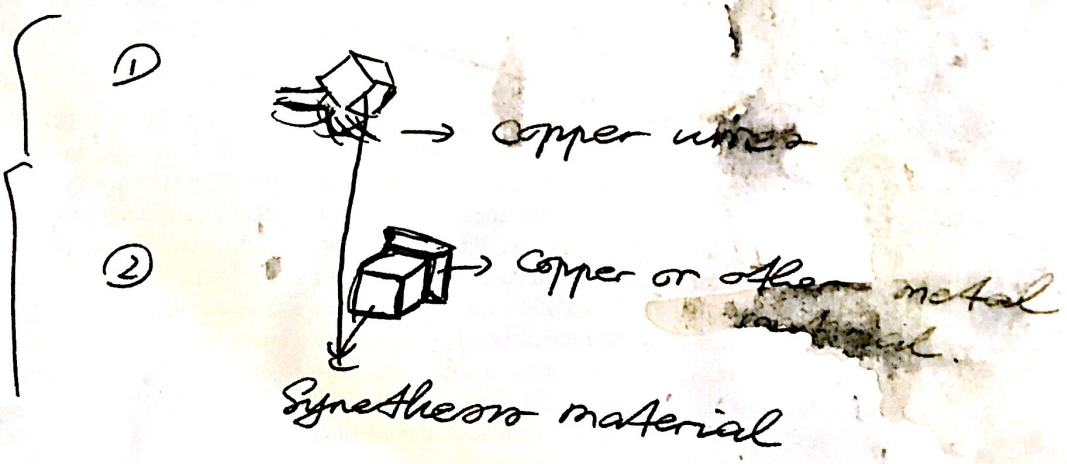
④ We can generate a plasma armature by using several pieces of 0.05 mm in diameter Cu copper wires.

⑤ Seperate the projectile and the armature or not ?

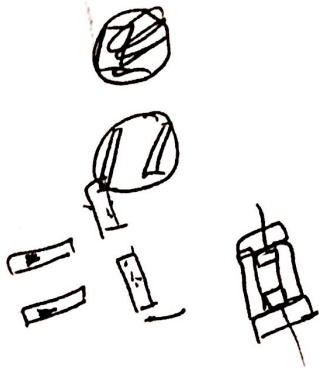
⑥ If seperate armature from projectile, how to design the armature and the projectile ?

P_{34} - P_{35} of Chinese Essay.

possible solution:



HmMAC Rail gun Version 0.2 Alpha



Σ Capacitance : 6600 μF

Schematic Voltage : 500 V

Maximum Voltage : 550 V+

Landing Kenitic Energy : $6600 \times 10^{-6} \times 0.5 \times 550^2 \times \sigma$

$= 1000 \cdot \sigma \approx 100 \sim 300$ J

Efficience (σ) = 10% ~ 30%

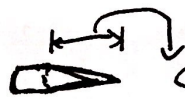
Rail Material : Aluminum / Graphite

Rail dimension :
- i) 4 x 4 x 100 (mm)
- ii) 6 x 6 x 100 (mm)

Projectile dimension :
(All of this section might be abandant since the wrong analysis of the armature!)
- i) r = 2 , h = 25 (mm)
- ii) r = 3 , h = 40 (mm)
- iii) 6 x 6 x 12 (Rect.) (mm)

Projectile Material : Iron / Aluminum

Projectile dimension ~~de~~ designing:



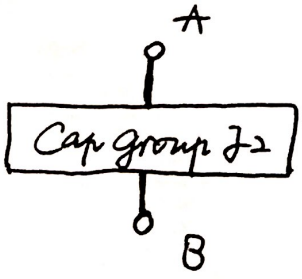
conic part
↳ Act as the projectile part

cylinder Part
↳ act as the armature

HMMAC V 0.2 Alpha Schematic

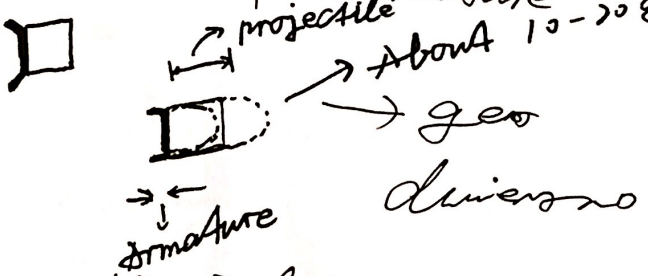
CG1 : Capacitor group J2 (cap group J2)

Shell :



Ana - ①

Two main Factors: { Rail design
Armature



Rail Gun: Magnetic Field. 3D: 有限源分析

Finite Element Analysis. ~~Am~~ Armature

FEM Analysis.

Materials choices:

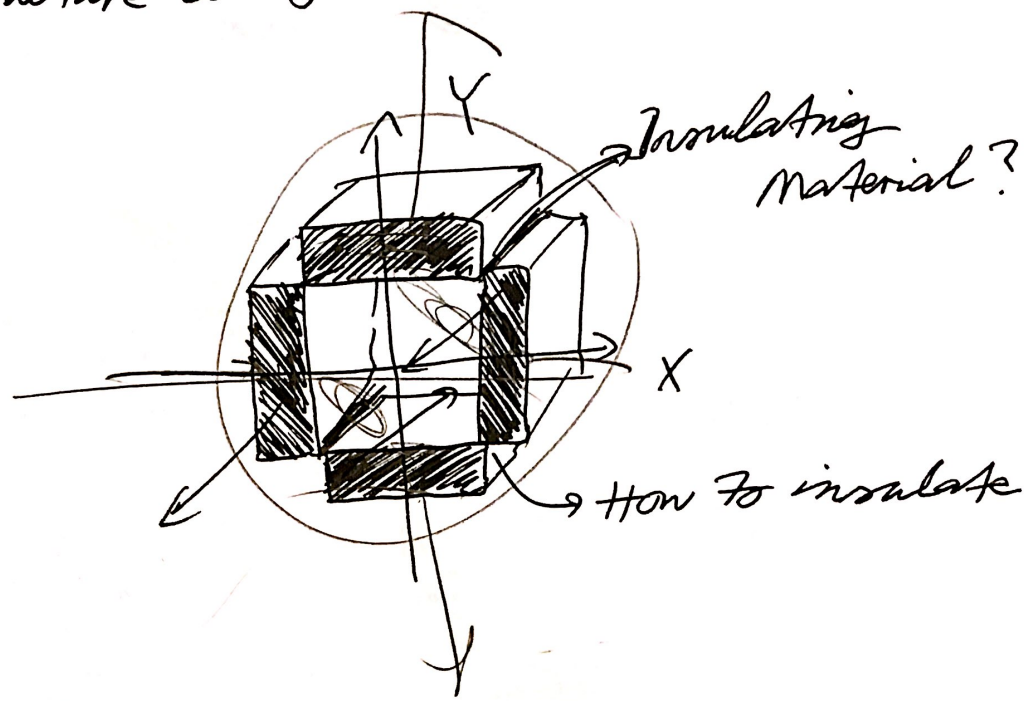
① Copper.
② Aluminum.
③ Graphite. (Carbon) →

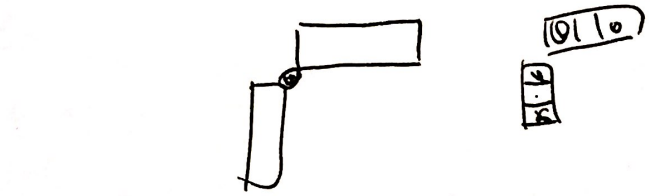
P.S: most of people / Military Researching facility have used Aluminum as the primary material. (Reasons unknown)

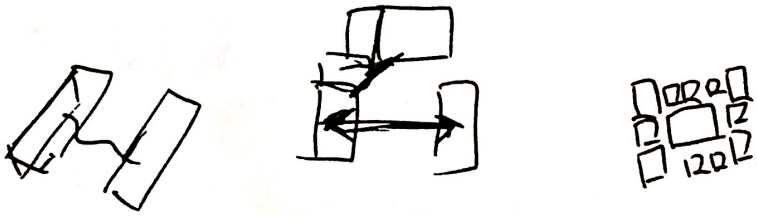
Waiting for further Analysis.

(Shape moment)
(Resistence)
(melting point)
(Hardness)

Structure design :







$\frac{E_R}{E_C}$