CDIO-3 Product Concept

Requirements Team

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Mission Statement

- Project Mission: Demonstrate the feasibility of electromagnetic control for formation flying satellites.
- Implications:
  - Demonstrate
  - EM Control
  - Formation maneuvering vehicles

Functional Requirements 1: the Customer

- Formation flying
  - Stability in formation
  - Interchangeable/replaceable modules
  - Both autonomy and command response
- EM control
  - "Use magnets to generate the … restoring forces"
  - "… will allow between 3 and 6 DoF EMFF"
- Architectural notes
  - High-permeability lightweight solenoid cores
  - Necessary heat dissipation
  - Reaction wheels

Functional Requirements 2: the System

- Top-Level: "The system shall…"
  - Have interchangeable system modules
  - Be tested on a realistic facility
  - Maintain relative separation/attitude
  - Follow steady course, predetermined or MC
- Subsystems

Power	Flight computer
ADS – Sensing	ACS - Control
Communication	Protection
Testing	Integration

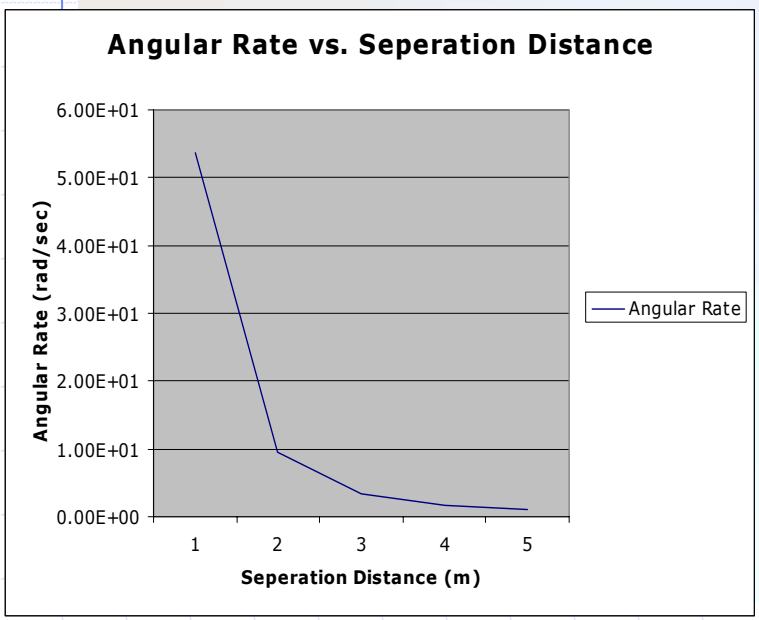
EM Trades

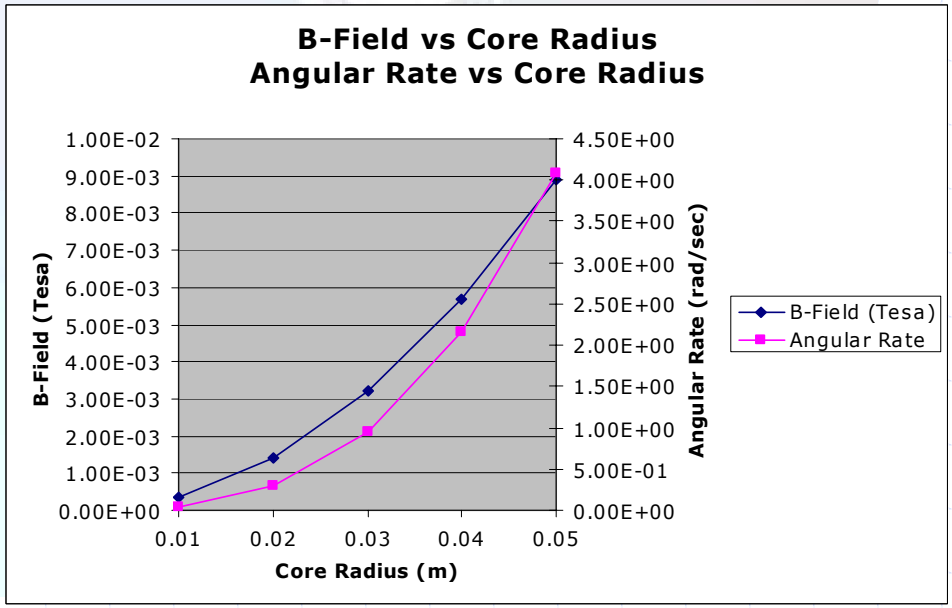
$$\beta = \frac{3}{4\pi}\frac{\mu_0 m_0}{\alpha}\sqrt{\frac{P_w}{\rho_c P_c}}$$

$$\omega = \chi\sqrt{\frac{3\mu_0\pi}{B^5}}\frac{m_0^{5/6}}{2\pi}\sqrt[3]{\frac{\alpha}{\pi\rho_s}}\sqrt{\frac{P_w}{\rho_c p_c}}$$

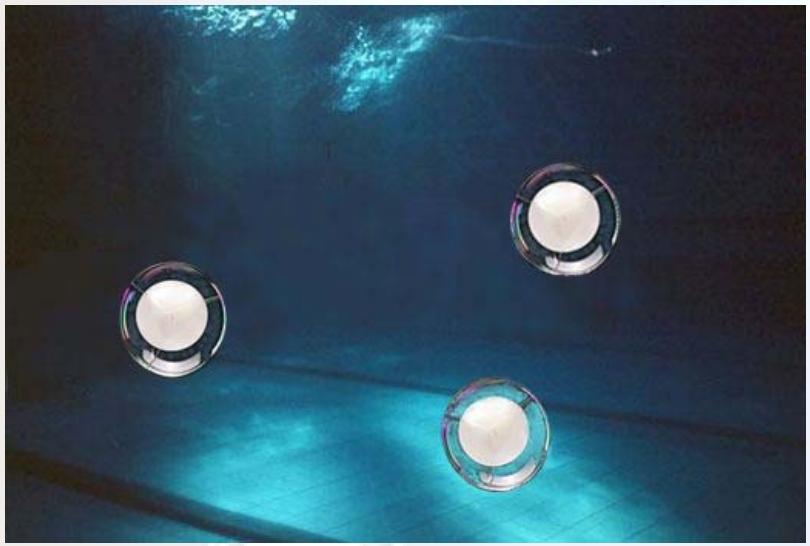
$$F = \frac{3}{2}\mu_0\pi\frac{(\chi nia^2)^2}{B^4}$$

$$m_0 = l^3\pi\alpha^2\rho_s$$





Final Design



Inside spheres:

- Reaction Wheels
- Computer
- Battery
- Coil and Core
- Transmitter/Receiver

Steel Core/Copper Coil

Mass = 5.26 kg

Separation =5m

Length of core = 0.3m

Radius of core =0.03m

Angular Rate = 0.959 rad/sec

B-field = 3.20E-03

Force = 58.12 N

Operations Concept

- Programmed response only
- Ground-to-vehicle communication
  - User-initiated autonomous tests
  - Realtime telemetry recording and storage
  - Emergency interrupt sequence
- Inter-vehicle communication
- Automated depth control

Pros and Cons

- Advantages
  - 3D flight
  - Simpler test carriage
  - Reduces danger of crash
- Disadvantages
  - Instability of water environment
    - Polarity
    - Currents
  - Increased drag due to high density of test medium