Design of the Target Injection and Tracking Experimental System

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GENERAL ATOMICS

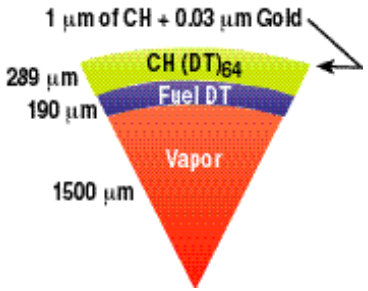
TOPICS

- Technology Development Strategy
- Target Injection and Tracking Requirements
- Conceptual Design
- Current Status

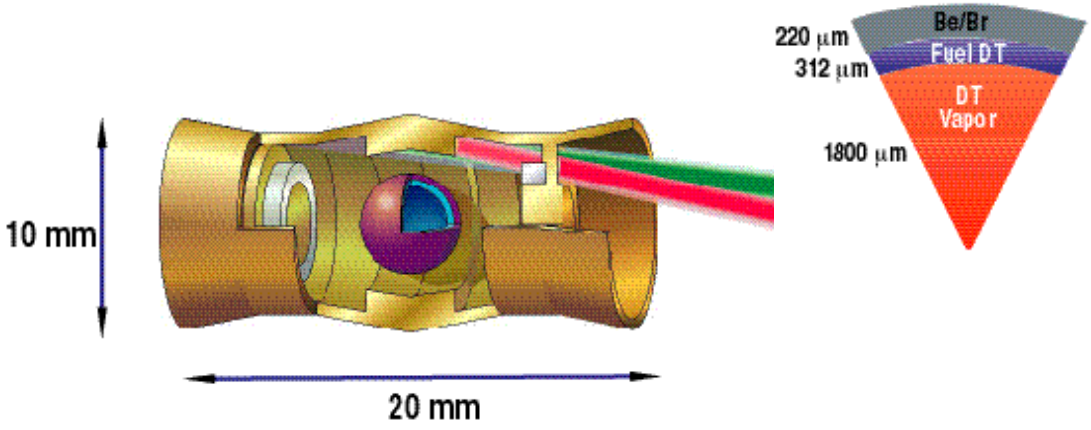
GENERAL ATOMICS

Target injection is a crucial component of the IFE community's phased development strategy

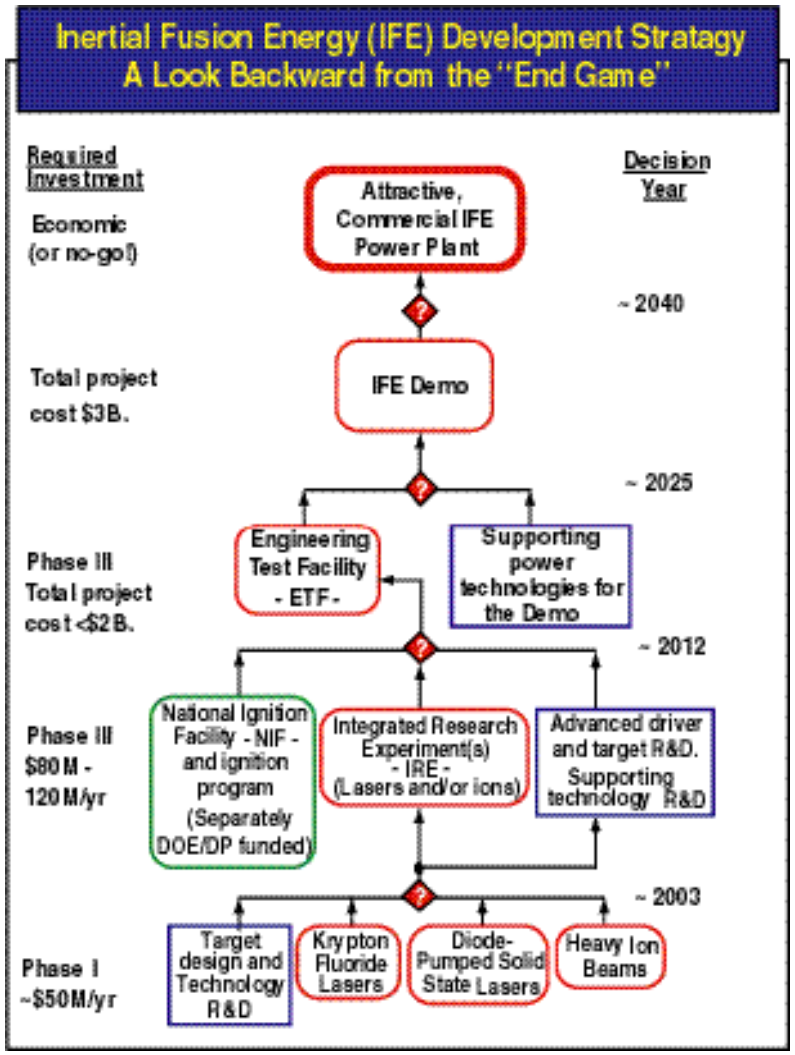
- **Do development necessary to support a decision for next machine at each step**



RADIATION PREHEAT TARGET FOR IFE (NRL)



INDIRECT DRIVE TARGET FOR IFE (LLNL)



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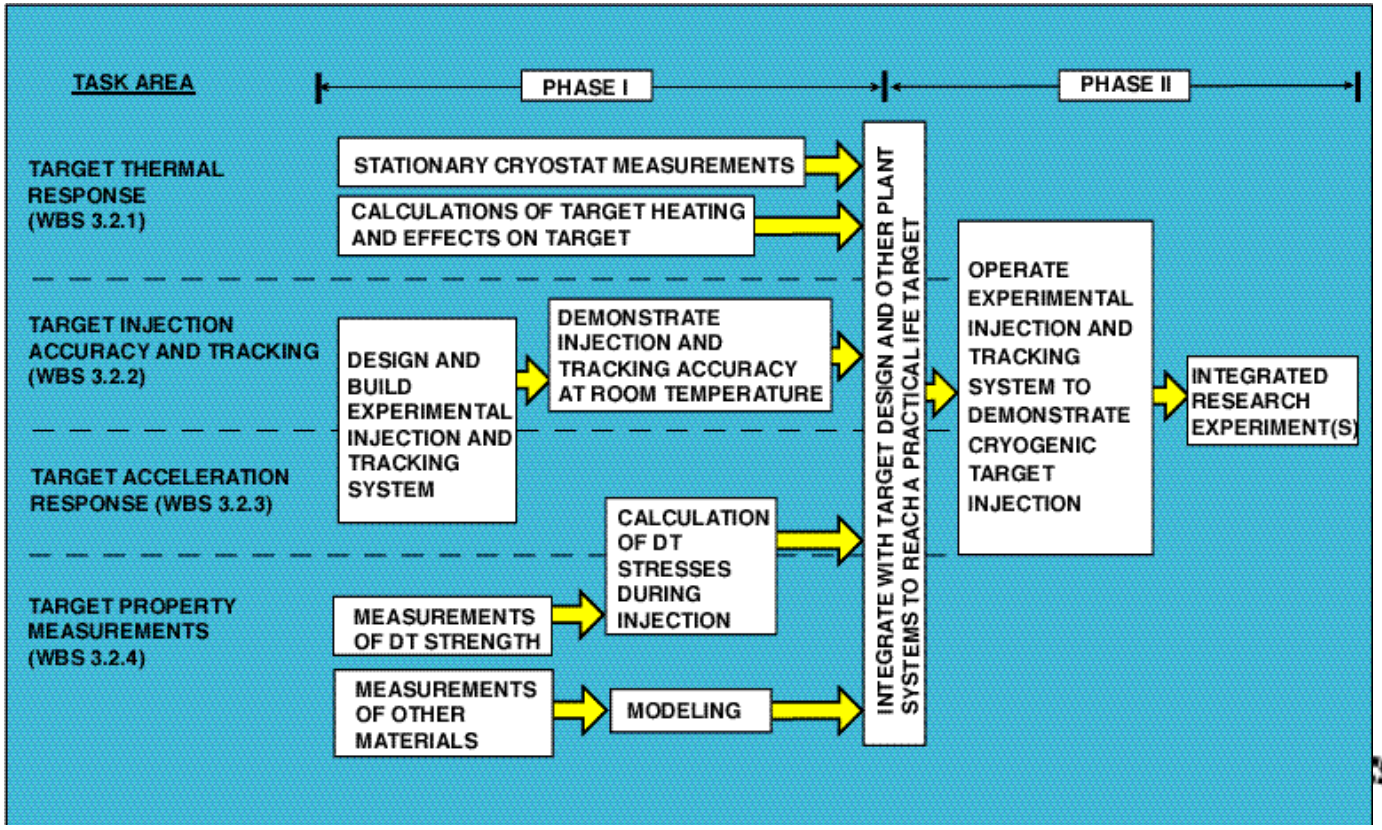
A strategy for demonstrating successful target injection and tracking has been defined

- **Critical issues were identified in "Chamber and Target Technology for Inertial Fusion Energy", Wayne Meier et. al., UCRL-ID-133629 (1999).**
- **We Must Address these Critical Issues:**
  - **Ability of targets to withstand acceleration during injection**
  - **Accuracy and repeatability of target injection**
  - **Ability to accurately track targets**
  - **Ability of targets to survive environment in chamber (thermal, gas, debris)**



The design of a rep-rated target injection and tracking system is underway

- **The intent is to provide not only a facility to demonstrate injection technology, but also to aid in the development of survivable targets**

- **Technical Approach:**
  - **Phase I: Demonstrate injection and tracking accuracy first at room temperature**
  - **Phase II: Upgrade to cryogenic operations and high temperature chamber**

- **Primary Design Documents:**

October 1999 – "Experimental Plan for IFE Target Injection and Tracking Demonstration", GA-C23241

May 2000 – "Target Injection and Tracking System Design Description", GA Report 7-0001-01DD

May 2000 – "Target Injection and Tracking System Design Requirements Basis", GA Report 7-0001-02DR

September 2000 – DRAFT "Conceptual Design Report for the Target Injection and Tracking System"

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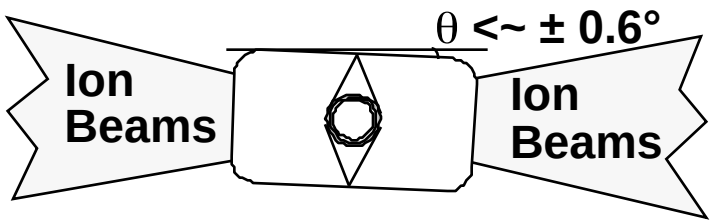
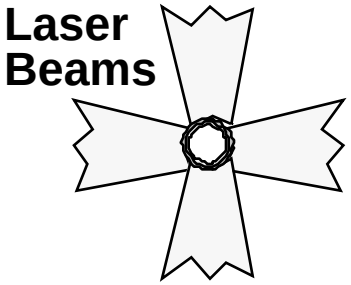
Targets must be precisely tracked into the reaction chamber at a speed of 100-400 m/s meeting tight positioning and temperature change requirements



Indirect drive



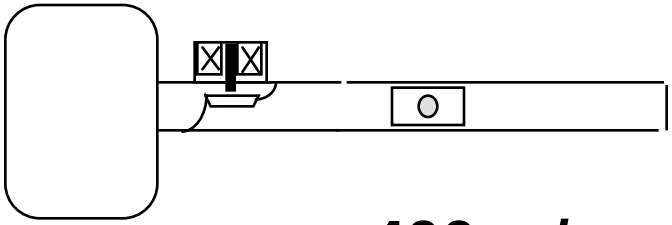
Direct drive

v ~ 100 m/s	~400 m/s (due to heating)
a ~ 1,000 - 10,000 m/s^2 (Acceleration is limited by target and DT strength)	Possibly higher
f ~ 6 targets/s	Same
Free flight distance ~8 m	~16 m
DT Temp rise <~0.5 K (hohlraum insulation)	<~0.5 K (greater in outer layer?)
Target placement variation <~± 5 mm	Same
Beams on target lateral position error <~±0.2 mm	Beams on target position error <~±0.02 mm

(much larger axial position error is acceptable)

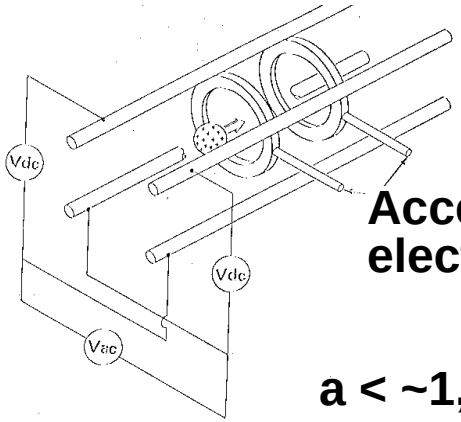
A gas gun is the recommended injector because of its simplicity and ability to meet injection requirements

Gas gun



v < ~400 m/s

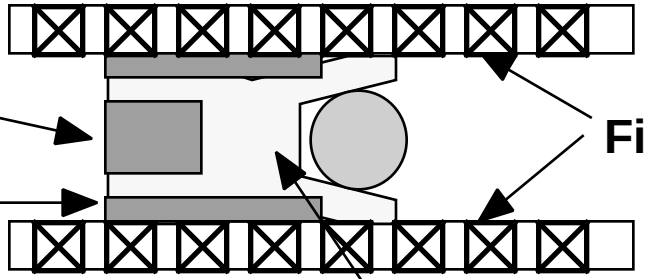
Electrostatic accelerator



Accelerating electrodes

a < ~1,000 m/s²

Magnetic accelerator



Ferromagnetic cylinder or conducting ring

Field coils

Sabot

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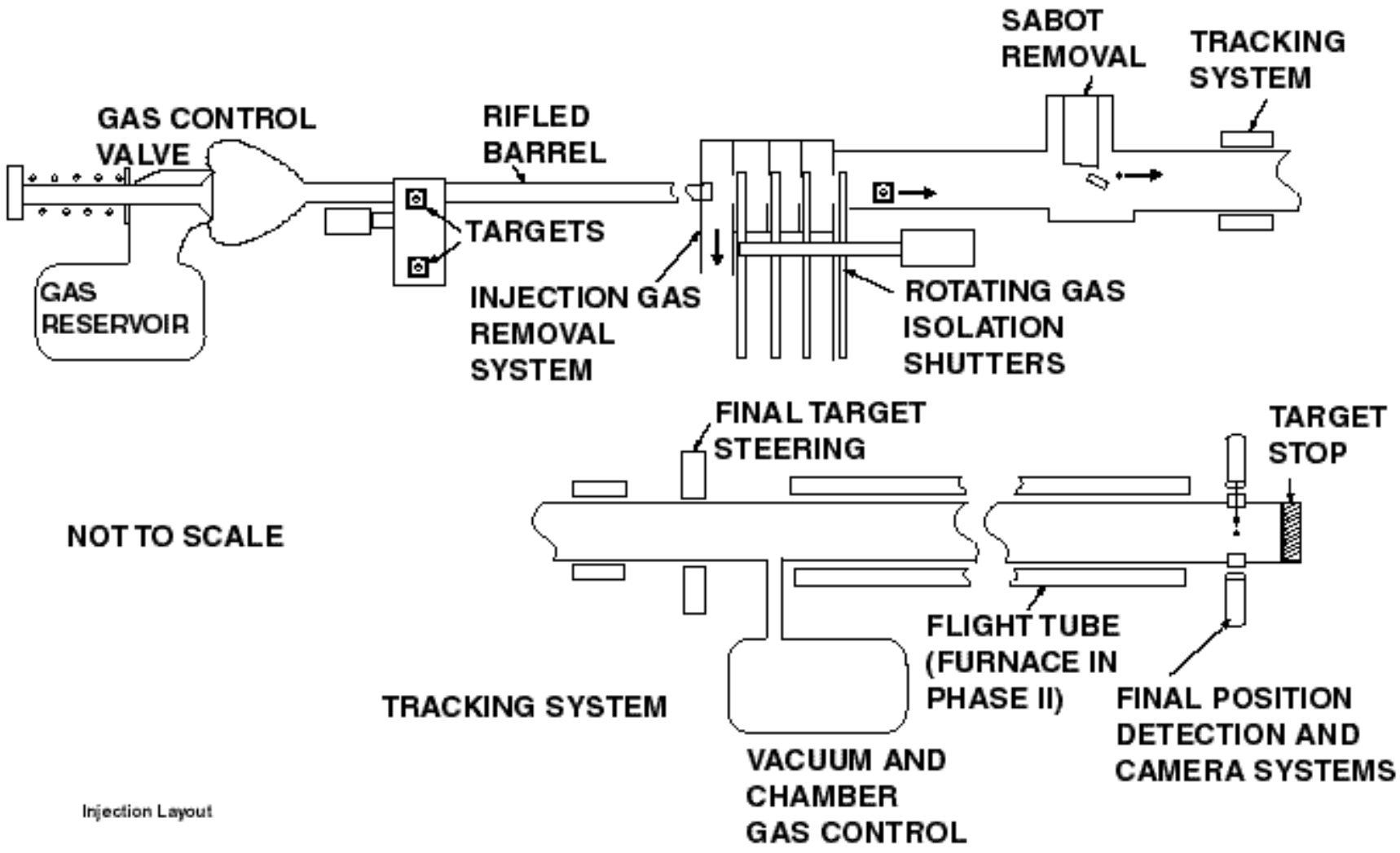
Target injection and tracking conceptual layout



Injection Layout

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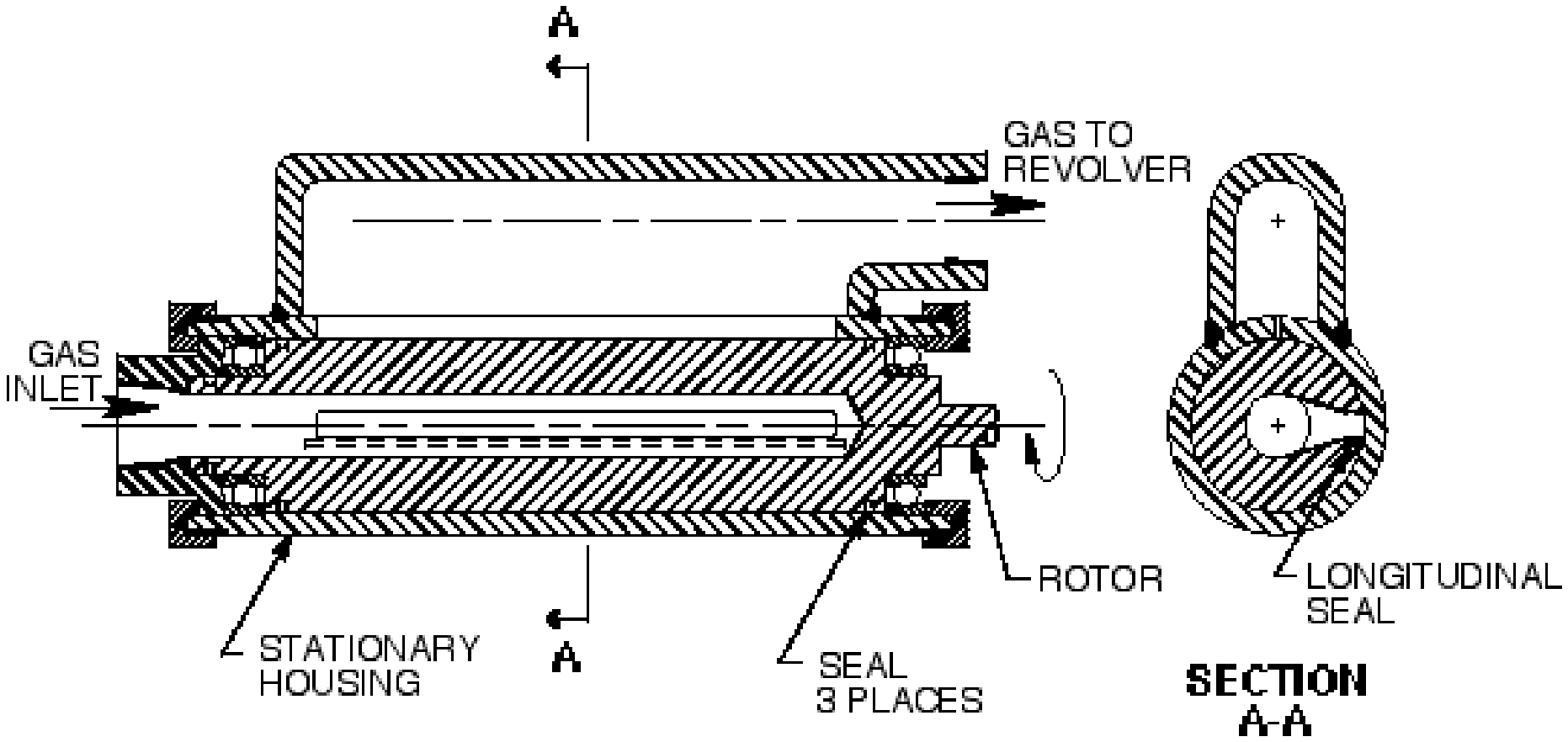
A rotary valve may be used to supply propellant gas quickly with sufficient flow rate



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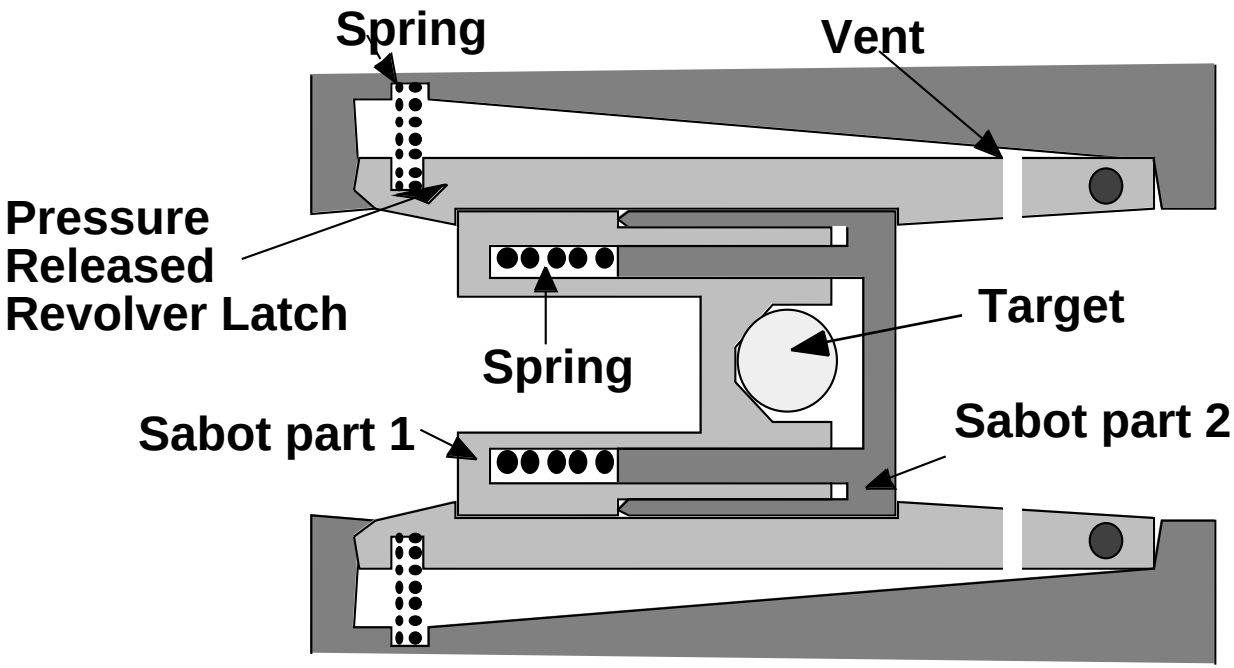
A sabot protects a direct drive target from thermal and mechanical damage in the gas gun

Gas pressure releases the sabot from the revolver latch assembly
A motion picture of the spring-loaded sabot separation is located at

http://aries.ucsd.edu/ARIES/WDOCS/IFE/sabot.html



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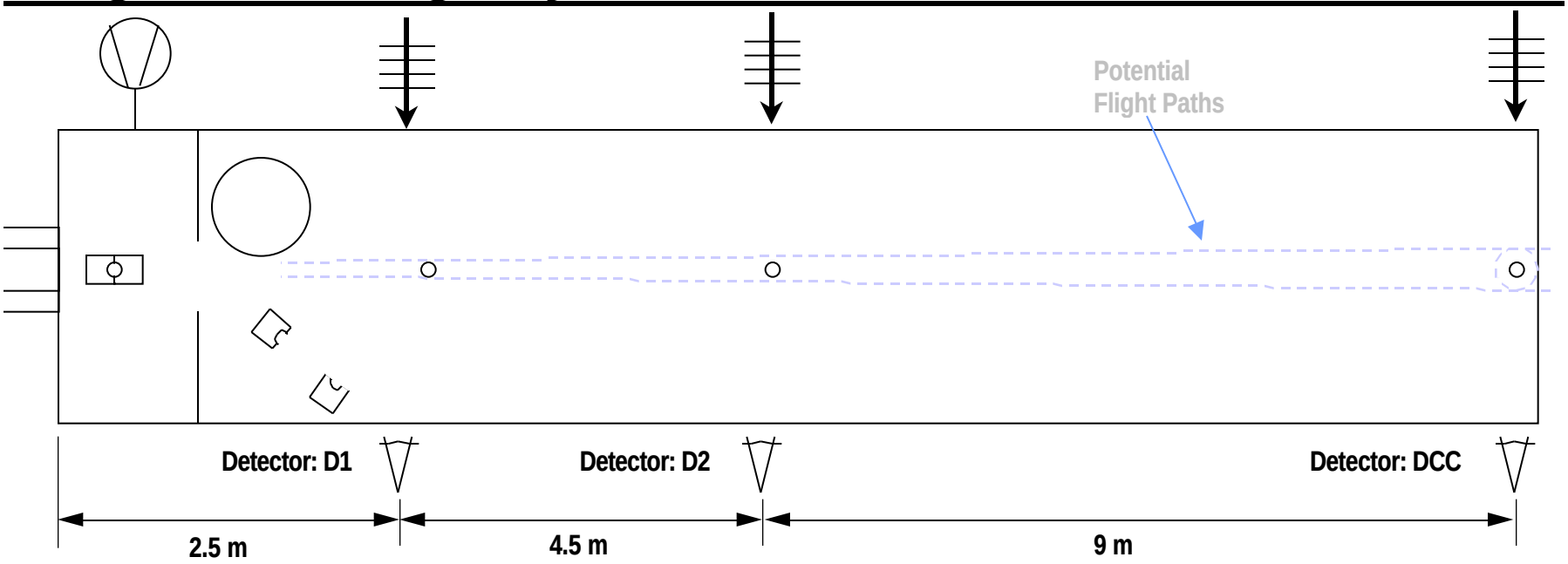
Target Tracking Layout



- Each detector is
  - A pair of orthogonal transverse position detectors
  - A timing photodiode (axial position)
  - Light sources
- Position at CC is triangulated from D1 and D2
- Additional timing photodiodes as required precede detectors for exposure ("shutter") control as needed

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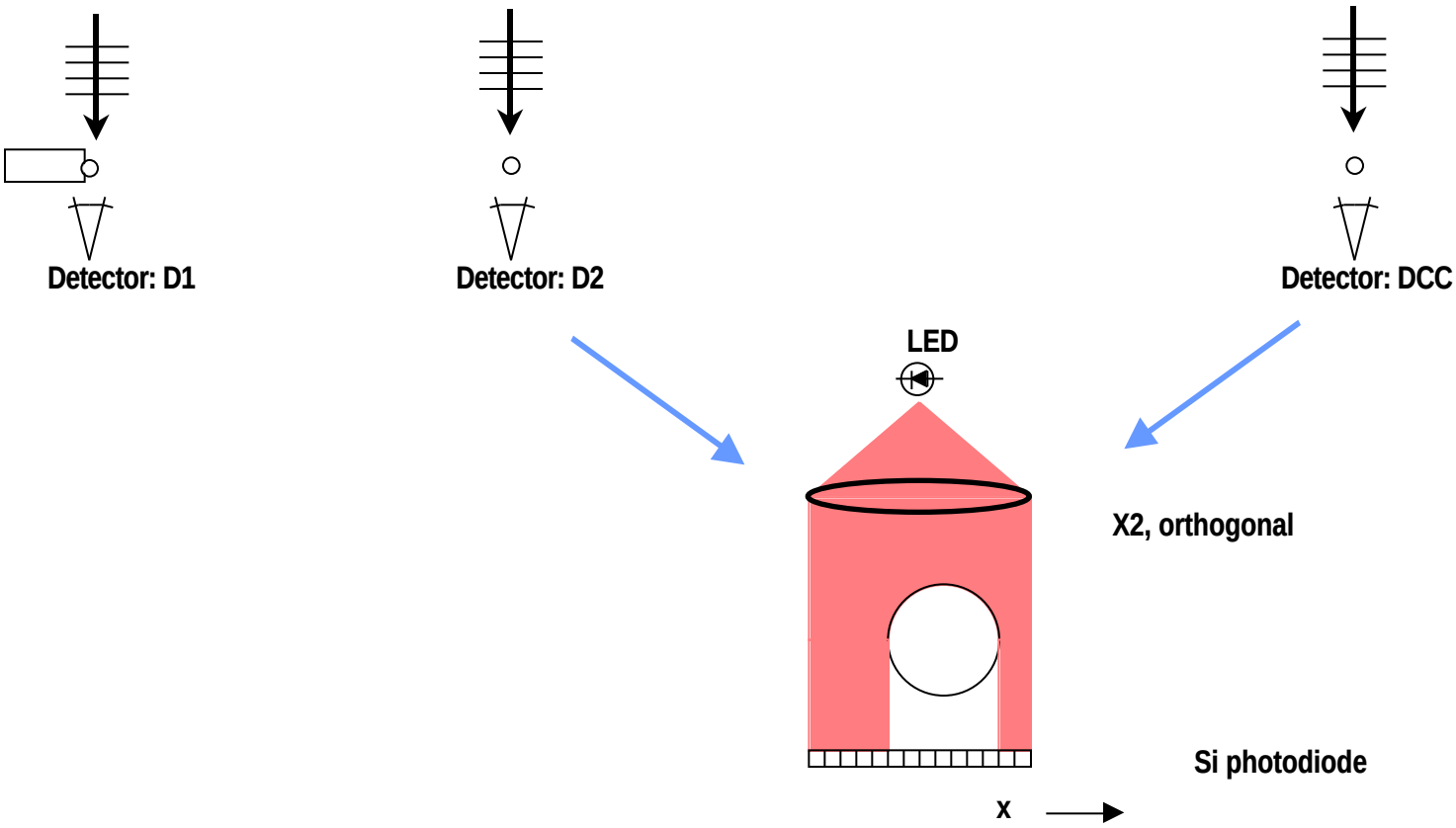
Linear Array Photodiode Method



- 8192 x 1 element arrays available with 7µm x 7µm pixels, 57 mm long
- 12.2 mm FOV / 8192 implies 1.6 µm resolution can be achieved
- Detector can view whole target, Poisson spot, or edge
- Various algorithms for computing center

GENERAL ATOMICS

Current Status

- Critical issues have been identified and agreed upon by the IFE community
- Requirements were developed and reviewed by the IFE community
- Development plan prepared to address the critical issues
- The Conceptual Design Review will be held 27 September 2000
- The project schedule will depend on funding levels

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