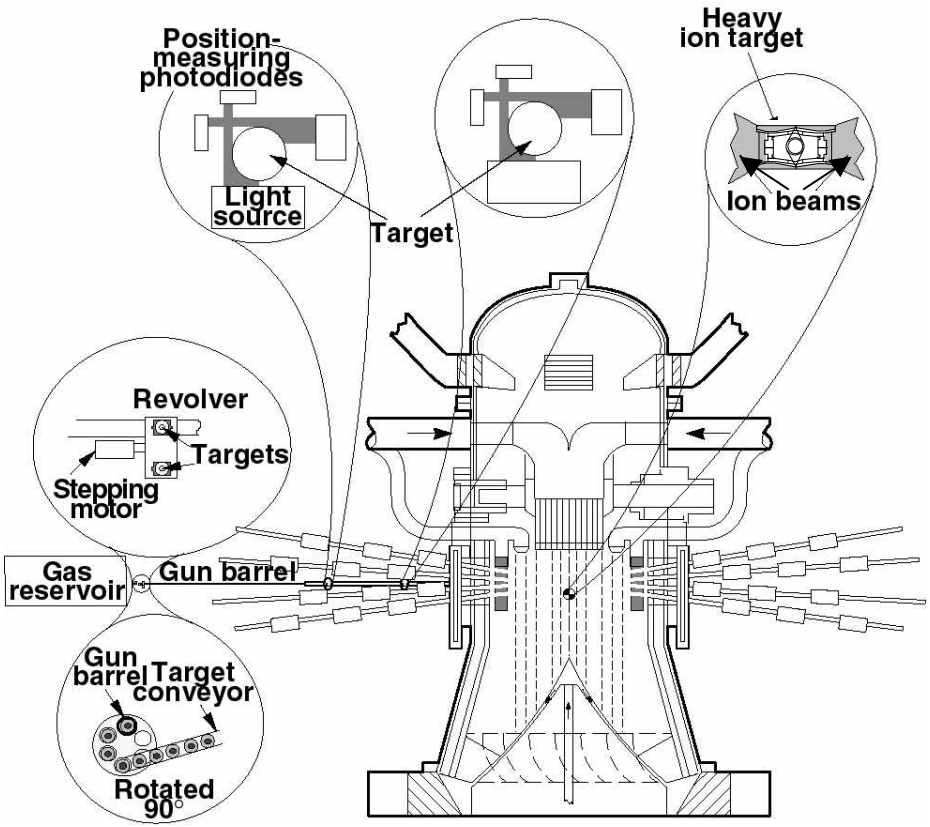
Indirect Drive Target Injection



Summary:

- **Target Structure for Acceleration**
- **Target Heating**
- **Flibe Diffusion**
- **Tracking/Positioning**

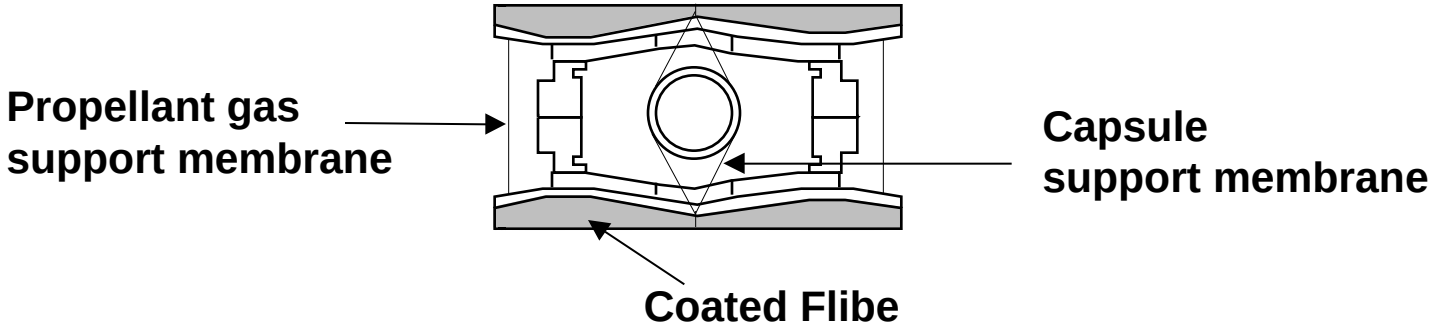
Ronald Petzoldt

ARIES IFE meeting, UCSD, La Jolla, CA **8 June 2001**

GENERAL ATOMICS

The target's structure must support acceleration

Target acceleration ~2500 m/s^2
Barrel length = $v^2/2a$ ~ (100 m/s)^2/[2(2,500 m/s^2)] = 2 m

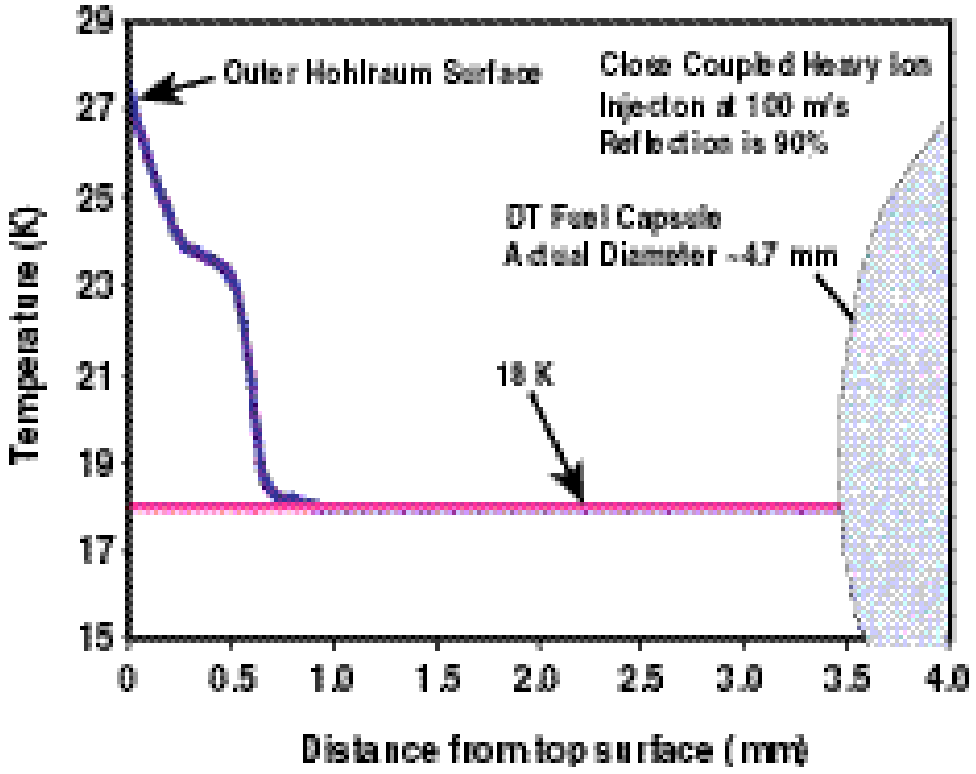


Flibe mechanical properties are unknown but may be similar to other salts
Low density foam properties are unknown
DT strength will be measured at LANL
(extrapolated DD properties indicate 10,000 m/s^2 acceptable)
Gas support membrane thickness for 2,500 m/s^2 is ~ 4 microns.
(4 microns absorbs about 1% of beam energy)
Capsule support membrane thickness ~ 0.2 micron* for 2,500 m/s^2
Capsule displacement ~100 microns can be reduced by pre-stressing membranes

*R. W. Petzoldt & R. W. Moir,
Membrane Support of Accelerated Fuel Capsules for Inertial Fusion Energy.
Fusion Technology, Vol. 30, Sep. 1996.

GENERAL ATOMICS

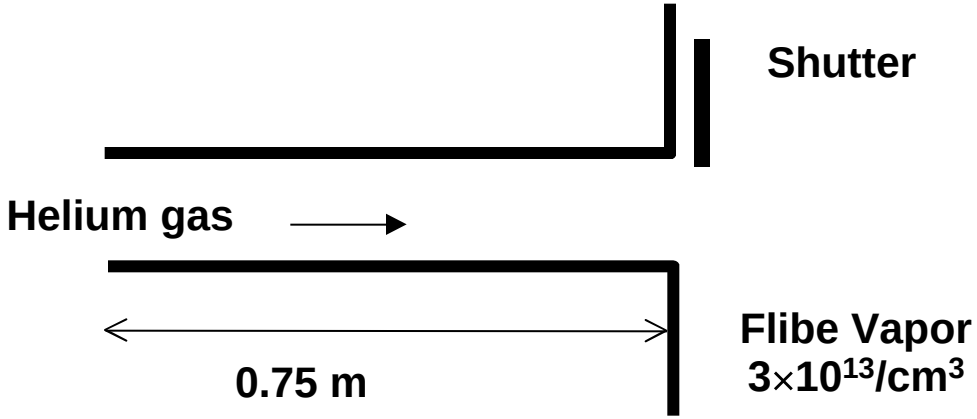
Heating of indirect drive targets during injection is small



Heating Profile:
300 K gas for 32 ms
No heat load for 30 ms
900 K chamber for 40 ms

GENERAL ATOMICS

Counter flowing helium and shutters can minimize Flibe vapor reaching tracking system*



2 cm opening requires ~4 Torr He with shutter open 5 ms.

Average flow rate ~0.4 mg/s.

Unabated Flibe diffusion = ~3 kg/year.

$$c = c_0 \exp\left[-\left(\frac{v}{D}\right)x\right]$$

D ~ 0.5 cm^2/s $(T/T_0)^{1.75}(P_0/P)$

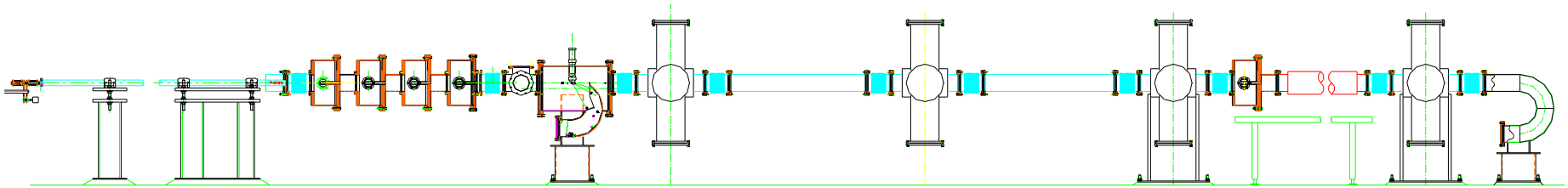
*R. W. Petzoldt, Flibe diffusion, Unpublished memo, (2000)

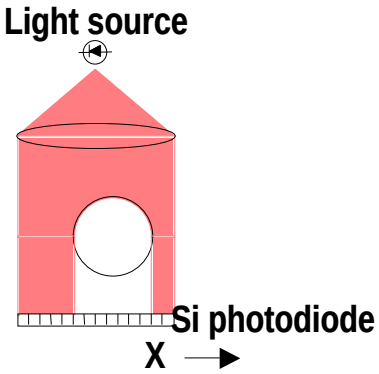
GENERAL ATOMICS

Need to demonstrate improved target tracking accuracy

1996-1998: Experimental injection and tracking experiment carried out at LBNL

- **Total transverse position prediction accuracy of σ = 160 μm achieved at 3 m distance, 70 m/s, and low repetition rate. Extrapolates to ~ 280 μm at 9 m.**
- **Current requirements:**
  - **Up to 180 m/s and nearly all targets ±100 μm at 9 m and 6 Hz**
  - **Vibration isolation and multi-segment arrays are expected to improve accuracy**
- **We're building experimental system to achieve improved accuracy**



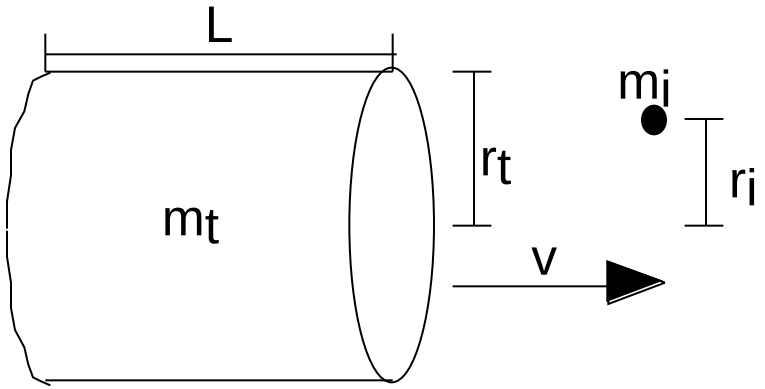


GENERAL ATOMICS

If Flibe droplet density and size are not excessive, in-chamber tracking should not be necessary

$$\Delta R = \frac{\Delta v}{v_0} R_c = \frac{m_d}{m_t} R_c \Rightarrow m_d = \frac{\Delta R}{R_c} m_t = \frac{0.3\ \text{mm}}{3\ \text{m}} 2\ \text{g} = 0.2\ \text{mg}$$

Droplet radius is 0.29 mm.
Smaller droplet density is limited to about 1 g/m^3.



Distance R_C from chamber center

Occasional verification of beam on target position may still be required.

GENERAL ATOMICS

Summary and Conclusions

- Targets must be strong enough for acceleration
- DT mechanical properties are being measured, others need to be
- Indirect drive target heating is calculated to be small during injection
- Gas counter flow can keep Flibe out of tracking system
- Target transverse position is measured with linear photodiode arrays.
  (Requires high speed arithmetic on pixel outputs.)

GENERAL ATOMICS

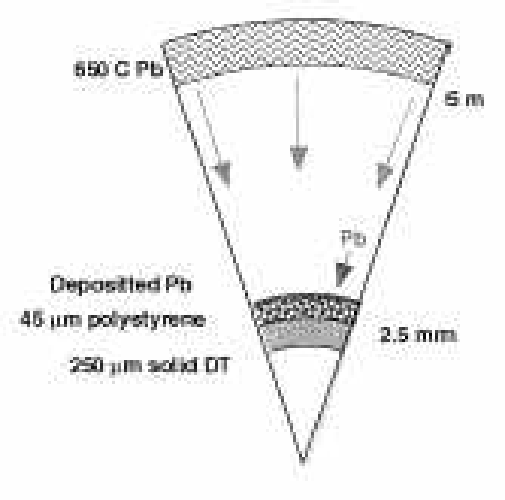
Target heating in chamber with metal vapor

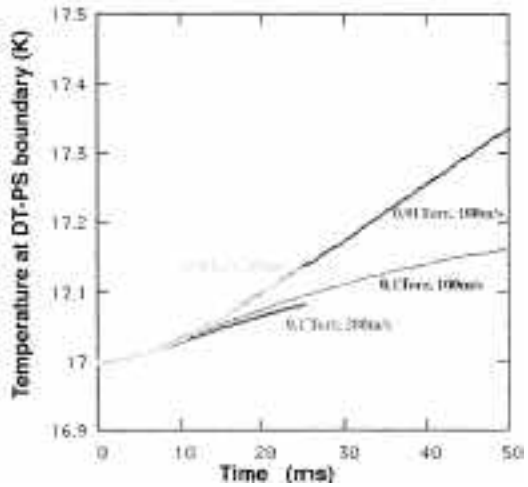
Norimatsu studied for KOYO reactor (650 C LiPb) conservatively assumed all vapor molecules that hit target stick.

Average 800 Å thick for 5 m at 200 m/s in 0.1 Torr LiPb vapor

not uniform even if target spinning.

DT surface heating <0.4 K is reduced to <0.2 K by deposited metal layer.





Influence of Residual Gas on Trajectory of Injected Target
T. Norimatsu, A. Sunahara, K. Nagai, and T. Yamanaka,
Institute of Laser Engineering Osaka University
Presented at the Target Fabrication meeting
November 8-11, 199, Avalon, CA

GENERAL ATOMICS