E906 Targets

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in collaboration with
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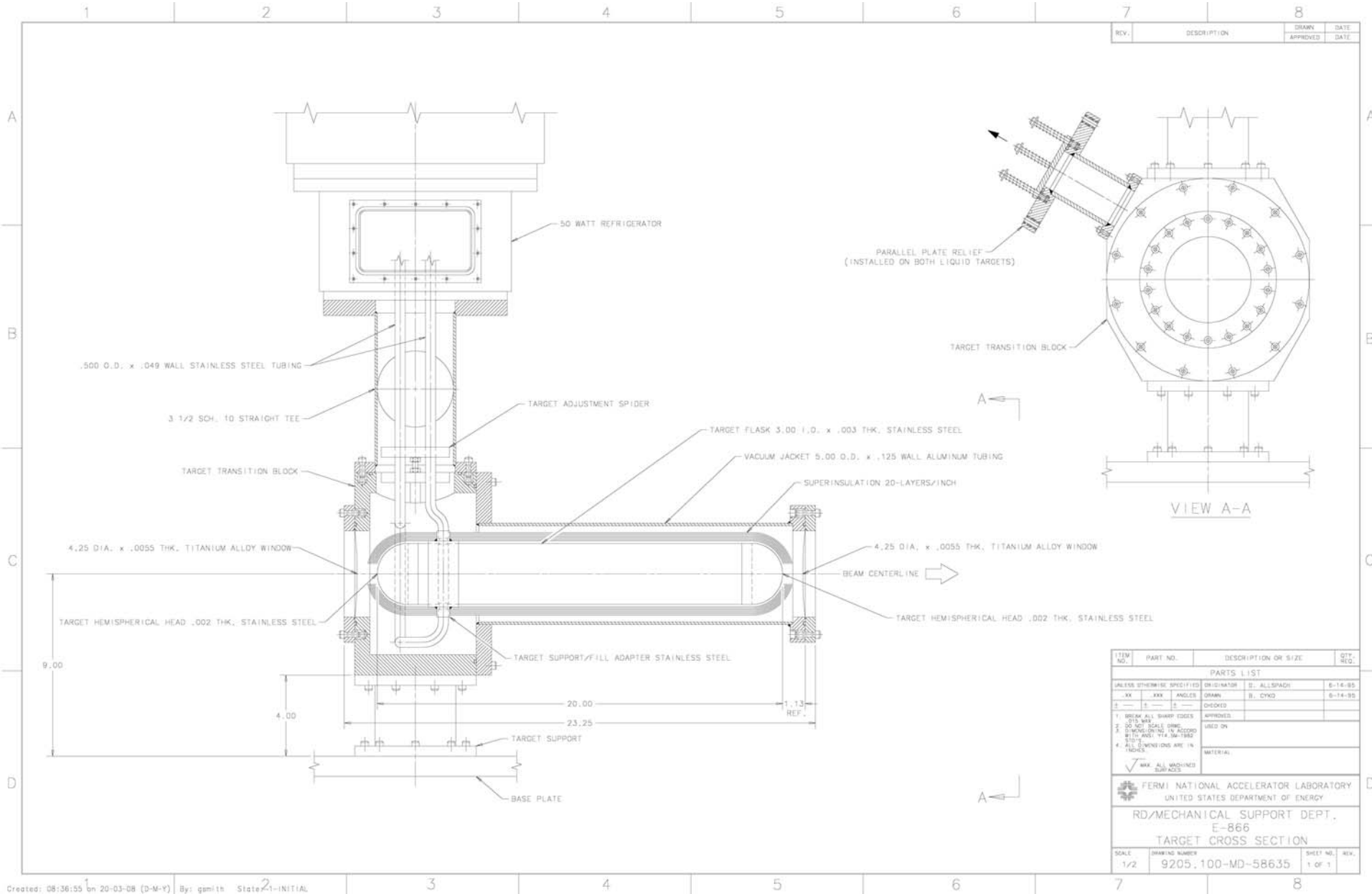
June 2008 collaboration meeting

E866 liquid target cell drawing exists



Stuff exists (in lab F…)

E906 targets

- same 3 cells (LD2, LH2, empty)
  - 50.8 cm long, interchanged every 30 min (takes 30 sec?)
- C, Ca or Fe, W
  - “approximately 10 mg/cm^2”
  - are these new? Is there an insertion mechanism?

- Is there a simulation/generator for the nuclear systems (any need to optimize thickness, choice of (Z,A) any further, etc)?

E906 Cryotargets: path to experiment

- Possible collaborative contribution from U Michigan and U Maryland -- still need to understand scope of work!
  - U Mich: target assembly/construction (Lorenzon + Raymond + …)
  - U Maryland: controls, safety documentation, etc. (Beise+postdoc+student)

1. identify existing parts/drawings (underway)
2. identify funding (??? possible NSF-MRI proposal?)
3. develop path for safety assessment (what bench tests required?) – will require substantial local support interaction
4. reassembly, etc.
5. How much hall infrastructure (plumbing/vent, etc.) is required/does any exist yes?
6. Is there a laboratory “standard” for controls system?

Cost estimate $200K (FNAL, Nov 2006)

- Cryogenics: $115K
  - includes 40 W refrigerator ~ $80K
- Instrumentation and Controls: $50K
  - includes pressure/temp transducers, slow controls instrumentation, I/O readout, computer…
- Target motion $8K
- Safety $5K

11/14/2006	Eng MW	Tech MW	M&S	
Target Cryogenics				
heat and mass balance documentation review	1	0	$0.0	review existing documents
operating procedures	1.5	0	$0.0	revise existing documents
commissioning	2	4	$0.0	
build and test flasks	0.5	6	$3.0	three stainless flasks, soldered construction, pressure test and leak test
build and test vacuum vessels	4	6	$5.0	three vessels, modify design around cryocoolers
cryocooler interfaces	6	6	$3.0	modify design around cryocoolers
purchase and test cryocoolers	1	3	$80.0	air cooled, 40 watts, performance test
electric power for cryocoolers	0.2	0	$1.0	
pneumatic actuated valves	0.1	1	$7.0	14 solenoid-pneumatic combos.
solenoid valves	0.1	0.2	$0.5	6 solenoid valves
manual valves	0.2	2	$9.0	46 manual valves
vacuum pumps	0.4	6	$6.0	salvage diff pumps, new roughing pumps, overhaul carts
Instrumentation & Controls				
Pressure instruments	1	2	$9.0	18 pressure transmitters
flow instruments	0.1	0.1	$1.0	2 flow transmitters
temperature instruments	1	1	$6.0	20 temperature instruments
power and current instruments	0.1	0.4	$3.0	heater power, pump motor current
Controller	1	0.5	$22.0	75 I/O count for cryogenics, assumes APACS
HMI, including PC	1	3	$10.0	
instrument air compressor, filter, reverse osmosis	0.1	0.2	$0.5	
misc terminal blocks, fuses, cabinet, cables	0.1	0.2	$1.0	
Target motion				
table mechanical	0.5	1	$0.5	polish guides, design & build support
table control	0.5	0.5	$1.5	new motor, driver, encoder, limit switches
wheel mechanical	0.2	6	$5.0	still looking for old frame, assume it's lost
wheel control	0.5	0.5	$1.5	new motor, driver, encoder
Target Safety				
Safety report preparation	3	0.5	$0.0	
ODH analysis	0.5	0	$2.0	
Safety review	1	0	$0.0	
Ventilation system	0.2	2	$2.0	
tent	0.5	1	$2.0	
Sum	28.3	55	$181.5	
Contingiency	42.45	82.65		

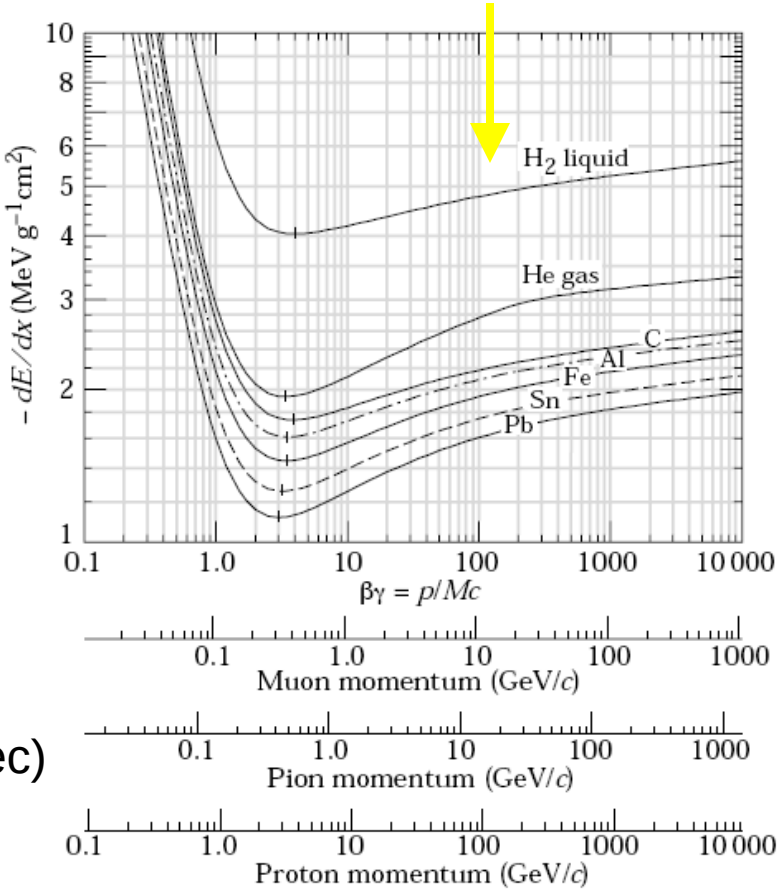
Power Deposition in Targets

$\beta\gamma \sim 128$

Energy Loss in Hydrogen
for 120 GeV protons:

$$\frac{dE}{dx}(H) = 4.5\,\mathrm{g/cm^2}$$

$$\Delta E = \left(4.5\ \mathrm{MeV\text{-}cm^2/g}\right) \times (0.07\,\mathrm{g/cc}) \times (50\,\mathrm{cm}) = 15\,\mathrm{MeV}$$



assuming 2x10^{12} p/s for 5 s:

peak power deposition = 5 W (for 5 sec)
→ 0.5 W average

w/convection:

$$\Delta T = \frac{\Delta Q}{m \cdot c_p} = \frac{(5\,\mathrm{W} \times 5\,\mathrm{s})}{(0.07\,\mathrm{g/cc} \times 2280\,\mathrm{cc}) \times (8.8\,\mathrm{J/g\text{-}K})} = 0.02\,\mathrm{K}$$

$$\frac{\Delta\rho}{\rho} \approx 0.015 \times \Delta T(K)$$

x20 higher if no convection (all heat in 1x1 cm^2 column of beam)

Target density vs temperature

(from G. Smith's Hall C target training slides
http://www.jlab.org/~smithg/target/Hall_C_Cryotarget.html)

ρ (T, P)

Hydrogen

T (K)	P (psig)	ρ (H2) (g/cm^3)
18.5	8.22	0.07283
19.0	"	0.07231
19.5	"	0.07176
19.0	7.35	0.07230
"	8.22	0.07231
"	9.09	0.07231

Deuterium

T (K)	P (psig)	ρ (D2) (g/cm^3)
21.5	8.3	0.16868
22.0	"	0.16743
22.5	"	0.16613
22.0	7.3	0.16741
"	8.3	0.16743
"	9.3	0.16744

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