

Notes on Booster Vacuum

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NOTES ON BOOSTER VACUUM

Booster Technical Note
No. 13

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In order to satisfy the condition in Ref. 1 by a good safety margin, design pressure of $3-5 \times 10^{-11}$ Torr has been adopted for Booster vacuum system described in Ref. 2. (designed by Dick Hseuh) This all metal system bakable to 200°C is firmly based on the ISR and CBA 60m model experience³ which serve as existence proves,

Basically this system consists of vacuum chambers with 50 cm perimeter (A) pumped every 8.4m by a CBA pumping station, having a pumping speed (S) of 1600 l/s and 1000 l/s for H_2 and CO respectively³. In such a system the average pressure, P_{ave} ,

$$P_{\text{ave}} = P_0 + ALQ \frac{1}{S} + \frac{L}{12C} \quad 1$$

Where

P_0 = Pressure in the pumping station (1×10^{-11} Torr)

L = Distance between pumps 840 cm

Q = H_2 Outgassing rate taken as 3×10^{-13} Torr $\text{l cm}^{-2}\text{s}^{-1}$

(Q = 1×10^{-13} Torr. $\text{l.cm}^{-2} \text{s}^{-1}$ was achieved⁴. However, due to bellows, pick-up electrodes etc. the above more conservative value is used)

C = Conductance of chamber for H_2 (720001 cm s^{-1})

Since more than 90% of gas content in the system is hydrogen⁴, Q, S and C values for H_2 (hydrogen) are used in Eg. 1 which yields

$$P_{ave} = 3 \times 10^{-11} \text{ Torr}$$

Presence of other gasses such as CO and CH₄ increases P_{ave} only slightly.

$P \approx 4 \times 10^{-11}$ Torr would provide a safety factor of four even for stringent conditions in Ref. 1.

Care must be taken that all special equipment in straight sections, such as RF cavities, injection system, septum magnets and kickers are designed for VHV operation, operating in 10^{-11} Torr range.

References

1. G. R. Young, RHIC pg.16 (1983)
2. AGS Booster Conceptual Design Report, Vol. 1; BNL#34989R pg.47 (1985)3. H.
3. Halama, Proceedings of 8th Intern. Vac. Congress; Cannes, France; Vol. 2
pg.115 (1980)
4. H. J. Halama, J. Vac. Sci. Technol. 16(2) (1979)

H. Hatakeyama

III Injection from Linac and
into AGS $\leq 1 \times 10^{-7}$ Torr
ion pumps

IV Differential pumped area
 $\leq 1 \times 10^{-8}$ Torr
by getter/cryopumps

HEBT $\leq 1 \times 10^{-7}$
AGS $\leq 1 \times 10^{-7}$

7. Ring Vacuum $\leq 1 \times 10^{-10}$ Torr
all metal system (4×10^{-11})
bakeable to 200°C

6 vacuum sectors

Ti sublimators + ion pumps

ACCUMULATOR / BOOSTER

II Transfer line from tandem $\leq 1 \times 10^{-9}$ Torr
bakeable to 150°C
non-evaporable getter + ion pumps

50 MEV LINAC BLDG

HEAVY IONS FROM TANDEN VAN DEGRAFF

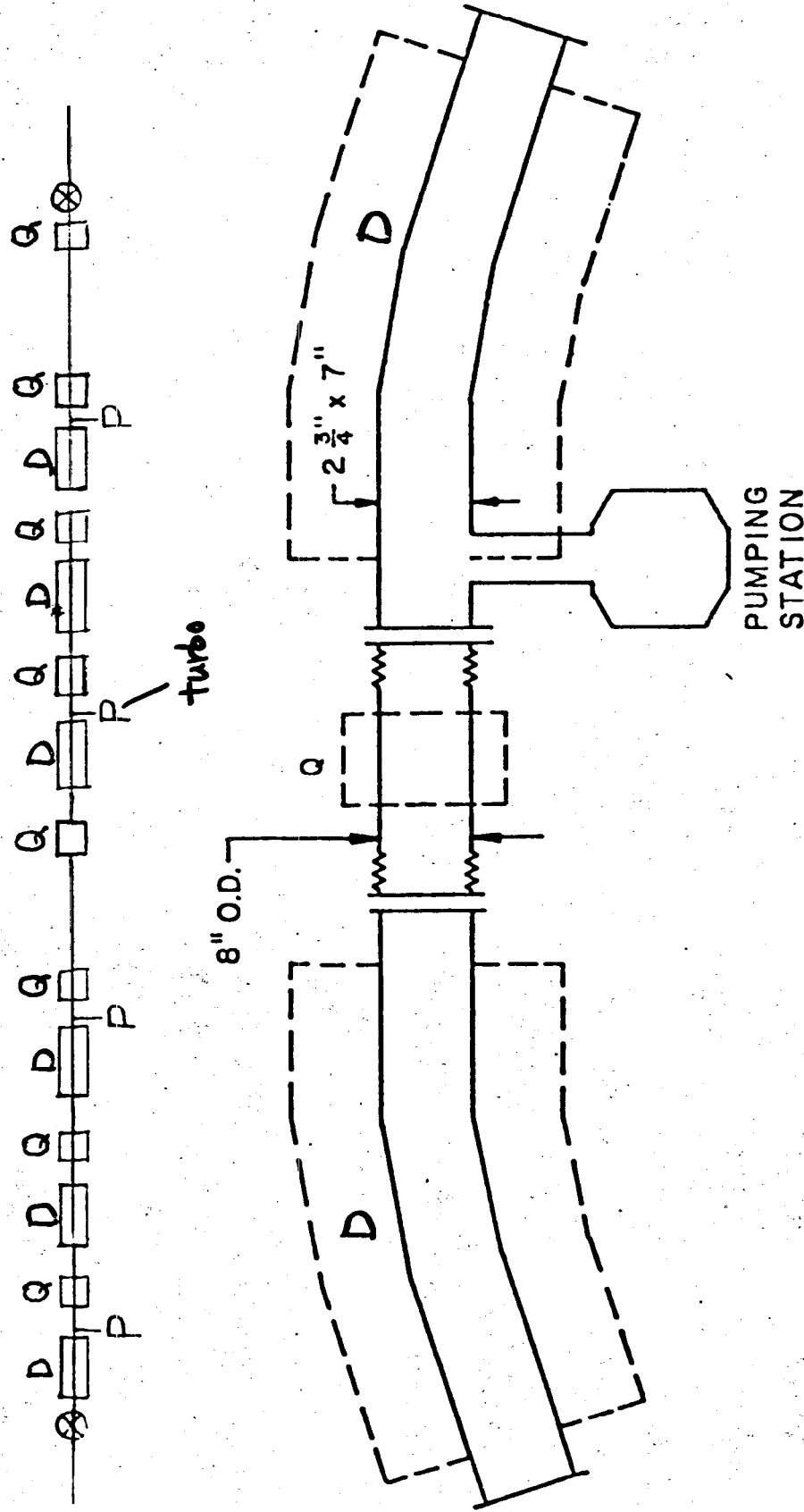
AGS RING

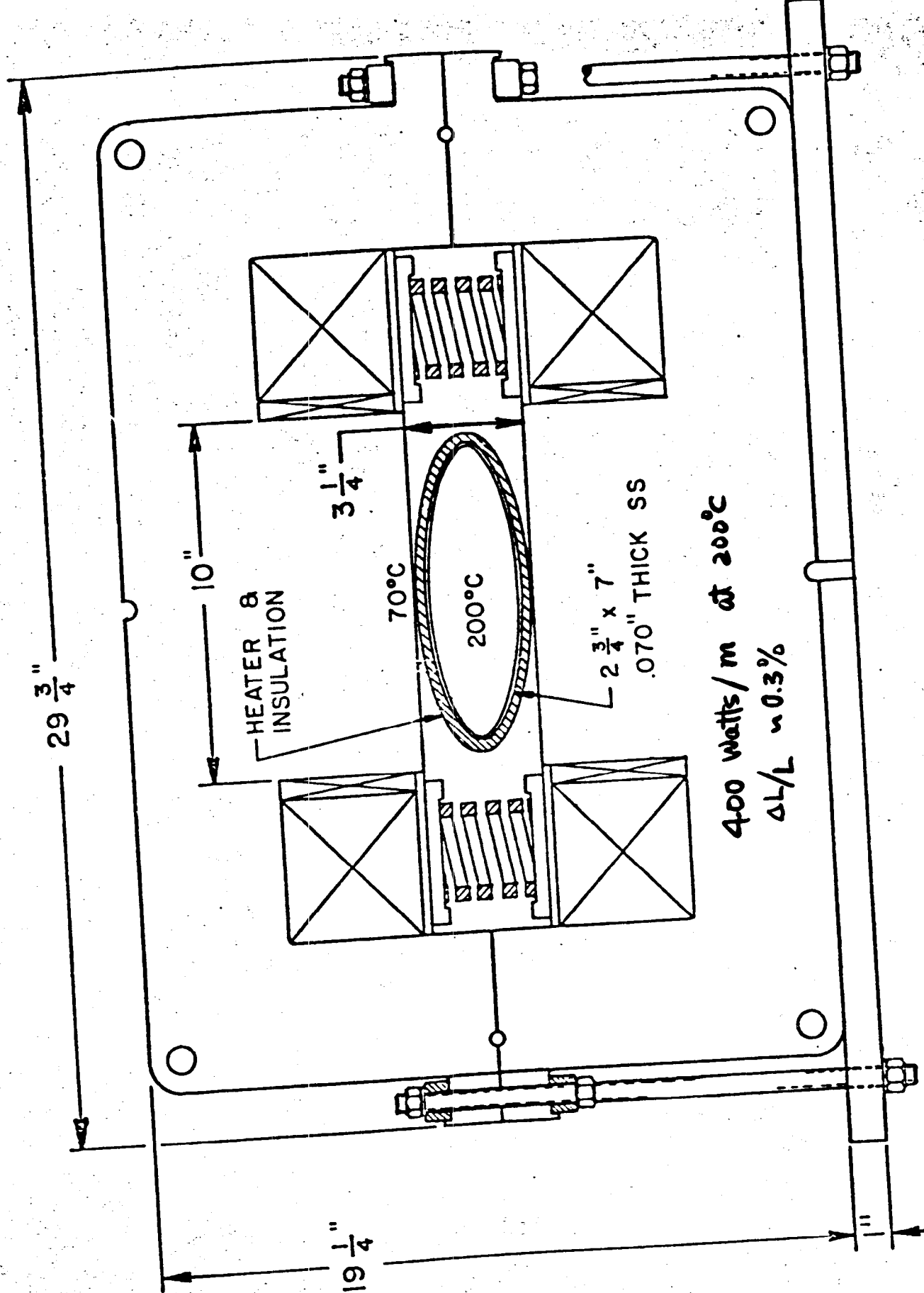
120

I Ring Vacuum System $\sim 4 \times 10^{-4}$ Torr

Vacuum sectors ~ 37 meter each

4. ultrahigh vacuum pumping stations (Ti, IP, IG) 8.5 m between pumps
1 turbomolecular pumping station





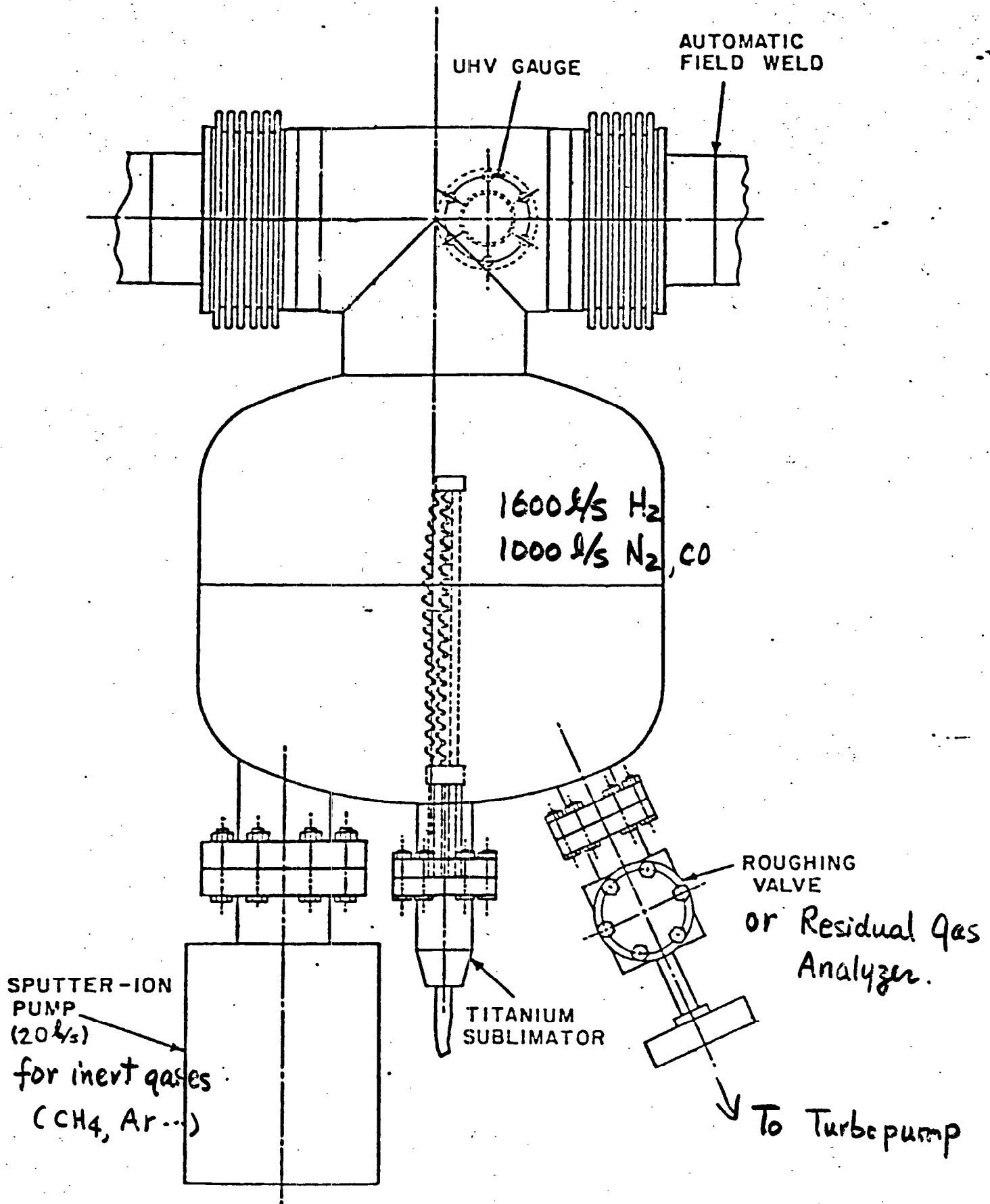


Figure 12 - Typical pumping station of accumulator/booster ring.

Vacuum Characteristics of Booster Ring

- all metal system
 - vacuum fired at 900°C
 - glow discharge cleaned before assembly
 - insitu baked at $200^{\circ}\text{C} \times 24 \text{ hrs}$
 - \Rightarrow outgassing $3 \times 10^{-13} \text{ Torr} \cdot \text{l/s} \cdot \text{cm}^2$
 - $\sim 90\% \text{ H}_2$, $\sim 10\% \text{ CO}$, $< 1\% \text{ CH}_4, \text{Ar} \dots$
 - pumped by Ti sublimation pump
 - 1600 l/s for H_2
 - 1000 l/s for CO, N_2
 - 20 l/s ion pump
 - 10 l/s for CH_4
-

III Injection from Linac and
into AGS $\leq 1 \times 10^{-7}$ Torr
ion pumps

IV Differential pumped area
 $\leq 1 \times 10^{-8}$ Torr
by getter/cryopump

HEBT $\leq 1 \times 10^{-7}$
AGS $\leq 1 \times 10^{-7}$

V T. Ring Vacuum $\leq 1 \times 10^{-10}$ Torr
entire metal system (4 $\times 10^{-11}$)
bakeable to 200°C
6 vacuum sectors
Ti sublimators + ion pumps

ACCUMULATOR / BOOSTER

II Transfer line from tandem $\leq 1 \times 10^{-9}$ Torr
bakeable to 150°C
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50 MEV LINAC BLDG

HEAVY IONS FROM TANDEN VAN DEGRAFF

AGS RING

1.70

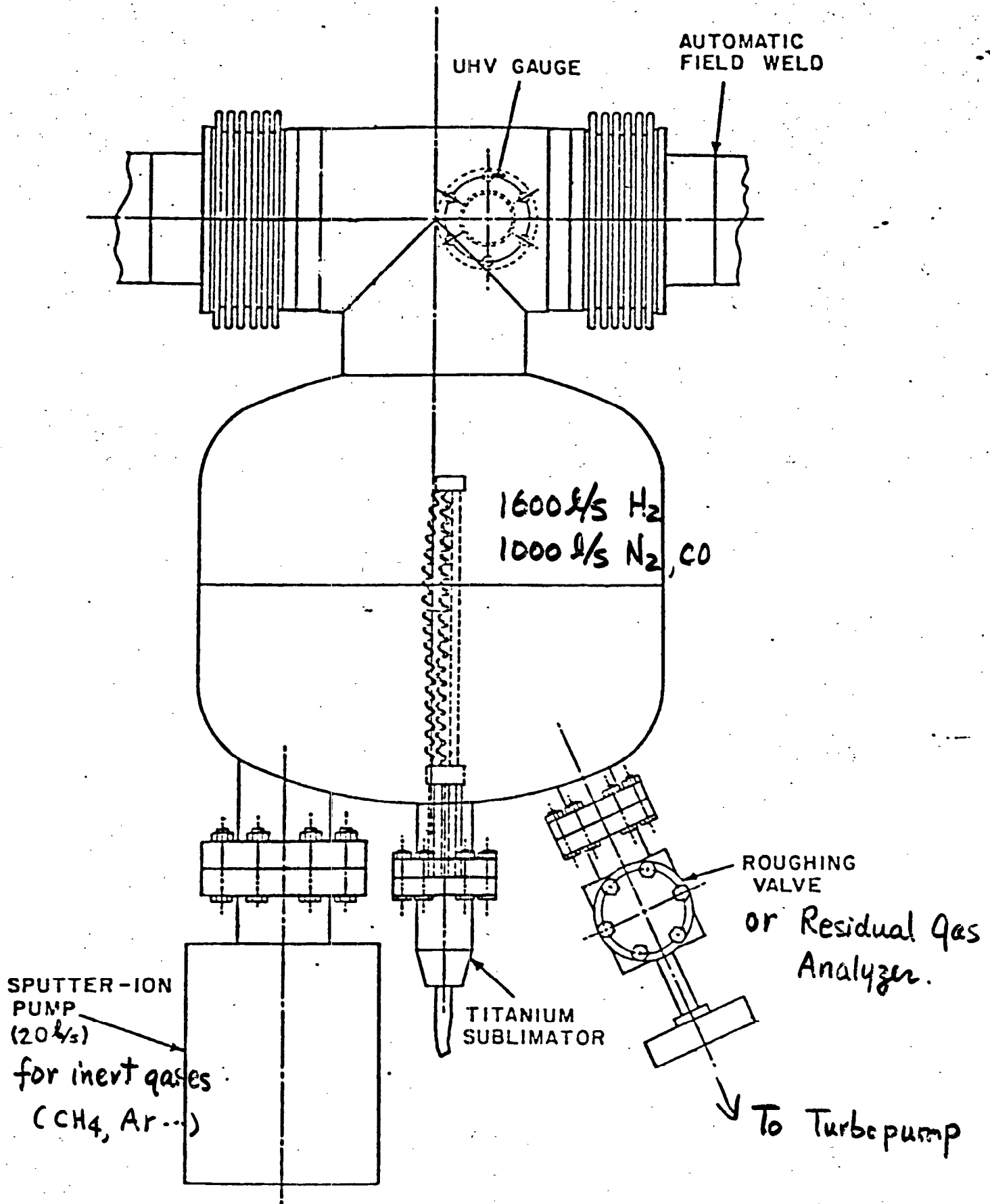


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1000 l/s for CO, N_2
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