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Notes on Booster Vacuum

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USDOE Office of Science (SC)

DISCLAIMER

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In order to satisfy the condition in Ref. 1 by a good safety margin, design pressure of $3\text{-}5\times10^{-11}$ 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 experience[3] which serve as existance prooves.

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 respectively[3]. In such a system the average pressure, P_{ave},

$$P_{ave} = P_o + ALQ \left(\frac{1}{S} + \frac{L}{12C} \right) \qquad 1$$

Where

P_o = 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 l $cm^{-2}s^{-1}$

($Q = 1 \times 10^{-13}$ Torr.l.cm $^{-2}$ s^{-1} was achieved[4]. 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 hydrogen[4], Q, S and C values for H_2 (hydrogen) are used in Eg. 1 which yields

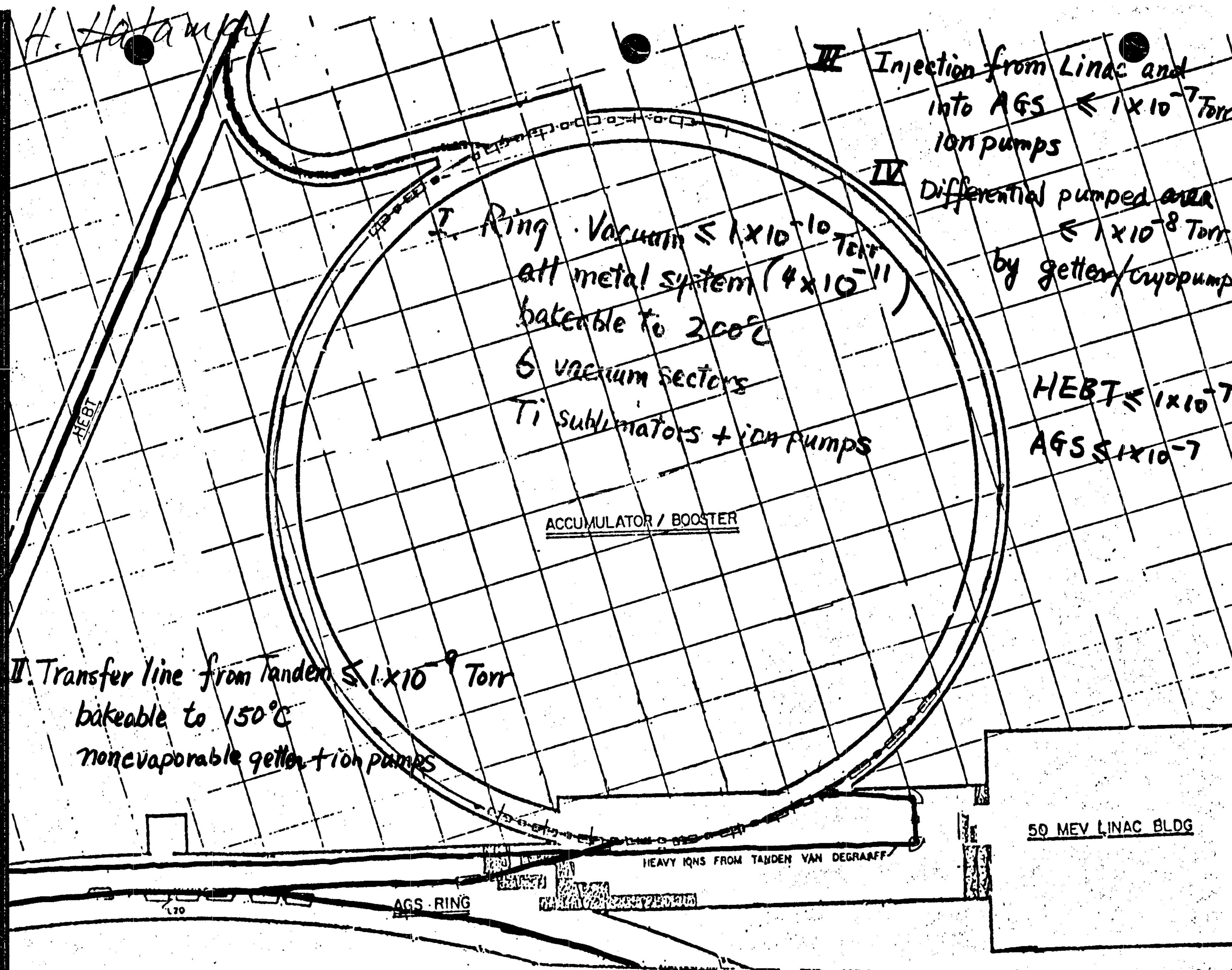
$$P_{ave} = 3 \times 10^{-11} \text{ Torr}$$

Presence of other gasses such as CO and CH_4 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)

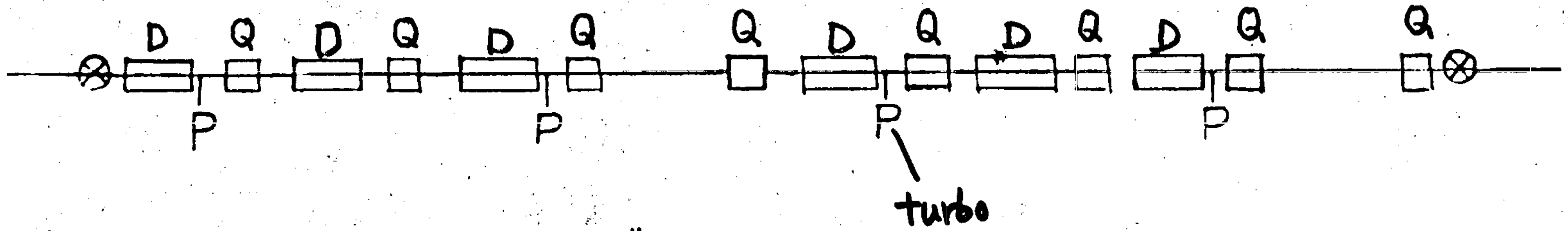

H. Halama
I. Ring Vacuum ≤ 1×10⁻¹⁰ Torr
all metal system (4×10⁻¹¹)
bakeable to 200°C
6 vacuum sectors
Ti sublimators + ion pumps
II. Transfer line from Tandem ≤ 1×10⁻⁹ Torr
bakeable to 150°C
nonevaporable getter + ion pumps
III Injection from Linac and
into AGS ≤ 1×10⁻⁷ Torr
ion pumps
IV Differential pumped area
≤ 1×10⁻⁸ Torr
by getter/cryopump
HEBT ≤ 1×10⁻⁷
AGS ≤ 1×10⁻⁷
HEBT
ACCUMULATOR / BOOSTER
HEAVY IONS FROM TANDEM VAN DEGRAAFF
AGS RING
50 MEV LINAC BLDG

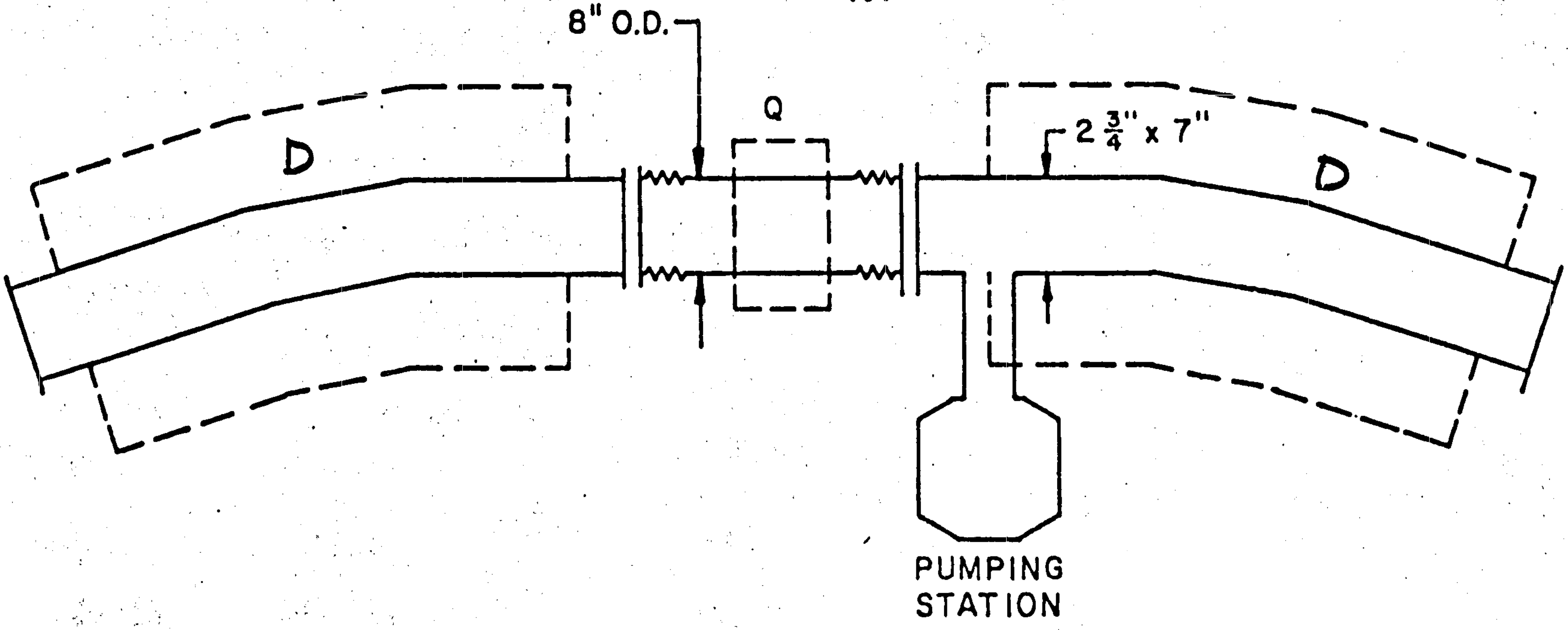
I Ring Vacuum System $\sim 4 \times 10^{-11}$ Torr

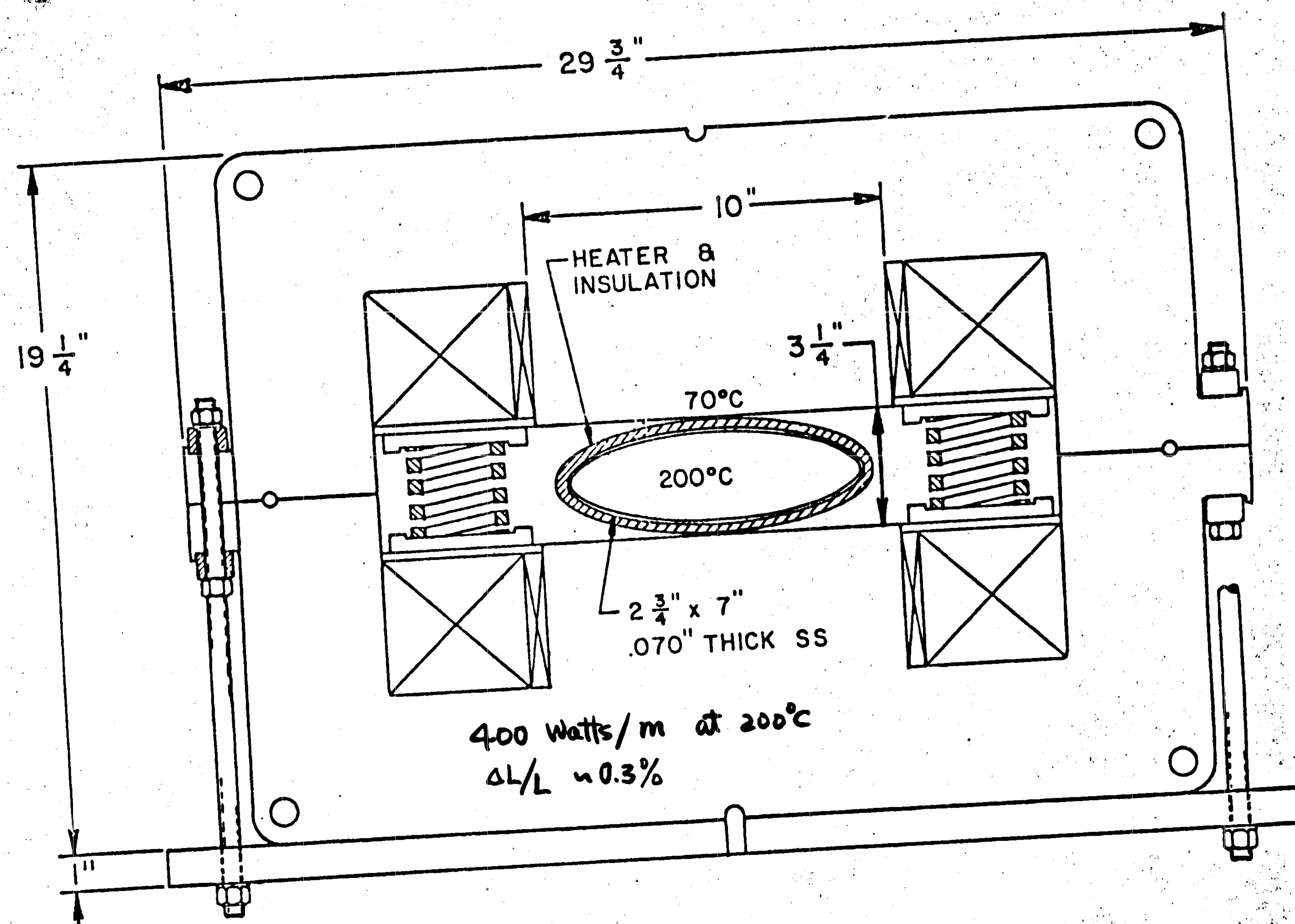
Vacuum sectors ~37 meter each

4 ultrahigh vacuum pumping stations (Ti, IP, IG) 8.5 m between pumps

1 turbomolecular pumping station







– Vacuum chamger in ring dipole magnet.

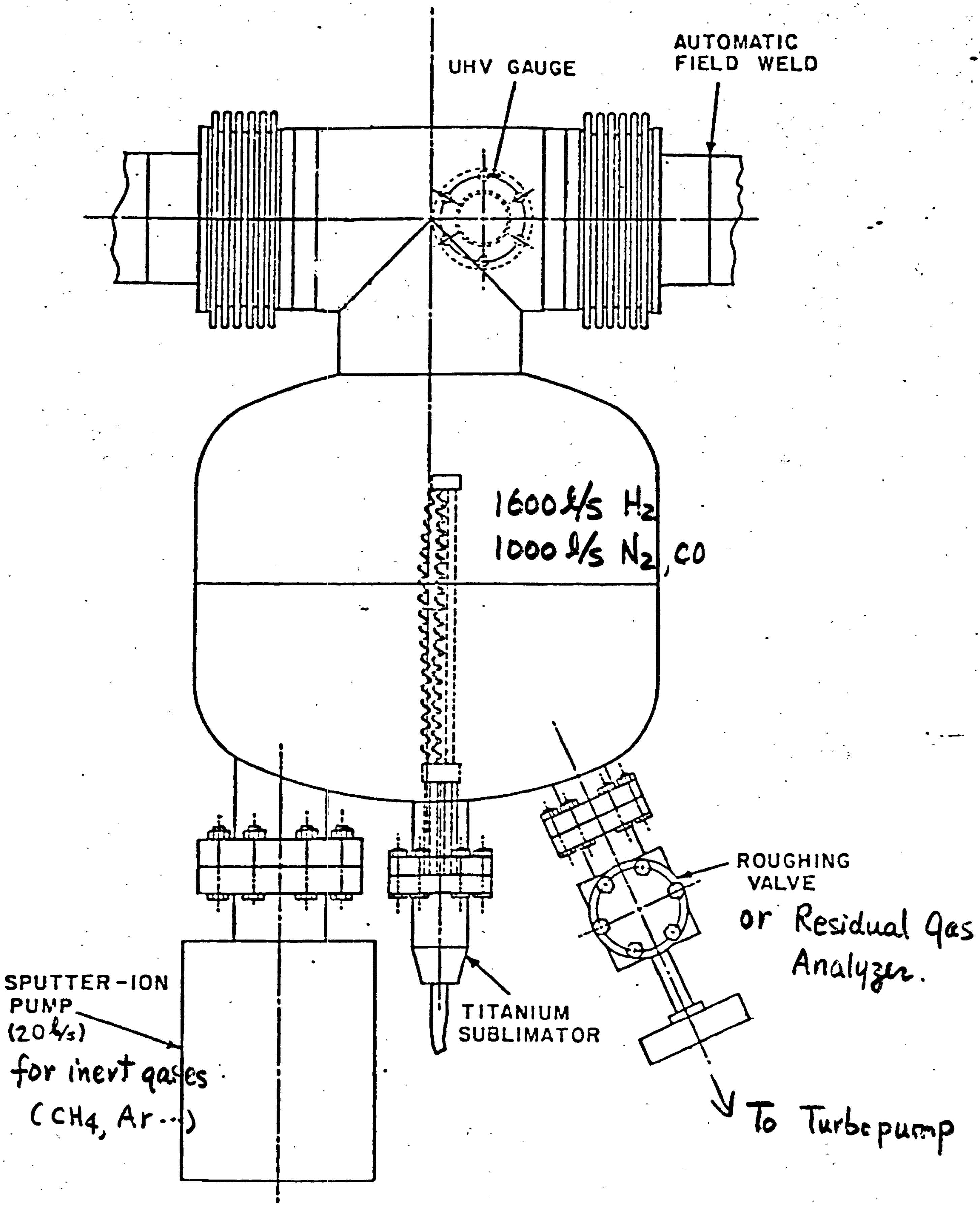


Figure 12 - Typical pumping station of accumulator/booster ring.

Vacuum Characteristics of Booster Ring

- all metal system
- vacuum fired at 900°C
- glow discharge cleaned before assembly
- insitu baked at 200°C × 24 hrs

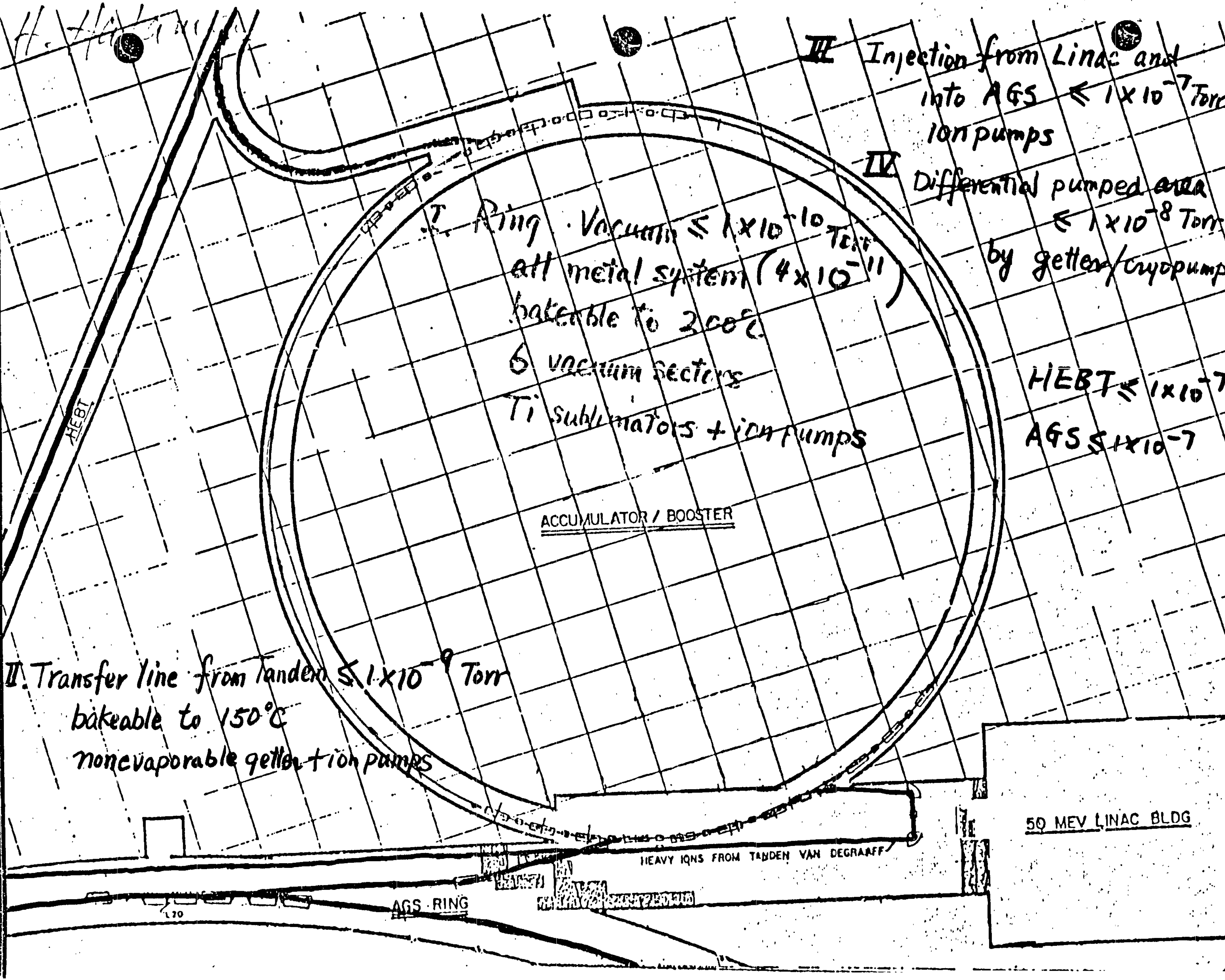
  ⇒ outgassing $3. \times 10^{-13}$ Torr·ℓ/s·cm²

  ~ 90% H_2, ~10% CO, < 1% CH_4, Ar...

- 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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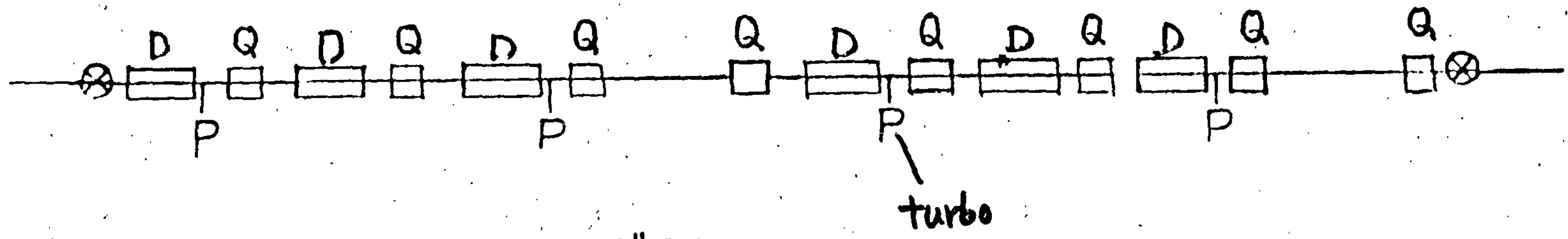


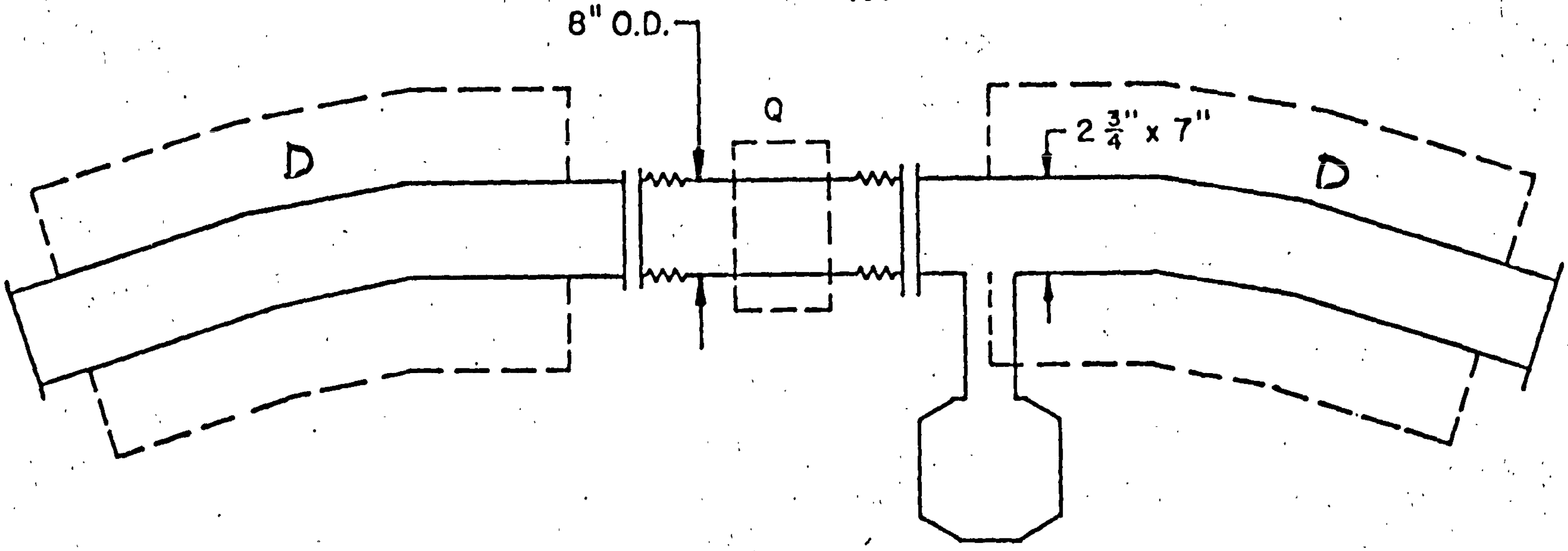
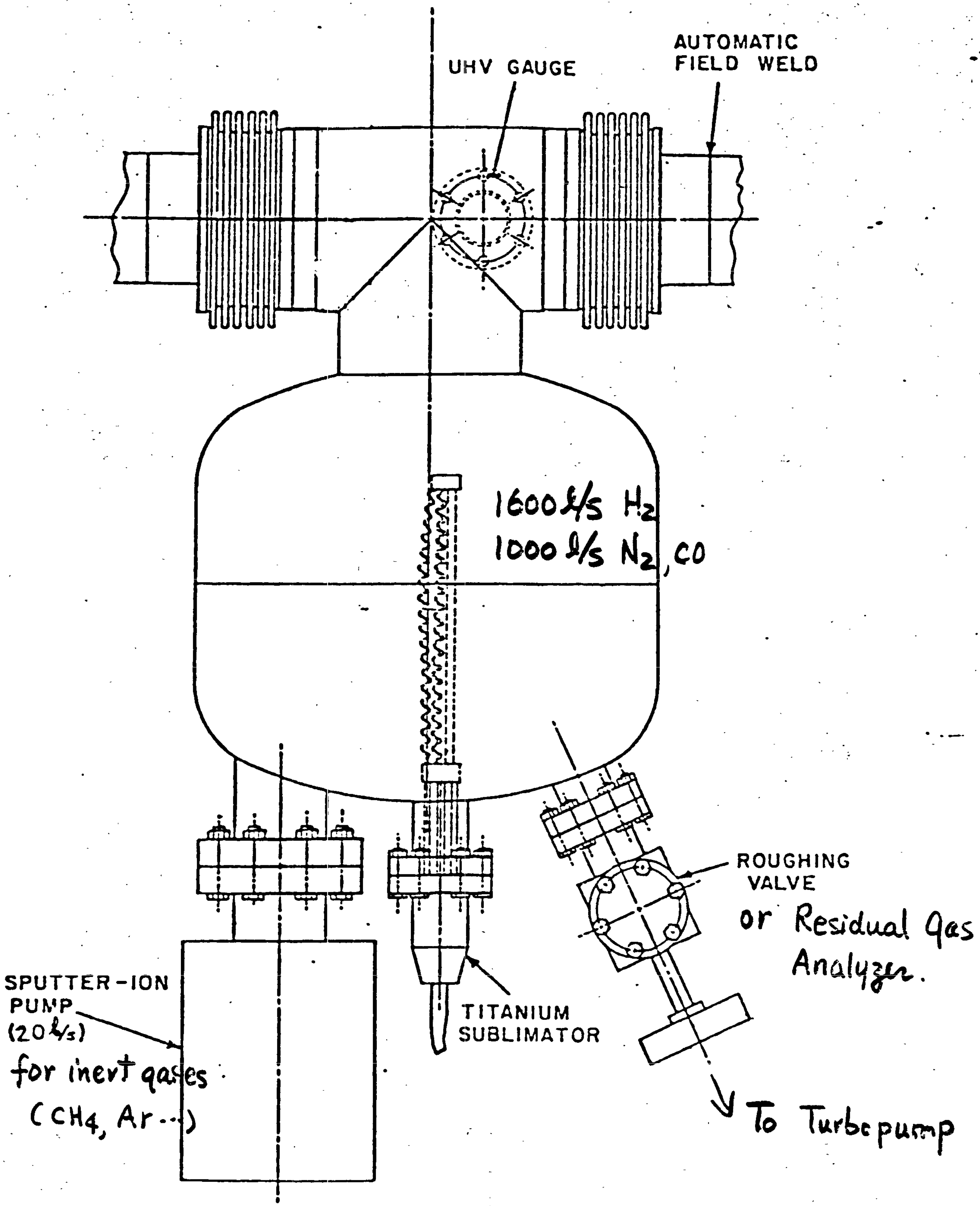


Figure 11 - Vacuum



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