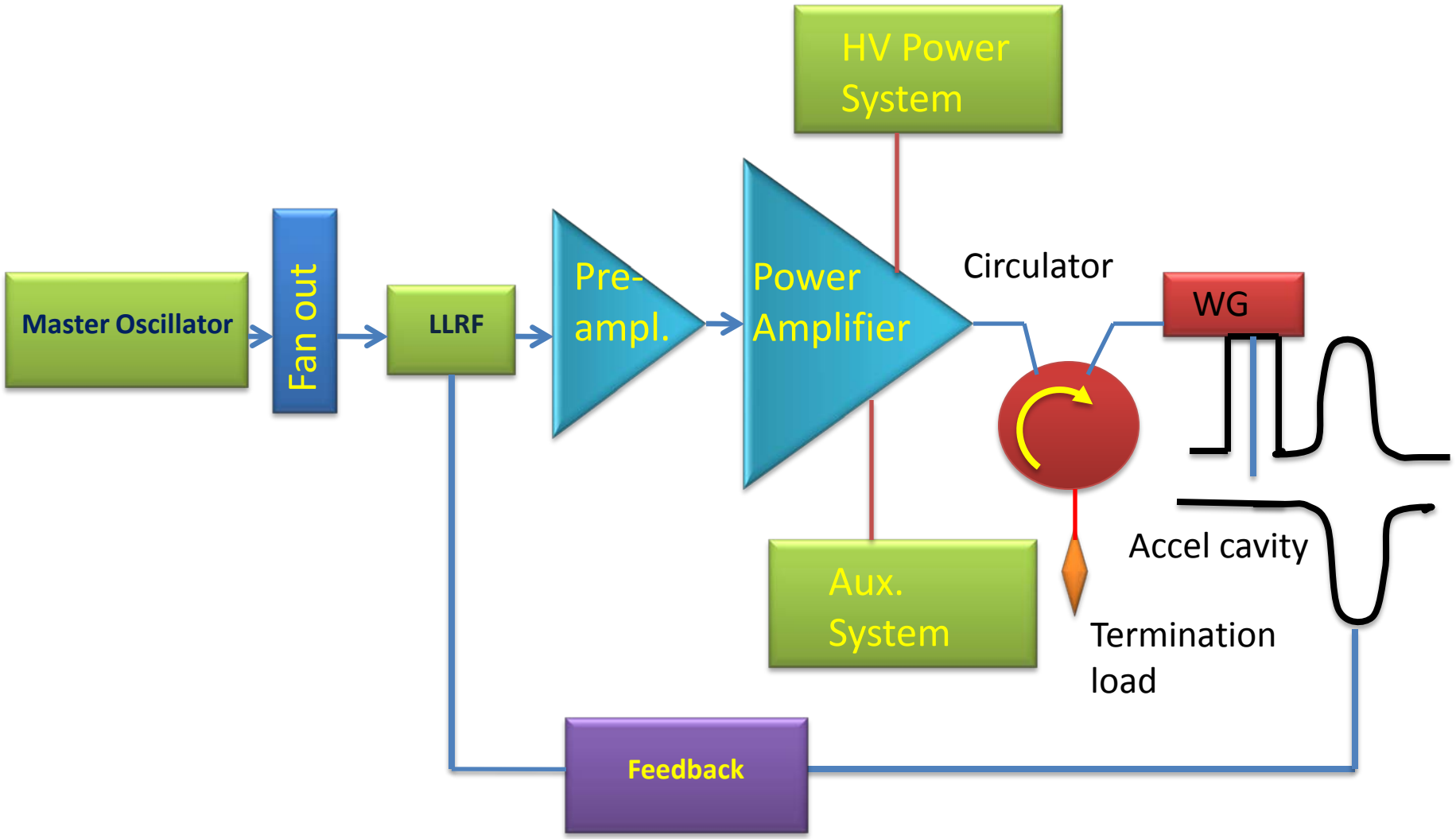
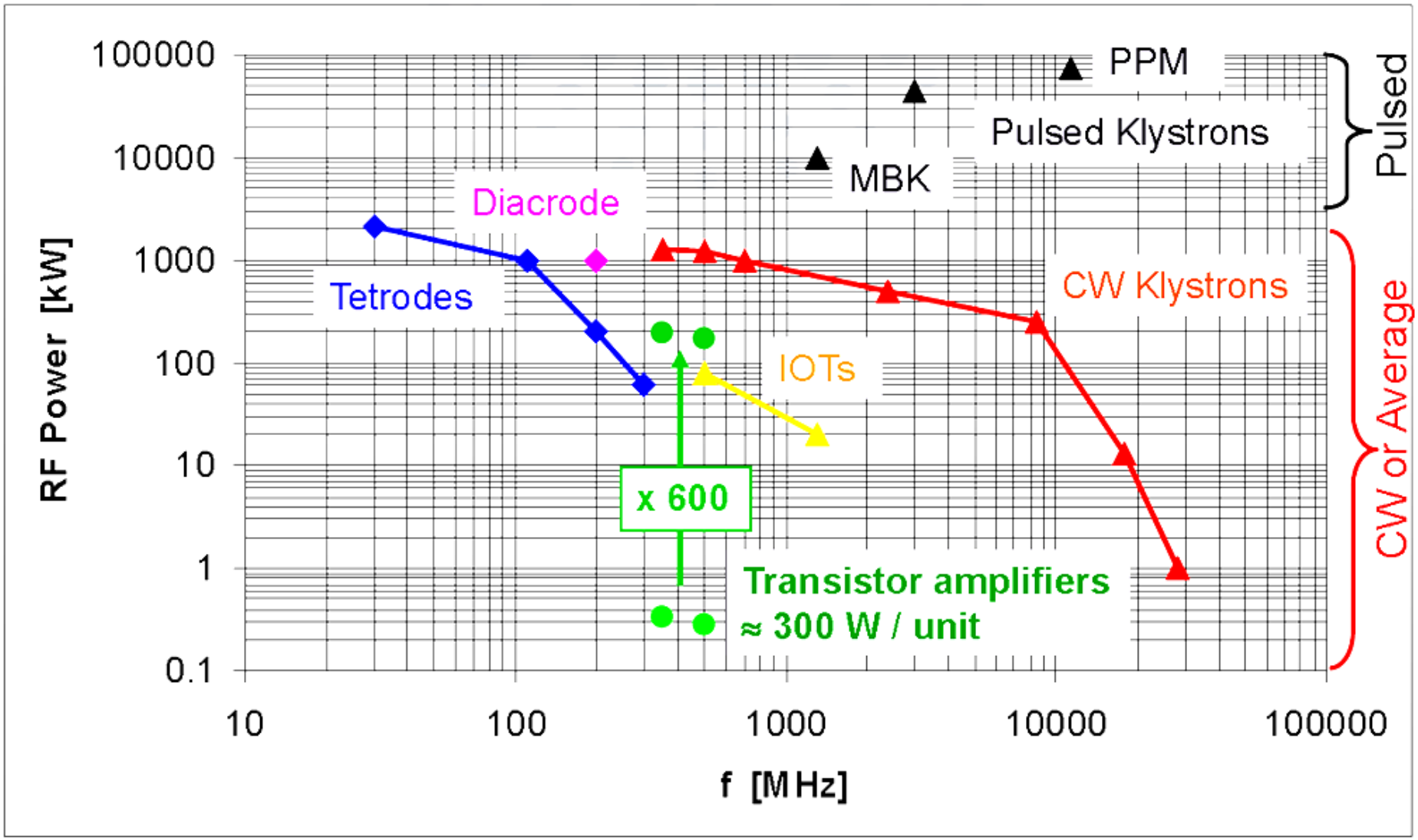
RF Power Sources

A. Nassiri - ANL

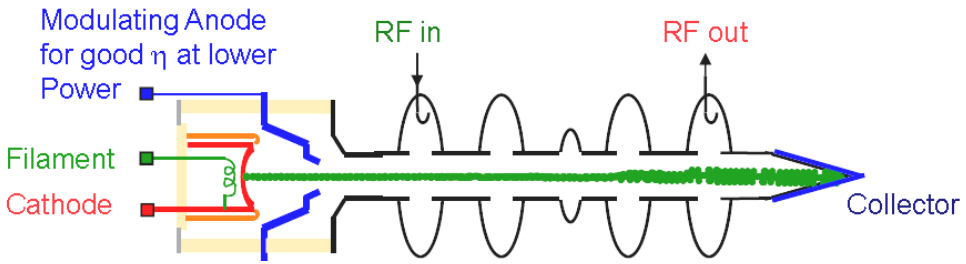
RF transmitter




100000
10000
1000
100
10
1
0.1
RF Power [kW]
10
100
1000
10000
100000
f [MHz]
PPM
MBK
Pulsed Klystrons
Pulsed
Diacrode
Tetrodes
CW Klystrons
IOTs
x 600
Transistor amplifiers
≈ 300 W / unit
CW or Average

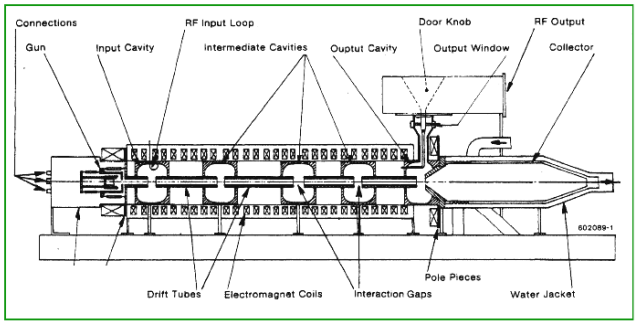
- Tetrode
  - Vacuum tube based on electron beam intensity modulation
  - Typically 200 MHz- 400 MHz for accelerator application
    - Limited in gain at higher frequencies due to finite electron drift time
  - Typical output power ranges between 10's kW to few MW (CW /average).
- Diacrode (Thales)
  - Can double the output power at a given frequency or double frequency at a given power
  - TH628 @ 200 MHz, 1MW CW, up to 4.5 MW in short pulses
  - TH680 up to 1GHz, 50 kW CW, 80 kW short pulse

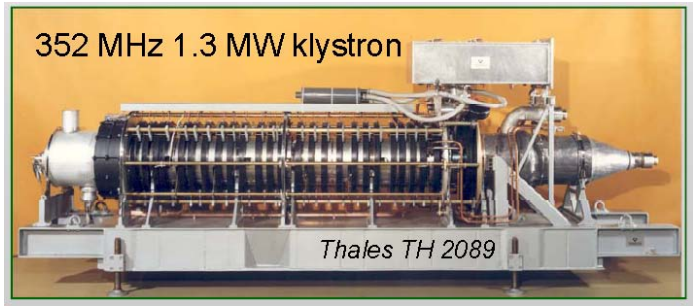
- Velocity modulation of beam with input cavity
- Drift space and “intermediate” cavities provide beam bunching resulting in high efficient DC to RF power conversion
- It is a high gain device
- $I_{DC} = KV^{3/2}$ (K < 1 μPerv)



- Modulating anode (mod-anode) my be incorporated for:
  - Gain control
  - Higher efficiency operation over a large dynamic range
  - Rf drive power in saturation
  - Drawback: low bandwidth (~10 Hz)

- 352 MHz/ 1.3 MW klystrons originally used at CERN for LEP project.
- Currently two high energy synchrotron light sources use these devices, APS at ANL (US) and ESRF (Grenoble, France)
- Others
  - Small devices
    - 40kW/60kW/500 MHz
  - Large devices
  - 1MW/500MHz/700 MHz
- Efficiency ~60%
- Gain ~42 dB – needs ~100W drive





- **100 kV, 20A dc**
- **Crowbar (tyratron, ignitron)**
- **IGBT-based switched supply as alternative**
- **X-ray shielding is required**