LEPP REU

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Summer Goals

- Gain valuable research experience
- Contribute productively to research at Cornell

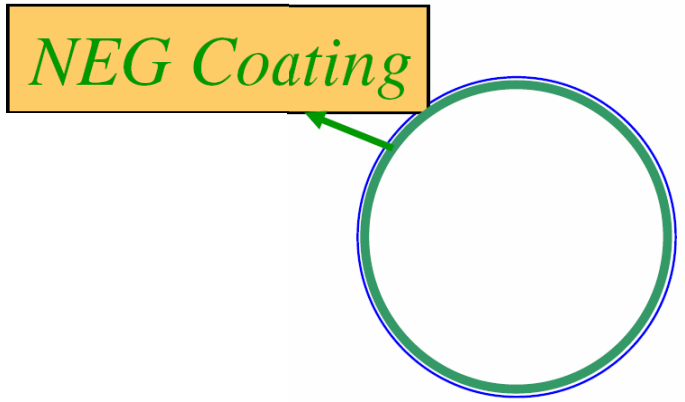
Research Project provides opportunity to complete both!!

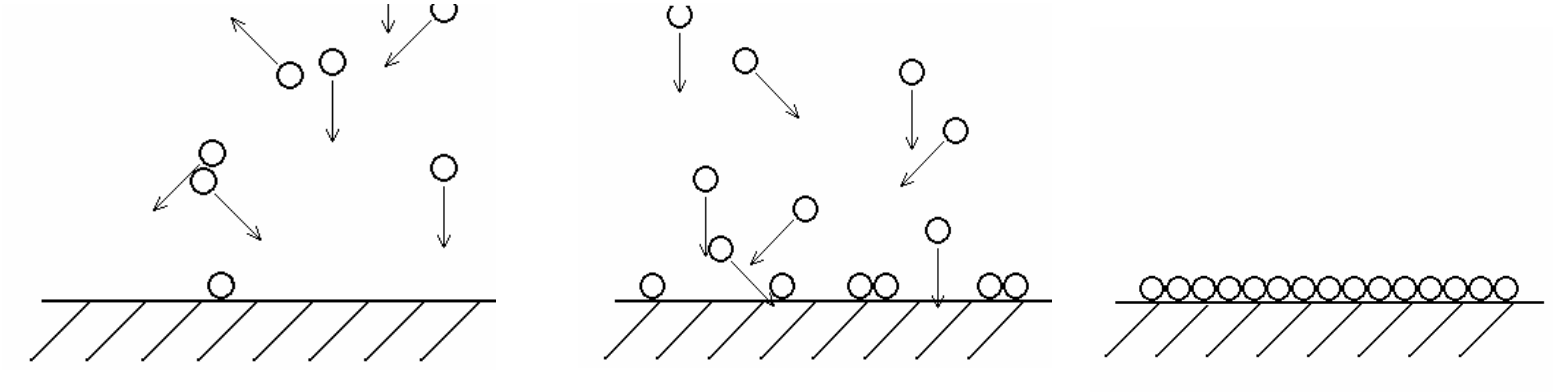
Project:

Evaluate RF properties of NEG coatings at frequencies up to 40 GHz

NEG (Non-Evaporable Getter)

- NEG pumps are capture pumps
- Bind gas molecules chemically to surface
- Once monolayer saturates NEG surface, must activate the NEG
- Order of microns in thickness (thin-films)





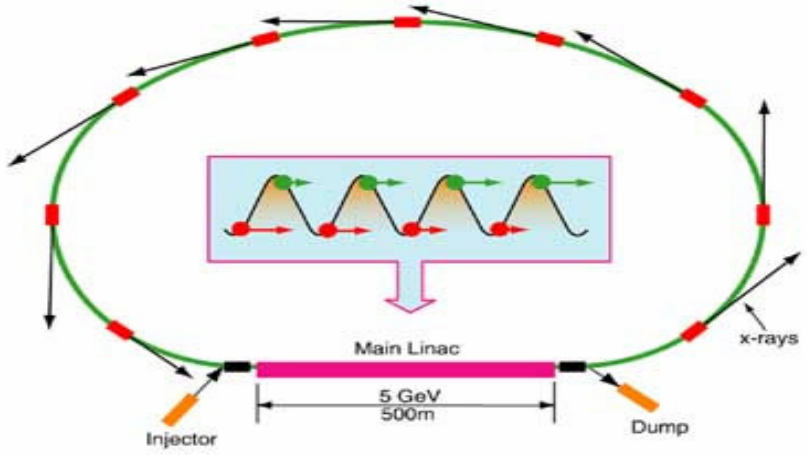
NEG in Lab

- Vacuum benefits well known
- Impedance with RF is not well known
- NEG's can be used in unconventional places
- Also prevent build up of electron clouds
- Must understand NEG properties in RF to utilize in ERL project

Low SEY ≈ 1.1 ~ 1.4

Low Outgassing
- Thermal
- Beam Induced (PID,EID,IID)

Distributed Pumping-> $\frac{1}{S_{eff}} = \frac{1}{C} + \frac{1}{S}$



Research

- Study transmission and reflection of NEG coated materials
- RF waveguides
- Original plan requires more sensitive equipment
- IDEA: Design new waveguides that can be coated for experiments

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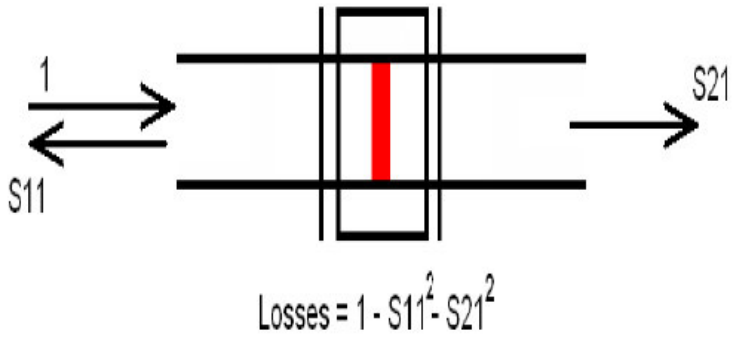
Increase Sensitivity

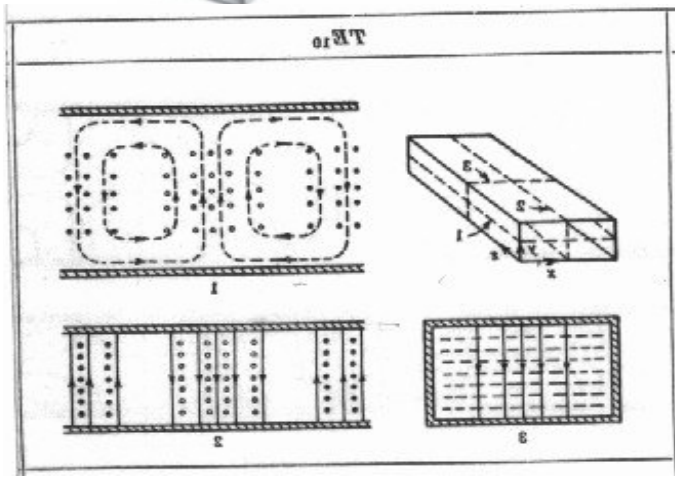
Frequency:
12.4 – 18 GHz

Dimensions:
620 x 310 mils



Design

- Must design waveguide that can be successfully coated and tested in the lab
- U-channel design leaves magnetic fields inside waveguide unaffected
- Firmly attach NEG coated flat side to U-channel
- Can now calculate loses from coated side



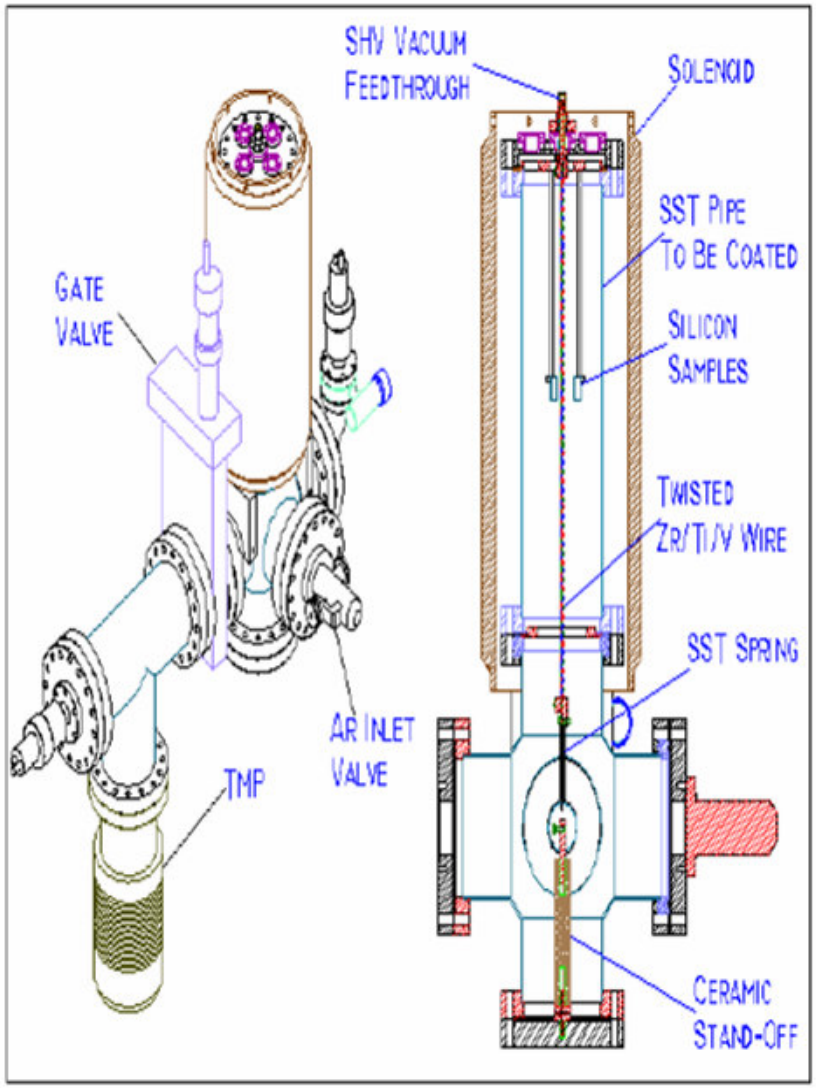
$$P_W \sim \int_0^{\Lambda}\int_0^{a} H_W{}^2(x,z)\,dx\,dz \qquad P_N \sim \int_0^{\Lambda}\int_0^{b} H_N{}^2(y,z)\,dy\,dz$$

$$P_W = \frac{P_W}{P_W + P_N} \qquad P_N = \frac{P_N}{P_W + P_N}$$

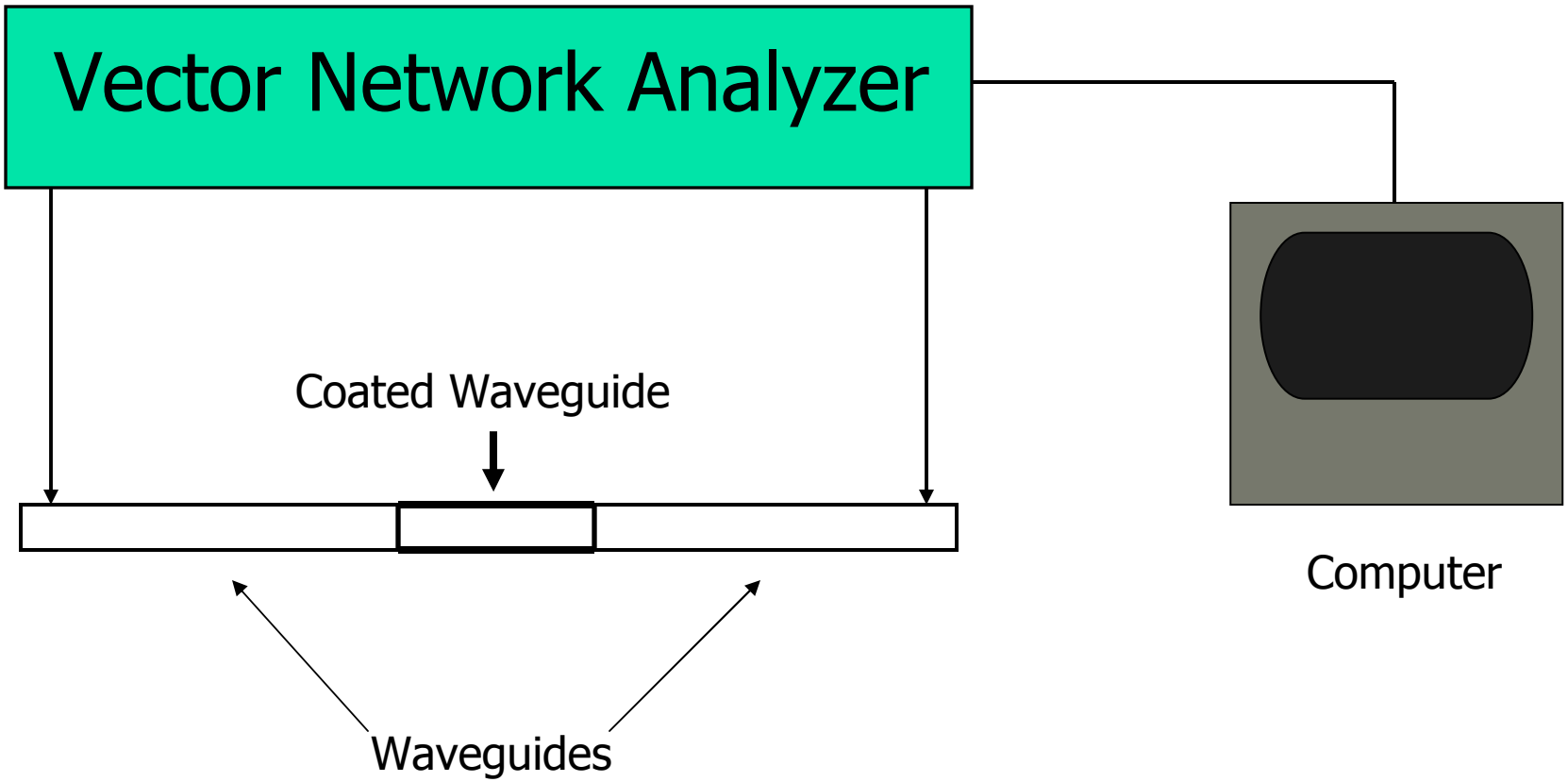
Coating Apparatus

- DC Magnetron Sputtering
- Negative potential applied to cathode
- Ar/Kr gas subject to field ionization
- Atoms ejected from cathode from energetic ion bombardment
- Magnetic field traps electrons to increase ionization
- Coating rate :

$$R_{atom} = \frac{N_{atom}}{A} = \frac{N_{ion} \cdot Y_{sputter}}{A} = \frac{I_{ion} \cdot Y_{sputter}}{2\pi a L \cdot q_e}$$

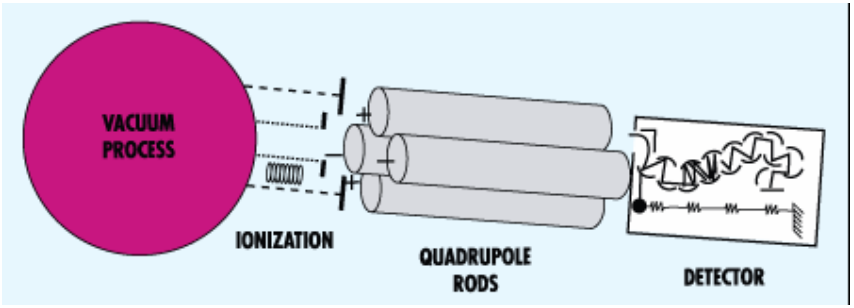


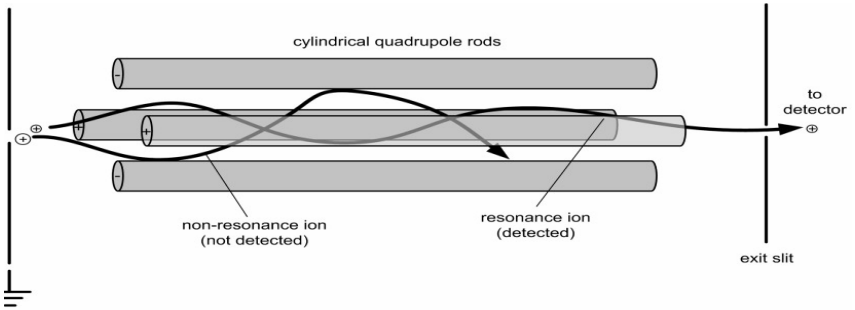
Basic Setup for Measurements



Additional project

- Residual Gas Analyzers (RGA) are important vacuum tools that alert when a system contains a leak and also what gas molecules a vacuum system contains
- Detailed calibration necessary for accurate results
- RGA work in four steps
  - Electron impact ionization
  - Ion optics focus beam
  - Beam enters mass analyzer (RF Quadrupole)
  - Ion detection through use of Faraday Cup and Channel Electron Multiplier





The Plan

- Learn to use CAD Inventor 11
- Design waveguide for thin-film NEG coating
- Uncoated Waveguide for Baseline Measurements
- Learn Coating technique
- Coat designed waveguide
- Test NEG waveguide in RF
- Analyze data for RF properties of NEG coating
- Calibrate RGA for use in LEPP