



# IAC Accelerators For ADSS

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# Neutron Source Energy Costs

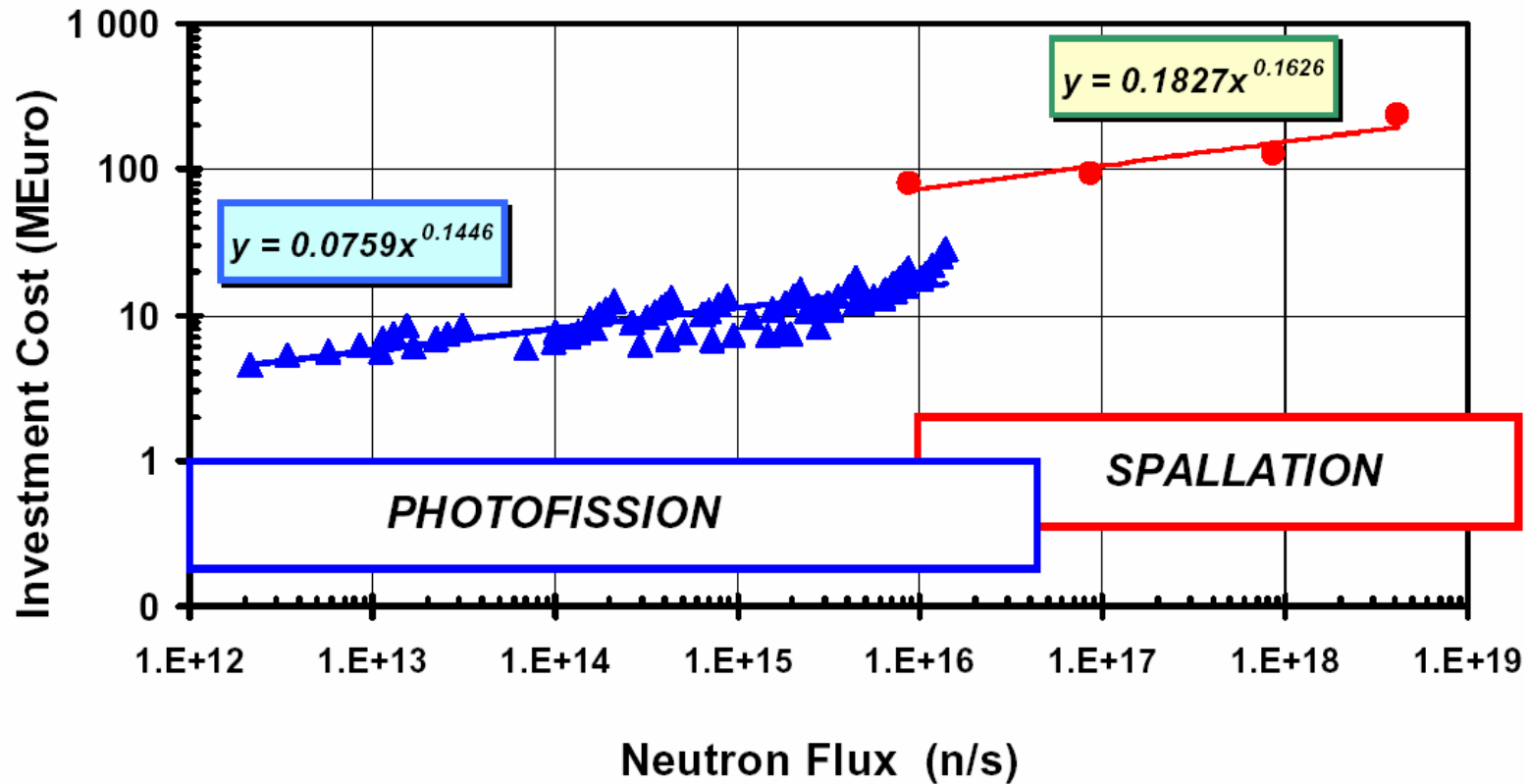
Process	Examples	Yield	Energetic cost (MeV/n) (on target only)
(d,t)	400 keV on T	$4 \times 10^{-5}$ n/d	10,000
(d,n)	35 MeV on Li	$2.5 \times 10^{-3}$ n/d	14,000
( $\gamma$ ,n)	20 MeV e- on U238	$1 \times 10^{-2}$ n/e	2,000
Spallation	800 MeV p on U238	30 n/p	27
Fission (k=1)	U235(n,f)	$\sim 1/f$	

# Neutron Source Energy Costs (cont.)

Process	Example	Relative n cost/unit energy (on target, not wall plug!)
(d,T)	200 keV T on d	5
(d,n)	35 MeV d on Li	7
(gamma,n)	20 MeV e on Pb	1
Spallation	1 GeV p on Pb	0.01

# Neutron Costs (cont.)

## Comparison Spallation / Photofission

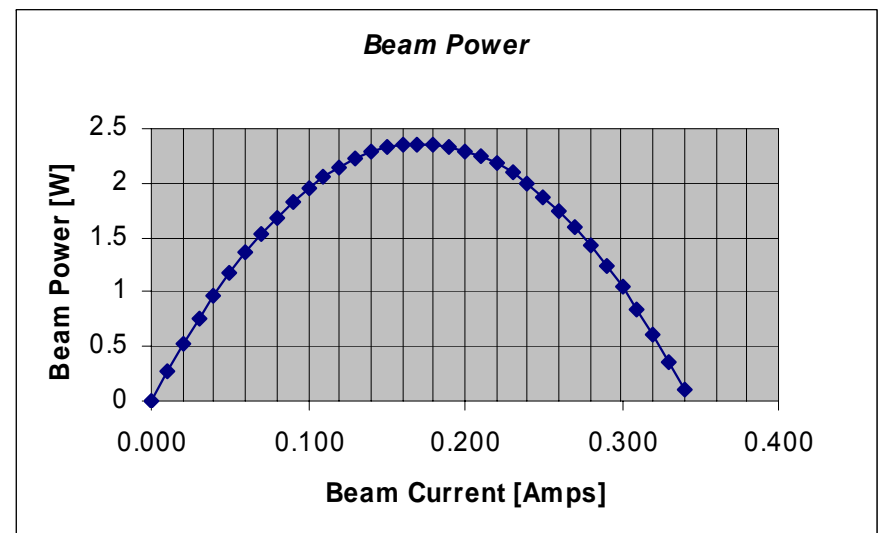
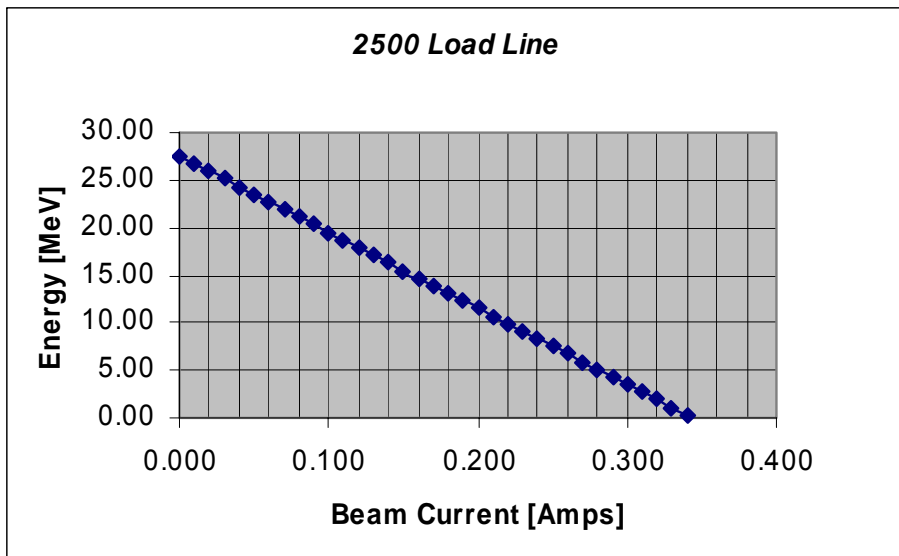


# RF Electron Linacs

- Photonuclear and photofission neutrons
- Yield/beam power second only to proton spallation
- Robust technology
- Flexible output characteristics
- Inexpensive and “small,” transportable
- Evaporation neutron spectrum, similar to spallation source, but less high energy tail

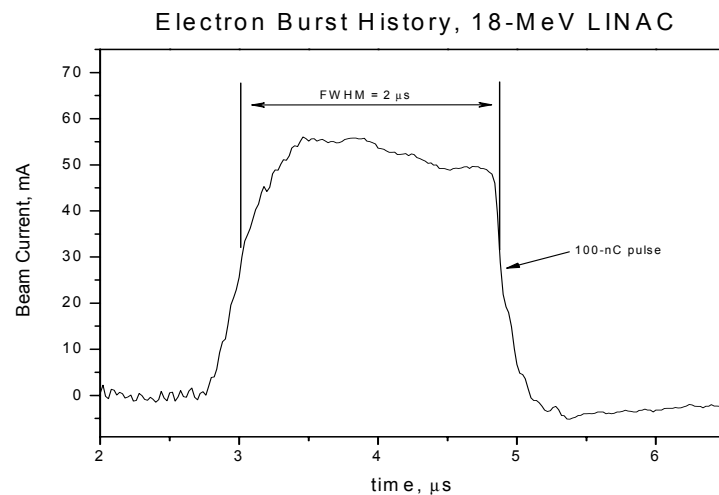
# Linacs and Load Lines

A characteristic of all RF linear accelerators is the property that as beam current increases, for a given RF power into the accelerator guide, the beam energy decreases. The accelerating electric fields are diminished by the energy carried by the beam. There is a family of lines parameterized by the square root of input RF power.

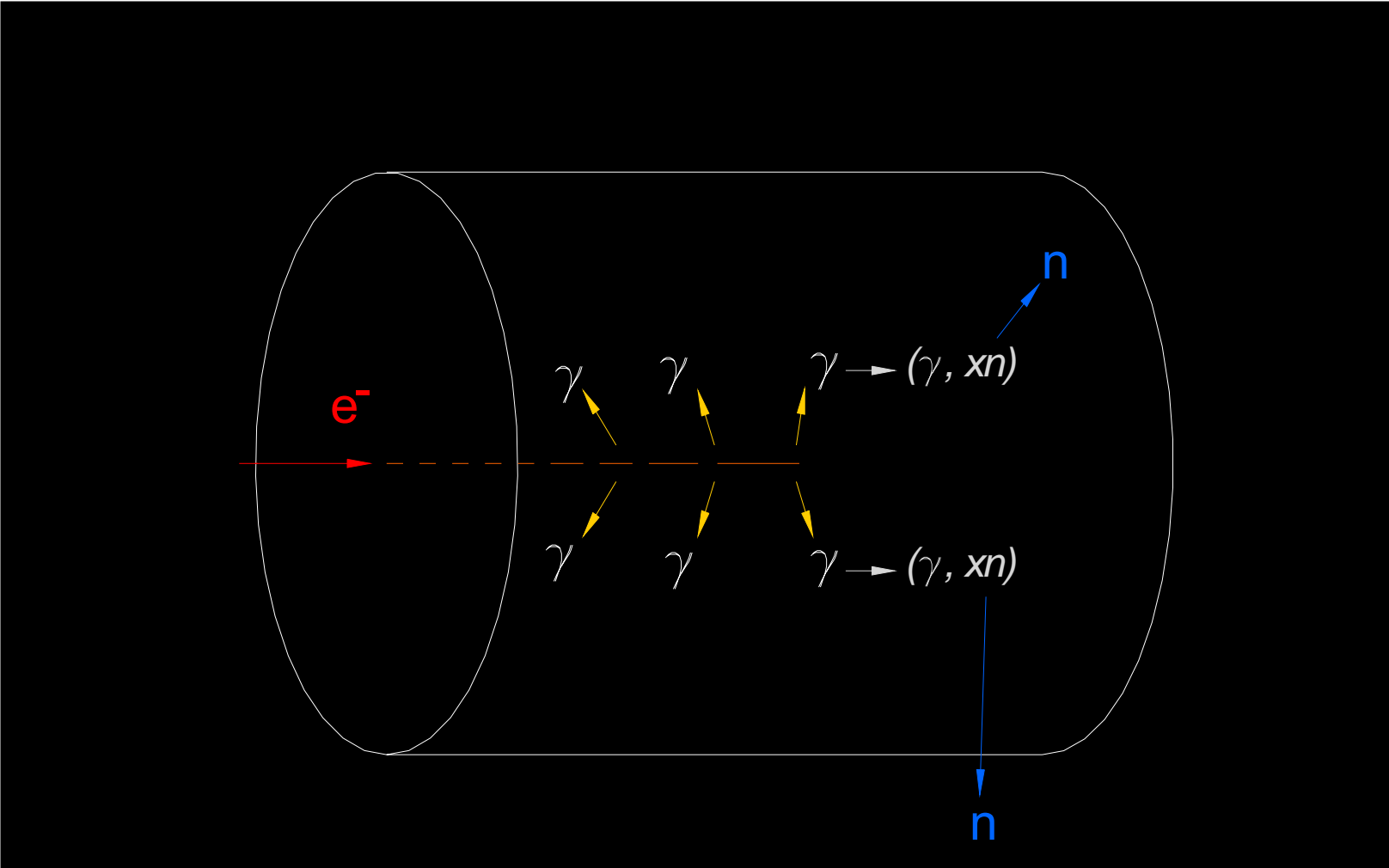


# Electron Beam Time Structure

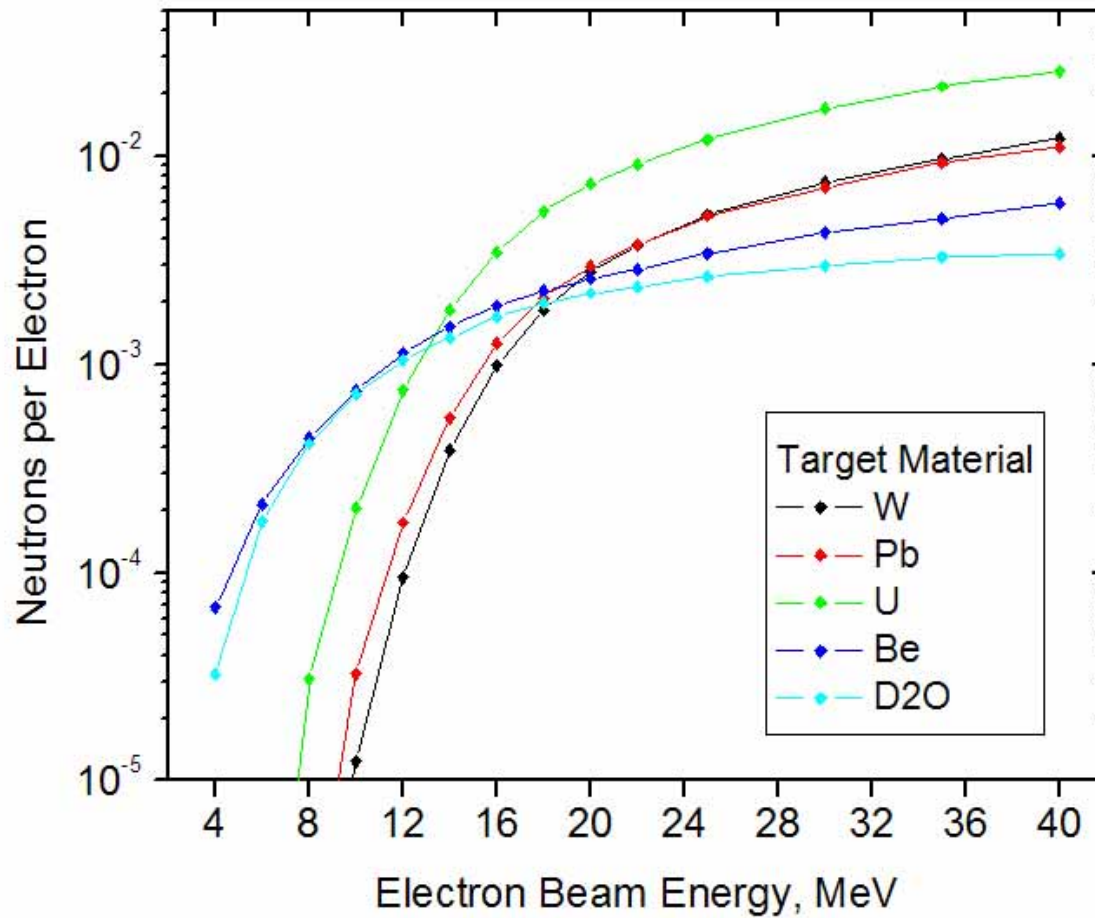
- The accelerator guide is filled with RF power in microsecond length pulses at millisecond repetitions.
- Electrons are injected into the accelerator guide during the microwave RF pulse, after the guide is completely filled with RF ( $\sim 1$  microsecond after start of RF).
- The electron beam pulse is accelerated to the full energy the accelerator structure characteristics and RF power level will provide.
- The electron beam has a distribution of energies  $\sim 10\%$  FWHM for a well tuned system.



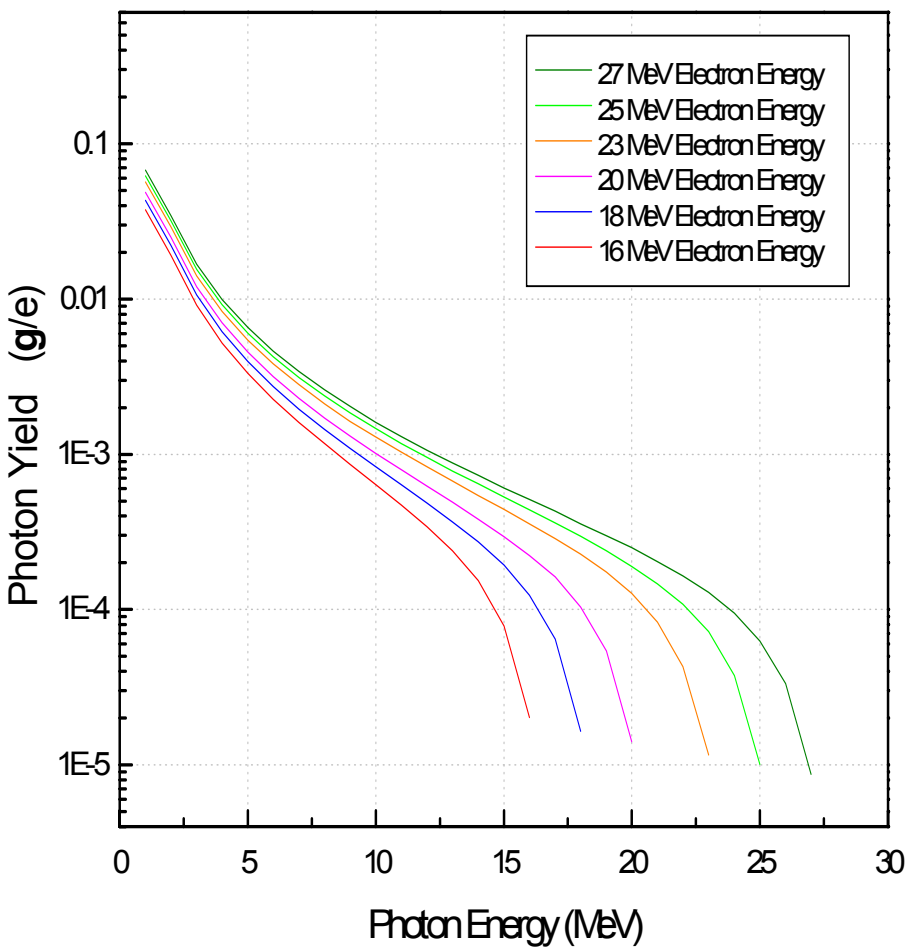
# Neutron Production in High Z Target



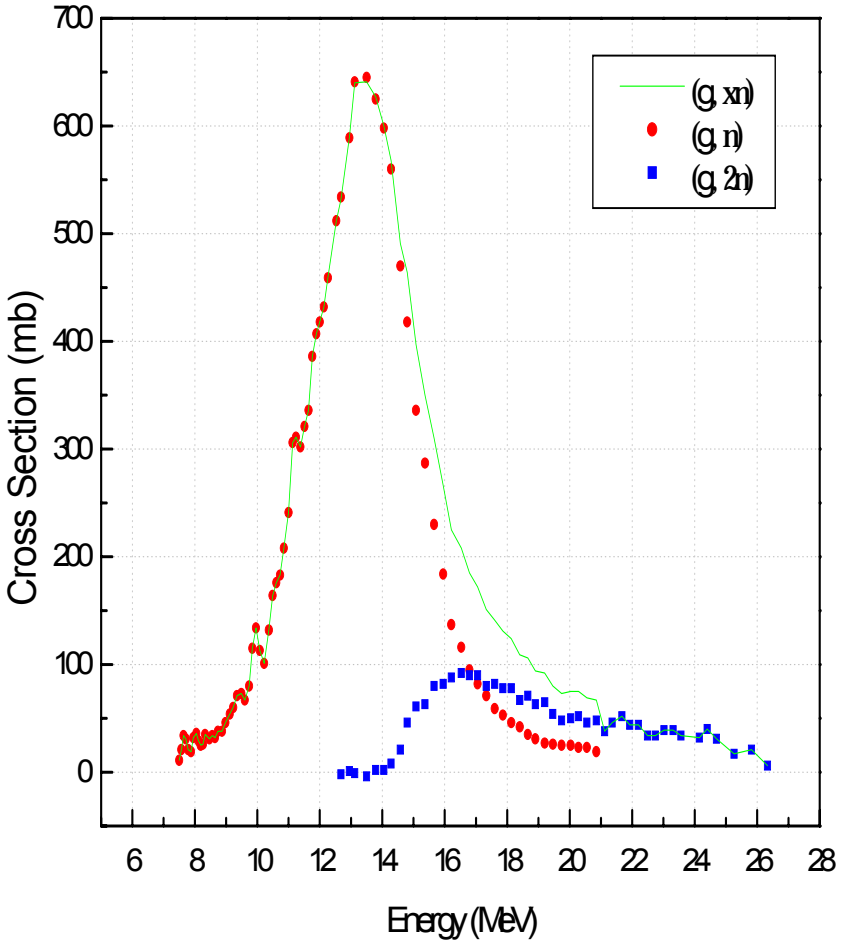
# Neutron Yield vs. Electron Energy



# Production Process



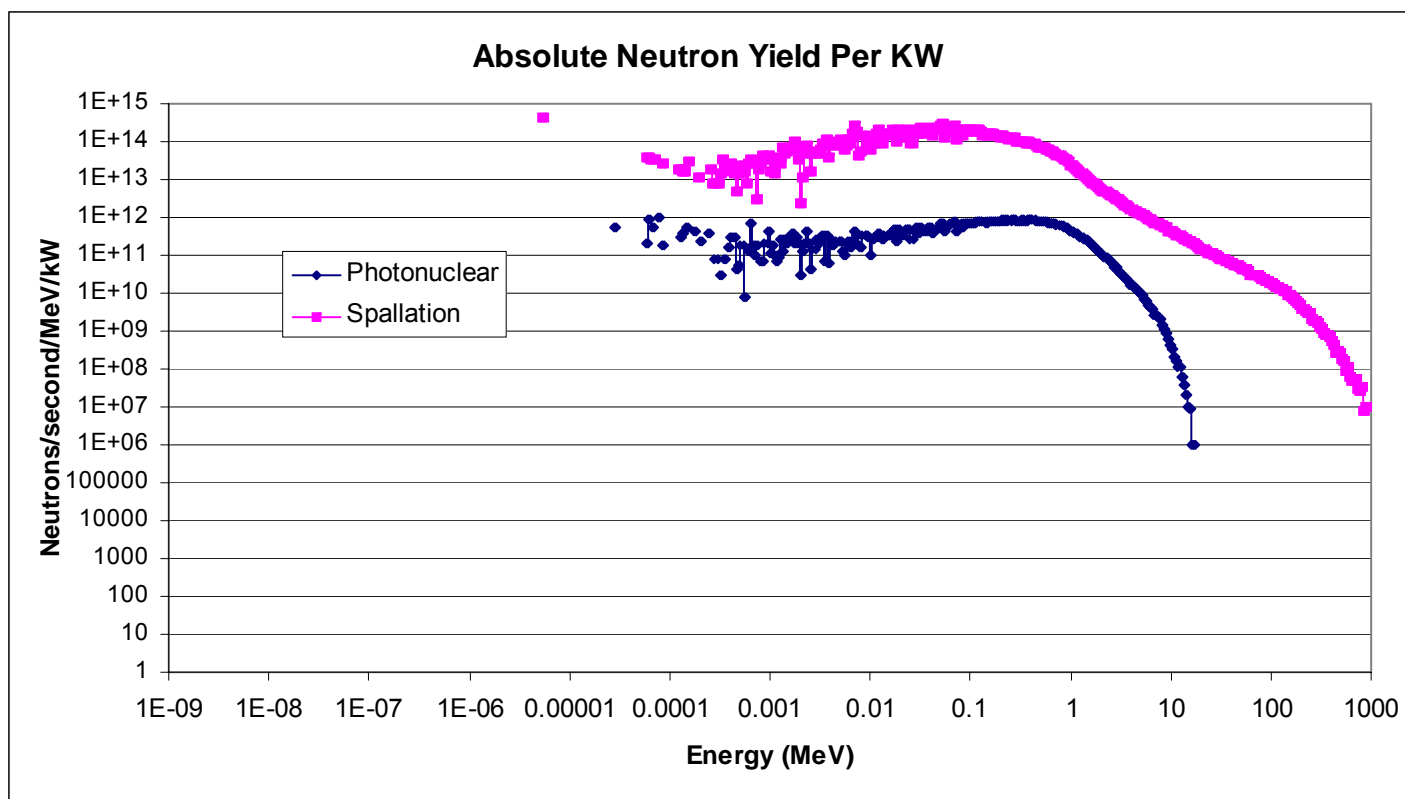
Bremsstrahlung Spectra



Photonuclear Giant Resonance Cross Section for Lead

# Spectra

25 MeV electrons (ISU RACE)  
compared to 1 GeV protons both on W-Cu target of  
appropriate size



# Texas RACE Accelerator



The guide is 1.8m long, 20 MeV at  $\sim 80$  mA peak current. The modulator and klystron will support a 4-5 microsecond beam pulse at  $\sim 230$ Hz.

- Up to  $\sim 2$  kW beam power with current electron gun and modulator/klystron
- Relatively compact
- Reliable off-the-shelf components
- Easy to operate
- Variable output by varying pulse rate

# High Power Modulator/Klystron

A high power klystron and modulator is available at IAC for application to RACE. This system will be dedicated to Texas RACE for FY'06 and beyond, pending funding. The modulator and associated high power klystron system will directly connect to the 20 MeV Texas RACE accelerator and the 25 MeV ISU RACE. Increased beam power and neutron output is achieved chiefly by increased pulse length (23 microseconds), increased rate (360 Hz) and increased beam current (>100 mA)

