Low Energy Nuclear Reaction Products at Surfaces

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Introduction and Agenda

There is much experimental evidence, which indicates that LENR occur on surfaces of solid materials.

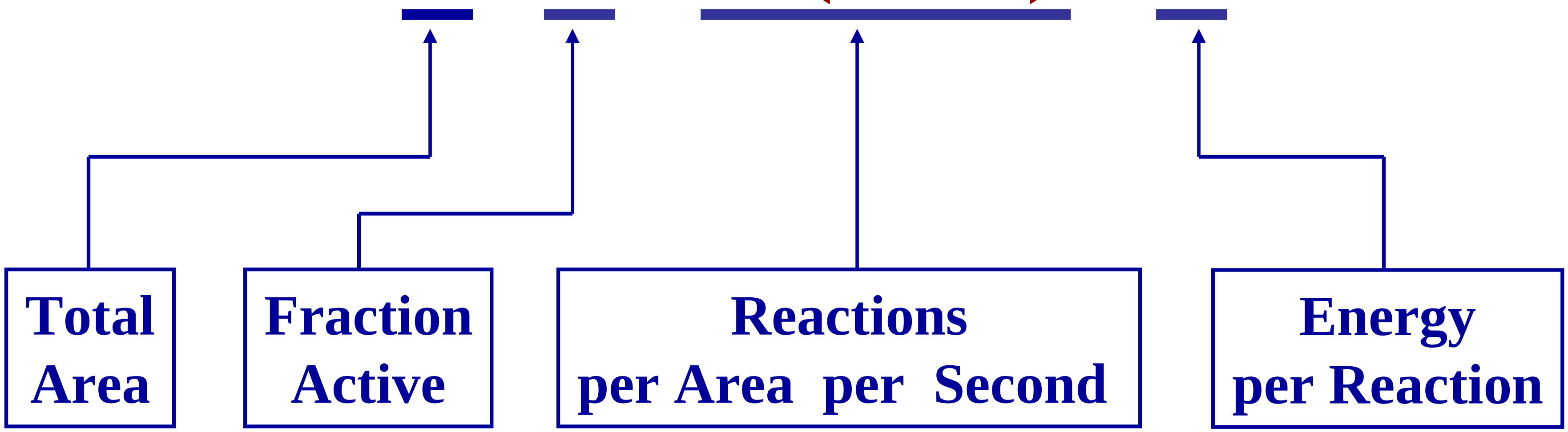
Simple equations relate the reaction rates to the surface area, the active fraction & the number of reactions per active area per second.

The equations are used to compute energy production rates (power) and the production rates for nuclear ash or energetic radiations.

This talk provides numerical and graphical means to compute power production at surfaces in LENR experiments.

Necessary Factors for Surface Power Production

$$E/T = \underline{A} \times \underline{F} \times \underline{[N/(\mathit{A} \times \mathit{T})]} \times \underline{\mathit{E}} = P$$



The values for each of these factors depend on the specific composition (atoms) and structure (geometry) in an experiment

Surface Area per Unit Volume after Deformation into a Thin Film or Fine Wire

Start with one cubic centimeter:

<u>Flattening</u> it into a thin film with a thickness of 1 nm would give a square area with a side that is 300 m long. The area of the film would be 10^5 square meters

<u>Stretching</u> the cubic centimeter into a wire that has a square cross section of 1 nm would yield a wire that is 10^{13} km long with an area of 4 x 10^5 square meters

Having one or two dimensions on the scale of nanometers results in very large total areas per cubic centimeter of material.

Fraction of the Surface Area That is Active

This factor is not known now. However, it is clear that deposits and coatings of surfaces may render some regions inactive, OR may make some regions active.

Can guesstimate the active fraction: It will not be higher than 1.0 and is more likely to be low, maybe in the range 0.01 to 0.0001.

It is very important to devise experiments that can yield values for the fraction of the total surface that is active, both to make calculations of expected powers and for studies to control (increase!) the active fraction.

High spatial- and temporal-resolution infrared images of thin films on active cathodes might yield useful information on this fraction.

Number of Reactions/Area/Time

This cannot even be guesstimated reasonably.

Experimental values are hard to obtain because of all the other parameters that link this factor to the measured total power generation rate.

Theoretical estimates are needed. The Widom-Larsen equation for surface nuclear reaction rates is:

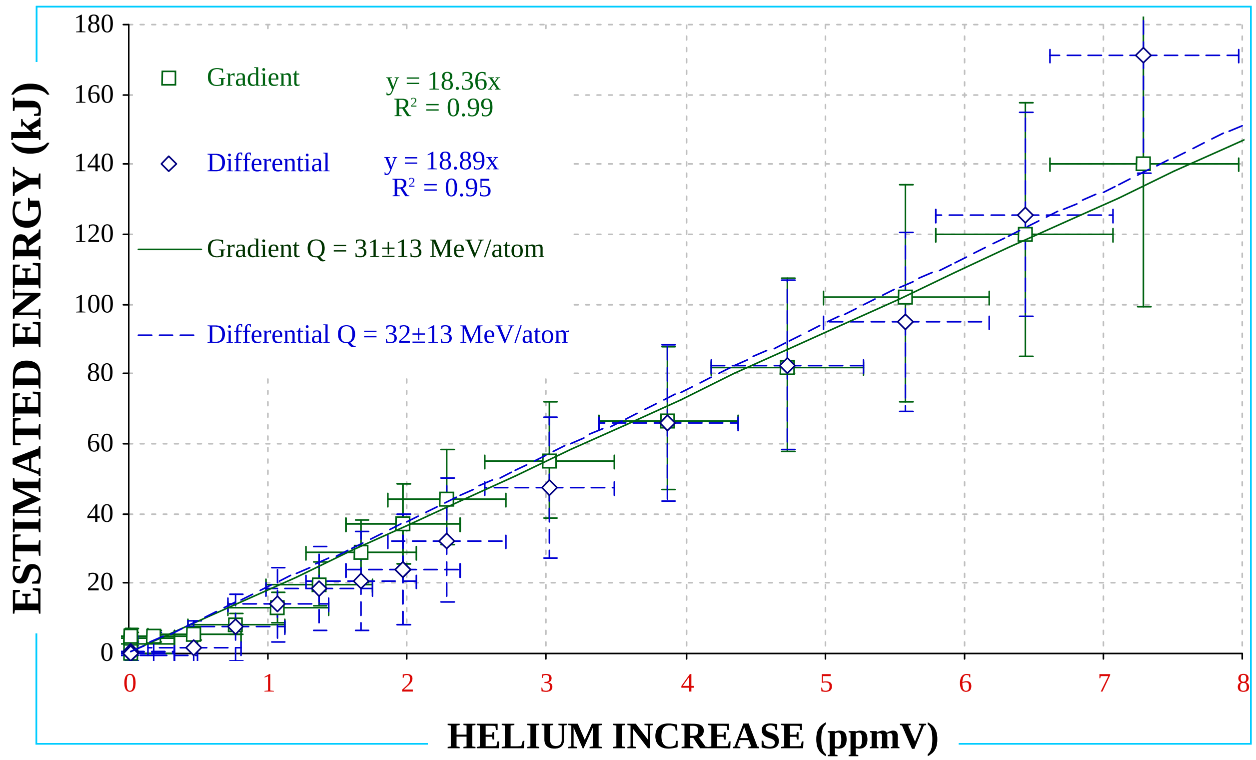
For a smooth surface, integrating the neutrino production rate over a thin slab at the electrode surface yields the estimate for the production rate per unit time per unit area,

$$\varpi_2 \approx \left(\frac{g_V^2 + 3g_A^2}{2\pi^2}\right) n_2 \left(\frac{G_F m^2}{\hbar c}\right)^2 \frac{mc^2}{\hbar}(\beta - \beta_0)^2. \quad (65)$$

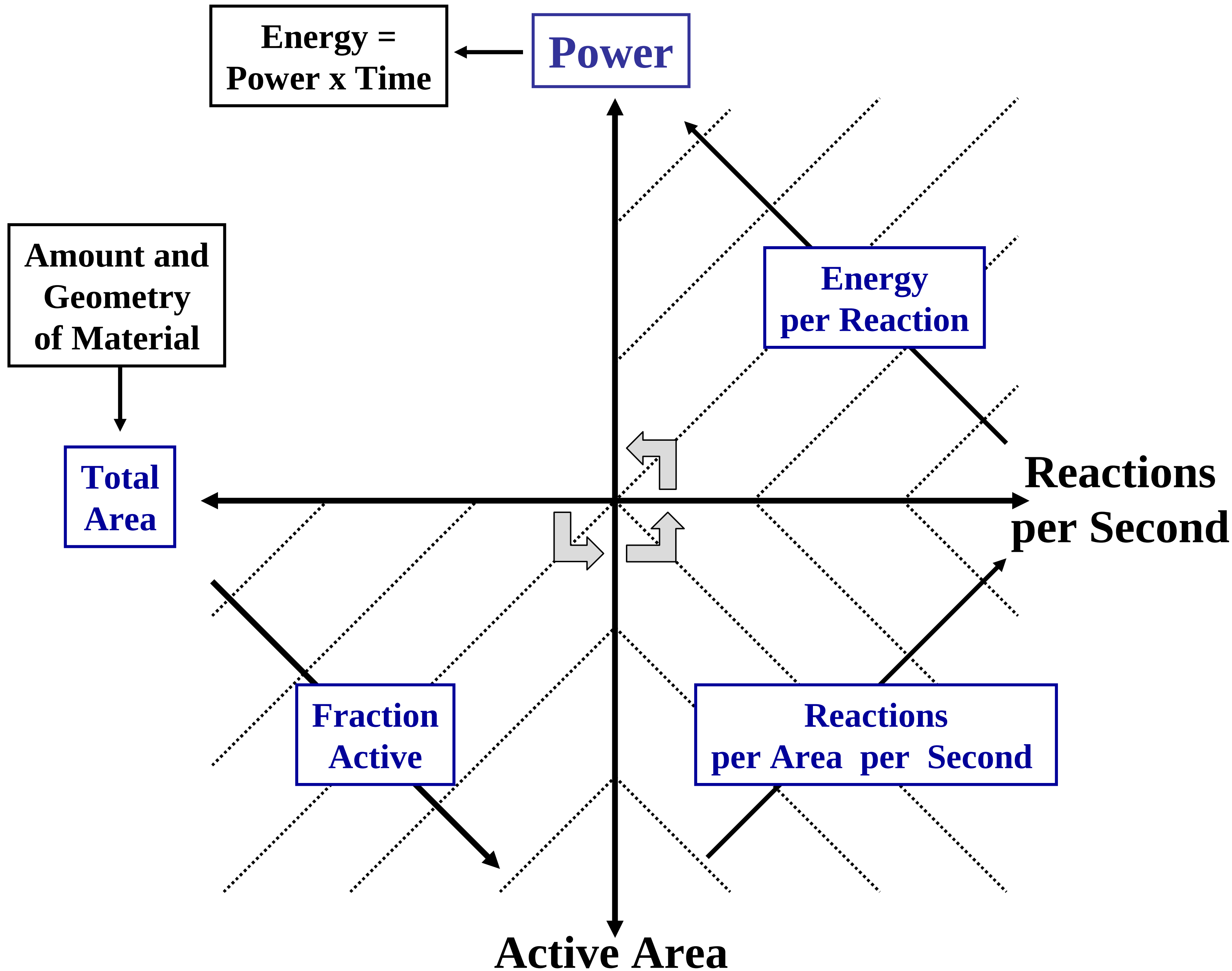
Energy per Reaction

This will be on the order of MeV, and probably in the range of about 30 MeV down to 0.3 MeV.

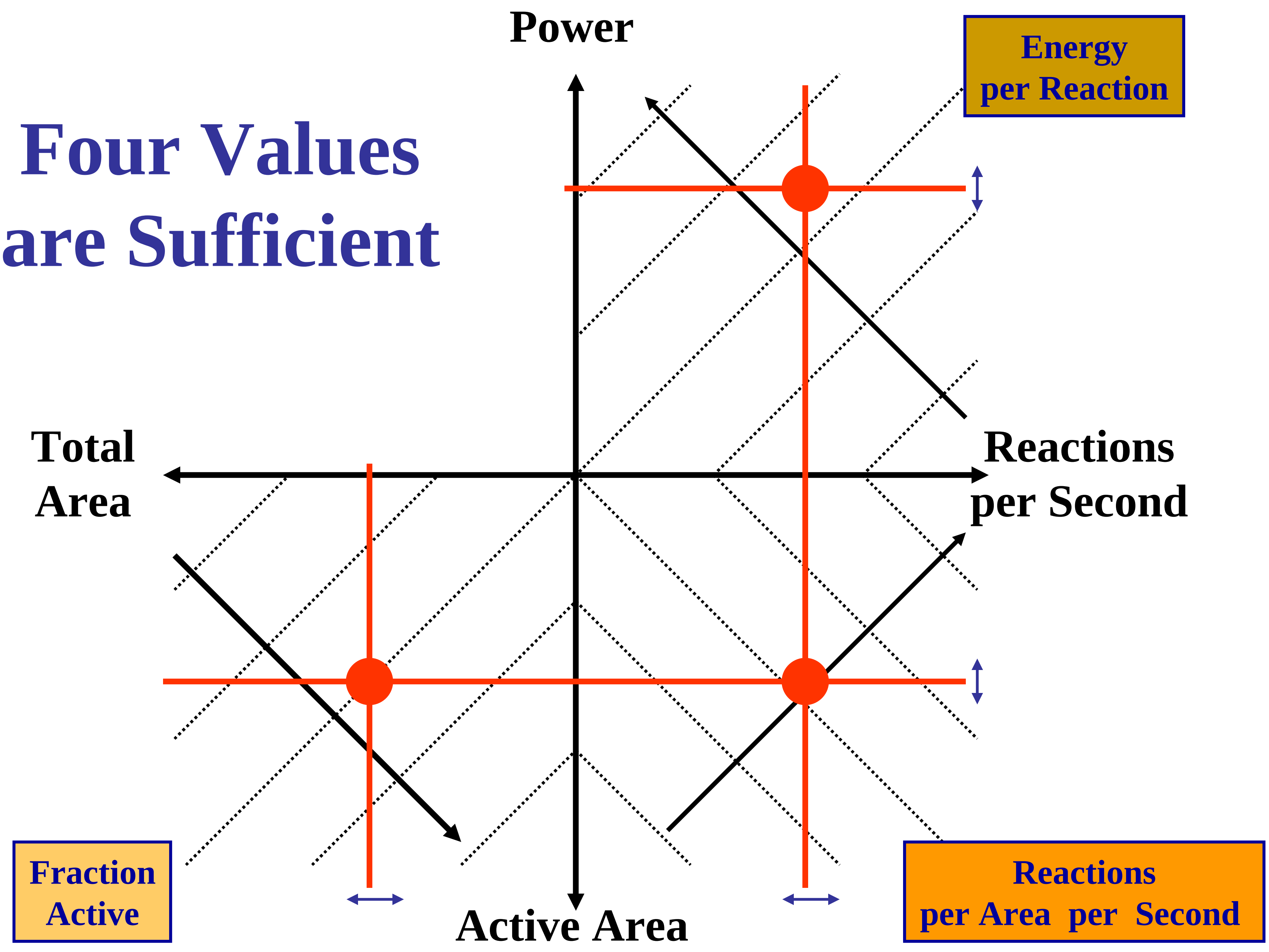
Experimental correlation of heat and He production has given values near 30 MeV per reaction.



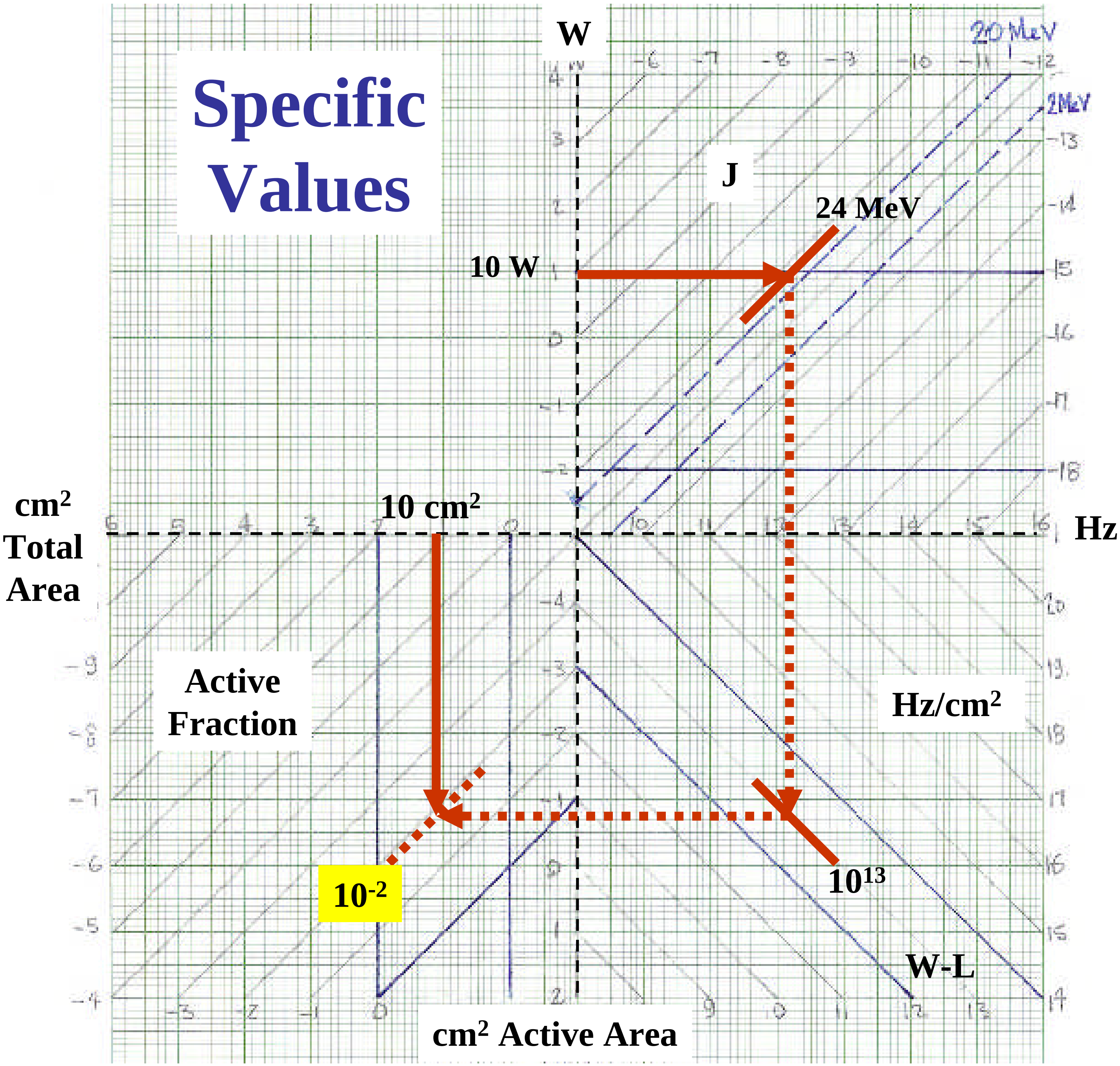
McKubre et al, SRI International


Energy =
Power x Time
Power
Amount and
Geometry
of Material
Total
Area
Energy
per Reaction
Reactions
per Second
Fraction
Active
Reactions
per Area per Second
Active Area

Four Values are Sufficient



Specific Values



Conclusion

**The focus here was on power generation,
but a similar computation applies to
the rates for production of transmutations.
This analysis dealt with LENR on surfaces,
but a similar analysis applies to LENR in the bulk.**

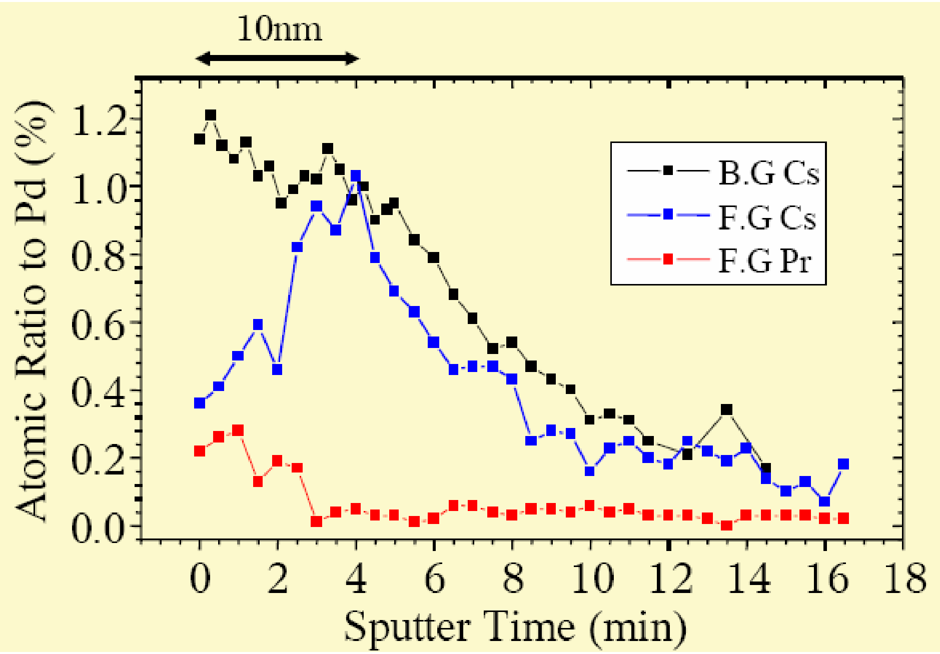
**Experimentalists:
Measure or Estimate Your Total Surface Area**

**Theoreticians:
Provide Values for the Reaction Rates per Area**

Additional Slides

The Case for LENR At or Near Surfaces: Experimental Evidence

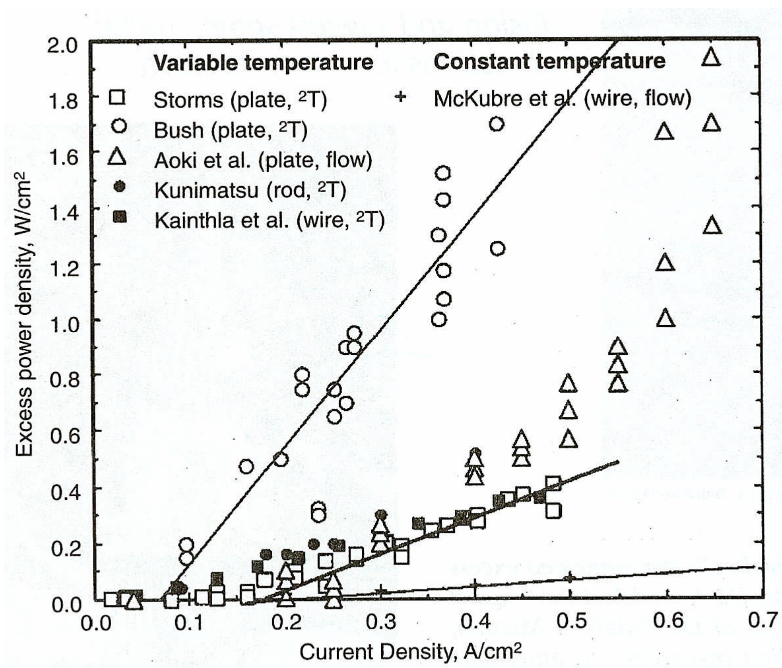
- The Letts-Cravens Effect, where shining a laser on a cathode increases the rate of power production, and the skin depth is on the order of nanometers.
- Arata and Zhang's use of Pd black in their Double Structure Cathodes, where most of the Pd atoms are near the surfaces.
- The transmutation experiments by Iwamura and his colleagues show the reaction products within about <10nm of the surface.



Iwamura *et al*
ICCF-11

The Case for LENR At or Near Surfaces: More Experimental Evidence

- ♦ Storms performed an experiment that started with the Pt as cathode and Pd as anode, which resulted in a thin Pd deposit on the Pt. Then, excess power was observed. The film was estimated to be about 2 micrometers thick.
- ♦ Many workers have found that the excess power scales with the electrical current density through the surface of the cathode.



"Cold Fusion:
The Experimental Evidence"
Edmund Storms
21st Century,
Winter 2004-2005