



Sidney Kimmel Institute for Nuclear Renaissance (SKINR) Overview



Sidney Kimmel Institute
for Nuclear Renaissance
University of Missouri

Graham K. Hubler, Ph.D.

Director, Sidney Kimmel Institute for Nuclear Renaissance (SKINR)

Department of Physics and Astronomy

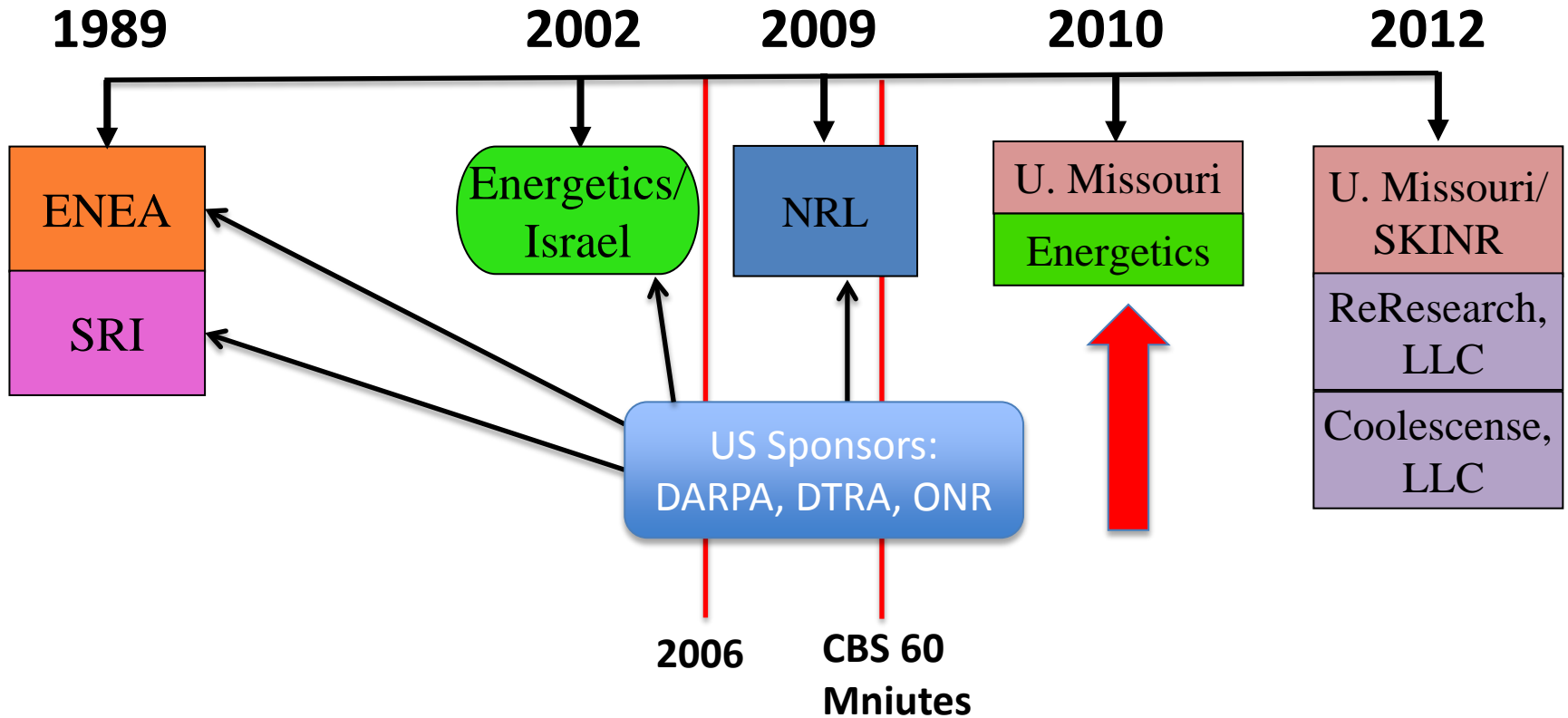
University of Missouri

Columbia, Missouri, 65211 USA

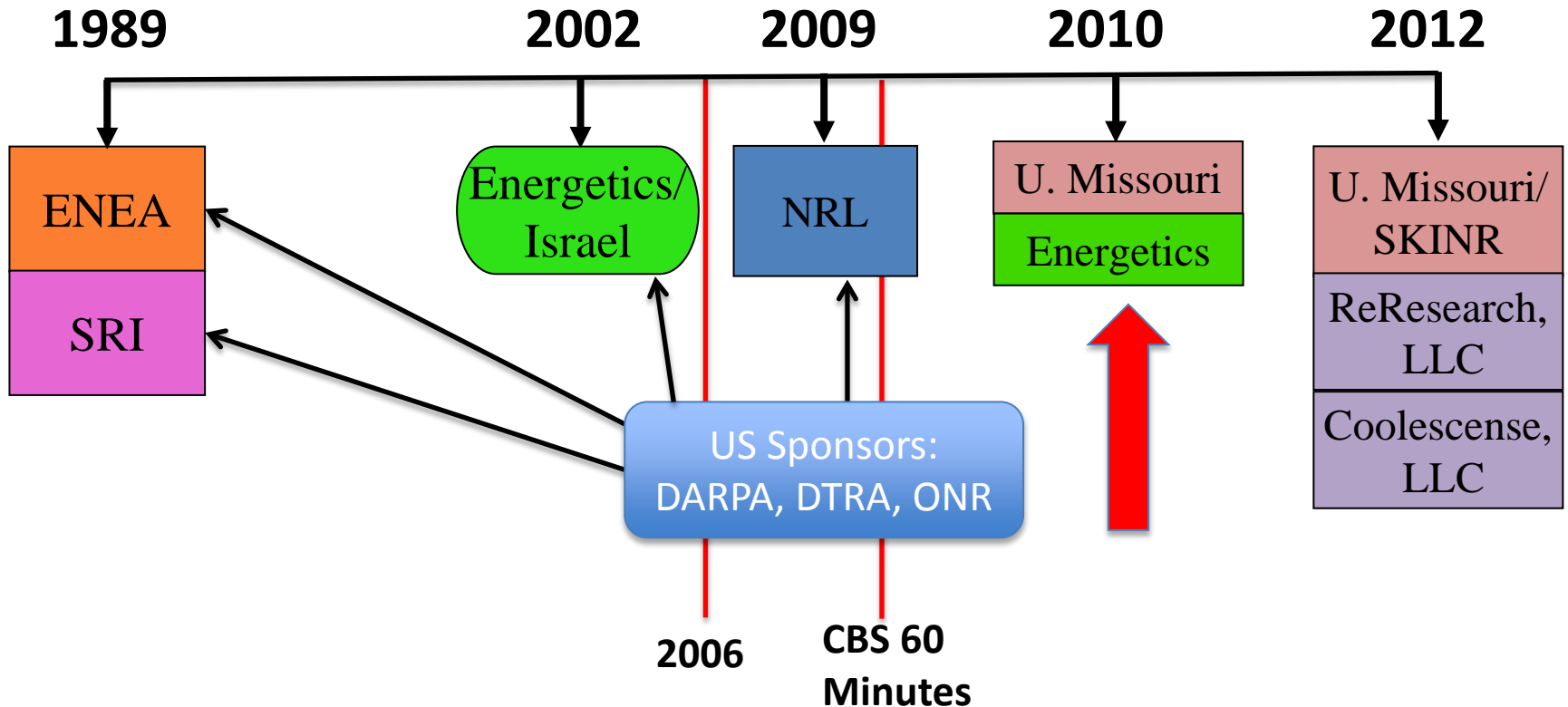
hublerg@missouri.edu

SKINR Directive: To find the origin of the Anomalous Heat Effect (AHE) with a sound materials science approach and with no preconceptions as to the origin of the phenomenon. To publish findings in the open literature and to openly collaborate world wide with researchers in the field and in cross disciplines.

International Collaboration and Time-Line of Partner Involvement



International Collaboration and Time-Line of Partner Involvement



Expected Progress:

- Improve Reproducibility
- Reveal Mechanism

Rob Duncan





SKINR Staff



Sidney Kimmel Institute
for Nuclear Renaissance
University of Missouri

**Administratively located in the UM Department of
Physics and Astronomy**

Orchideh Azizi

Arik El-Boher (Research Group Leader)

Graham Hubler (Director)

William Isaacson

Dennis Pease

Mark Tsirlin

R. Duncan; UM Vice Chancellor for Research

SKINR has Laboratory space in
the Department of Physics and in
the Department of Electrical
Engineering – Dr. Shubra
Ganghpadhyay was
instrumental in donating space
to SKINR



Involvement of UM Professors in SKINR-related Activities



Sidney Kimmel Institute
for Nuclear Renaissance
University of Missouri

J. Gahl, Electrical Engineering

-Pd(d,p); Ni(p,p) on cyclotron

S. Gangopadhyay; Electrical Engineering

-CNT; nanoporous; artificially structured cathodes; Pd deposition on membranes

H. Kaiser; Dept. of Physics & Astronomy/MURR

-neutron scattering on PdD. PdH

K. Kattie; Dept. of Radiology

-In situ nanoparticle deposition on cathodes

S. Kovaleski, Electrical Engineering

-Piezoelectric ion sources, low energy ion bombardment

M. Prelas, Nuclear Engineering

-Neutrons from thermally shocked TiDx, diamond particle detectors

P. Pfeiffer; Dept. of Physics & Astronomy

-Fundamental Hydrogen charging of metals studies



Graduate Students and Post-Docs



Sidney Kimmel Institute
for Nuclear Renaissance
University of Missouri

Charles Weaver – M. Prelas – Nuclear Engineering

Peter Norgard – J. Gahl and S. Kovaleski – Electrical Engineering

Cherian Mathai – S. Gangopadhyay - Electrical Engineering

Somik Mukherjee - S. Gangopadhyay - Electrical Engineering

Gupta Sagar – K. Katti - Radiology

Andrew Gunn – H. Kaiser – Physics & Astronomy

Most Energetic Anomalous Heat Events by the University of Missouri (SKINR)

ENEA fabricated cathodes

40% reproducibility

Experiment	ENEA fabricated cathodes			GD-141	40% reproducibility			
	56	64a	64b		US1-15	US3-05	US3-06	US3-21
EE, MJ	3.1	1.1	> 3.5	2.4	0.19	1.1	1.32	0.026
EP, W	3	19	> 11	14	0.25	0.8	0.9	0.13
Max COP, %	80	2500	> 1500	75	600	3000	525	650
Duration of EH, h	300	17	80	90	280	960	445	55



Many Initiatives at SKINR







Sidney Kimmel Institute
for Nuclear Renaissance
University of Missouri

Gas Reactors:

- Celani replication
- High temperature reactor/calorimeter

Electrochemical cells:

- Cathode development (many choices) 
 - Self assembled Pd nanoparticle cathodes
 - Pd coated carbon nanotube cathodes
 - Artificially structured Pd cathodes
 - New alloy compositions
 - Dealloying for nanoporous Pd
- Magnetic fields 
- In situ ultrasound surface stimulation
- Glow discharge cleaning
- Hydrogen permeation kinetics 
- Radiation detection 

Related studies

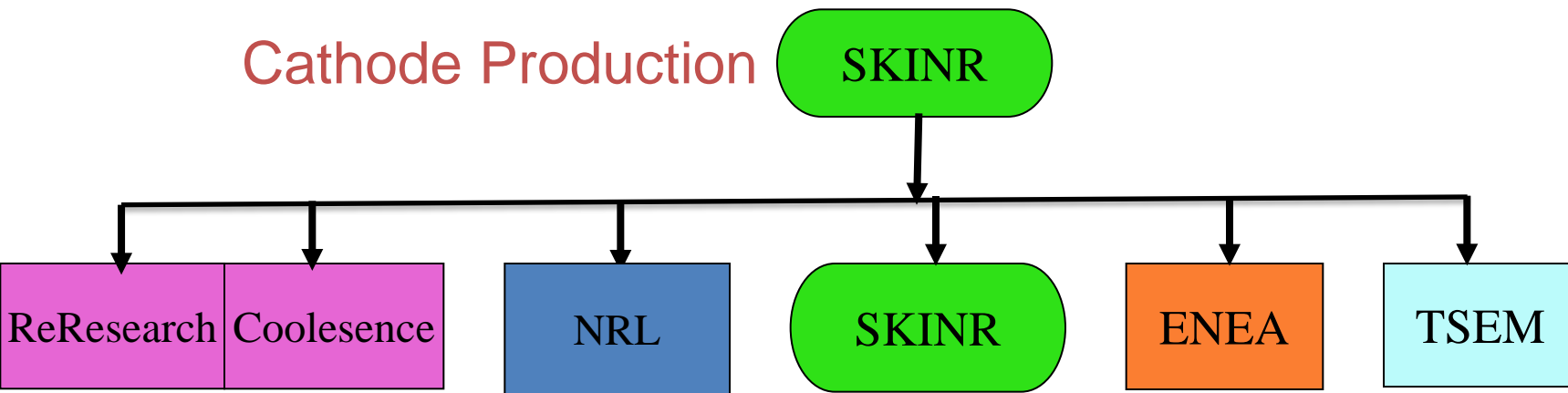
- Neutron scattering
- MeV and keV bombardment of D on Pd
- Thermal shock of TiD₂
- Hydrogen absorption thermodynamics at high pressure/temperature
- Diamond radiation detectors
- Theory



Cathode Development Plan

Empirically guided cathode modifications

Cathode Production



Cathode Electrolysis

With collaboration partners, run hundreds of fabricated cathodes in parallel using NRL designed common equipment and common protocols.



**Expected Progress:
Improved Reproducibility**



Electrochemical cell



Cell in calorimeter



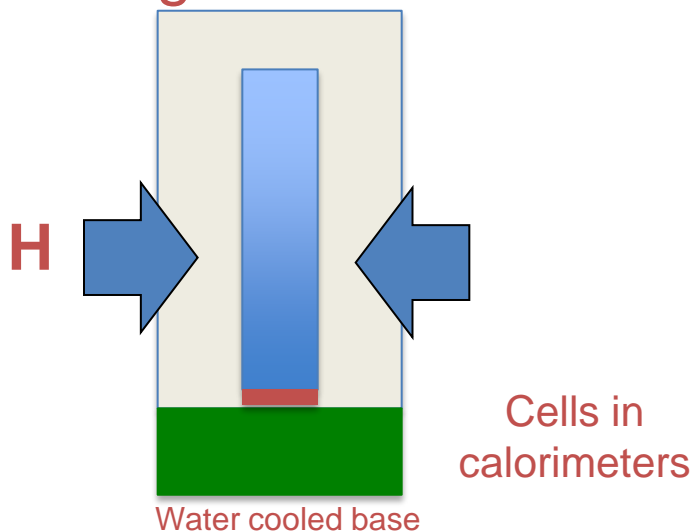
Mechanistic Experiments

Two Examples

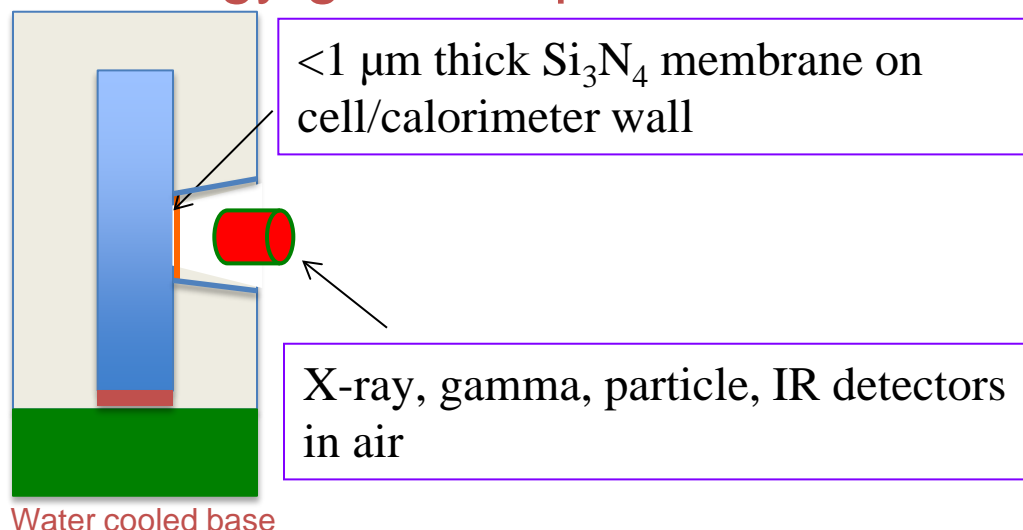


Sidney Kimmel Institute
for Nuclear Renaissance
University of Missouri

Magnetic Fields



Low energy gamma, particle emissions



$<1 \mu\text{m}$ thick Si_3N_4 membrane on cell/calorimeter wall

X-ray, gamma, particle, IR detectors in air

Build on previous work by:
Bockris – Texas A&M
Boss & Gordon – SPAWAR
Cravens & Letts – NM
Swartz – Jet Energy

Low energy emissions have never been thoroughly investigated in REAL TIME

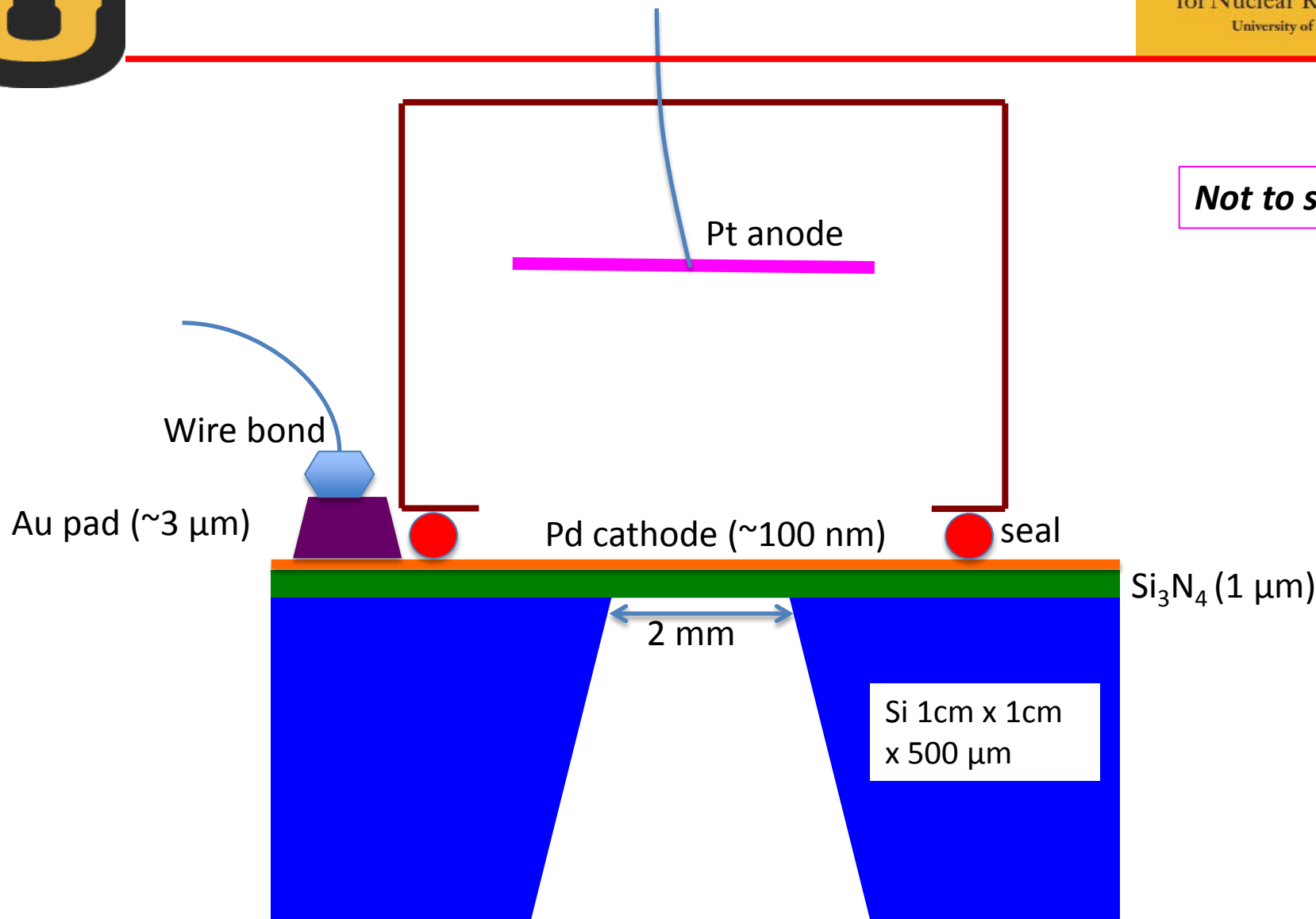
**Expected Progress:
Reveal Mechanism**



Membrane Experiment Schematic



Sidney Kimmel Institute
for Nuclear Renaissance
University of Missouri



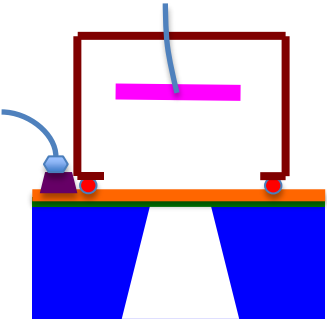


Membrane Experiment Sensitivity



Sidney Kimmel Institute
for Nuclear Renaissance
University of Missouri

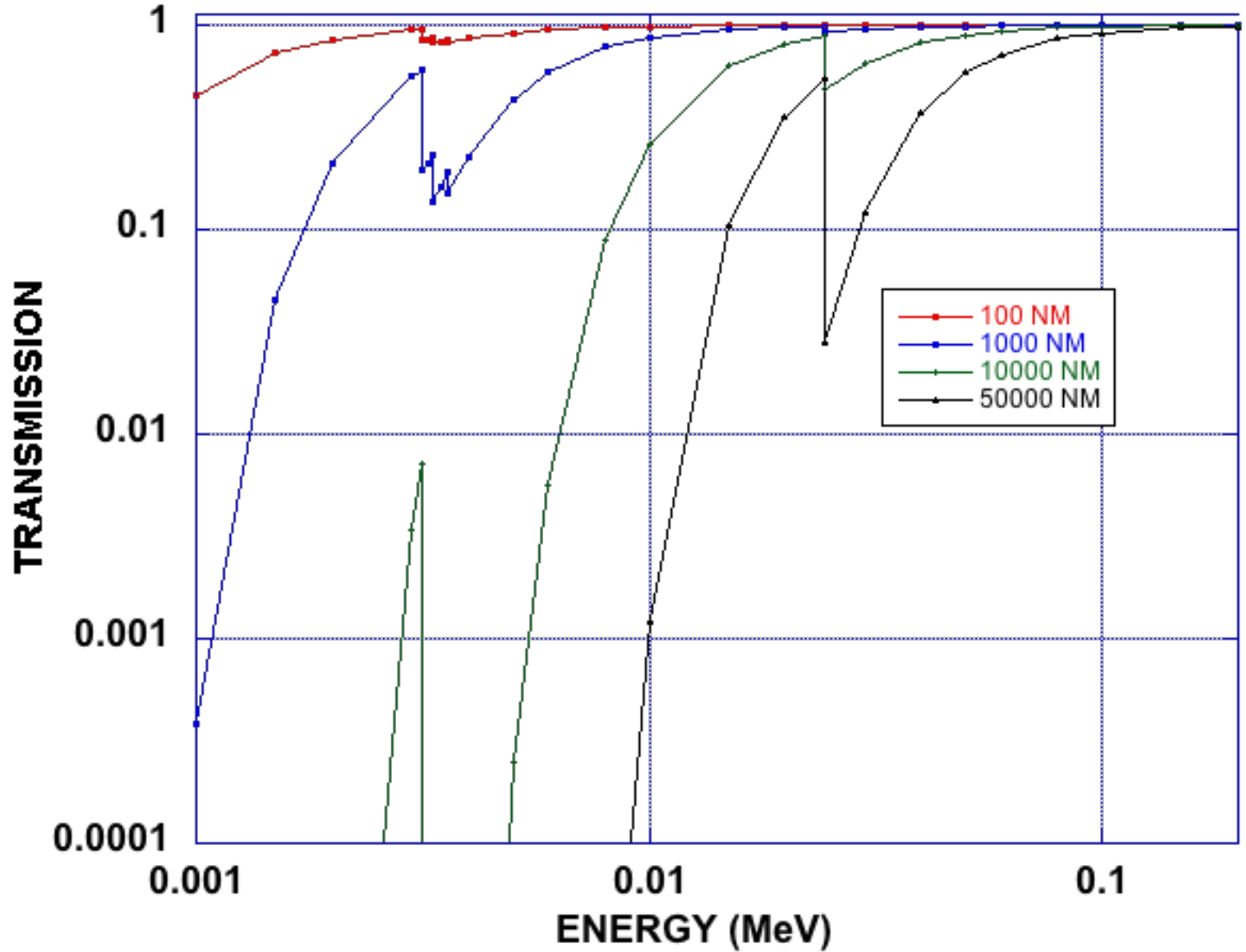
Most calorimeters have power sensitivity in the range of 1 to 10 mW



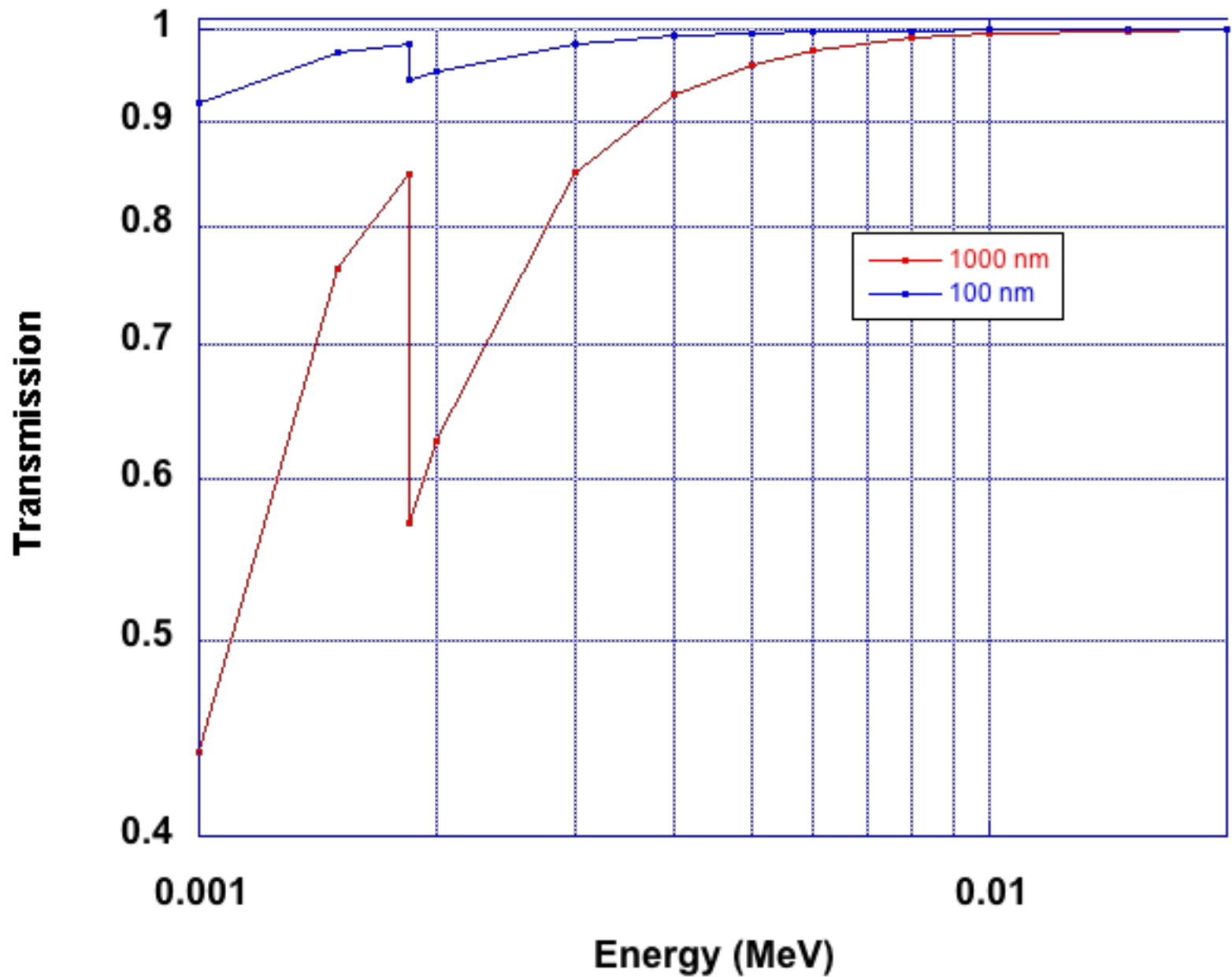
Suppose that the anomalous heat mechanism is active much of the time but at the micro-, nano-, or pico-Watt level. The the calorimeter is insensitive to this power output

If in the membrane experiment we see a 1 keV x-ray at a rate of 1 Hz, the corresponding power sensitivity is 0.2 femtowatts, an excess power sensitivity improvement of 10^{12} !

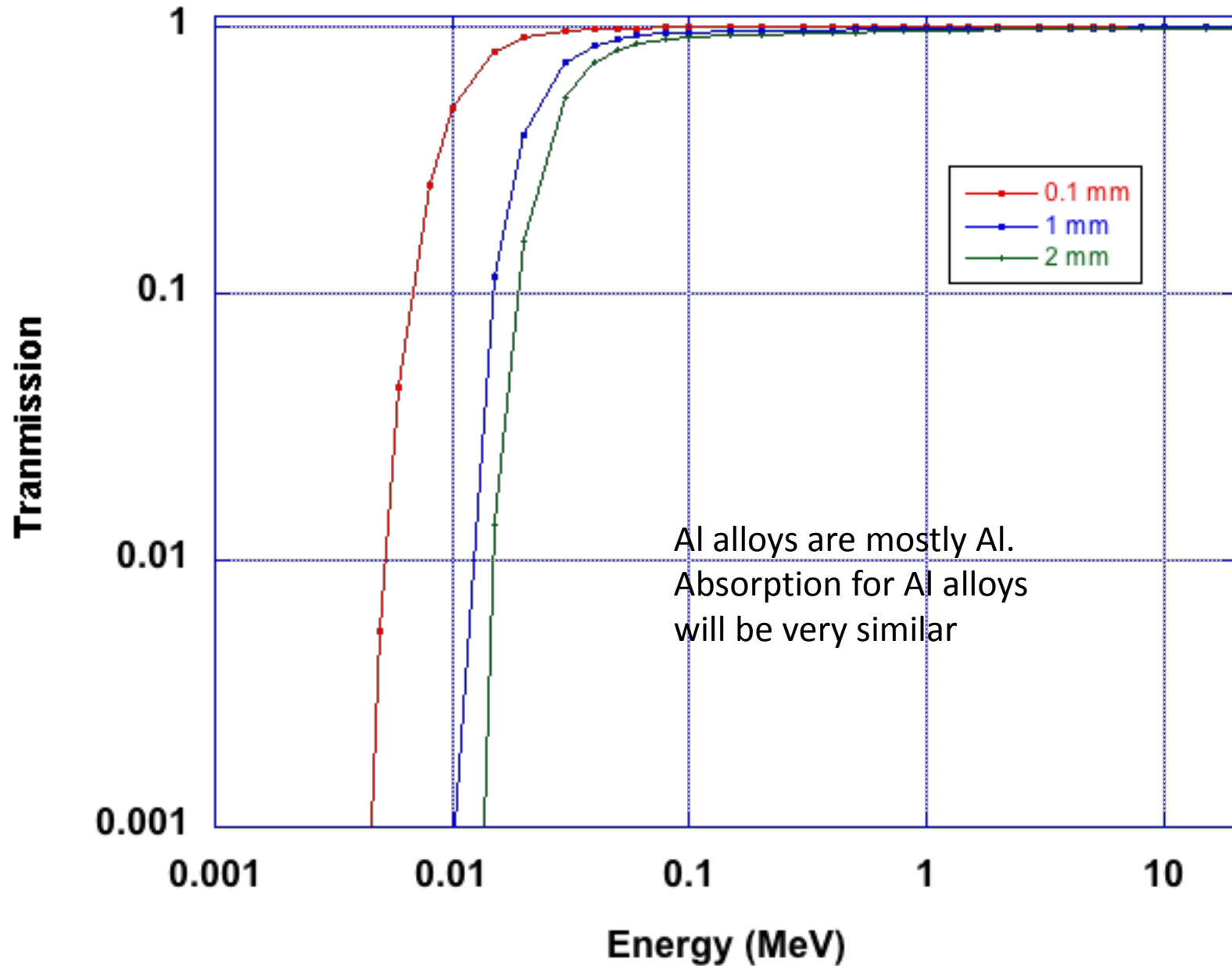
Pd Transmission



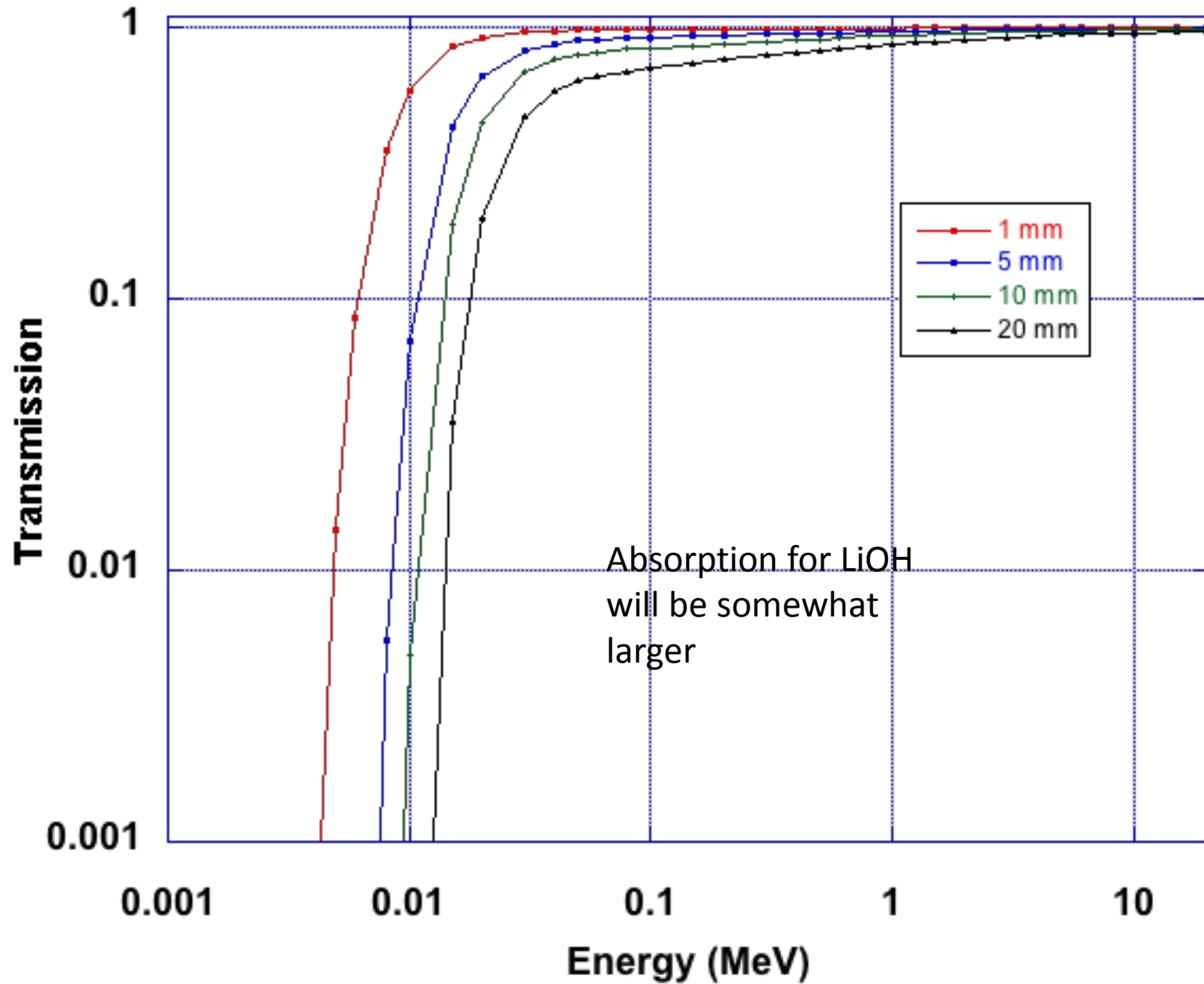
Si3N4 Transmission



Al Transmission



Water Transmission



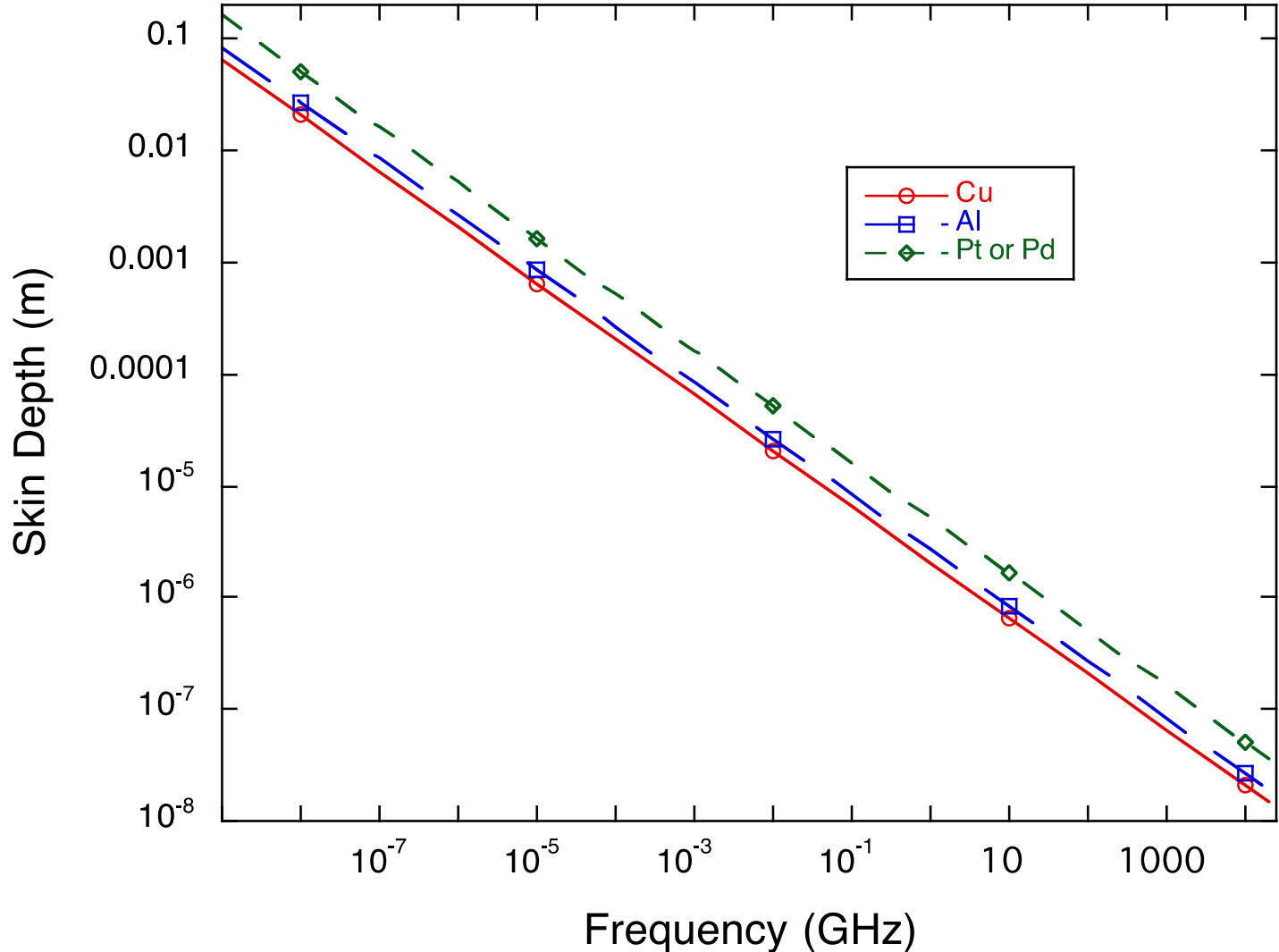
Skin Depth (m) = $\text{SQRT}((2 \cdot \text{Resistivity}) / (2\pi \cdot \text{permeability} \cdot \text{relative permeability} \cdot \text{frequency (Hz)}))$

Resistivity: Al = 28.2 nOhm-m
 Cu = 16.8 nOhm-m
 Pd & Pt = 105 nOhm-m

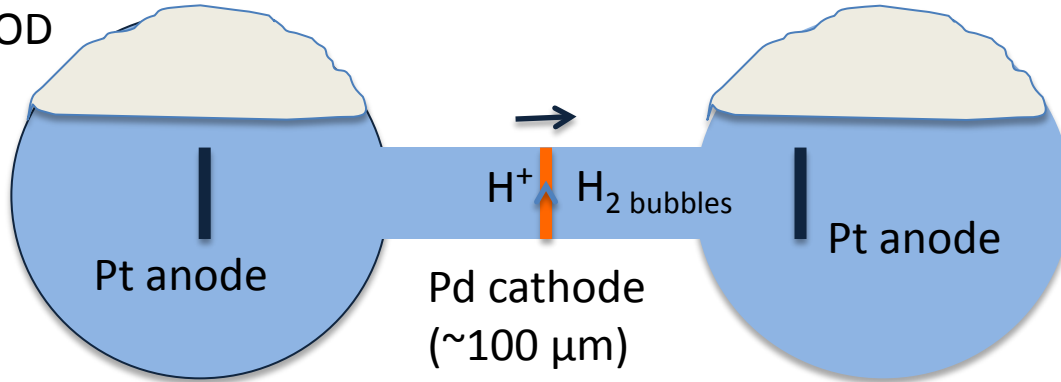
For Al, Cu, Pt, Pd
 Permeability = 12.56E-7 H/m
 Relative permeability = 1.0

Si₃N₄ is transparent to E&M radiation over most of this range

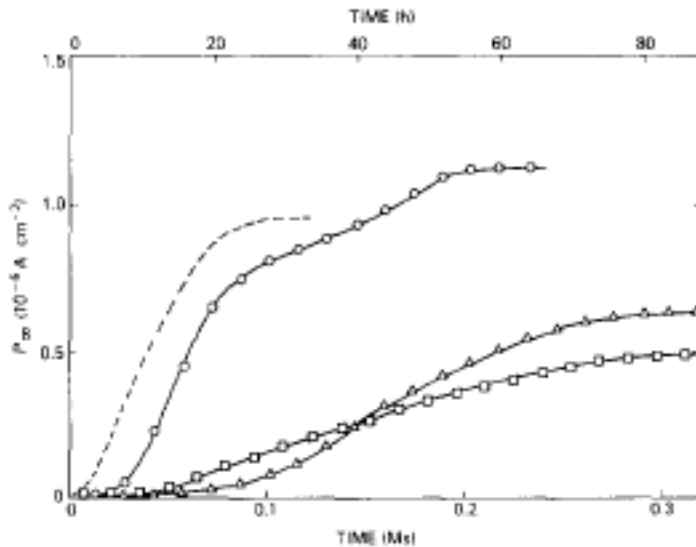
Skin Depth vs. Frequency for some metals



0.1 M LiOH or LiOD



0.1 kmol/m³ NaOH



$$D_{lag} = L^2/6 t_{lag}$$

$$P = D_{lag} \times C_H \times F / L$$

Obtain:

- D_{Lag} - Diffusion constant
- C_H - H conc. Just below surface
- P - relative surface activity

Fig. 7. Hydrogen permeation transients of nickel implanted with a fluence of $3 \times 10^{15} \text{ Pt}^+ \text{ cm}^{-2}$ before and after treatment with aqueous 0.2% HF: \circ , $t = 0 \text{ s}$; \triangle , $t = 60 \text{ s}$; \square , $t = 180 \text{ s}$.



Summary



Sidney Kimmel Institute
for Nuclear Renaissance
University of Missouri

- **SKINR owes its existence to Sidney Kimmel, Energetics, LLC, CBS news and Rob Duncan**
- **Another ~four years to run the Institute**
- **Expected to raise more funds to prolong and expand the institute**
- **Studying both electrochemical and gas loading experiments**
- **Plan for increasing reproducibility in electrolysis experiments**
- **Mechanistic studies may lead to improved understanding of the origin of anomalous heat**
- **Extensive collaborations developed and invite more collaborators**
- **Completely open research objectives, plans and results**
- **Publication of results is an objective**

Much Optimism on the SKINR Team, and, We are having fun!

Sidney Kimmel Institute for Nuclear Renaissance (SKINR) Overview

Graham K. Hubler

Director, SKINR, Department of Physics and Astronomy, University of Missouri, Columbia, MO 65211

Abstract

The Sydney Kimmel Institute for Nuclear Renaissance (SKINR) was established in April 2012 as an entity within the Department of Physics and Astronomy at the University of Missouri (MU) that reports directly to the Vice Chancellor for Research, Dr. Robert V. Duncan. The Institute was formed through negotiations between Dr. Duncan and Philanthropist Mr. Sydney Kimmel who provided initial 5-year funding totaling \$5.5 M. The nucleus of the SKINR staff originated with the company Energetics, LLC. Energetics had carried out research since 2002 in the Anomalous Heat field. Dr. Arik El-Boher is the Group Leader running day-to-day operations.

The mission SKINR laid out by Dr. Duncan was **“to find the origin of the Anomalous Heat Effect (AHE) with a sound materials science approach and with no preconceptions as to the origin of the phenomenon. To publish findings in the open literature and to openly collaborate world wide with researchers in the field and in cross disciplines.”**

Dr. Duncan began by setting up projects with seven UM professors in the departments of Electrical Engineering, Physics, Nuclear Engineering, Missouri University Research Reactor, and Radiology. The experiments set up under Institute guidance are fundamental investigations into aspects related to the Anomalous Heat Effect. The Institute funds graduate and undergraduate students as well as several post-Docs, in addition to the SKINR staff.

This talk will review this history of SKINR, describe the SKINR facilities and experiments, and describe on-going projects with University staff and external collaborators.