TMS Symposium

The World Is Flat: *Globalization of Materials R&D*

Implications for National Laboratories

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National Laboratories: An International Community

- **Oak Ridge National Laboratory – a community of nearly 4,000 employees and an equal number of badged guests and visitors on a given day**
  - **Nearly 3000 guests are in residence for longer than 2 weeks during the year**
  - **In FY04, there were over 2,500 foreign national guests and visitors to ORNL**
    - **A third of visitors were from sensitive countries**
    - **Half of guests were from sensitive countries**

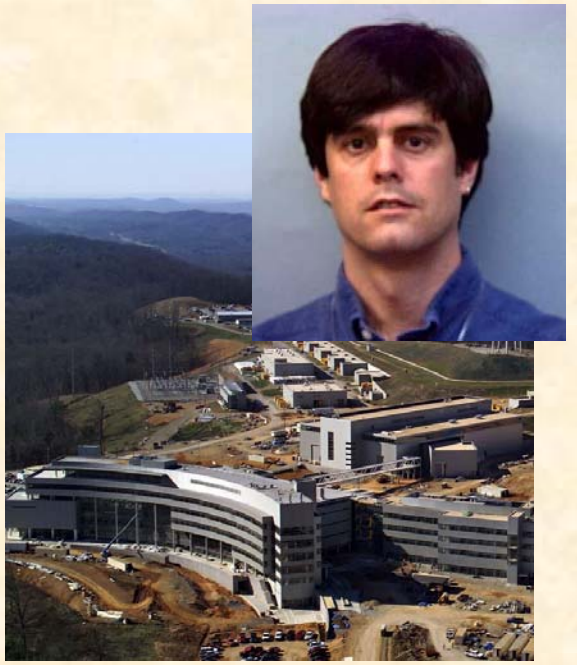
ORNL Materials Community: a diverse group

- **Metals and Ceramics Division:**
  - **Nearly half of the R&D group leaders are or were foreign nationals**
  - **>12% of the research staff are not citizens of the US**
    - **Over 25% were/are citizens of other countries**
  - **Badged guests outnumber employees by a factor of 3: Nearly a third are foreign nationals**
  - **Majority of postdoctoral fellows are not US citizens**
- **Condensed Matter Sciences Division**
  - **Half of the guests are foreign nationals**

ORNL Materials Science Staff born outside of the United States have a high impact....

Laboratory Director:
Jeff Wadsworth (England)

Associate Director for Computing and Computational Sciences:
Thomas Zacharia (India)



Associate Director for the Spallation Neutron Source:
Thom Mason (Canada)

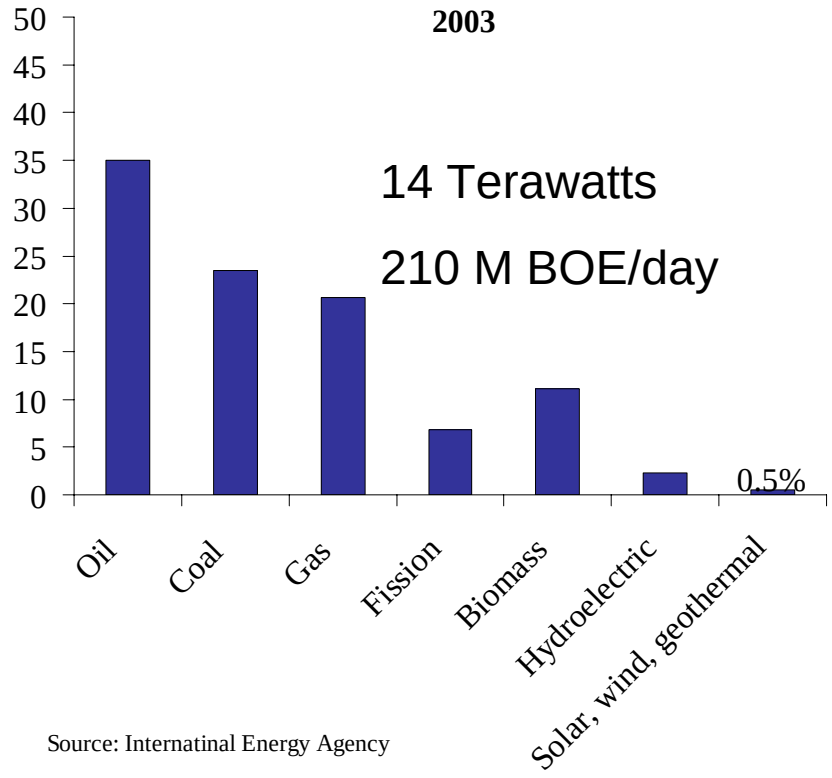
Of 8 top scientific leaders, 5 were foreign nationals

5 ORNL TMS Fellows: All were foreign nationals when they began their careers!

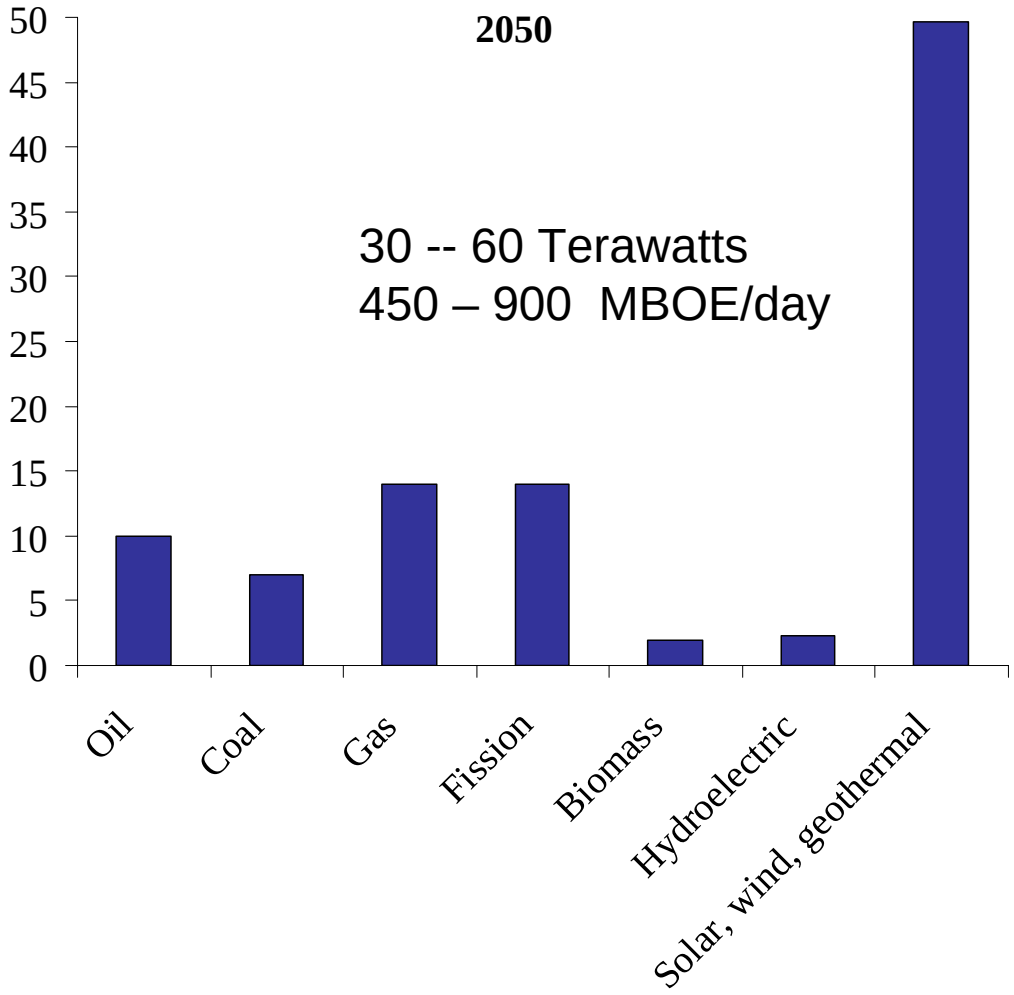
C. T. Liu – a leader in intermetallics research

Photo of a subset of the materials community who have been involved with CT's research (standing on CT's coat-tails!)

Energy: An International Challenge



Source: Internatinal Energy Agency



After Smalley

International Collaborations are a key part of the solution

- **Energy:**
  - **IEA (http://www.iea.org)**
- **Fusion:**
  - **ITER (http://www.iter.org)**
- **Hydrogen**
- **Ongoing lab to lab collaborations**

International Energy Agency: Formed in 1973

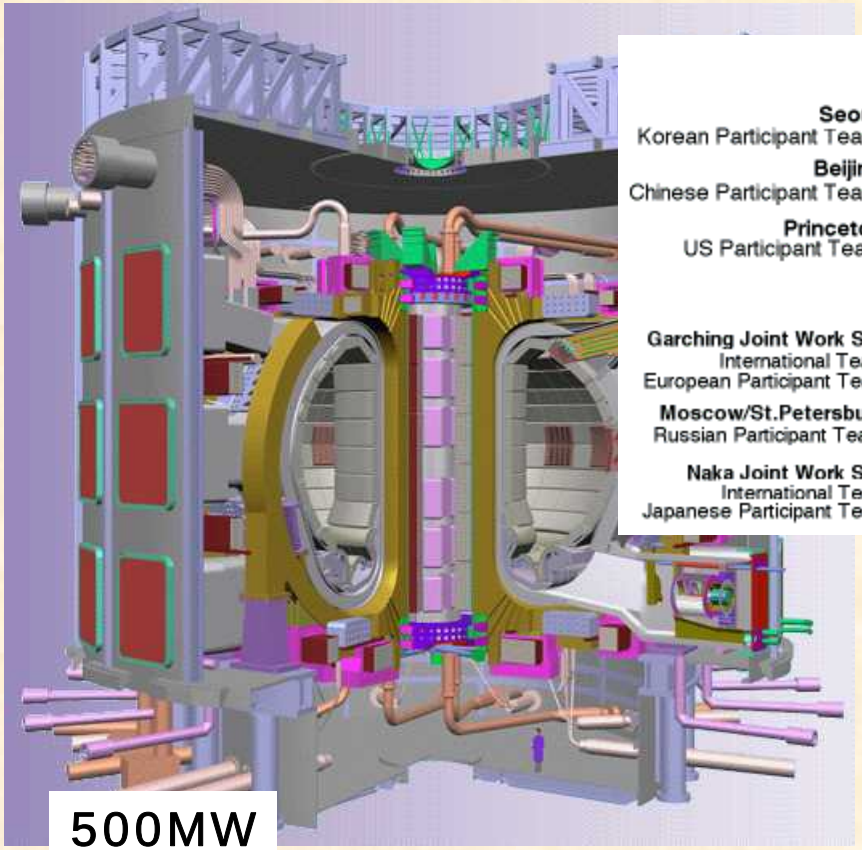
- **Goals:**
  - **Committed to taking joint measures to meet oil supply emergencies**
  - **Share energy information**
  - **Co-ordinate energy policies and to co-operate in the development of rational energy programs**

- **Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Republic of Korea, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States**

Shared policy goals of the IEA member countries…

- Diversity, efficiency and flexibility within the energy sector … for longer-term energy security: ….
- Energy systems should have the ability to respond promptly and flexibly to energy emergencies..
- The environmentally sustainable provision and use of energy is central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should where practicable have regard to the Polluter Pays Principle.
- More environmentally acceptable energy sources need to be encouraged and developed. …. Renewable sources will also have an increasingly important contribution to make.
- Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. ..
- Continued research, development and market deployment of new and improved energy technologies make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-Member countries, should be encouraged.
- Undistorted energy prices enable markets to work efficiently. …
- Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security….
- Co-operation among all energy market participants helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. …

International Fusion Research ITER: "The Way"



Being built under the auspices of the IAEA

First operations expected in 2015

Est cost $2.7B

International Collaborations are a key part of the solution

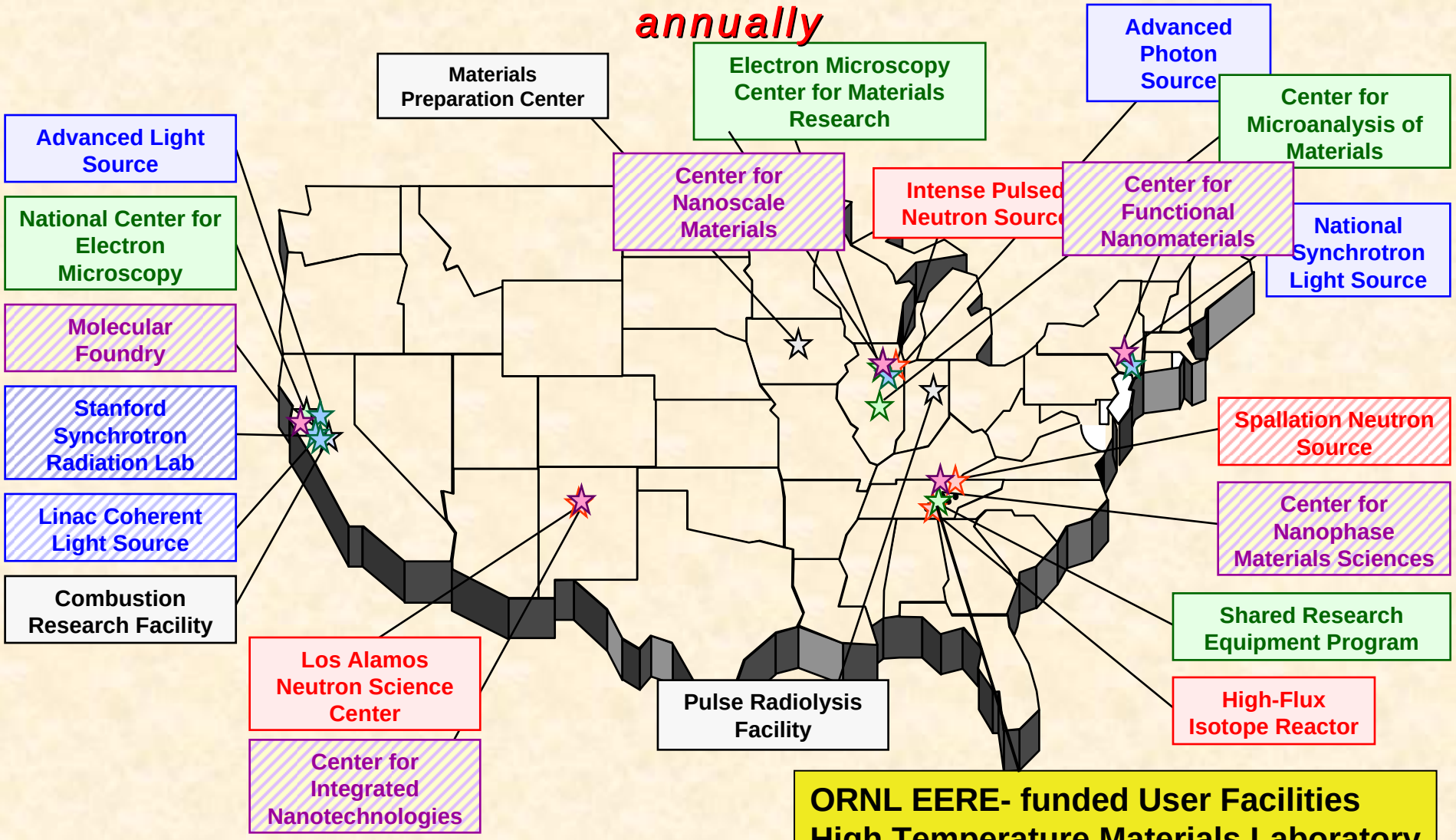
- **Hydrogen**
  - In November 2003: 15 nations, including the United States and the European Union, agreed to establish the International Partnership for the Hydrogen Economy (IPHE).
    - Mechanism to efficiently organize and coordinate multinational research, development and deployment programs that advance the transition to a global hydrogen economy.
    - Partners represent more than 85 percent of the world's gross domestic product and two thirds of the world's energy consumption and greenhouse gas emissions.
  - Lead to the addition of a US representative on the Scientific Advisory Committee of the UK Energy Research Center

International Collaborations are a key part of the solution

- **Energy: IEA (http://www.iea.org)**
- **Fusion: ITER (http://www.iter.org)**
- Hydrogen
- Ongoing lab to lab collaborations
  - Some formal
    - ORNL – JAERI (Fusion)
  - Exchange programs with European labs
  - Humboldt Fellowships
    - Usually form the basis for ongoing interactions
  - Sabbaticals...
  - Typically R&D collaborations

User Facilities – Host for international scientific research

DOE Basic Energy Sciences User Facilities: Over 10,000 users annually



ORNL EERE- funded User Facilities
High Temperature Materials Laboratory
Materials Processing User Centers
Roof Research User Facility

- *4 Synchrotron Radiation Light Sources*
- *Linac Coherent Light Source (PED)*
- *4 High-Flux Neutron Sources (SNS unde*
- *4 Electron Beam Microcharacterization*
- *5 Nanoscale Science Research Centers (PED and construction)*
- *2 Special Purpose Centers*

Major User Facilities greatly increase the numbers of international guests and visitors

- **In FY04, there were over 2,500 foreign national guests and visitors to ORNL**
- **Argonne National Laboratory – with the APS had over 5,600 foreign national guests and visitors**
- **Brookhaven National Laboratory – with the NSLS had nearly 4,800 foreign national guests and visitors**

US User Facilities also collaborate with their overseas counterparts

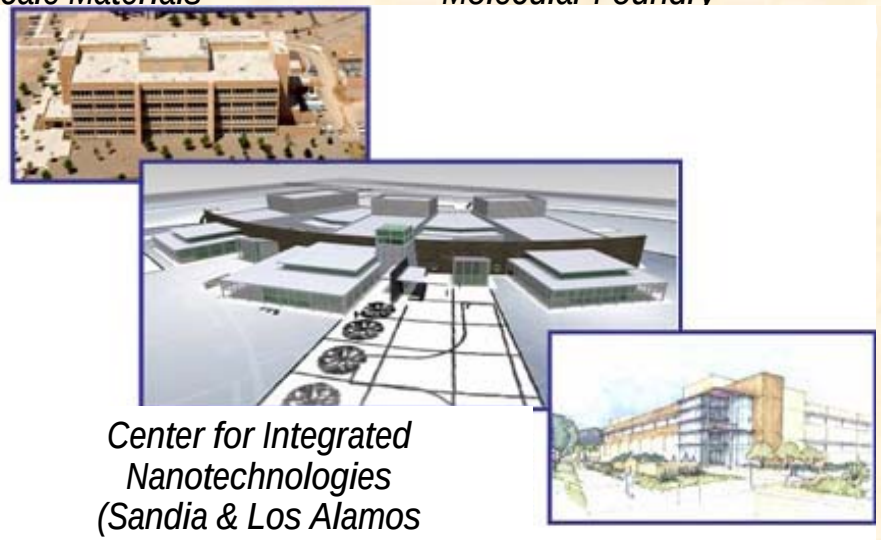
- **Advisory Committees**
- **Review panels**
- **Joint planning activities**
  - **NMI3**
    - **Integrated Infrastructure Initiative (I3) for Neutron Scattering and Muon Spectroscopy (NMI3) brings together 23 partners from 14 countries, including 11 research infrastructures, together with other interested organizations.**
    - **US involved in jointly sponsored workshops**
- **Sponsorship of facilities**
  - **VULCAN beamline at the Spallation Neutron Sources is funded by Canada**

BES National User Facilities for Nanoscale Science

Center for Nanoscale Materials
(Argonne Natio

Molecular Foundry

Center for Nanophase Materials Sciences
(Oak Ridge National Laboratory)



Center for Integrated
Nanotechnologies
(Sandia & Los Alamos
National Labs)

These centers will add to the numbers and the complexity of foreign national interactions

International Collaborations – The DOE Challenge

- **Foreign National access to DOE laboratories is governed by a host of requirements**
  - **9/11 enhanced the rules – made access to many national laboratories more difficult**
  - **Visa issues….**
  - **Export control – discussion of commercially sensitive research with foreign nationals (controlled by law…)**
  - **Some differences exist among the labs – adding to confusion for our international partners**
    - **Defense Labs at one extreme**
    - **Lawrence Berkeley National Lab, Jefferson Lab, Fermi Lab, etc. at the other**
    - **The majority of the DOE energy labs are in the middle**
  - **Different requirements for different countries**
    - **Non-sensitive, sensitive, terrorist sensitive (established by the State Department - the list changes with international situation)**

State Department Classification of Foreign Nationals

Sensitive Countries

- Algeria
- Armenia
- Azerbaijan
- Belarus
- China
- Georgia
- Hong Kong
- India
- Iraq
- Israel
- Kazakhstan
- Kyrgyzstan
- Moldova
- Pakistan
- Russia

Sensitive Countries (cont.)

- Taiwan
- Tajikistan
- Turkmenistan
- Ukraine
- Uzbekistan

Terrorist Sensitive Countries

- Cuba
- Iran
- Libya (under review)
- North Korea
- Sudan
- Syria

Sensitive country citizens are a large fraction of the foreign national visitors and guests

- **In FY04, there were over 2,500 foreign national guests and visitors to ORNL**
  - **A third of visitors were from sensitive countries**
  - **Half of guests were from sensitive countries**
- **Argonne National Laboratory – with the APS had over 5,600 foreign national guests and visitors**
  - **About a third were from sensitive countries**
- **Brookhaven National Laboratory – with the NSLS had nearly 4,800 foreign national guests and visitors**

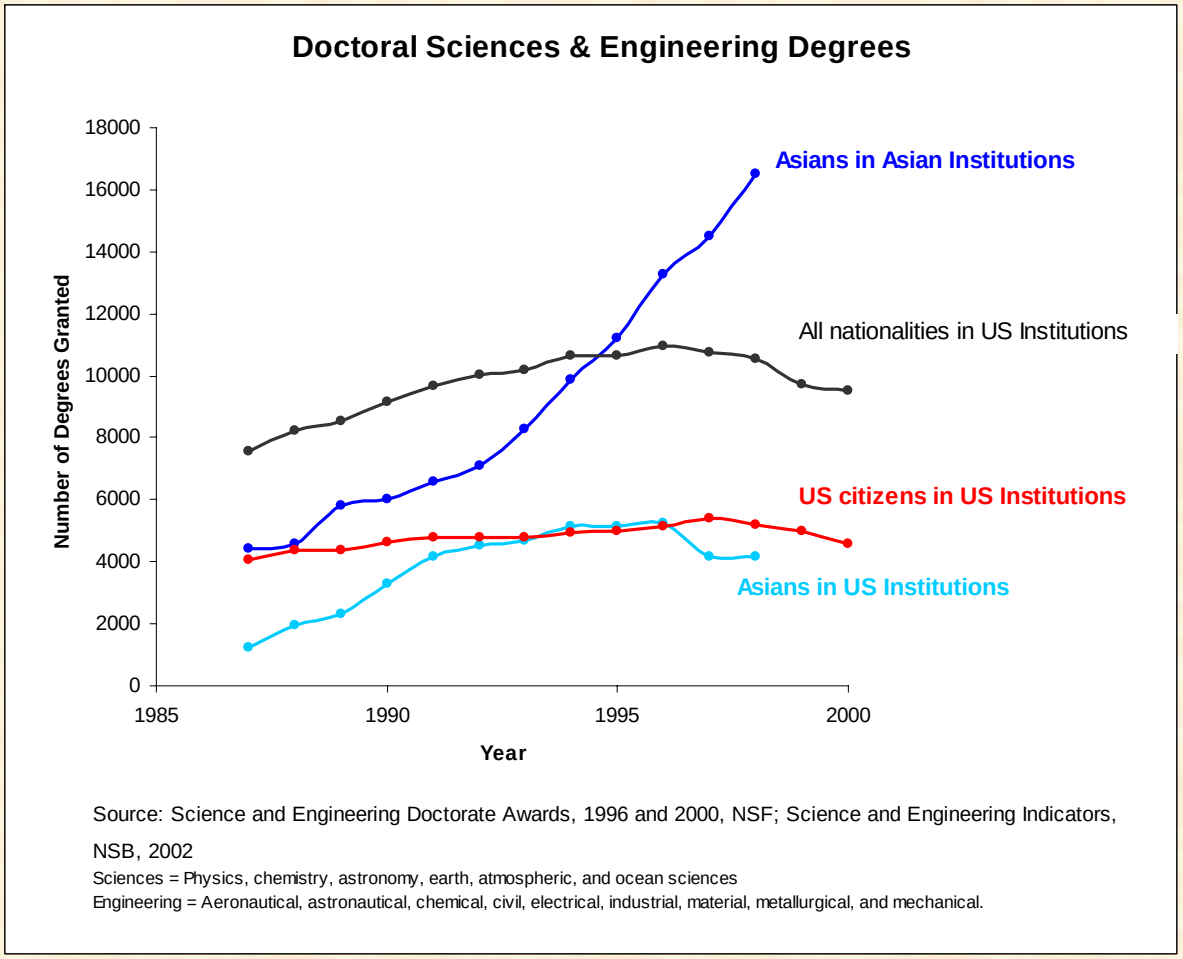
One of the long-standing issues – red badges

Some labs use lab-specific (won't allow access to other labs) badges to avoid this..

International Access – Improvements on the horizon

- **Scientists recognize the problems**
  - **labs are establishing offices to help**
    - **ORNL has a newly established international services office and a foreign national advisory council**
  - **Professional societies are getting involved**
- **DOE's latest foreign national order**
  - **Focuses the restrictions on the most sensitive areas**
  - **Improves the process for open research collaborations**
  - **Central data base with indices (security clearance evaluations) valid for a year – at any lab!**

International Interactions: Science and Engineering Workforce for the Future



Source: Science and Engineering Doctorate Awards, 1996 and 2000, NSF; Science and Engineering Indicators, NSB, 2002

Sciences = Physics, chemistry, astronomy, earth, atmospheric, and ocean sciences

Engineering = Aeronautical, astronautical, chemical, civil, electrical, industrial, material, metallurgical, and mechanical.

New Metals and Ceramics Division postdocs and staff – from a recent newsletter

Foreign National Collaborations will Continue to Play a Major Role in the Science Performed at the DOE Laboratories

- **The nature of the energy problem – an international concern with the need for a variety of technologies**
- **User facilities – a 2-way opportunity**
  - **Using them and development of new techniques and instrumentation**
  - **Use of US facilities by foreign nationals and use of overseas facilities by US scientists**
- **The mobility of the scientific workforce**
- **Improvement of processes and procedures will continue to be challenging in the current political climate**

Abstract: International collaborations are an important component of research at national laboratories, especially in fundamental and energy research. The beneficial aspects of these partnerships, both on an informal and formal level, in raising the level of research and development cannot be undervalued. In global energy R&D, in particular, the challenges are broad and the solutions often will be tailored to regional needs, providing ample opportunities for complementary research activities. Likewise, in frontier areas such as nanoscience and in the development of major user facilities, international cooperation has become increasingly important in the development of new instrumentation and techniques. However, any partnership must be in the interest of the nation, the funding agency, the laboratory and the partner. Issues of national security and economic competitiveness, even with the globalization of many industries, remain areas of ongoing attention.