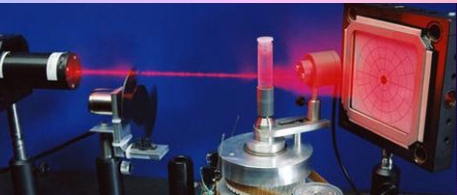


SUMMARY:

- Timeline for Photonics IMI (Slide 75)
- Key must-haves for photonics IMI:
 - Technologies that have broad applications
 - Strong participations by SMEs
 - Supports education and workforce training
 - Led by industry
 - Sustainable without NNMI funding after 5-7 years
- Learning from the Fraunhofer Institutes for Photonics
 - 67 institutes, 7 Fraunhofer groups one of which is Light & Surfaces
 - A subgroup of that is Applied Optics and Precision Engineering (IOF) located in Jena
 - Current Major Project areas include: Freeform optics, fiber lasers, micro and nano modification of surfaces, and human interface with automation systems
 - Exact model is not optimum for the US given several differences between German and the US
- Data on Photonics companies presented (slide 85):
 - 69 firms with photonics revenues > \$500M account for >72% of total sales
 - 2132 firms with photonics revenues <\$10M account for only 3.7% of total sales
- Potential Photonics IMI technologies include: Lasers, advanced optics, imaging and sensing, biophotonics, photonic integrated circuits, displays, LEDs, PV, Metrology (Scope of technologies can be found on slide 87-90)
- Photonics IMI's support other IMIs (Graphic demonstrating relationships on Slide 91.
Example of Distributed COE model (Slides 92 - 94).

Our Photonics IMI Timeline

- **October 2012:** submitted response to NIST RFI recommending establishment of POMATech (Photonics and Optics Manufacturing Technology)
- **December 2012:** held first town hall meeting – over 100 participated
- **January 2013:** attended NNMI Design mtg. in Huntsville
- **January 2013 – March 2014 :** refined model and built awareness nationally
- **May 2014:** received AMTech grant, allowing us to accelerate effort
- **July 2014:** submitted response to DoD RFI calling for establishment of PRISM (Photonics Research, Innovation, Systems, and Manufacturing)
- **July and August 2014:** Visited major optics and photonics universities and gained some consensus on what is in the best national interest.

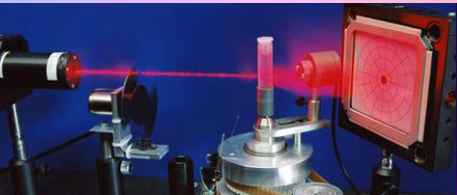


NTRP
National Technology Roadmap for Photonics

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

Key Must-Haves for a Photonics IMI

- Works on technologies that will have broad economic impact
- Works on translational technologies (TRL 4 – TRL 7)
- Strong Participation by SMEs
- Supports Education and Workforce Training
- Led by industry
- Sustainable without NNMI funding after 5-7 years

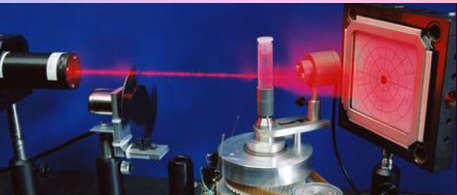


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University Perspectives



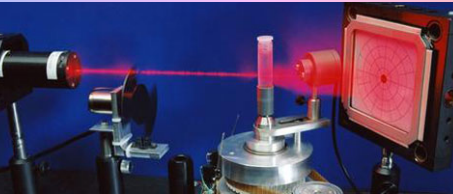
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U.S. Department of Commerce

Design of a National Institute for for Photonics Manufacturing

Leveraging the Nation's Resources and
Planning for the Future

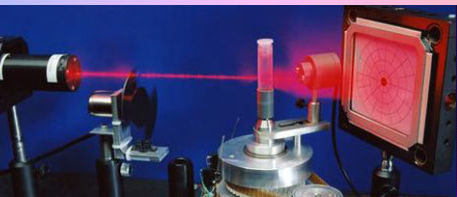


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Learning from the Fraunhofer Institutes for Photonics



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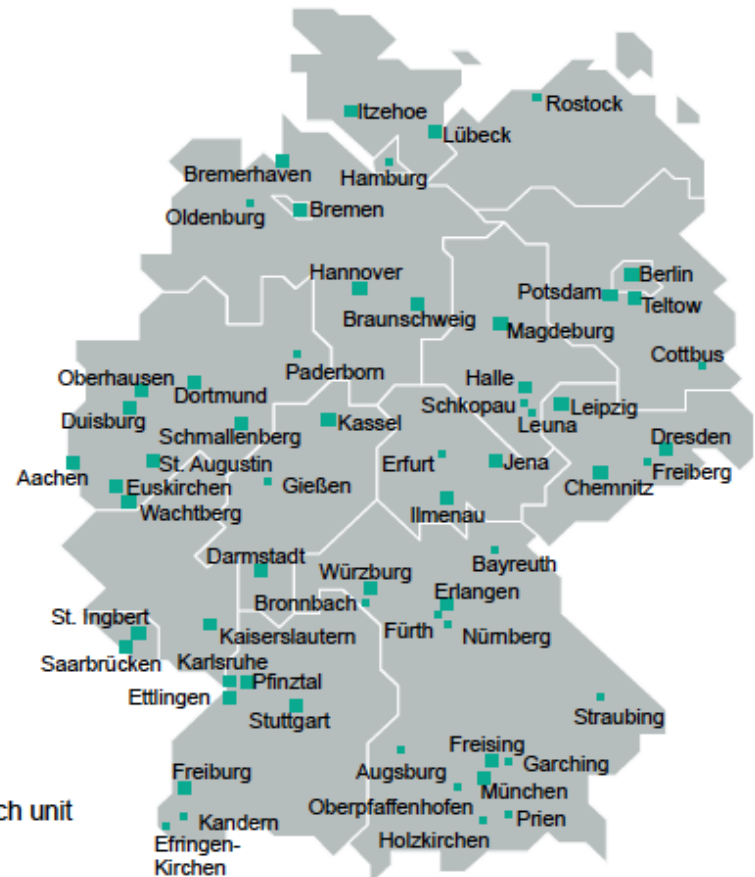
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Fraunhofer-Gesellschaft

Locations in Germany

Data 2013

- 67 institutes and independent research units
- 7 Fraunhofer Groups
- Worldwide locations



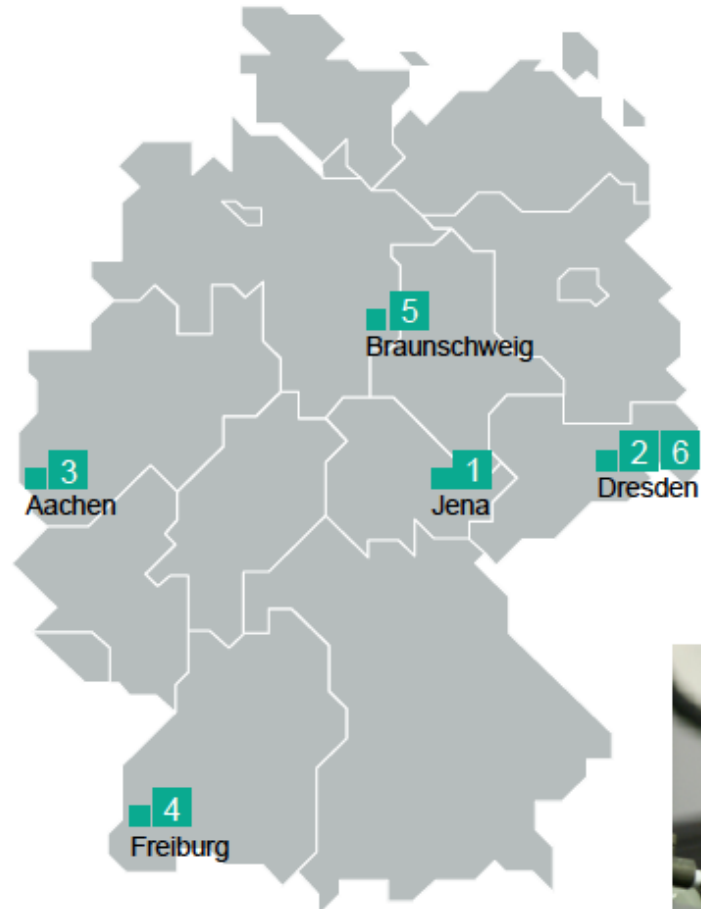
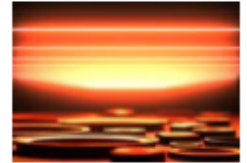
Pooling expertise Fraunhofer Groups



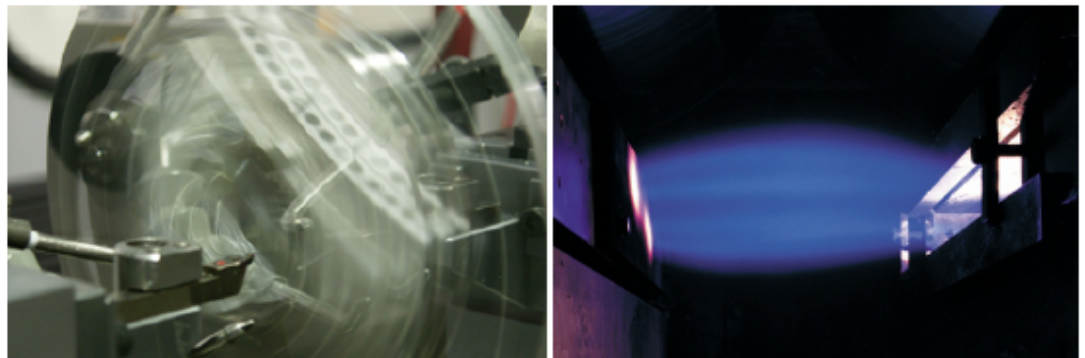
- Institutes working in related subject areas cooperate in Fraunhofer Groups
 - foster a joint presence on the R&D market
 - help to define the Fraunhofer-Gesellschaft's business policy

- ICT
- Life Sciences
- Light & Surfaces
- Microelectronics
- Production
- Materials and Components – MATERIALS
- Defense and Security VVS

Fraunhofer Group for Light & Surfaces



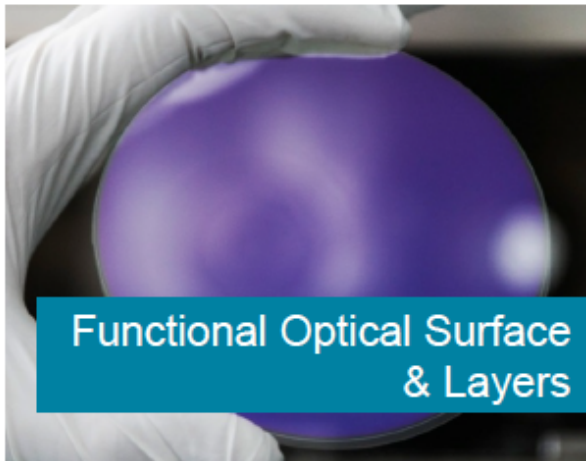
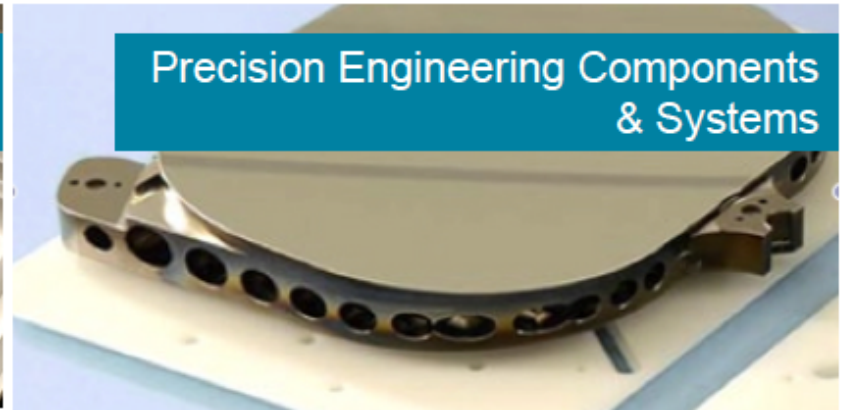
- 1 Applied Optics and Precision Engineering **IOF**
- 2 Electron Beam and Plasma Technology **FEP**
- 3 Laser Technology **ILT**
- 4 Physical Measurement Techniques **IPM**
- 5 Surface Engineering and Thin Films **IST**
- 6 Material and Beam Technology **IWS**



Fraunhofer IOF Business Fields

Current Major Project Areas:

1. Freeform optics
2. Fiber lasers
3. Micro and nano modification of surfaces
4. Human interface with automation systems



Some Differences Between Germany and U.S.

Germany

- 400 miles wide, 137K sq miles
- 80 million people
- GDP \$3.7 trillion
- Military budget \$44B
- Industry/Govt. collaboration common

US

- 3000 miles wide, 3.8M sq miles
- 314 million people
- GDP \$17 trillion
- DoD budget \$600B
- Less Industry/Govt. collaboration

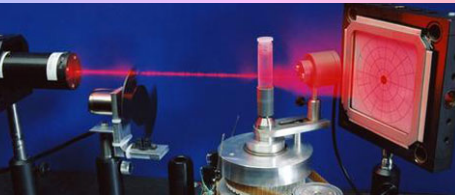
Exact same model is not optimum for the U.S.

Fraunhofer Institutes

- Founded in 1949
- 67 Institutes
- ~20% of budget comes from foundation

NNMI

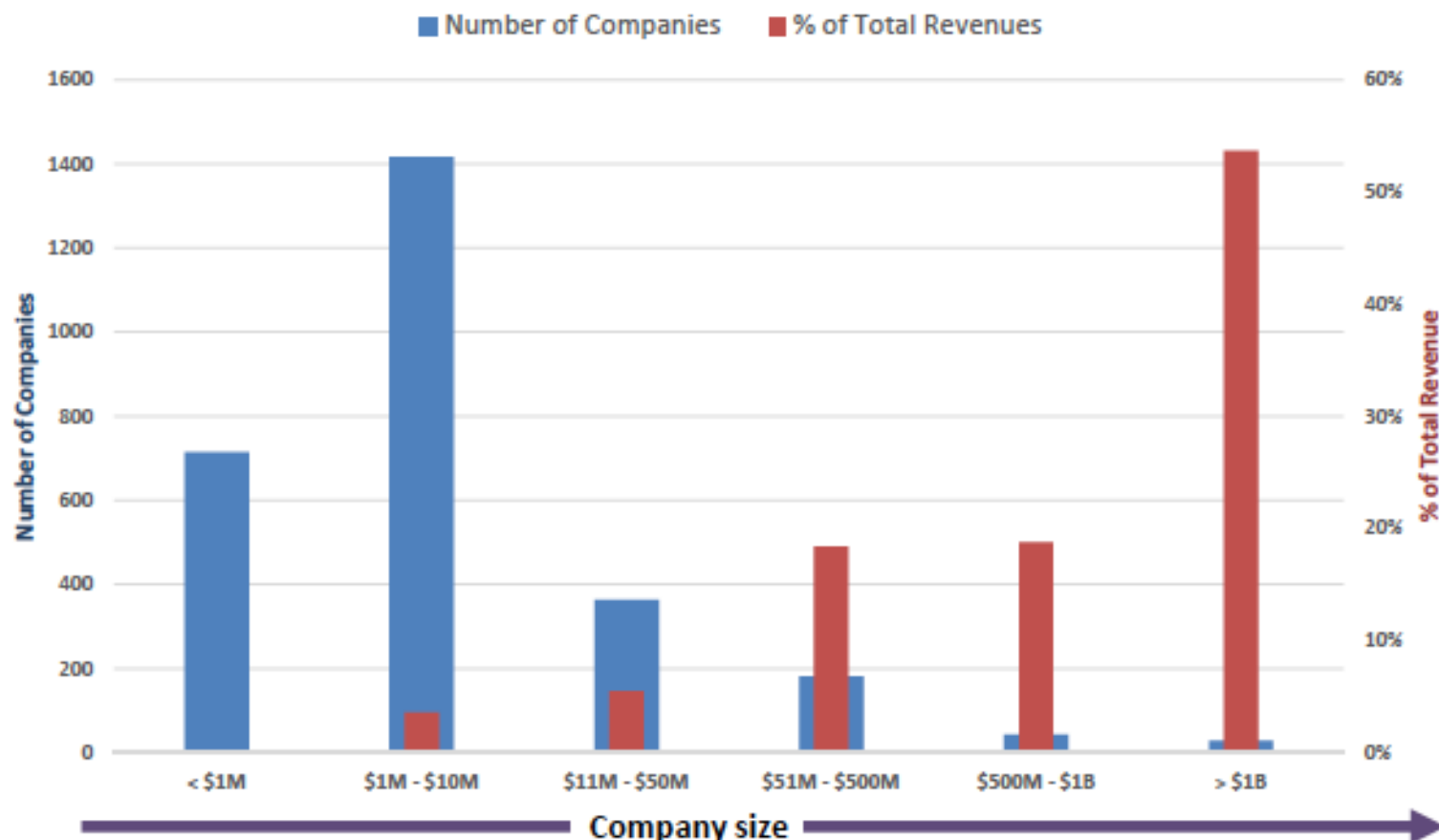
- Founded in 2012
- 45 after 10 years
- Are to be self sustaining in 5-7 years



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National Technology Roadmap for Photonics

Companies Grouped by Size (\$) for Core Photonics Suppliers, WW



- ✓ **69 firms with photonics revenues > \$500 M account for >72% of total sales**
- ✓ **2132 firms with photonics revenues < \$10 M account for only ~3.7% of total sales**
- ✓ **<10% of photonics firms employ ~77% of the workforce**

Potential Photonics IMI Technologies

- Lasers
- Advanced optics
- Imaging and Sensing
- Biophotonics
- Photonic Integrated Circuits
- Displays
- LEDs
- PV
- Metrology

Lasers, Sensors, and Imaging (LSI) IMI

- Lasers
- Advanced optics
- Imaging and Sensing
- Biophotonics
- Photonic Integrated Circuits
- Displays
- LEDs
- PV
- Metrology

LSI Scope

- Advanced Optics
- Detectors
- Imaging and Sensing Systems
- QCL Lasers
- E/O IR
- Biophotonics
- Fiber lasers
- DoD influenced
- ITAR compatible

Photonic Integrated Devices (PID) IMI

- Lasers
 - Advanced optics
 - Imaging and Sensing
 - Biophotonics
 - Photonic Integrated Circuits
 - Displays
 - LEDs
 - PV
 - Metrology
- (PID) Scope
- Photonic Integrated Circuits
 - Biophotonic ICs
 - Imaging Arrays
 - PIC Foundry
 - Primarily commercial
 - NIST influenced

Advanced Photonic Manufacturing (APM) IMI

- Lasers
- Advanced optics
- Imaging and Sensing
- Biophotonics
- Photonic Integrated Circuits
- Displays
- LEDs
- PV

APM Scope

- High Power Lasers (e.g. fiber lasers)
- Lithography and Metrology
- Machine vision
- Both manufacturing of industrial lasers and applications of lasers in manufacturing
- NIST and DOD influenced

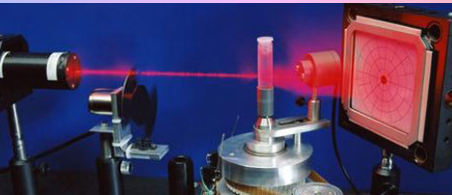
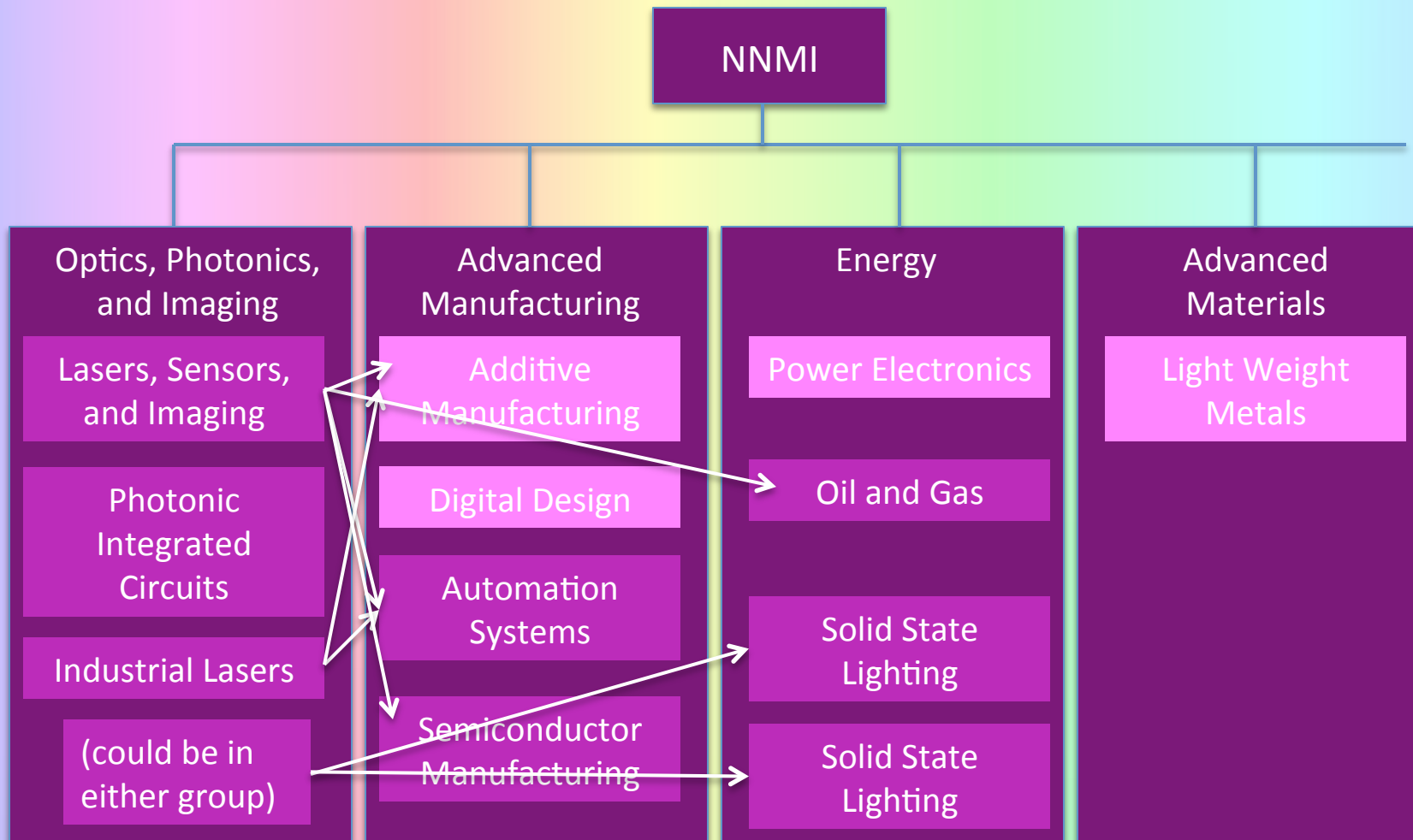
PV and Solid State Lighting (PVSSL) IMI

- Lasers
- Advanced optics
- Imaging and Sensing
- Biophotonics
- Photonic Integrated Circuits
- Displays
- Solid State Lighting
- PV

PVSSL Scope

- PV
- Solid State Lighting
- DOE and NIST influenced

Photonics IMIs Support Other IMIs

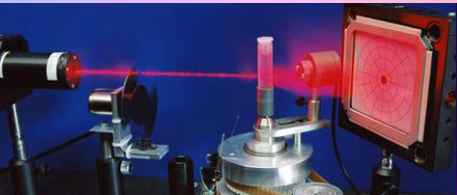


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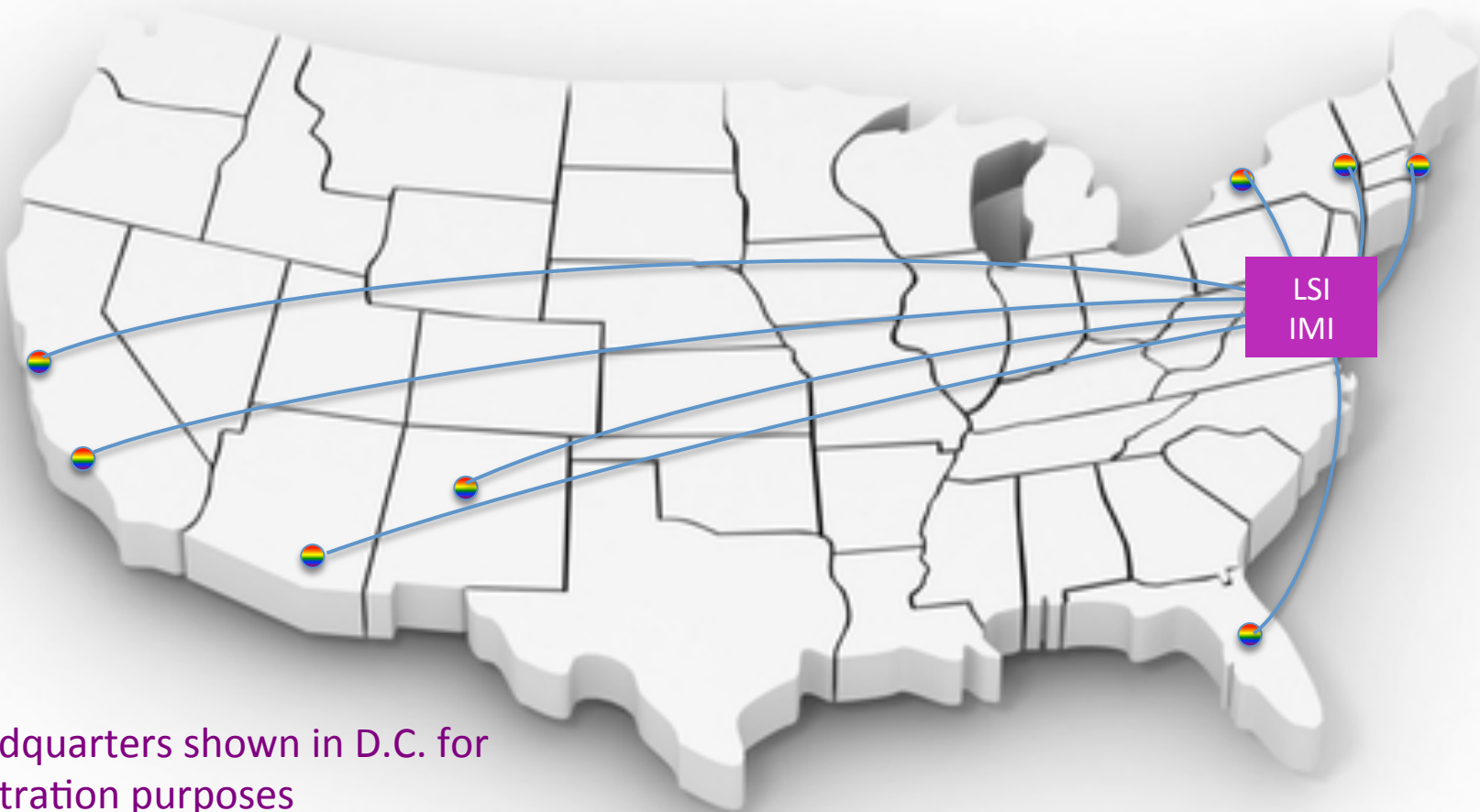
National Technology Roadmap for Photonics

One Approach to Setting up Photonics IMIs

- Set up one first – we suggest Lasers, Sensing, and Imaging
- Make that the base for the eventual OPI group
- Have the LSI IMI be composed of Centers of Excellence (COEs) around the major photonics hubs in the U.S.
 - Albany – photonic integrated circuits
 - Albuquerque – IR materials and systems
 - Boston – biophotonics and photonic integrated circuits
 - Orlando – Lasers and Optics
 - Rochester – Optics, Imaging, and Lasers
 - Tucson – Optics, biophotonics, imaging
- If more photonics IMIs are set up, the COEs could evolve into them.
- Close collaboration within the group ensures continuity of strategy and operation



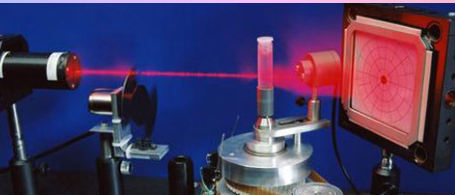
NNMI OPI Group



Headquarters shown in D.C. for illustration purposes

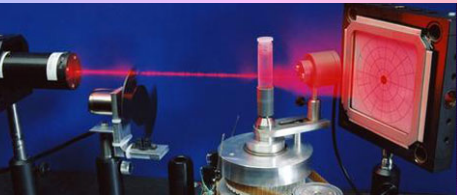
Value of a Distributed COE Model

- The US has vast photonics resources with several large clusters. These should be leveraged in an NNMI
- Regional centers will make participation by SMEs much easier.
- Regional centers will make workforce training at the 2-year school level more valuable
- Regional centers will enhance industry/university collaboration and increase efficiency and economic impact
- State and regional governments are making large investments in photonics-related economic development. This should be leveraged at the national level.
- The current plan is to have “only” 45 IMIs within 10 years. Germany has 67 Fraunhofer Institutes for an economy 1/5 the size of the US, so having each IMI include multiple COEs may be appropriate for the US.



Possible Starting Focus Areas of a LSI IMI

- Freeform optics manufacturing
- E/O IR
- Photonic materials
- QCLs
- Biophotonic devices
- Hyperspectral Sensing and Imaging



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National Technology Roadmap for Photonics