ICCAD Workshop on Variability Modeling and Characterization
Nov. 5, 2015

NEEDS:

Science, Circuits, and Systems

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Purdue University
MIT, U.C. Berkeley, Stanford

NEEDS
needs.nanoHUB.org

NEEDS

Goal:

To advance the science of nanodevices and enable new applications.

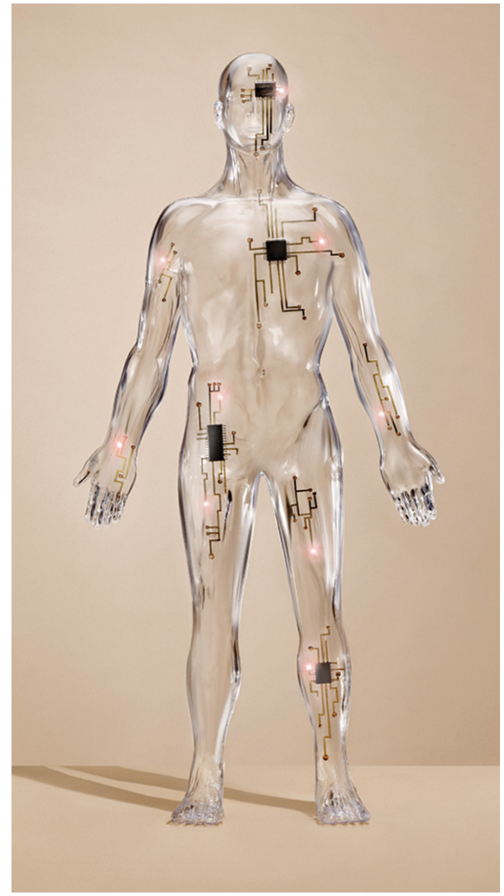
Focus:

1) Physics-based compact models for emerging devices.

2) Infrastructure to support the NEEDS team and the broader community.

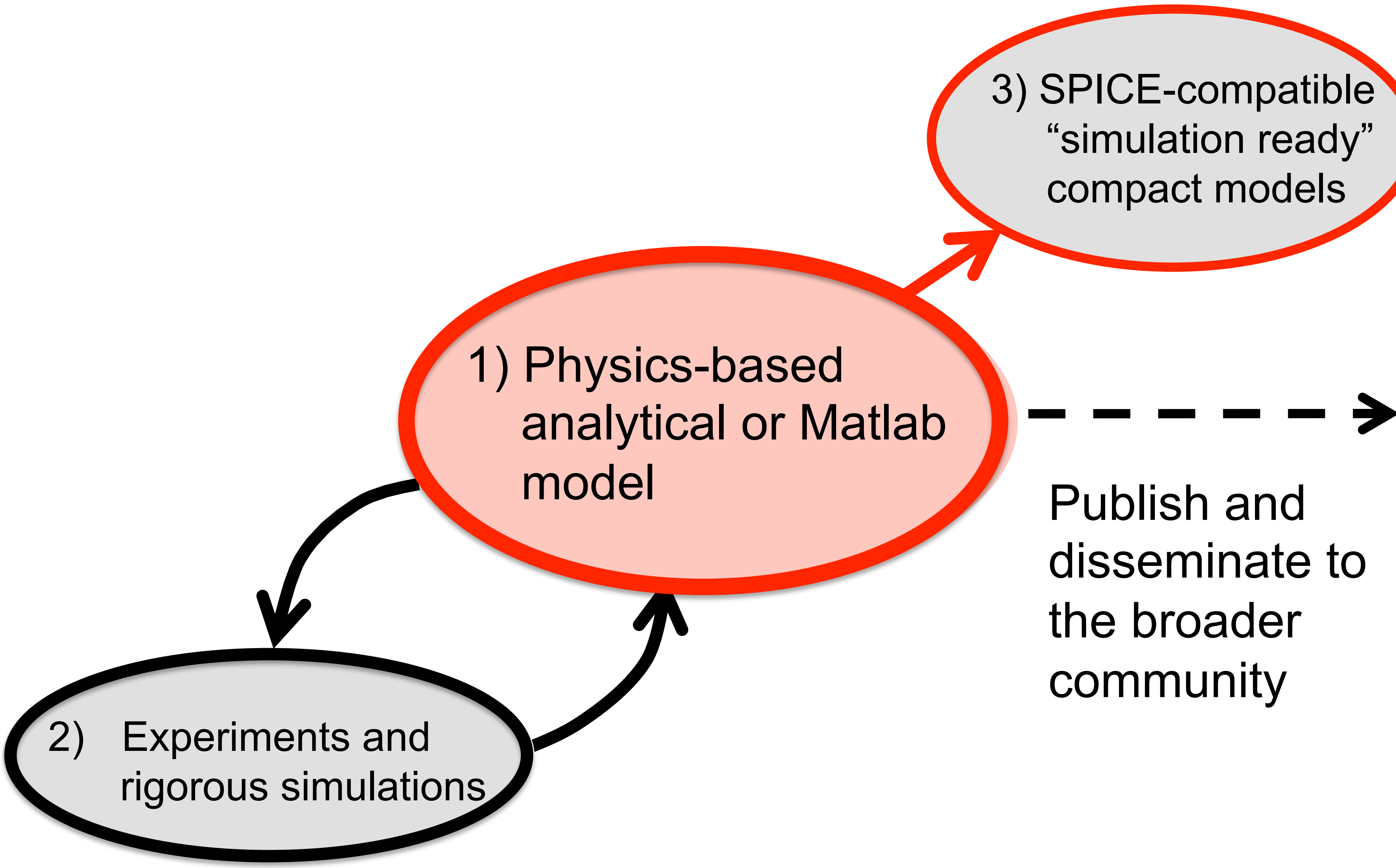
Electronics is in transition

- We Will End Disability by Becoming Cyborgs
- Robots Will Pave the Way to Mars
- Make Your Own World With Programmable Matter
- Digital Actors Go Beyond the Uncanny Valley
- The Rise of the Personal Power Plant
- Wearable Computers Will Transform Language
- Driverless Cars: Optional by 2024, Mandatory by 2044
- So, Where Are My Robot Servants?



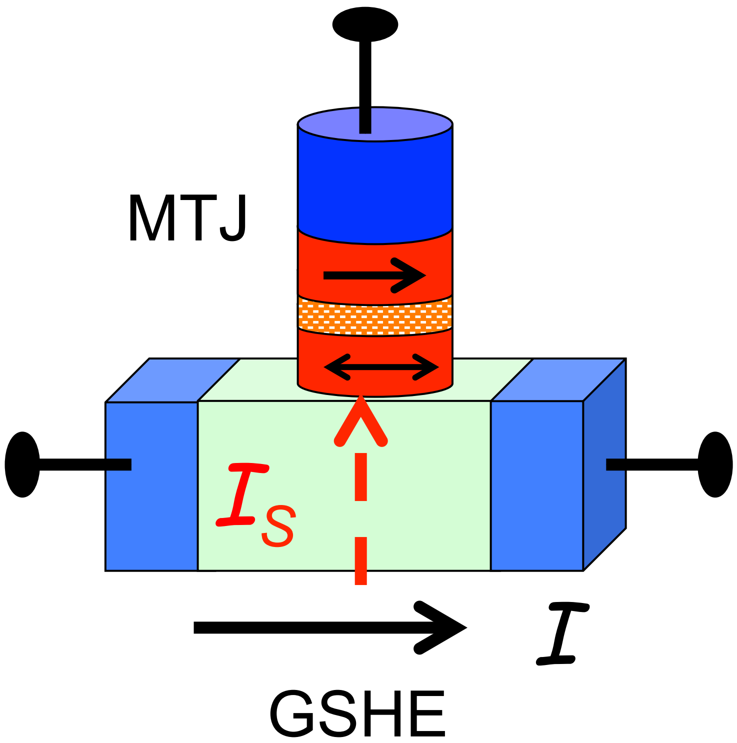
"The Future We Deserve", *IEEE Spectrum, Jan. 2015.*

systems and applications



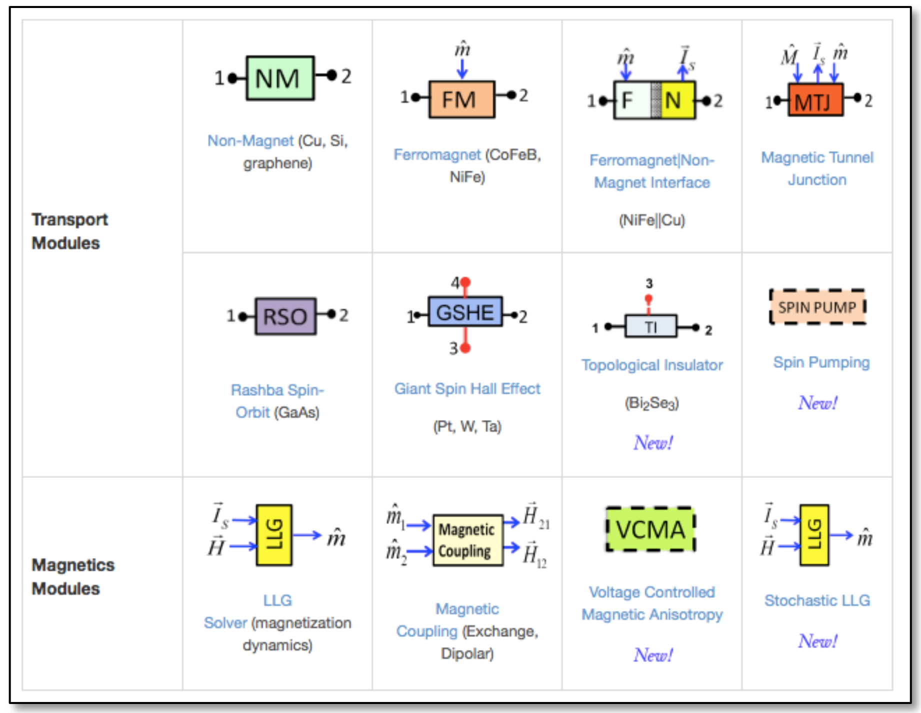
nanoscience of materials and devices

NEEDS device science: spintronics



$$\begin{Bmatrix} V \\ \vec{V}_s \end{Bmatrix}, \begin{Bmatrix} I \\ \vec{I}_s \end{Bmatrix}$$

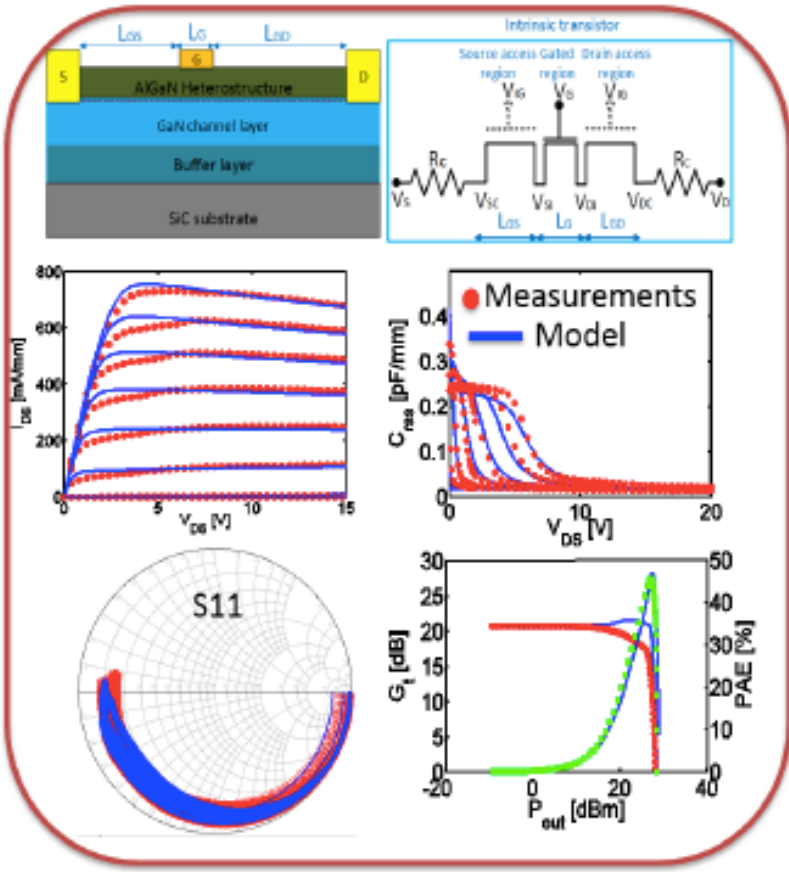
Elemental Modules



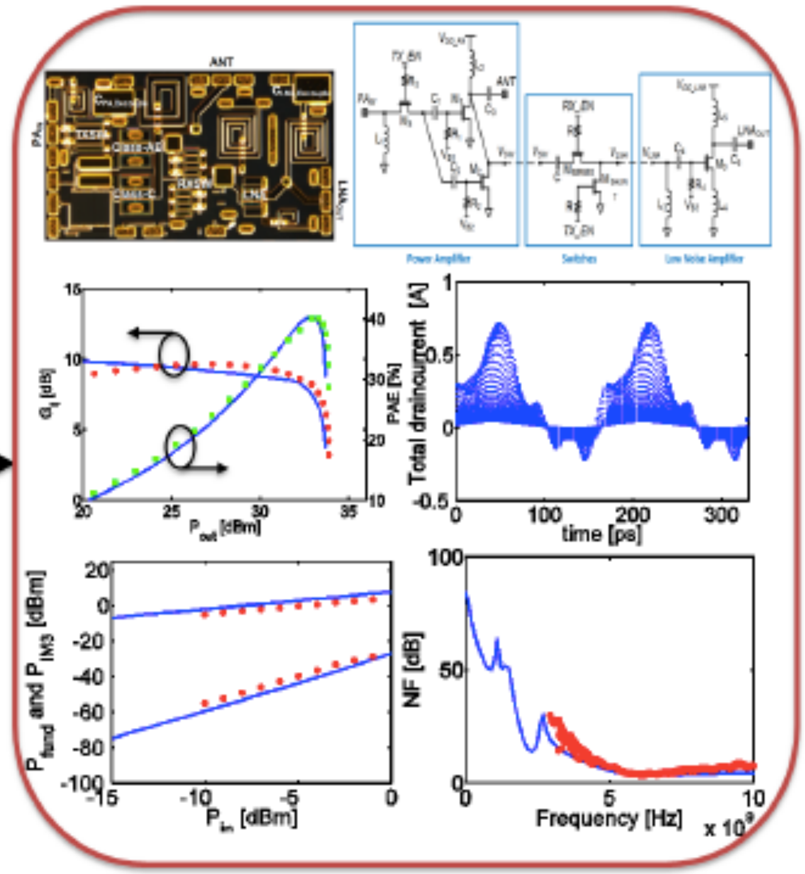
Supriyo Datta and Kerem Camsari, Purdue

NEEDS device science: RF GaN FETS

Device Technology



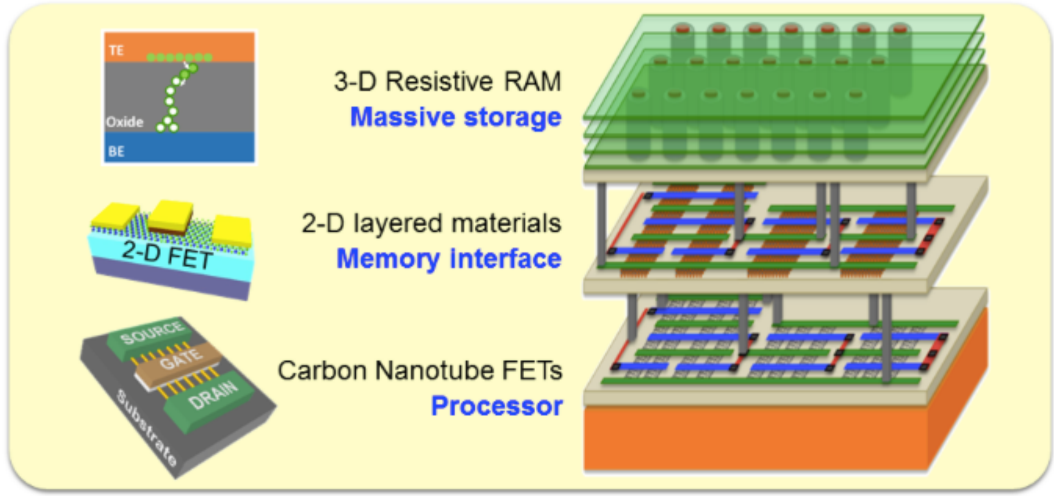
Circuit Design



Dimitri Antoniadis and Ujwal Radhakrishna , MIT

NEEDS device science: Integrated nanosystems

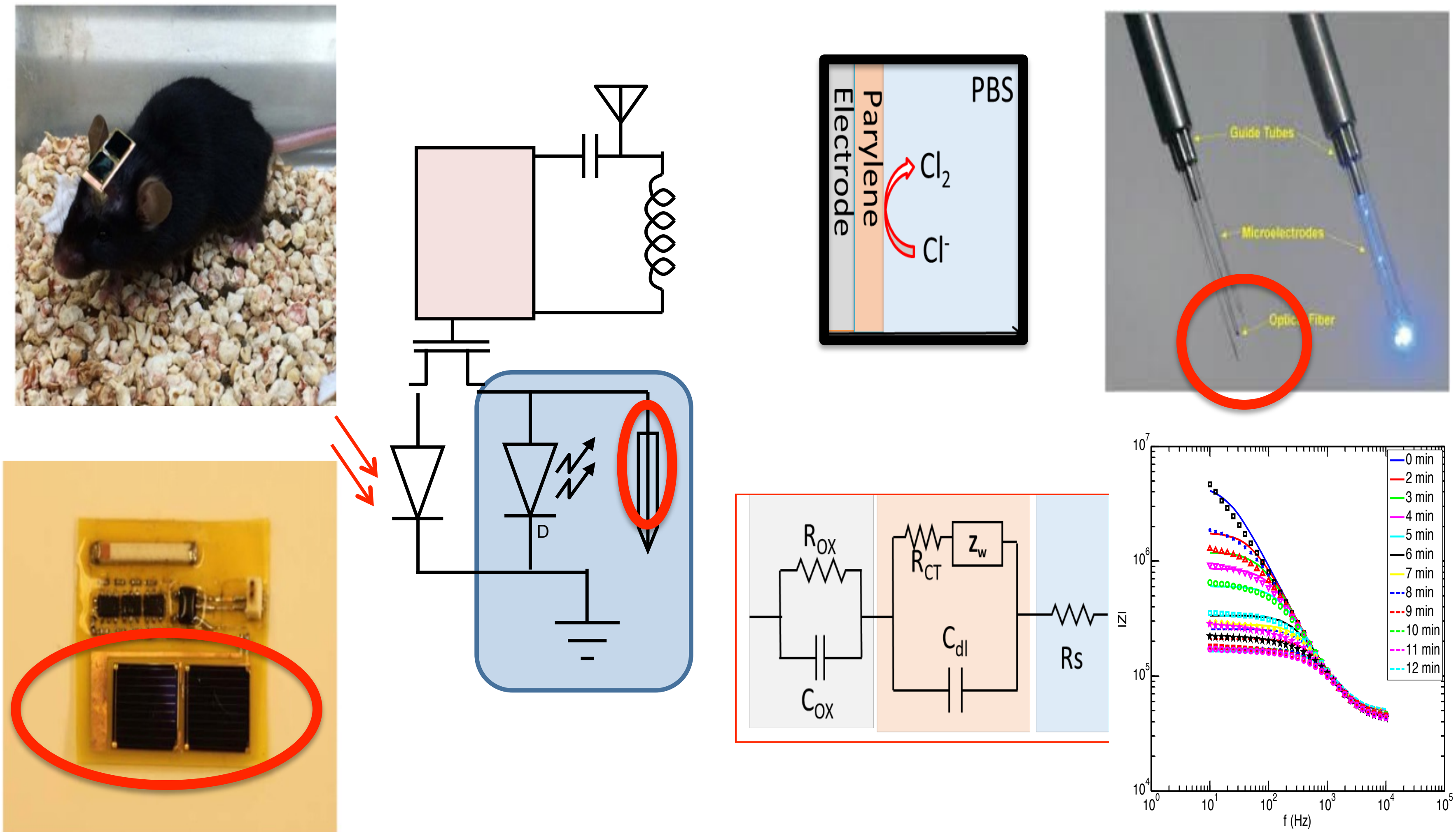
Compact models: essential, but **insufficient alone**



H.S.P. Wong and S. Mitra

(ICCAD 2015 Workshop on Variability Modeling and Characterization)

NEEDS device science: implantable optogenetics



J. Rogers (UIUC), P. Irazoqui, T. Fisher, and M. Alam (Purdue)

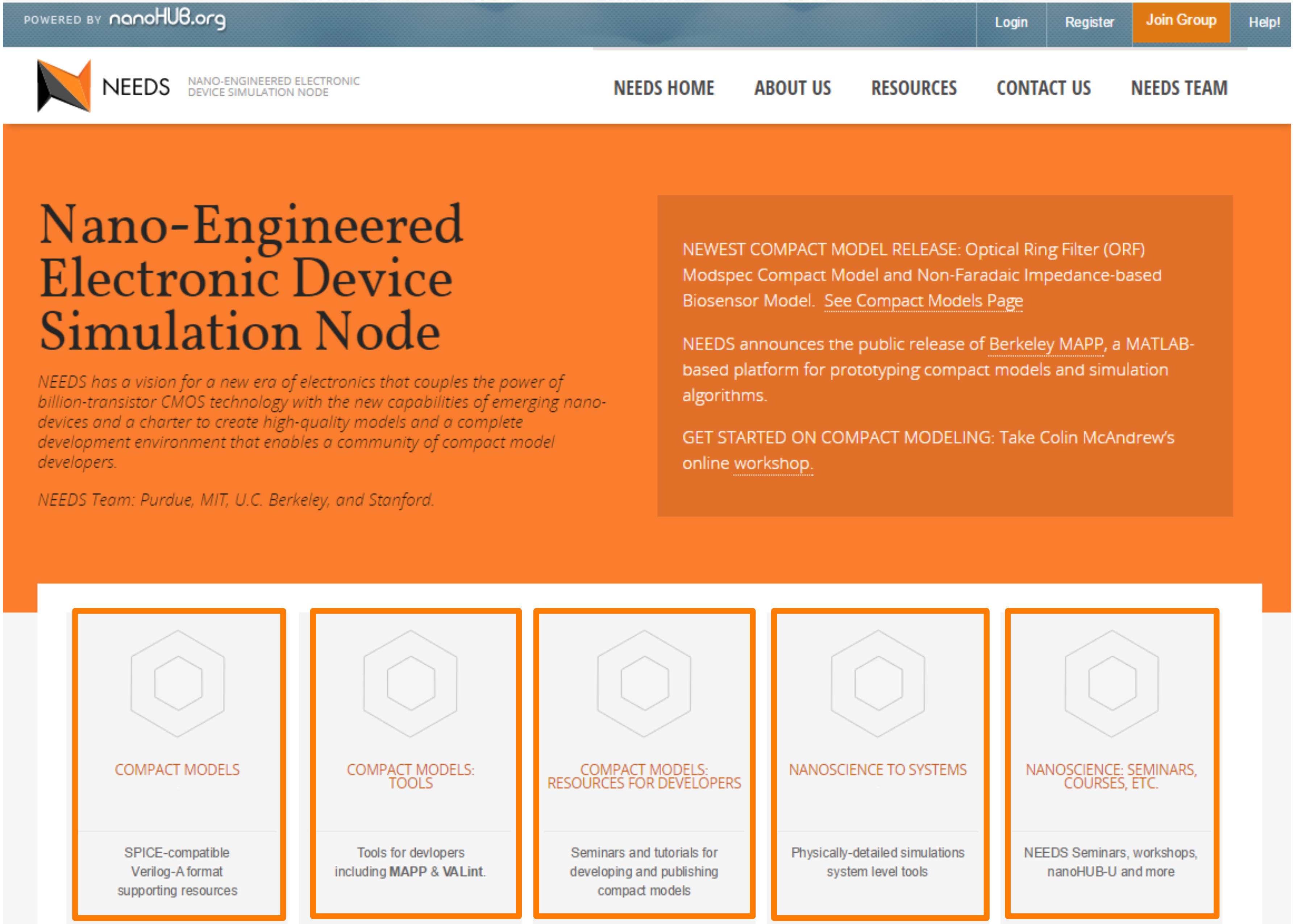
Specific Infrastructure Goals

1) Develop a suite of open-source, **physics-based** compact models for emerging nanodevices.

2) Create **tools and processes** for developing compact models.

3) Produce **educational resources** to support 1) and 2).

4) Leverage **nanoHUB.org** to engage a broad community of device researchers and designers.



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1) physics-based compact models

Virtual source transistor models for:

Si
Graphene
GaN – RF and high-voltage
CNTFETs
etc.

Novel transistors:

2D TMD
FeFETs
TFETs

Memory devices:

RRAM
CBRAM
phase change

Spintronic devices

TMJ, etc.

Optical devices:

VCSELs
Si-based modulators

MEMS resonators:

released
unreleased

Energy devices:

solar cells
thermoelectric devices

biosensor models for:

FET-based sensing
impedimetric sensing
mechanical sensing

publish your model with NEEDS

NEEDS NANO-ENGINEERED ELECTRONIC DEVICE SIMULATION NODE

NEEDS HOME | ABOUT US | RESOURCES | CONTACT US | NEEDS TEAM

For Developers

Submit Compact Model >> Start Here

Resources for deploying NEEDS compact models:

Checklist for Submitting a NEEDS Compact Model (33 Kb)

Detailed Instructions for Submitting a NEEDS Compact Model (45 Kb)

Compact Model Council's recommendations for versioning compact models

NEEDS-modified Compact Model Council Standard license for compact models (2 Kb)

Tips for Verilog-A NEEDS Compact Model Release – Lessons Learned from MVS 1.0.0
by Shaloo Rakheja

Guidelines for Writing NEEDS-certified Verilog-A Compact Models
by T. Wang and J. Roychowdhury

Compact Model Council Compact Model QA Specification

General resources for compact model developers:

How to Write, Develop and Implement a Real Compact Model
A Hands-on Workshop by Colin McAndrew

Basics of Compact Model Development
by Sivakumar Mudanai

How Really Smart People Can Write Really Dumb Models
by Colin McAndrew

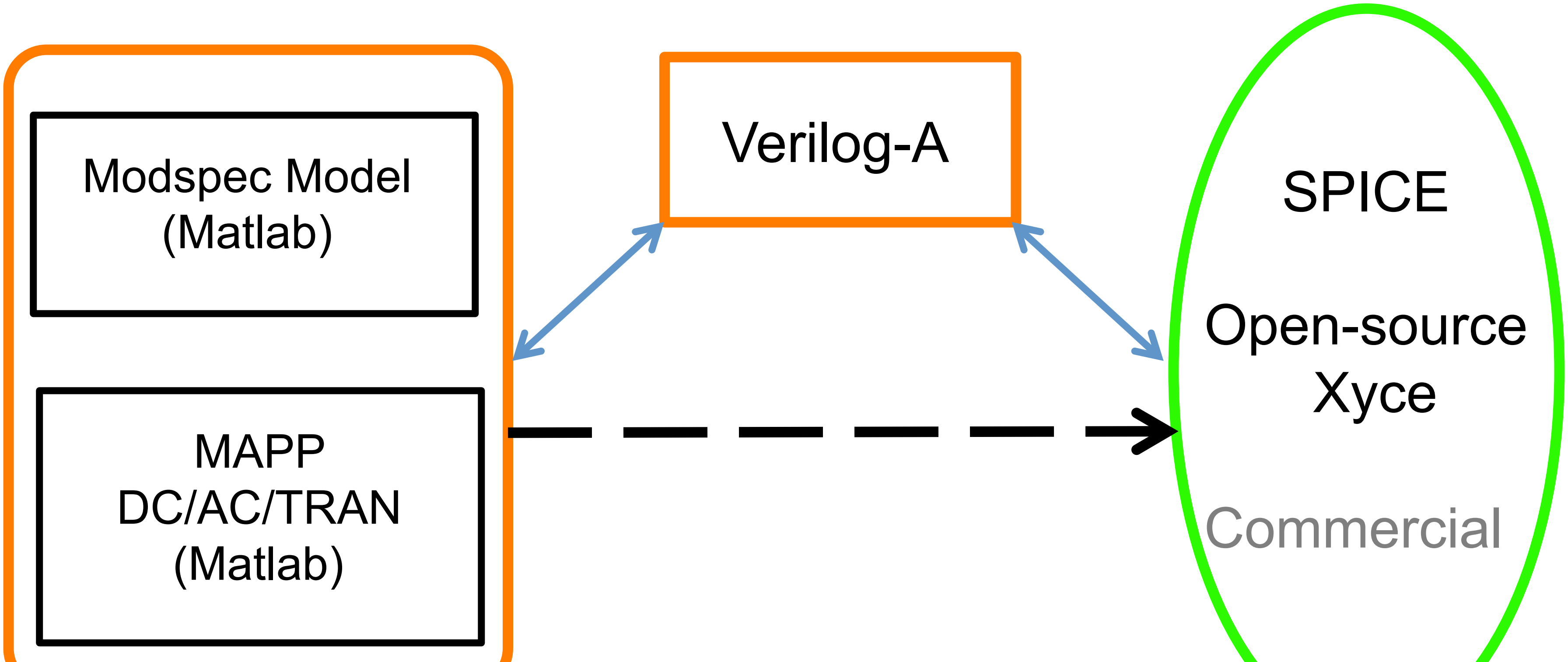
Case Studies in Compact Modeling

The MVS Nanotransistor Model: A Case Study in Compact Modeling
by Shaloo Rakheja

digital object identifiers (DOI's)
Thompson-Reuters Web-of-Science

Goal 2: tools for developing compact models

Model and **A**nalysis **P**rototyping **P**latform

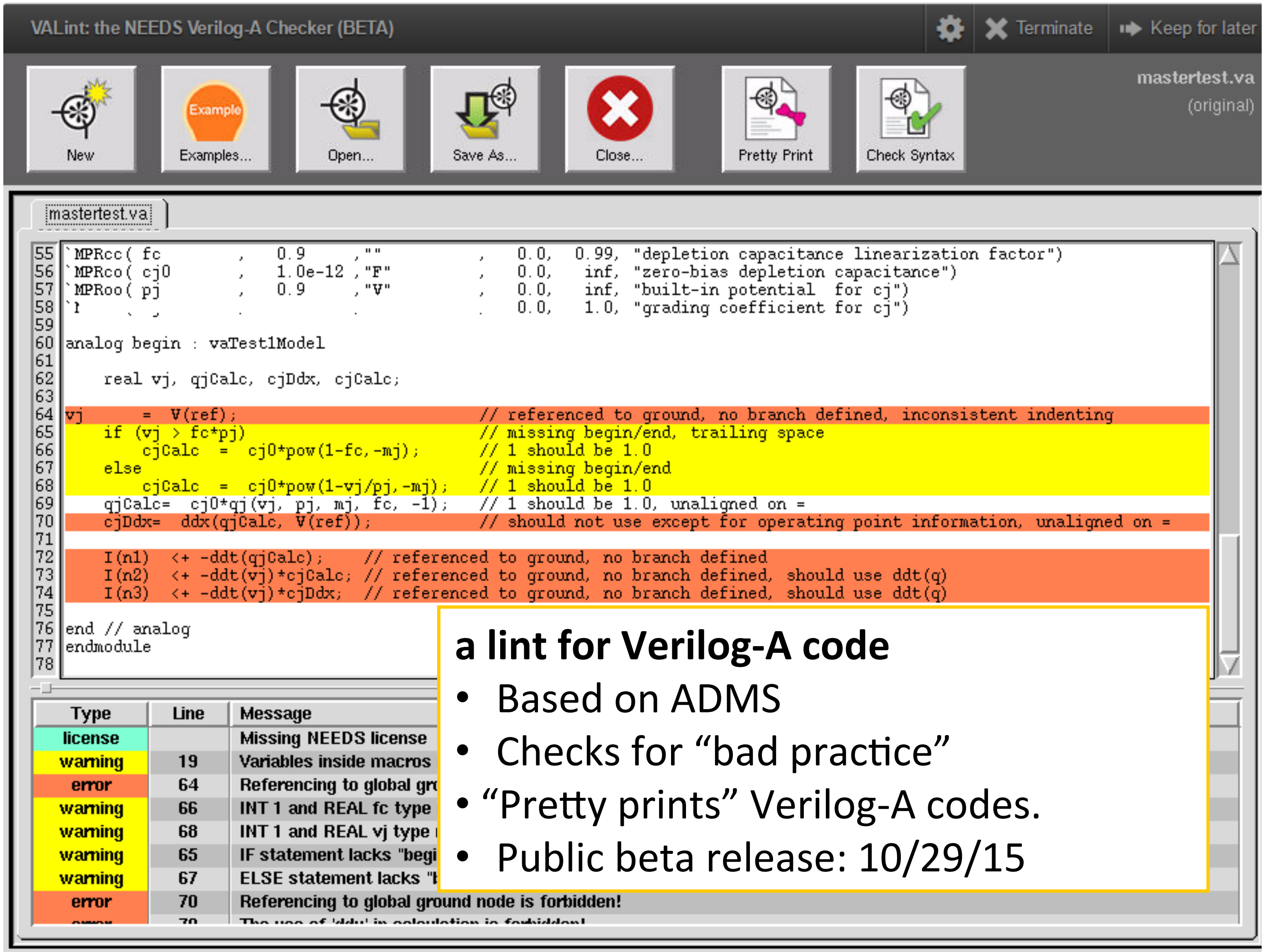


MAPP

Led by Jaijeet Roychowdhury, U.C. Berkeley

First public release: Dec. 2014

VAlint (Xufeng Wang, Coram, and McAndrew)



a lint for Verilog-A code

- Based on ADMS
- Checks for “bad practice”
- “Pretty prints” Verilog-A codes.
- Public beta release: 10/29/15

PUQ: Open source tools for UQ

PRISM
NNSA Center for Prediction of Reliability, Integrity and Survivability of Microsystems

ncn nanoHUB.org

home | search | documentation »

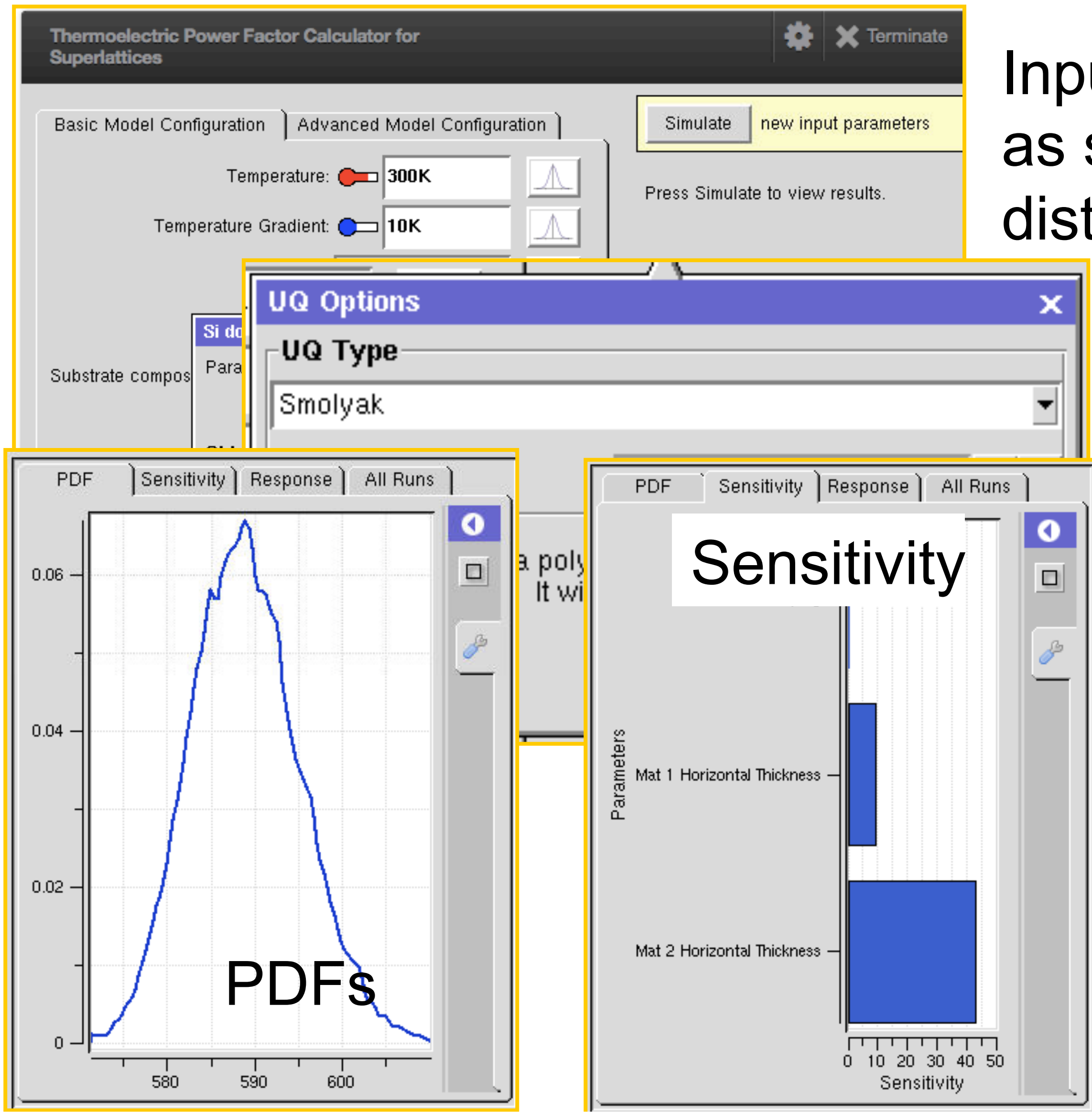
PUQ – PRISM UNCERTAINTY QUANTIFICATION FRAMEWORK

http://c-primed.github.io/puq/

Contents:

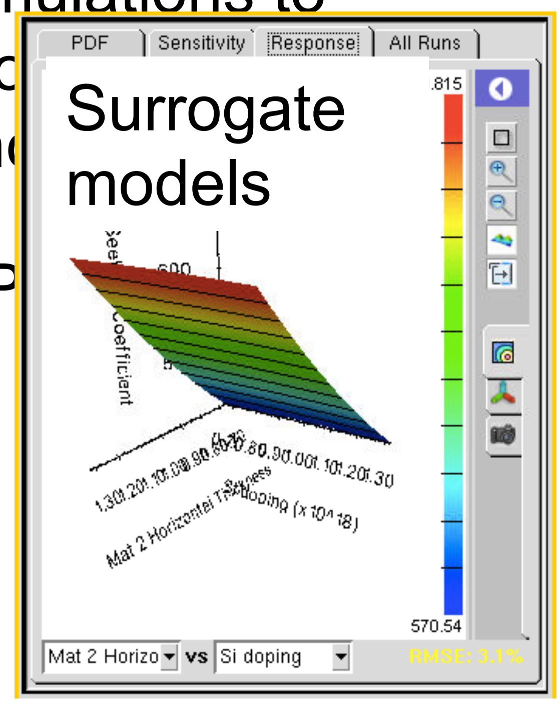
Automatic UQ in nanoHUB.org

Inputs can be specified as single values or distributions



Run multiple simulations to pro… unc…

P

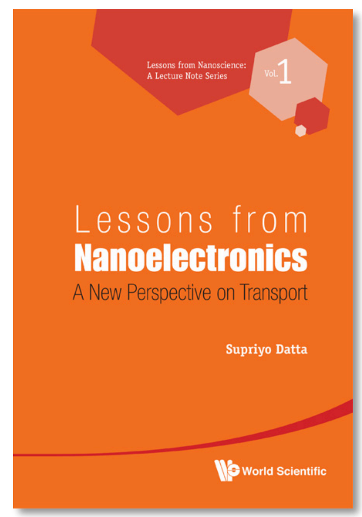


education for 21st Century Electronics

"SEEC" 1960's

Richard Adler, MIT

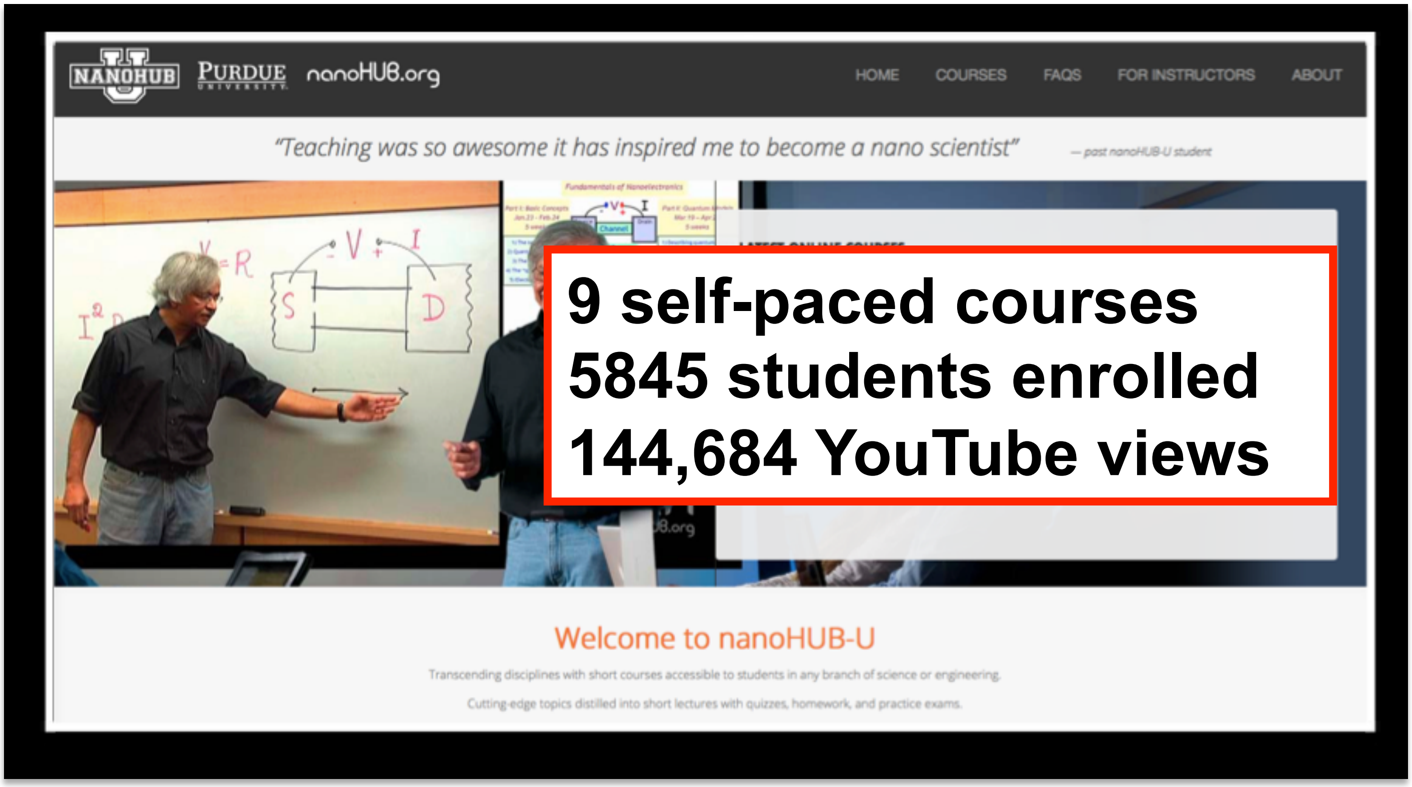
http://nanohub.org/u



web.mit.edu/klund/www/books/seec.html

nanohub.org/wiki/LessonsfromNanoscience

nanoHUB.org/u



12 Courses Offered

~7,000 Learners

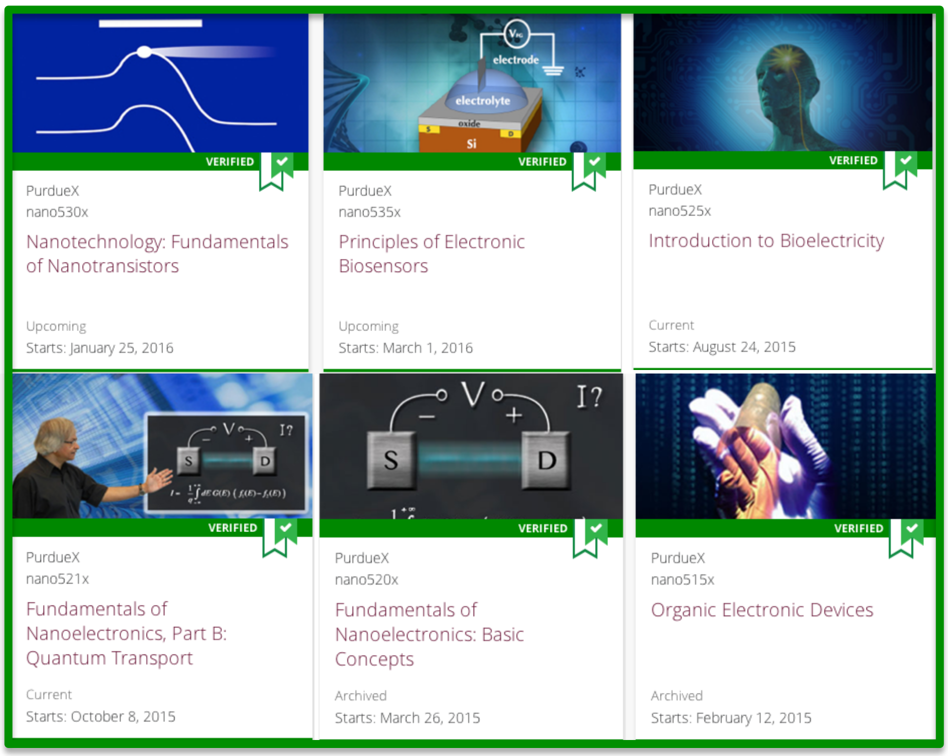
1,000 Universities

166 Companies

91 Countries

PurdueX nanohub.org/u

Back to schools and partners



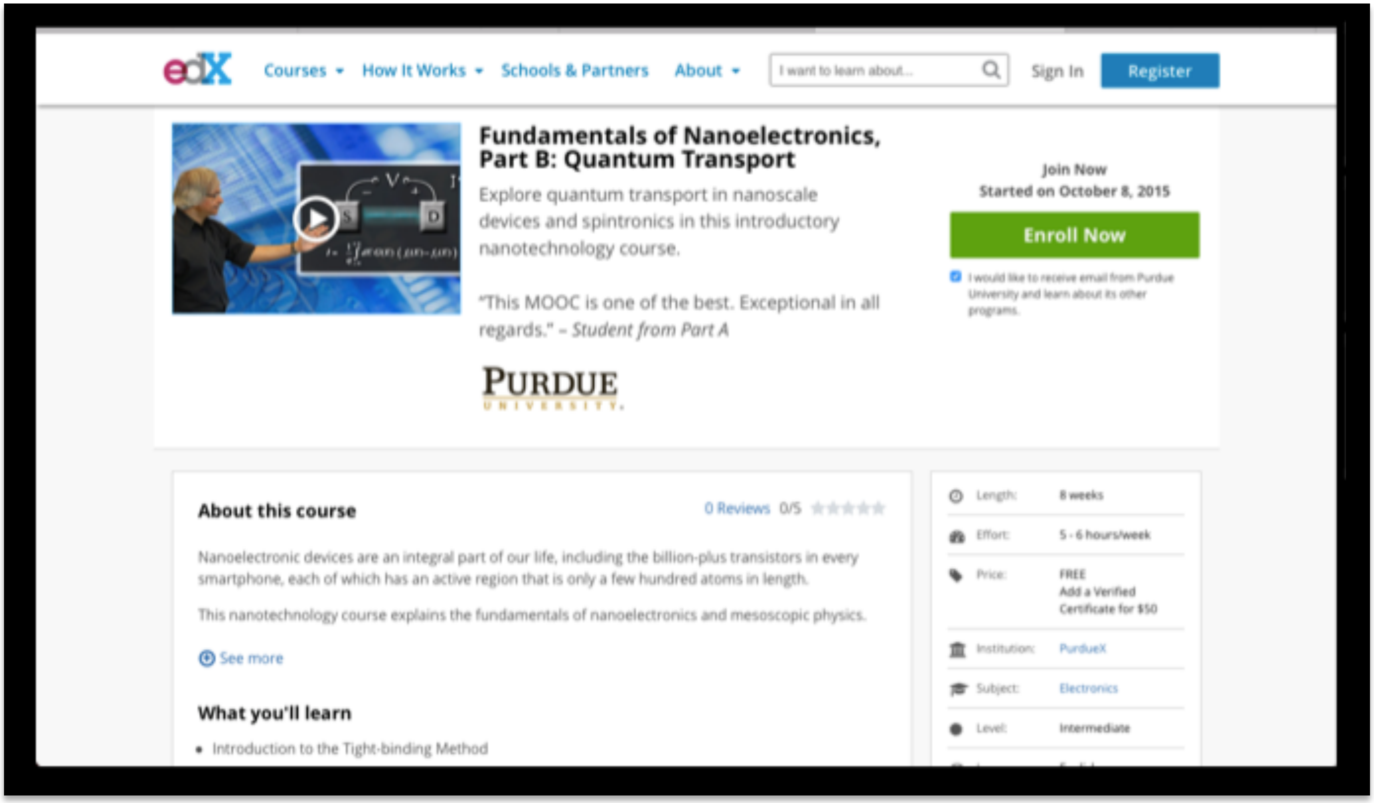
Fundamentals of Nanoelectronics:

5447 students
20 USA
22% India
129 countries
Ave. age. 26

"This course challenged me to think deeply about things I had never been exposed to before."

"I may start a new career as a result of this course."

edX.org



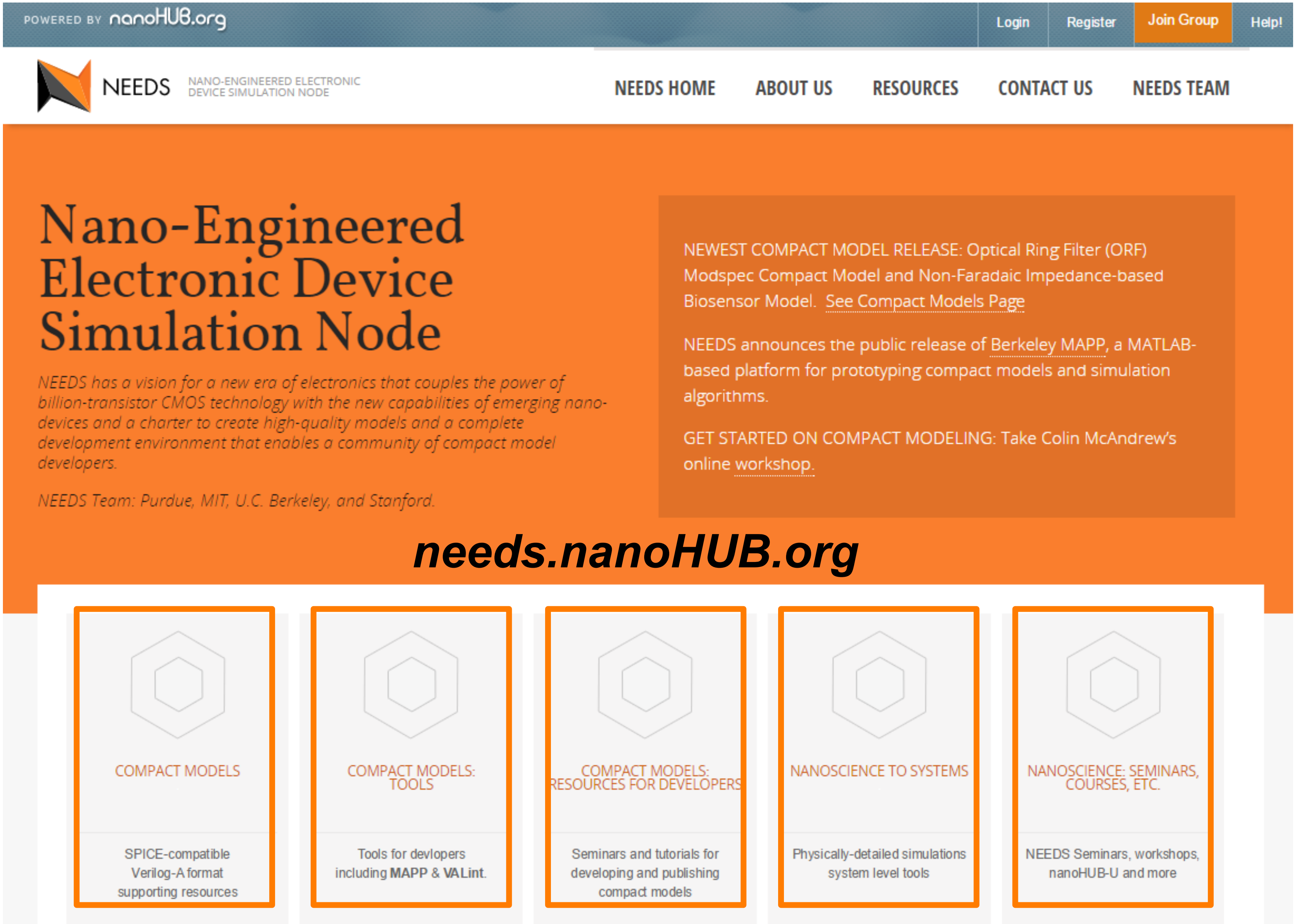
4 Courses Offered

~24,000 Learners

884 Universities

~25% Industry

141 Countries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Help!
NEEDS
NANO-ENGINEERED ELECTRONIC DEVICE SIMULATION NODE
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RESOURCES
CONTACT US
NEEDS TEAM
Nano-Engineered Electronic Device Simulation Node
NEEDS has a vision for a new era of electronics that couples the power of billion-transistor CMOS technology with the new capabilities of emerging nano-devices and a charter to create high-quality models and a complete development environment that enables a community of compact model developers.
NEEDS Team: Purdue, MIT, U.C. Berkeley, and Stanford.
NEWEST COMPACT MODEL RELEASE: Optical Ring Filter (ORF) Modspec Compact Model and Non-Faradaic Impedance-based Biosensor Model. See Compact Models Page
NEEDS announces the public release of Berkeley MAPP, a MATLAB-based platform for prototyping compact models and simulation algorithms.
GET STARTED ON COMPACT MODELING: Take Colin McAndrew's online workshop.
needs.nanoHUB.org
COMPACT MODELS
SPICE-compatible Verilog-A format supporting resources
COMPACT MODELS: TOOLS
Tools for devlopers including MAPP & VALint.
COMPACT MODELS: RESOURCES FOR DEVELOPERS
Seminars and tutorials for developing and publishing compact models
NANOSCIENCE TO SYSTEMS
Physically-detailed simulations system level tools
NANOSCIENCE: SEMINARS, COURSES, ETC.
NEEDS Seminars, workshops, nanoHUB-U and more

needs.nanohub.org

NEEDS

Driven by problems and applications

R and D accelerated by tools, cyberinfrastructure, education