LA-UR-18-27509
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Title: 3rd Parallel Computing Summer Research Internship: Student Lightning Talks

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Robey, Robert W.
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Koo, Eunmo
Van Roekel, Luke

Intended for: ISTI Day at LANL Presentations

Issued: 2018-08-07

# 3rd Parallel Computing Summer Research Internship

Creates **next-generation leaders** in **HPC research** and **applications development**

## Student Lightning Talks

http://parallelcomputing.lanl.gov

August 7, 2018

**PCSRI Leads:**
Bob Robey (XCP-2), Hai Ah Nam (CCS-2), Kris Garrett (CCS-2),
Luke Van Roekel (T-3), Eunmo Koo (EES-16)

Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

# PCSRI Goals

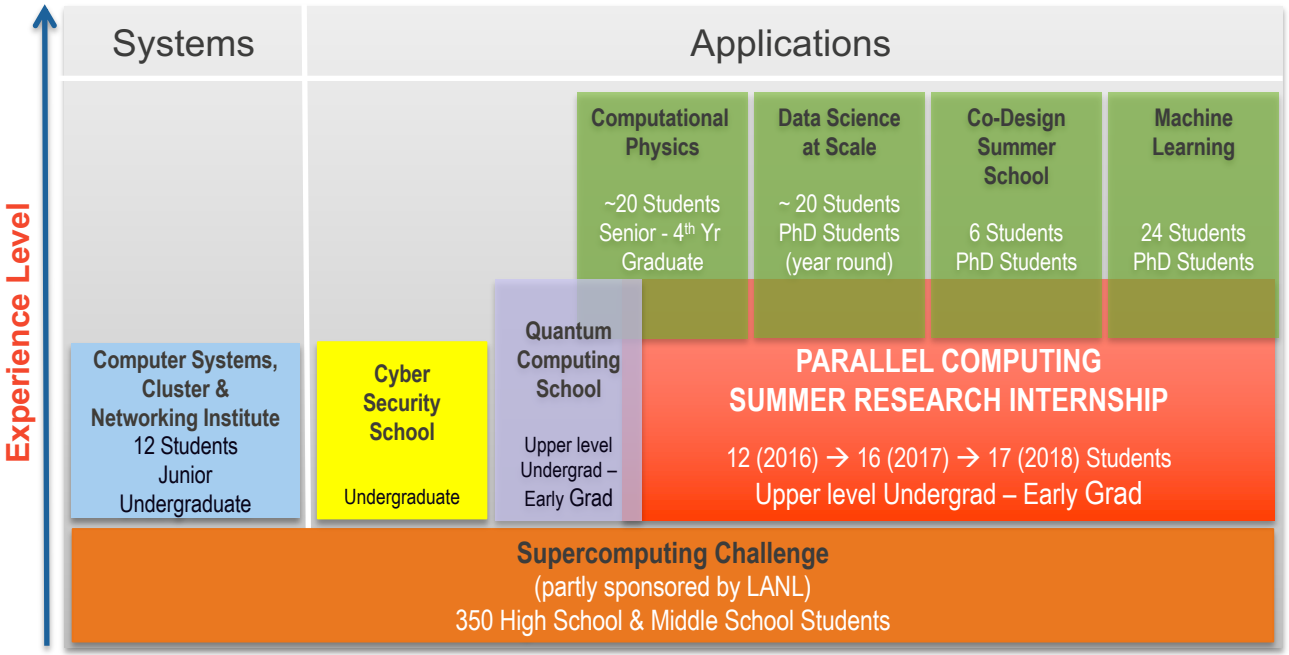


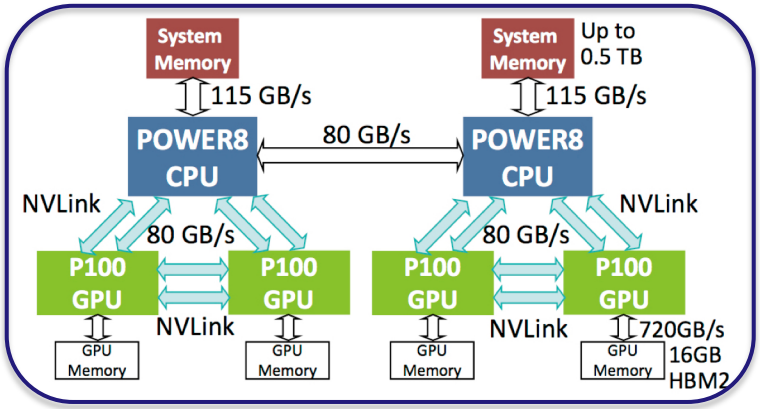

**Figure 1: LANL HPC/Computing Student Pipeline by experience level and topic area.**

- **TRAINING NEXT GENERATION**
  - Provide solid HPC education
  - Explore algorithms, methods and technologies based on architectural features
  - Instill good software development practices
- **DEVELOP COLLABORATION SKILLS**
  - Create a common language and break down barriers from science domain to hardware
- **ESTABLISH NEW PIPELINE FOR LANL & OTHER PROGRAMS**
  - Over half of staff historically have started in student programs
  - Prepare students for other schools or single mentor success

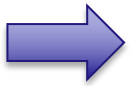
# Needed NOW more than ever

## *Computing resources are increasing in complexity*

### CPUs + GPUs




### Many-Core

**EXASCALE**

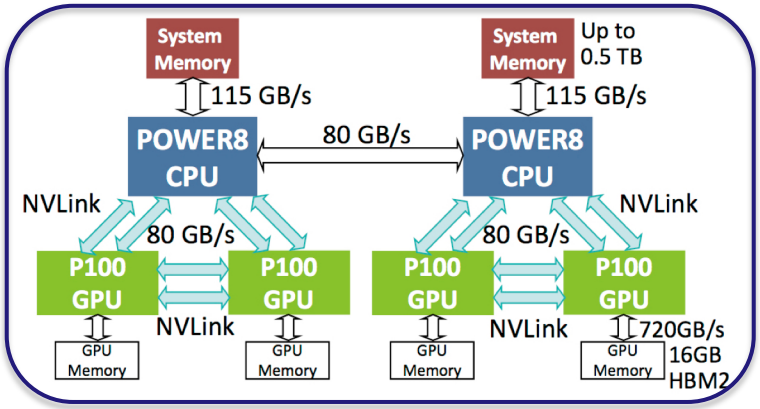
# Needed NOW more than ever

## *THE NODE is increasing in complexity*

OpenMP

CUDA

### CPUs + GPUs




### Many-Core


EXASCALE

Asynchronous Task-Based

Memory Hierarchy

Threading + Scoping

Vectorization

Abstractions

OpenMP

# Needed NOW more than ever

## *THE ENVIRONMENT is increasing in complexity*

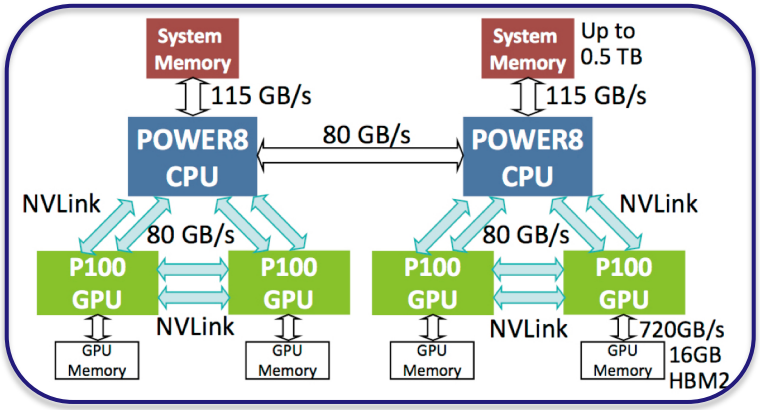
Affinity

In-Situ Visualization

CUDA

MPI

### CPUs + GPUs




### Many-Core


EXASCALE

Asynchronous Task-Based

Memory Hierarchy

Profiling

Schedulers – SLURM

Threading + Scoping

Vectorization

Compiler Bugs

Parallel Computing SRI

ISTI

NSEC National Security Education Center

Abstractions

OpenMP

# Needed NOW more than ever

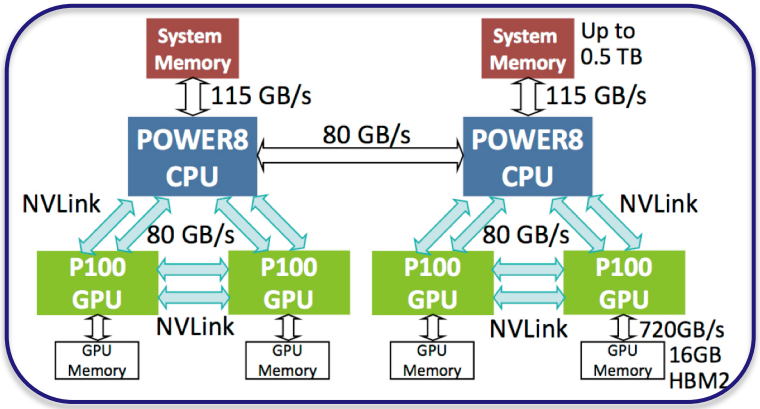
## *APPLICATION REQUIREMENTS* *are increasing in complexity*

Affinity

CUDA

MPI

### CPUs + GPUs




### Many-Core


In-Situ Visualization

EXASCALE

Asynchronous Task-Based

Memory Hierarchy

Performance Portability

Profiling

Schedulers – SLURM

Threading + Scoping

Vectorization

Compiler Bugs

Parallel Computing SRI

ISTI

NSEC

# Three Phases of PCSRI


## Real-World Computing Resources

- Darwin in CCS @ LANL
  - Skylake, Broadwell, Haswell
  - Knights Landing
  - GPUs: IBM Power8 + P100, Power9 + V100
- LANL Institutional Computing
  - Grizzly (Broadwell), Kodiak (Intel + GPU)
- NERSC
  - Cori (Intel Haswell + Knights Landing), Cray Programming Environment

**Compute-time allocations via proposal**

# Leadership/Organization: Layered Mentorship

**ISTI: Stephan Eidenbenz (Director) | Nickole Aguilar Garcia (Program Administrator)**

## LEADS: (mentorship, HPC supervision, community, availability, resources, applicant selection, logistics, answers)

**Bob Robey**
**XCP-2**

**Hai Ah Nam**
**CCS-2**

**Kris Garrett**
**CCS-2**

**Luke**
**Van Roekel**
**T-3**

**Eunmo Koo**
**EES-16**

## PROJECT MENTORS:

- Neil Carlson (CCS-2)
- Zach Jibben (CCS-2)
- Kris Garrett (CCS-2)
- Mark Petersen (CCS-2)
- Jeff Haack (CCS-2)
- Jonas Lippuner (CCS-2)
- Garrett Kenyon (CCS-3)
- Luke Van Roekel (T-3)
- Carrie Manore (T-6)
- Bob Robey (XCP-2)
- Laura Monroe (HPC-DES)
- Rajesh Pawar (EES-16)
- Satish Karra (EES-16)
- Geoffrey Fairchild (A-1)
- John Pennycook (Intel)
- Doug Jacobsen (Intel)

# Leadership/Organization: It Takes a Community

## Guest Lecturers

Bill Archer (ADX)

Galen Shipman (CCS-7)
Scott Pakin (CCS-7)
David Rogers (CCS-7)
Ron Green (CCS-7)
Joe Zerr (CCS-2)
Kent Budge (CCS-2)
KT Thompson (CCS-2)

Terry Tarnowsky (HPC)
Lena Lopatina (HPC)

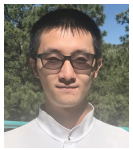
Brendan Krueger (XCP-2)
Gabe Rockefeller (XCP-1)
Angela Herring (XCP-1)

Kathleen McDonald (FCI)

Joe Schoonover (CIRES)
Doug Jacobsen (Intel)
John Levesque (Cray)
Rebecca Hartman-Baker (LBL)

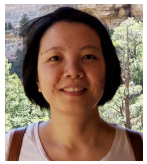
THANK YOU!

# 2018 Students: 17 Brave & Diverse Souls

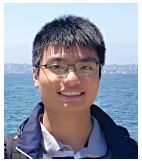


**Shu Wang**
Electrical Eng, PhD
UNM

**David Neill Asanza**
CS & Math, BA
Grinnell College



**June Wu**
App & Comp Math, PhD
University of Chicago



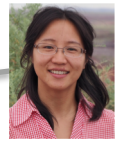
**Wentao Chen**
Mech Eng, BS
Purdue Univ.

**Stephen Harrell**
Earth, Atm, Planetary Sc, MS
Purdue University

**Mohit Dubey**
Physics, BS/Classical Guitar, BM
Oberlin College

**Jamil Gafur**
CS, BS
CUNY Lehman College

**Timothy Goetsch**
CS, BS
New Mexico Tech



**Abigail Hsu**
Applied Math, PhD
Stony Brook University

**Kevin Rosa**
Physical Oceanography, PhD
URI Grad School of Ocean.

**Hector Carrillo Cabada**
CS, BS
UNM

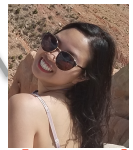
**Joy Kitson**
CS & App Math, BS
University of Delaware

**Divya Jaganathan**
Fluids & Thermal Sciences, MS
Brown University

**Haydn Jones**
Math & CS, BS
New Mexico Tech

**Jack Cheng An**
**Petroleum Eng**, PhD
Texas A&M Univ

**Katherine Kempfert**
Math & Statistics, BS
University of Florida



**Heesoo Kim**
Chem Physics & Math
Brown University


**Competitive Selection: 114 applicants**

**Funded by ISTI (9), CCS (3 ), HPC (1), NSF (1), and NMC (3)**

# 2018 PCSRI Student Research Projects

- **Plasma Meets Portability: A Journey to Performance Portability and Productivity in a Particle-in-Cell Code**
  Stephen Harrell (Purdue University), Joy Kitson (University of Delaware), Mentors: Bob Bird (CCS-7), Douglas Jacobsen (Intel)
- **Challenges of Performance Portability for Fortran Unstructured Mesh Codes**
  Abigail Hsu (Stony Brook University), David Neill Asanza (Grinnell College), Mentors: Neil Carlson (CCS-2), Zach Jibben (CCS-2)
- **Parallel and on-the-fly weight computation for the Boltzman transport equation**
  Hector Carillo Cabada (University of New Mexico), Heesoo Kim (Brown University), Mentors: Jeffrey Haack (CCS-2), Jonas Lippuner (CCS-2)
- **Parallelize Subsurface Flow Simulator using a Hybrid MPI-OpenMP-GPU Approach**
  "Jack" Cheng An (Texas A&M University), Wentao Chen (Purdue University), Mentors: Rajesh Pawar (EES-16)
- **Large-Scale Subsurface Flow Inversion**
  Shu Wang (University of New Mexico), Mentor: Satish Karra (EES-16)
- **Variable-resolution ocean model improves physics at reduced computational cost**
  Kevin L. Rosa (URI Graduate School of Oceanography), Mentor: Mark Petersen (CCS-2), Luke Van Roekel (T-3)
- **Can Reduced Numerical Precision Improve Performance without Loss of Fidelity? A Case with A Global Ocean Model**
  June Wu (University of Chicago), Mentors: Mark Petersen (CCS-2), Luke Van Roekel (T-3)
- **Characterizing and Optimizing Performance in MPAS-Ocean (poster only)**
  Divya Jaganathan (Brown University), Mentor: Mark Petersen (CCS-2), Luke Van Roekel (T-3)
- **Budget Aware Computation: Affordable Precision on Mini-Apps**
  Timothy Goetsch (New Mexico Tech), Abida Haque (North Carolina State University), Mentors: Laura Monroe (HPC-Des), Bob Robey (XCP-2), Kris Garrett (CCS-2)
- **Forecasting Dengue in Brazil with Time Series Modeling in Parallel**
  Jamil Gafur (CUNY Lehman College), Katherine Kempfert (University of Florida), Mentor: Carrie Manore (T-6), Geoffrey Fairchild (A-1)
- **Versatile Scaling for Neurally Inspired Auditory Source Separation**
  Mohit Dubey (Oberlin College), Haydn Jones (New Mexico Tech), Mentor: Garrett Kenyon (CCS-3)

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**HPC is Diverse**

# Questions

- Hold applause
- Hold questions for lunch & poster session today @ 4:00 PM