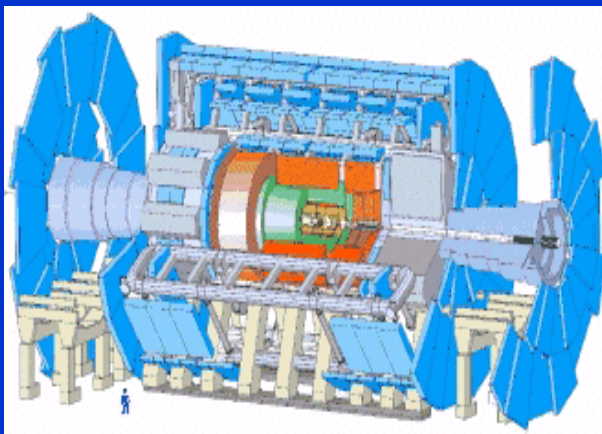


Fresno State and CSU's ATLAS Program at Large Hadron Collider of CERN

Yongsheng Gao

(Physics Department, Fresno State)

2/24/2012 at CSU Chancellor's Office

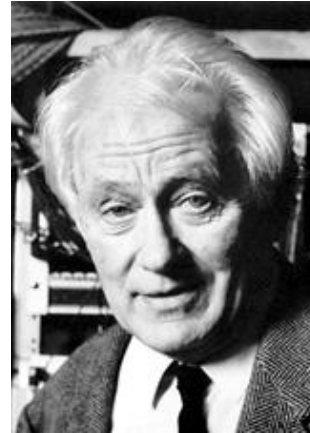




CERN: World Laboratory



~9000 scientists: ~580 institutions of ~90 countries



Invention & development of particle detectors, in particular the multiwire Proportional chamber (Nobel Prize 1992)

W,Z discovery: Nobel Prize 1984



World Wide Web (1989)



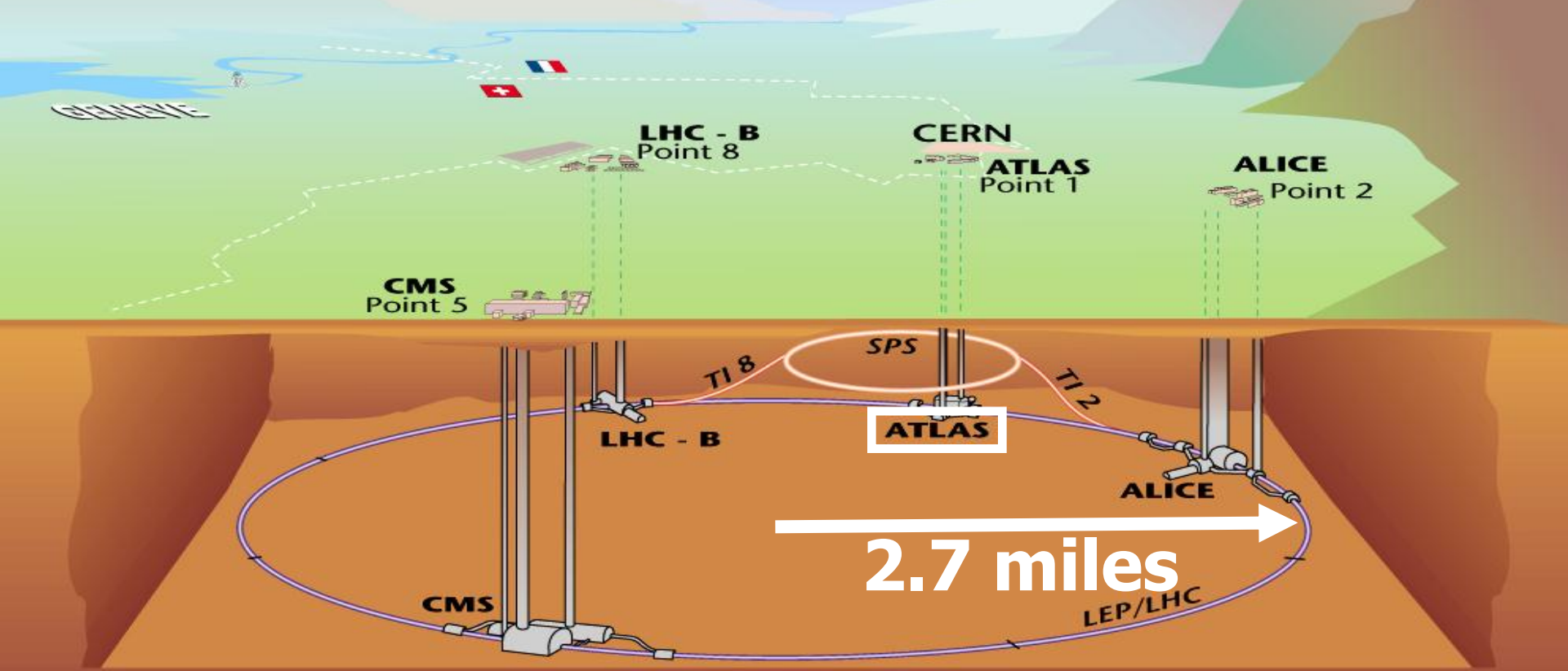
Other Nobel Laureates at CERN



LHC and ATLAS



**\$10 billion dollar, started collision in 2009.
THE energy frontier until at least 2030**



Large Hadron Collider

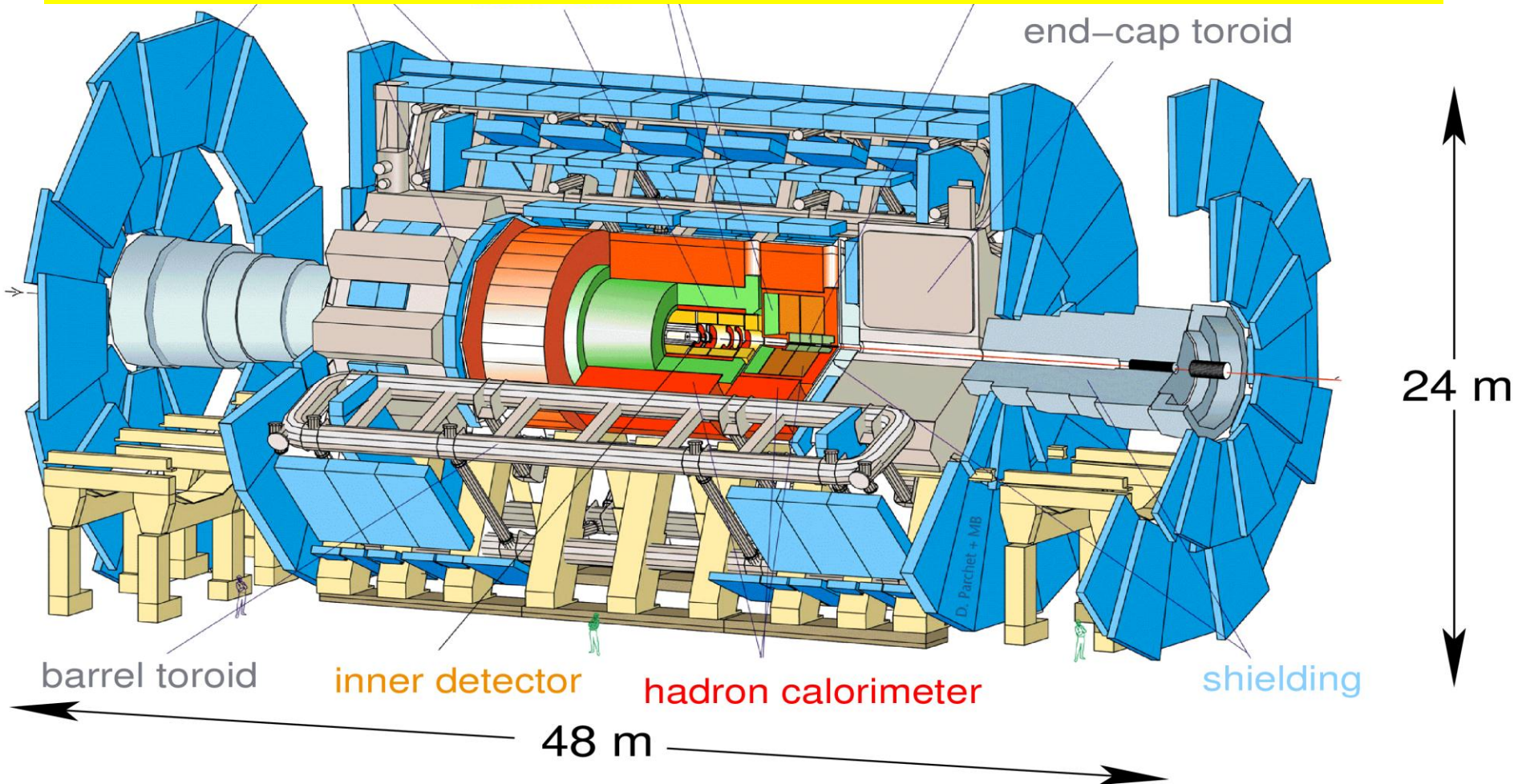
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ATLAS Experiment of LHC

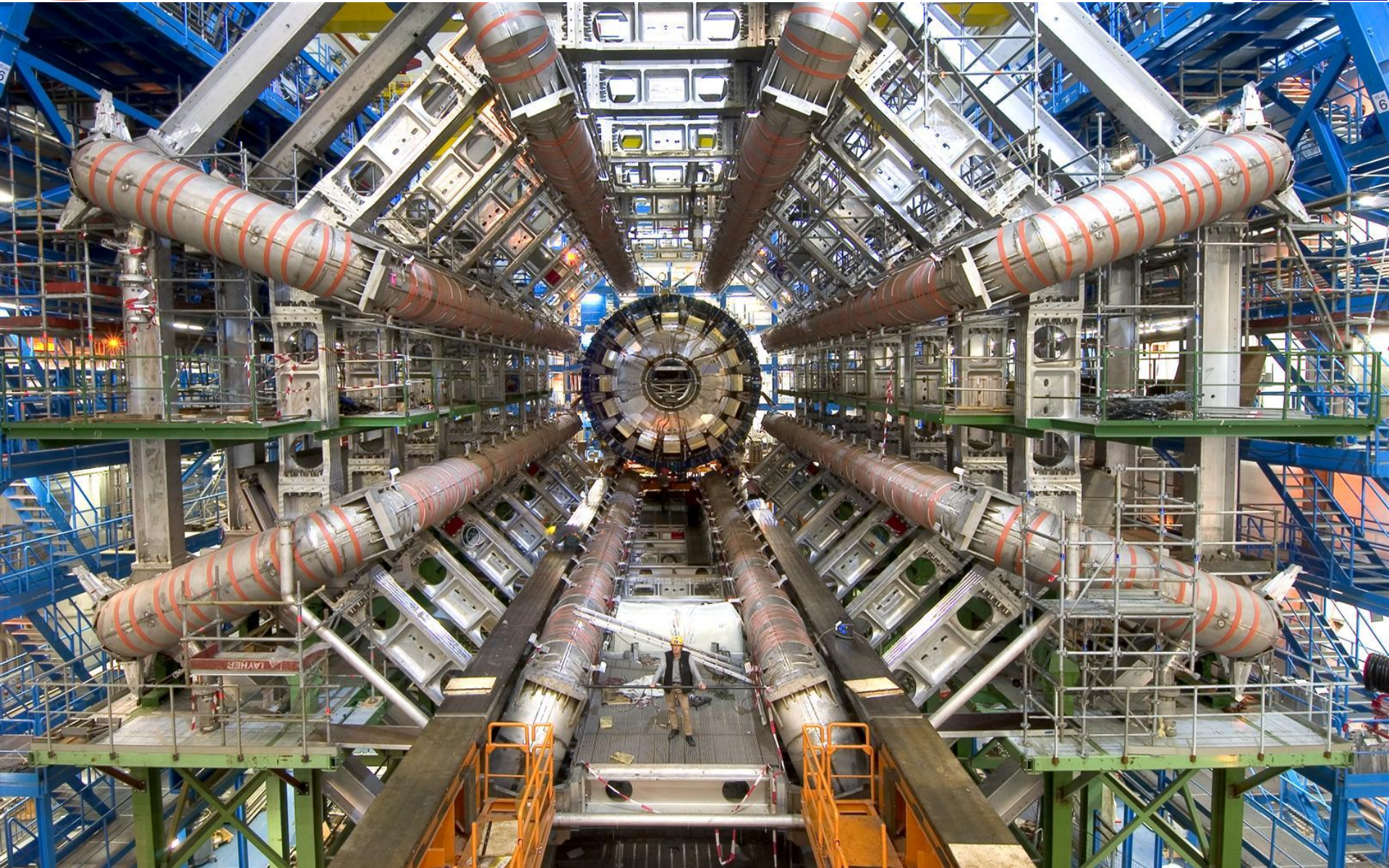


Size: 48m x 24m x 24m; Weight: 7000 tons
 $\sim 10^8$ electronic channels; ~ 3000 km cables





ATLAS Detector (2005/11)





ATLAS Institutions



~3000 physicists, ~200 institutions, 38 countries

~500 US physicists from ~50 US institutions

- **International/national labs: CERN, INFN, LAL, DESY, KEK, ...; US (ANL, BNL, LBNL and SLAC)**
- **Research Universities: Cambridge, Oxford, U. Tokyo, ...; US (Chicago, Columbia, Harvard, MIT, Michigan, Yale, UC-Berkeley, UW, etc.)**

We were admitted to ATLAS in 2007, the only CSU campus on ATLAS experiment Consortium: Bakersfield, Chico, DH, Humboldt, LA, LB, Pomona, Sac State, SB, SF, Stanislaus



ATLAS at Fresno State



Faculty: Yongsheng Gao, Cui Lin (CS)

**Postdocs: Harinder Bawa & Andrew Lowe
(both are stationed at CERN)**

Students: 6 graduate & undergraduate

- **New Physics searches and new tools for NP searches: Bawa/Gao/Lowe's talks at ATLAS Higgs, SM, e/γ , Exotics, Jet/Etmiss, Tau WG meetings since 2006**
- **Significance Calculation and a New Method to Search for New Physics at LHC" by Y. Gao, L. Lu & X. Wang; European Physical Journal C45, 659 (2006)**

Supported by \$145K (CSM), \$200K (Provost and ORSP), \$15K/year (CSM), ~\$10K/year (IRA), etc.



External Funding Received



- DOE and NSF pay our annual membership fee to CERN (~\$17,000 per US physicist per year) since 2007
- \$460K NSF EPP base/core grant (9/2009 to 7/2012). Covers Dr. Bawa and Gao (salary/benefit, travel, etc.)
- NSF EPP Base/Core grant: Designed to provide long term and stable funding support for key personnel in HEP research. Renewable every 3 years for many years
- EPP Base/Core Institution: Chicago, Columbia, Cornell, Johns Hopkins, Michigan, Stanford, UCLA, UCSD, Washington, Yale, ... Funded by EPP for over 30 years
- Typical 3-year EPP Base/Core grant: >1 million dollars (~4 faculty, ~5 postdocs/scientists, travel, etc.)



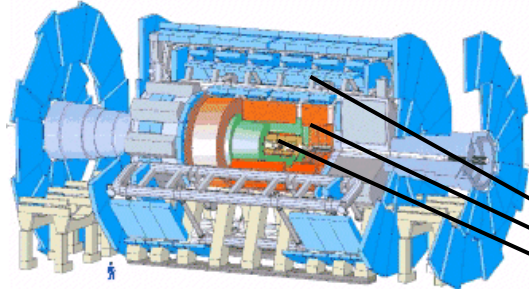
External Funding Received



- **Our EPP Base/Core grant has ample space to grow, if we can be productive by NSF EPP base/core program standard. Great opportunity for Fresno State/CSU**
- **EPP Base/Core grant qualifies us for many other funding opportunities of NSF, some are only available or specially designed for EPP Base/core institutions. LHC experiments: Top priority for NSF EPP program**
- **\$620K NSF MRI grant (3/2010 to 2/2013) to all 9 NSF EPP institutions on ATLAS. Fresno State: Only lead institution with other 8 (Chicago, Columbia, Hampton, MSU, NIU, NYU, Stony Brook, UW) as subcontractors.**
- **Joining of Dr. Cui Lin allows us to work on ATLAS Cloud Computing, and go after ample funding opportunities**



Physics from ATLAS Data



~PByte/sec

CERN/Outside Resource Ratio ~1:2
Tier0/(Σ Tier1)/(Σ Tier2) ~1:1:1

Online System

~100-400 MBytes/sec **>10 PB/Yr!**

Tier 0 +1

Offline Farm, CERN Computer Ctr

Tier 1

10+ Gbits/sec

France

UK

Italy

BNL

Tier 2

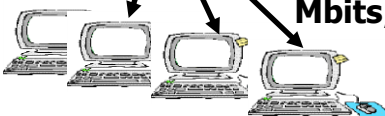
Tier2 Center Tier2 Center Tier2 Center Tier2 Center Tier2 Center

Tier 3

~2.5+ Gbps

Institute Institute Institute Institute

100 - 10000 Mbits/sec



Fresno State Tier 3: 136 cores, 108 TB ATLAS computing needs up to 2013 only



Fresno State



CSU Fresno Tier 3 Cluster



**Fresno State ATLAS Tier 3 Cluster (136 cores, 108 TB)
in operation for ATLAS physics analyses since 4/2011**

**Dr. Cui Lin (new CS faculty) just joined ATLAS and is
leading our new ATLAS Cloud computing effort (1st US
ATLAS Tier 3 on Cloud) with Chinese CS collaborators**



Grow EPP Base/Core Grant



- **Typical 3-year EPP grant: >\$1M and over 30 years (supports ~4 faculty, ~5 postdocs/scientists, etc.)**
- **NSF EPP Renewal Proposal submitted on 10/26/2011 (added Prof. Lin/Dr. Lowe to the renewal proposal): Total budget for 8/2012 – 7/2015: \$1,033K**
- **If other CSU Consortium campus is interested in hiring a new experimental HEP faculty on ATLAS, we can try to add him/her to our existing EPP base/core grant. Much easier than starting a new base/core program.**
- **Long Term Goal: make our CSU HEP Consortium an effective strong ATLAS group, similar to any well established ATLAS group from top research university**



ATLAS Cloud Computing



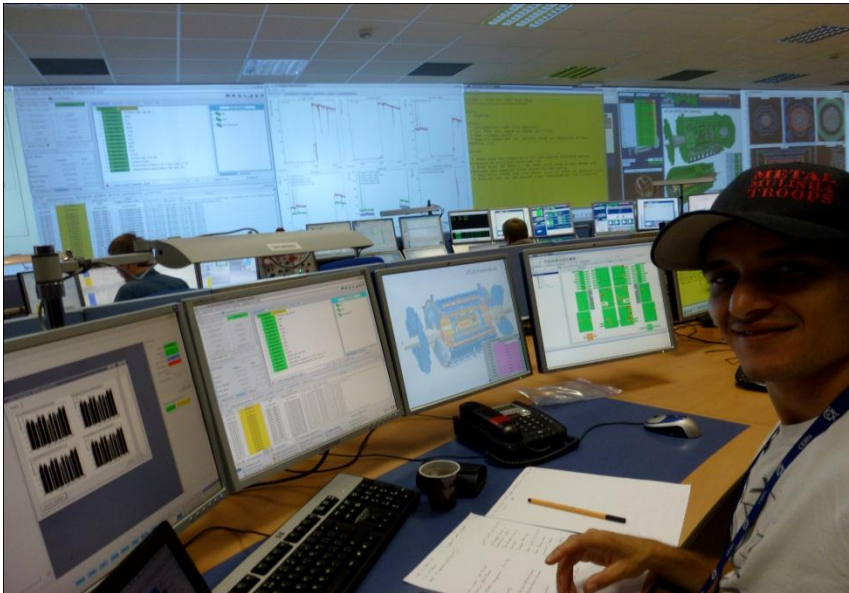
- **US ATLAS Computing costs US DOE/NSF ~\$30M/year (~\$60K per US ATLAS physicist per year)**
- **ATLAS data and computing needs are increasing very rapidly, continue with current model (dedicated ATLAS Grid Computing facilities) won't be cost efficient**
- **Cloud Computing: future solution for ATLAS computing**
- **New ATLAS Cloud Computing effort at Fresno State: Build the first Cloud-based Tier 3 for US ATLAS: Led by our new CS faculty Dr. Cui Lin with CS faculty and Ph.D students from Chinese research universities**
- **New collaboration & funding opportunities for CS researchers on our CSU HEP Consortium campuses**



CSU Students at CERN



- 20 students (Fresno: 14, LB: 2, Pomona: 2, Sac: 2) have worked at CERN with our ATLAS program since 2008
- Projects: detector monitoring, testing, upgrade R&D, software, grid computing, search for new physics, etc.
- Funded by CSM (\$15K/yr), IRA (~\$10K/yr), FSSR, etc. Reported by Fresno Bee, Channel 30 News, etc.





Before students' CERN trip



- Students contact me and send in their applications: CV (skills in computing, electronics), interests (hardware, software, physics), references, transcript, ... by Feb. 1
- I contact my ATLAS colleagues to identify suitable projects (match interests, well defined and can be completed within 10 weeks) for students. **Non trivial and very time consuming (takes more than 2 months)**
- Register students as members of Fresno State ATLAS group, safety training, mentor students to learn new skills or sharpen existing skills, etc. to prepare their projects; coordinate their travel, housing at CERN, ...

<http://zimmer.csufresno.edu/~yogao/ATLAS/>



Past Student Projects



- **Adding New Features to Virtual Point One 3-d Event Display Package: Ben Zastovnik (Fresno State) in 2008**
- **Inner Detector Environmental Monitoring Summary (IDEMS): Lawrence Carlson (Fresno State) in 2008**
- **New Detector Control System (DCS) Tool: Geraldo Rude, Steve Wilburn (Fresno State) in 2008**
- **Semi Conductor Tracker (SCT) Fatal Charge Dosage Study: James MacDougall (Sac State) in 2009**
- **Muon Detector Upgrade R&D project: Sasha Moskaleva (Sac State) in 2010**
- **Search for W/Z from first ATLAS data: Michael Duncan and Brent Wilson (Fresno State) in 2010**



Student Projects in 2011



- **New ATLAS Simulation NLOjet++ and APPLGrid, comparison with Pythia: Navid Rad (Fresno State)**
- **Micromegas R&D and Module Testing for ATLAS Muon Detector Upgrade: Emmanule Angulo (Fresno State)**
- **Micromegas R&D Data Analysis for ATLAS Muon Detector Upgrade: Lawrence Carlson (Fresno State)**
- **Simulation with ATHENA using Fresno State ATLAS Tier 3 Cluster: Michael Hatfield (Cal Poly Pomona)**
- **New Physics Search in Di-Jet Final State with ATLAS Data: Arya Afshari (Fresno State)**
- **Improving ATLAS Physics Analysis Software and Tools: Andrew Castro (Cal Poly Pomona)**



Student Presentations



- Most students have given presentations at ATLAS WG meetings on their research projects and results
- Fresno State ATLAS students talked about their CERN work at our department colloquia each fall
- 5 Fresno State ATLAS students gave presentations at 32nd Central California Research Symposium (CCRS)
- Brent Wilson (Fresno State) won the Best Graduate Student Presentation Award at the 32nd CCRS
- ATLAS students from CSULB, Sac State gave physics colloquia on their CERN work at their campuses
- Sasha Moskaleva (Sac State) gave poster presentation at 2011 APS meeting on her ATLAS Muon R&D work



CSU Students at CERN



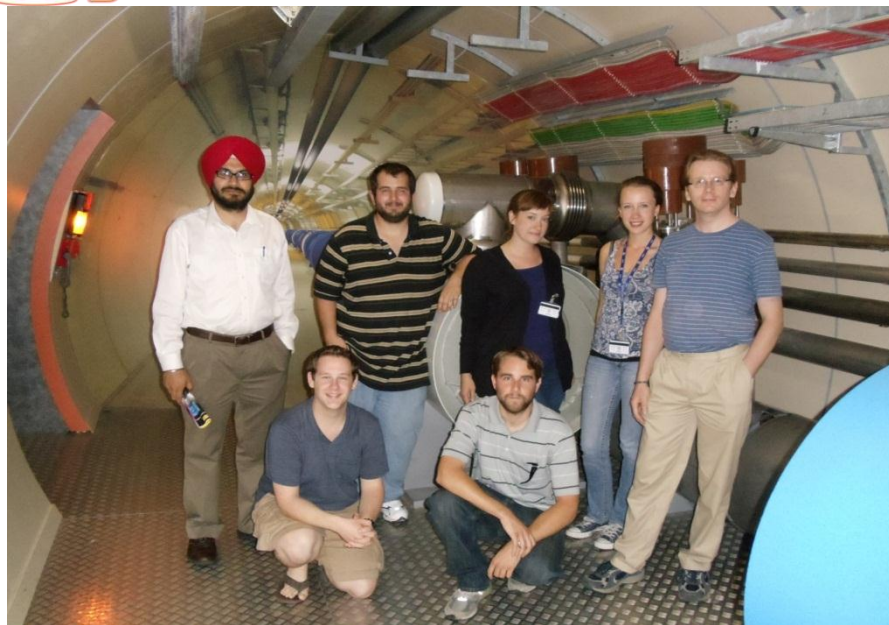
**Talks about research work at ATLAS meetings,
attend CERN Summer Student Lecture Series**

**James MacDougall (Sac State): My CERN
trip is a life-changing experience for me**





CSU at CERN in 2010, 2011



Charlie Young (SLAC): James MacDougall is the best summer student we have ever worked with, including those from SLAC and Stanford.

Sarah McGovern (Long Beach) received \$7,650 from NSF Office of International Science and Engineering (OISE)

<http://zimmer.csufresno.edu/~yogao/ATLAS/>



Cost for 10 week CERN Trip



- Airline ticket: ~\$1,500
- Lodging: ~40 CHF/day: ~2,800 CHF total
- Meal: ~30 CHF/day: ~2,100 CHF total
- Other: Transportation, medical insurance, ...

Total Cost Per Student: ~\$7,000

Cost is significantly higher due to exchange rate (Dollar decreased ~30% against Euro or CHF).

Serious problem for postdocs stationed at CERN!

Fresno State: \$15K (CSM), \$9K (IRA, capped at \$1.5K per student) and FSSR (\$600 per student) for students to work at CERN in summer of 2012



Students for summer 2012



- **Navid Rad (Fresno State): Continue with NLOjet++ and APPLGrid work to finish his Master thesis**
- **James MacDougall (Fresno State): Work on new ATLAS inner detector R&D project as his Master thesis**
- **Emmanual Angulo (Fresno State): Continue with Muon detector upgrade R&D project as his Master thesis**
- **Arya Afshari (Fresno State): Continue with ATLAS new physics search using ATLAS data as his Master thesis**
- **Simon Gonzalez (Fresno State): Will work on Muon detector upgrade R&D project with Emmanual Angulo**
- **Michael Hatfield (Cal Poly Pomona): Wants to continue his simulation work at CERN, but lack of support**



Experience with NSF IRES



- **Applied for NSF International Research Experience for Students in 2010: \$150K for 15 CSU ATLAS Consortium students to work at CERN for 3 summers. PI: Gao, Senior Personnel: All liaison faculty on consortium, Foreign Collaborators: My ATLAS collaborators at CERN**
- **Reviewers like the concept very much. Requested resubmission with more details on student preparation and training, selection process, roles of liaison faculty.**
- **HEP and Computing education essential to prepare our students before they can work at CERN**
- **Many CSU students are very interested in ATLAS while the number of students in each campus may be small**



Online Courses



- **Solution: Online HEP and Computing courses across consortium campuses. First course offered at Pomona in 2011 Spring with Humboldt and Fresno participated.**
- **IRES: Offer online HEP and Computing courses on regular basis (two/year) across Consortium campuses**
- **Assigned time for the online course instructor because of the significant additional work for grading of all the consortium students not on his/her campus, etc.**
Possible assigned time for other consortium faculty
- **HEP course at Fresno State this fall: Particle physics and ATLAS detector/experiment: Minimum background knowledge for ATLAS students. Can offer it online.**



Experience at Fresno State



Online HEP course offered at Cal Poly Pomona (Dr. Peter Siegel) in S11 and S12 which Fresno State participated.

Fresno State's experience about **FORMAT** of Online course

S11: 175T at CSUF	S12: Pomona Only
No additional paper work for students	Additional Paper work (drive students away) required, Semester/Quarter issue
Active faculty involvement (enter grade, proctor tests, office hour), allow valuable feedback to instructor	Minimum work (proctor tests) for faculty at Fresno State, no interaction with students at Fresno State
Tuition for Fresno State and credit for CSUF faculty	Tuitions go to Pomona and no credit for CSUF faculty



Knowledge/Skills for ATLAS



- All ATLAS analysis framework and software are written in C++. Essential for students interested in working on ATLAS software. Other language: Python
- ROOT (developed at CERN: Framework for large scale data analysis): Essential for students interested in ATLAS data analysis and new physics searches
- Essential background knowledge: Particle physics, detector techniques and how ATLAS detector works
- Essential computing skills: C++, ROOT, (Python)
- Preferred sequence of online courses for ATLAS: One course in Particle Physics/ATLAS (every Fall) and one course in Computing (C++/ROOT) (every Spring)



Funding for CSU Students



- **NSF IRES (on hold in 2011): solicitation expected in early 2012 with submission deadline in late summer**
- **NSF's Research Experience for Students (REU): due late August each year (8/22/2012)**
- **Plan: Go after IRES or REU as a consortium, with well defined online student education, selection, roles of liaison faculty, strong internal support (Chancellor's office, consortium campuses, with release time, etc.)**
- **Release time for faculty to work on grant proposal, and to carry out the project, reporting to funding agency, consortium campuses, etc. once proposal is funded**



Student Working at CERN



- **Web site/Contact Person:** Info. about CERN/ATLAS, past student projects, ask questions and send in full applications (CV, transcript, reference, interest) by 2/1
>50 students contacted me about working at CERN
- **Identify student research projects at CERN,** student training/preparation, registration, coordinate travel and housing at CERN, ... (Gao: from 2/1 to end of May)
- **Student supervision** while they work at CERN from early June to mid August: Gao and postdocs at CERN (daily email or phone, weekly group meeting at CERN)

<http://zimmer.csufresno.edu/~yogao/ATLAS/>



Student Supervision at CERN



- Significant time and efforts needed to identify suitable research projects for students with varying background and interests. Student supervision at CERN on daily basis essential for their productivity and success
- This has been done by ATLAS faculty and postdocs in their “spare” time while carrying out their full time physics/service work. Not sustainable with increasing number of CSU students at CERN. **IRES provides no release time or fund for the PI or Senior Personnel**
- Travel/compensation for faculty, compensation for postdocs needed for their significant amount of work in identifying student projects, student supervision, ...



Funding and Online Courses



- Go after IRES or REU this year. Online HEP, computing courses on regular basis essential for IRES, students
- Online HEP/ATLAS course each Fall, Online C++/ROOT course each Spring across consortium campuses
- Online courses instructor, liaison faculty at individual campuses to help run the course, additional faculty to offer additional office hours for all consortium students
- HEP/ATLAS course in Fresno in Fall 2012. Need to plan for C++/ROOT course in Spring 2013 and repeat of the sequence for following years. HEP/ALICE course at Cal Poly SLO? Advanced HEP theory course also useful
- Internal funding for students: IRA, FSSR, etc.



Grow EPP Base/Core Grant



- **Typical 3-year EPP grant: >\$1M and over 30 years (supports ~4 faculty, ~5 postdocs/engineers, etc.)**
- **NSF EPP Renewal Proposal submitted on 10/26/2011 (added Prof. Lin/Dr. Lowe to the renewal proposal): Total budget for 8/2012 – 7/2015: \$1,033K**
- **If other CSU Consortium campus is interested in hiring a new experimental HEP faculty on ATLAS, we can try to add him/her to our existing EPP base/core grant. Much easier than starting a new base/core program.**
- **New effort in ATLAS Cloud Computing, and new collaboration/funding opportunities for CS faculty of our CSU HEP Consortium campuses**



Summary and Outlook



- **Fresno State and CSU's ATLAS Program**
 - Exciting, promising, high profile research
 - Strong Support from Fresno State (Provost, ORSP, CSM, Physics, IRA), NSF(\$460K EPP, \$620K MRI)
 - CSU ATLAS Consortium (11 other campuses)
 - 20 CSU students worked at CERN already
 - New efforts (cloud computing, UC, Chinese CS)
- **Challenges of our ATLAS Program**
 - New NSF EPP Core program
 - Competing with well established EPP programs
 - Limited resources, infrastructure, technical support
 - Put our efforts together to build a well established program which benefits CSU for years to come

Lot of hard work ahead of us!