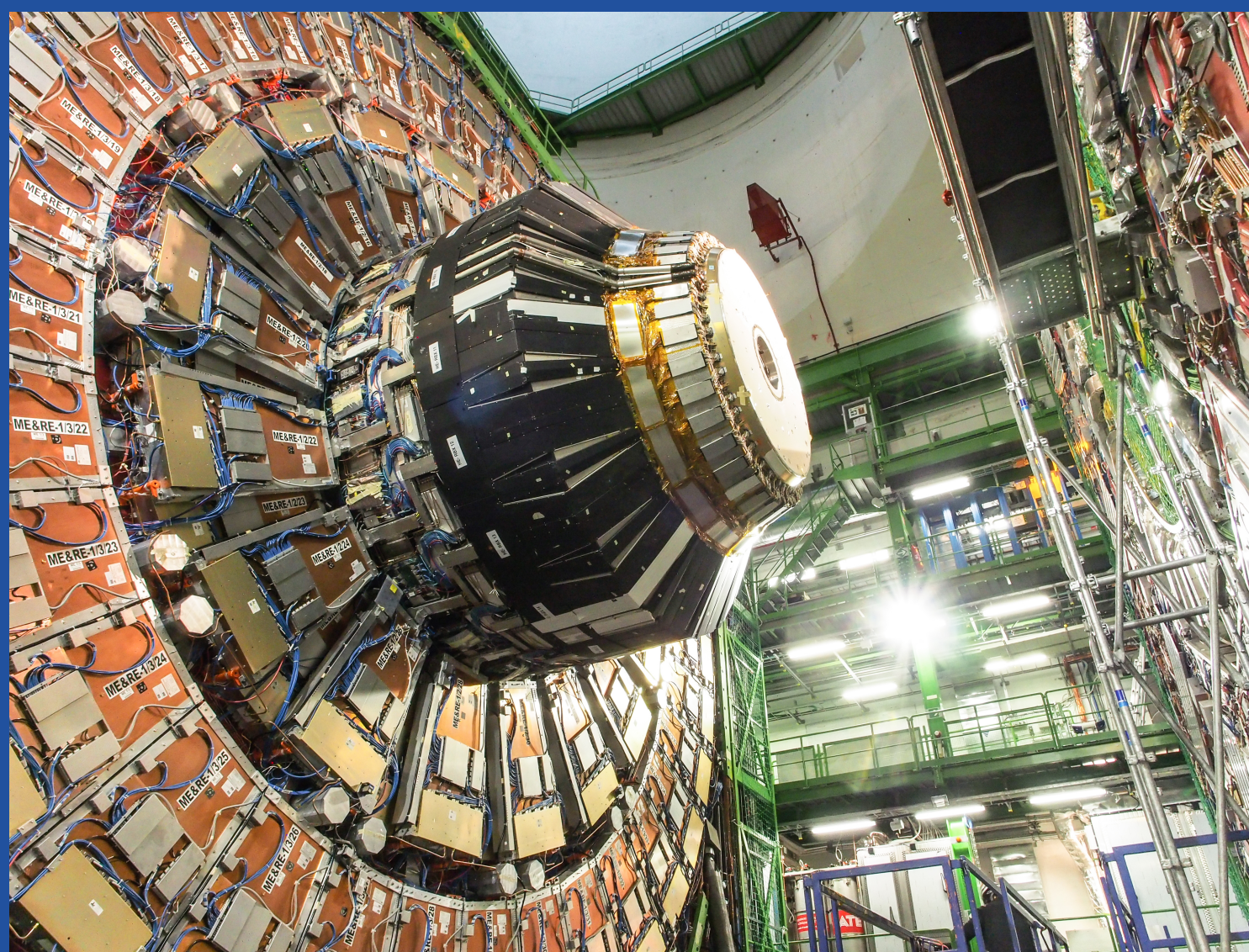
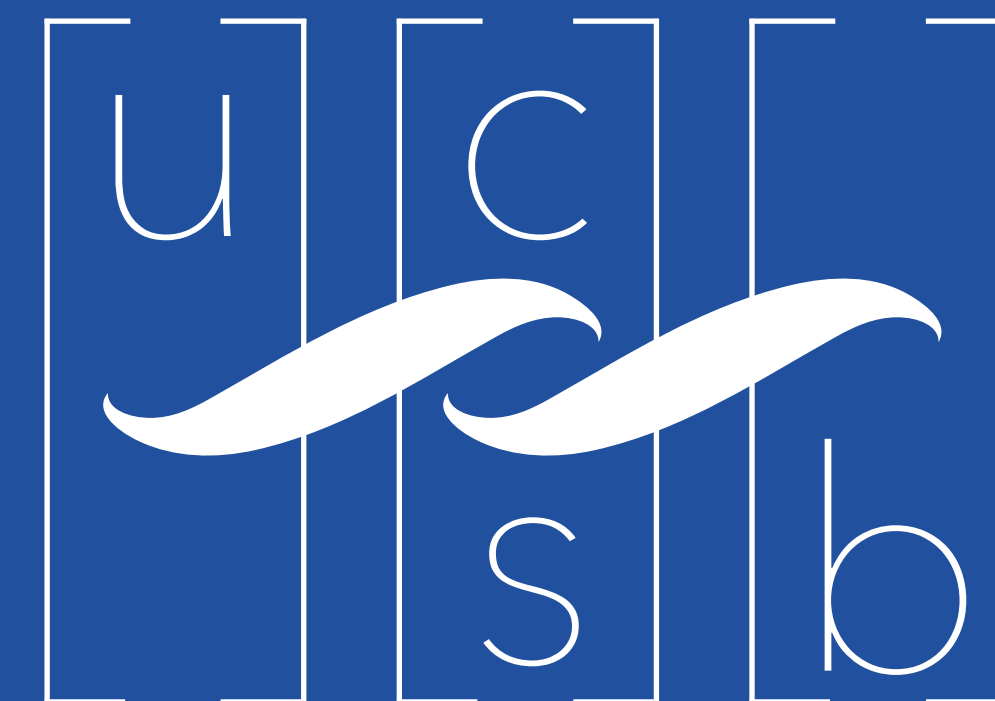


Postdoc Opportunity at UCSB on CMS

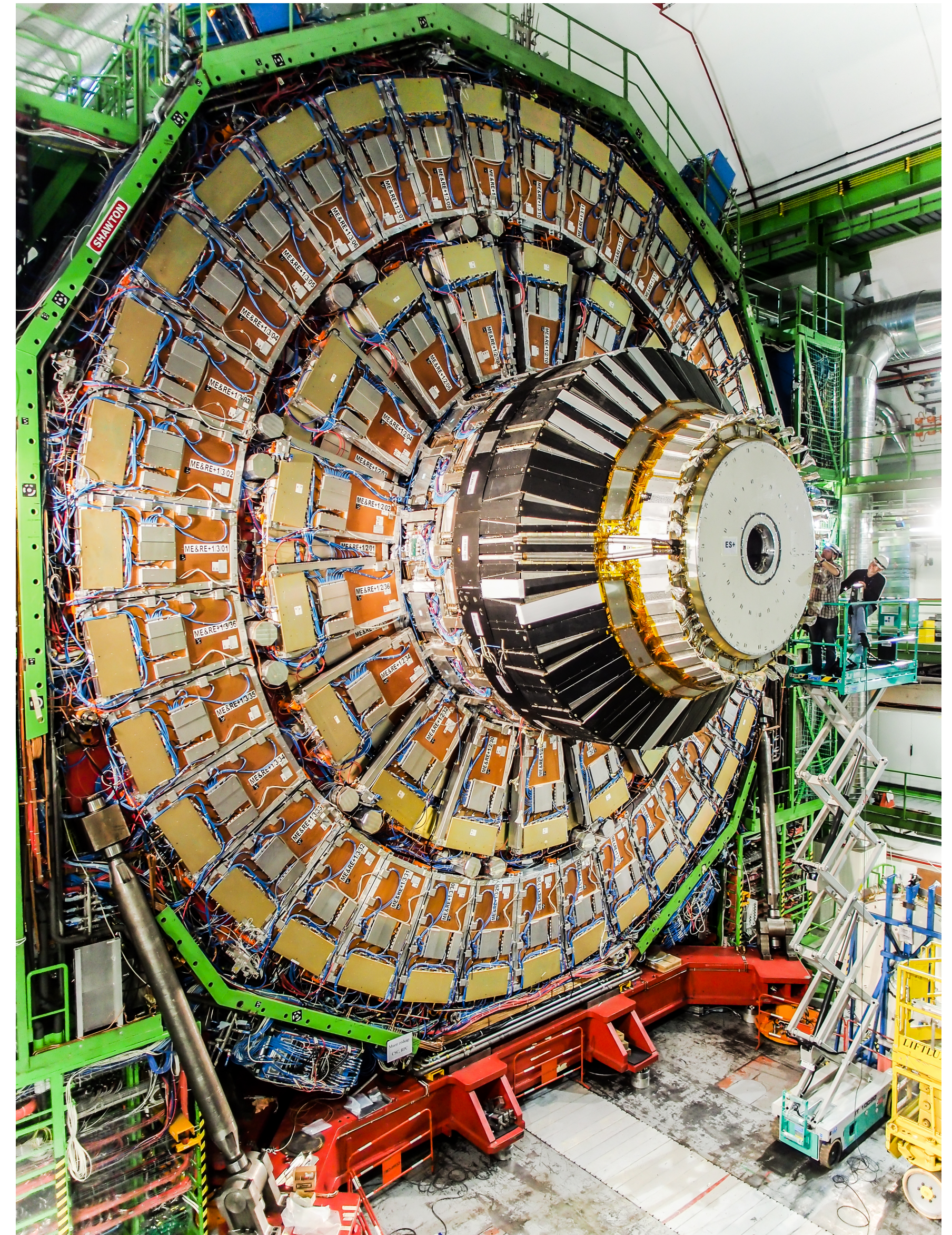
Jeff Richman
Professor of Physics
University of California, Santa Barbara



CMS Postdoc Matching Event, September 23-24, 2020



- Thank you for coming to my presentation!
- This is an unusual and difficult time, which only adds to the stress that you are likely feeling as you finish your theses and move to the next stage of your careers. From what I have seen, graduate students and postdocs are doing remarkably well!
- I will present a short overview of my research goals and interests. I am happy to take questions. Many thanks to the organizers for setting this up!
- But this event is just a starting point. There won't be time to go into many details.
- Please feel free to contact me, and we can set up a Skype/Zoom call with me to discuss the position in more detail.



- You can learn about my work in physics from my web page:
<http://hep.ucsb.edu/people/richman/>
- Education/Positions. B.S. Yale (1979), Ph.D. Caltech (1985), Postdoc CERN (1985-86), Postdoc LBNL (1987-88), Faculty UCSB (1988 — present)
- Experiments: Mark III (SPEAR), UA1 (CERN - SpbarS), Mark II (SLAC SLC), SLD (SLAC SLC), CLEO (Cornell CESR), BaBar (SLAC PEP-II), CMS (CERN LHC)
- CMS: Muon HLT & tracking software, SUSY convener, EXO and SUSY Pub Comm Boards, CSC Muon System, high speed electronics: Optical Data MotherBoard for CSC
- People from my group currently or previously connected with LHC: Tae Min Hong (faculty, Pittsburgh/ATLAS), Jeff Berryhill (staff scientist, FNAL/CMS), Finn Rebassoo (staff scientist LLNL/CMS), Jean-Roch Vlimant (senior scientist Caltech/CMS), Anders Ryd (faculty, Cornell/CMS), Tom Danielson (Engineer, SB Infrared), David Lange (senior scientist Princeton/CMS), Kristen Flowers (Scientist, AT&T), Jack Bradmiller-Feld (Data Scientist), Adam Dishaw (Data Scientist), Manuel Franco Sevilla (faculty, U Maryland/LHCb), Ana Ovcharova (Data Scientist)
- Current group members: Jaebak Kim (pd & CSC Upgrade Coordinator), Alex Dorsett (gs), Michael Oshiro (gs), +1 gs TBN

- CSC muon system upgrade and Run 3 operations - Long involvement in CSC system (electronics). Now in prototyping phase for new, high-speed Optical DAQ board (ODMB7). Major UCSB responsibilities in next few years. Collaboration with Claudio Campagnari group (UCSB) and Ohio State group (Stan Durkin, Ben Bylsma).
- Supersymmetry - long record of leadership and work on key SUSY searches: all hadronic inclusive, single-lepton inclusive, electroweakinos. Currently working on search for Higgsino pair production in collaboration with U Colorado group (Keith Ulmer). Expect long-term involvement in searches for electroweak SUSY production in the future.
- Higgs - joined the Higgs PAG about a year ago. Focusing on preparations for $H \rightarrow Z\gamma$ in Run 3. Currently serving as LE for $H \rightarrow Z\gamma$ paper based on Run 2 data by Northwestern and Taiwan. Expect signal to be accessible in Run 3, but there are already indications of a signal in Run 2 data with a higher than expected cross section!
- Open to new and innovative ideas for physics analysis projects!



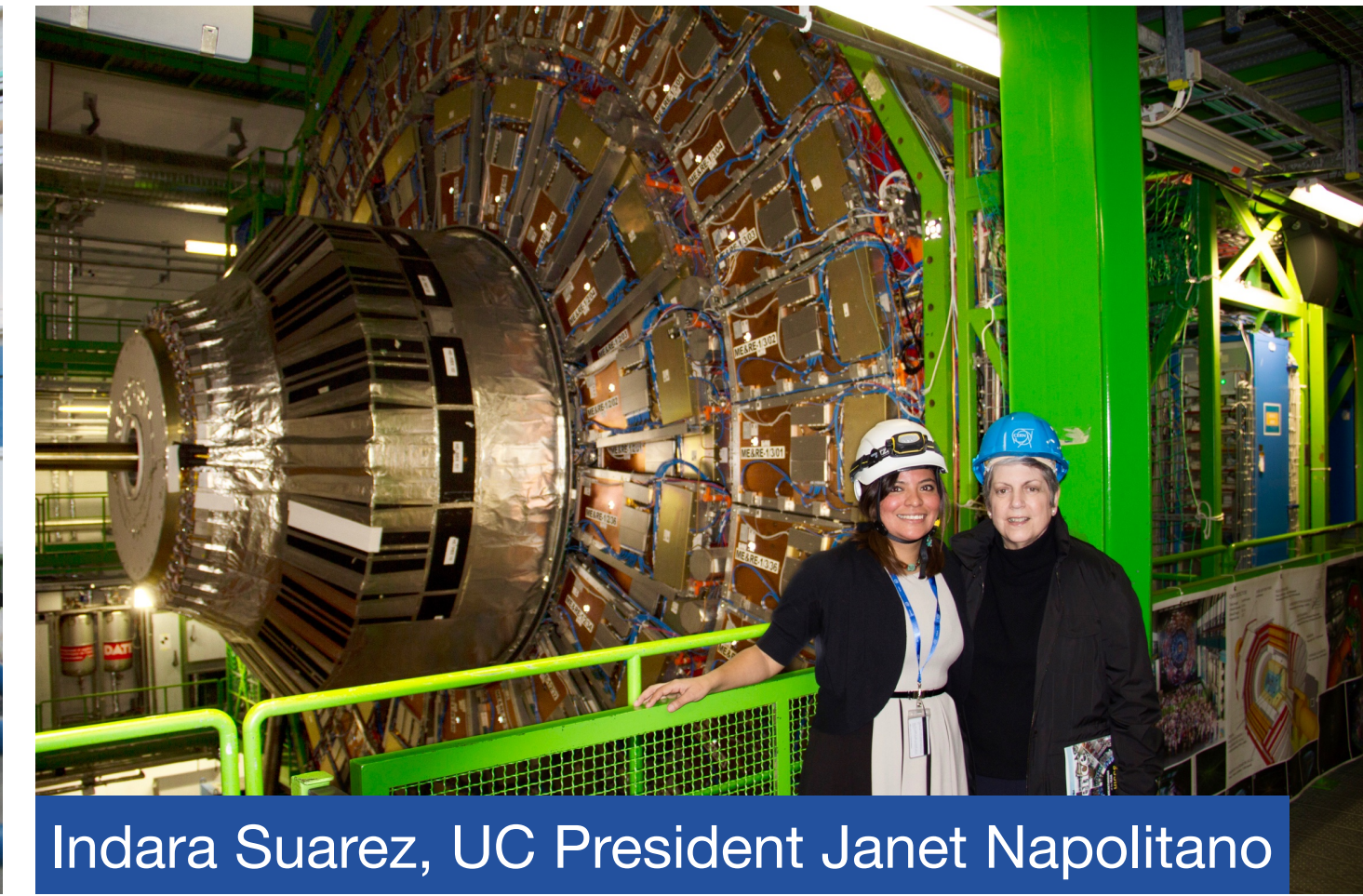
Manuel Franco Sevilla



Hualin Mei

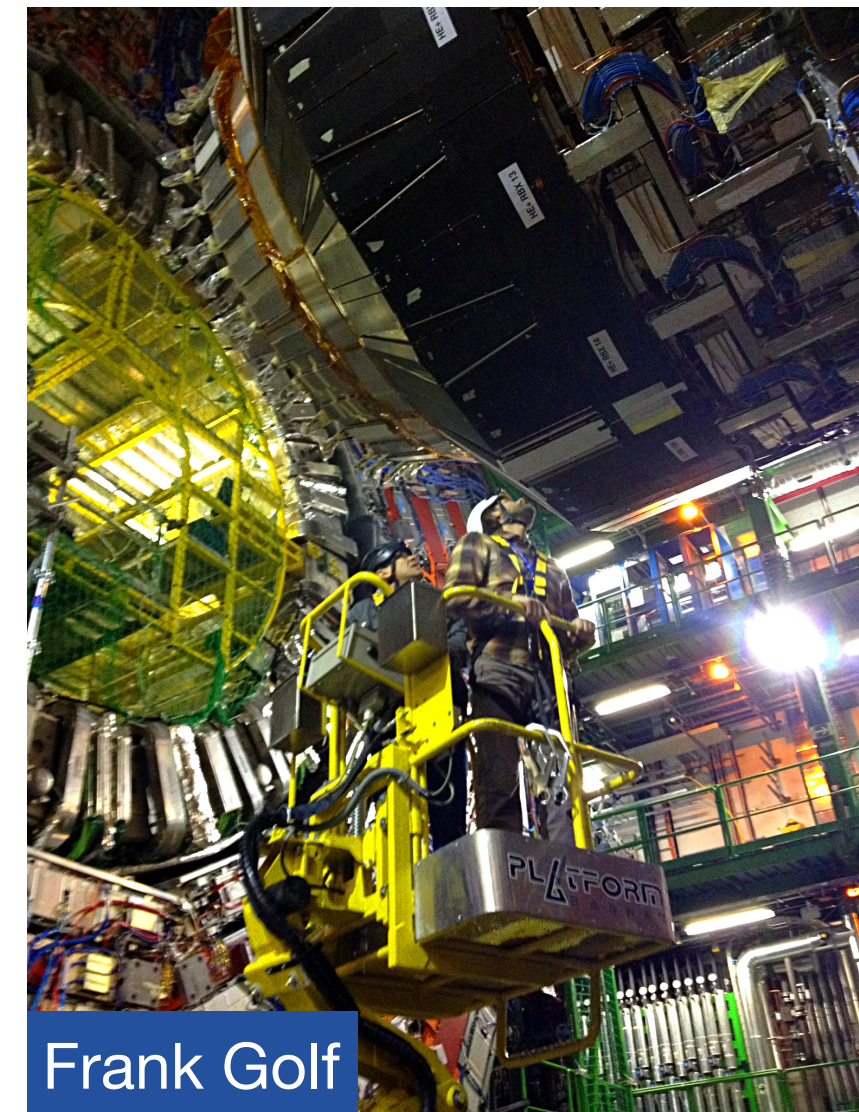


Alex Dorsett, Michael Oshiro

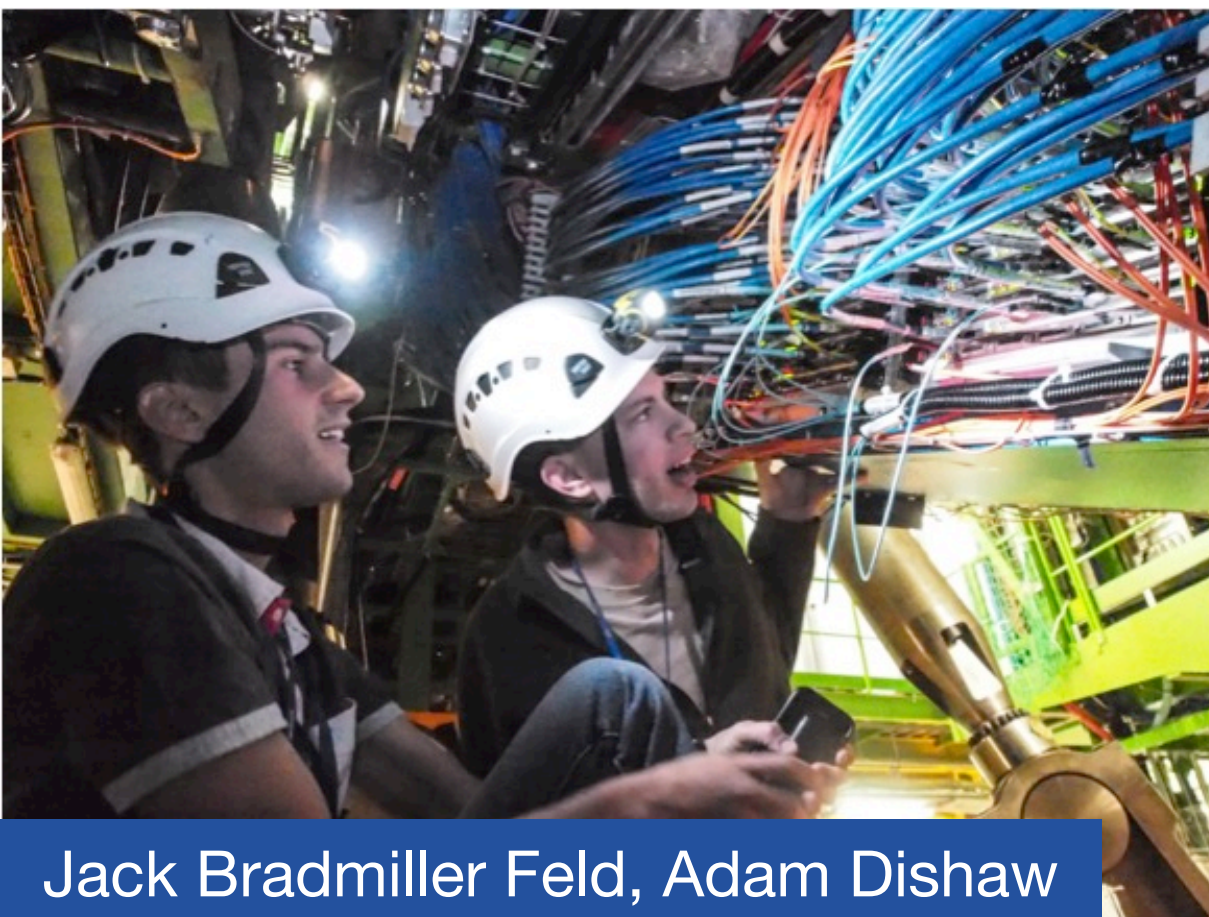


Indara Suarez, UC President Janet Napolitano

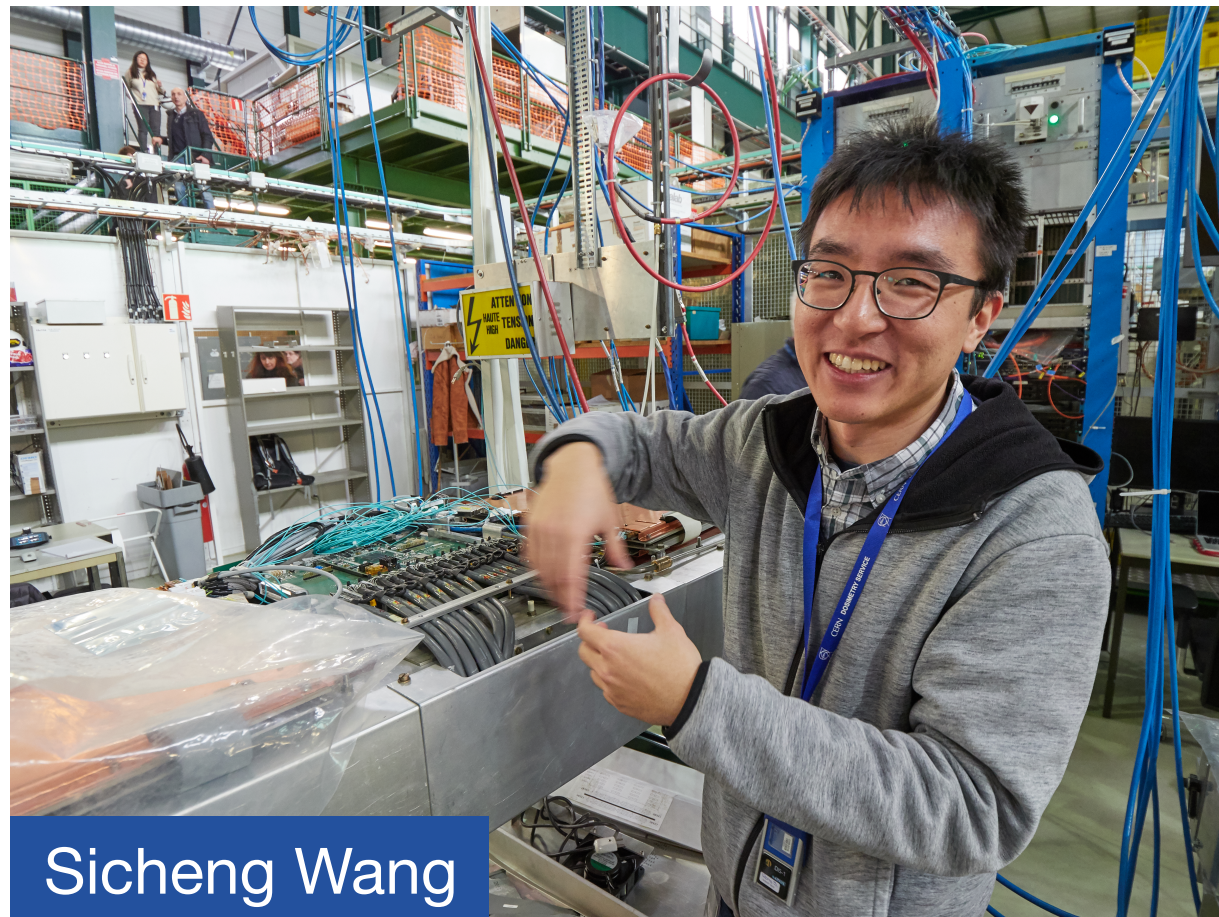
Working on the detector is essential for training complete physicists. Members of the Campagnari + Richman group have played major roles in the CSC system.



Frank Golf



Jack Bradmiller Feld, Adam Dishaw



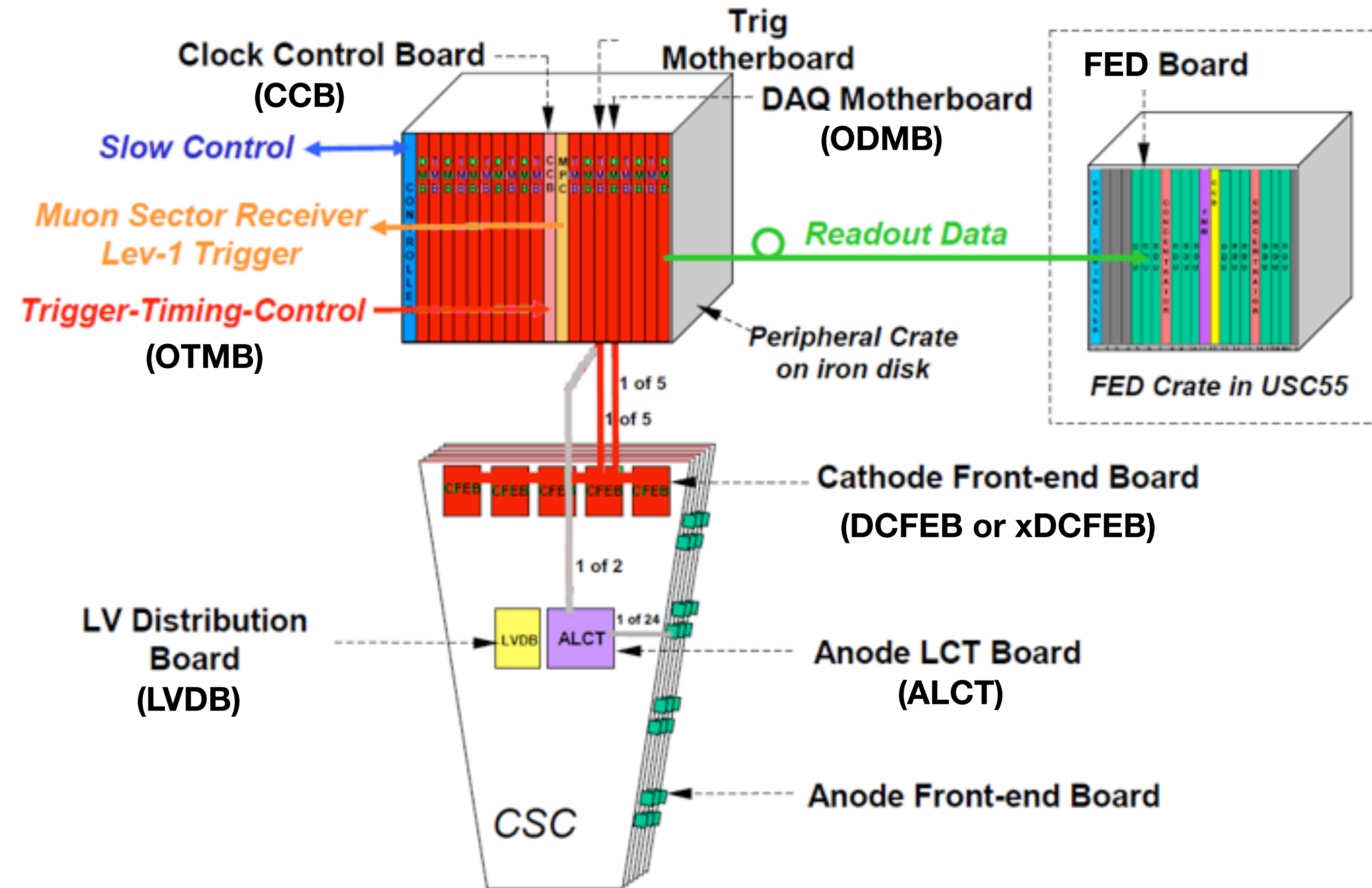
Sicheng Wang



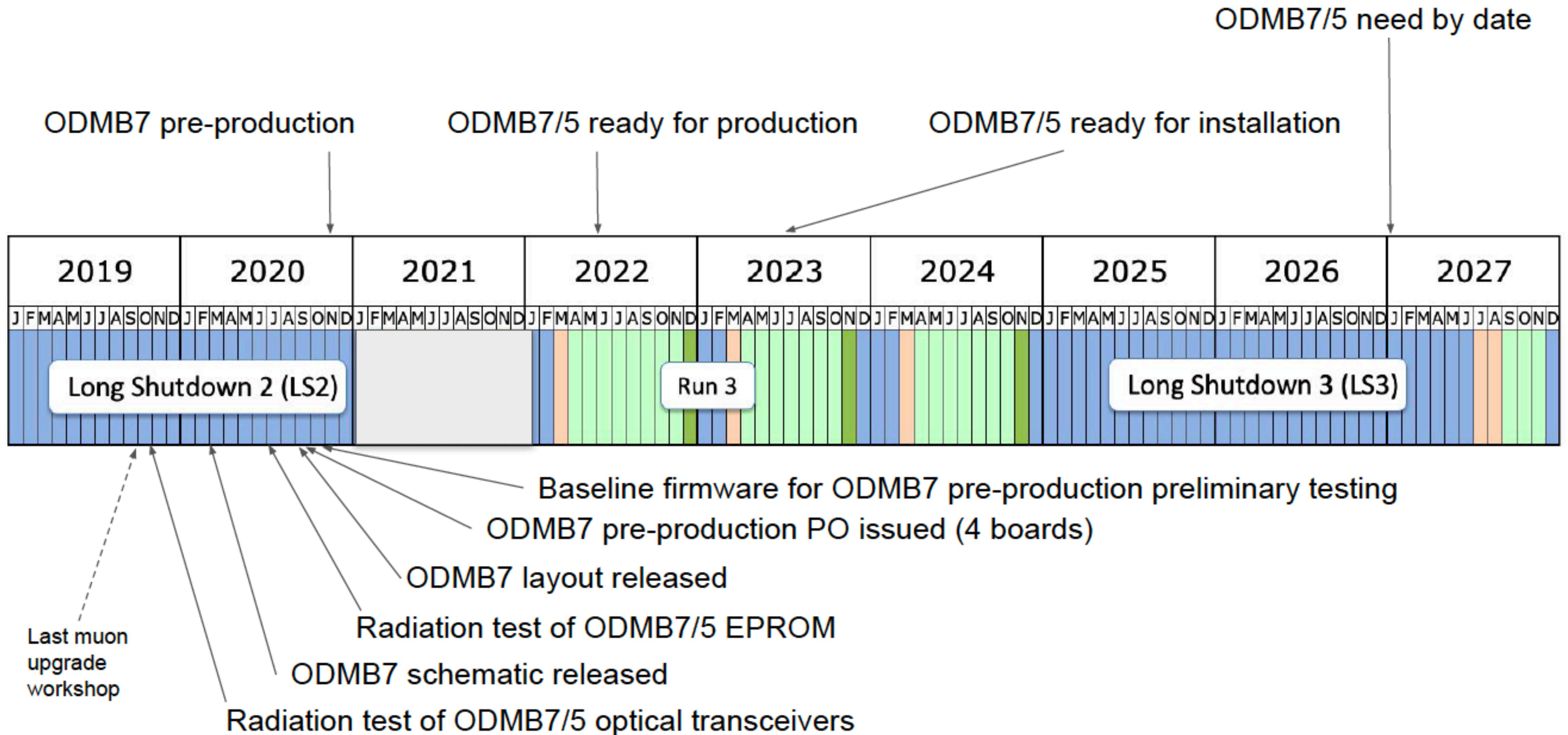
Jeffrey Richman



Jaebak Kim

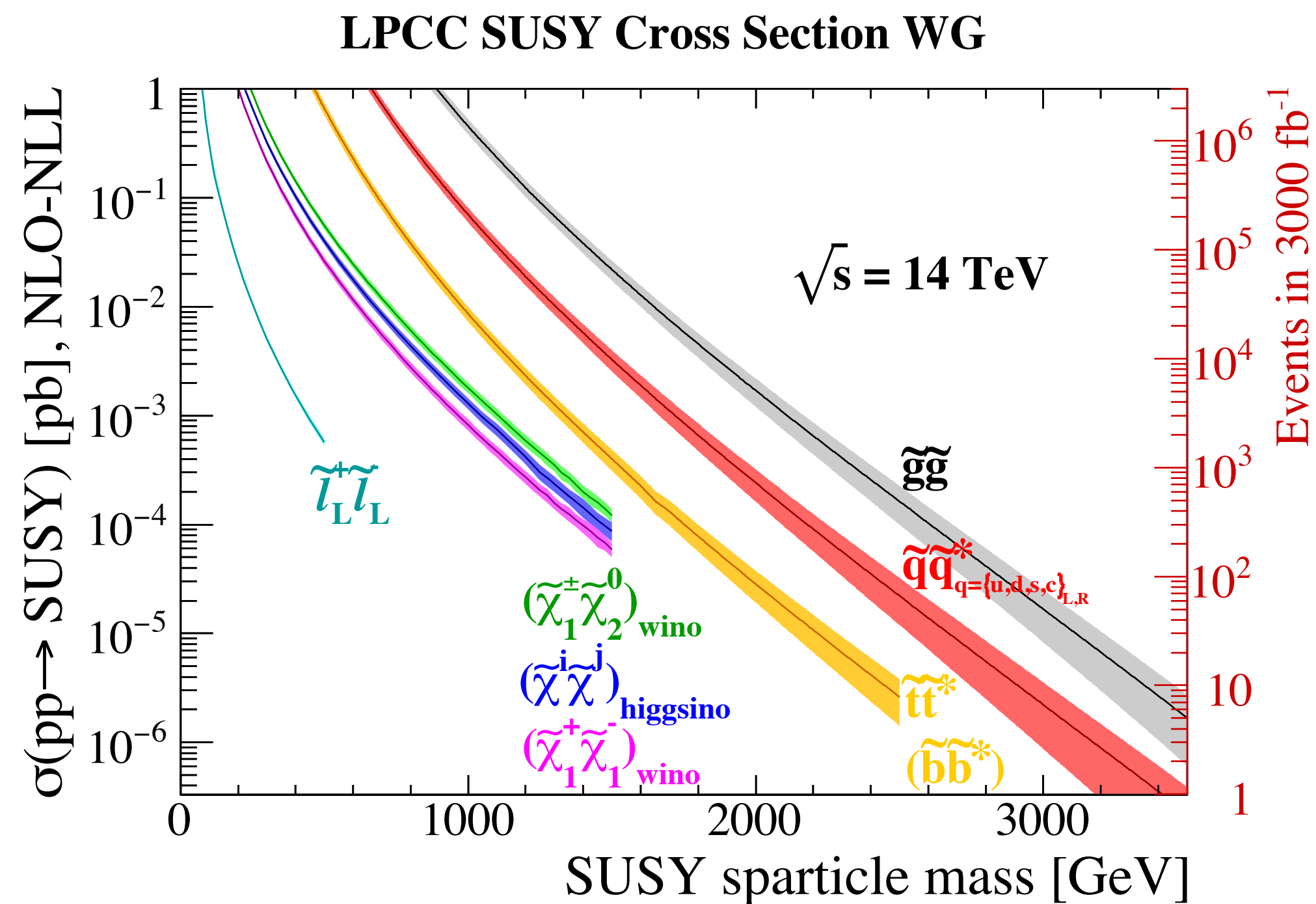


- **ODMBs** reside in a 9U VME crate with a custom backplane. These crates in the cavern are mounted at the periphery of the detector.
- Each ODMB communicates with the on-chamber signal processing electronics for both the anodes (**ALCTs**) and the cathode strips (**DCFEBs**), as well as the **LVDB** low-voltage control board.
- Within the VME crate, the ODMB communicates with the trigger (**OTMB**) and clock & control (**CCB**) boards.
- Upon receiving a local trigger accept signal, the ODMB builds data packets and sends them via high-speed optical links to the CSC back-end DAQ electronics (**FEDs**).

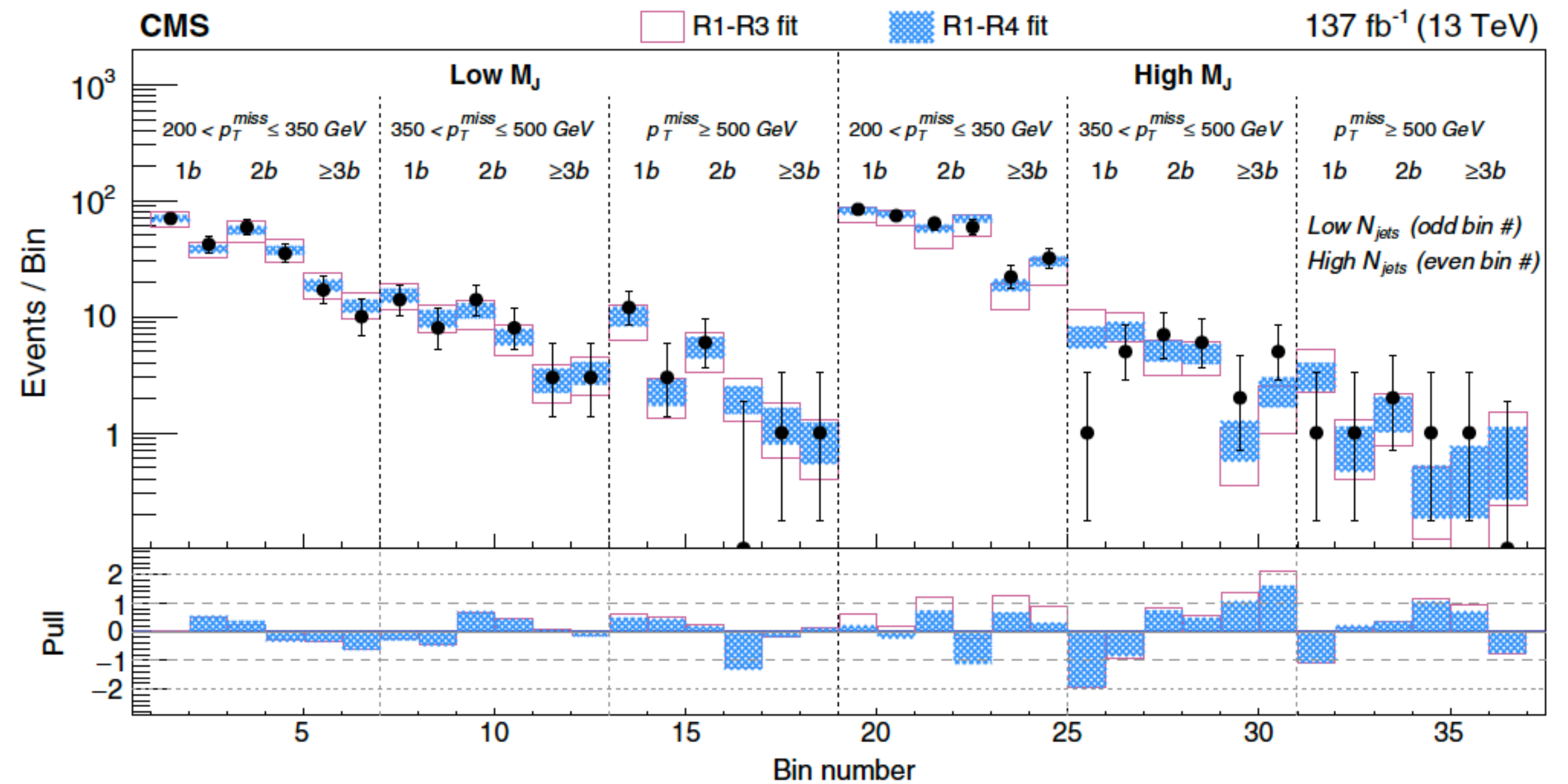


- Served as SUSY convener during first CMS data taking. Formulated many aspects of the SUSY search plan and strategy. Wrote SUSY section of HL-LHC of the Phase 2 Technical Proposal. For most of Run 2, have been focusing on searches for strongly produced SUSY partners (gluinos, top squarks, ...). So far, no signals observed...
- So, haven't we killed SUSY yet?

SUS-19-007: single-lepton + jets + MET, published in 2020

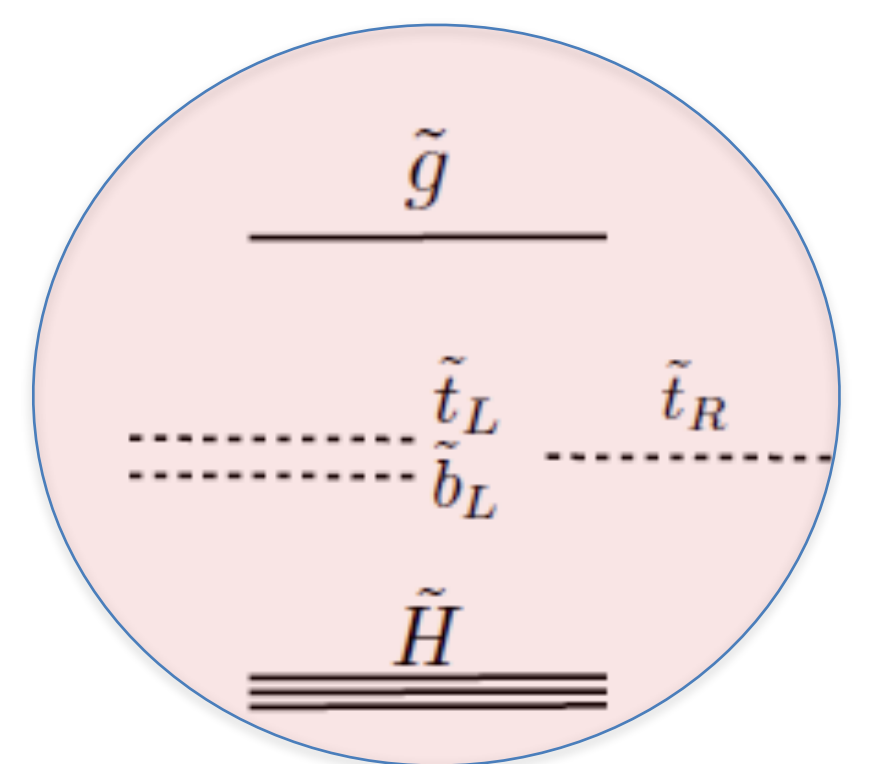


<https://twiki.cern.ch/twiki/bin/view/LHCPhysics/SUSYCrossSections> arXiv:1407.5066

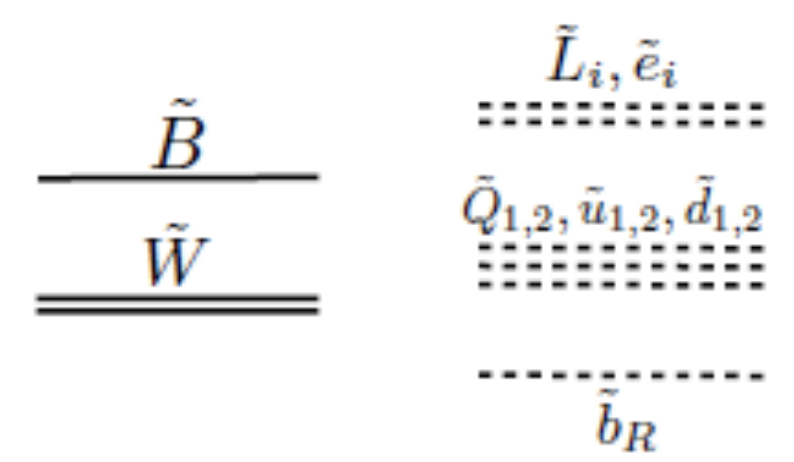


- Negative results from searches for strongly produced partners have major importance, but theory (“natural SUSY”) suggests that the lightest SUSY partners could be the Higgsinos. SUSY-motivated signatures are important even if nature doesn’t care about SUSY!
- Large data samples are expected to have more impact for EWK than for strong production.
- Higgsino analysis underway (HH+MET → (bb)(bb) +MET) with both resolved (AK4) and boosted (AK8) jet topologies (Colorado + UCSB).

Focus of SUSY searches

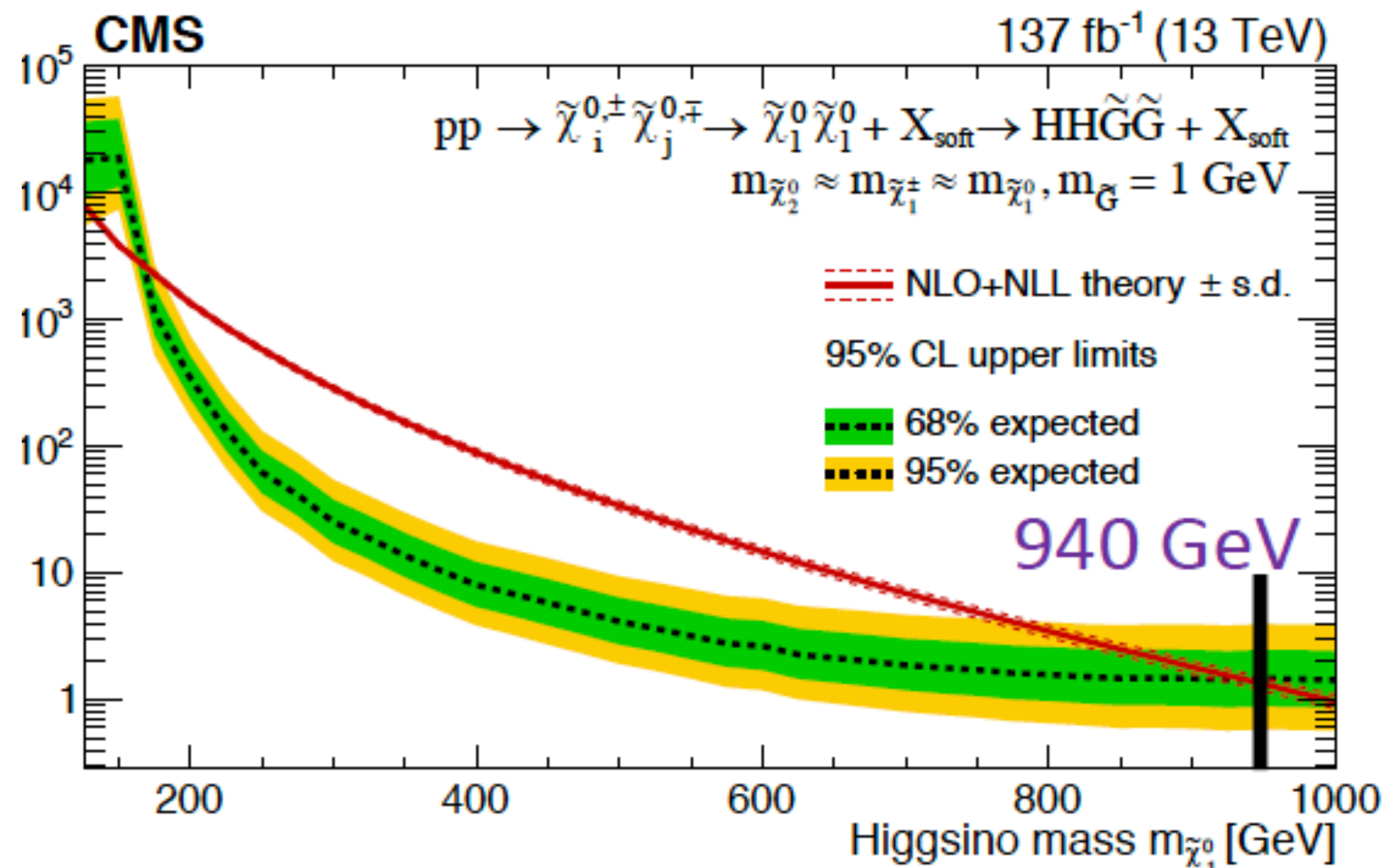


natural SUSY

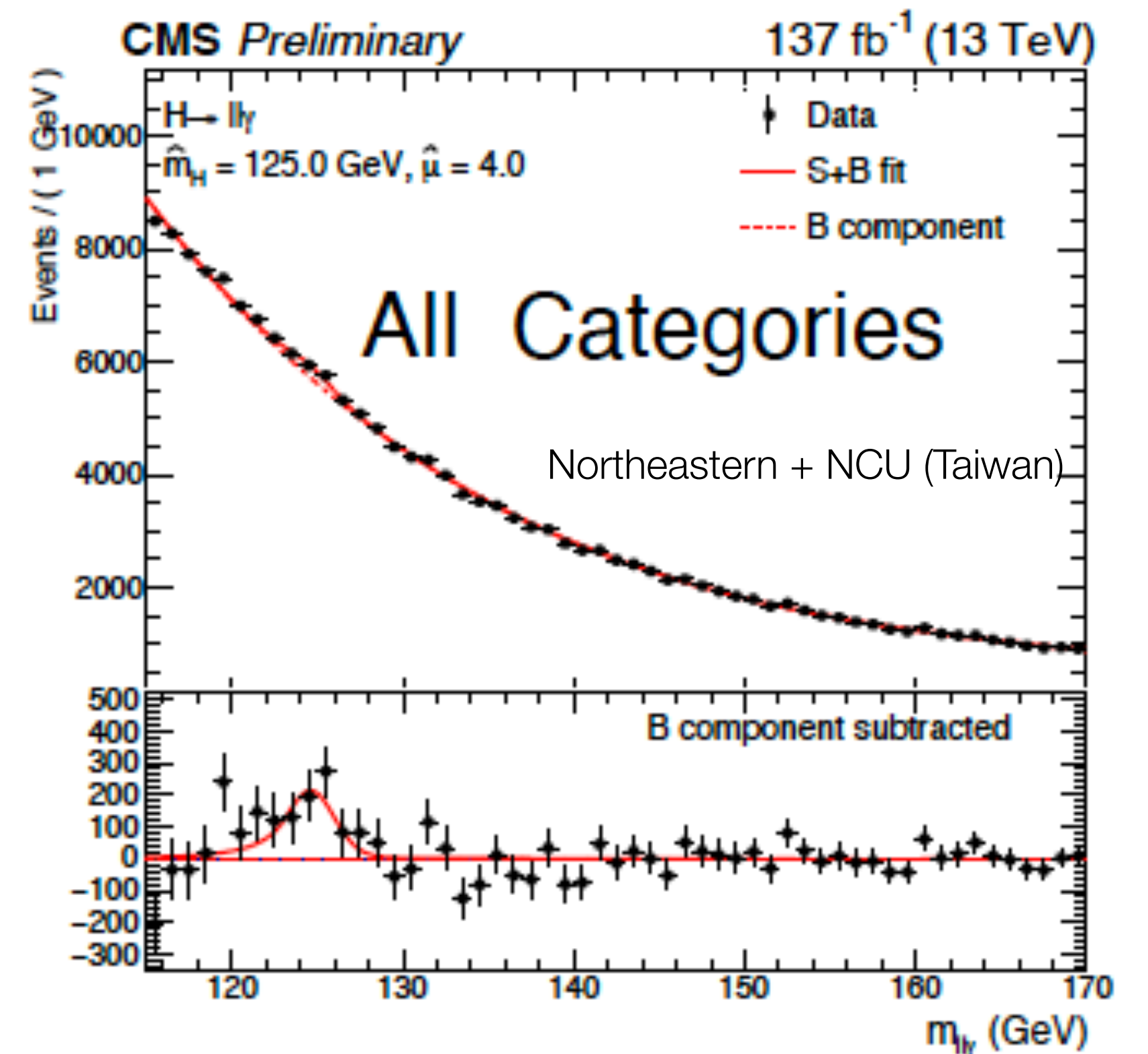
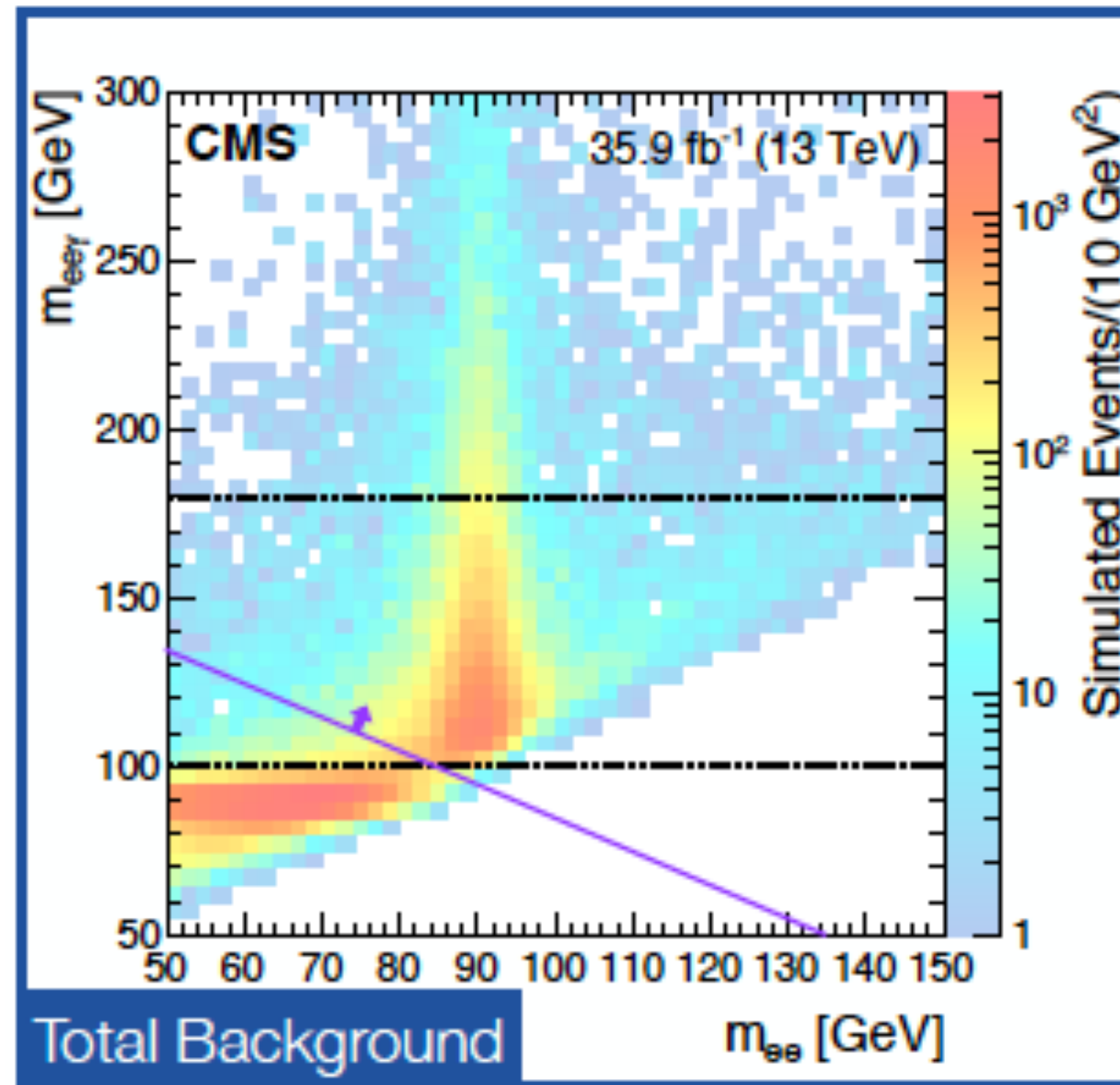
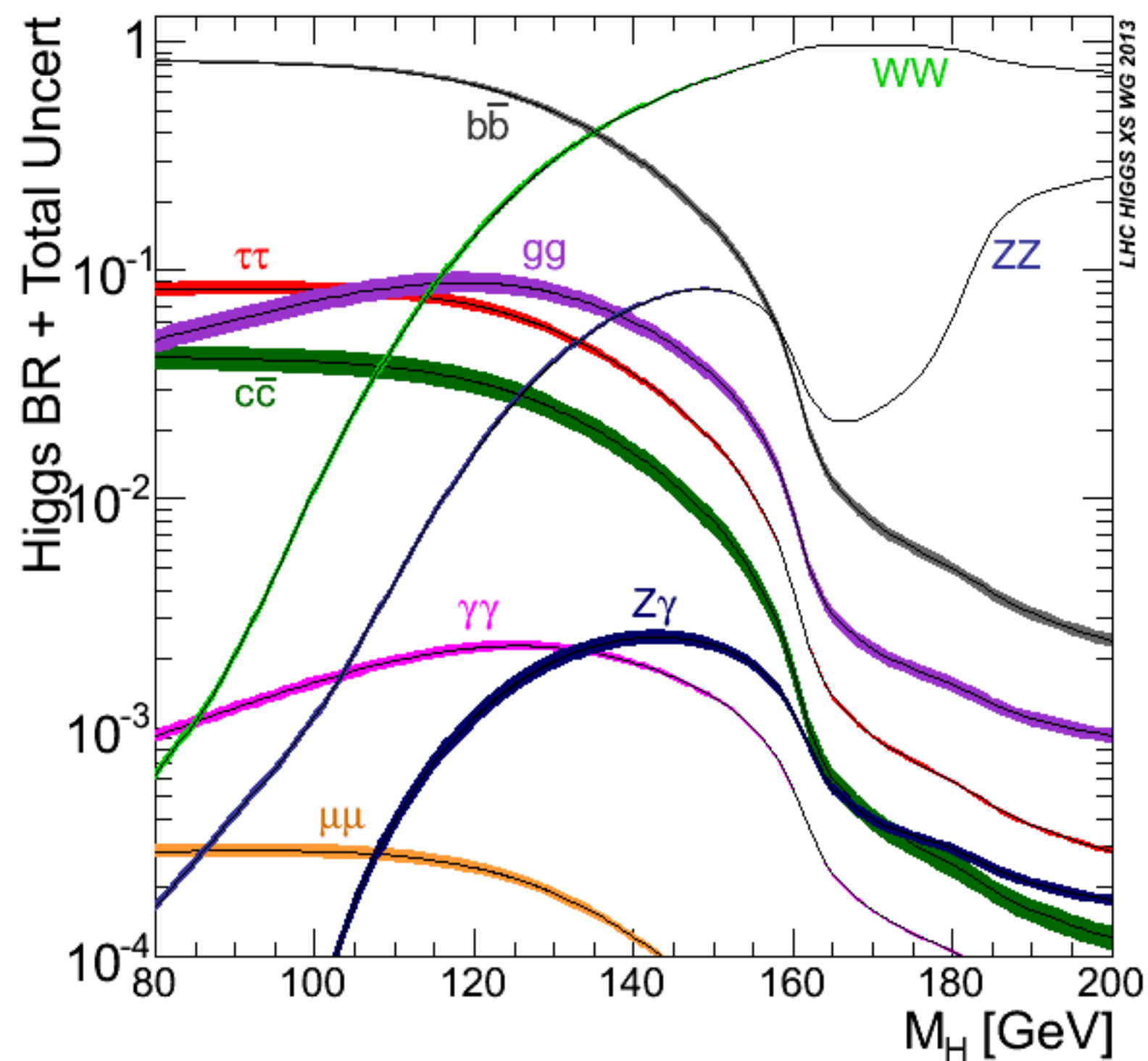


decoupled SUSY

Very preliminary sensitivity estimate (model dependent)



- We have joined the $H \rightarrow Z\gamma$ effort (with Northeastern & NCU Taiwan) and have been preparing for Run 3. https://indico.cern.ch/event/944262/contributions/4014091/attachments/2101399/3532859/20-08-20_Dorsett_ZGamma-Talk.pdf
- Surprisingly, the Run 2 analysis has recently unblinded and has a signal with $\sim 4\sigma$ significance and with signal strength $\mu = 4.0^{+1.2}_{-1.3}$. This will be interesting in Run 3! https://indico.cern.ch/event/952782/contributions/4011029/attachments/2104607/3539169/20200917_CMSweek_HZg.pdf



- Looking for candidates who have a strong interest in both physics analysis and hardware.
- Hardware work includes extensive firmware development for Xilinx Ultrascale Field Programmable Gate Array. Learning to work with this high-end FPGA is a very powerful and general job skill.
- Physics program: currently centered on Higgsino searches and Higgs measurements.
- Current group members (Jaebak Kim - pd, Alex Dorsett -gs, and Michael Oshiro -gs) + members of Campagnari group (Hualin Mei -pd, Francesco Setti -gs, Sicheng Wang - gs).
- Job is posted on INSPIREHEP and AJO.
- Thank you for applying!

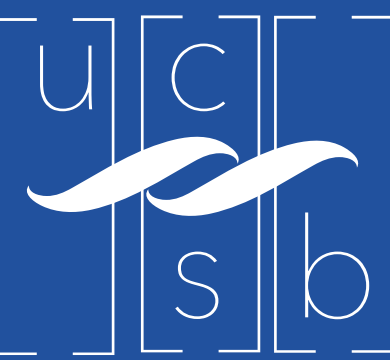
<https://inspirehep.net/jobs/1811875>

<https://academicjobsonline.org/ajo/jobs/16669>

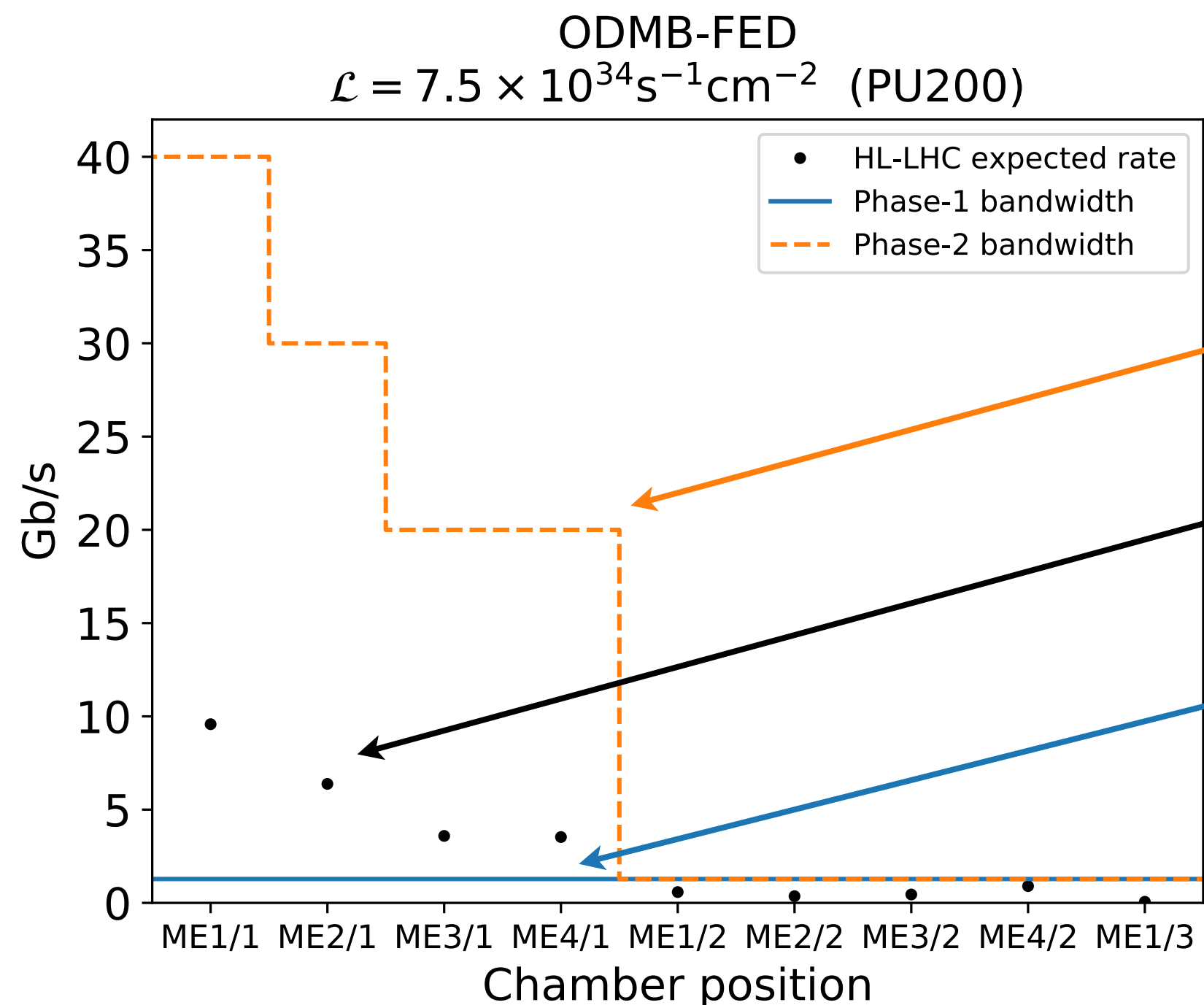




Backup slides



- Simulation studies show that current CSC electronics for chambers closest to the beam pipe cannot cope with the projected data rates.
- Postdoc Manuel Franco Sevilla served as editor for the CSC section in the CMS Technical Design Report on *The Phase-2 Upgrade of the CMS Muon Detectors*.



ODMB-FED data path

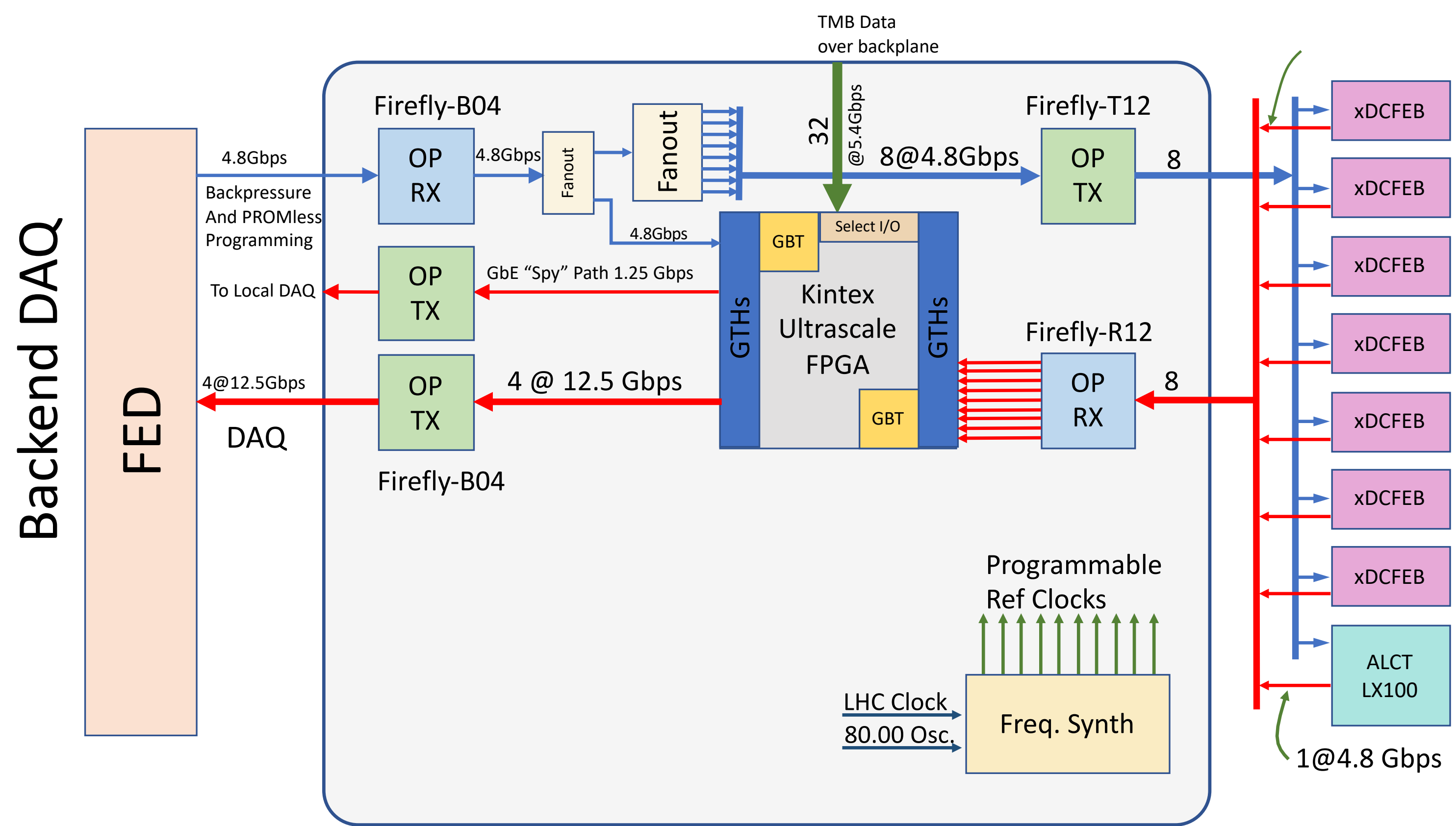
Phase-2 bandwidth

Predicted rate

Phase-1 bandwidth
(1.6 Gb/s)



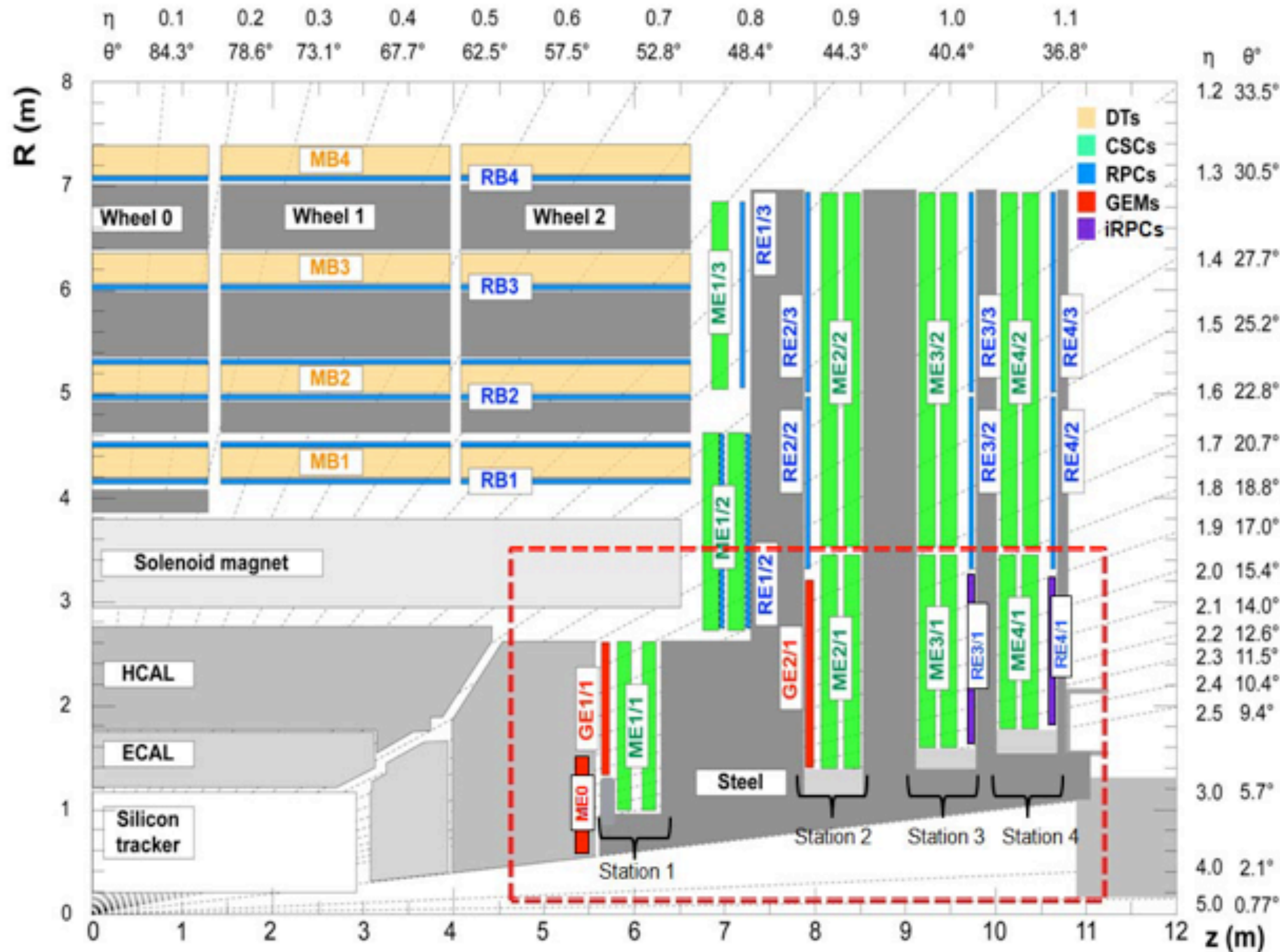
9U, 16 layer VME board in CSC peripheral crates



Front-end chamber electronics

- ✓ FPGA Xilinx Ultrascale XCKU035-1FFVA1156C
 - ➔ 510 I/Os, 400k FF, 16 GTH (12.5 Gbps)
 - ➔ Controls data flow and monitors board
- ✓ Firefly optical links (B04, T12, R12)
 - ➔ Samtec 14 Gbps optical transceivers (14 bi-directional)
 - ➔ Transmit and receive data from boards
- ✓ Optical transmission protocol
 - ➔ GBT-core: CERN radiation-error resilient data transmission protocol
 - ➔ 8B/10B encoding protocol for DC leveling
- ✓ VME
 - ➔ VME64x + custom VME backplane
 - ➔ Slow control/Monitoring/Clock distribution/Data transmission
- ✓ Clocks
 - ➔ 40 MHz, 80 MHz, 160 MHz
 - ➔ Optical data transmission/VME/firmware logic
- ✓ Fanout chips
 - ➔ Distributes 4.8 Gbps data to FPGA and front-end chamber electronics
 - ➔ PROM-less programming/DAQ back-pressure reduction
- ✓ JTAG interface

Will build 72 ODMB7 boards (ME1/1) & 108 ODMB5 boards (ME2,3,4/1) → 180 boards + spares



- 180 CSC chambers in inner rings need full electronics upgrade to handle projected data rates.
- ME1/1, ME2/1, ME3/1, ME4/1.
- For on-chamber electronics, requires >1 year operation to remove chambers, replace multiple electronics boards, and re-install chambers.
- Replacement operations already started in early 2019.
- UCSB group has been heavily involved in refurbishment & chamber testing at LHC Point 5.

- UCSB is typically ranked in the top 10 of US physics departments.
<https://www.usnews.com/best-graduate-schools/top-science-schools/physics-rankings>
- 5 members of the UCSB faculty have won Nobel Prizes in the physical sciences since 1998.
- The Physics Department now ranks in the top 3 of US universities in terms of the number of undergraduate physics majors.
- The Department is strengthened by the Kavli Institute of Theoretical Physics (KITP), which is very close to the Physics Building. The KITP hosts a large number of physicists from around the world and has many workshops and events relevant to particle and astroparticle physics.
- COVID-19 status - research has resumed in Department labs, with controlled lab occupancy. Our CMS electronics lab is operational with 1 person in the lab at a time.