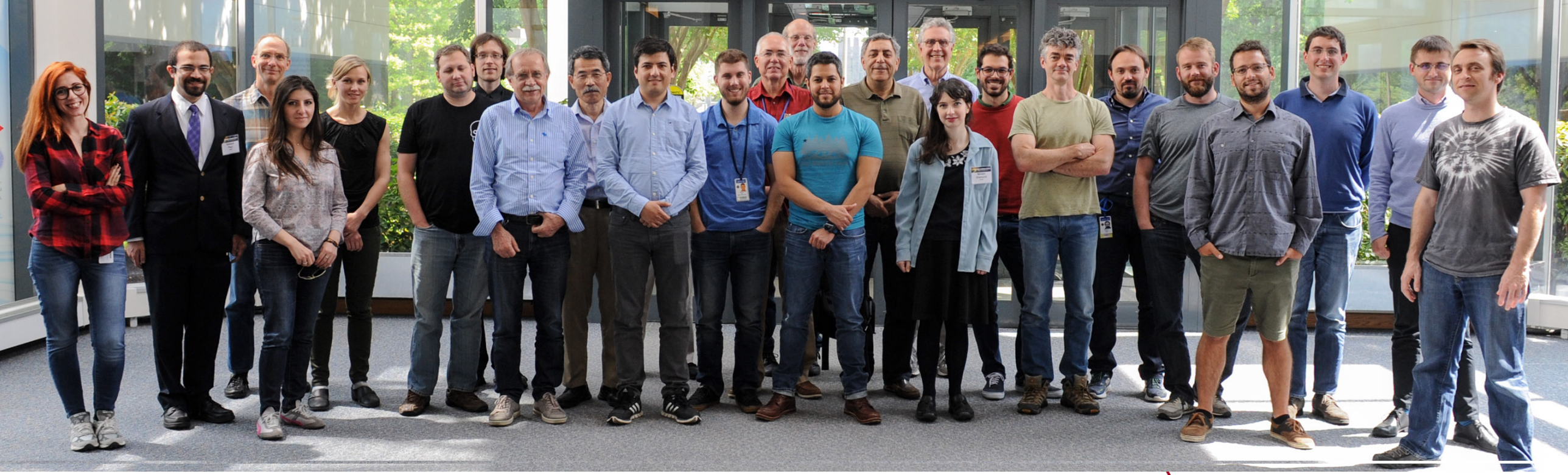


HPS: Collaboration, Budget and Schedule

Tim Nelson - SLAC

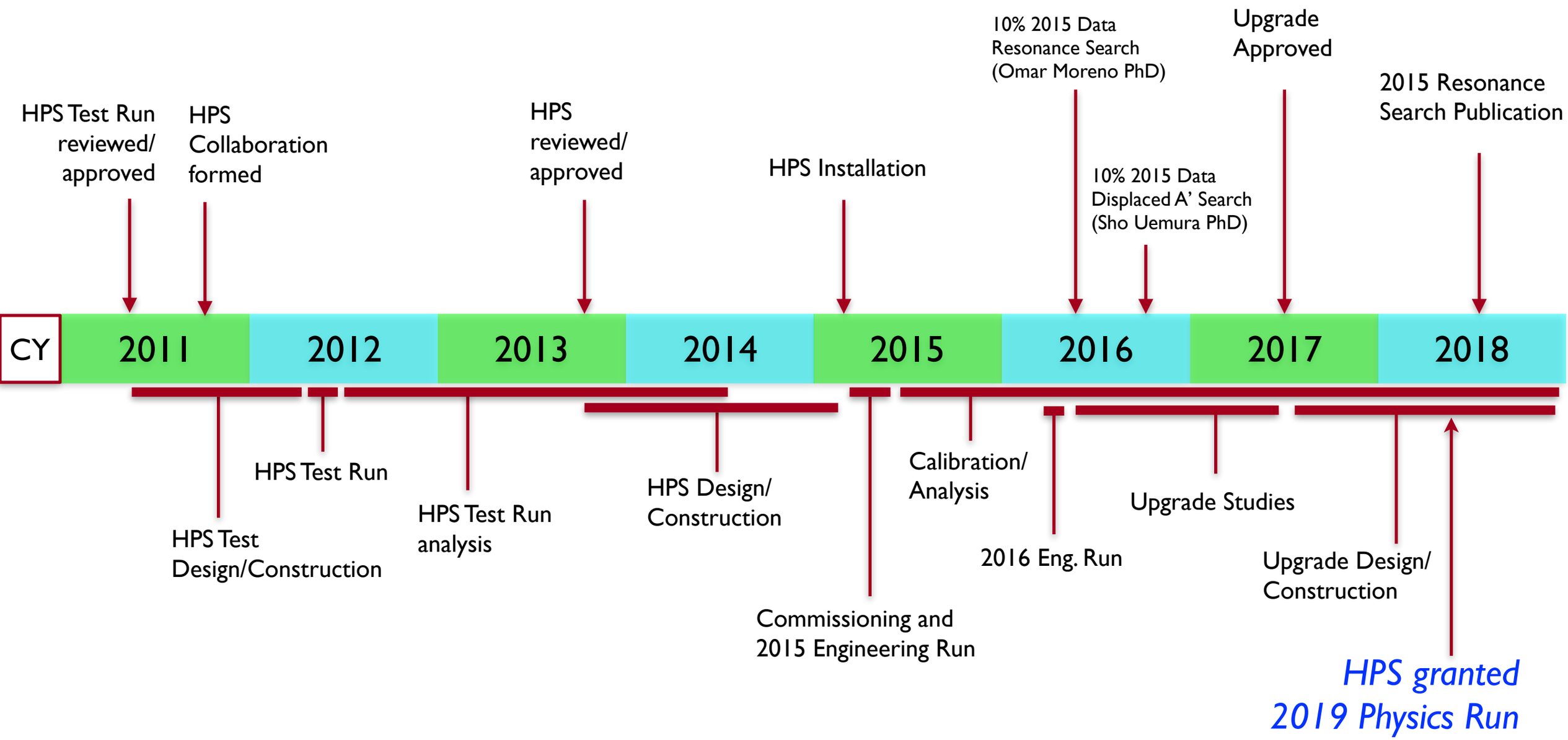
HPS DOE Review

SLAC - January 18, 2019

U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

HPS History



Small experiments are great for students!

HPS Students

Past Students: (in order graduated)

Luca Colaneri Ph.D., INFN Roma
A Monte Carlo Generator for Trident Production

Omar Moreno Ph.D., UCSC - now @ SLAC
Search For a Heavy Photon in the 2015 Engineering Run Data of the Heavy Photon Search Experiment

Sho Uemura Ph.D., Stanford - now @ LANL
Searching for heavy photons in the HPS experiment

Ani Simonyan Ph.D., Orsay
Dark Photon Search with the HPS Experiment at JLab

Holly Szumila-Vance Ph.D., ODU - now @ JLab
Searching for displaced heavy photons in 2015 engineering run

Sebouh Paul Ph.D., UNH - now @ Tel Aviv University
Searching for a Dark Photon in the HPS Experiment

Current Students: (in order joined)

Kyle McCarty, UNH

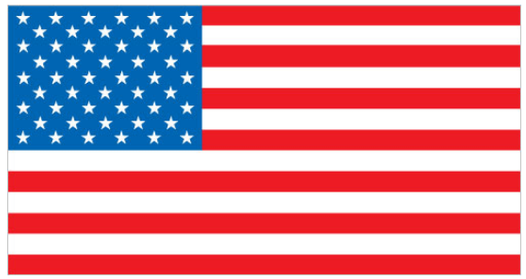
Bradley Yale, UNH

Matt Solt, Stanford

Alic Spellman, UCSC

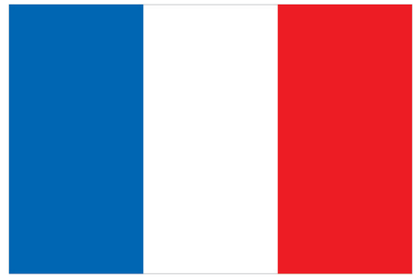
Expect ~2–4 more additions in the next year.

The HPS Collaboration for 2019 Run



JLab (16)
ODU (1)
SLAC (13)
Stony Brook (1)
UCSC (3)
UNH (4)
William & Mary (1)

INFN Catania (3)
INFN Genova (4)
INFN Padova (1)
INFN Rome (1)
INFN Sassari (3)
INFN Torino (1)



Orsay (5)

Yerevan (3)

Glasgow (2)

European institutions,
especially INFN and Orsay,
have made large contributions to the construction of the experiment and continue to be involved in operations.

HPS Organization

SLAC

Spokespeople:

Maurik Holtrop (UNH), Tim Nelson (SLAC), Stepan Stepanyan (JLab)

Executive Committee:

Nathan Baltzell (JLab), Marzio De Napoli (INFN Catania), Raphael Dupre (Orsay),
Matt Graham (SLAC), Maurik Holtrop (UNH), John Jaros (SLAC-ex officio),
Tim Nelson (SLAC), **Stepan Stepanyan (JLab - chair)**

Publications and Presentations Committee:

Gabriel Charles (Orsay), Andrea Celentano (INFN Genova - Chair),
Rouven Essig (Stony Brook), Norman Graf (SLAC), Rafayel Paremuzyan (UNH)

HPS Subgroups and Leadership

SLAC

SVT/Tracking: *T. Nelson(SLAC), N. Graf(SLAC)*

- construction, commissioning, operations
- calibration and alignment
- track and vertex reconstruction

ECal: *R. Dupre(Orsay)*

- construction, commissioning, operations
- calibration and alignment
- ECal reconstruction

Beamline: *S. Stepanyan(JLab)*

- beam controls and diagnostics
- detector protection and interlocks

DAQ: *S. Boyarinov(JLab), R. Herbst(SLAC)*

- Integration of SVT DAQ/JLab TDAQ
- Event building and data handling

Trigger: *V. Kubarovsky(JLab)*

- study of trigger rates and efficiencies
- definition of trigger menu

Software: *M. Holtrop(UNH)*

- reconstruction framework and data processing
- simulation framework and MC production
- detector calibrations

Analysis: *M. Graham(SLAC), N. Baltzell(JLab)*

- data quality
- directing physics analysis
- planning publications and releases of new results
- define critical tasks for software and detector groups

DOE Effort on HPS

DOE HEP Effort (FTE)

	2016	2017	2018	2019 (expected)
SLAC (research)	5.89	5.44	5.27	4.5
SLAC (operations)	0.47	0.13	0.01	0.5
UCSC	†	†	†	0.5
UNH	0	0	0	1.0
HEP Total	**6.36**	**5.57**	**5.28**	**6.5**

† supported through SLAC subcontract

DOE NP Effort (FTE)

	2016	2017	2018	2019 (expected)
JLab (research)*	1	0.25	0.25	0.5
UNH	2.5	2.5	2.5	2.25
ODU	0.75	0.75	0.75	0.1
W&M	0.75	0.75	0.75	0.5
NP Total	**5**	**4.25**	**4.25**	**3.35**
DOE Total	**11.36**	**9.82**	**9.53**	**9.85**

*does not include beam delivery, power, infrastructure, engineering/technical support in Hall B.
JLab staff are allocated 25% to research (1 person = 0.25 FTE on research)

HEP support for new postdoc and student at SLAC, and UNH postdoc and UCSC student is important and appreciated.

Limited effort requires a lot of multitasking, stretching timelines for non-critical tasks.

DOE Funding for HPS

DOE HEP Funding

	2016	2017	2018	2019 (committed)
SLAC (research)	$2,137K	$1,797K	$1,682K	$1,417K
SLAC (operations)	$205K	$90K	$18K	$450K
UCSC	†	†	†	$45K
UNH	$0K	$0K	$0K	$92K
HEP Total	**$2,342K**	**$1,887K**	**$1,700K**	**$2,004K**

† supported through SLAC subcontract

DOE NP Funding

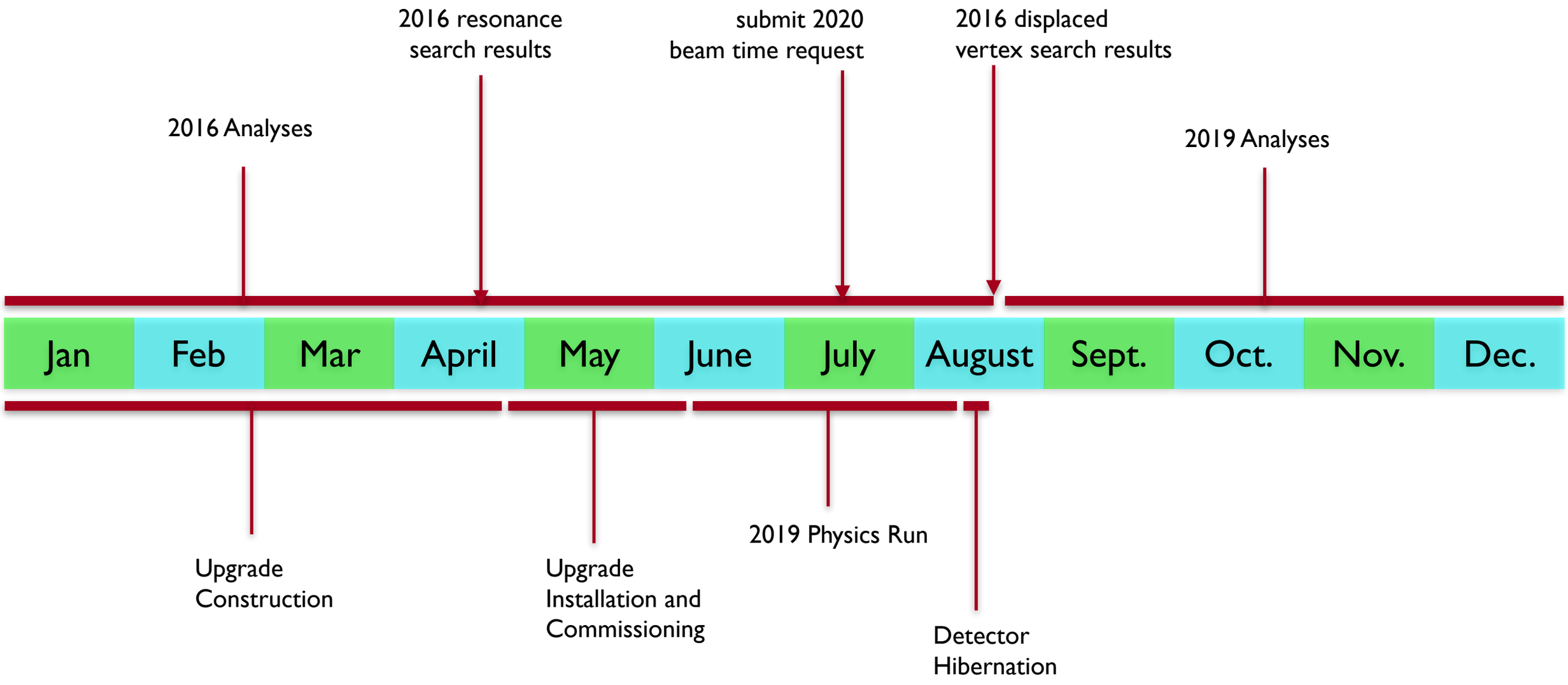
	2016	2017	2018	2019 (expected)
JLab (research)*	$106K	$17K	$18K	$85K
UNH	$230K	$230K	$230K	$200K
ODU	$53K	$39K	$12K	$6K
W&M	$21K	$21K	$21K	$10K
NP Total	**$410K**	**$307K**	**$281K**	**$301K**
DOE Total	**$2,752K**	**$2,194K**	**$1,981K**	**$2,305K**

*does not include beam delivery, power, infrastructure, engineering/technical support in Hall B

Majority of research support flows through HEP, but NP collaborators do a lot of work with limited support.

Ramp-up of activity on CLAS12 has impacted JLab effort on HPS.

2019 HPS Schedule Overview



Upgrade Schedule

SLAC

SVT schedule

Item	Vendor/Institution	Completion dates
Project Approved	SLAC	Complete
Sensor Masks Delivered and Sensor Fabrication Start	IMB-CNM	Complete
Sensors Fabricated	IMB-CNM	Complete
Hybrids Ready for Module Assembly	SLAC, UCSC	Complete
Sensors Processed, Tested, and Ready	UCSC	01/10/2019*
Detector Mechanics Complete	SLAC	02/15/2019
Modules Ready	SLAC, UCSC	03/18/2019
SVT Fully Assembled at SLAC	SLAC	04/08/2019
SVT Fully Assembled at JLAB	SLAC, JLAB	04/22/2019
SVT Installed and Ready for Beam – Project Complete	SLAC, JLAB	04/26/2019

*in progress - some sensors ready

Hodoscope schedule

Item	Institution	Completion dates
Simulation/validation of hodoscope and trigger rates	ODU, UNH	Complete
Conceptual design	Orsay, UNH, JLAB	Complete
Mechanical design	Orsay	Complete
Fabrication of mechanical parts complete	Outside vendor	Complete
Prototyping and tests	UNH, JLAB	01/21/2019*
Full assembly	UNH, JLAB	02/28/2019
Installation in the hall	UNH, JLAB	04/29/2019
Trigger firmware change	JLAB	05/06/2019

*in progress

Analysis Schedule

Item	Target date
2016 Resonance Search Results	May 2019
2016 Vertex Search Results	August 2019
2019 Resonance Search Results	August 2020
2019 Vertex Search Results	December 2020

- Given limited effort and the importance of 2019 run, 2016 analysis is squeezed.
- 2019 resonance search schedule is conservative.
- Vertexing with much larger datasets always bring new surprises: less certainty.
- Once we have conquered vertexing with 2019 dataset, analysis time for future large datasets will be shorter and more certain, as with resonance search.

HPS Beyond 2019

There is more physics for HPS to do.

Running at 2.2 GeV is still an option, but the experiment gets easier at higher beam energies (multiple scattering). Higher energies could also enable first observation of true muonium.

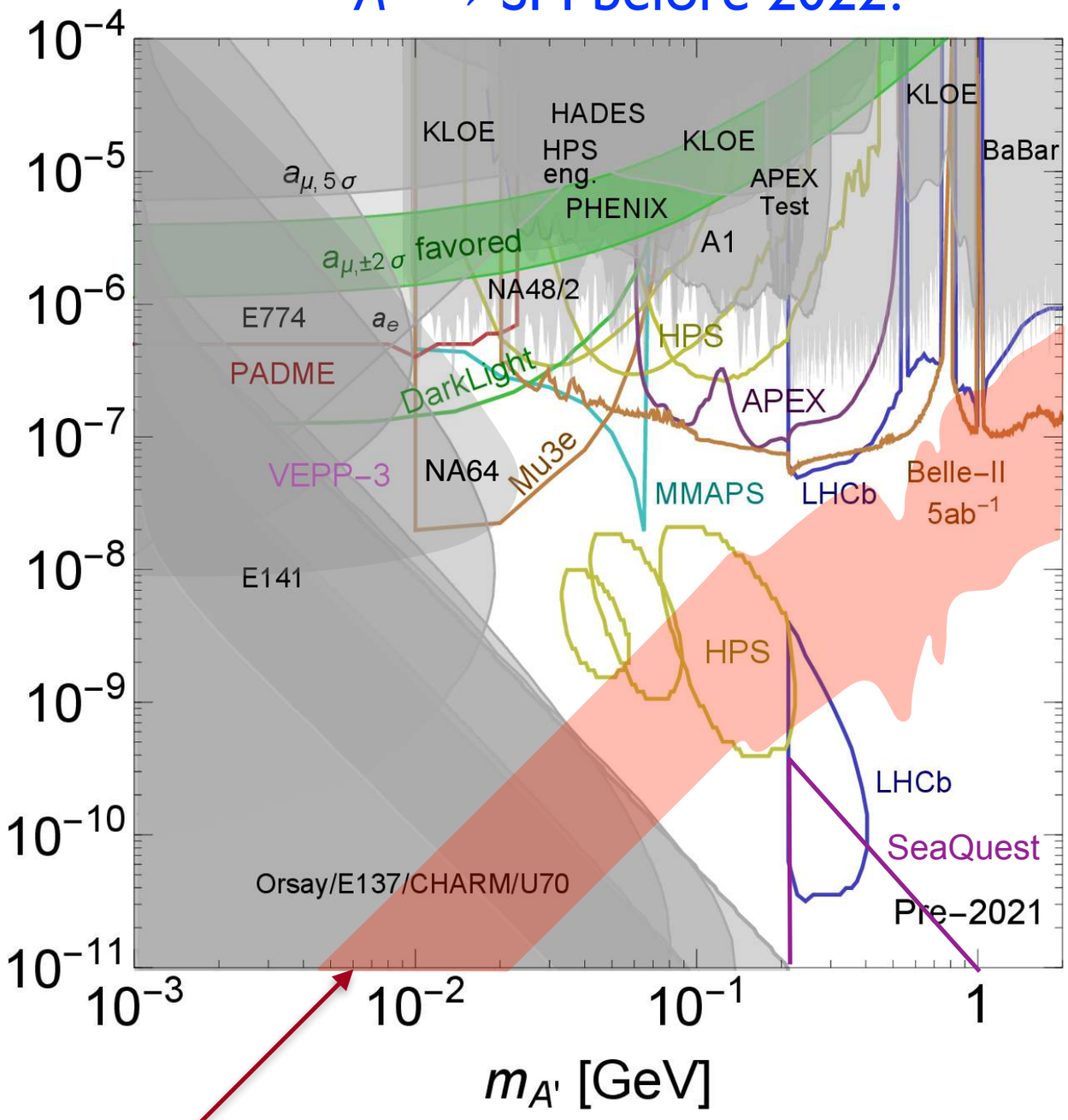
- 6.6 GeV evaluated when HPS proposed and should be revisited
- 5.5 GeV may be more compatible with beam availability at JLab

Beyond 2021 there will be likely be real competition in parts of our parameter space:

- LHCb if triggerless readout is fully successful and long-lived meson decays have zero background.
- Seaquest with an ECal upgrade.

A′ from meson decays cannot probe leptophilic models, just as HPS cannot probe leptophobic ones.

$A' \rightarrow$ SM before 2022?



thermal targets

$\alpha_D = 0.5, M_{A'}/M_\chi = 1.5$

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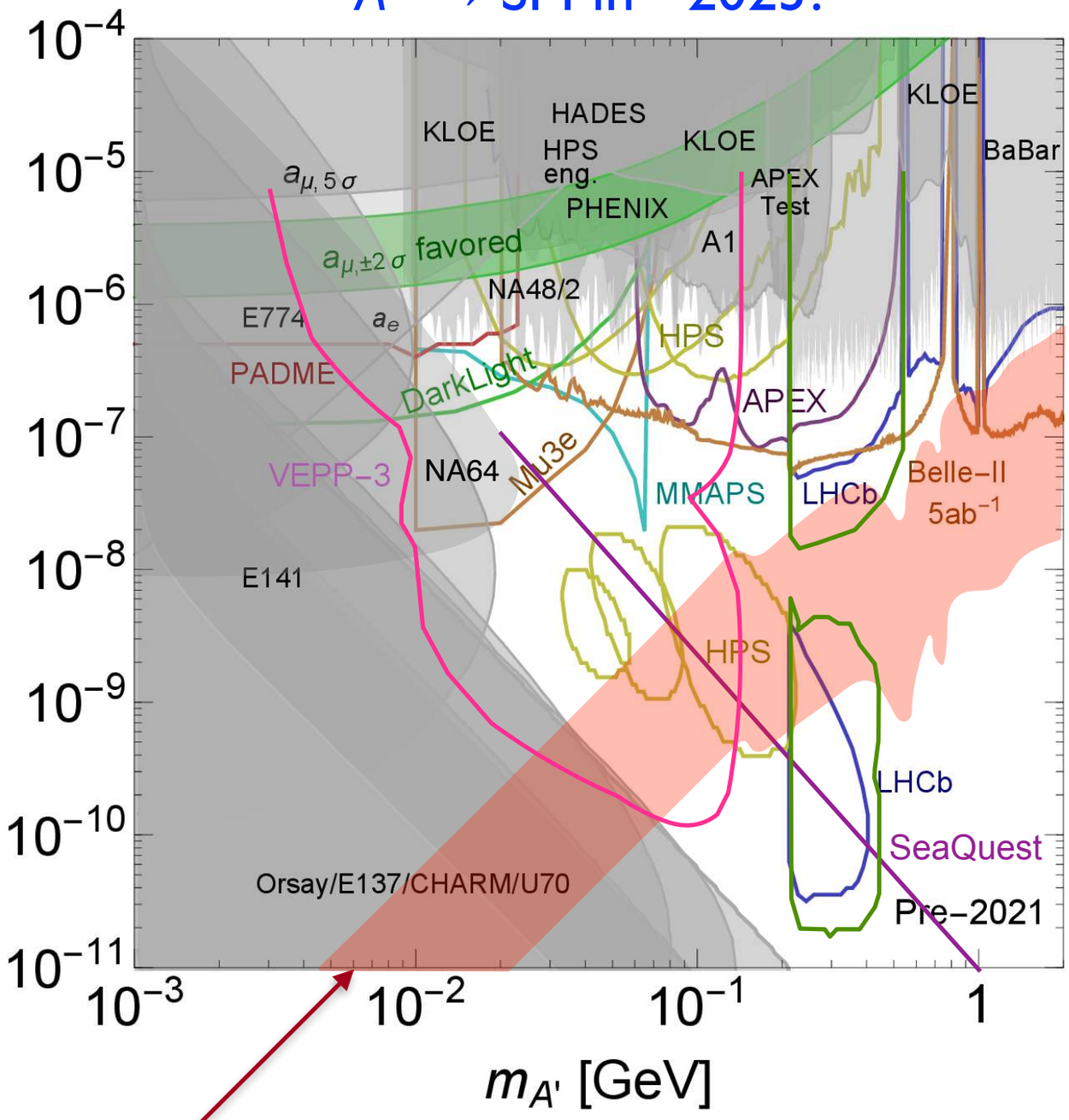
$A' \rightarrow$ SM in ~2023?



thermal targets

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Summary

Inspired by exciting new ideas in Dark Matter, HPS has grown from grassroots into a mature experiment with the opportunity to explore highly motivated parameter space.

After successful test and engineering runs, HPS is on the verge of collecting its first large dataset with an upgraded detector, roughly 6 years after being approved.

As a training ground for young physicists, small experiments like HPS are excellent; turning talented students into physicists with exceptionally broad skill sets.

Although HPS is a small experiment with a simple signature, there is much to do for a small collaboration to collect, process, and analyze the data, where extreme statistics and unusual kinematics require the mastery of arcane details to achieve the desired precision.

Additional postdocs who are strong analysts, and students to work with and learn from them, would be particularly valuable in converting DOE investment in HPS into results.

Future physics runs, at lower or higher beam energy, can continue to produce important physics results into the 2020s, and will be requested by the experiment at JLab.