

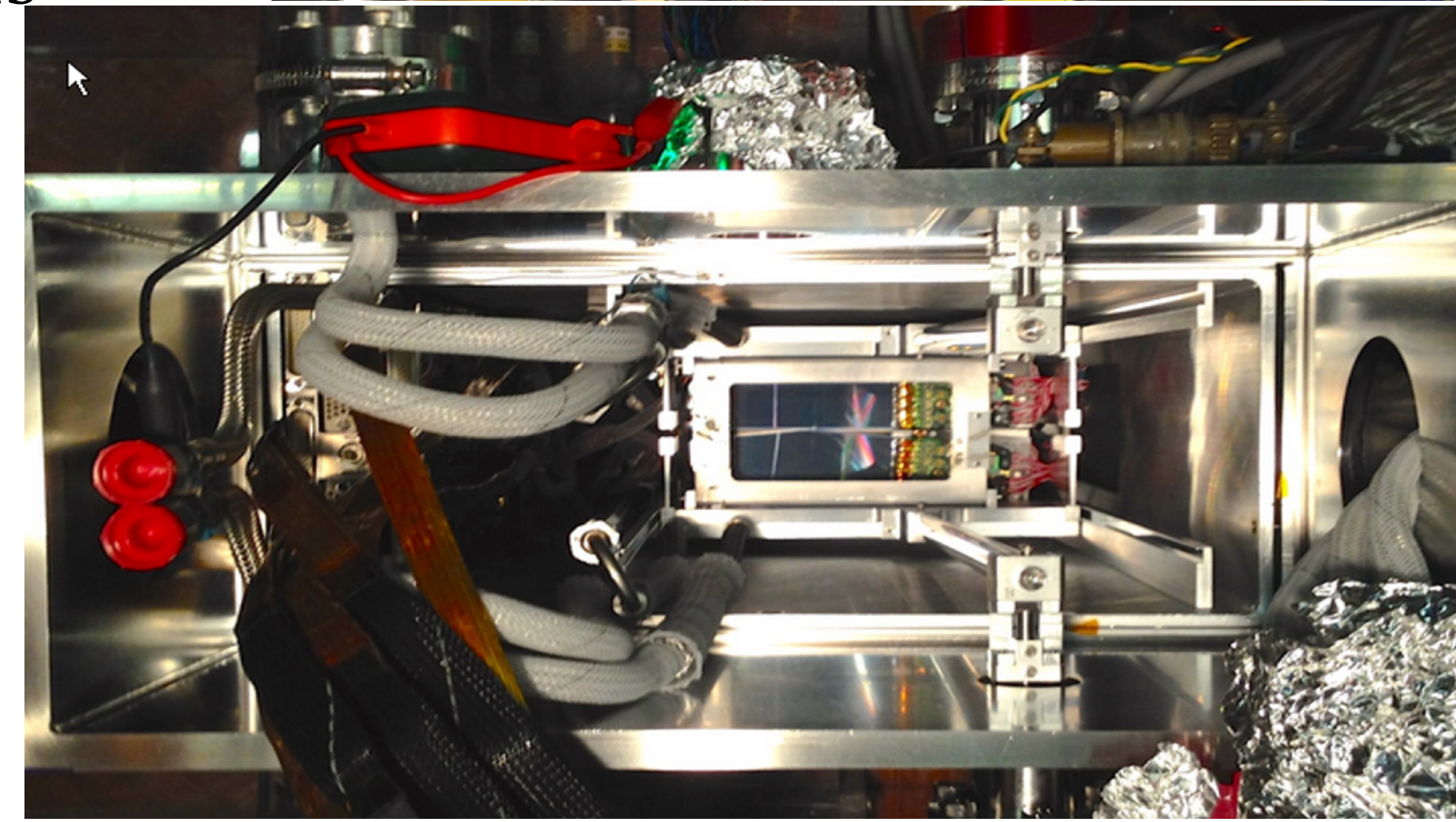
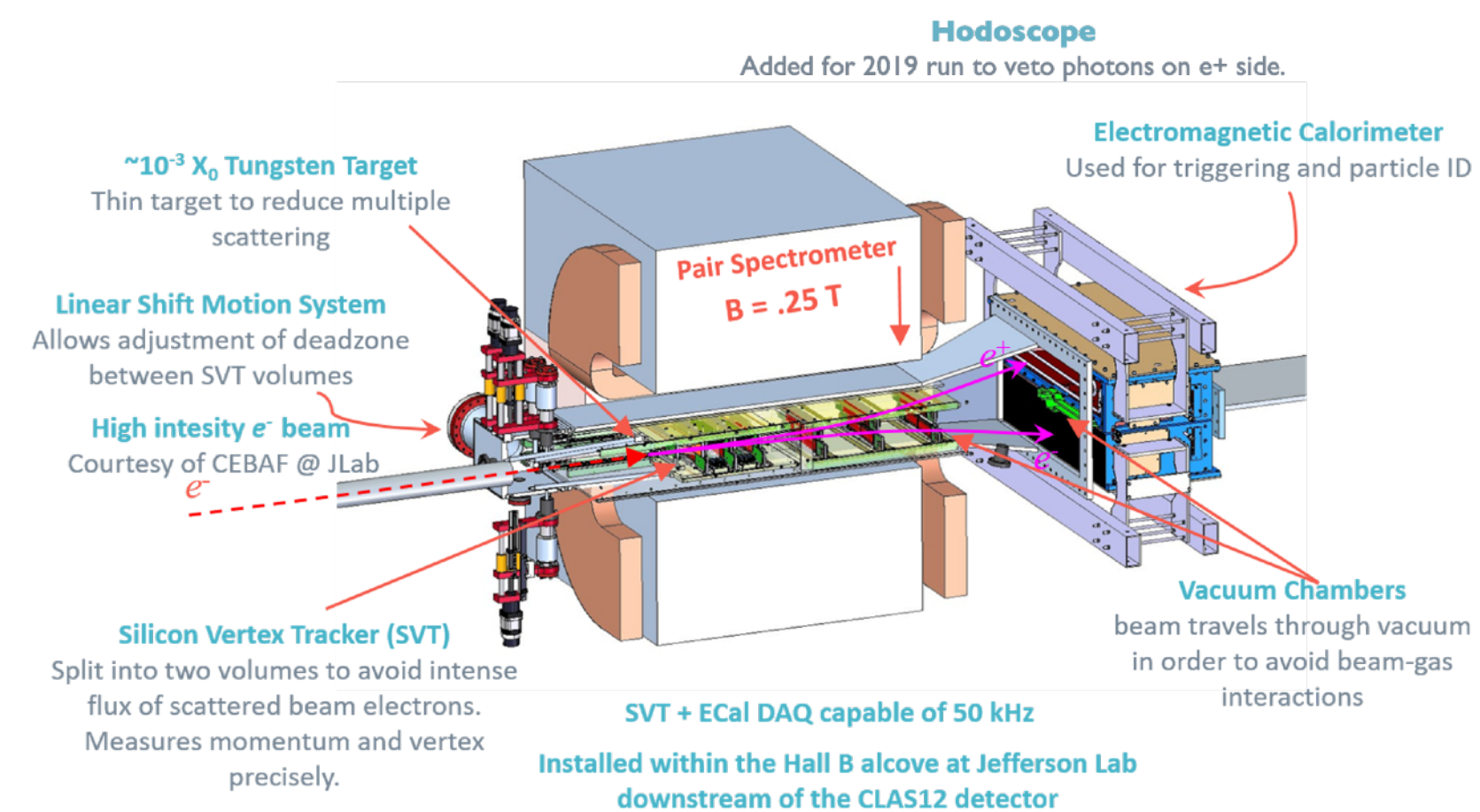
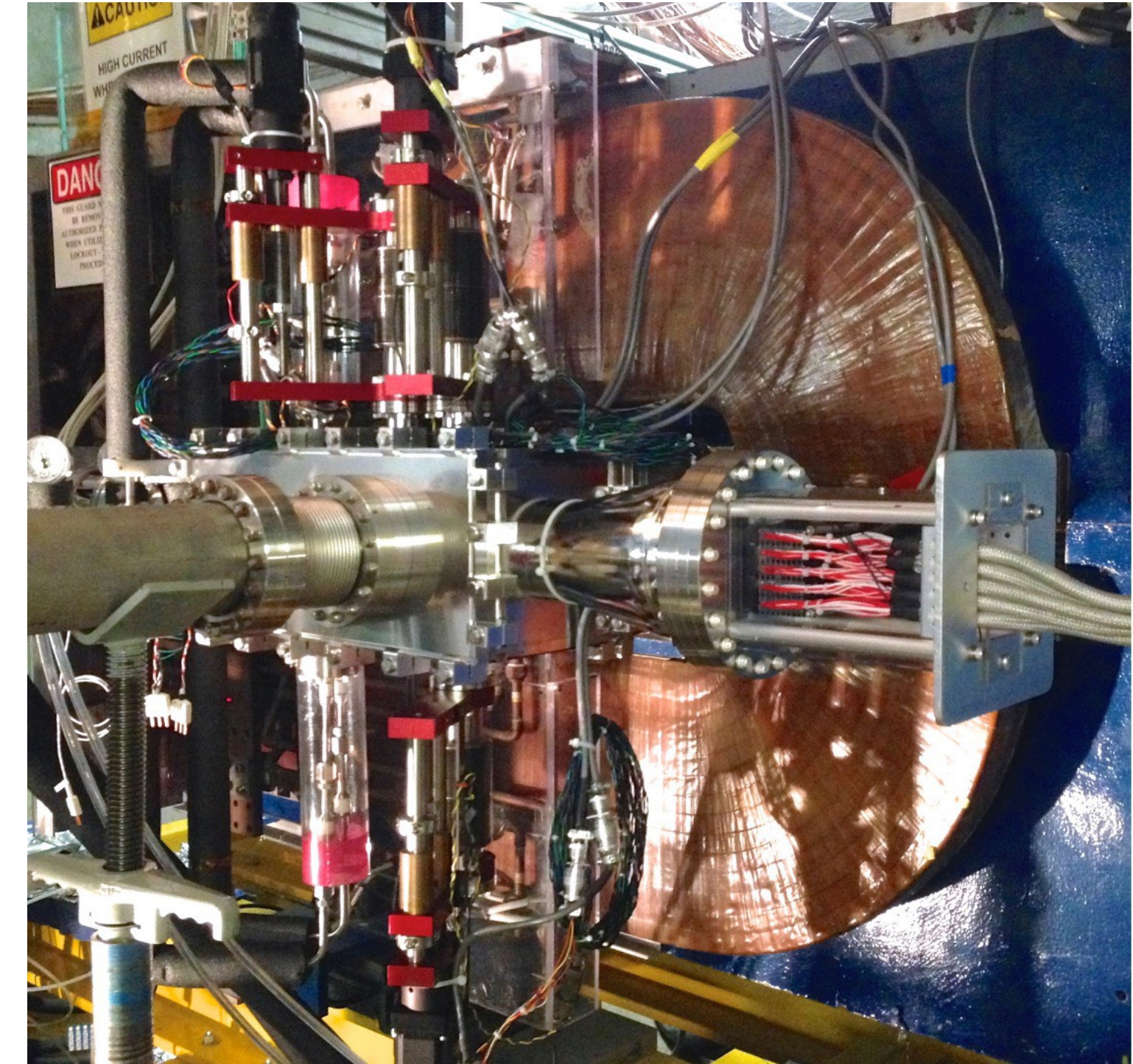
HPS Overview & Plans

Spring 2024 Collaboration Meeting

Maurik Holtrop, June 3, 2024

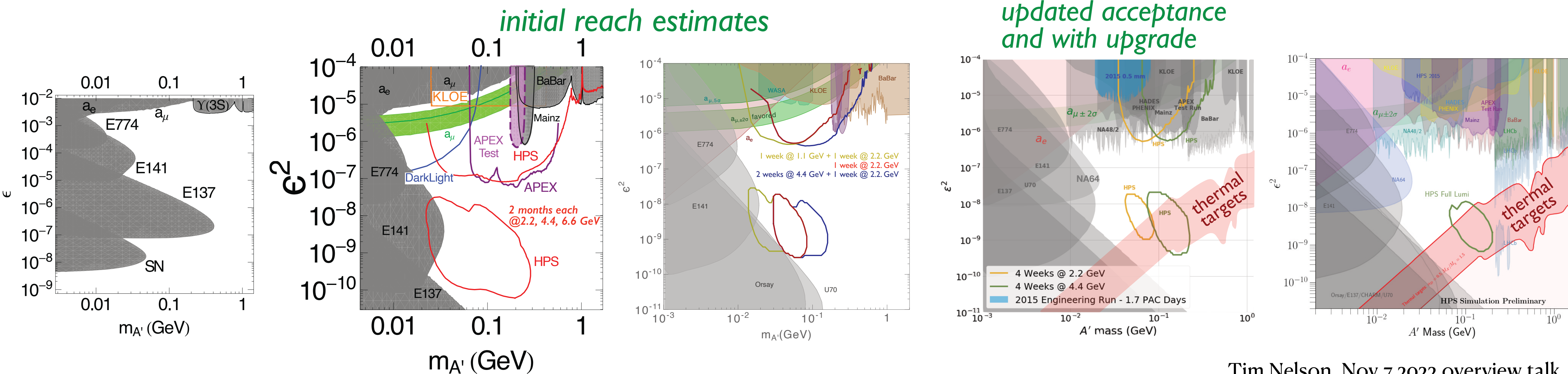
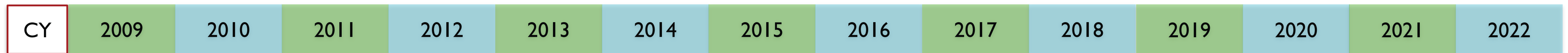
Status of HPS & the Collaboration

- This is the “overview talk”, but we probably don’t really need one.
 - Nearly all of the attendees to this meeting are “regulars”, who regularly attend the Tuesday and Wednesday meetings.
 - We skipped the overview talk the last 2 collaboration meetings.
- Preparing I noted that:
 - Wednesday meetings usually do not post slides, we should.
 - Tuesday meetings post slides, but often slides are missing.
 - Your presentations are a way to document your work. Post your slides!
- Collaboration meetings are great for the discussions we have. I hope that we can have some good, productive, constructive discussions this meeting.



HPS A' search

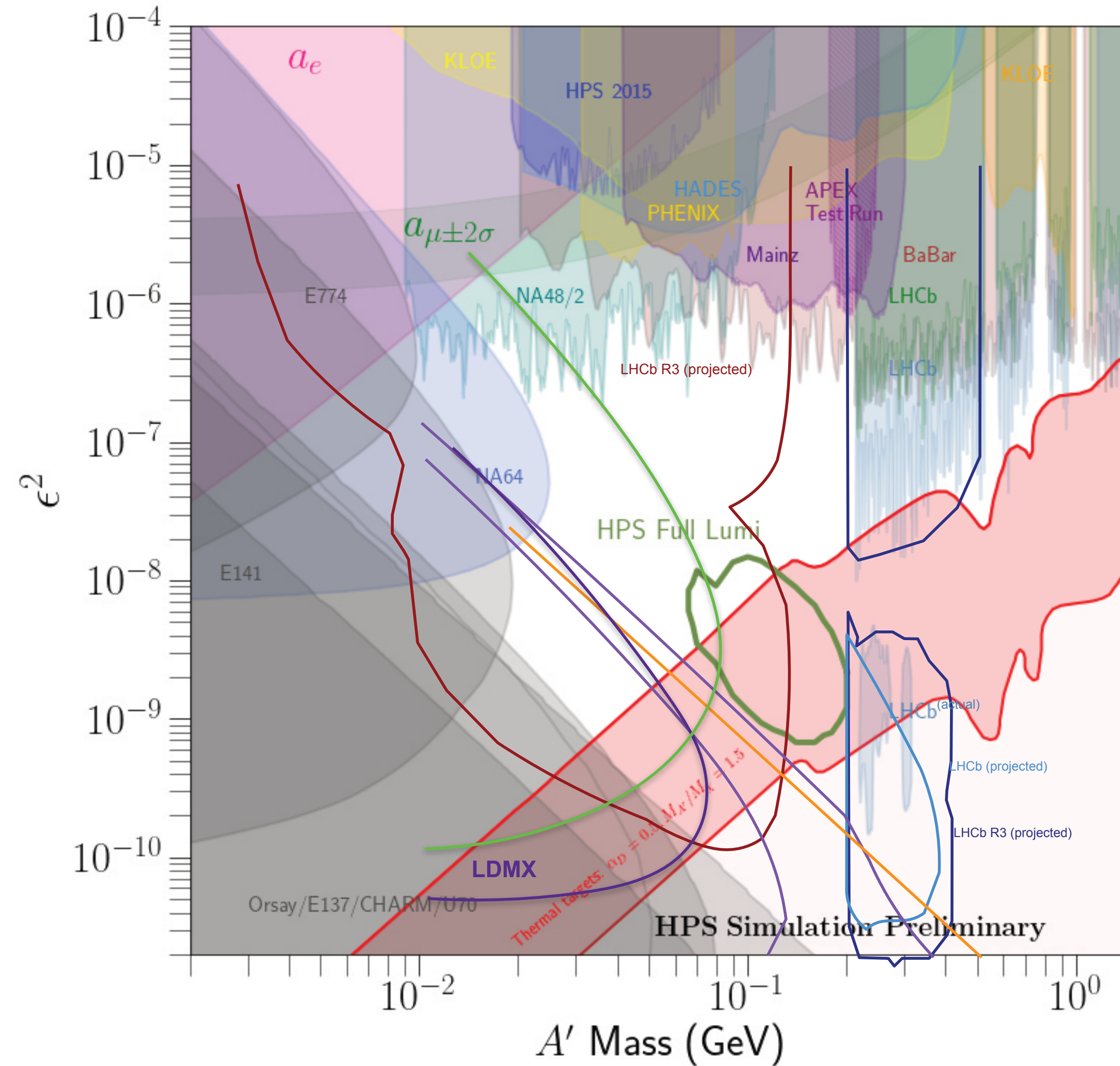
- The evolution of the reach estimates shows how this is tricky business.
- Other collaborations (LHCb, Atlas) had also made optimistic predictions (i.e. cover nearly all the parameter space).
- HPS still has a very interesting and unique contribution to make to the A' searches.



From Tim's talk

- Not to be dismissed, but lots of experiments have promised to cover large regions before.
- It is harder than it seems for them too!
- But the competition is real.

From European Strategy Update – arXiv:1910.11775



Collaboration Membership, 2024

- Membership list updated for the 2024 Jeopardy update document.
 - Need to update the Confluence page membership.
- 58 current members (was 75 for the 2016 run)
- 17 institutions, 7 US, 7 Italy, 1 France, 1 Armenia, 1 UK
 - Some junior members left for other positions.
 - Some groups left due to the funding tension: HEP - NP.
 - Some retirements.
 - We also gained some new members, and hopefully will recruit some more in the near future.

Update on the Heavy Photon Search Experiment

C. Bravo, P. Butti, C. Field, S. Gaiser, M. Graham, R. Herbst, J. Jaros, T. Nelson^{a,b}, E. Peets, B. Reese, P. Schuster, N. Toro

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Stanford University, Stanford, CA 94305

V. Fadeyev, R. Johnson, A. Spellman

University of California, Santa Cruz, CA 95064

P. Achenbach, N. Baltzell, S. Boyarinov, T. Cao, C. Cuevas, A. Deur, R. De Vita, H. Egiyan, V. Kubarovskiy, R. Paremuzyan, B. Raydo, S. Stepanyan^a, M. Ungaro, H. Szumila-Vance, B. Wojtsekhowski

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University of New Hampshire, Department of Physics, Durham, NH 03824

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Yerevan Physics Institute, 375036 Yerevan, Armenia

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S. Bueltmann

Old Dominion University, Norfolk, Virginia 23529

M. Bondi, M. De Napoli, N. Randazzo

Istituto Nazionale di Fisica Nucleare, Sezione di Catania, Italy

M. Carpinelli

Università di Milano Bicocca, Dipartimento di Fisica e INFN, 20126 Milano MI, Italy

D. D'Urso, V. Sipala

Università di Sassari and Istituto Nazionale di Fisica Nucleare, 07100 Sassari, Italy

G. Simi

Dipartimento di Fisica e Astronomia, Università di Padova and Istituto Nazionale di Fisica Nucleare, Sezione di Padova, Padova, Italy

A. D'Angelo

Dipartimento di Fisica dell'Università Tor Vergata, Roma and Istituto Nazionale di Fisica Nucleare, Sezione di Roma-TorVergata, Italy

A. Filippi

Istituto Nazionale di Fisica Nucleare, Sezione di Torino, Torino, Italy

B. McKinnon, D. Sokhan

University of Glasgow, Glasgow G12 8QQ, United Kingdom

New meeting picture Tuesday at noon.



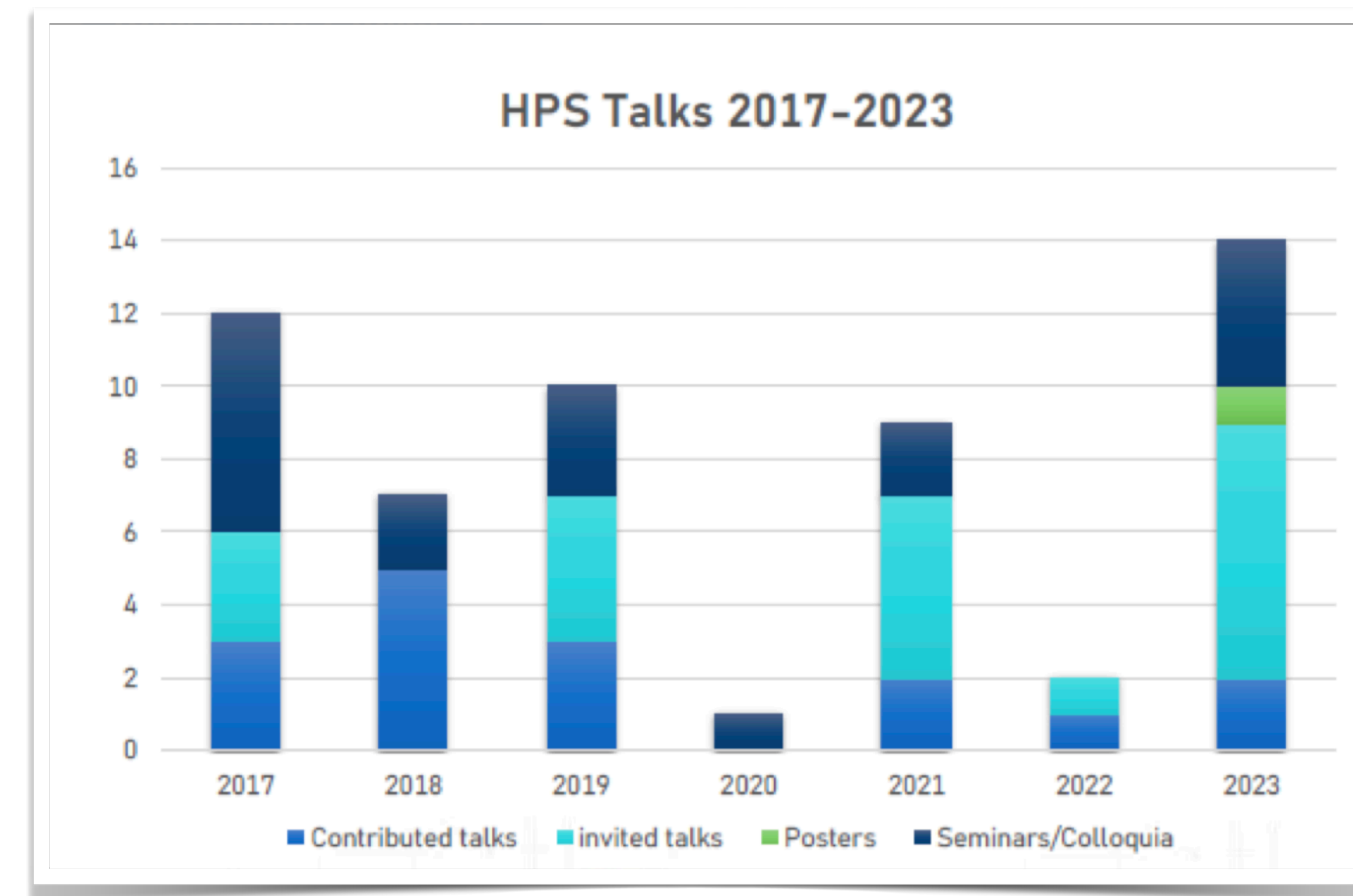
^aCo-spokesperson
^bContact person

Organization

- **Executive committee:** Tim Nelson (Chair, SLAC), Stepan Stepanyan (JLab), Maurik Holtrop (UNH), Cameron Bravo (SLAC), Alessandra Filippi (INFN-Torino), Matt Graham (SLAC), John Jaros (SLAC), and Rafayel Paremuzyan (JLab).
- **Publications and Presentations Committee:** Alessandra Filippi (Chair, INFN-Torino), Andrea Celentano (INFN-Genova), Rouven Essig (Stony Brook), Mathew Graham (SLAC), Robert Johnson (Santa Cruz)
- **Data Analysis Working Group:**
 - Conveners: Matt Graham and Cameron Bravo (SLAC)
 - Production & Processing Managers: Rafayel Paremuzyan (JLab)
 - MC Production: Tongtong Cao (JLab)
- Main meeting is every Wednesday at 11:30 EST, Analysis/Recon/MC/Software is Tuesday noon EST.

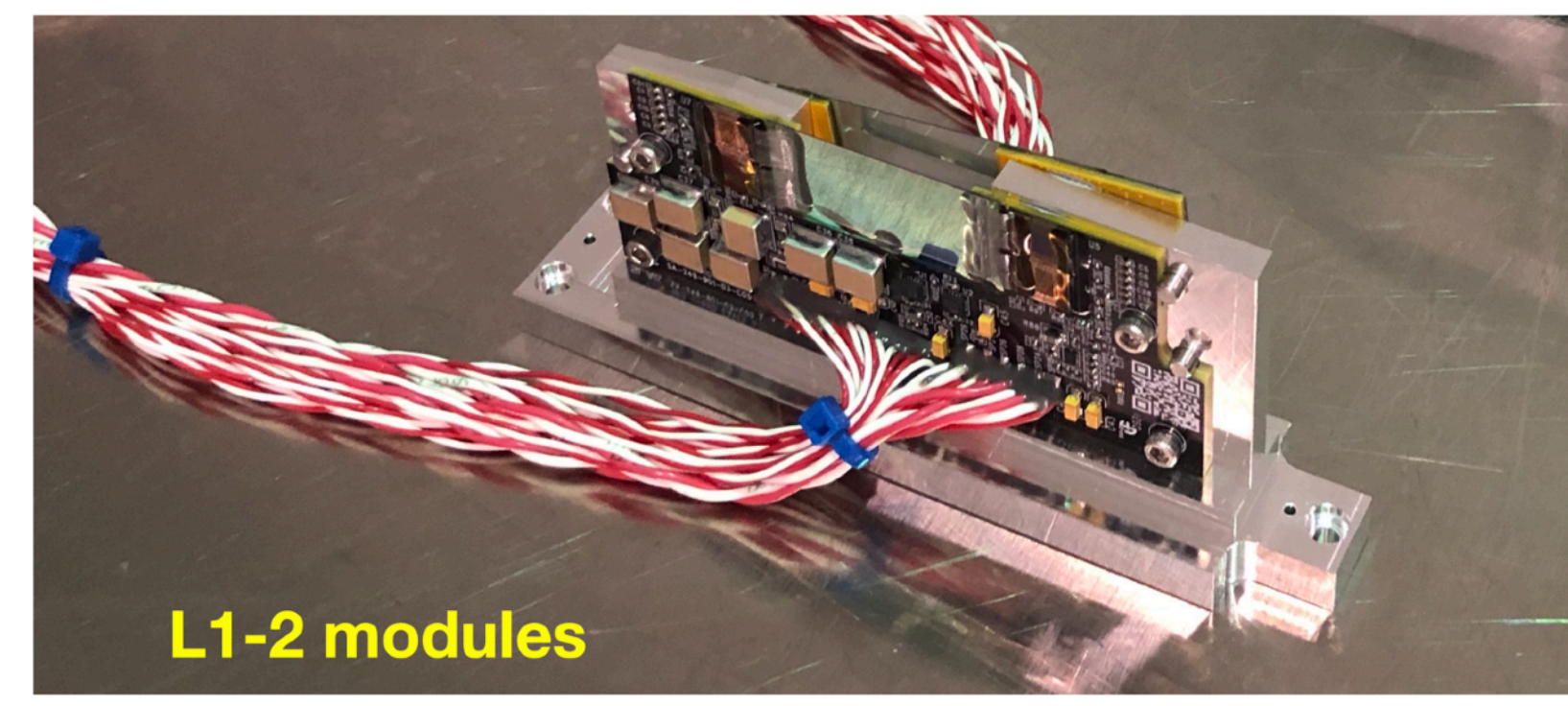
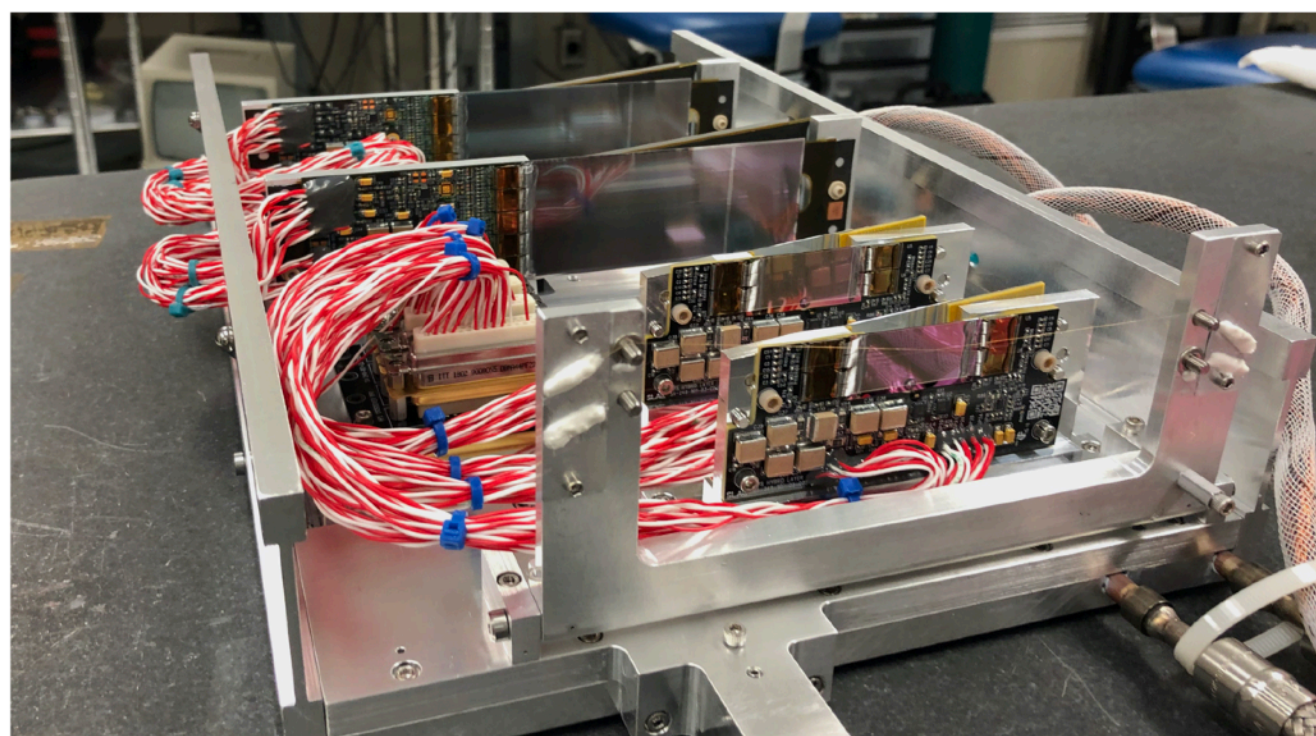
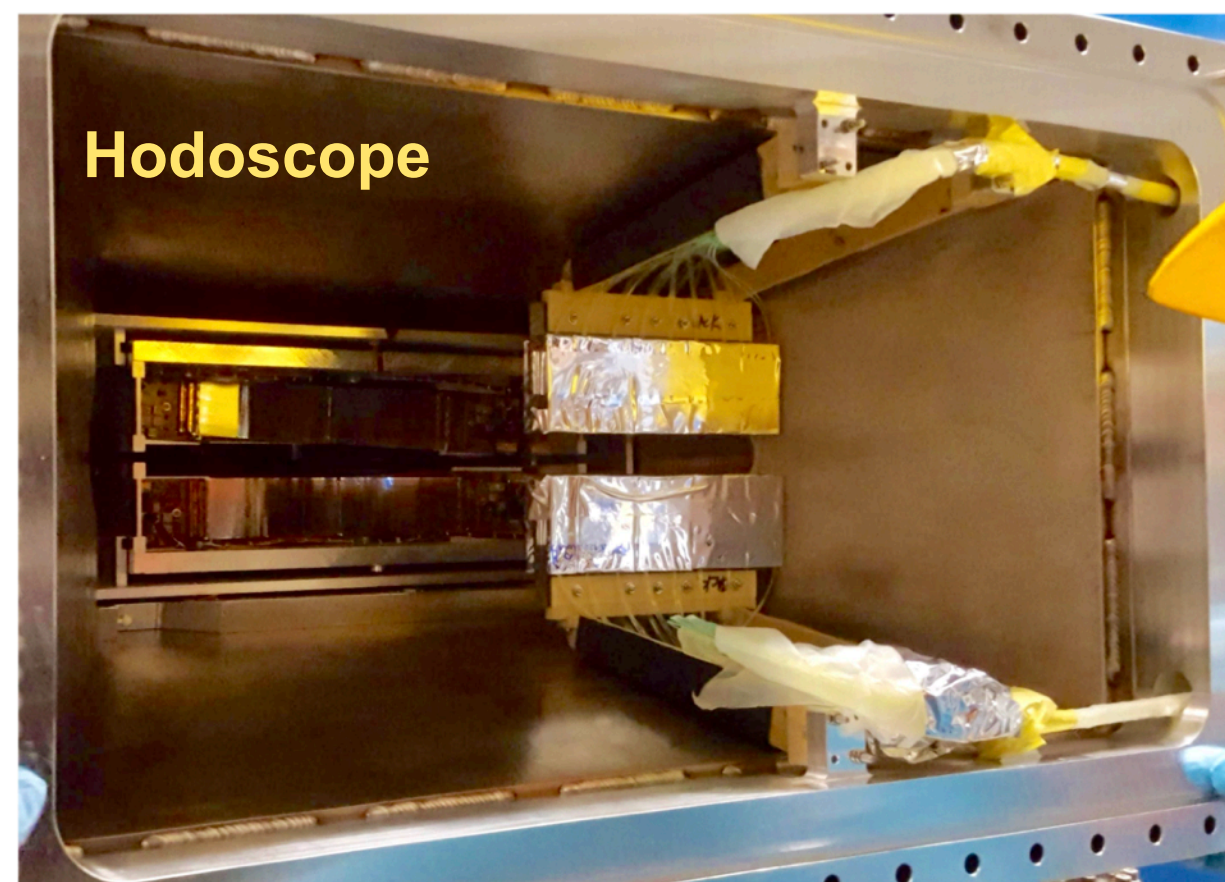
Presentations Committee

- PPC report on Wednesday, 9:15am.
- Really well maintained presentations page on Confluence.
 - List of talks presented.
 - Extensive list of possible conferences.
- The PPC reviews abstracts & presentation slides and any publications.
- Alessandra requests that we all notify the PPC of *any* talk that mentions HPS, even if it is a few slides.



Detector

- Detector overview, DAQ & Tracking status, Wednesday morning.
- The HPS detector has changes quite a bit from the initial concept.
 - The 2019 detector made significant improvements to the reach.
 - Are there additional, cost effective, hardware improvements that would have a big impact for future runs? Or run procedures?
 - Improve mass resolution, high-z background rejection, detector efficiency?
 - Improve alignment (resolution & vertexing), improve ECal/Hodoscope (trigger efficiency, pid)?

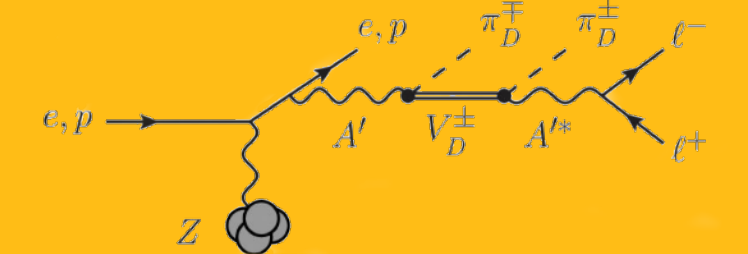


Data

- Engineering run: 2016, ~5.4 days @ 2.3 GeV
 - Our most analyzed dataset!
 - Still relevant, still being (re)analyzed
 - Now at processing pass4kf
- Physics run 2019, ~ 14 days @ 4.55 GeV
- Physics run 2021, ~ 24 days @ 3.74 GeV
- Looking at analyzing as a combined dataset.
 - Challenging alignment issues caused major delay.
 - (Nearly?) ready for pass-1
 - Way, way, way more data than we have looked at until now!
 - This will give other new challenges.
 - What are our strategies for combining the different data sets?

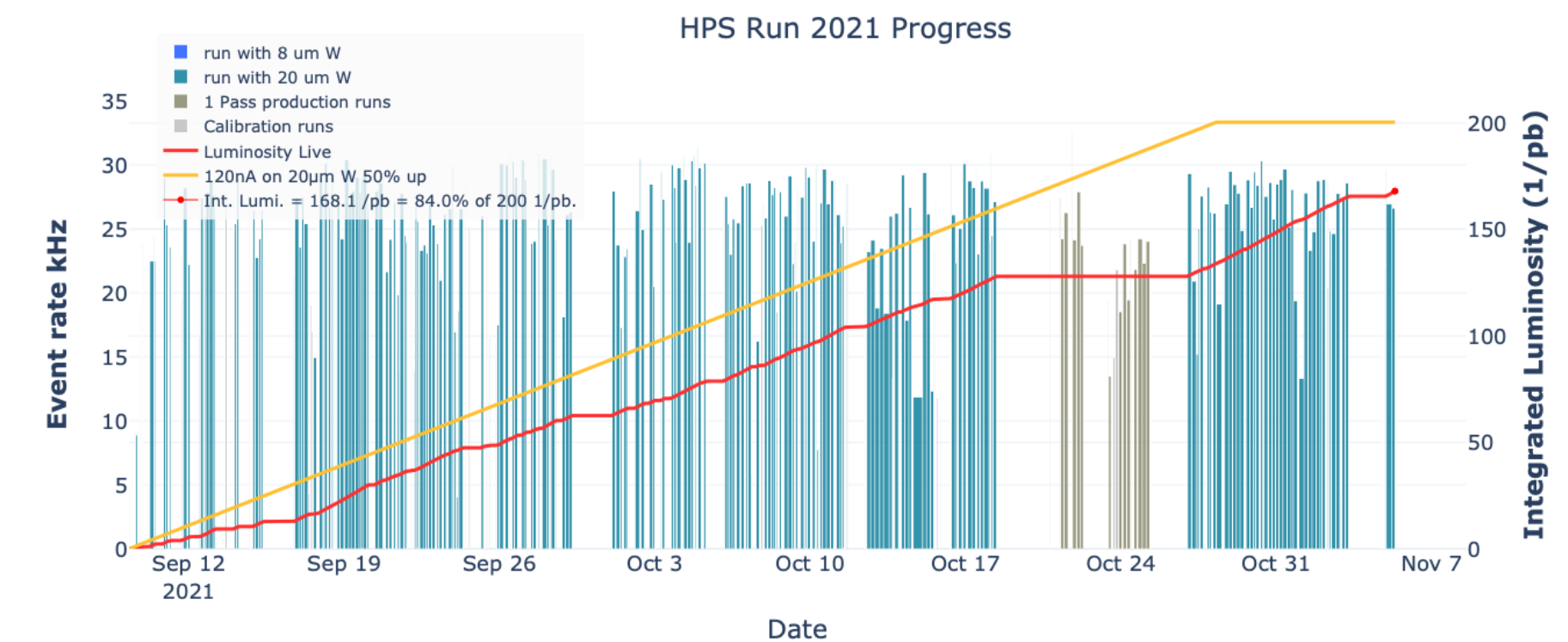
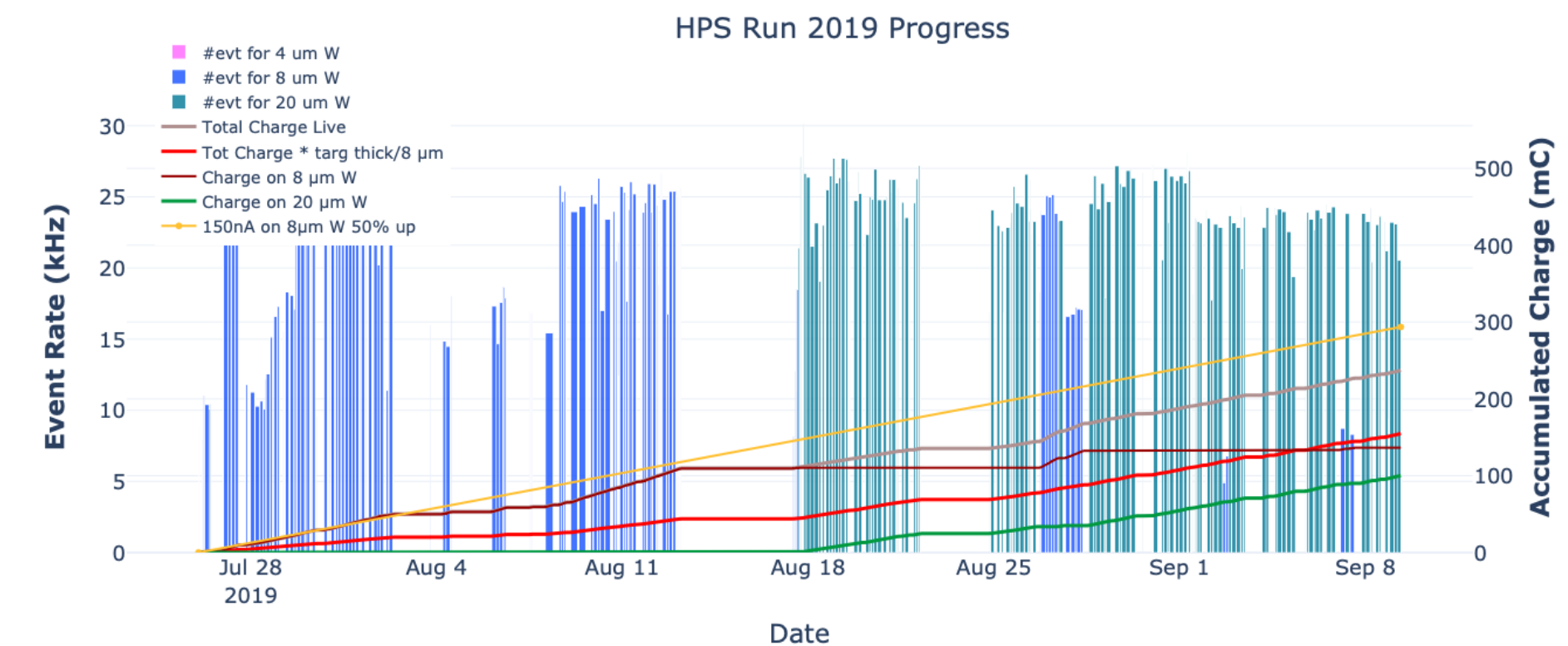
Bump Hunt + Vertexing ✓

SIMPS



Bump Hunt background

Tests - KF, SVT clustering ...



Calibrations & Processing

- **ECal**

- were done a long time ago.
- Now revisiting some details, see Lewis's talk Tuesday.

- **SVT**

- Hit reconstruction being revisited, see talk by Rory, Tuesday

- **Alignment**

- See presentations on Tuesday by Cameron and PF.
- Aligning the detector has been a very major effort.
 - Documentation, best practices?
- How can we do this better/faster next time?
 - Are there calibration measurements that could help?
 - The straight track was never successful, but do we know why?

- **Data Processing**

- We'll start with a 1% pass, then 10%.
- A lot of data, so we need to get more efficient.
 - Reduce the SLCIO file size.
 - Fewer passes
 - (code efficiency?)

Tuesday afternoon presentations.

1:30 PM → 3:00 PM Reconstructon and data processing

1:30 PM

2019: alignment and remaining issues

Speakers: Cameron Bravo (SLAC), Pierfrancesco Butti (SLAC)

2:00 PM

2021: alignment and remaining issues

Speakers: Cameron Bravo (SLAC), Pierfrancesco Butti (SLAC)

2:30 PM

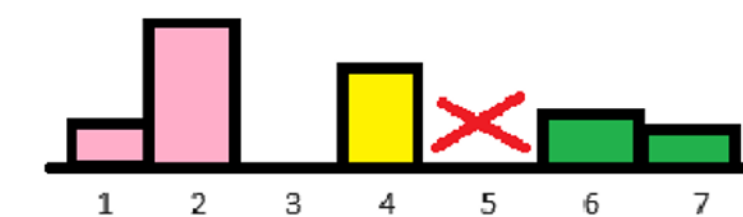
SVT hit reconstruction

Speaker: Rory O'Dwyer (Stanford University)

4:30 PM

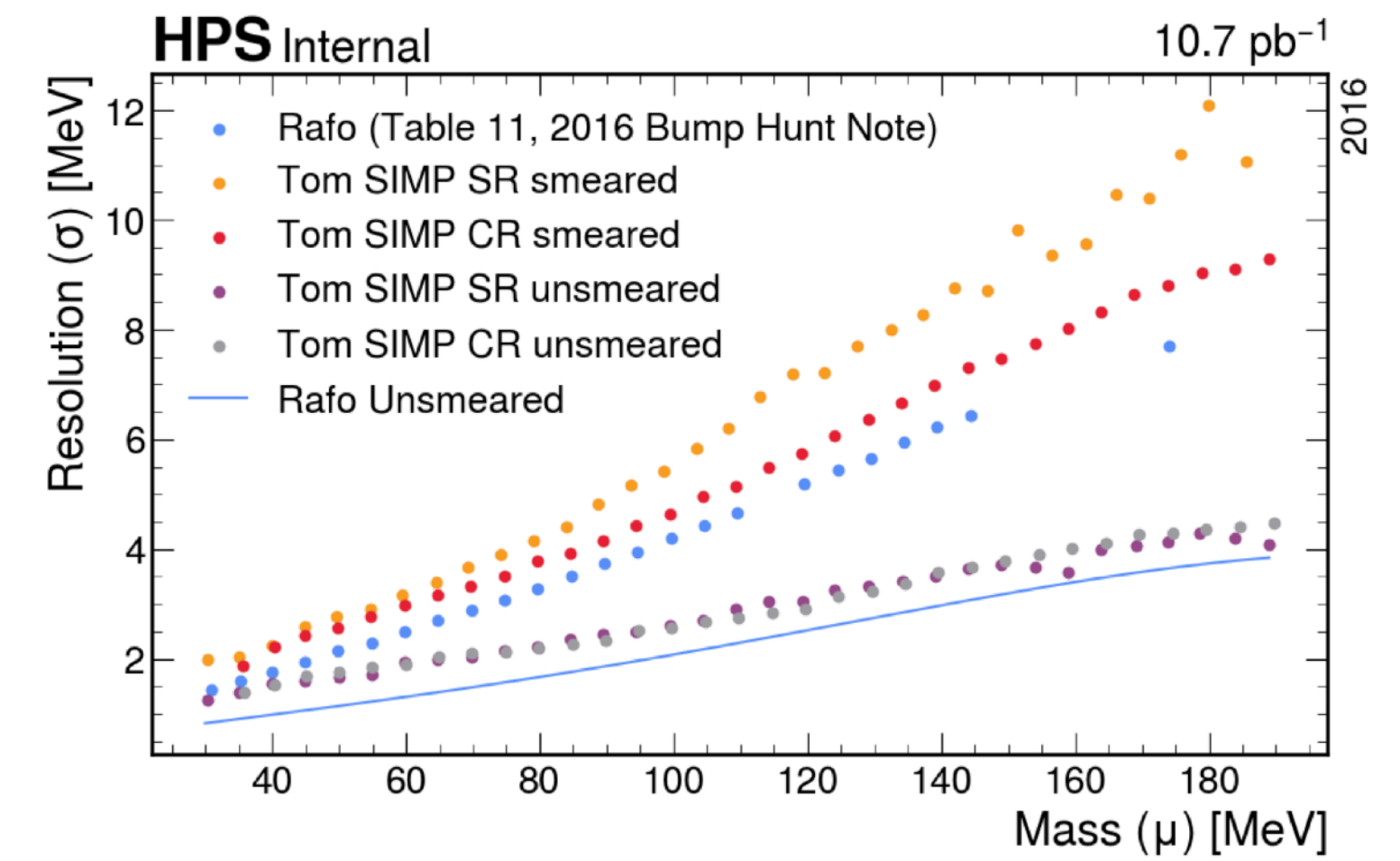
Track extrapolation to EC

Speaker: Lewis Wolf (University of New Hampshire)

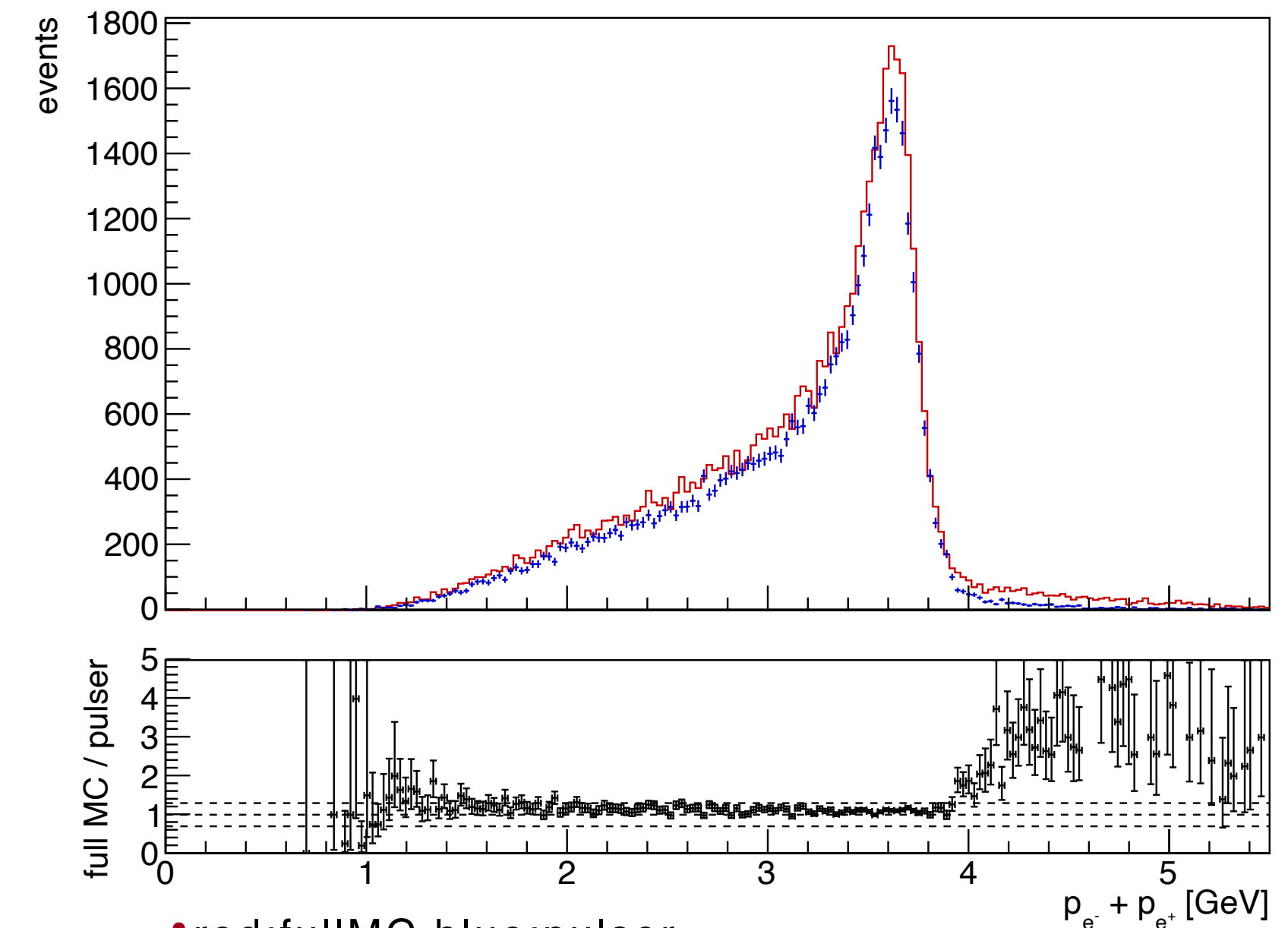


Monte Carlo

- Presentations this meeting:
 - MC overview talk by Tongtong, Tuesday afternoon.
 - New results on validating the pulser overlay for MC by Sarah, Tuesday afternoon.
- MC has been relatively stable for some time.
 - We are still using SLIC, the more flexible hps-mc was abandoned in favor of the LDMX-mc, which was abandoned too.
 - SLIC still crashes at the end, and sometimes on the middle of the run. Code is not as flexible as it should be.
- Recent Improvements:
 - Pulser background overlay, Sarah
 - Revisit momentum smearing in 2016 data, Tom (3/26, 4/2), PF, Alic
 - MC based mis-alignment studies, Sarah
 - Hit killing, Matt G.
 - See Tongtong's presentation for details of improvements.
- Correspondence of MC to data
 - Has been a concern for a while, and effort is made to make improvements.
 - Really important!
 - For confidence in the detector, analysis and the results.
 - Higher energy data has no Møllers to check resolution.
 - Using MC to train ML requires good correspondence.



Tom Eichlersmith 4/2/24



• red:fullMC,blue:pulser

• constant ratio → pulser is missing same fraction of events

Sarah Gaiser 5/14/24

Monte Carlo

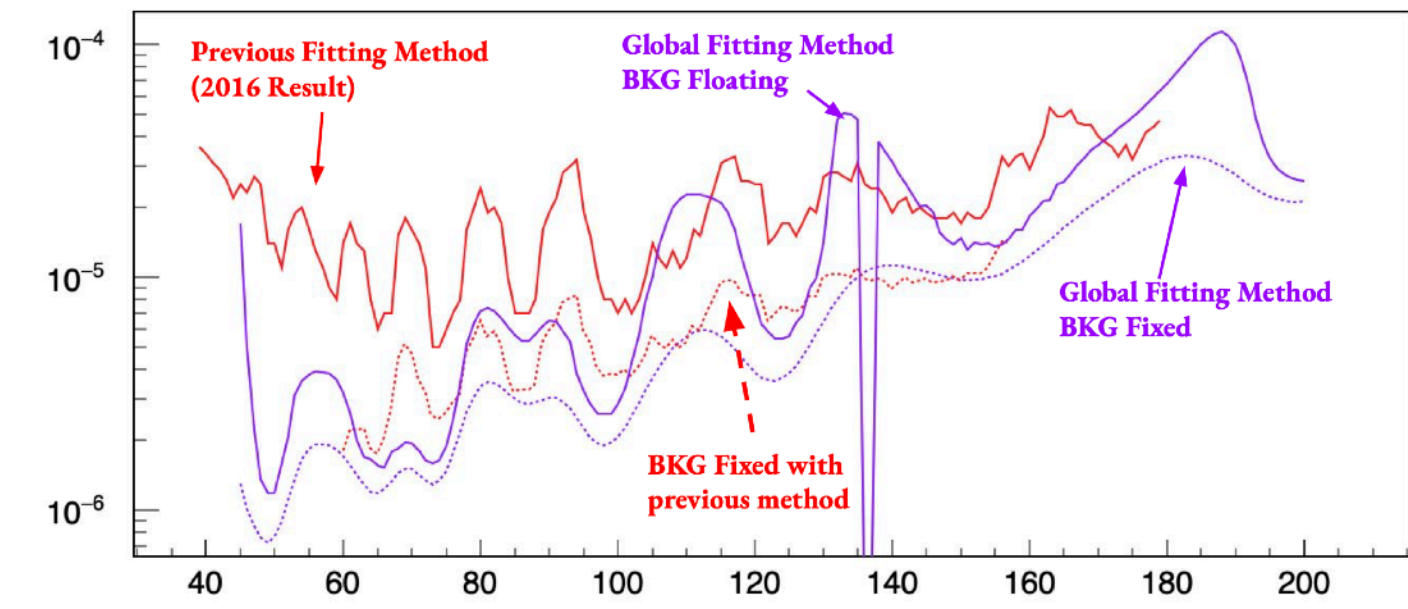
- The 19&21 data sets will need large MC production.

This brings up some old worries:

- Should we re-consider using OSG? i.e. can the JLab farm accommodate our need? (Nathan's talk tomorrow.)
- SLIC is slow, but so are the spacing and readout steps of MC.
 - Is this something we should revisit too? (Human time and effort is often more expensive than CPU cycles.)
- What are the actual numbers for the realistic scenario for 19&21 MC production?
- We still do not have functioning WAB biassing (or do we? Are we using this? Do we actually need it?)

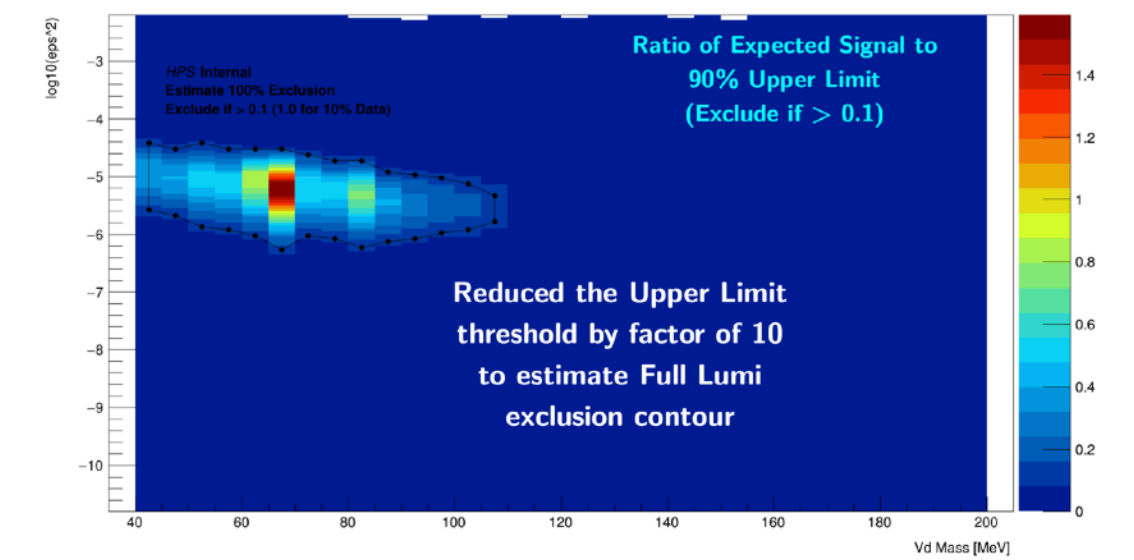
Analysis

- Talks this meeting:
 - Analysis overview, and hit killing talk, by Matt on Tuesday morning.
 - Bump hunting background revisited, by Emrys, Tuesday morning.
 - SIMPS analysis update by Alic, Tuesday morning.
 - High Psum study by Tom, Tuesday morning.
- Analysis mini-workshop Wednesday afternoon, 3pm - 5pm.
- Really need to get going on the 2019 and 2021 data sets.
 - We may (will?) encounter unexpected challenges.
 - Already seeing this in alignment.
 - We will need to get results out quicker.
- We have also learned a lot already about the data, how to process it, and how to analyze it.

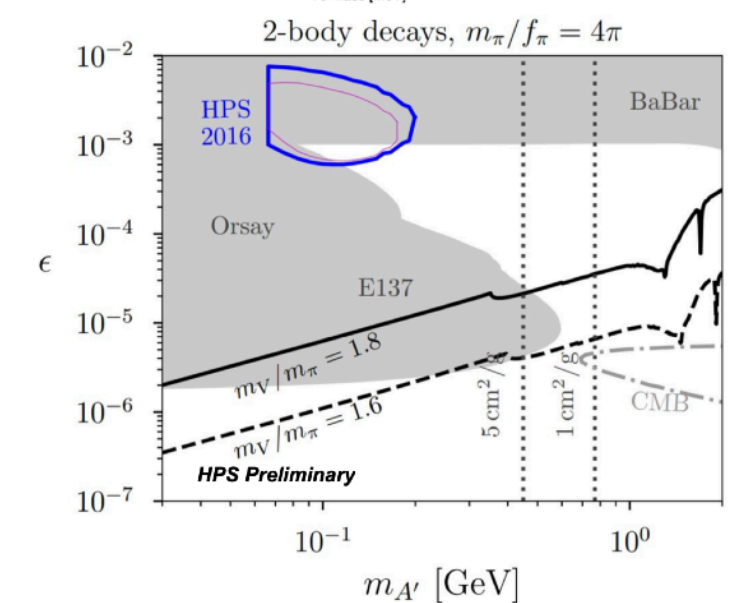


Emrys Peets, 2/6/24

Full Lumi Estimate – 90% Exclusion Contour

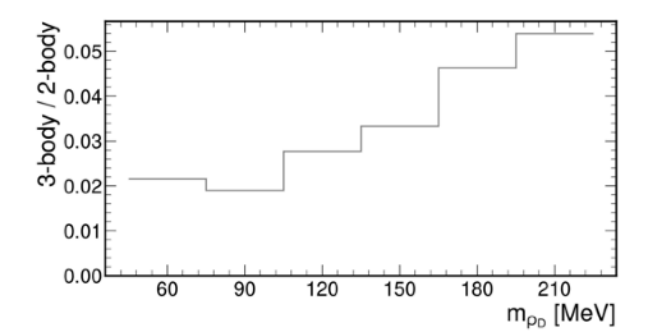
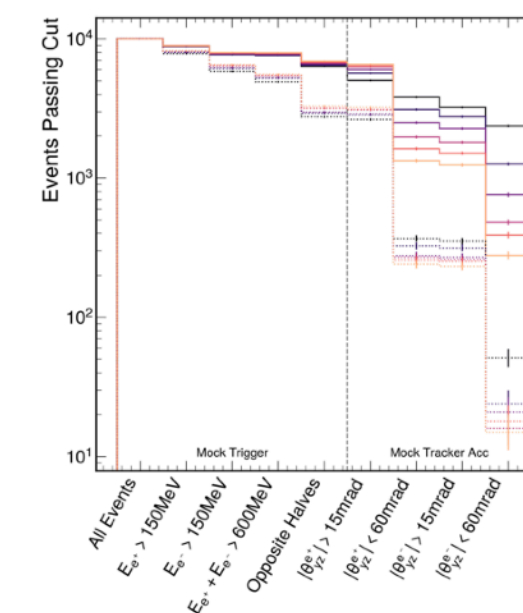


Alic Spellman
3/5/24



Using generator-level information, apply some basic cuts to mimic the 2016 pair-wise trigger (left) and rough tracker acceptance (right).

- Lose a factor of ~ 3 at the trigger and ~ 20 at tracker acceptance
- Similar to what was seen with iDM



Tom Eichlersmith, 12/12/23

Analysis output: Papers

2016 Engineering Run:

Searching for prompt and long-lived dark photons in electroproduced e^+e^- pairs with the heavy photon search experiment at JLab

P.H. Adrian et al. Phys. Rev. D 108, 012015 – Published 21 July 2023

2015 Engineering Run:

Search for a dark photon in electroproduced e^+e^- pairs with the Heavy Photon Search experiment at JLab

P.H. Adrian et al. (Heavy Photon Search Collaboration) Phys. Rev. D 98, 091101(R) – Published 12 November 2018

Detector Papers:

The Heavy Photon Search test detector, NIM A 777 (2015) 91–101

The HPS electromagnetic calorimeter, NIM A 854 (2017) 89-99

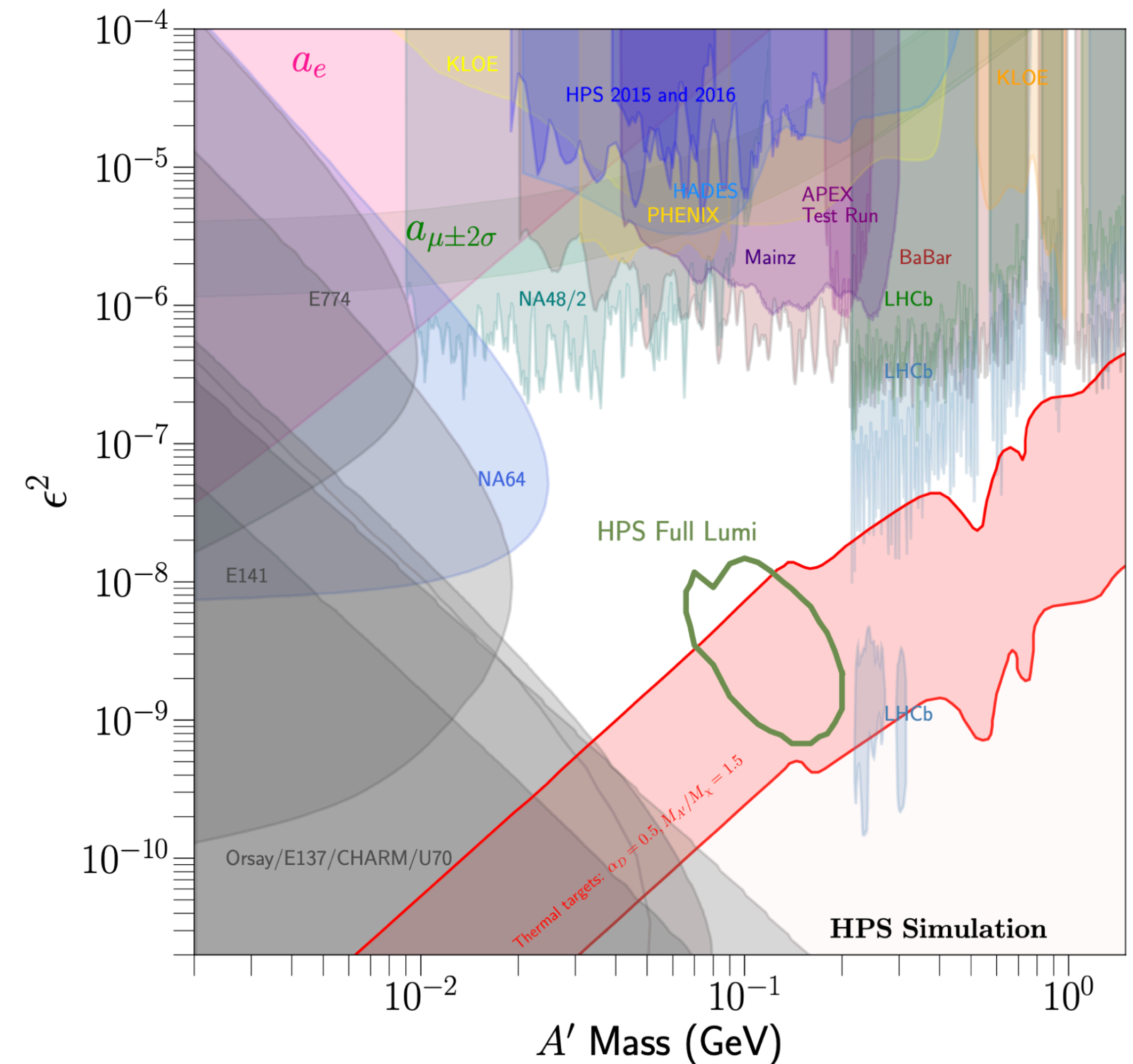
The Heavy Photon Search beamline and its performance, NIM A 859 (2017) 69-75

Design and performance of silicon strip sensors with slim edges for HPS experiment. NIM A 969 (2020) 163991

- Looking forward to:
 - SIMPs paper on 2016 data set.
 - Vertexing & bump-hunt on 2019 & 2021 data sets - One paper or two, (more)?
 - SIMPs (& iDM?) on 2019 & 2021 data sets.
 - Other physics?
- Timelines, to-do lists? - looks outdated on confluence. Are these useful?

Jeopardy 2024 & future running.

- Document submitted to PAC on April 30th.
- Presentation by Tim on Thursday, July 11, 9 am.
- We hope to keep the remaining 105 PAC days.
 - ~ 63 days of running with 2-pass, ~ 4 GeV beam
 - ~ 42 days of running with 1-pass, ~ 2 GeV beam.
- Jlab will have reduced running due to budget shortfall \Rightarrow next run in 2026(?), (63 PAC days?)
 - Long run, will be demanding on collaboration.
 - Long run, will be demanding on the equipment.
 - STV repairs, update, Tim, Wednesday.



Discussion

- No conclusions here, just lots of questions.

