Weekly Meeting

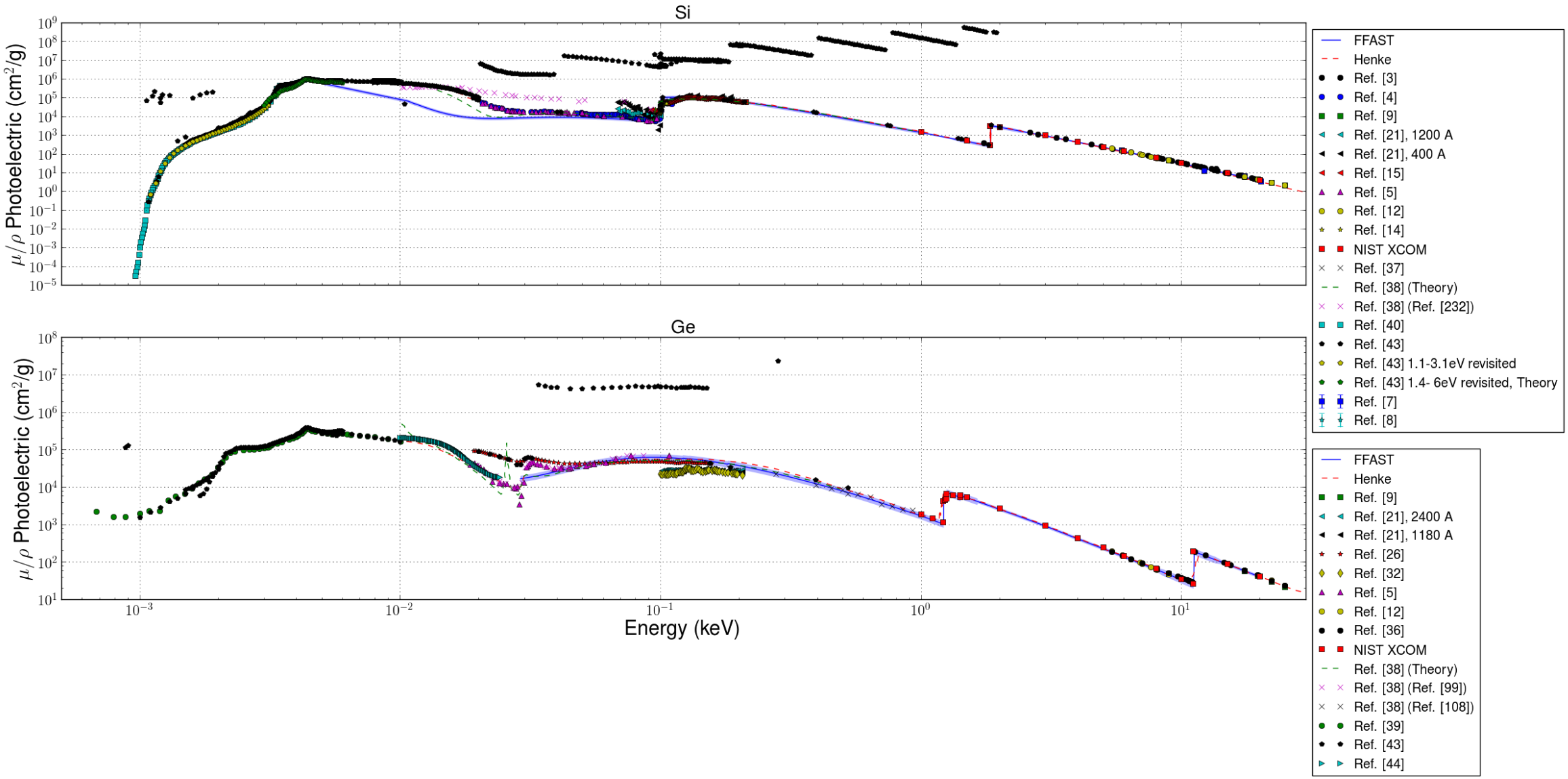
Jan 11th 2018

Trip to Africa

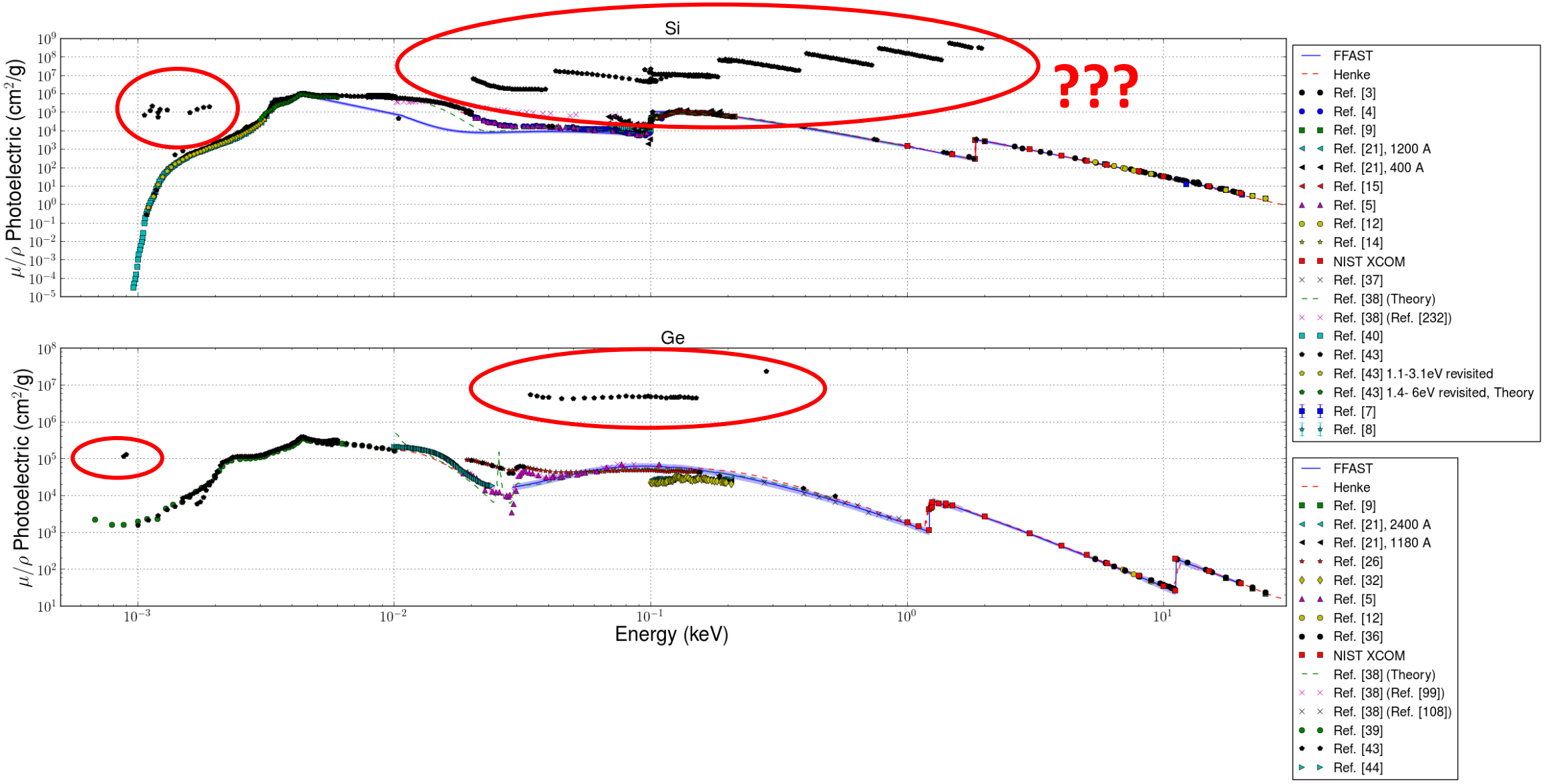
Dark Photon

- Before holiday break, able to obtain more experimental data to cover the entire ROI
  - Without temperature dependence

Dark Photon


Si
Ge
μ/ρ Photoelectric (cm^2/g)
Energy (keV)
FFAST
Henke
Ref. [3]
Ref. [4]
Ref. [9]
Ref. [21], 1200 A
Ref. [21], 400 A
Ref. [15]
Ref. [5]
Ref. [12]
Ref. [14]
NIST XCOM
Ref. [37]
Ref. [38] (Theory)
Ref. [38] (Ref. [232])
Ref. [40]
Ref. [43]
Ref. [43] 1.1-3.1eV revisited
Ref. [43] 1.4- 6eV revisited, Theory
Ref. [7]
Ref. [8]
FFAST
Henke
Ref. [9]
Ref. [21], 2400 A
Ref. [21], 1180 A
Ref. [26]
Ref. [32]
Ref. [5]
Ref. [12]
Ref. [36]
NIST XCOM
Ref. [38] (Theory)
Ref. [38] (Ref. [99])
Ref. [38] (Ref. [108])
Ref. [39]
Ref. [43]
Ref. [44]

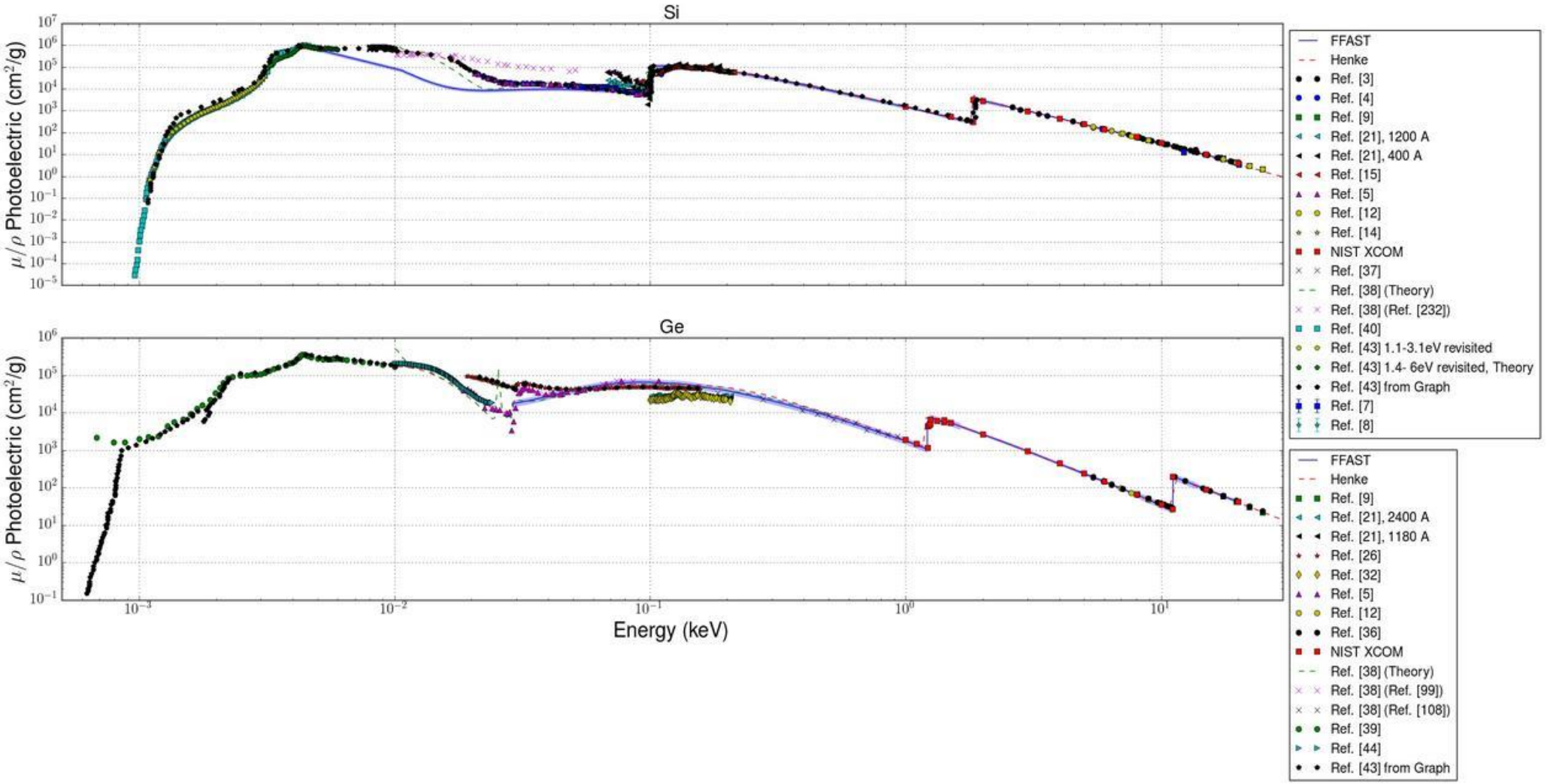
Dark Photon


Si
???
Ge
μ/ρ Photoelectric (cm^2/g)
Energy (keV)
FFAST
Henke
Ref. [3]
Ref. [4]
Ref. [9]
Ref. [21], 1200 A
Ref. [21], 400 A
Ref. [15]
Ref. [5]
Ref. [12]
Ref. [14]
NIST XCOM
Ref. [37]
Ref. [38] (Theory)
Ref. [38] (Ref. [232])
Ref. [40]
Ref. [43]
Ref. [43] 1.1-3.1eV revisited
Ref. [43] 1.4- 6eV revisited, Theory
Ref. [7]
Ref. [8]
FFAST
Henke
Ref. [9]
Ref. [21], 2400 A
Ref. [21], 1180 A
Ref. [26]
Ref. [32]
Ref. [5]
Ref. [12]
Ref. [36]
NIST XCOM
Ref. [38] (Theory)
Ref. [38] (Ref. [99])
Ref. [38] (Ref. [108])
Ref. [39]
Ref. [43]
Ref. [44]

Dark Photon

- These seemingly out-of-place data points are from the Handbook of Optical Constants of Solids, where the data is taken from a data table
- However, this source also provides a plot of their data…I redid my plots using data extracted from the plots instead of data tables:

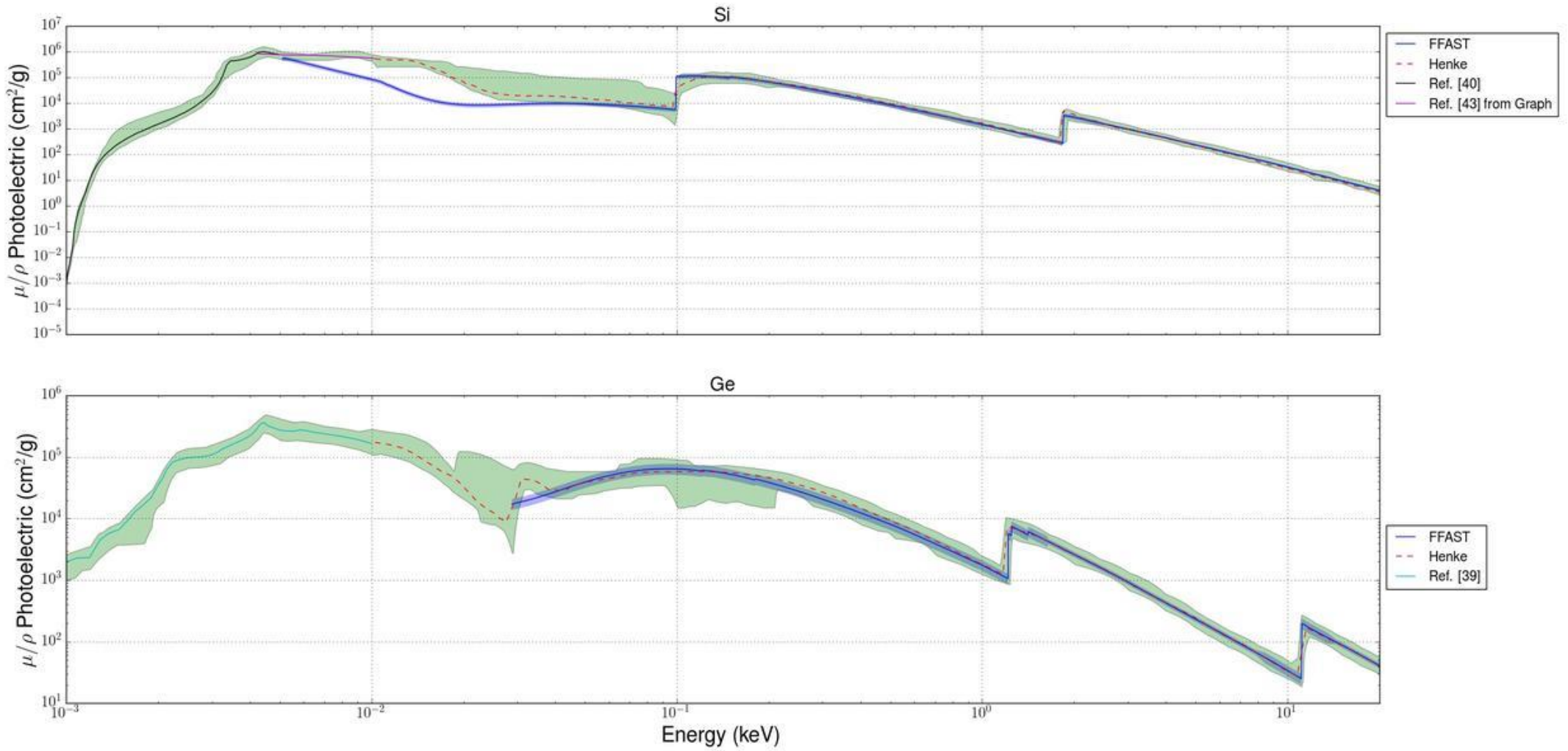
Dark Photon


Si
Ge
μ/ρ Photoelectric (cm^2/g)
Energy (keV)
FFAST
Henke
Ref. [3]
Ref. [4]
Ref. [9]
Ref. [21], 1200 A
Ref. [21], 400 A
Ref. [15]
Ref. [5]
Ref. [12]
Ref. [14]
NIST XCOM
Ref. [37]
Ref. [38] (Theory)
Ref. [38] (Ref. [232])
Ref. [40]
Ref. [43] 1.1-3.1eV revisited
Ref. [43] 1.4- 6eV revisited, Theory
Ref. [43] from Graph
Ref. [7]
Ref. [8]
FFAST
Henke
Ref. [9]
Ref. [21], 2400 A
Ref. [21], 1180 A
Ref. [26]
Ref. [32]
Ref. [5]
Ref. [12]
Ref. [36]
NIST XCOM
Ref. [38] (Theory)
Ref. [38] (Ref. [99])
Ref. [38] (Ref. [108])
Ref. [39]
Ref. [44]
Ref. [43] from Graph

Dark Photon

- In order to obtain a min and max estimate for the cross section, I traced out a line across the max data points and min data points
- I extended the lines by 30%, mainly to account for errors in extracting data
- Some considerations:
  - The traces only include experimental data points (not the pure theory calculations), with the semi-exception of the Henke line
  - The traces don’t take into account temperature dependence at this point

Dark Photon

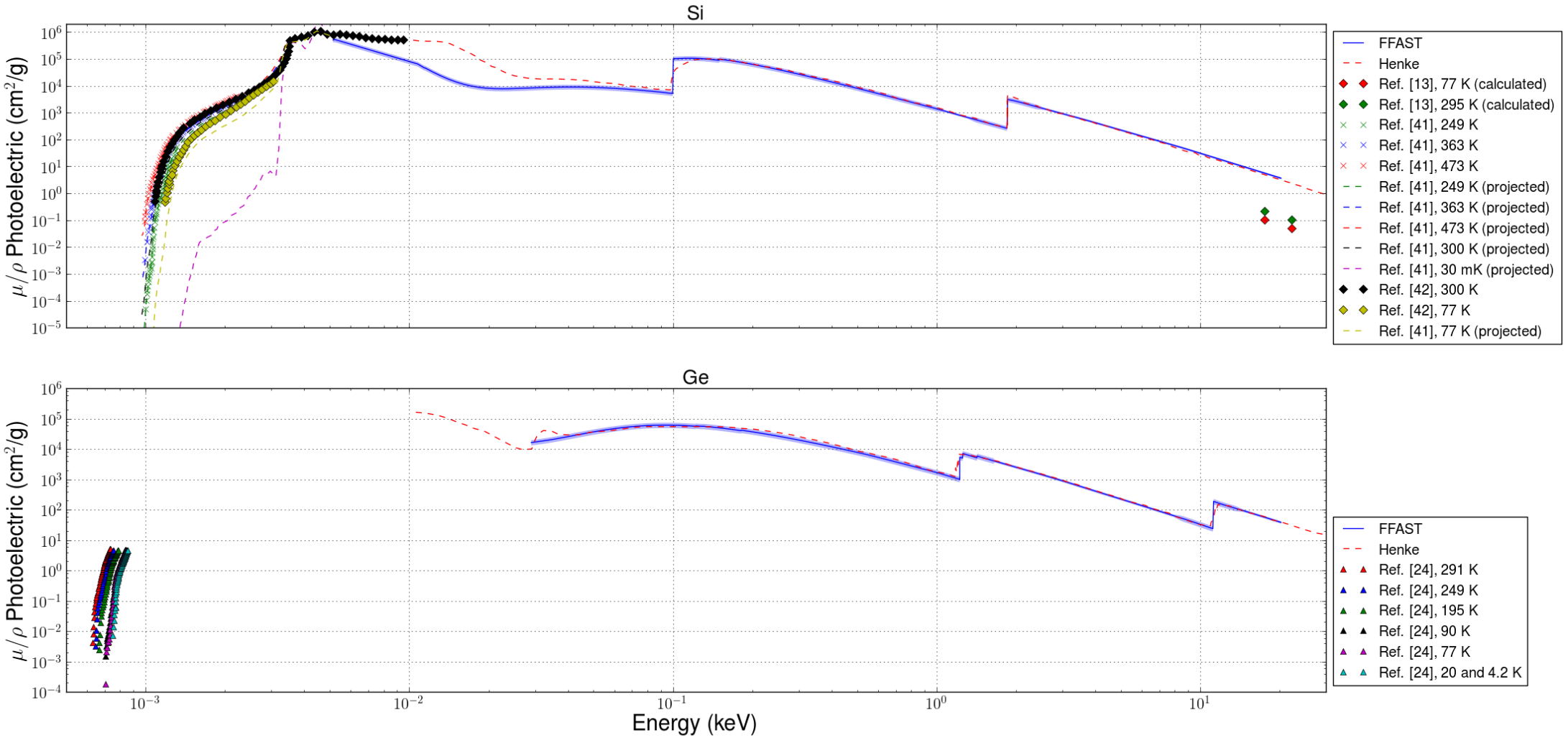

Si
μ/ρ Photoelectric (cm^2/g)
FFAST
Henke
Ref. [40]
Ref. [43] from Graph
Ge
μ/ρ Photoelectric (cm^2/g)
FFAST
Henke
Ref. [39]
Energy (keV)

Dark Photon

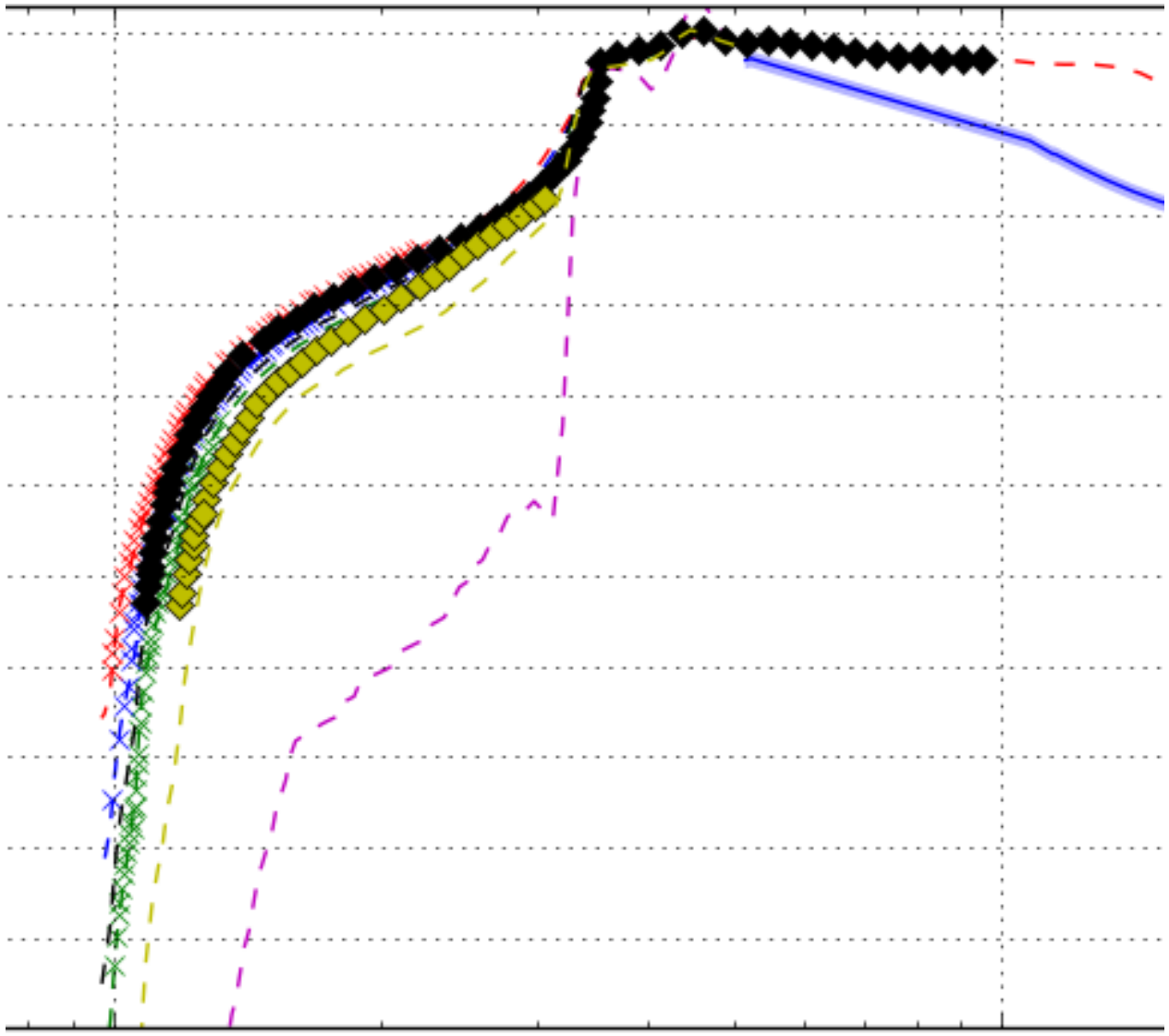
Now looking at temperature dependence

- I found a good reference that does look at the temperature dependence of absorption coefficient at low energies (between 1 – 10 eV)
- They use a power law method to extrapolate experimental data to new temperatures
- It would be an oversimplification to assume that this extrapolation works down to our temperature requirements
- However, it does suggest that the temperature dependence is only important a very low energies (a few eV), near the band gap energies

Dark Photon


Si
μ/ρ Photoelectric (cm^2/g)
FFAST
Henke
Ref. [13], 77 K (calculated)
Ref. [13], 295 K (calculated)
Ref. [41], 249 K
Ref. [41], 363 K
Ref. [41], 473 K
Ref. [41], 249 K (projected)
Ref. [41], 363 K (projected)
Ref. [41], 473 K (projected)
Ref. [41], 300 K (projected)
Ref. [41], 30 mK (projected)
Ref. [42], 300 K
Ref. [42], 77 K
Ref. [41], 77 K (projected)
Ge
μ/ρ Photoelectric (cm^2/g)
FFAST
Henke
Ref. [24], 291 K
Ref. [24], 249 K
Ref. [24], 195 K
Ref. [24], 90 K
Ref. [24], 77 K
Ref. [24], 20 and 4.2 K
Energy (keV)

Dark Photon



Dark Photon

Some physics explanations discussed with Belina:

- Absorption of phonons to conserve momentum: in order for the pe process to take place, ejected electron may need to absorb thermal phonon to conserve momentum
  - Would be more important near band gap energies, less important at higher energies where direct transition is possible. This would explain temperature dependence only at low energies
  - Lower temperature = less thermal phonons = less probable that pe process can occur near band gap, which explains the drop in cross section expected at low energies
- Temperature dependence of band gap
  - As temperature decreases, band gap energies increases

Dark Photon

Next steps for cross section work:

- Look at temp dependence of band gap energy
- Determine at what energies direct transition can exists (can help determine where temp dependence is important)
- Look at other forms of extrapolation (linear, log)
- Discuss these concepts with condensed matter people at UofT

Dark Photon

Other upcoming work:

- Limit calculations/code for SNOLAB/CUTE experiment
- Ideally want to have a lot of this done before SLAC meeting

DQM

Before holiday break:

- Made some changes to the noisePSD decider, as discussed in the last meeting:
  - Generalized the ‘read settings’ code so that it can read in specified txt file for any general decider settings (it is expected that this would only be used to initiate decider settings, while changes will be made on web interface)
  - Made some hierarchy changes to the structure of noisePSD settings

Upcoming work:

- Working with Ben to develop user interface to make changes to noisePSD decider settings
  - Display plot with thresholds, ability to add/delete/edit segments
- Working with Ben on appropriate responses to certain actions on web interface
  - E.g. warning if attempt to add an element that already exists somewhere else, warning if attempt to add datatype that exists somewhere else
- Develop decider code for OF energy resolution – this will be much simpler.

Upcoming Events

- Supervisory committee meeting next week
  - Goal is to send out report by the end of the day today (~5 pages)
- Analysis meeting followed by DAQ meeting at SLAC from Jan 29th to Feb 2nd – booked
- EDIT2018 conference, first 2 weeks in March – registered