Recent progress in the search for light WIMP-like particles in South America: DM^2 and CONNIE

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TAUP 2023

Two different experiments, same type of detector

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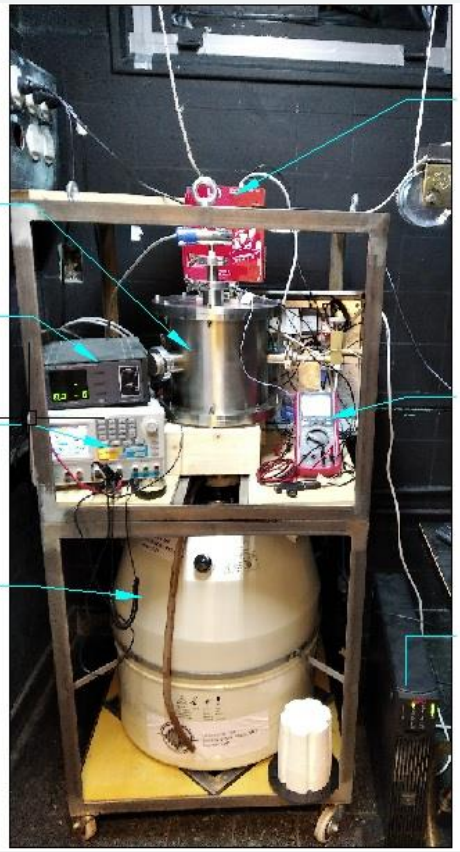
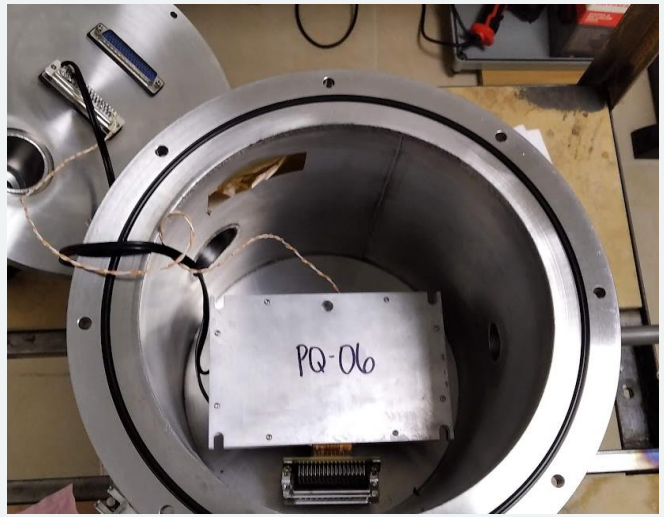
1) DM^2 (Dark Matter Daily Modulation experiment)

Bariloche

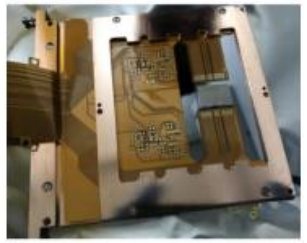


A 6k x 1.5k pixel, 675 um thick Skipper CCD



Two different experiments, same type of detector
2) CONNIE (COherent Neutrino-Nucleus Interaction Experiment)

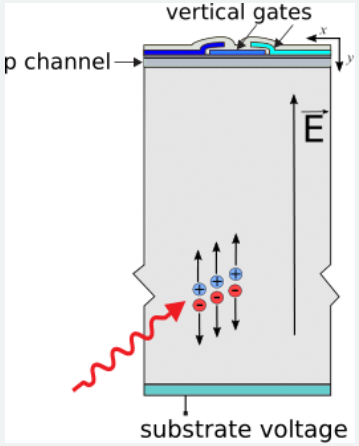
See A. Aguilar-Arévalo's talk in the Neutrino parallel session! (later today)

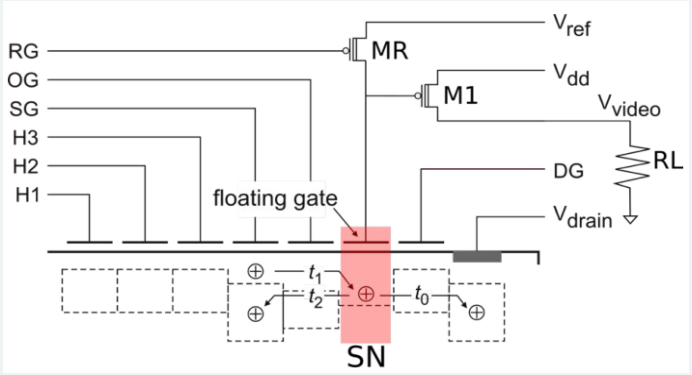


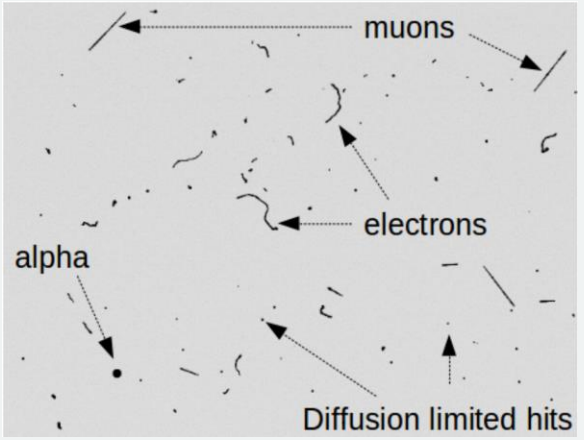
Two 0.7k x 1.2k pixel, 675 um thick Skipper CCDs

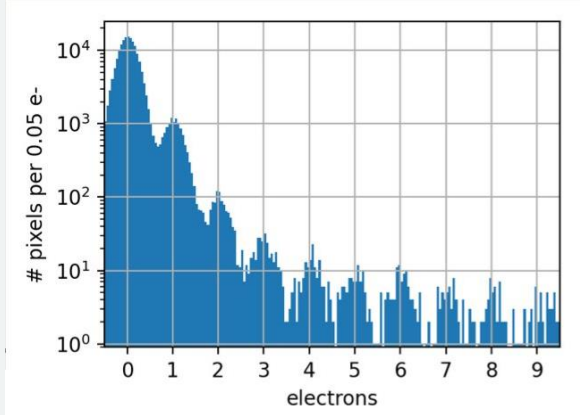
Skipper CCDs

- Charge-Coupled Devices (CCDs) with a modified readout stage that allows to resolve single-electron events
- We can see interactions with a lower threshold of deposited energy of 1.2 eV
- However this comes with a cost – increased readout time





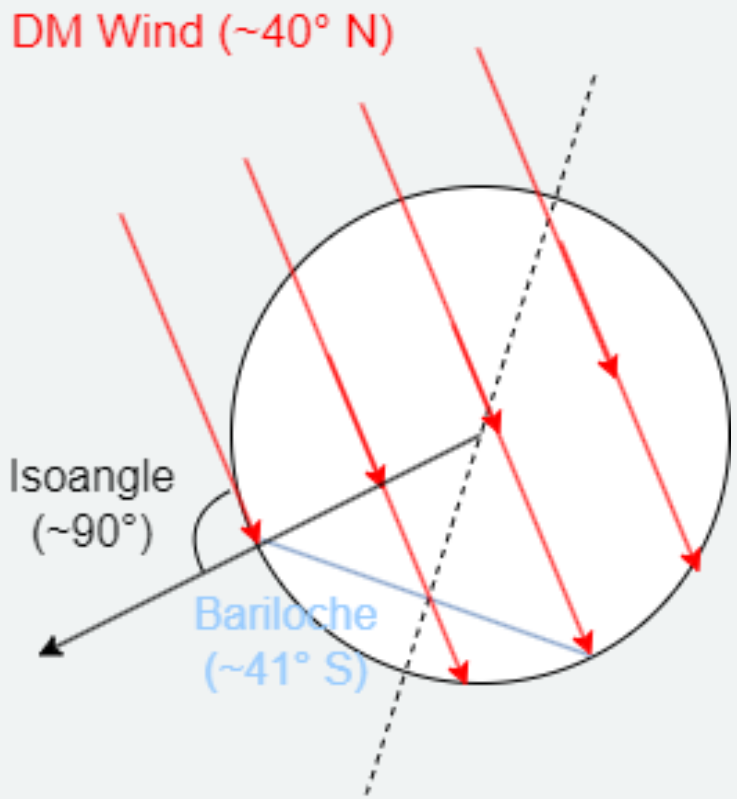




Diurnal modulation of Dark Matter

Diurnal modulation of Dark Matter events

- As the Solar System travels through the galaxy, a wind of DM particles arrive from a particular direction
- The angle between this direction and the normal to the surface is called "isodetection angle" or, abbreviating, "isoangle"
- As seen from the Earth surface, this direction varies throughout the day



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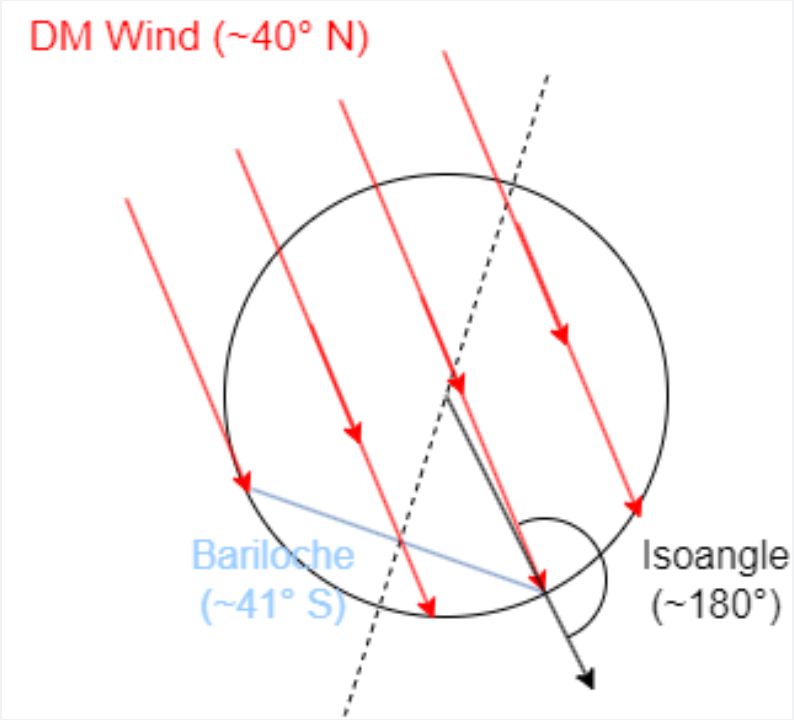
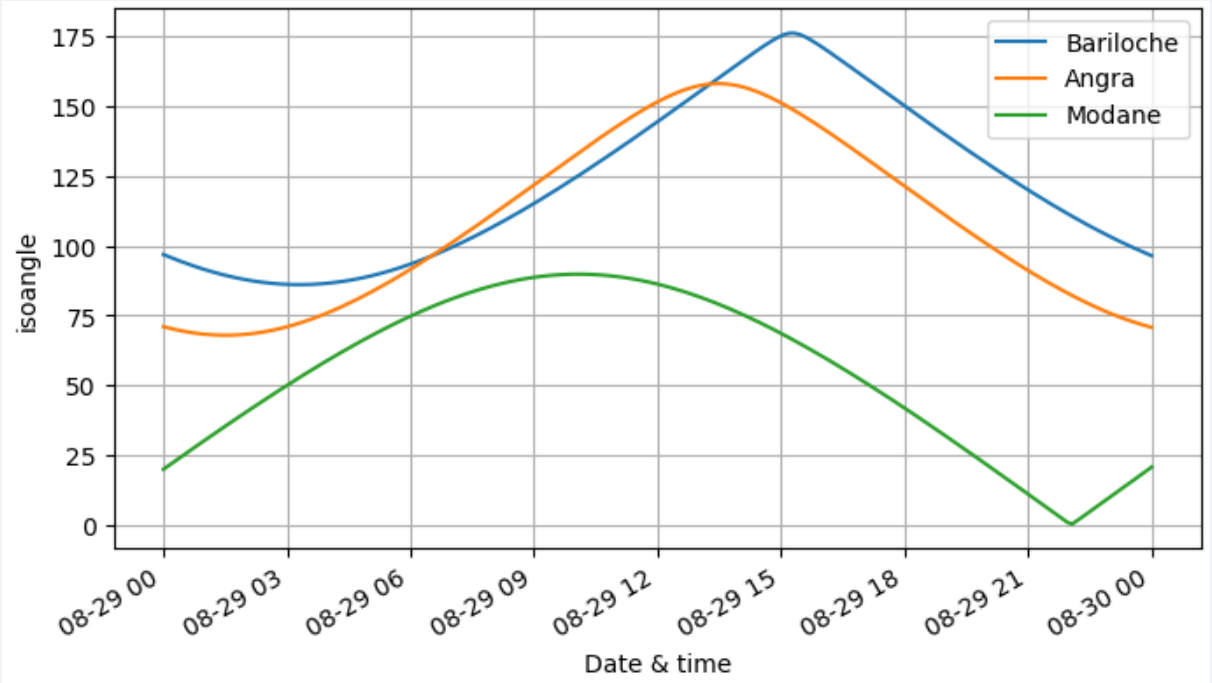
- An isoangle of 0° means the DM wind comes from above. An isoangle of 180° means it comes from below and has to traverse the whole Earth to reach the detector.



Diurnal modulation of Dark Matter events

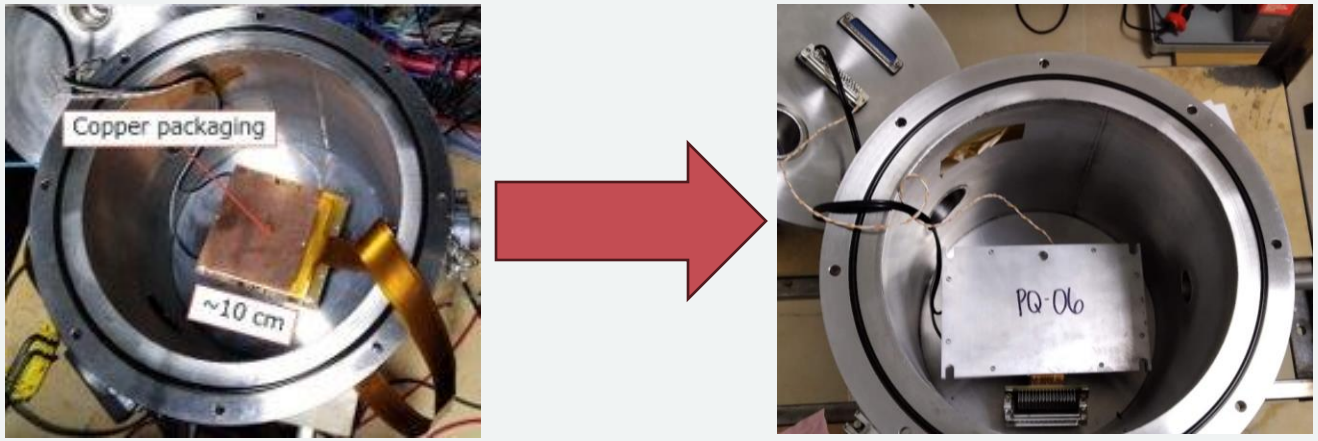
- Depending on where we stand on the Earth surface, we can scan different isoangles
- For masses in the MeV range, there is a range of non-rejected cross-section in which DM particles may interact strongly enough to scatter inside the Earth and generate a diurnal modulation of flux in the detector
- See Xavier Bertou's talk on Thursday!



Data

DM2: new data & analysis

- Detector upgrade: from a 0.1 g prototype Skipper-CCD (presented @ TAUP 2021) to a 3 g Skipper-CCD (provided by the DAMIC-M collaboration)



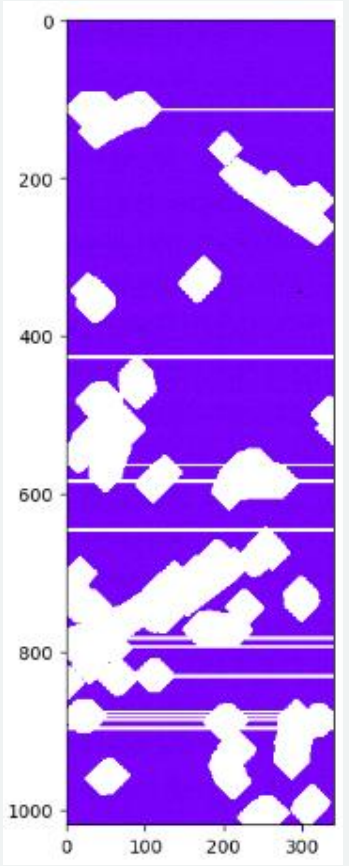
- Analysis upgrade: binned-likelihood rejection method
  - We now bin in isoangle

CONNIE: brand-new analysis

- It is a neutrino experiment...
- But now a DM experiment too :)

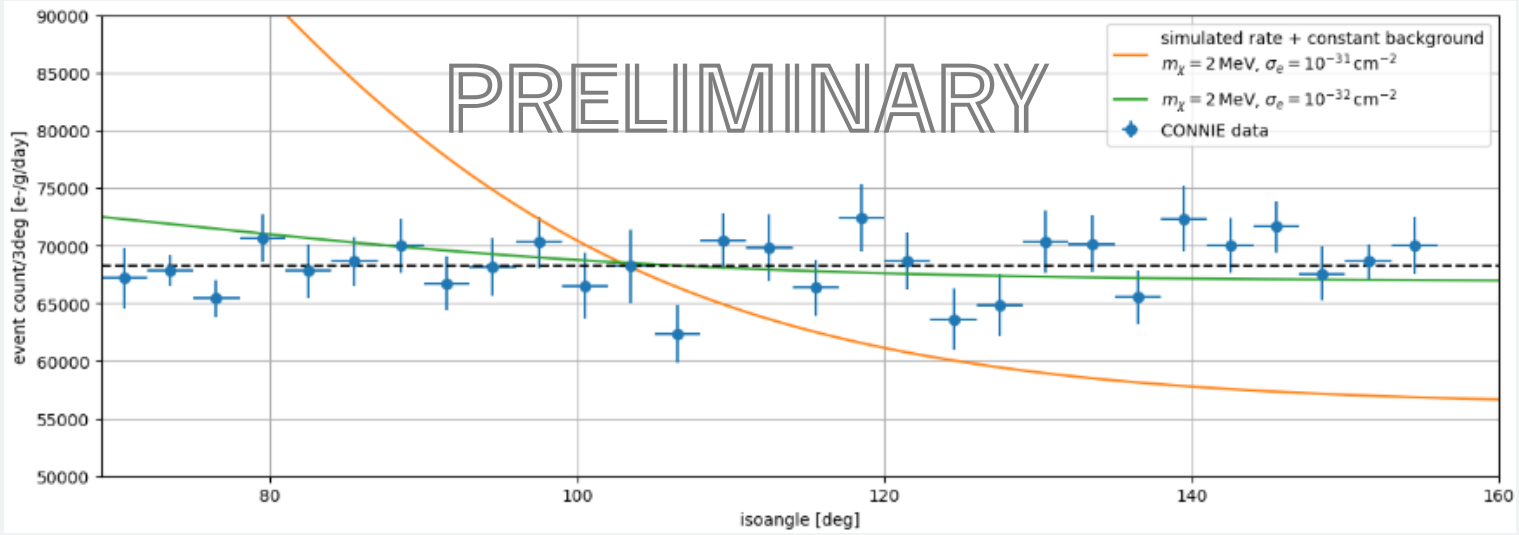
Data analysis

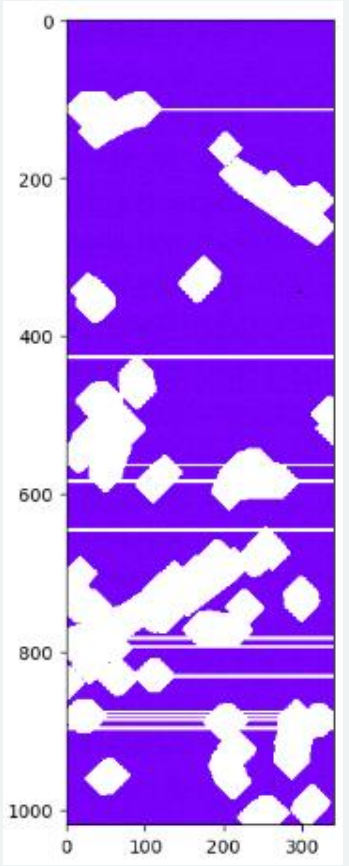
- Raw image -> High-energy events mask -> Serial Register events mask
- Count empty, 1e- and 2e- pixels



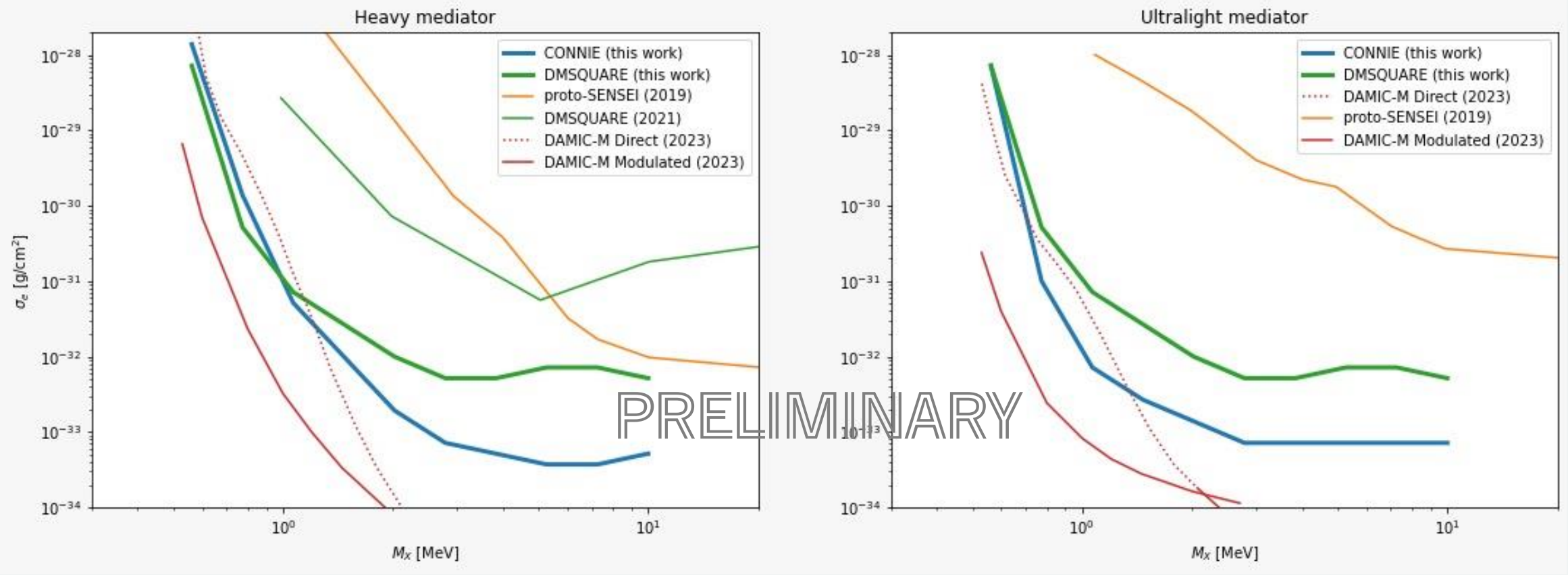
Data analysis

- Raw image -> High-energy events mask -> Serial Register events mask
- Count empty, 1e- and 2e- pixels
- Compute the isoangle, compare with simulations, find the 90% CL rejection limits





DM-electron interaction limits



For DAMIC-M: see P. Privitera's talk on Thursday!

Summary

- DM-electron interactions in the low mass range can be explored via a diurnal modulation
- Both DMSQUARE and CONNIE yield very good constraints to these interactions, even when they are located at surface
- Stability of single-electron events is crucial for this search

Future prospects

- What do we need?
  - Less fluctuations in single-electron events
  - Shielding the experiments works well, going underground too
- Moving to the south?

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Thank you!