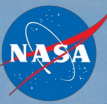


# Cosmic Antimatter Search

Mana 7 Year Celebratory Symposium  
February 2022

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# Existence of dark matter

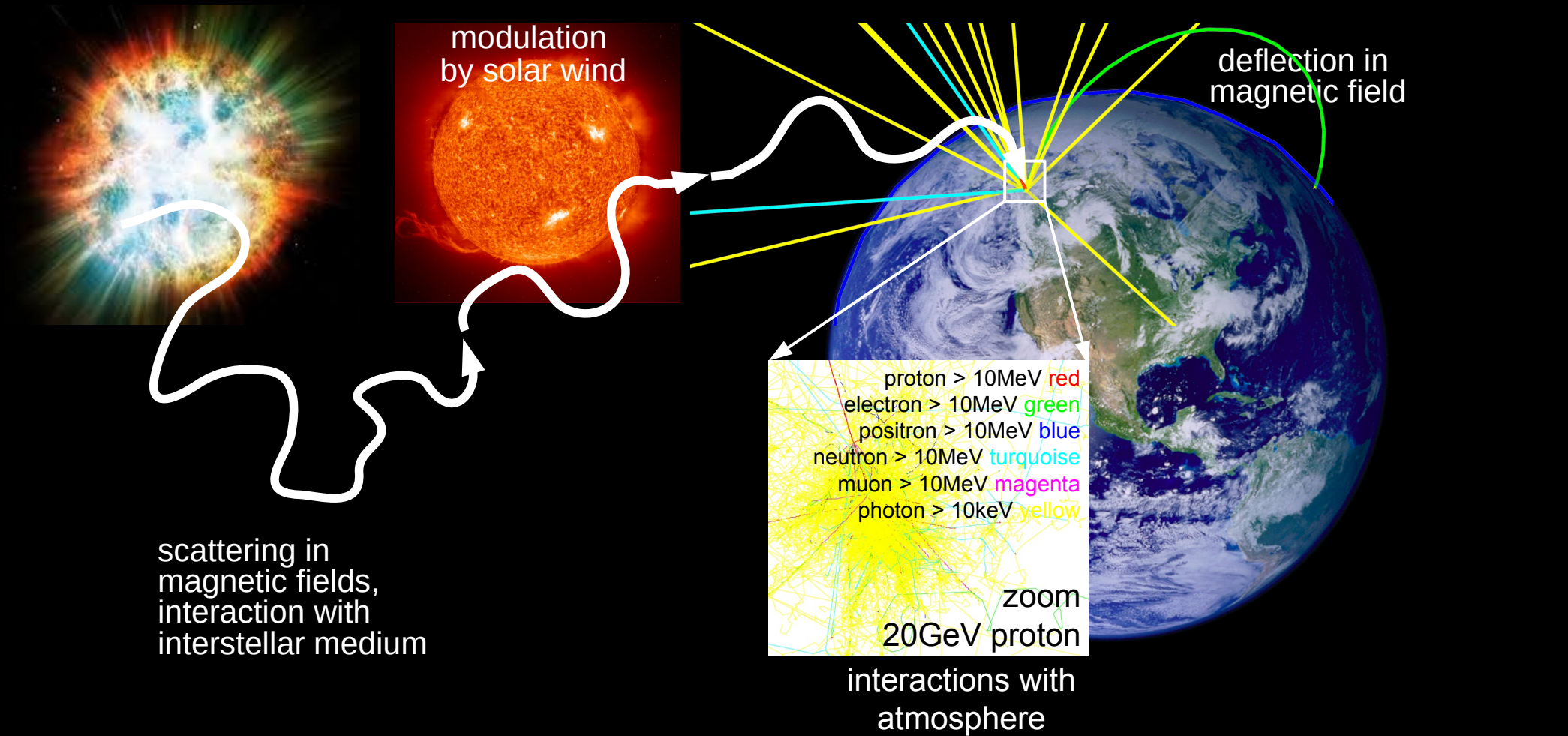
## Bullet cluster

**red:** hot X-ray emitting gas

**blue:** distribution of dark matter

- **dark matter exists, but nature remains unknown!**
- luminous matter cannot describe the structure of the Universe
- evidence for dark matter comes from many different type of observations on different distance scales

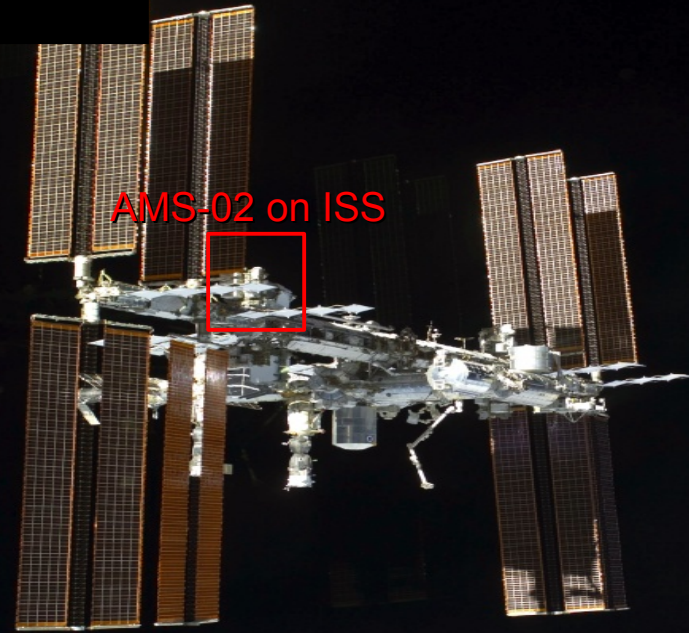
# Cosmic rays as messengers for new physics



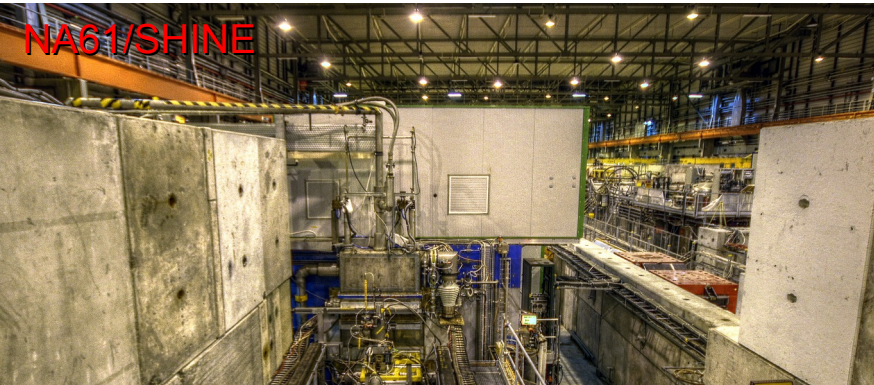
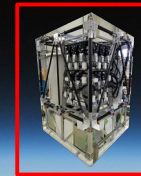


# Cosmic antimatter

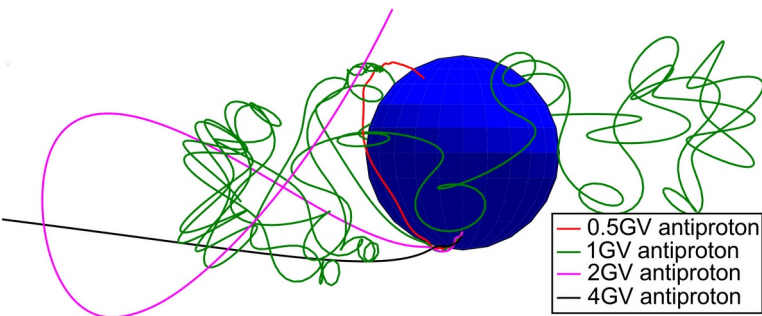
- Dark matter might annihilate into antimatter (same as regular matter, but opposite charge) and becomes part of the cosmic rays
- Antimatter is otherwise very rare and is not easily produced in other processes
- UH CR $\bar{A}$  team works on multiple efforts:
  - AMS-02 on the ISS
  - Upcoming balloon experiment GAPS
  - Measurements on ground with NA61/SHINE



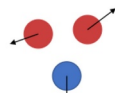
GAPS from  
Antarctica



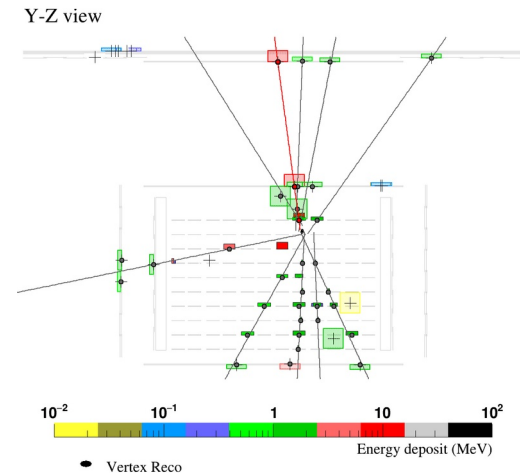
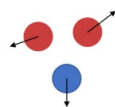
# Mana HPC usage



All at the same time:



In an iterated process:



- Early adopters: Started in 2015 with simulations of the deflection of charged particles in the geomagnetic field (~100s of years of compute time)
- First time event-by-event simulation of the creation of antihelium (~1000s of years of compute time) → grad student: Anirvan Shukla
- Simulation and reconstruction of antimatter interactions with the upcoming GAPS experiment (~1000 of years of compute time) → postdoc: Achim Stoessl

# Thanks a lot

- Mana enables cutting-edge world-class research of far reaching relevance.
- The UH CRA group and their national and international partners (e.g., MIT, Columbia, Berkeley, INFN, JAXA) benefit tremendously from this huge amount of computing power.
- I would like to express my gratitude for the hard work of the whole Mana HPC team. The collaboration over the years was always enjoyable, very efficient, and fruitful.

**Thanks a lot!**