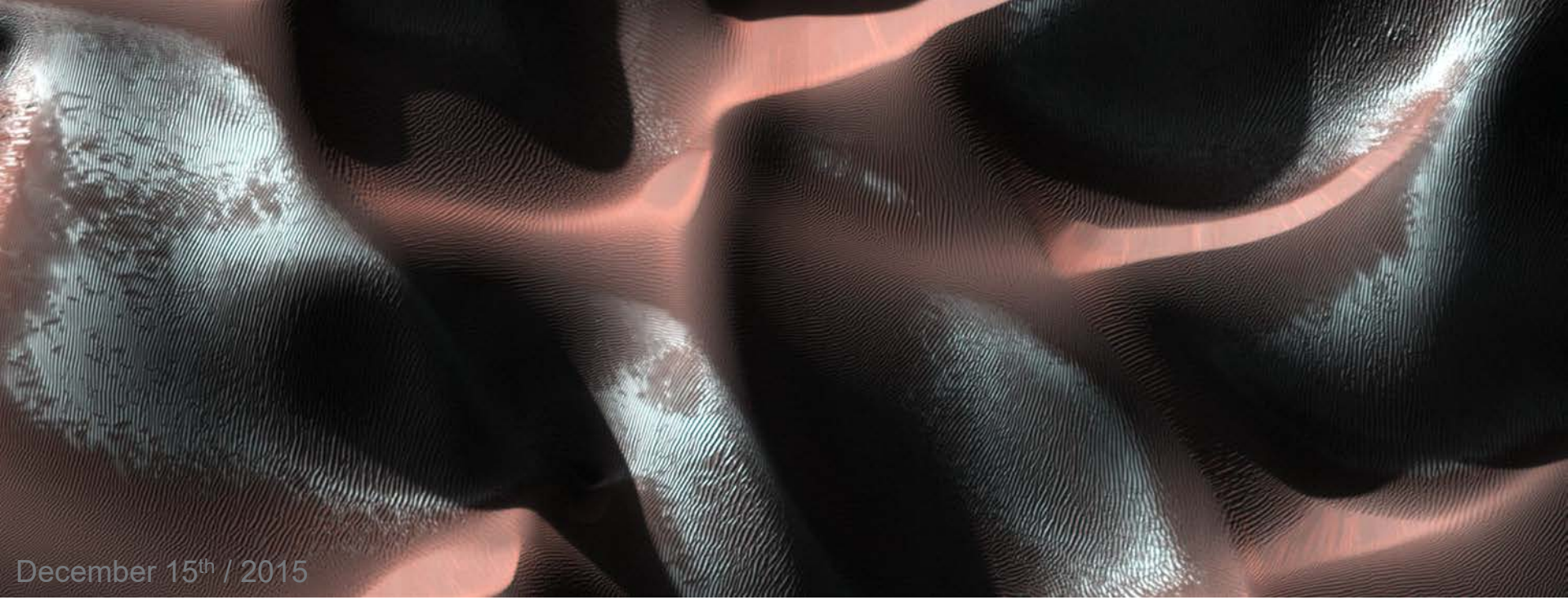

Parallel study of HEND, RAD, and DAN instrument response to Martian radiation and surface conditions

Luz Maria Martinez Sierra

Insoo Jun – Jet Propulsion Laboratory
Maxim Litvak – IKI, Space Research Institute
Anton Sanin – IKI, Space Research Institute
Igor Mitrofanov – IKI, Space Research Institute
Cary Zeitlin – Southwest Research Institute

Jet Propulsion Laboratory
California Institute of Technology

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Agenda

- Introduction
- Radiation sources and interactions
- Detection instruments
  - Description
  - Data sample and take outs
- Results
- Conclusions

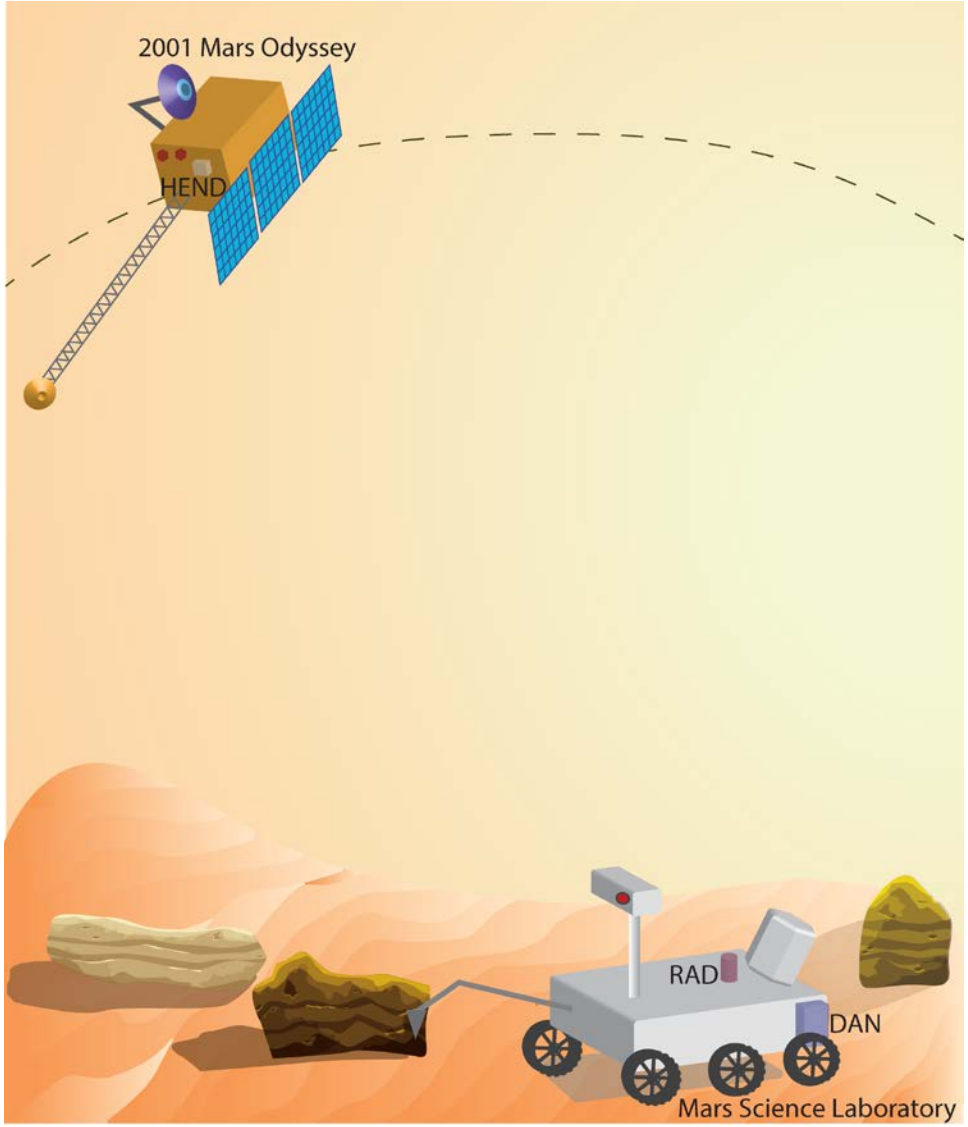
Introduction

- Nuclear detection methods are being used to understand the Radiation environment at Mars
- JPL assets on Mars include:
  - Orbiter - 2001 Mars Odyssey
  - Mars Science Laboratory Rover - Curiosity.
- Spacecraft have instruments able to detect ionizing and non-ionizing radiation.
- Instrument response on orbit and on the surface of Mars to space weather and local conditions.*

*Data available at NASA-PDS

Background - Radiation Environment on Mars

- GCR and SPE interact with the elements to create a cascade of secondary particles
  - Charge Particles
  - Neutrons
  - Gamma Rays
- Charged particles are easily stopped
  - Ionization
  - Excitation
  - Continuous energy loss
- Neutrons and gamma rays travel further



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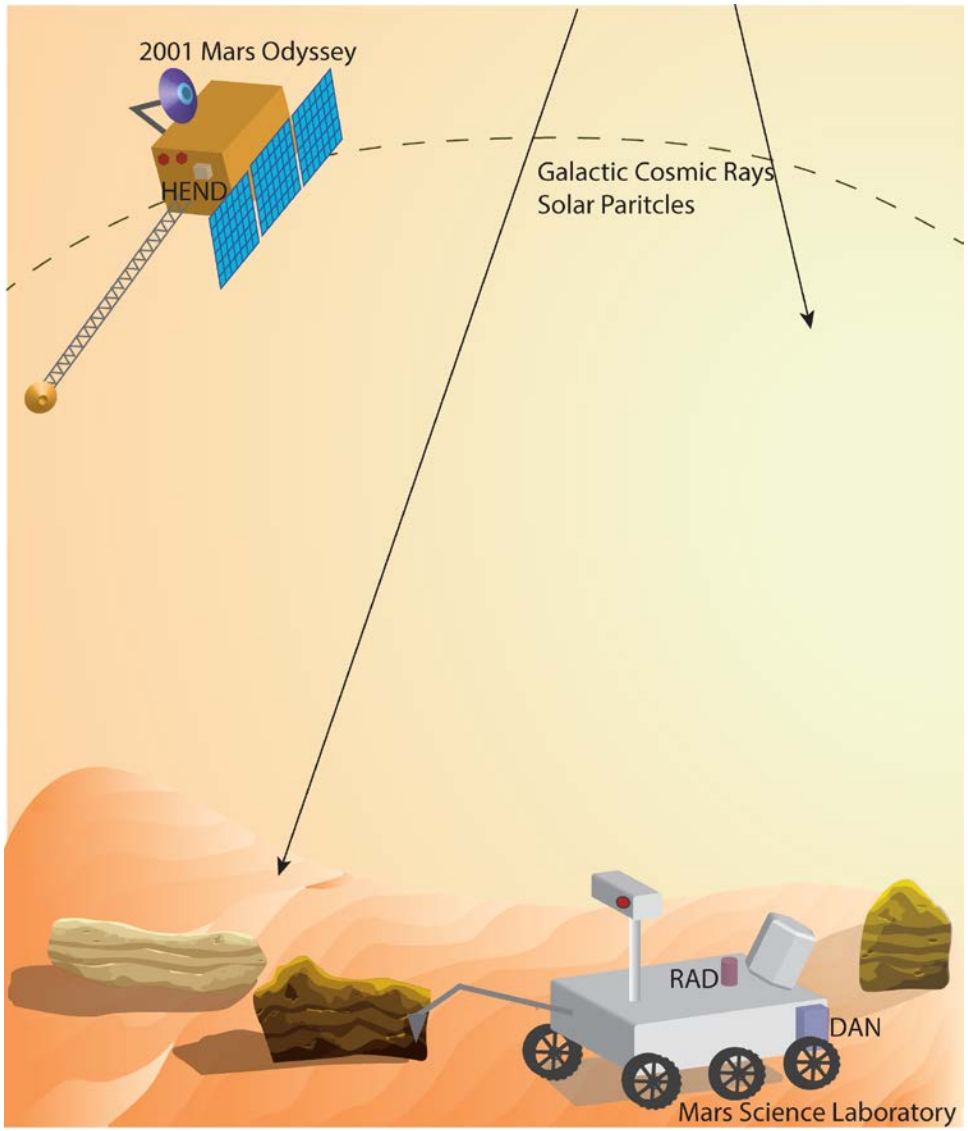

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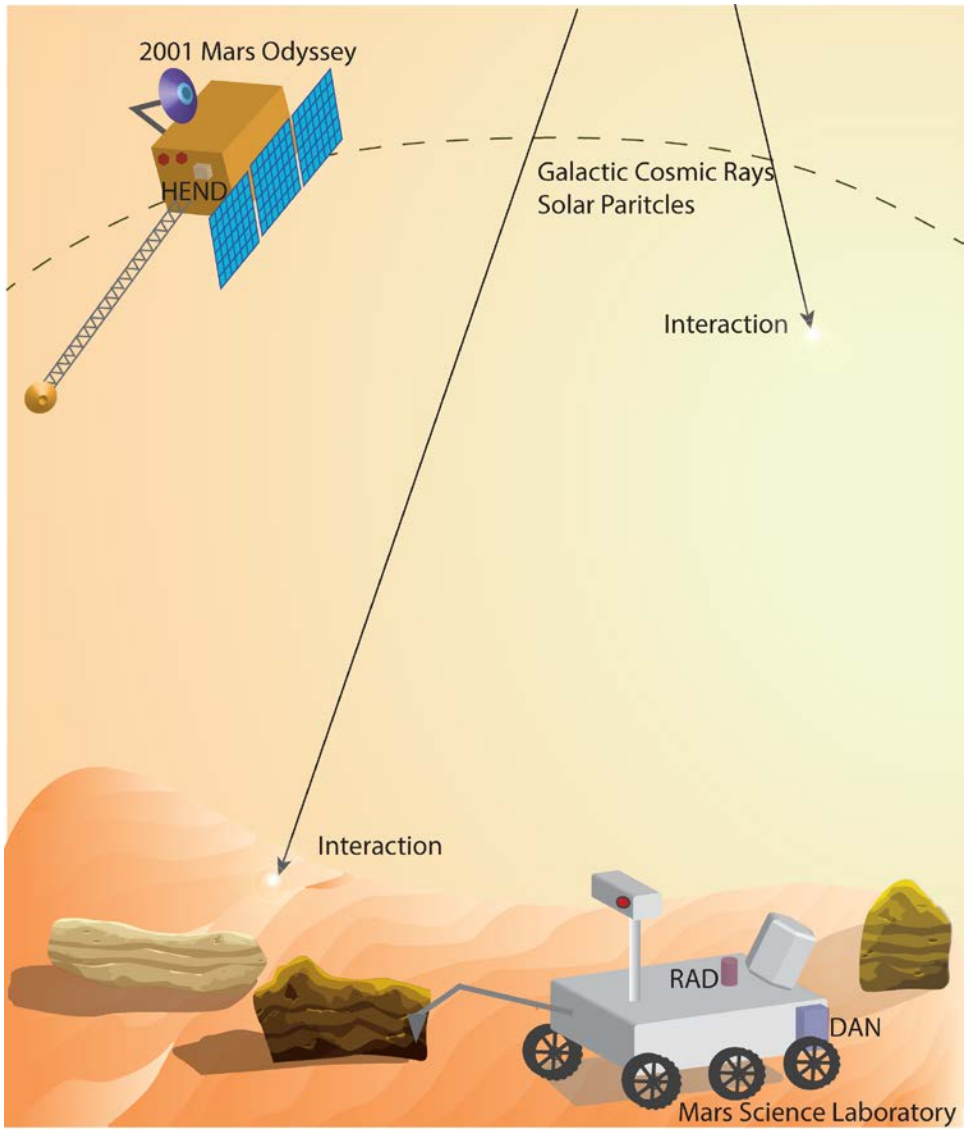

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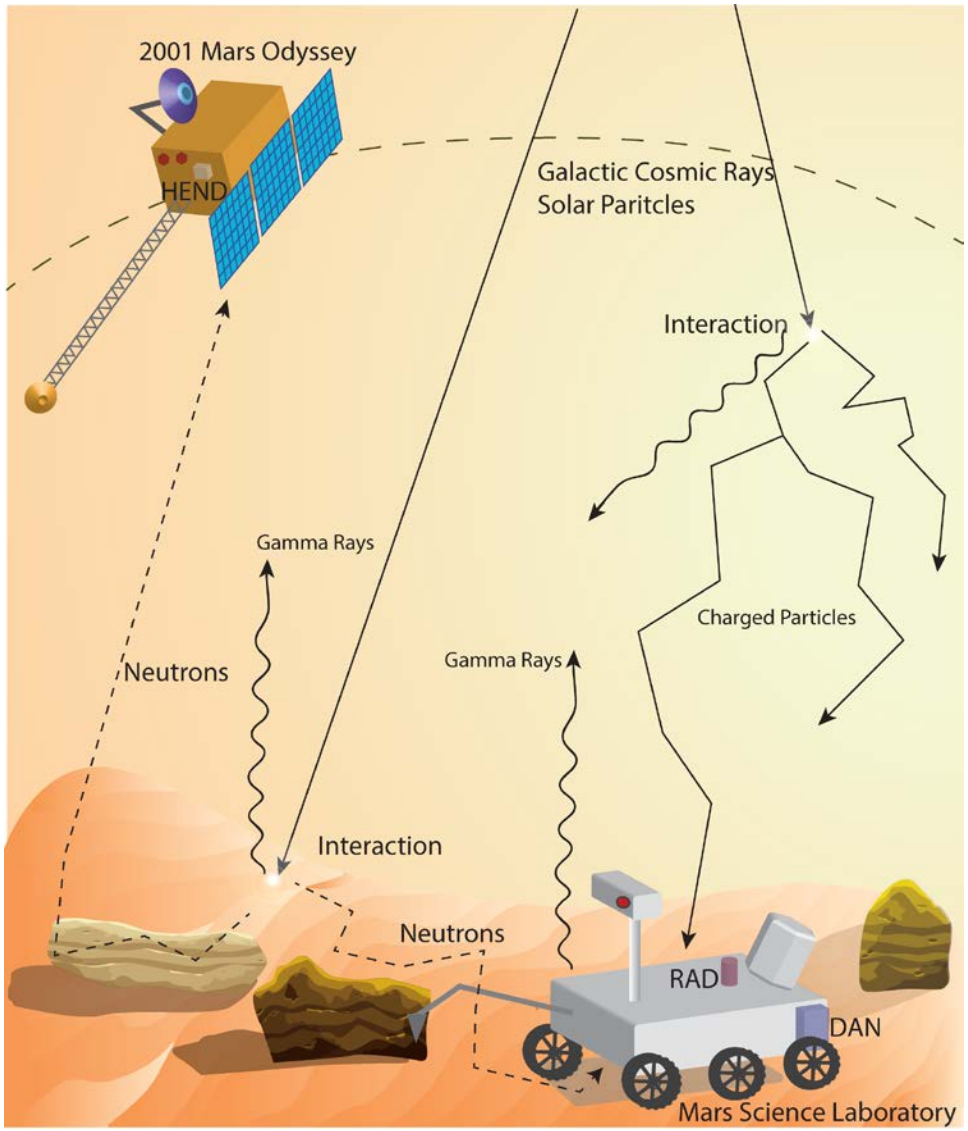

Instruments summary

	High Energy Neutron Detector	Radiation assessment Detector	Dynamic Albedo Neutron
	HEND	RAD	DAN
On board-	2001 Mars Odyssey	MSL	MSL
Science Objective	Map the hydrogen-abundant regions of the Martian surface	Define radiation environment and dose rate equivalent on Martian surface	Passive mode: background neutron environment on Active mode: Subsurface hydrogen content
Detectors	3 ^{3}He proportional counters 2 scintillator crystals	3 Si detectors CsI scintillator Plastic scintillator	2 ^{3}He proportional counters (Passive and Active mode)
Radiation	High energy neutrons	Ionizing and non ionizing radiation environment	Thermal and epithermal neutrons
Start Operation	2002	2012	2012

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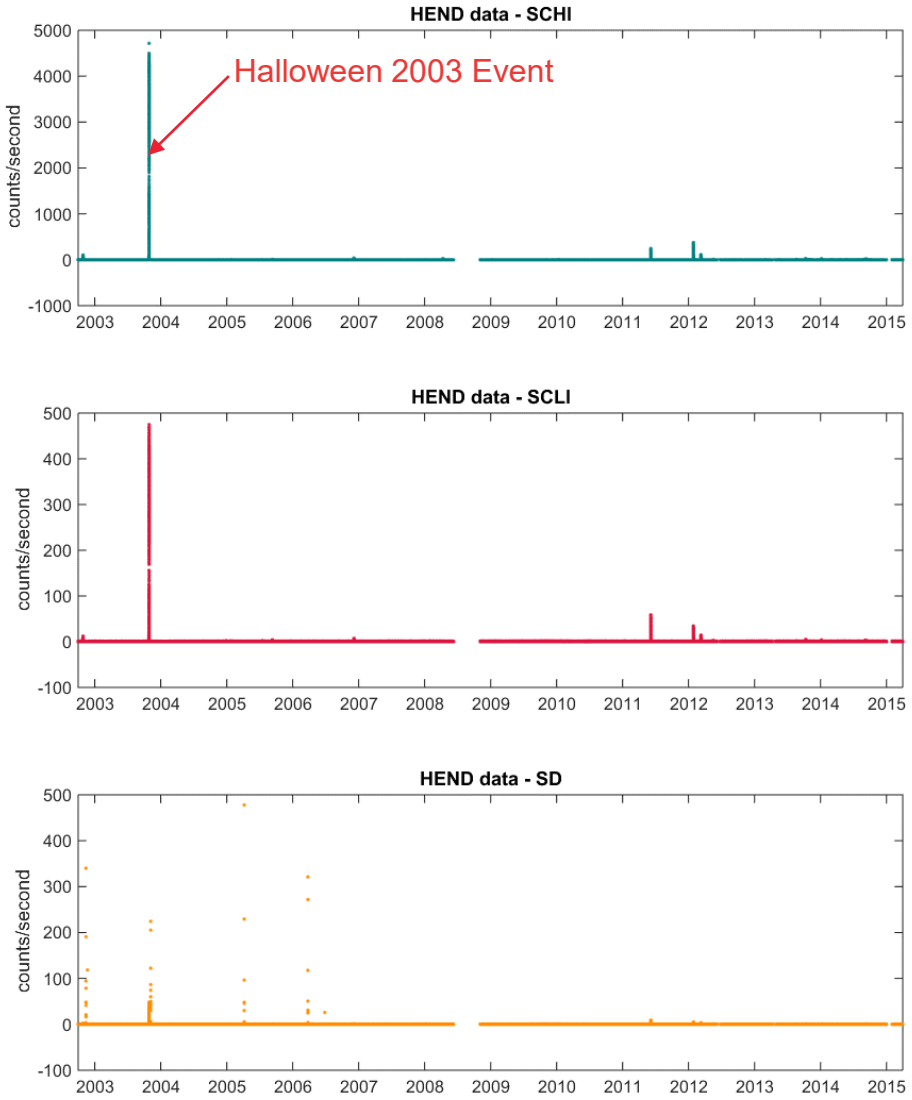
HEND data – data set 2002-2015

Odyssey – Neutron counts

- Solar Particle Events can be recorded on multiple channels
- The strength of the SPE can be determined - proportional to the counts detected



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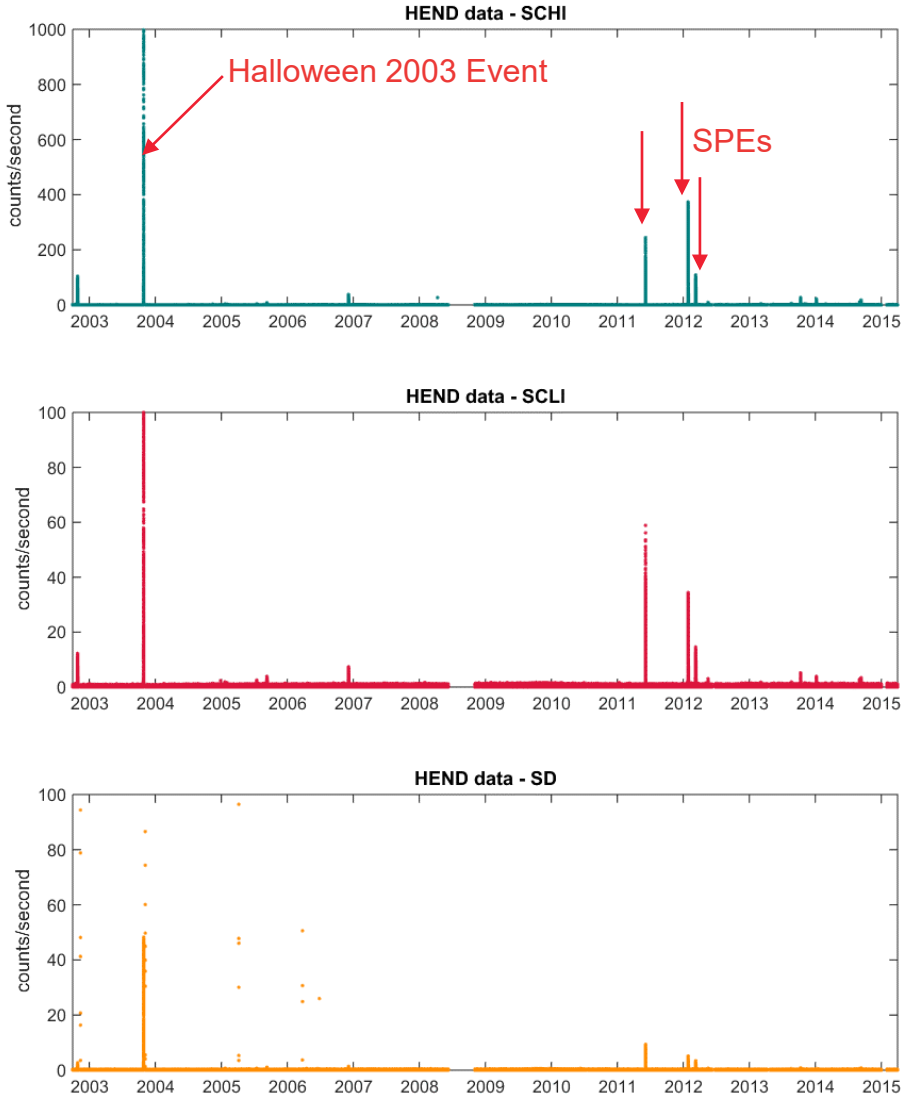

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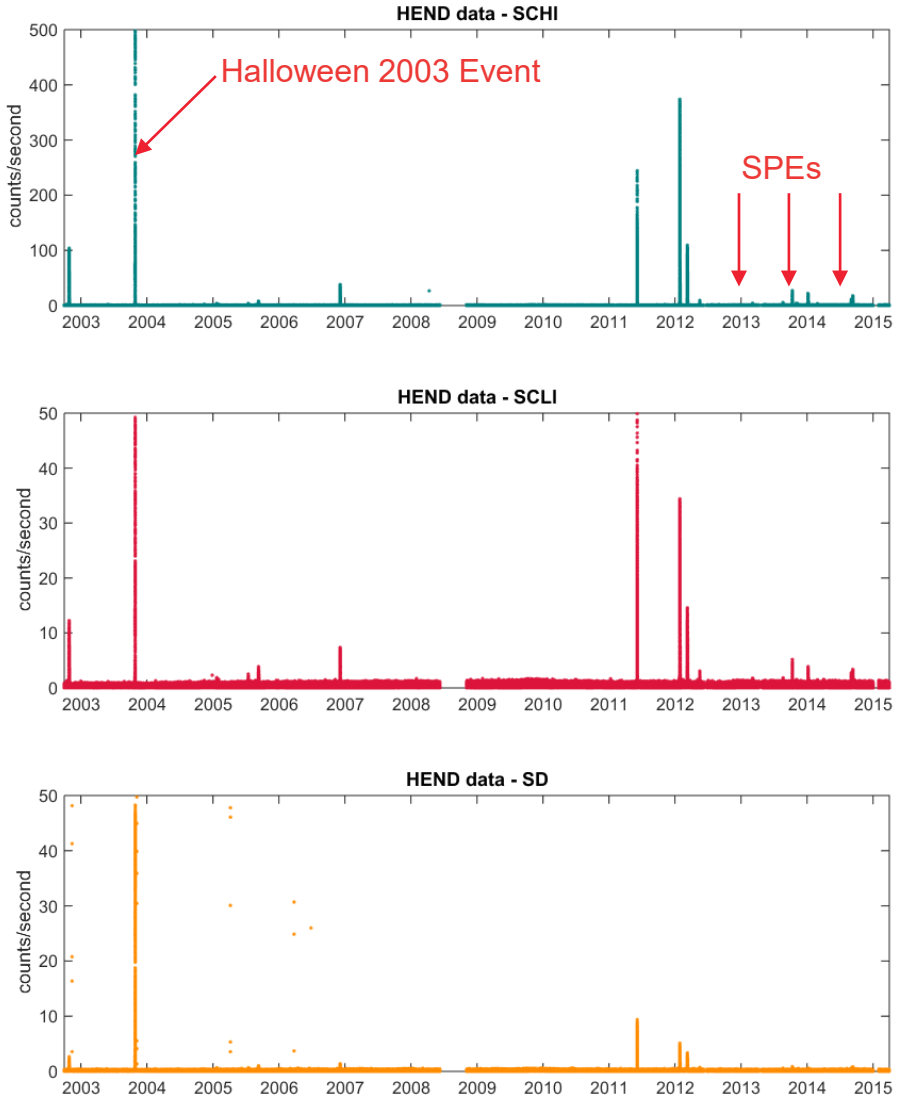
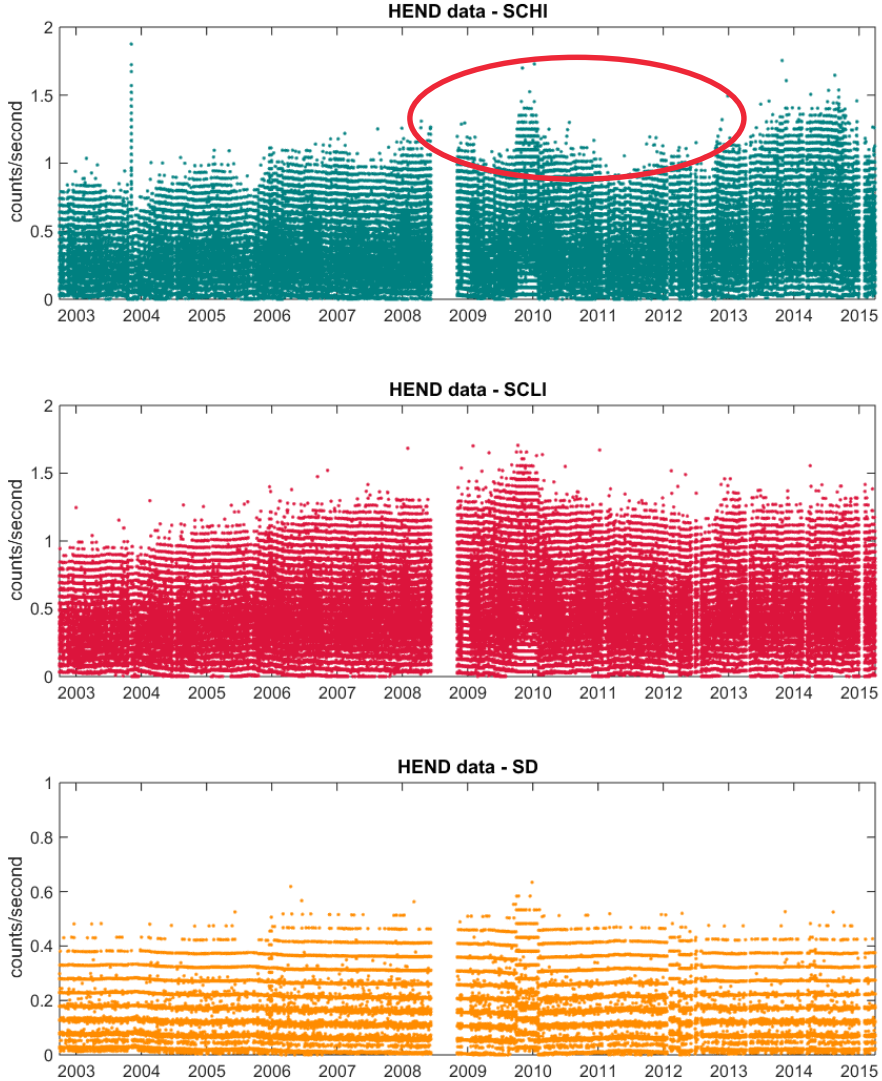


HEND data – data set 2002-2015

Odyssey - Neutron counts with no SPE

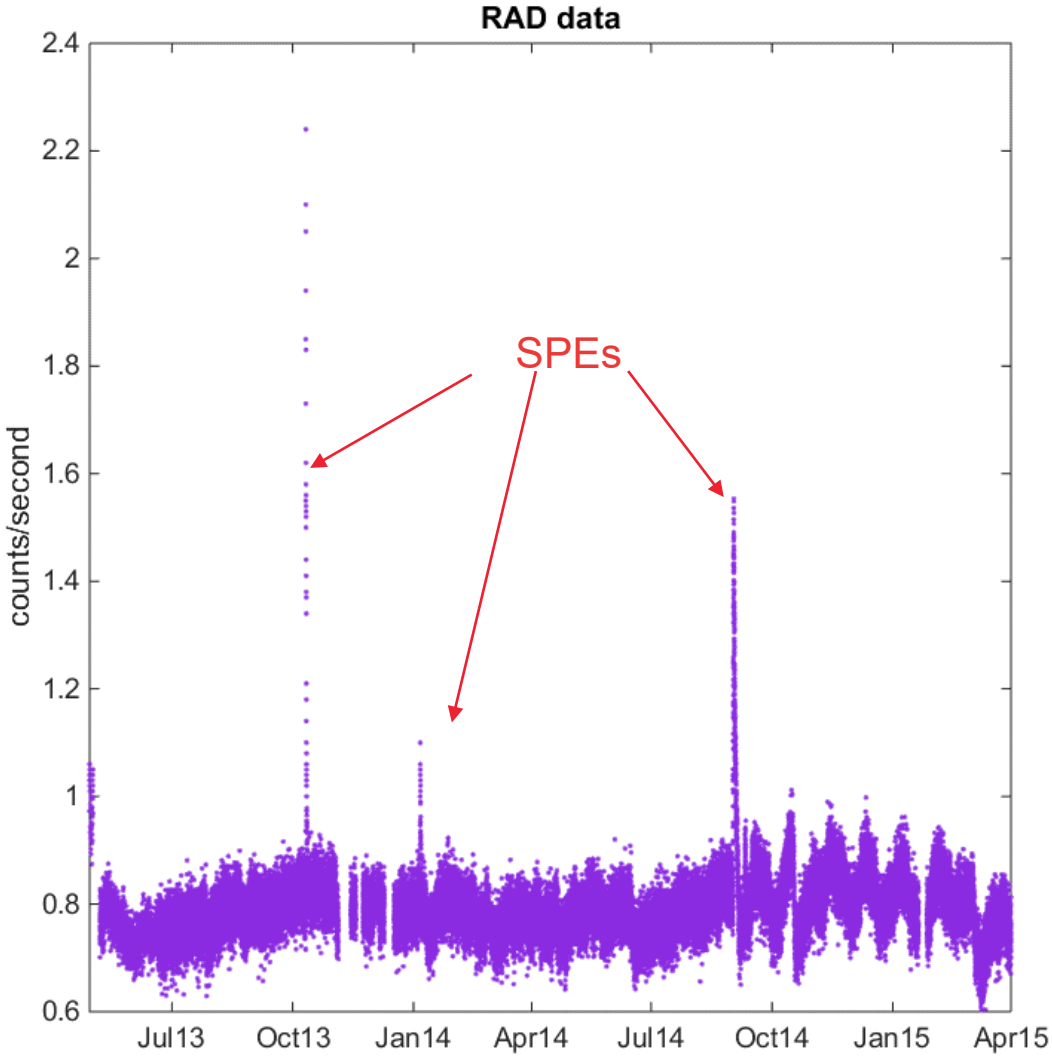
- Galactic Cosmic ray indirect counts can be observed throughout the whole mission
- GCR enhancement during the last solar cycle can be seen



RAD data

MSL - Charged particle flux

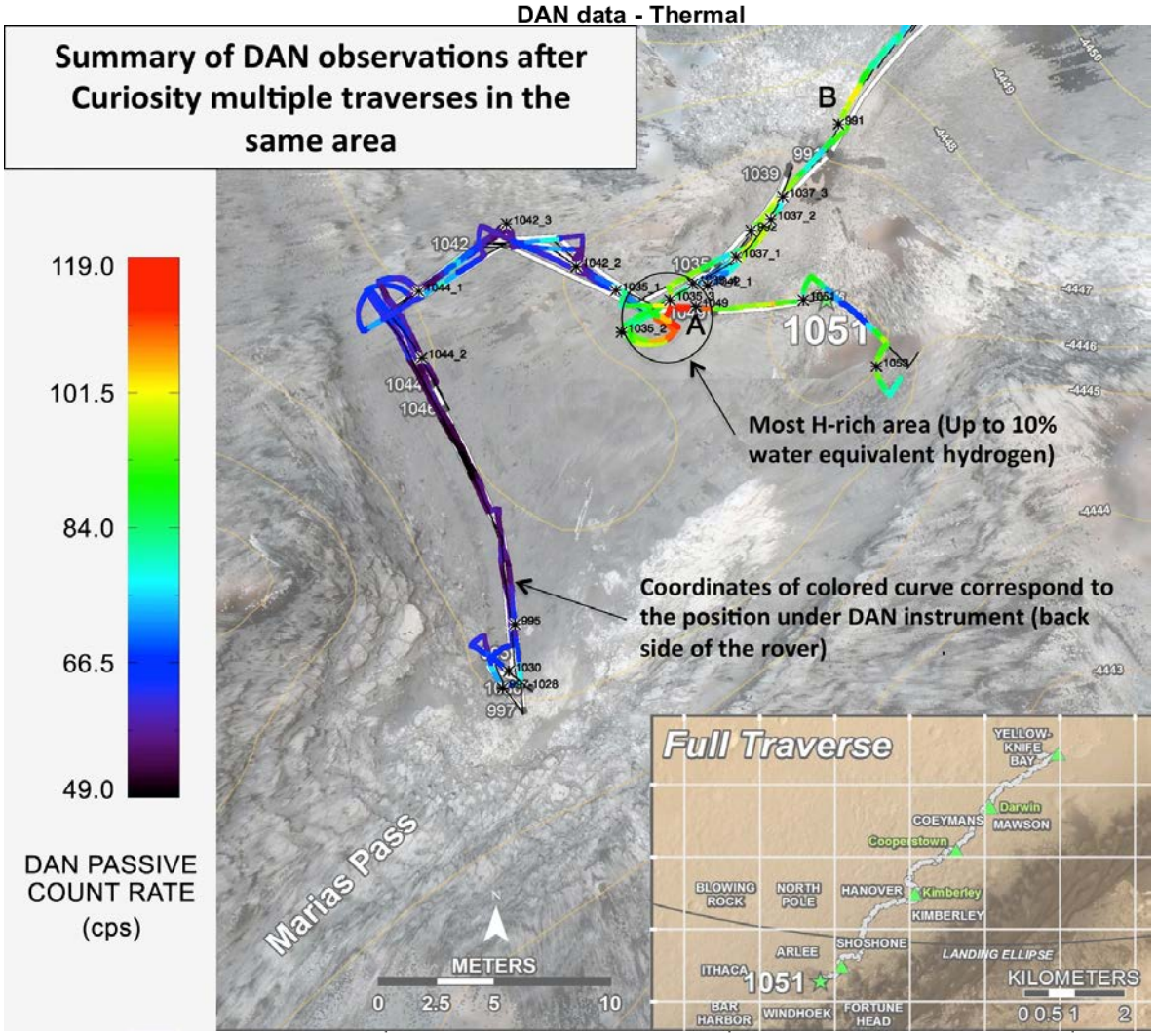
- Sensitive to Solar particles and secondary charge particles generated.
- Direct correlation between charged particles flux at the surface with the Solar particle events



DAN data

MSL – Thermal and Epithermal Neutron counts ADD MAP

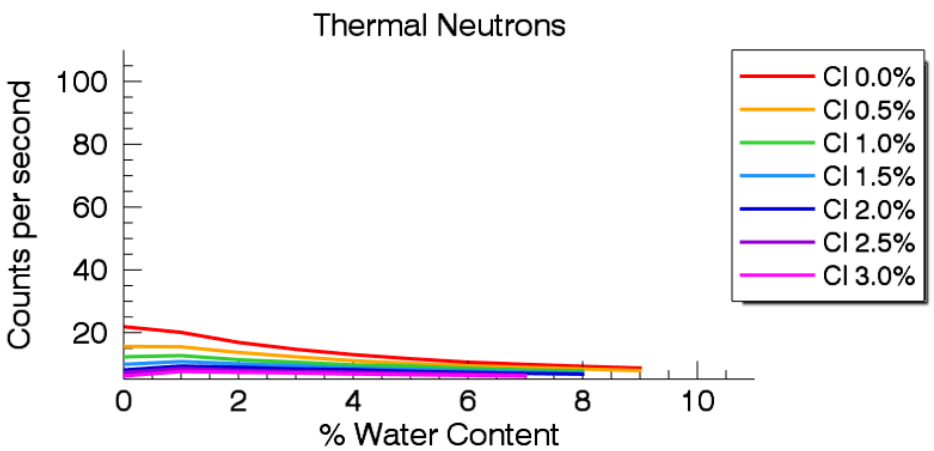
- Thermal data sensitive to location
- Epithermal neutrons do not show strong variation



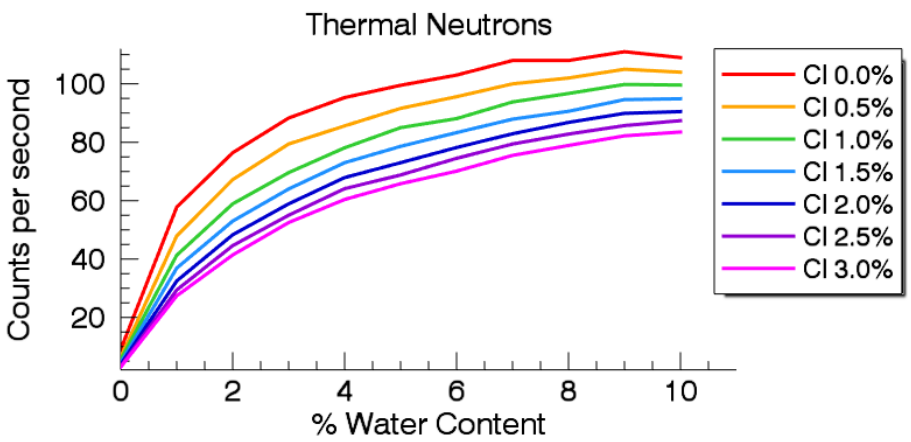
DAN sensitivity to GCR and RTG

- Simulation made for different compositions varying the source of the neutrons to understand the response of DAN instrument.

GCR only – neutrons source

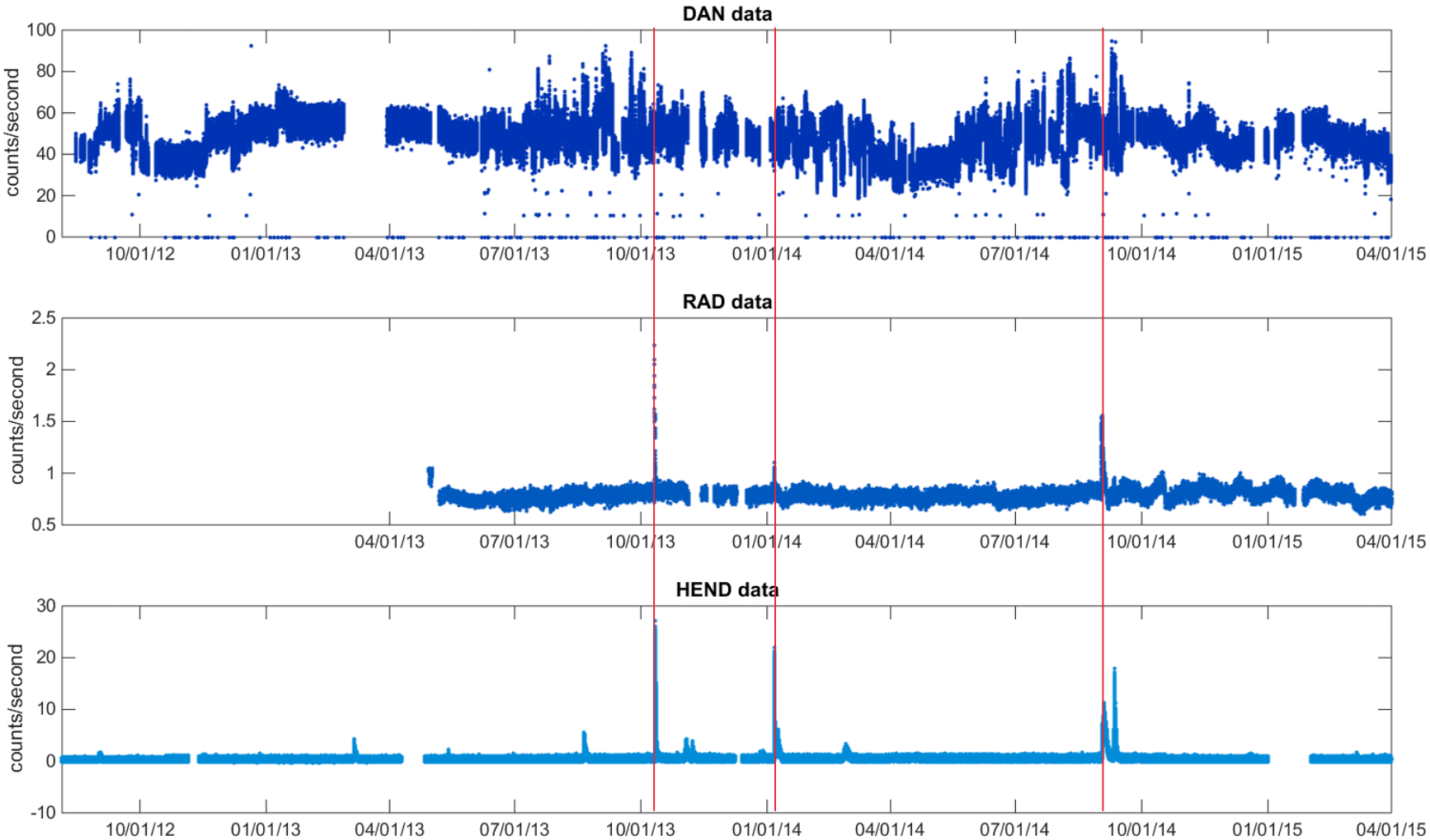


RTG only – neutrons source



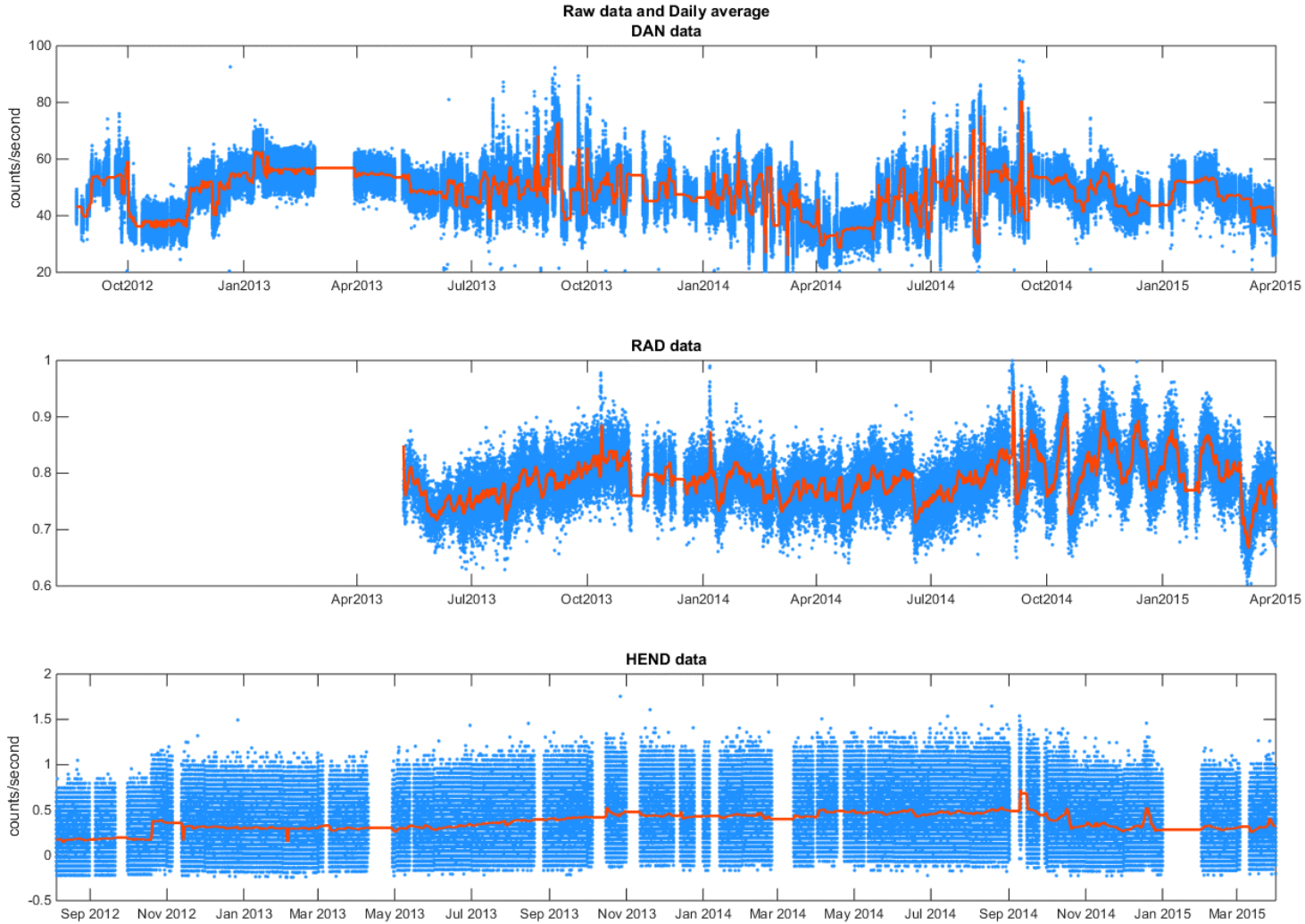
Data Comparison – Instruments

Solar Particle Events included



Data Comparison - Instruments

Daily Running Average of the date (no SPEs)



Results Summary

	SPEs	GCRs	Elemental Composition
HEND	Sensitive	Sensitive	Sensitive
DAN	Not Sensitive	Not Sensitive	Sensitive
RAD*	Sensitive	Sensitive	Not Sensitive

* RAD measurements can vary with local conditions (i.e. atmospheric conditions and seasonal changes)

Conclusion

- No direct correlation can be observed between the instruments studied.
- DAN is unresponsive to the Solar Particle Events (so far) and GCR induced neutrons.
  - DAN instrument spatial resolution is smaller than the resolution that HEND is seeing (60x60 km)
  - Different moderation distances traveled by detected neutrons (GCR neutrons vs RTG neutrons)
- Martian radiation environment can only be fully understood with inter instrument studies.
- Same type of instrument could be useful to determine radiation environments on orbit and surface.

Jet Propulsion Laboratory
California Institute of Technology

jpl.nasa.gov

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- Image credits: NASA- Caltech JPL