

# HiSPARC

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HiSPARC

- **High School Project on Astrophysics Research with Cosmics**
- HiSPARC offers high school students the opportunity to contribute to real scientific research.

## Netherlands

University of Amsterdam,  
VU University Amsterdam,  
Eindhoven University of Technology,  
University of Groningen,  
Leiden University,  
Radboud University,  
University of Twente,  
Utrecht University

## United Kingdom

University of Bath,  
University of Birmingham,  
University of Bristol,  
University of Cambridge,  
Cardiff University,  
Durham University,  
University of Sheffield,  
University of Sussex

## Denmark

Aarhus University

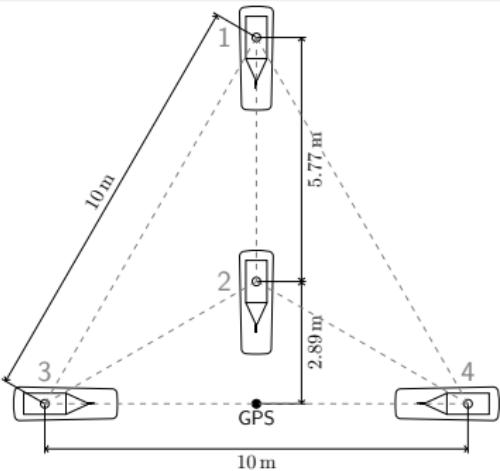
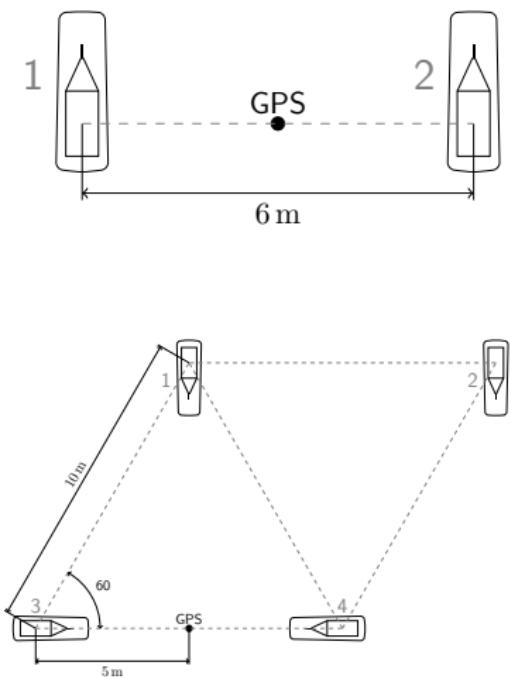


## Principle:

- If multiple detectors are hit within a narrow time window, these hits are deemed to be caused by particles from the same shower.
- We store coincidences and single rates.

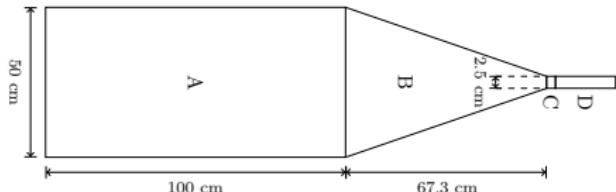


# HiSPARC Station



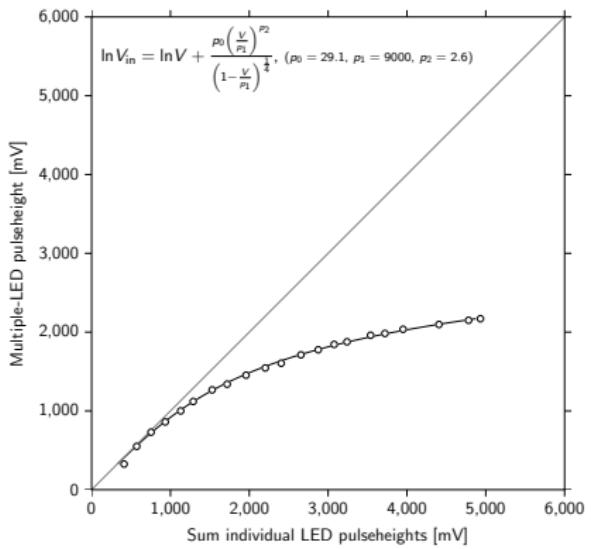
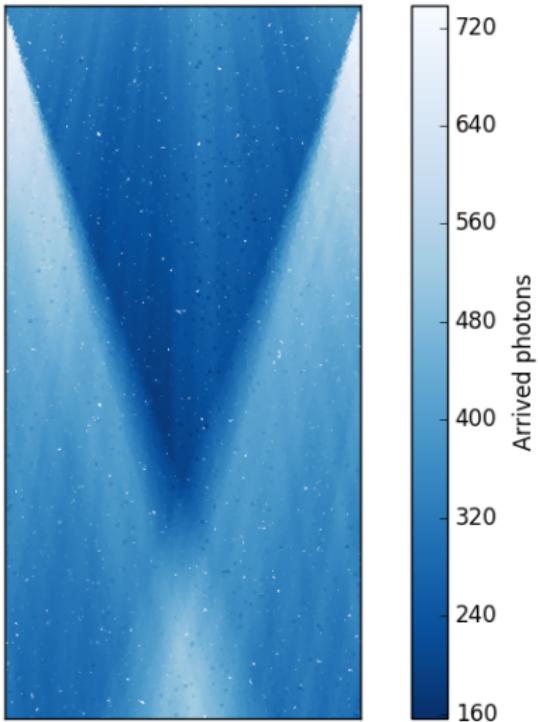
- Otherwise if no roof space available

# HiSPARC Detector

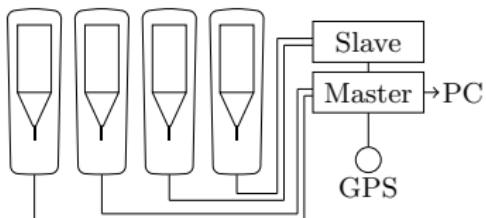


- A = Scintillator
- B = Lightguide
- C = Adaptor piece
- D = PMT

# Detector transmission



# HiSPARC Station

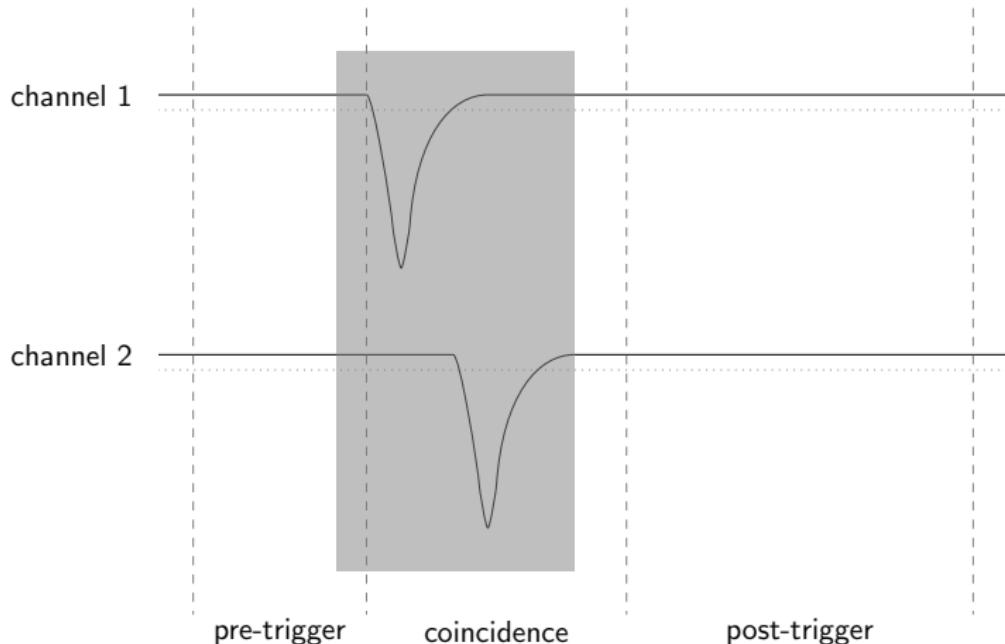


- Master & Slave combination
- 2 or 4 detectors
- GPS timestamp
- 400 MHz sample rate (2.5 ns)

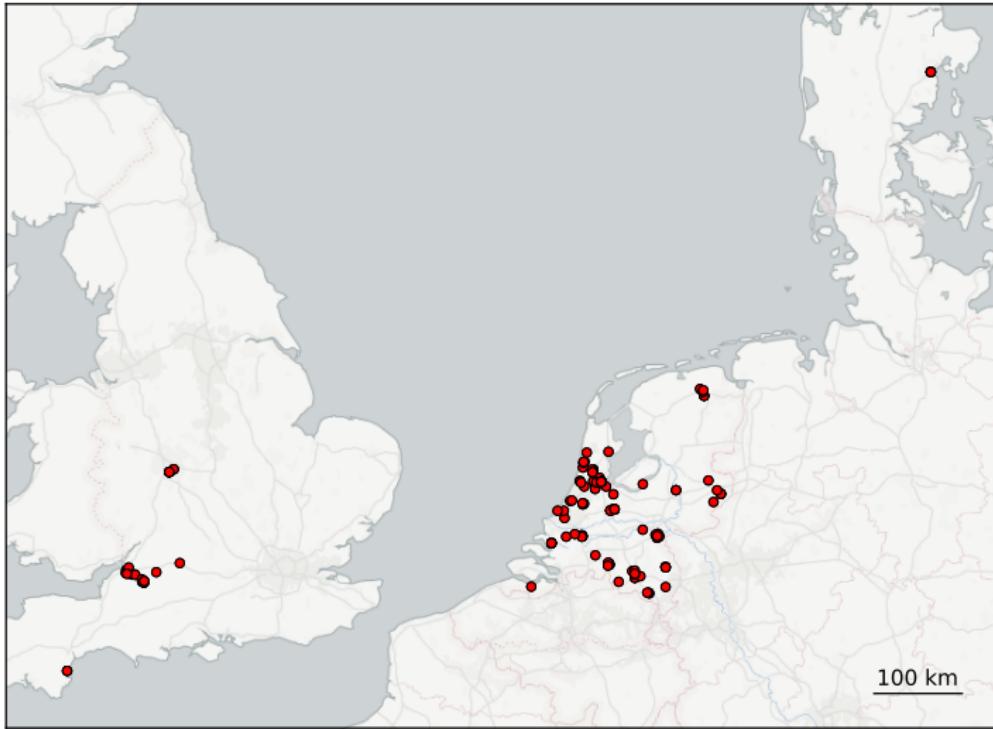
Trigger on:

- at least 2 low signals
- at least 3 low signals or 2 high signals

# Time window



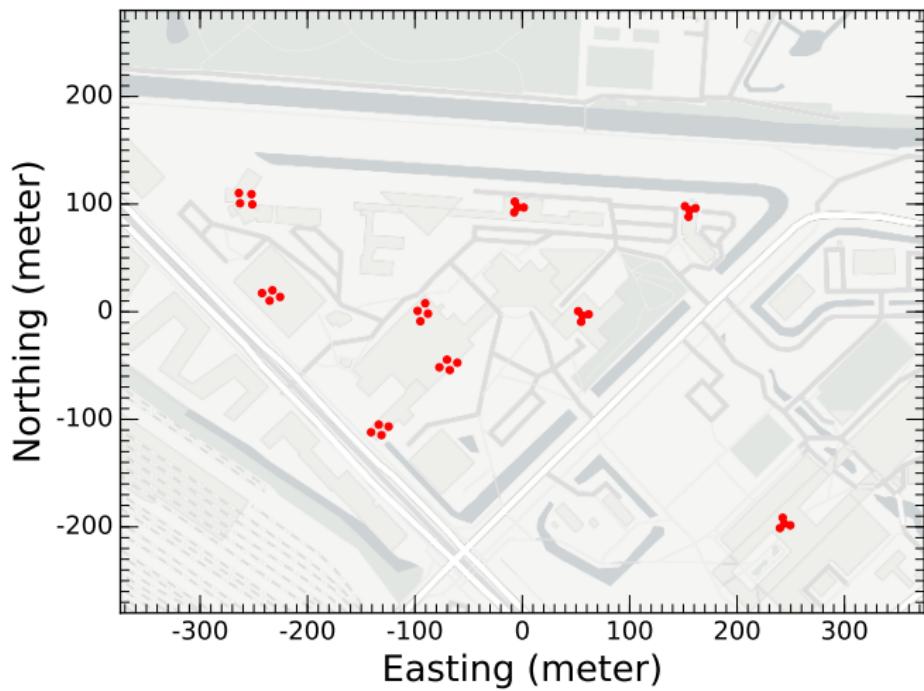
# HiSPARC Array



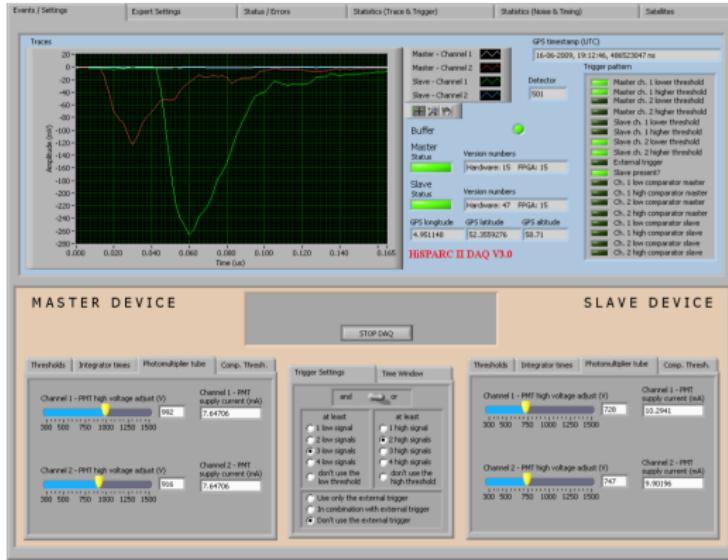
~140 stations



# Science Park Array



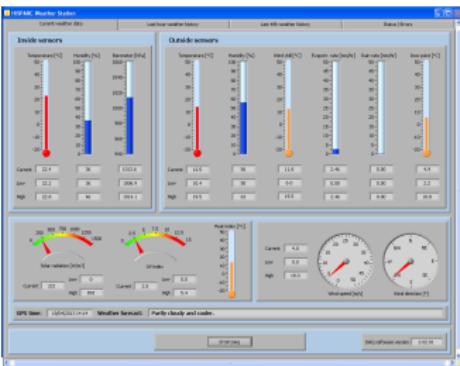
# Data Acquisition



- LabVIEW
- local data storage
- data reduction on station computer
- buffer + upload

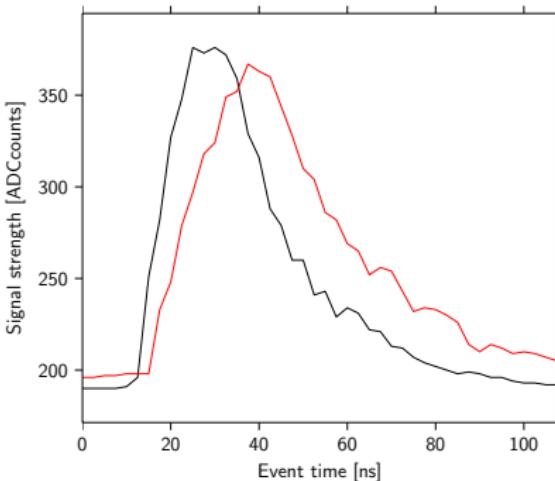


# Weather Station



# What do we store?

- Timestamp
- Signal
- Event properties
  - Baseline
  - Pulseheight
  - Pulseheight integral
  - Number of peaks
- Also: no thinning  
CORSIKA  
simulations



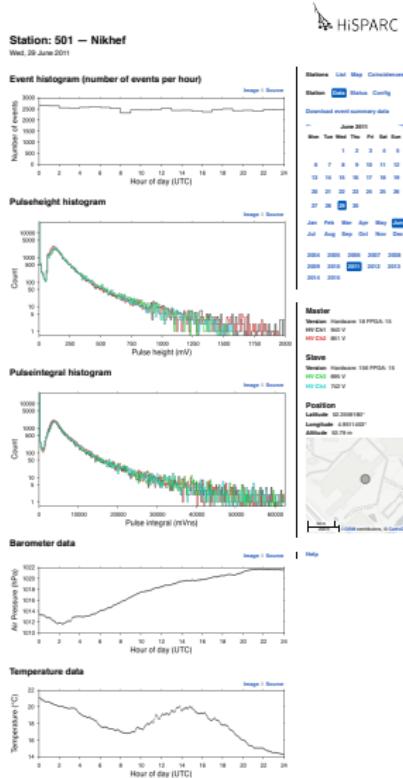
- Virtual Private Network
- Remote login
- Distributed Control System (Nagios)
- Encrypted

Service Status Details For Host 'sciencepark501'

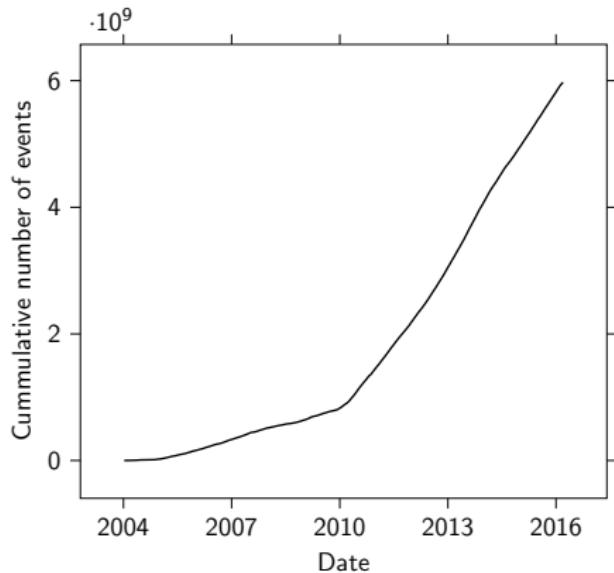
Host ↗	Service ↗	Status ↗	Last Check ↗	Duration ↗	Attempt ↗	Status Information
sciencepark501	Buffer size	OK	10-30-2011 22:54:32	7d 18h 47m 40s	1/3	Buffer DB contains 251 events
	CPU Load	OK	10-30-2011 22:57:57	7d 16h 44m 15s	1/3	CPU Load 47% (5 min average)
	Drive Space C:	OK	10-30-2011 22:57:22	7d 18h 44m 50s	1/3	c: - total: 232.88 Gb - used: 13.83 Gb (6%) - free 219.05 Gb (94%)
	EventRate 	OK	10-31-2011 15:51:32	18d 13h 23m 2s	1/3	Event rate for a period of 61,14 seconds is 0.95
	LabviewUsage	OK	10-30-2011 22:54:22	7d 17h 37m 50s	1/3	Memory usage: 39.3 Mb
	Memory Usage	OK	10-30-2011 22:56:22	7d 16h 35m 50s	1/3	Memory usage: total 2440.90 Mb - used: 771.87 Mb (32%) - free: 1669.03 Mb (68%)
	StorageGrowth 	OK	10-31-2011 15:51:33	25d 3h 3m 1s	1/3	Storage growth: -0.716667 Hz
	StorageSize 	OK	10-31-2011 15:51:31	25d 3h 3m 3s	1/3	Storage size: 5 events
	TriggerRate 	OK	10-31-2011 15:51:11	0d 1h 0m 33s	1/3	Trigger rate: 0.58 Last update: 6 seconds ago
	Uptime	OK	10-30-2011 22:57:43	7d 16h 34m 29s	1/3	System Uptime - 17 day(s) 20 hour(s) 32 minute(s)

# Data Access

- Public Database
- Application Programming Interface
- SAPPHiRE (HiSPARC analysis framework)
- jSparc (javascript library)
- Jupyter Notebooks -> see presentation Niek
- Source codes available on github



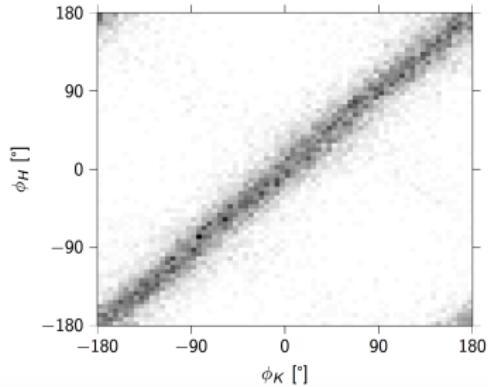
# Where are we now?



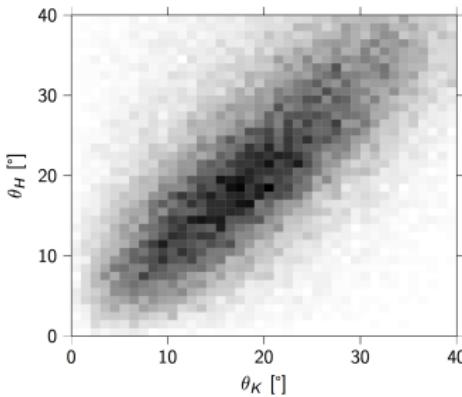
- ~140 stations
- 3 PhD theses  
(1 in prep.)
- teachers in research

# Direction Reconstruction compared with KASCADE

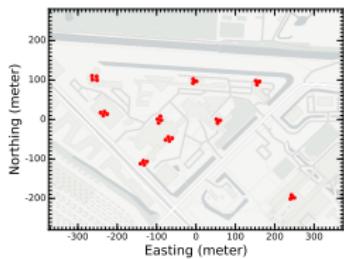
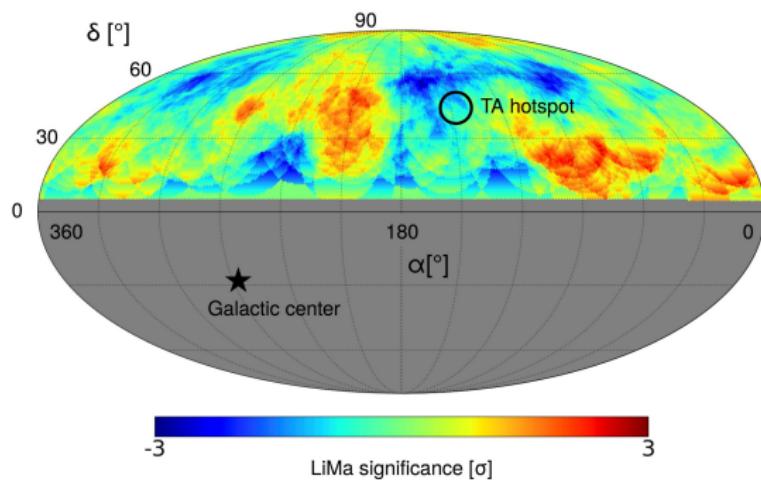
Azimuth



Zenith



# Search for a hot spot using science park array

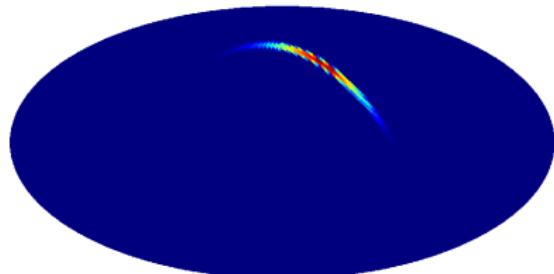
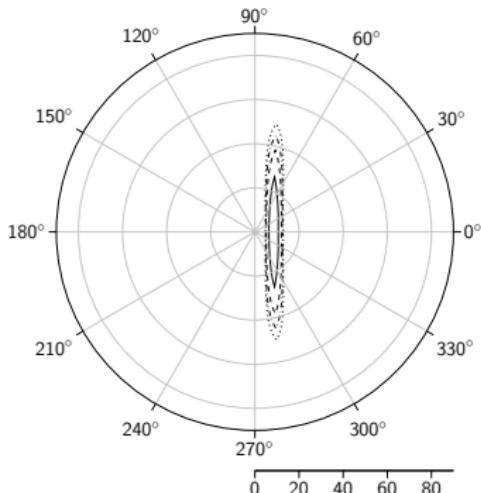


- Work of a high school teacher

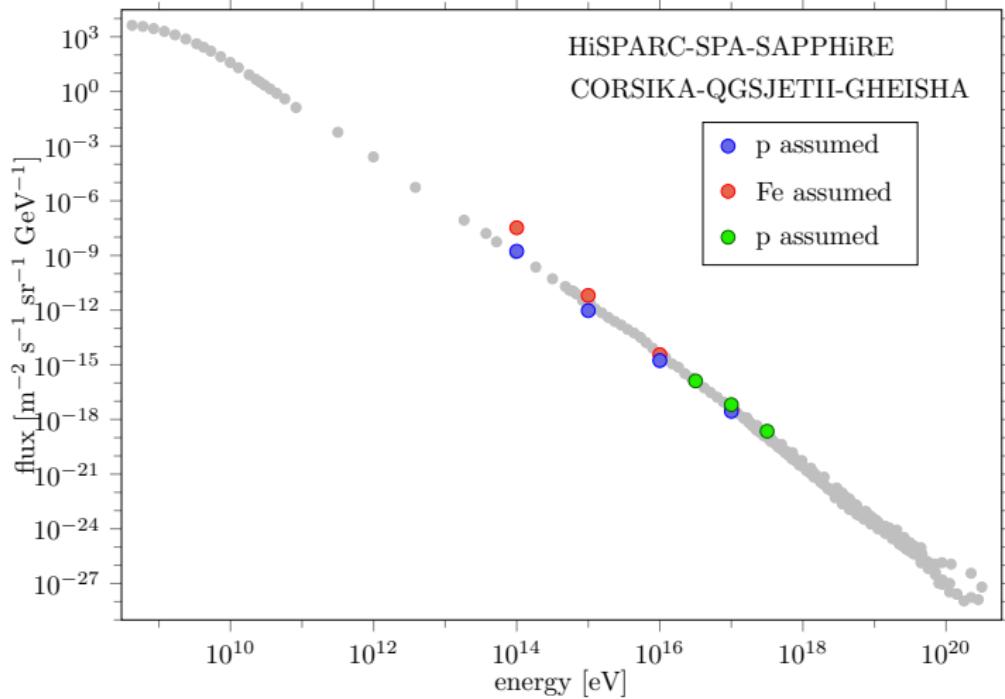


# Reconstruction two detector station

- 5 ns time difference
- 10 meter detector separation
- azimuth and zenith angles



# CR Energy Spectrum

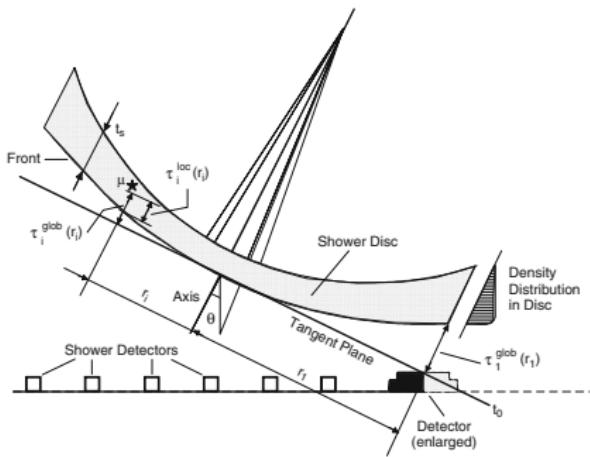


PhD thesis of Hans Montanus, in prep.



# Outlook

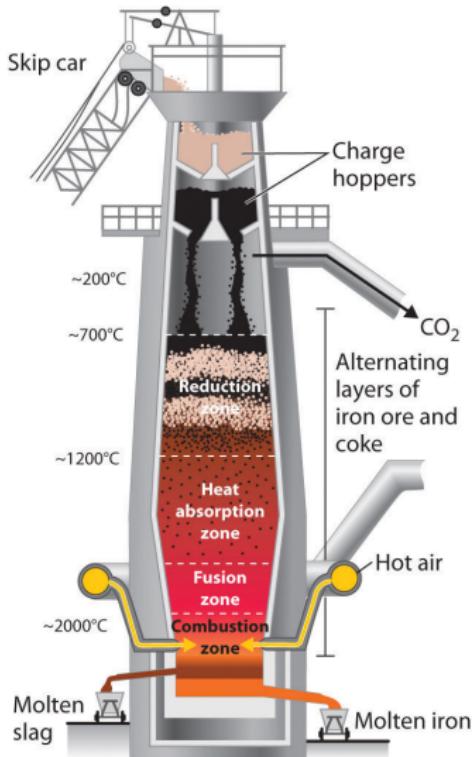
- Optimize energy reconstruction
- Only for Science Park Array
- Combine density and timing information



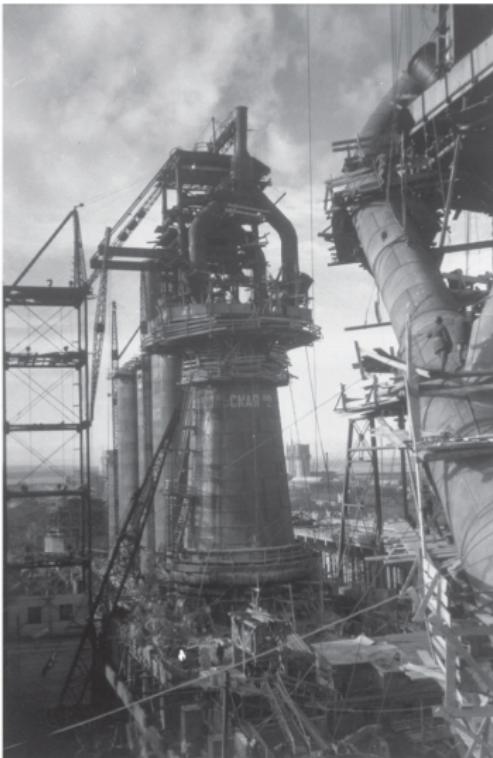
from Extensive Air Shower - Grieder

- ~140 stations
- over 6 billion events
- open data system
- analysis framework
- online programming environment
- over a decade of experience
- no thinning CORSIKA simulations
- Muon tomography steel blast furnaces

# Questions?



(a) Blast furnace



(b) World's largest blast furnace in 1931