



European Space Agency

ESA and CERN Report on Remote Internships

Kristina Jarůšková
FNSPE CTU in Prague

ESA: CAVES & PANGAEA

CAVES & PANGAEA Introduction



- Part of the **EAC - European Astronaut Center**
 - Located in Cologne, Germany
 - Astronauts space analog training
 - Astronauts, mission developers, ...
- **CAVES – Cooperative Adventure for Valuing and Exercising human behavior and performance Skills**
 - Expeditionary skills training
- **PANGAEA – Planetary Analog Geological and Astrobiological Exercise for Astronauts**
 - Geological and Astrobiological training
 - Analogue geologic environments
 - Ries Crater (Germany)
 - Dolomites (Italy)
 - Lanzarote (Canary Islands)



CAVES & PANGAEA Introduction



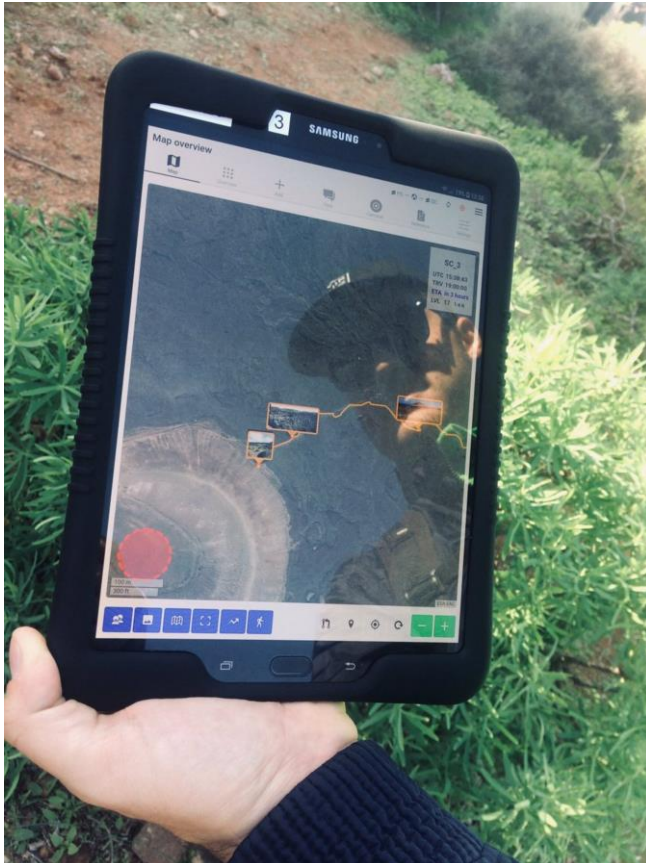
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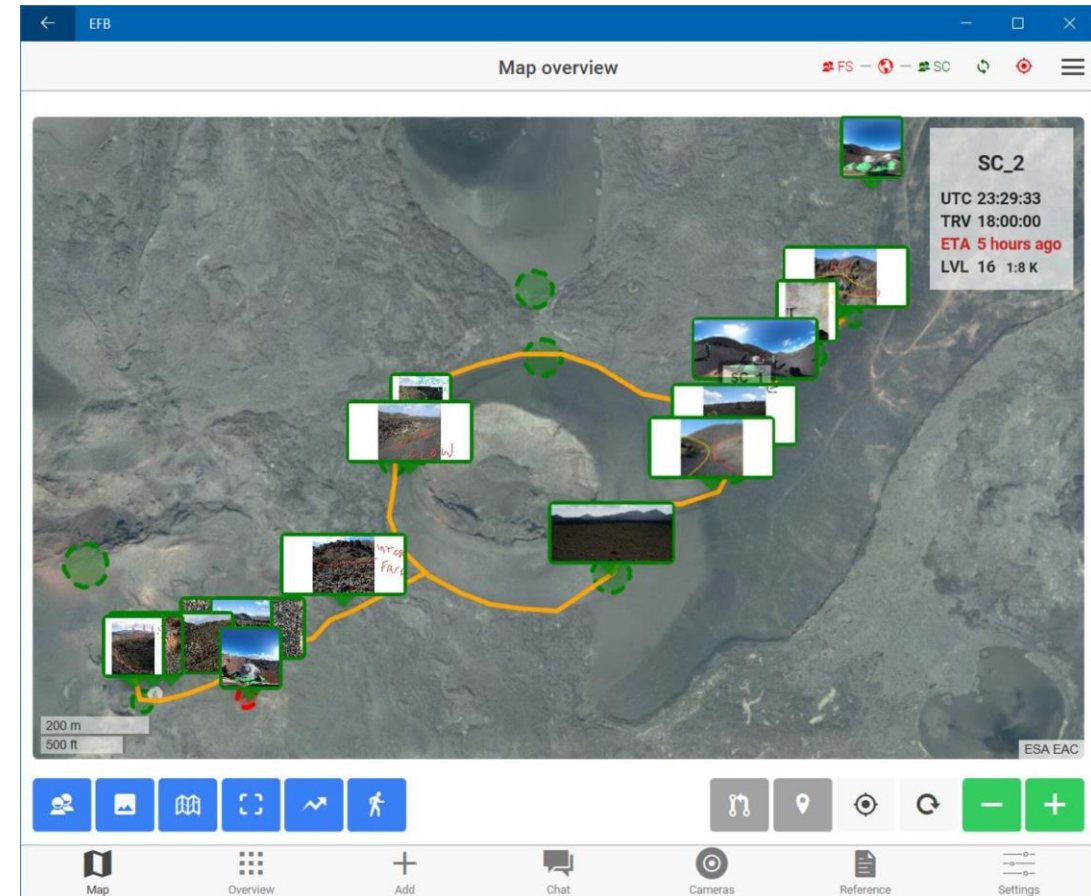
EFB - Electronic Field Book

Earth team: "Nice shot. Do you think you could take a close-up of that large boulder for us? It could be a volcanic bomb!"

Astronaut's response: "Copy that. I might also take some samples, I can see traces of olivine."



- All-In-One app for tablet or smartphone
- Map – plan of the expedition track
- Recording every step
- Link information from sensors and photos to places
- Communication with Earth team
- Mineralogical database and mineral recognition algorithm

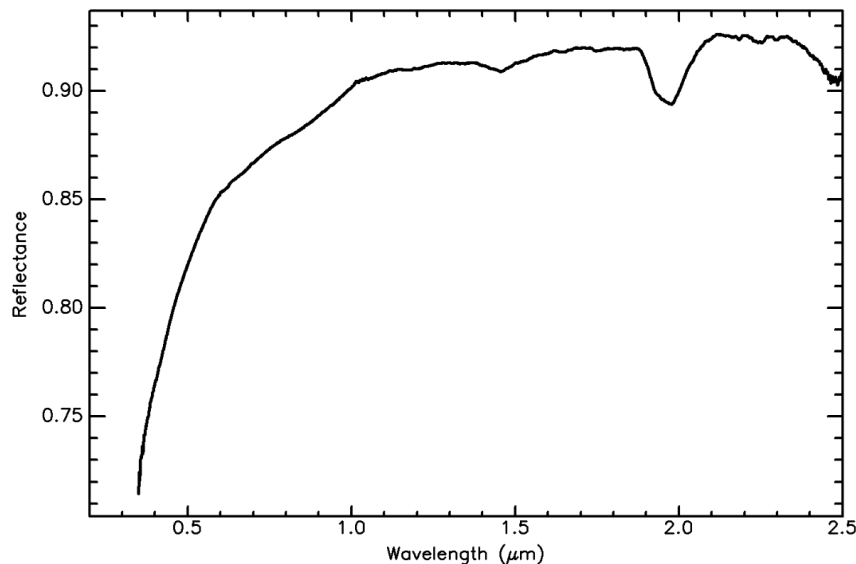
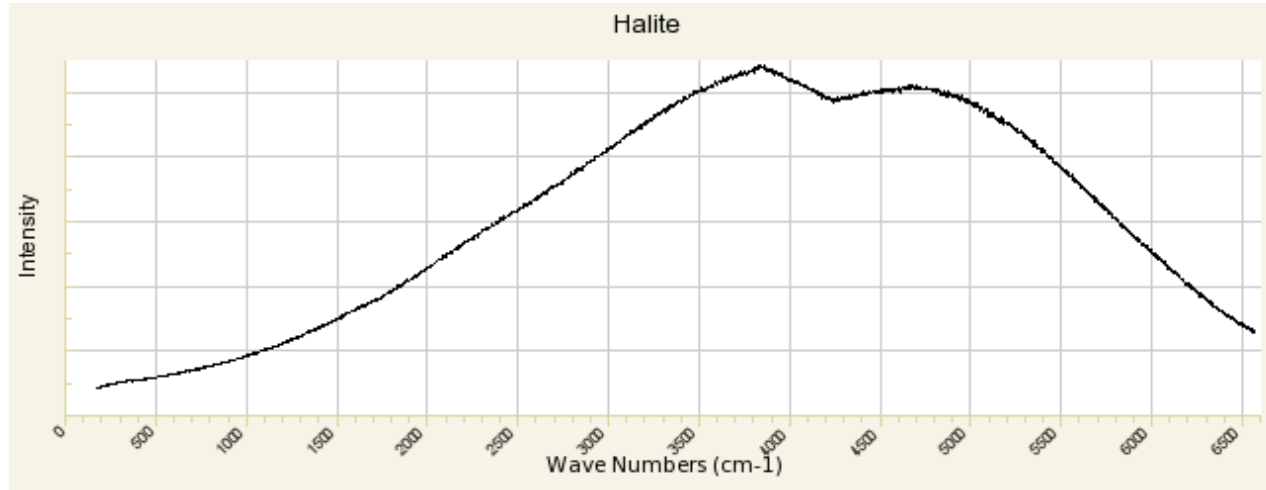


Mineral Recognition

- Mineralogical database
 - Collect real spectra of pure minerals from different sources
 - Collect spectra of mixtures
 - Different types of spectrometers
 - Raman, VNIR, LIBS, XRF, ...



1	Name	Formula	Group	Subgroup1	Subgroup 2	Structural groupname	# Raman spectra	Raman Detection	# VNIR spectra	VNIR Detection	Mars
2	Acanthite	Ag ₂ S	Sulfides			Acanthite	2				
3	Actinolite / Actinote / Actynol	(Ca ₂)(Mg _{4-5-2.5} Fe _{0.5-2.5})(Si ₈ O ₂₂)(OH) ₂	Silicates	Inosilicates	Amphibole	Amphibole	115	0.9	115	0.5	
4	Addibischoffite	Ca ₂ Al ₆ Al ₆ O ₂₀	Oxides	Metal Oxides	Sapphirine	Sapphirine					
5	Adrianite	Ca ₁₂ (Al ₄ Mg ₃ Si ₇)O ₃₂ Cl ₆	Silicates	Nesosilicates	Wadalite						
6	Aegirine / Aegirite	NaFe ³⁺ Si ₂ O ₆	Silicates	Inosilicates	Clinopyroxene	Pyroxene	50	0.9	19	0.1	Mars
7	Aenigmatite / Cossyrite	Na ₄ [Fe ²⁺ ₁₀ Ti ₂]O ₄ [Si ₁₂ O ₃₆]	Silicates	Inosilicates	Aenigmatite	Sapphirine	28				
8	Ahrensite	SiFe ₂ O ₄	Silicates	Nesosilicates	Spinel	Spinel					Mars
9	Akaganeite / Akaganéite	(Fe ³⁺ ,Ni ²⁺) ₈ (OH,O) ₁₆ Cl _{1.25} ·nH ₂ O	Oxides	Hydroxides		Coronadite	1		7		Mars
10	Akaogiite	TiO ₂	Oxides	Metal Oxides		Baddeleyite					
11	Åkermanite / Akermanite /	Ca ₂ Mg(Si ₂ O ₇)	Silicates	Sorosilicates	Melilite	Melilite	20				
12	Akimotoite	MgSiO ₃	Oxides	Metal Oxides	Ilmenite	Corundum					
13	Alabandite / Alabandine	MnS	Sulfides	Metal Sulfides	Galena	Rocksalt	4				
14	Albite	NaAlSi ₃ O ₈	Silicates	Tectosilicates	Albite	Albite	139	0.9	53	0.6	Mars



Spectra of Halite
(NaCl):

Top - Raman

Bottom - VNIR

- Classification
 - Multi-class classification – pure spectra
 - Multi-label classification – spectra of mixtures
- Possible approaches
 - Convert multi-label problem to multiple binary classification problems
 - Perform multi-label classification directly
- Problems
 - Not enough spectra of real mixtures -> create synthetic mixtures
 - Large database, large number of minerals
 - Noisy data (errors of spectrometers)

- Duration of 4 – 6 months, start in any month
- Usually on-site in Cologne, currently only remote
- Internships for undergraduate or master students
- Trainee positions (for 1 year) after graduation

- CTU and CAVES & PANGAEA
 - Pavel Jahoda (FIT CTU)
 - Tomáš Faltejsek (FIT CTU)
 - Kristina Jarůšková (FNSPE CTU)

- Links
 - [CAVES & PANGAEA](#)
 - [Internship offers](#)

Home to the European astronaut corps

Based at ESA's Astronaut Centre in Cologne, Germany:



- Luca Parmitano (IT), 2013 and 2019-20
- Alexander Gerst (DE), 2014 and 2018
- Samantha Cristoforetti (IT), 2014
- Andreas Mogensen (DK), 2015
- Tim Peake (UK), 2015-16
- Thomas Pesquet (FR), 2016-17
- Matthias Maurer (DE), began training in 2017

Back: Tim, Andreas, Alex, Luca; Front: Samantha, Thomas, Matthias ▶

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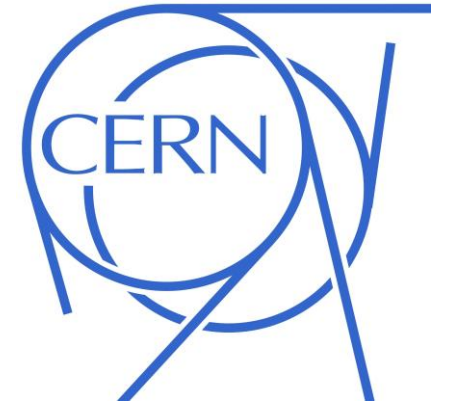


CERN openlab Summer Student Programme



CERN openlab Introduction

- R&D division at CERN
- Development of ICT (Information and Communication Technologies) solutions for scientific research
- Public-private partnership
 - Oracle, Intel, IBM, Google, Siemens



- Research topics:
 - **Machine learning and data analytics**
 - **Data-centre technologies and infrastructures**
 - **Computing performance and software**
 - **Quantum technologies**
 - **Applications in other disciplines**
(e.g. applications for satellite imagery)

3DGAN Motivation

- Simulations of detectors
 - Currently Monte Carlo algorithm
 - **Grid** – 50 % of resources devoted to simulations for LHC
 - HL-LHC will need **100x** more simulations
-> faster alternative is needed
- 3D images of energy depositions – detailed -> time consuming
- **GAN** - **Generative Adversarial Network**
 - Speed up larger than **three orders** of magnitude



3DGAN

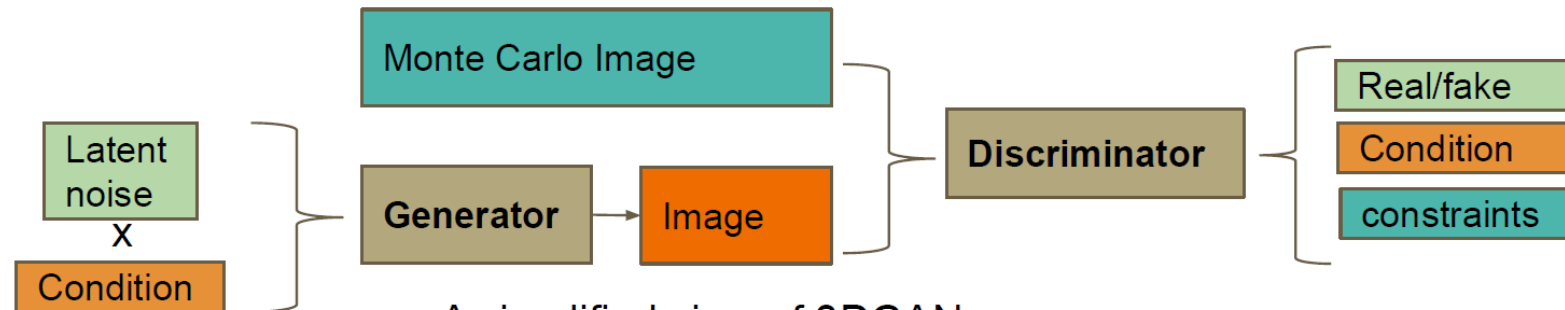
- GAN structure
 - Two networks – generator and discriminator – competing against each other
 - Trained on Monte Carlo simulated data
- Discriminator
 - Distinguishes between real and generated data
 - Provides feedback to the generator
- Generator
 - Maps latent noise vector (e.g. random sample from Gaussian distribution) to an image
 - Tries to fool the discriminator

How to evaluate the GAN?

- Does it produce similar images?
- Does it cover all possible events?
- On what feature do we want to measure the similarity?

Birthday paradox

- How many people need to be in one room if we want $P(\text{at least two people born on the same day}) > 0.5$?



A simplified view of 3DGAN

Summer Programme at CERN

- Duration of 2 – 3 months, only in the summer
 - Wide range of topics
 - Particle physics, electrotechnics, computer science, machine learning
 - Two main programs:
 - Summer Student – mostly physics
 - Openlab Summer Student – mostly computer science
 - Usually in CERN (Geneva)
 - In 2020 cancelled, specific projects done remotely
 - For undergraduate or master students (or right after graduation)
 - Other opportunities: Technical Student, PhD Programme
- Links
 - [CERN openlab](#)
 - [Internship offers](#)



Thank you for your attention!

