Mladý vedec

Samuel Amrich


Observe &
Wonder
Ask Research
Question
Design
Investigation
Collect
Evidence
Analyze &
Interpret
Share
Results
Communicate &
Collaborate

Vedecké projekty
na Ústave experimentálnej fyziky SAV

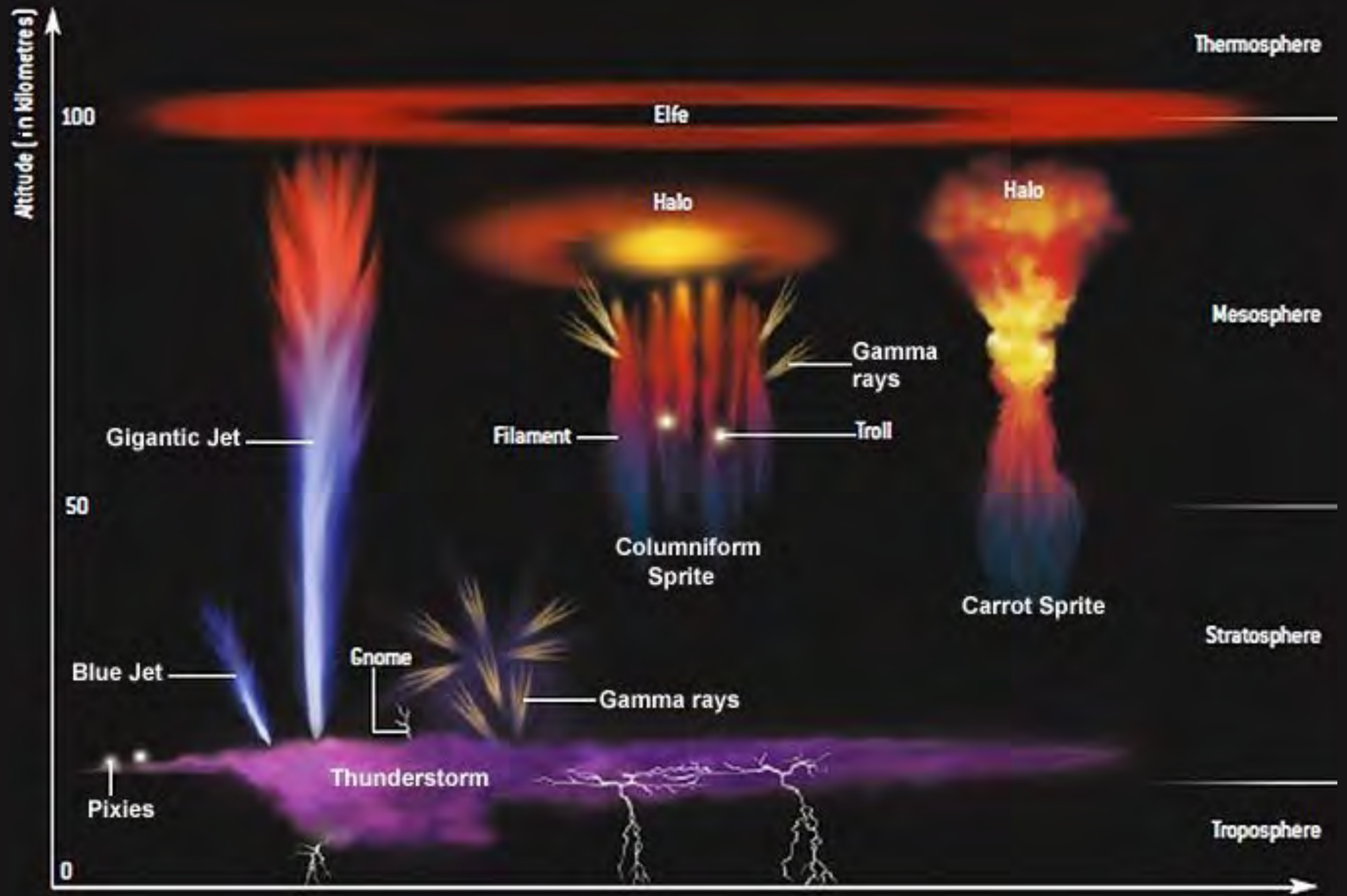
2019 - 2021

2022 - 2023

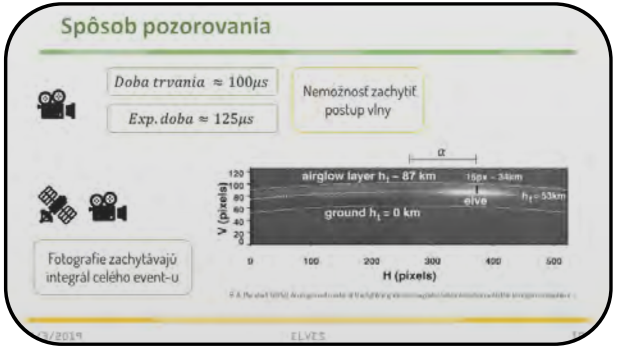
2024 - 2025

“Chcem lepšie porozumieť Atmosférickým javom na planétach a exoplanétach a to pomocou štúdia „Upper-atmospheric lightning“ v atmosfére Zeme. Štúdiom týchto úkazov v našej atmosfére môžeme lepšie porozumieť správaniu sa atmosfér na iných planétach a prípadne exoplanétach. Znalosti z konštrukcie meracej aparatúry sa v budúcnosti dajú aplikovať aj na prípadné kozmické sondy...”

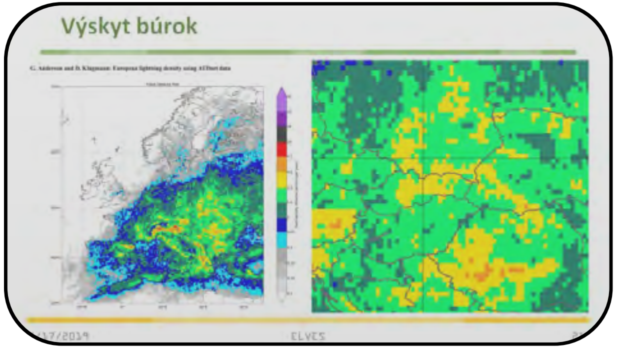
Text so Samovej prihlášky do súťaže
SPACE::PROJECT (Máj, 2019)


Altitude (in kilometres)
Thermosphere
100
Elfe
Halo
Halo
Mesosphere
Gamma
rays
Gigantic Jet
Filament
Troll
50
Columniform
Sprite
Carrot Sprite
Stratosphere
Gnome
Blue Jet
Gamma rays
Thunderstorm
Pixies
Troposphere
0

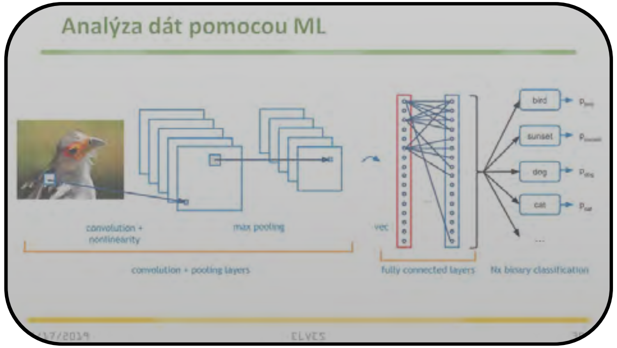
Teória okolo ELVES



Spôsoby pozorovania



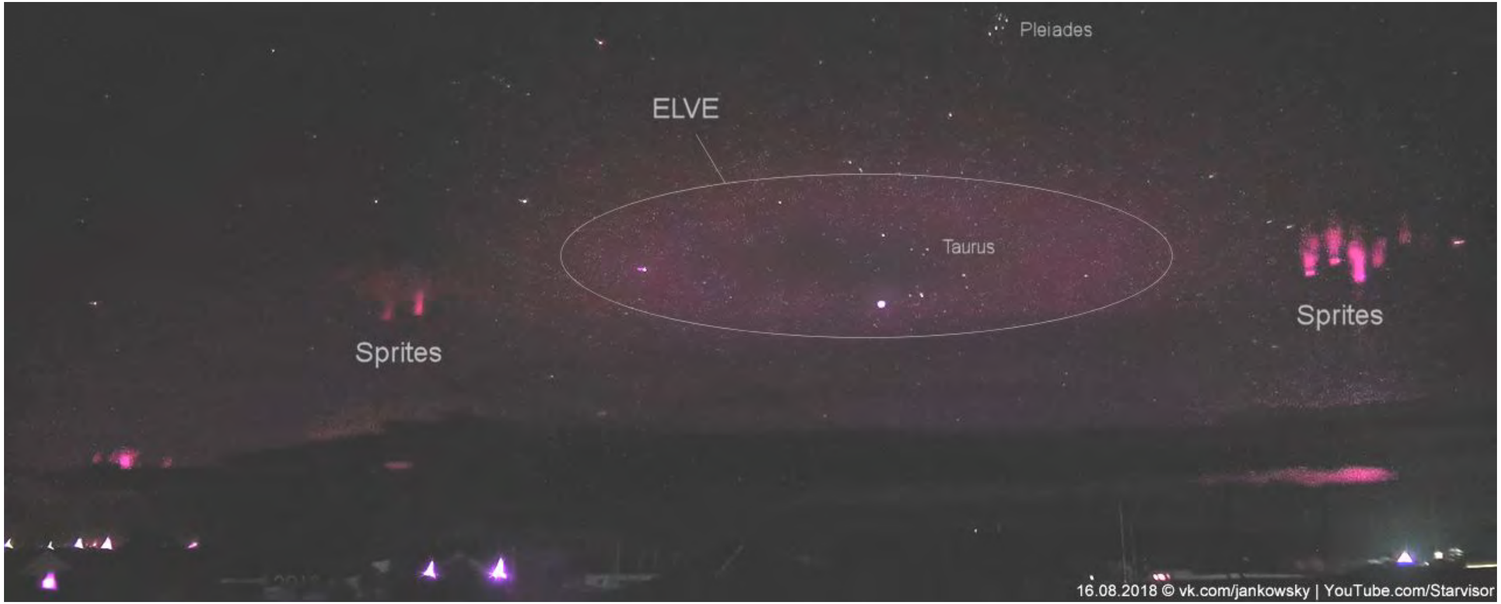
Návrh pozorovacieho st. v Kolonici



Vlastné pozorovanie/dátová analýza

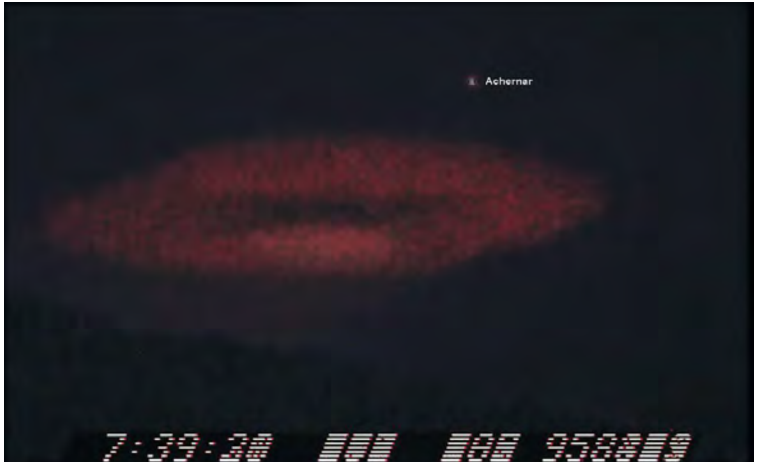
Čo sú „Elfovia“ ?

ELVES = **E**mission of **L**ight and **V**ery Low Frequency perturbations due to **E**lectromagnetic Pulse **S**ources



História pozorovania

Prvé pozorovania v ´90 rokoch



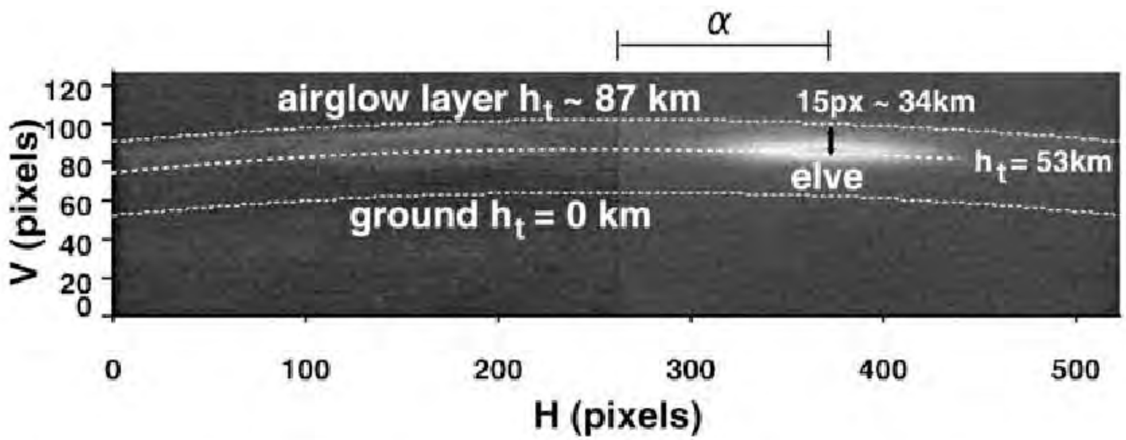
Spôsob pozorovania

$$Doba\ trvania\ \approx 100\mu s$$

$$Exp.doba \approx 125\mu s$$

Nemožnosť zachytiť postup vlny

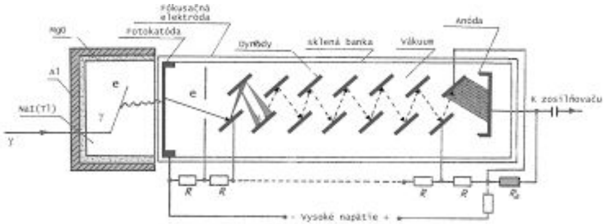
Fotografie zachytávajú integrál celého event-u



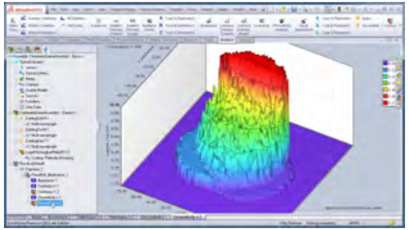
R. A. Marshall. (2012). An improved model of the lightning electromagnetic field interaction with the D-region ionosphere

Ďalšie spôsoby pozorovania

Scintilačné počítače / PMT



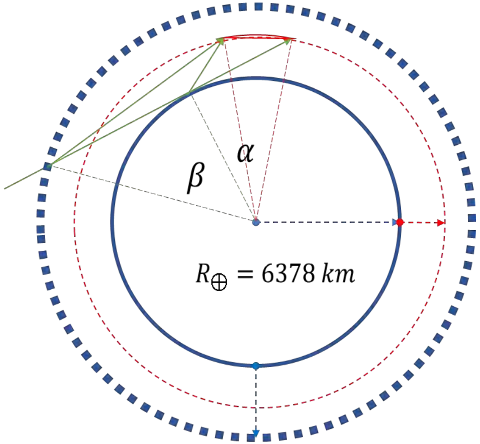
Rýchla fotometria

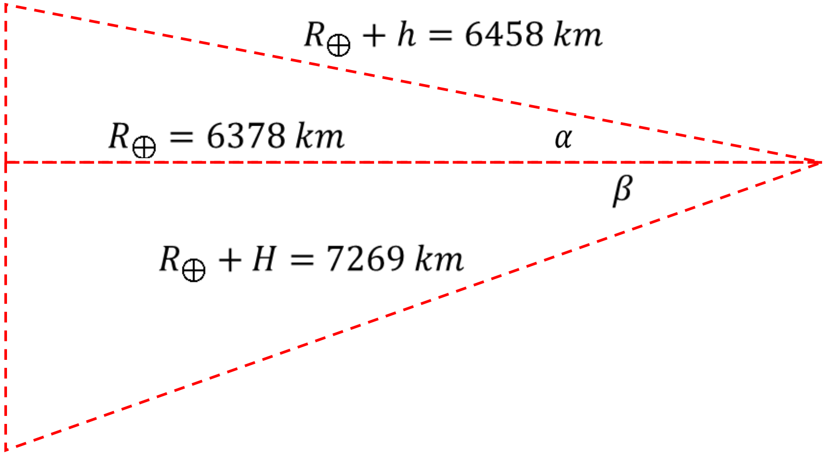


Fluorescenčné teleskopy

Poukazujú iba na prítomnosť a intenzitu

Možnosti pozorovania





$h = 85\ km$

$H = 891\ km$

$$\left(\sqrt{(R_\oplus + h)^2 - R_\oplus{}^2} + \sqrt{(R_\oplus + H)^2 - R_\oplus{}^2}\right)^2 = (R_\oplus + h)^2 + (R_\oplus + H)^2 - 2\,(R_\oplus + h)(R_\oplus + H)\cos(\beta)$$

$$\beta = \arccos\left(\frac{\left(\sqrt{(R_\oplus + h)^2 - R_\oplus{}^2} + \sqrt{(R_\oplus + H)^2 - R_\oplus{}^2}\right)^2 - (R_\oplus + h)^2 - (R_\oplus + H)^2}{-2\,(R_\oplus + h)(R_\oplus + H)}\right)$$

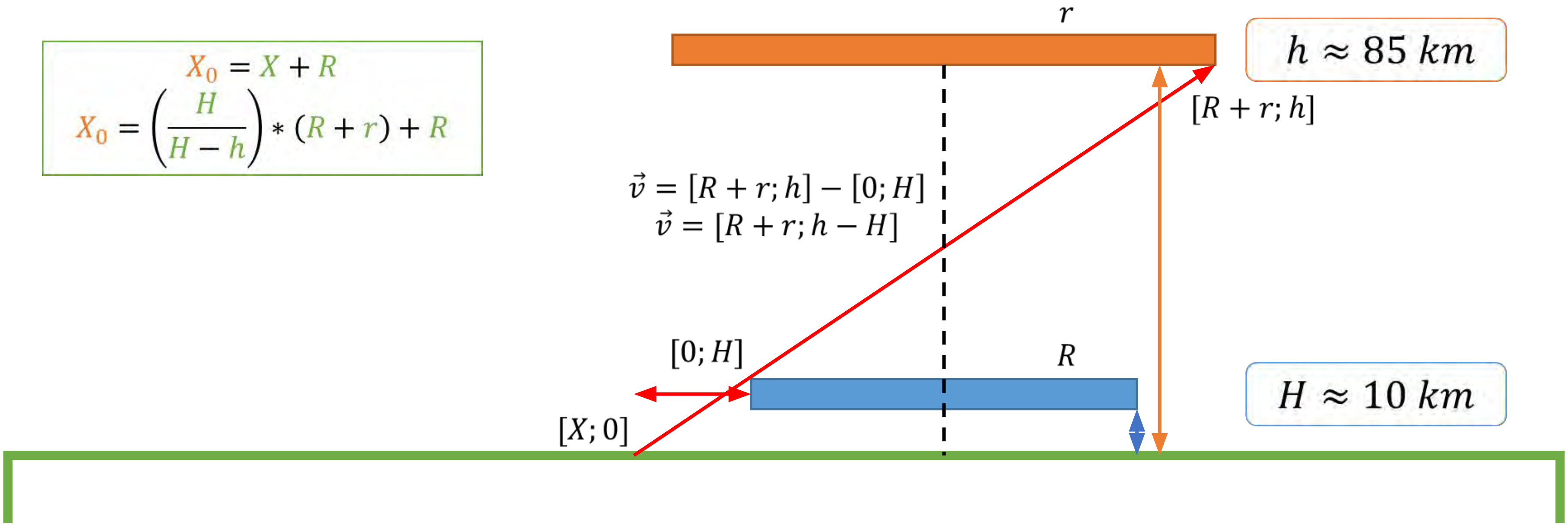
$\alpha \approx 9° \rightarrow 1000km$

$\beta = 38° \rightarrow 4500km$

Obmedzenia pozorovania

$$X_0 = X + R$$

$$X_0 = \left(\frac{H}{H-h}\right) * (R + r) + R$$



Pozorovacie možnosti stanovišťa Kolonica

Určenie výškového profilu

WGS 84

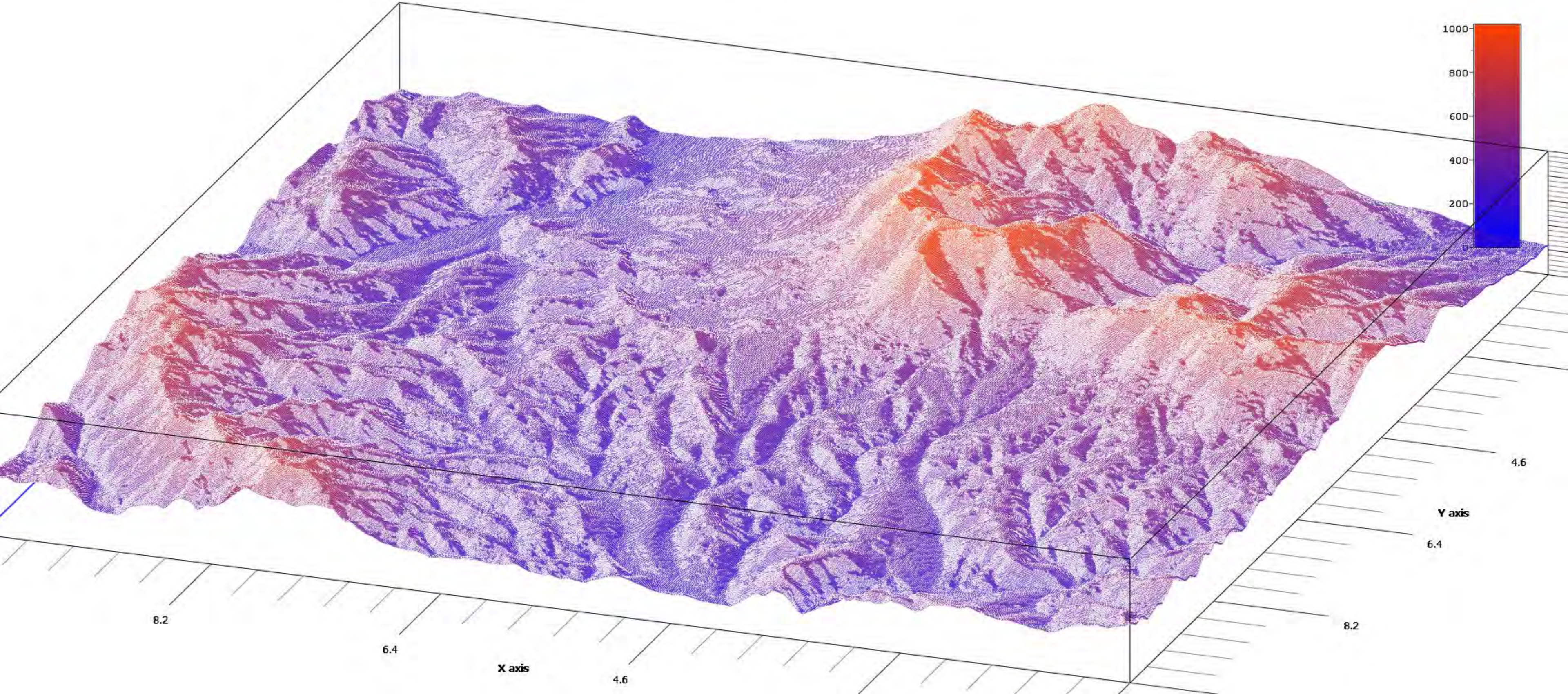
SRTM 1

Pozorovací úhly TLE vůči vzdálenosti bouře při ideálním horizontu.

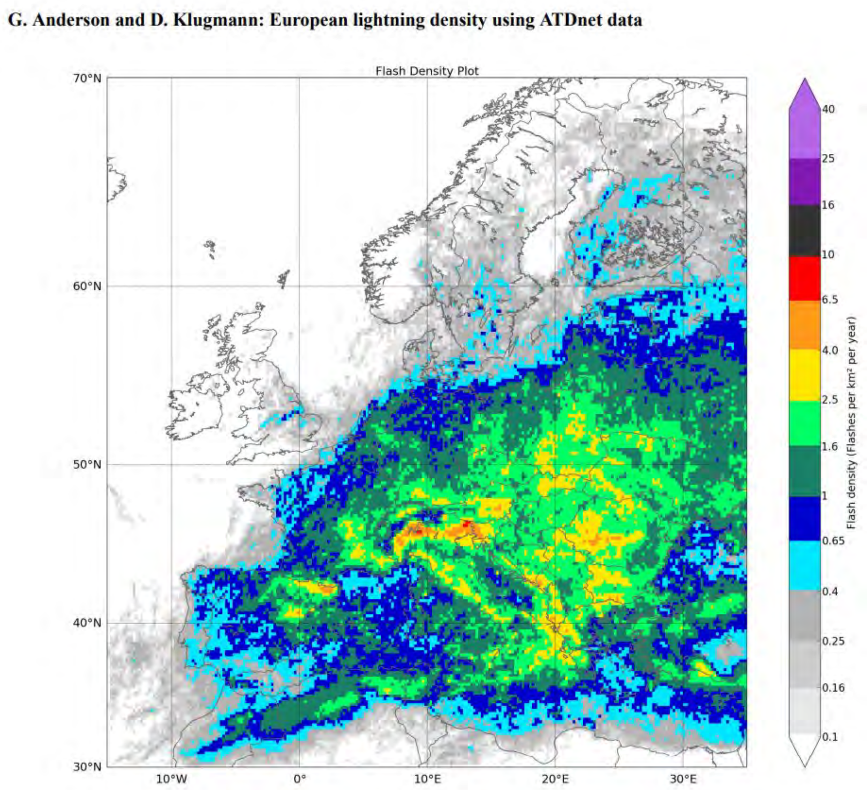
		Celý jev – výška 50-90 km				Tělo – výška 60-80 km		Elf – výška 90-95 km	
Vzdálenost:	**Střed:**	**Jednotlivý - šíře 5 km:**		**Skupina - šíře 50 km:**		**Jednotlivý - šíře 5 km:**		**Šíře 350 km:**	
25 km	**67°**	57-77°	α = 20°	43-90°	α = 47°	60-76°	α = 16°	24-148°	α = 124°
50 km	**52°**	41-63°	α = 22°	33-75°	α = 42°	50-58°	α = 8°	22-143°	α = 121°
100 km	**33,5°**	24-43°	α = 19°	21-51°	α = 30°	29-38°	α = 9°	18-128°	α = 110°
150 km	**23,5°**	16-31°	α = 15°	14-35°	α = 21°	21-28°	α = 7°	15-104°	α = 89°
200 km	**17,5°**	11-24°	α = 13°	10-26°	α = 16°	15-21°	α = 6°	13-74°	α = 61°
250 km	**14°**	9-19°	α = 10°	8-21°	α = 13°	12-17°	α = 5°	11-51°	α = 40°
300 km	**12°**	8-16°	α = 8°	7-18°	α = 11°	9-14°	α = 5°	9-36°	α = 27°
350 km	**10°**	6-14°	α = 8°	5-15°	α = 10°	7-12°	α = 5°	8-28°	α = 20°
400 km	**8,5°**	5-12°	α = 7°	4-13°	α = 9°	6-10°	α = 4°	7-22°	α = 15°
450 km	**7°**	4-10°	α = 6°	3-11°	α = 8°	6-9°	α = 3°	6-18°	α = 12°
500 km	**5,5°**	3-8°	α = 5°	2-9°	α = 7°	4-7°	α = 3°	5-15°	α = 10°
550 km	**4,5°**	2-7°	α = 5°	2-8°	α = 6°	3-7°	α = 4°	4-13°	α = 9°
600 km	**4°**	2-6°	α = 4°	2-7°	α = 5°	3-6°	α = 3°	3-11°	α = 8°
650 km	**3,5°**	2-5°	α = 3°	2-5°	α = 3°	2-5°	α = 3°	3-9°	α = 6°
700 km	**2,5°**	1-4°	α = 3°	1-4°	α = 3°	1-4°	α = 3°	2-8°	α = 6°
750 km	**2°**	1-3°	α = 2°	1-3°	α = 2°	1-3°	α = 2°	2-7°	α = 5°
800 km	**1°**	0-2°	α = 2°	0-2°	α = 2°	0-2°	α = 2°	1-6°	α = 5°

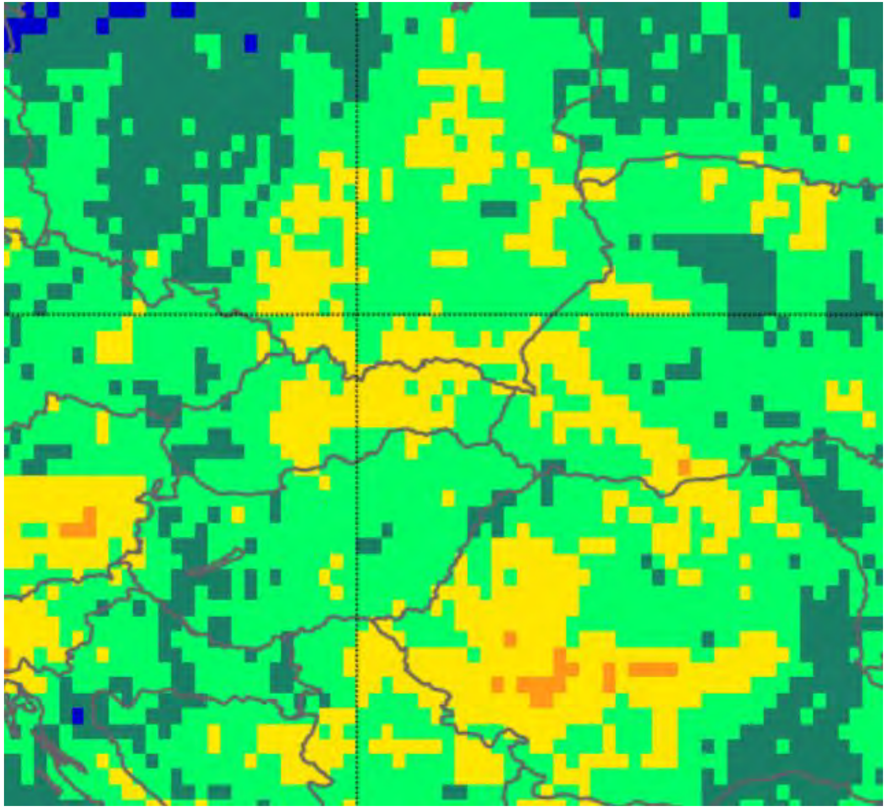
Autor: Daniel Ščerba (www.scerba-daniel.cz , daniel.scerba@post.cz). Consultation and support: Martin Popek

Výškový profil



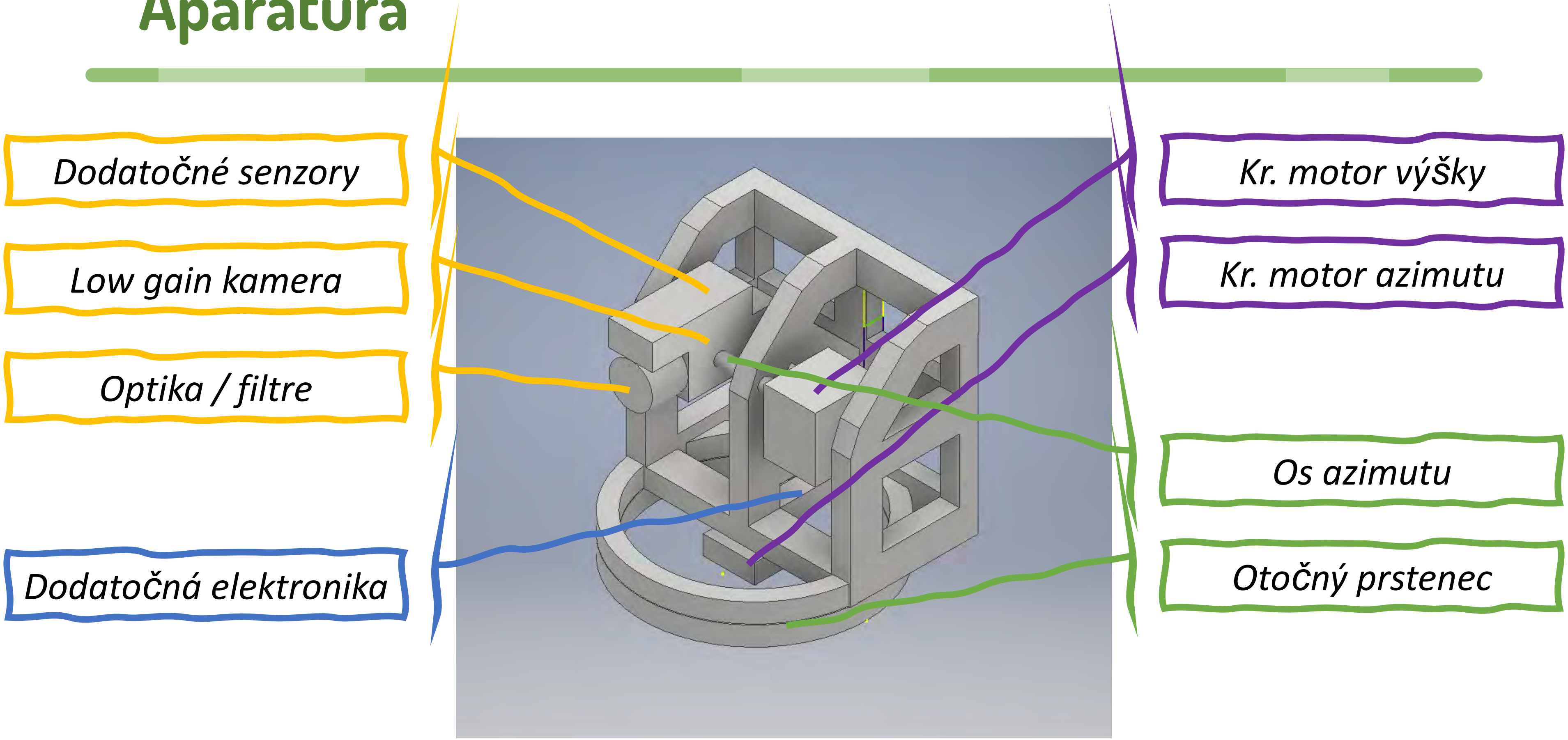
Výskyt búrok



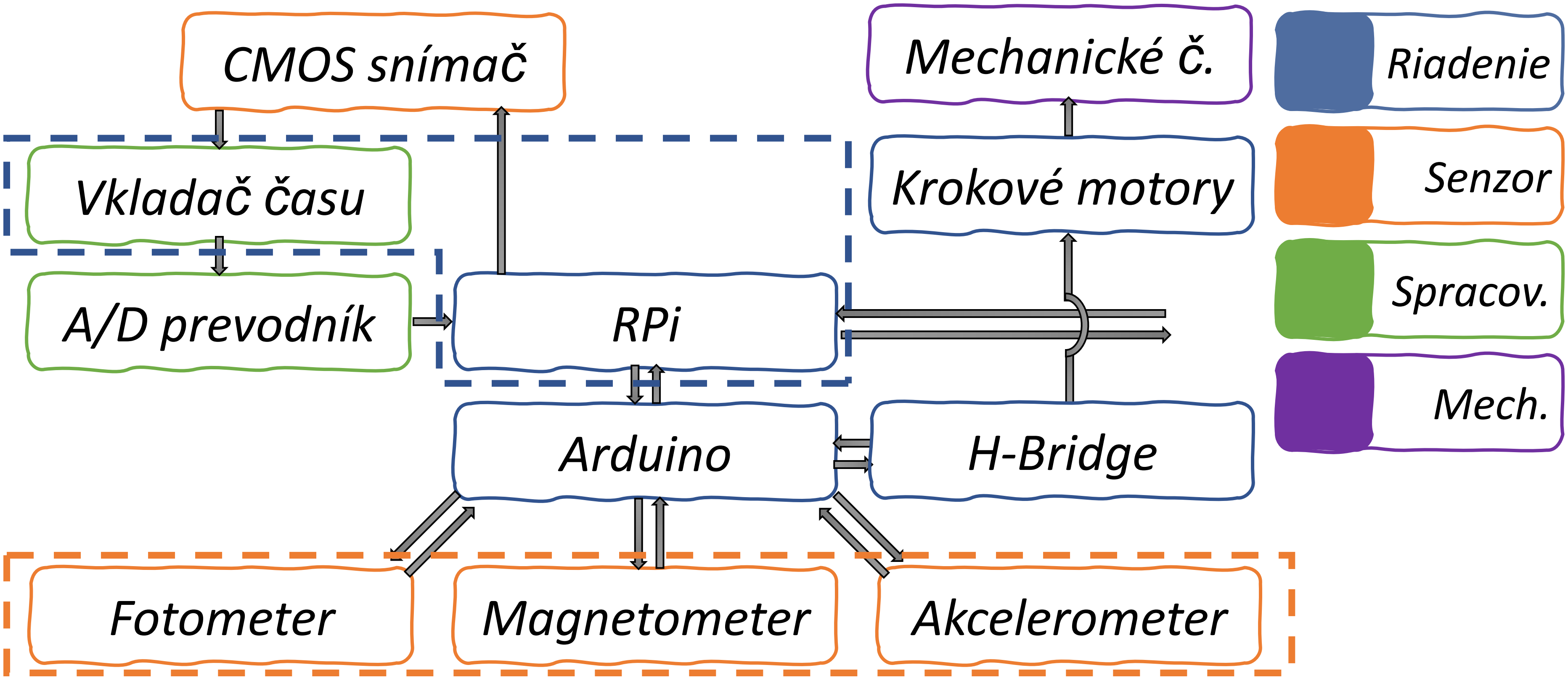


Pozorovacie možnosti stanovišťa Kolonica

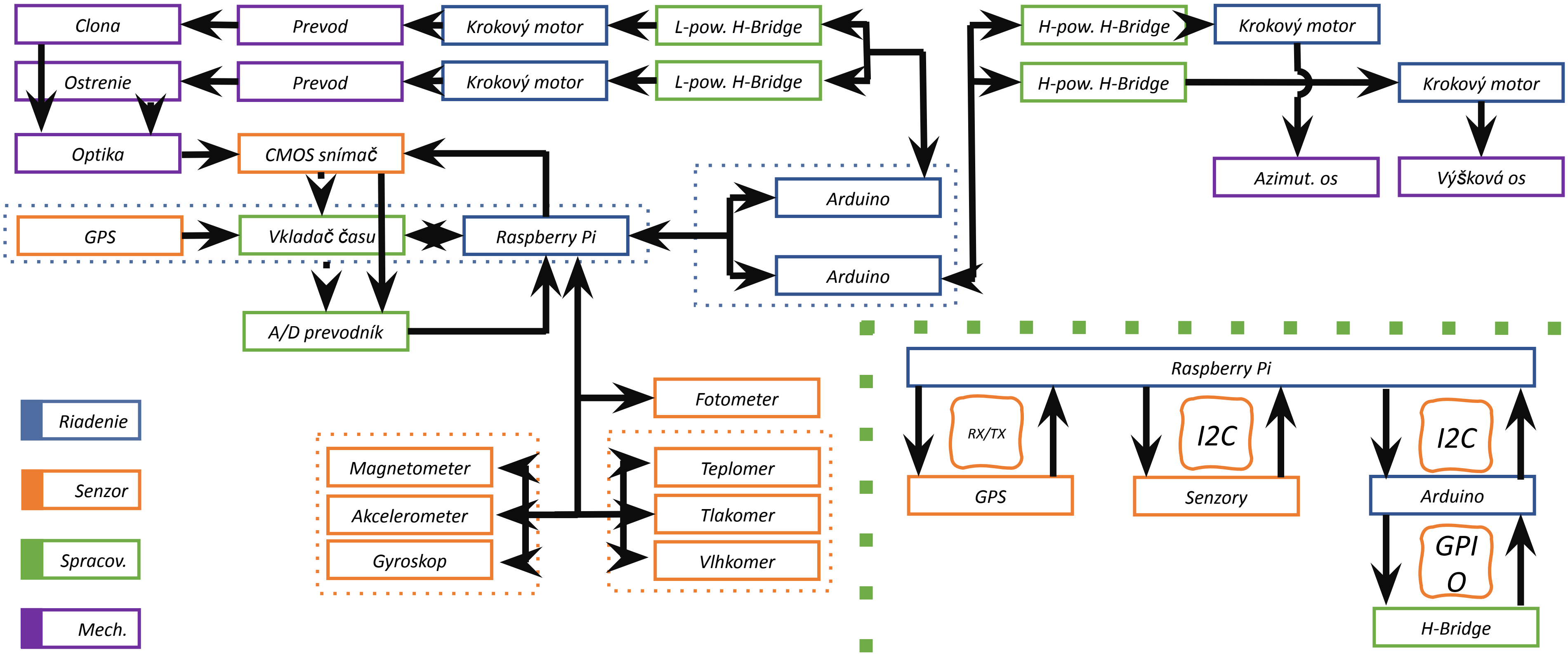
Aparatúra


Dodatočné senzory
Low gain kamera
Optika / filtre
Dodatočná elektronika
Kr. motor výšky
Kr. motor azimutu
Os azimutu
Otočný prstenec

Aparatúra - schéma

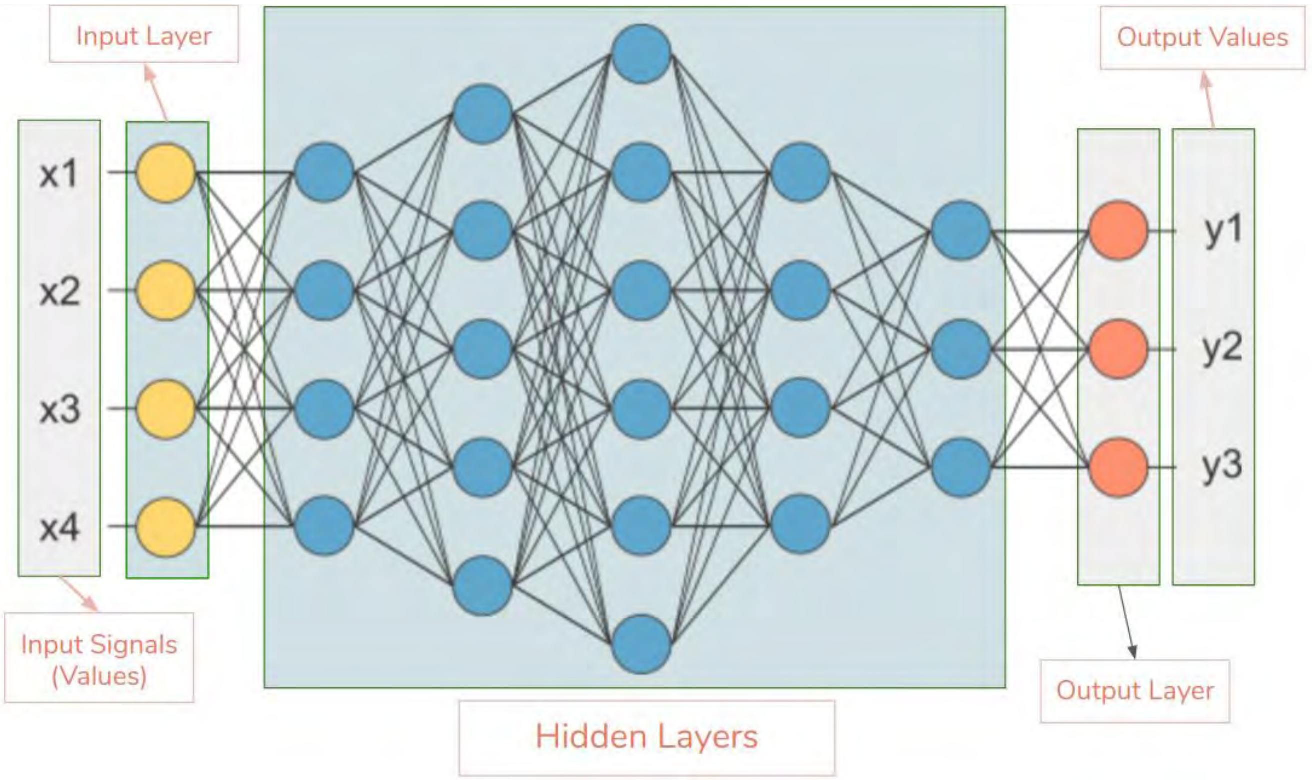


Full schéma



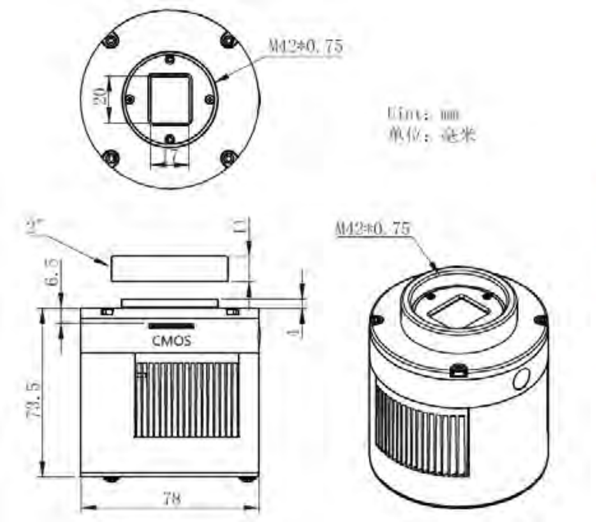
Clona
Prevod
Krokový motor
L-pow. H-Bridge
Ostrenie
Prevod
Krokový motor
L-pow. H-Bridge
H-pow. H-Bridge
Krokový motor
H-pow. H-Bridge
Krokový motor
Azimut. os
Výšková os
Optika
CMOS snímač
Arduino
GPS
Vkladač času
Raspberry Pi
Arduino
A/D prevodník
Raspberry Pi
RX/TX
I2C
I2C
GPS
Senzory
Arduino
GPI O
H-Bridge
Fotometer
Magnetometer
Akcelerometer
Gyroskop
Teplomer
Tlakomer
Vlhkomer
Riadenie
Senzor
Spracov.
Mech.

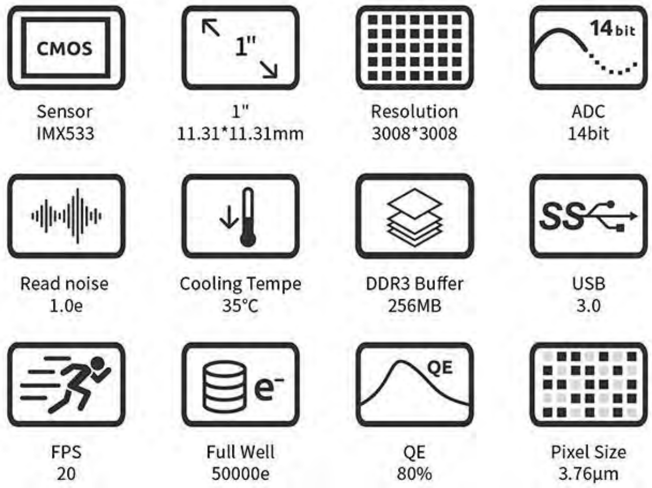
Analýza dát pomocou ML



Návrh aparatúry Kamerový box

Kamerový modul – Použitá kamera

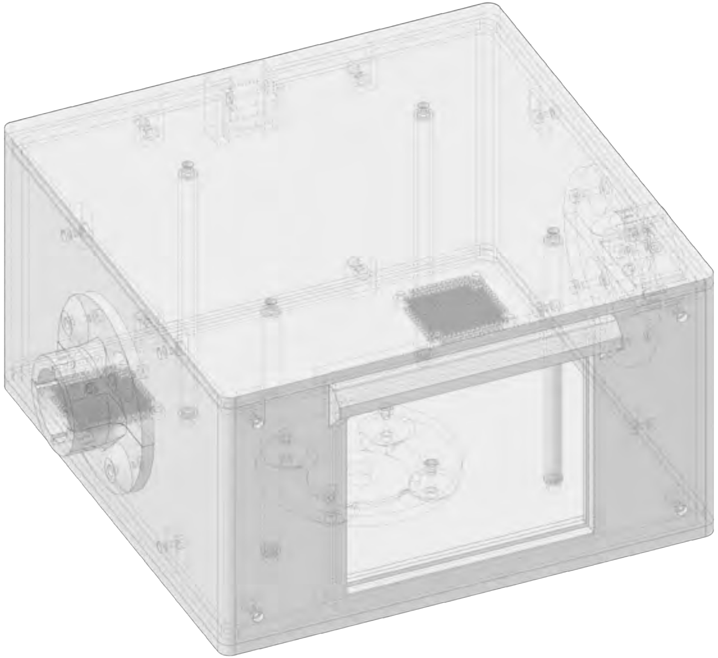




Kamerový modul – Použitý objektív

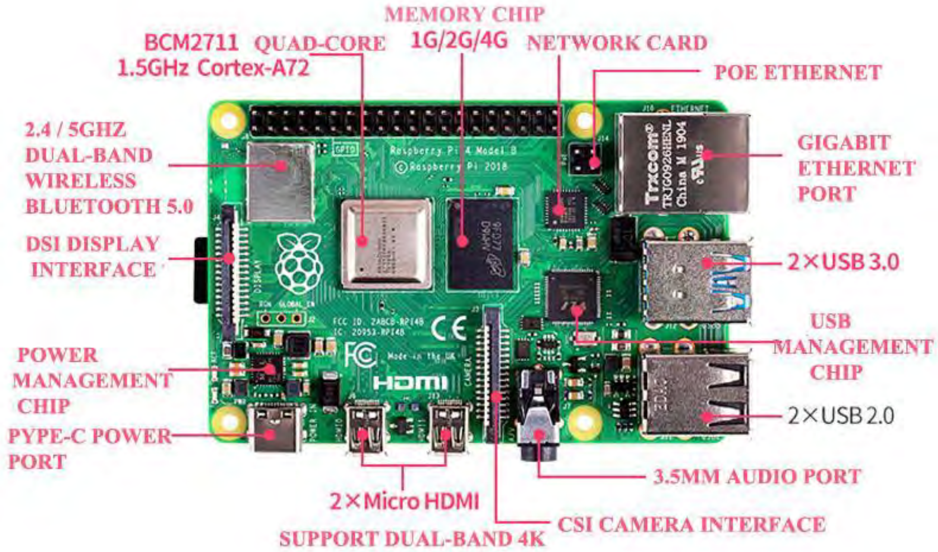
- Ohnisková vzdialenosť objektívu : 24 mm
- Maximálna / Minimálna clona: f/1.4 - f/22
- Zorný uhol : 84.1° / 57.6° (Full Frame / APS-C)
- Konštrukcia objektívu : 13 členov / 12 skupín
- Počet lamiel clony: 8
- Minimálna zaostriteľná vzdialenosť: 0,25m
- Rozmery: 97.5 x 83 mm
- Hmotnosť: 580g

Kamerový modul - Box



Použitý SBC

Raspberry pi 4 (4 GB)



CPU_freq = 1.5 GHz

CPU_freq_OC = 2.0 GHz

GPU_freq = 0.5 GHz

GPU_freq_OC = 0.75 GHz

Metóda prevádzky

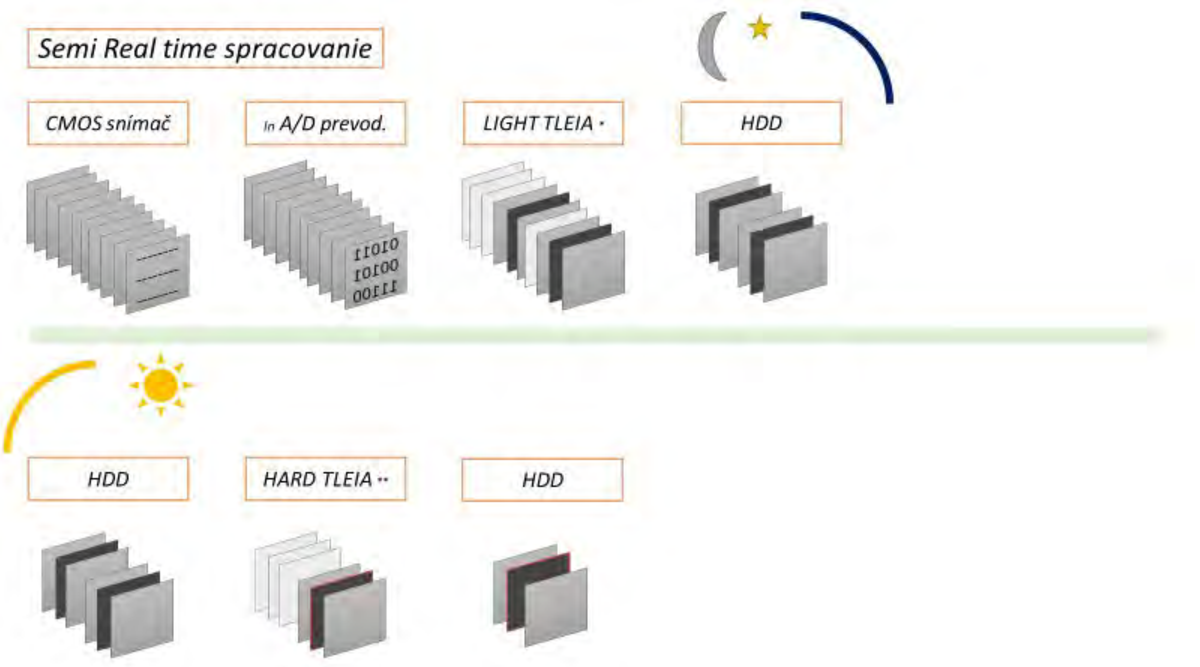
Motivácia

Zjednodušiť pozorovanie TLE automatizáciou identifikácie javov

Využitie nástrojov urýchľujúcich klasifikáciu javov

Možnosť objaviť nové úkazy a javy počas TLE

Schéma


Semi Real time spracovanie
CMOS snímač
In A/D prevod.
LIGHT TLEIA •
HDD
11010
10100
00111
HDD
HARD TLEIA ••
HDD

Spracovanie dát

720x576 px

250x200 px

Model neurónovej siete - Cerberus

```python
# Vytvorenie modelu Huge

tleia_model_phoenix = Sequential([
    Conv2D(16, 3, padding='same', activation='relu',
           input_shape=(IMG_HEIGHT, IMG_WIDTH ,3)),
    MaxPooling2D(),
    Dropout(0.1),

    Conv2D(32, 3, padding='same', activation='relu'),
    MaxPooling2D(),
    Dropout(0.1),

    Conv2D(64, 3, padding='same', activation='relu'),
    MaxPooling2D(),
    Dropout(0.1),

    Conv2D(128, 3, padding='same', activation='relu'),
    MaxPooling2D(),
    Dropout(0.1),

    Flatten(),

    Dense(512, activation='sigmoid', use_bias=True),
    Dropout(0.05),

    Dense(1024, activation='sigmoid', use_bias=True),
    Dropout(0.05),

    Dense(512, activation='sigmoid', use_bias=True),
    Dropout(0.05),

    Dense(1, activation='sigmoid', use_bias=True)

    ])
```

```
Model: "sequential_10"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_40 (Conv2D)           (None, 200, 250, 16)      448
_________________________________________________________________
max_pooling2d_40 (MaxPooling (None, 100, 125, 16)      0
_________________________________________________________________
dropout_70 (Dropout)         (None, 100, 125, 16)      0
_________________________________________________________________
conv2d_41 (Conv2D)           (None, 100, 125, 32)      4640
_________________________________________________________________
max_pooling2d_41 (MaxPooling (None, 50, 62, 32)        0
_________________________________________________________________
dropout_71 (Dropout)         (None, 50, 62, 32)        0
_________________________________________________________________
conv2d_42 (Conv2D)           (None, 50, 62, 64)        18496
_________________________________________________________________
max_pooling2d_42 (MaxPooling (None, 25, 31, 64)        0
_________________________________________________________________
dropout_72 (Dropout)         (None, 25, 31, 64)        0
_________________________________________________________________
conv2d_43 (Conv2D)           (None, 25, 31, 128)       73856
_________________________________________________________________
max_pooling2d_43 (MaxPooling (None, 12, 15, 128)       0
_________________________________________________________________
dropout_73 (Dropout)         (None, 12, 15, 128)       0
_________________________________________________________________
flatten_10 (Flatten)         (None, 23040)             0
_________________________________________________________________
dense_40 (Dense)             (None, 512)               11796992
_________________________________________________________________
dropout_74 (Dropout)         (None, 512)               0
_________________________________________________________________
dense_41 (Dense)             (None, 1024)              525312
_________________________________________________________________
dropout_75 (Dropout)         (None, 1024)              0
_________________________________________________________________
dense_42 (Dense)             (None, 512)               524800
_________________________________________________________________
dropout_76 (Dropout)         (None, 512)               0
_________________________________________________________________
dense_43 (Dense)             (None, 1)                 513
=================================================================
Total params: 12,945,057
Trainable params: 12,945,057
Non-trainable params: 0
_________________________________________________________________
```

Event

Nothing

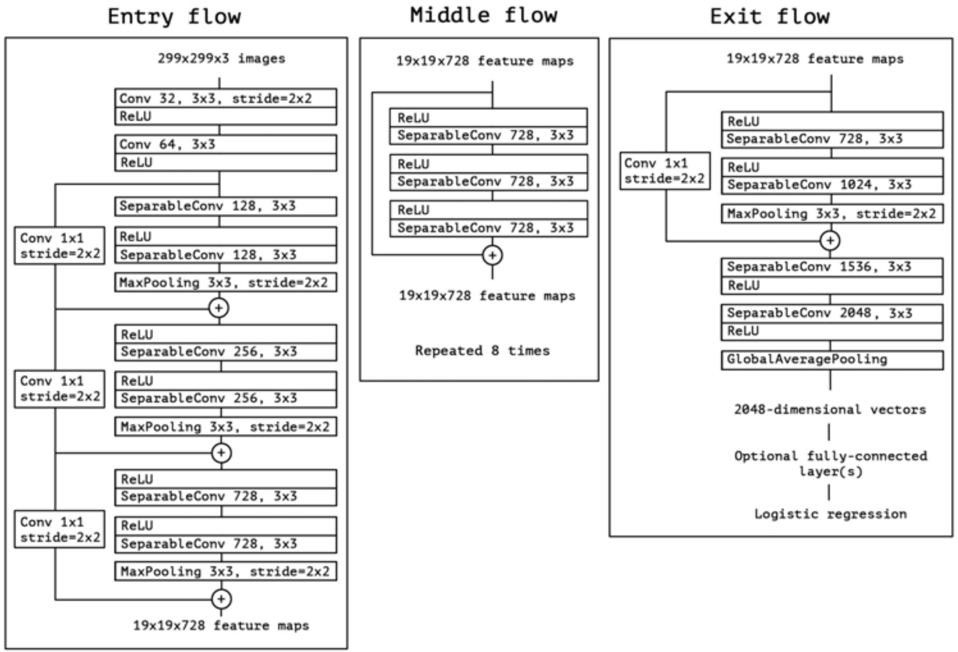
```python
# Skompilovanie modelu a jeho sumarizacia Huge

METRICS = [
        keras.metrics.TruePositives(name='TN'),
        keras.metrics.FalsePositives(name='FN'),
        keras.metrics.TrueNegatives(name='TP'),
        keras.metrics.FalseNegatives(name='FP'),
        keras.metrics.BinaryAccuracy(name='accuracy'),
        keras.metrics.Precision(name='precision'),
        keras.metrics.Recall(name='recall'),
        keras.metrics.AUC(name='auc'),
        keras.metrics.SpecificityAtSensitivity(0.25, name="SpecATSen")
        ]

tleia_model_phoenix.compile(optimizer='adam',   #Pod+la porovnani najlepsi optimizer
                loss=tf.keras.losses.BinaryCrossentropy(from_logits=True),
                metrics=METRICS)

tleia_model_phoenix.summary()
```

Model neurónovej siete - Hydra



Elves

Meteor

Sprite

Nothing

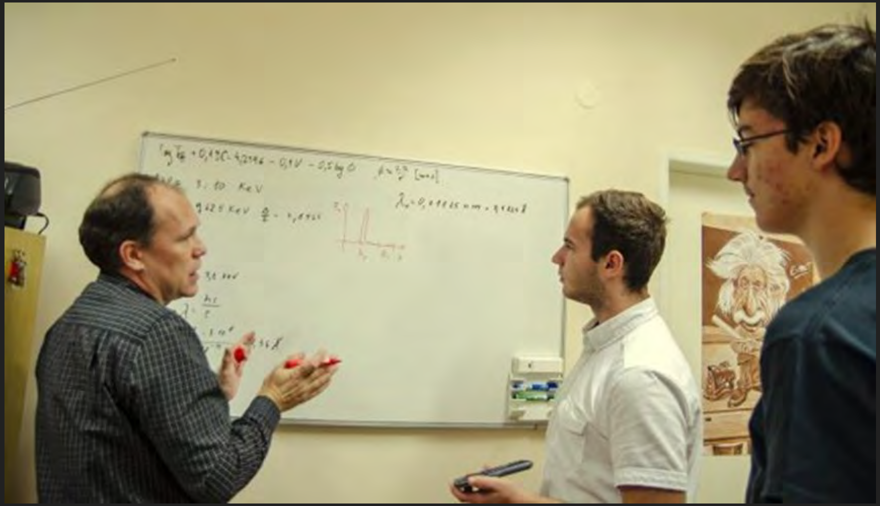
Model Hydra

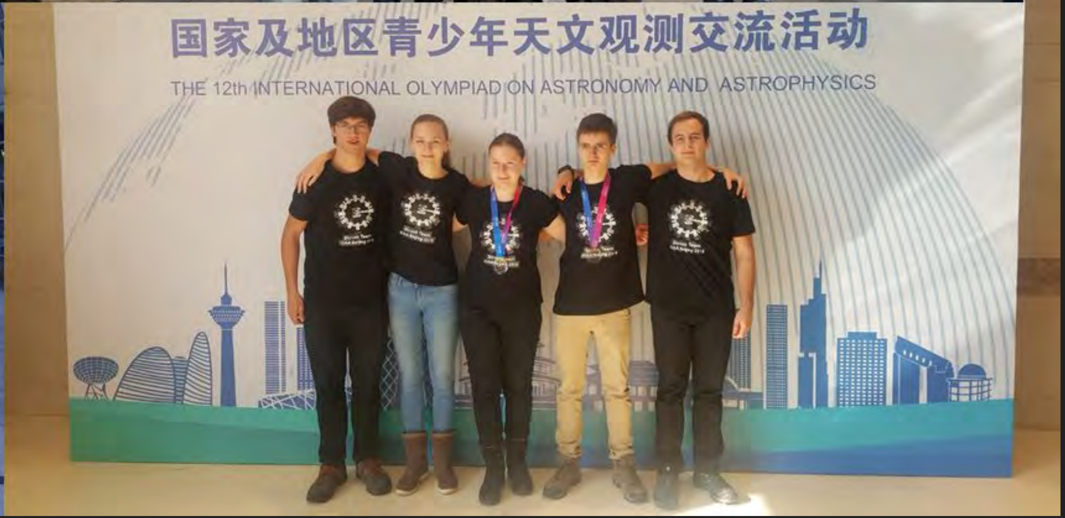
		Predikcia ~1400ms			
		Elves	Meteor	Nothing	Sprite
Skutočnosť	Elves	0	0	0	0
	Meteor	0	0	0	0
	Nothing	10	0	3034	15
	Sprite	0	105	14	410



Výroba a využitie
užitočných materiálov
z rastlinného odpadu
20
ENERGOLAND MOCHOVCE

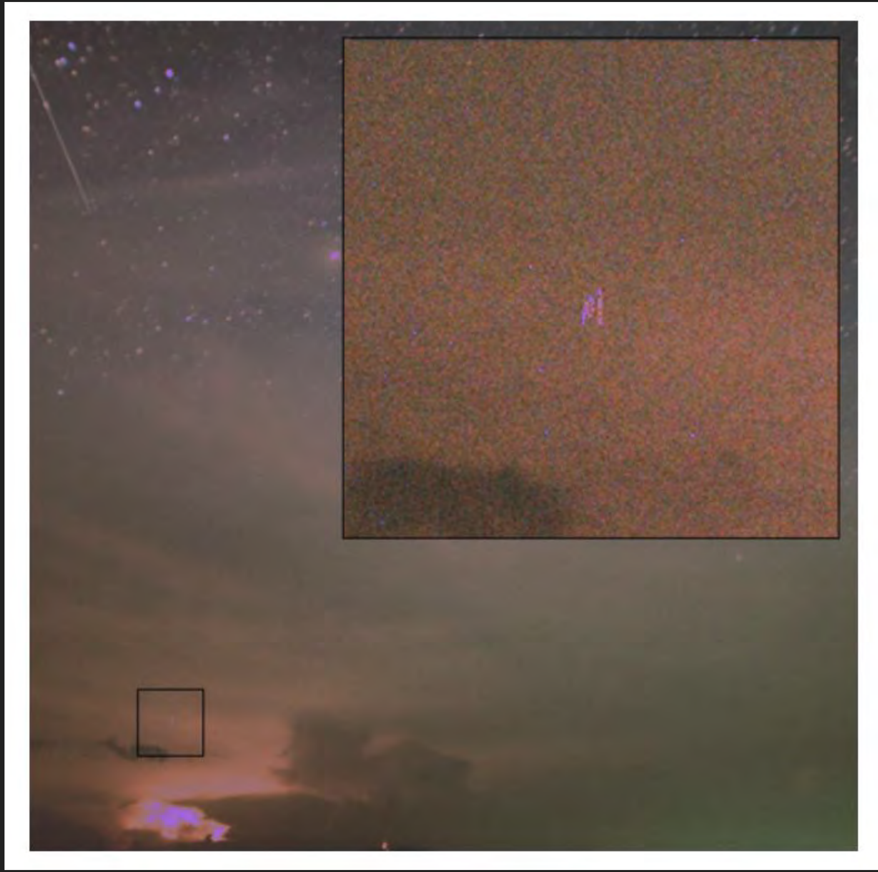

GALILEOSCOPE




国家及地区青少年天文观测交流活动
THE 12th INTERNATIONAL OLYMPIAD ON ASTRONOMY AND ASTROPHYSICS

Astronomické observatórium na Kolonickom sedle - 8. 9. 2020

Astronomické observatórium na Kolonickom sedle - 9. 9. 2020



JINST

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ACCEPTED: *December 8, 2021*
PUBLISHED: *December 21, 2021*

TECHNICAL REPORT

Design and construction of hardware and software for autonomous observations of Transient Luminous Events

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Ke Karlovu 3, 121 16 Praha 2, Czech Republic
[b]*Department of Space Physics, Institute of Experimental Physics, Slovak Academy of Sciences,*
Košice, Slovakia
[c]*Faculty of mechanical engineering, Technical University of Košice,*
Košice, Slovakia

Amrich et al. (2021)

https://doi.org/10.1088/1748-0221/16/12/T12016

Vedecké projekty
na Ústave experimentálnej fyziky SAV

2019 - 2021

2022 - 2023

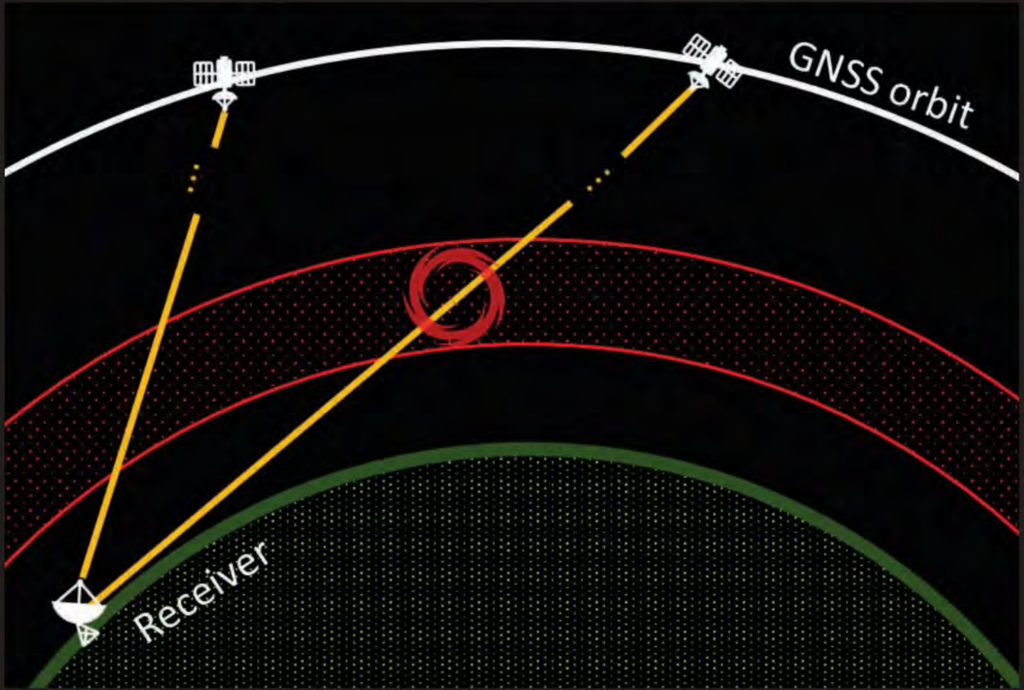
2024 - 2025

Konferencia mladých astronómov - Bezovec - 18. 6. 2023

Konferencia mladých astronómov - Bezovec - 18. 6. 2023

What is ionospheric scintillation

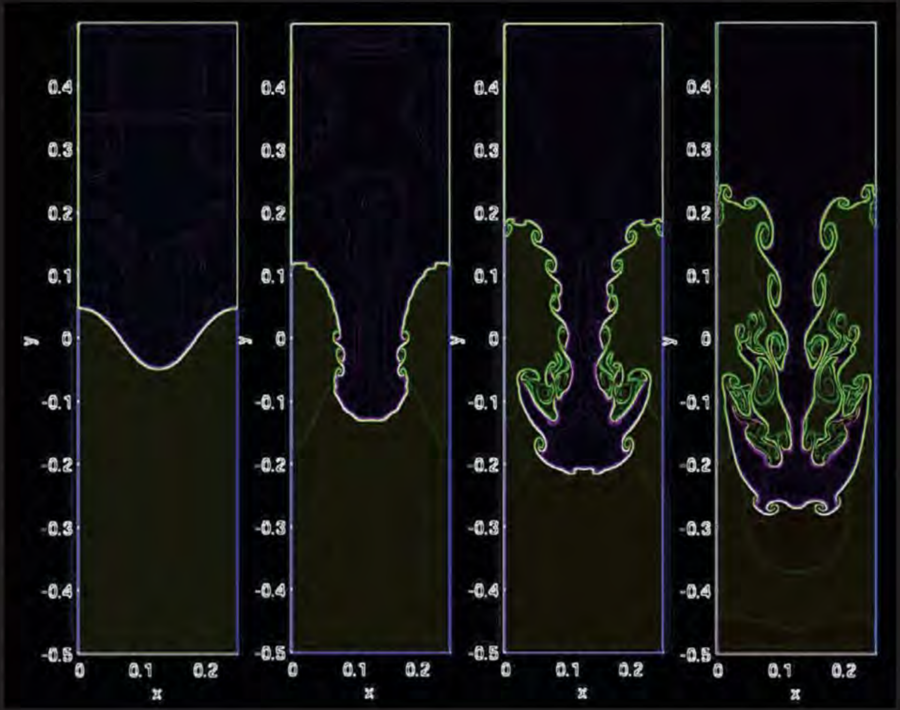
- <u>Ionospheric scintillation</u> is the rapid modification of radio waves.
- Propagating through ionosphere.
- Caused by small scale structures in the ionosphere.



What is ionospheric scintillation

- Ionosphere is the ionized part of the upper atmosphere.
- Different layers have different densities.
- Because gr. field is present

=> Rayleigh–Taylor instability



Coster, A.J. and Yizengaw, E. (2021). GNSS/GPS Degradation from Space Weather. In Space Weather Effects and Applications (eds A.J. Coster, P.J. Erickson, L.J. Lanzerotti, Y. Zhang and L.J. Paxton). https://doi.org/10.1002/9781119815570.ch8

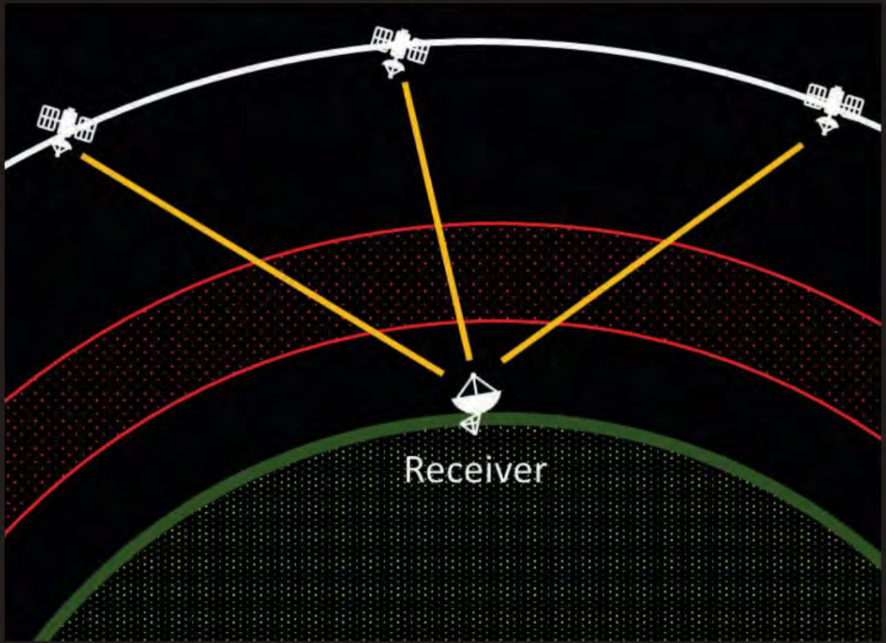
Global satellite navigation (GNSS)

- Artificial satellites that autonomous geopositioning.

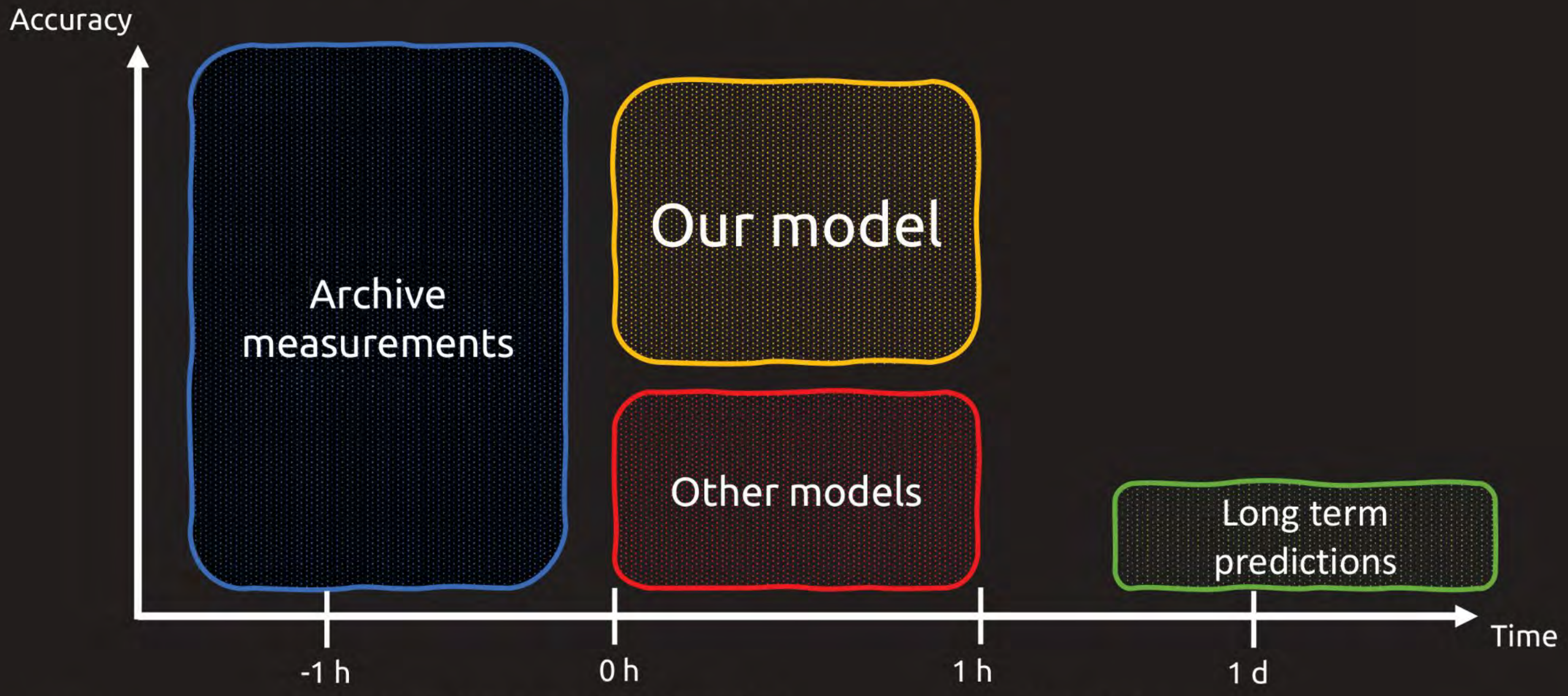
- Scintillations may cause loss of geopositioning capabilities.

- Affects all main systems:

GPS, GLONASS, Galileo.



Other models - Family photo

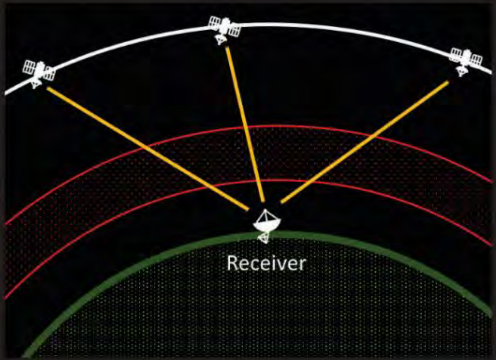


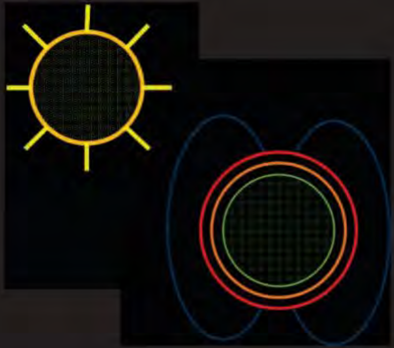
Our approach

- Data driven method

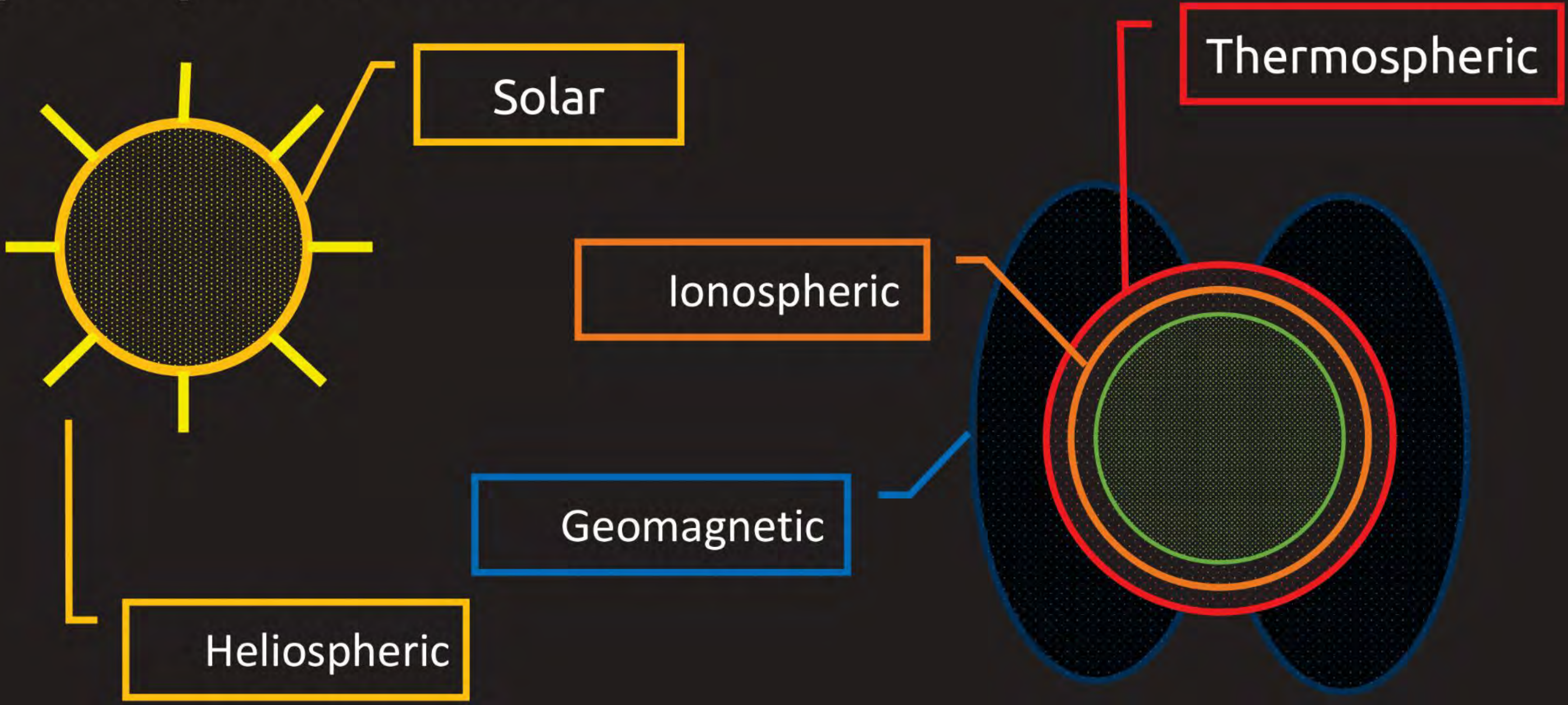
  Years of measurements, with an emphasis on physics

- Using of deep neural network



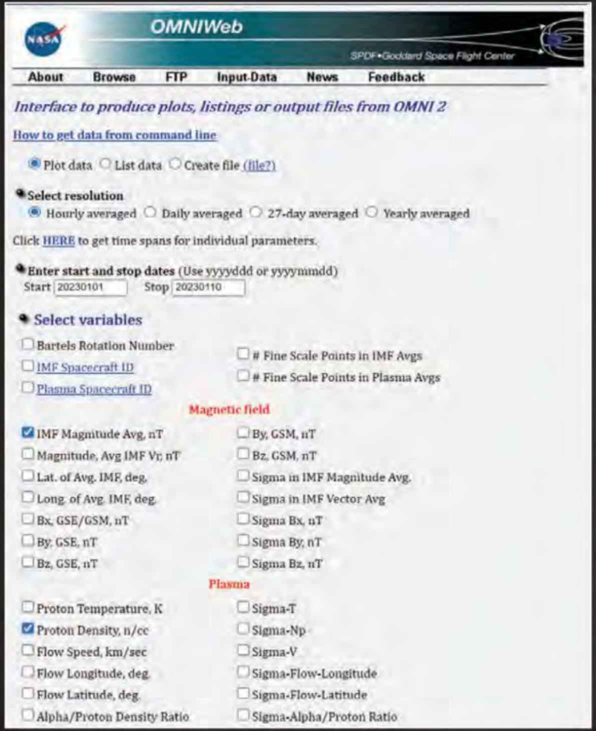


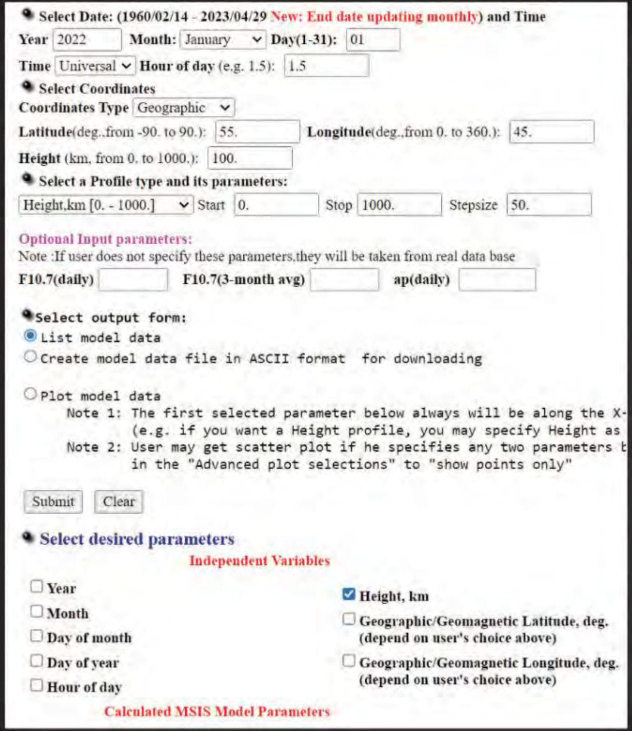
Space parameters

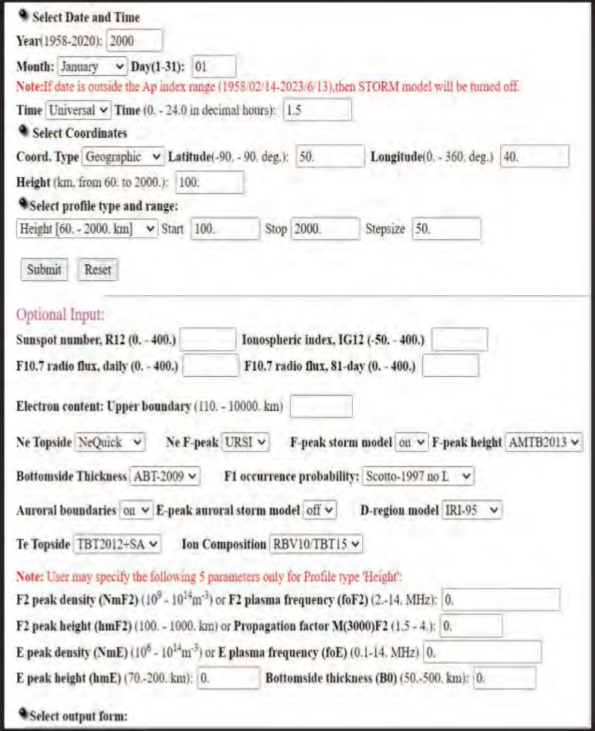


Sources of data

OMNIWeb	NRLMSISE-0	IRI-2016

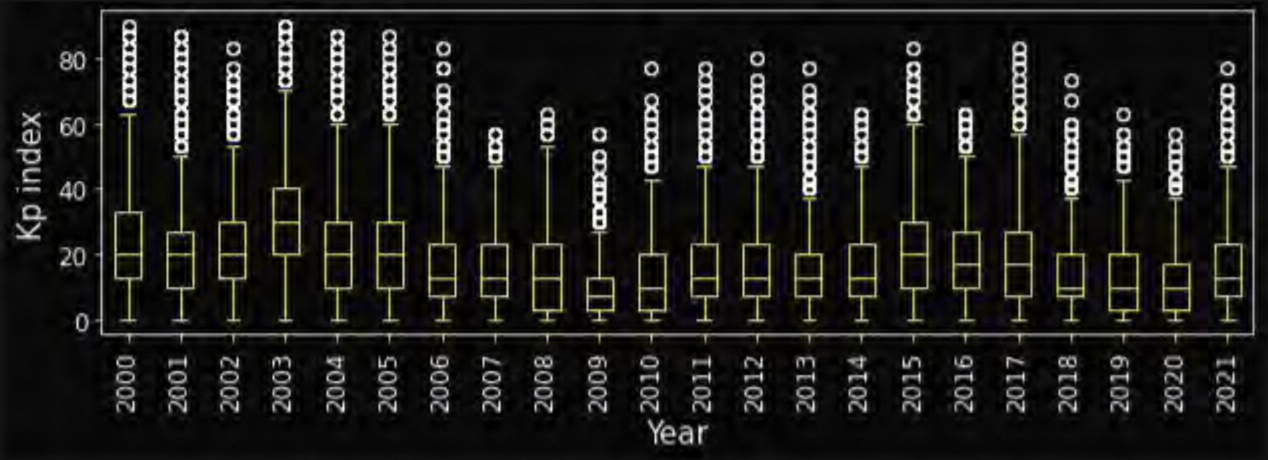






Statistical analyses

- 55 parameters
- 1 hour resolution
- Box plots
- Observing of long-term changes

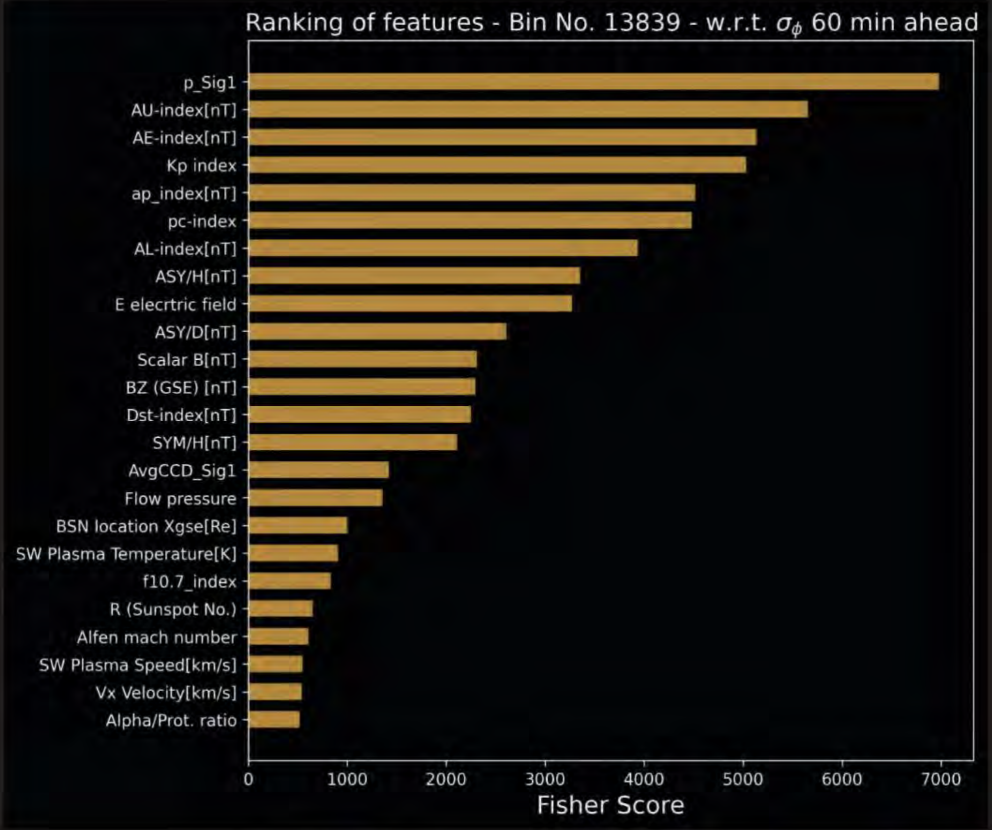


ANOVA analyses of data

- Important parameters to consider.

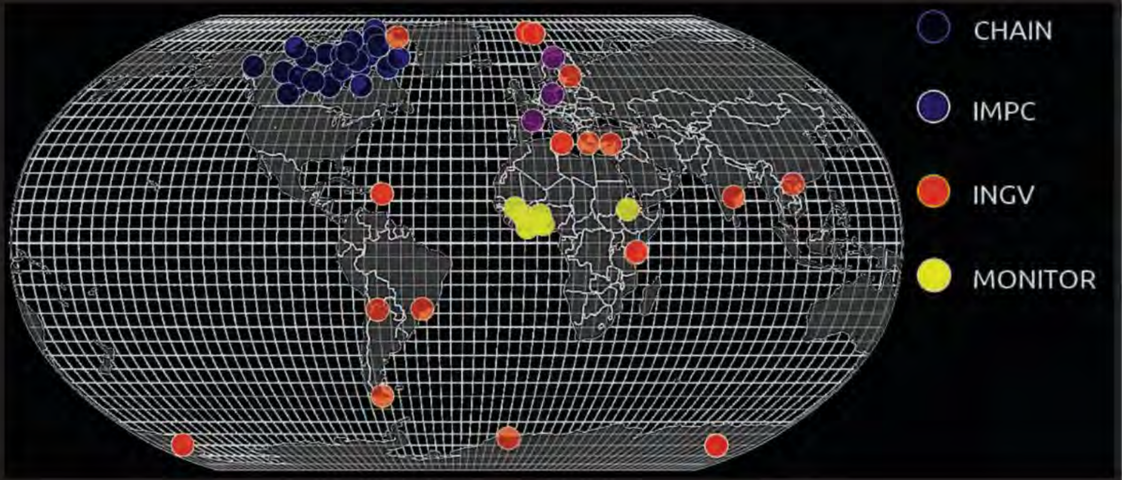
- Possible use in models.

- **Kp index**
- Bz GSE
- AE index
- PC(N)
- Electric field



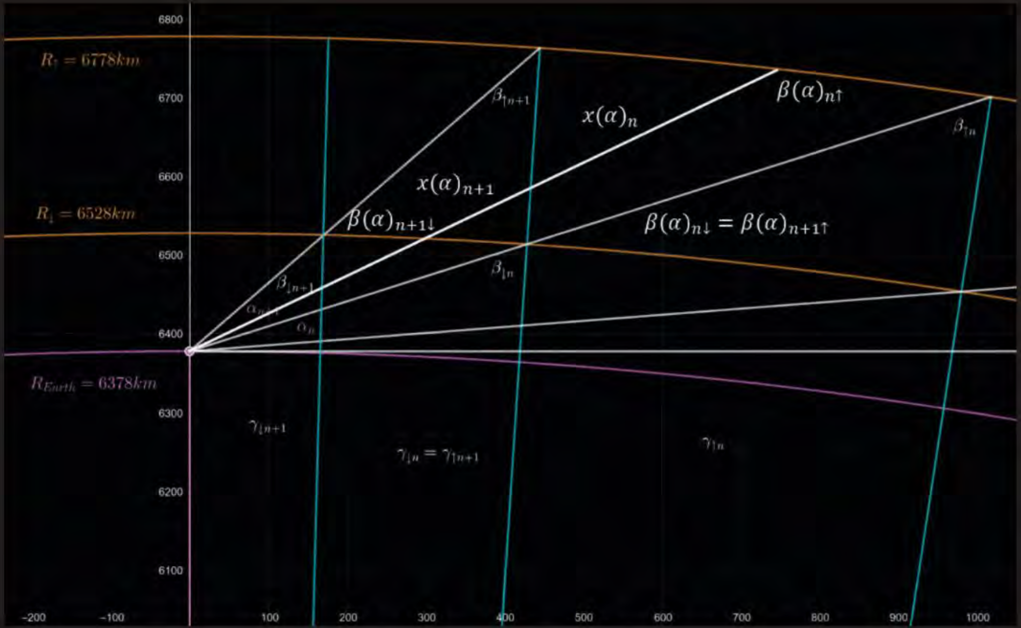
Sources of data

- Canadian high arctic ionospheric network
(CHAIN).
- Every hour published measurements.
- 2008-> present
- 26 stations



Problem of sphere

- How to interpret measurement.
- Measurement create ruled surface.
- Ionosphere is between sphere.



Transformation to Sphere

- Nontrivial task of transforming

ruled surface ->sphere

$$|\vec{x}| = \sqrt{R_{Earth}^2 + r^2 + 2R_{Earth} r sin(\alpha)}$$

$$\varphi_x = \arcsin\left(\frac{\left(R_{Earth} + rsin(\alpha)\right)\sin(\varphi) + rcos(\alpha)\cos(A)\cos(\varphi)}{|\vec{x}|}\right)$$

$$l_x = \mathrm{arctg}\left(\frac{\left(R_{Earth} + rsin(\alpha)\right)\cos(\varphi)\sin(l) - rcos(\alpha)\left(\cos(A)\sin(\varphi)\sin(l) - \sin(A)\cos(l)\right)}{\left(R_{Earth} + rsin(\alpha)\right)\cos(\varphi)\cos(l) - rcos(\alpha)\left(\cos(A)\sin(\varphi)\cos(l) + \sin(A)\sin(l)\right)}\right)$$

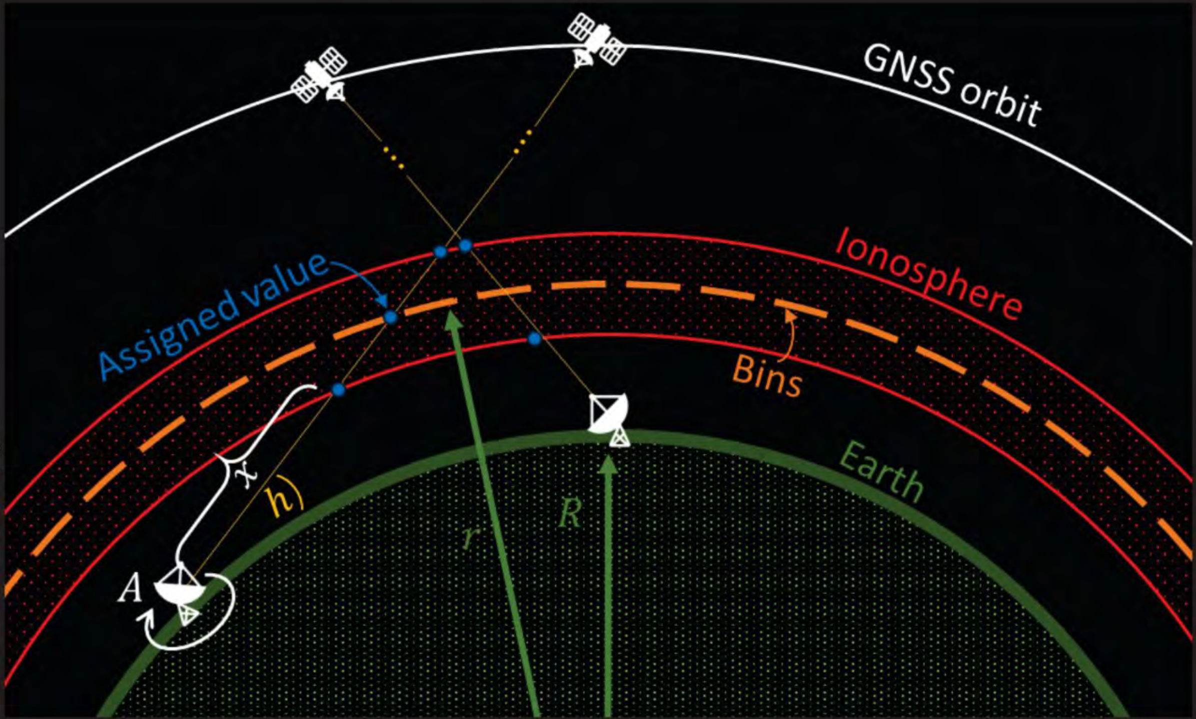
- For binning

$$a = \sin\left(\frac{\Delta l}{2}\right) + \cos(l_1)\cdot\cos(l_2)\sin^2\left(\frac{\Delta\varphi}{2}\right)$$

$$c = 2\cdot \mathrm{arctan2}\left[\sqrt{a}; \sqrt{a-1}\right] = 2\cdot\arctan\left(\frac{\sqrt{a}}{\sqrt{a-1}}\right)$$

Binning

- Uniform binning of ionosphere
- Central of mass
- Nearest bin centrum for intersection of ionosphere and measurement



ASPIS API About

Date | Time | Region

Nowcast

2025-05-29 03:00

Forecast

2025-05-29 04:00

DLR - German aerospace center - Neustrelitz - 13. 9. 2022

Berlin - 16. 9. 2022

Vedecké projekty
na Ústave experimentálnej fyziky SAV

2019 - 2021

2022 - 2023

2024 - 2025

Vigil mission

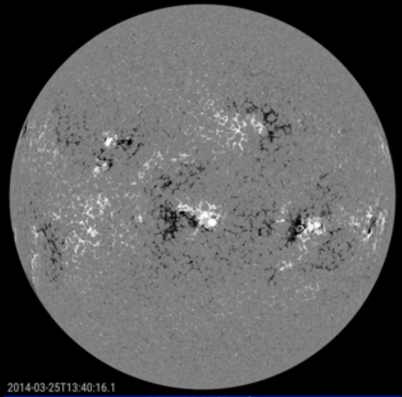
- Plánovaný space weather satelit
- 2029 (Štart)-2032 (prevádzka)-2037
- L5 point (60° napred Zemou)

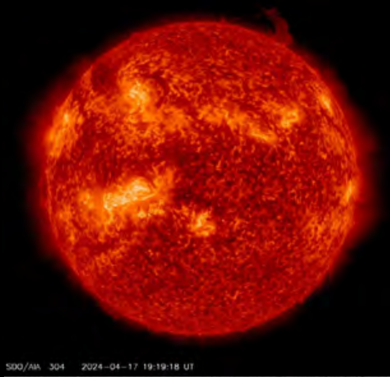
Vybavenie satelitu

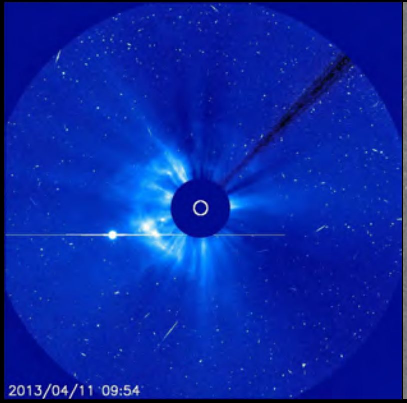
- PMI - Photospheric Magnetic field Imager
- NIO - EUV imager of solar corona –

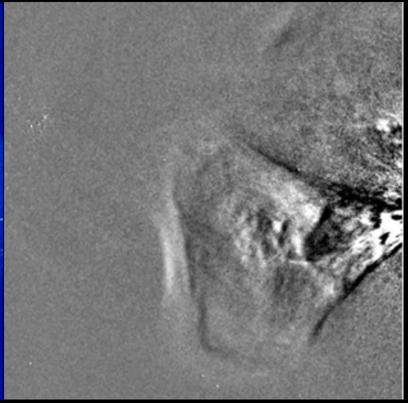
  NASA Instrument of Opportunity
- CCOR - Compact Coronagraph
- HI - Heliospheric Imager

- MAG – Magnetometer
- PLA - Plasma Analyser









Porovnanie k existujúcim satelitom

	SOHO	SDO	SolO	STEREO	GOES	SWFO-1	Punch	WIND	Juice	ACE	DSCOVR
PMI	**MDI**	**HMI**	**PHI**								
NIO	**EIT**	**AIA**	**EUI**	**SECCHI EUV**	**SUVI**						
CCOR	**LASCO**				**CCOR**	**CCOR**					
HI			**HI**	**SECCHI**			**HI**				
MAG	**MFI**		**MAG**						**JMAG**	**MAG**	**MAG**
PLA			**SWA**					**SWE**		**SWEPAM**	**FC**

Prístrojové vybavenie

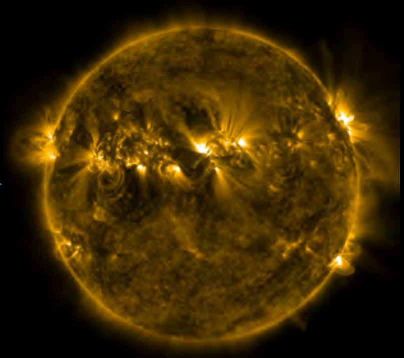
- Z internej komunikácie
- Takto sme schopný získať najpodobnejšie dáta z existujúcich

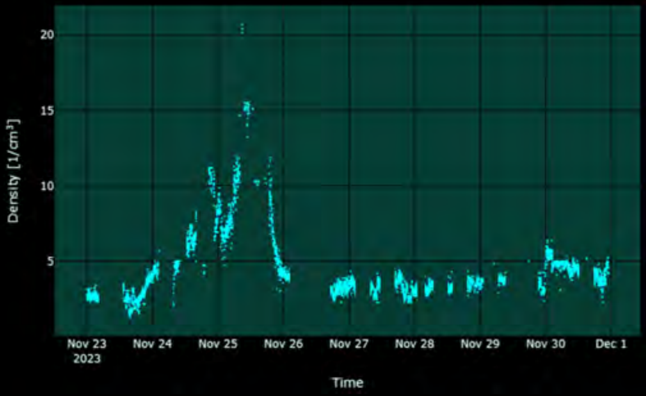
Instrument	FoV	Resolution [px]	Ang. res. [arcsec]	Cadence [min]	Latency [min]
PMI					
NOI					
CCOR					
HI-1					
HI-2					
MAG					
PLA					

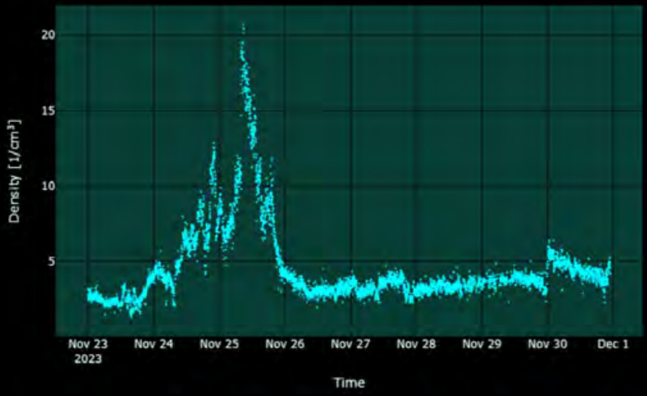
TOP SECRET

Vigil like data

- Z existujúcich dát
- Prevzorkovanie pre Vigil
- Kadencia
- Latencia
- Rozlíšenie
- Vlnová dĺžka







Dashboards - Vytvorené pre prehľadnosť

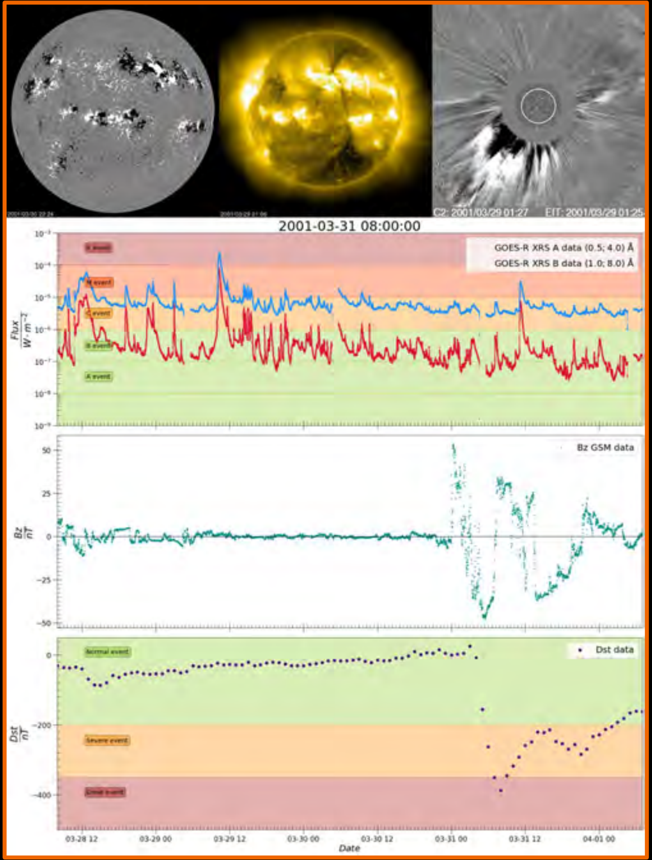
- Chceli sme vidieť správanie

  rozličných parametrov

- Pomáhajú nám vidieť progres

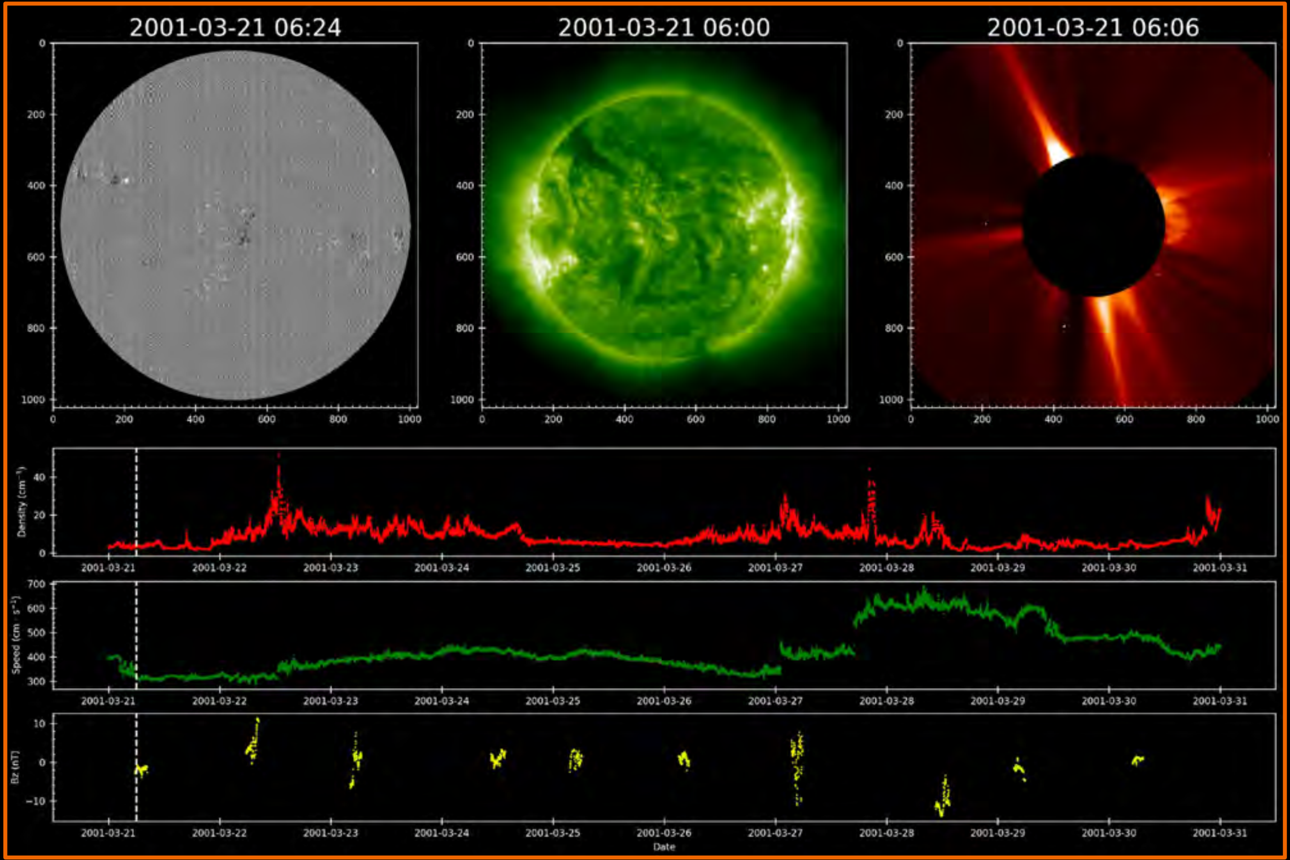
- Používané interne

- Manuálne sťahovanie a spájanie



Dashboards - Vytvorené pre prehľadnosť

- Druhá verzia
- Verejné použitie
- Ukazujú súsled
- Automatická pipeline



Vigil-like data of most extreme SWE events

github.com/space-lab-sk/vigil-like-data

zenodo.org/records/13365042

4 events, 4 x 20 days, ~12 GB

More details:

Majirsky et al. (2025)

https://doi.org/10.1029/2024EA003937

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ADVANCING EARTH AND SPACE SCIENCES

AGU

Earth and Space Science

DATA ARTICLE

10.1029/2024EA003937

Extreme Space Weather Events of the Past 30 Years: Preparation for Data From Mission Vigil

Adam Majirský[1,2], Šimon Mackovjak[1], Silvia Kostárová[1], and Samuel Amrich[1,3]

[1]Department of Space Physics, Institute of Experimental Physics, Slovak Academy of Sciences, Košice, Slovakia, [2]Department of Cybernetics and Artificial Intelligence, Faculty of Electrical Engineering and Informatics, Technical University of Košice, Košice, Slovakia, [3]Faculty of Mathematics and Physics, Charles University, Prague, Czechia

Key Points:

- Vigil-like data are images and time series from 24 instruments onboard 8 missions which are similar to the planned space mission European Space Agency Vigil
- Our pipeline gathers Vigil-like data for the most extreme space weather events in the past 30 years
- The new data set implies opportunities to improve predictions of the most dangerous space weather events

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Š. Mackovjak,
mackovjak@saske.sk

Citation:

Majirský, A., Mackovjak, Š., Kostárová, S., & Amrich, S. (2025). Extreme space weather events of the past 30 years: Preparation for data from mission Vigil. *Earth and Space Science*, *12*, e2024EA003937. https://doi.org/10.1029/2024EA003937

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Accepted 12 JAN 2025

Author Contributions:

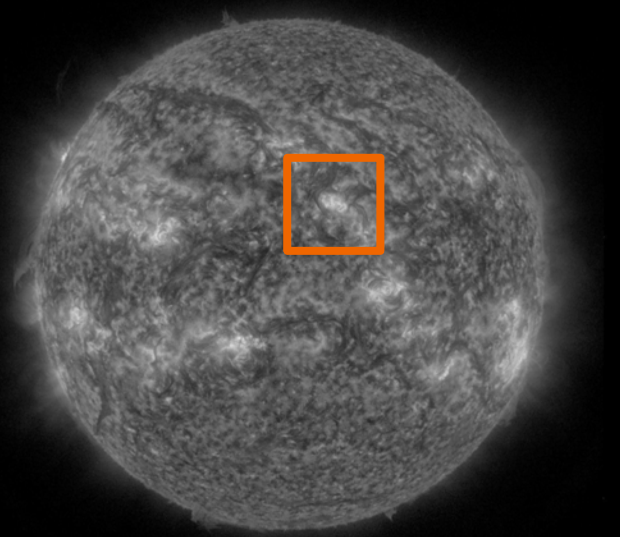
Conceptualization: Šimon Mackovjak
Data curation: Adam Majirský, Silvia Kostárová
Formal analysis: Adam Majirský, Šimon Mackovjak, Silvia Kostárová
Funding acquisition: Šimon Mackovjak

Abstract Extreme Space Weather events can negatively affect ground-based infrastructure and satellite communications. European Space Agency plans to launch a new operational mission, Vigil, to monitor space weather activity and provide timely warnings about immediate danger. In this work, we have identified 24 instruments that have already acquired data on 8 space missions and are similar to instruments planned for mission Vigil. We then selected the 39 most extreme space weather events that affected the Earth in the past 30 years and gathered Vigil-like data for them. The objective of this work and our main motivation was to address the following question: "How would Vigil have observed extreme space weather events if it had been operational during those events?" For this reason, we prepared a pipeline for the community to obtain images and in-situ measurements for these specific periods, allowing straightforward applications for the follow-up data-driven studies. This effort could maximize Vigil's potential. Additionally, we studied the sources of extreme space weather events and the time it took for solar plasma to reach Earth's magnetosphere. This analysis demonstrates the utilization of the gathered data set and provides interesting insights into the most hazardous space events that influenced society in recent decades.

Plain Language Summary Extreme space weather events are among the most dangerous hazards for modern society. The main mitigations of these risks are reliable and timely predictions. The planned European Space Agency mission Vigil will provide critical data for these predictions in real-time. In this study, we present an overview of the existing instruments that are somehow similar to instruments that Vigil will have onboard. For the 39 most extreme space weather events, we gathered Vigil-like data to answer the question: "How would Vigil have observed extreme space weather events if it had been operational at that time?" The developed pipeline for collecting specific data sets is available for the community, enabling follow-up data-driven studies with the utilization of machine learning techniques to improve predictions of severe space weather events.

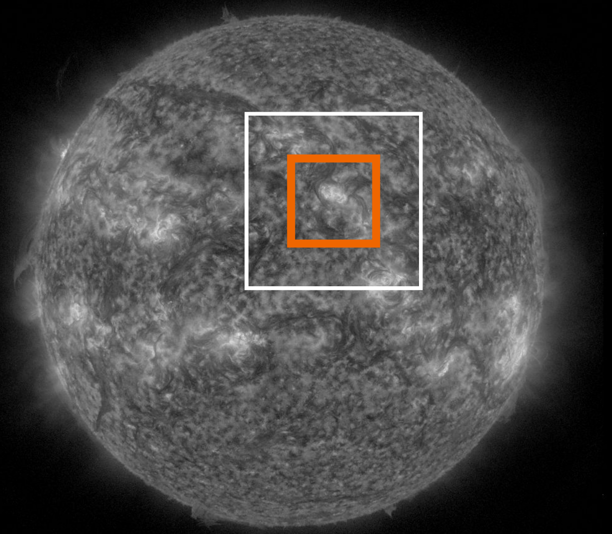
Trackovanie slnečných štruktúr

- Označenie „Area of Interest“ (AoI)

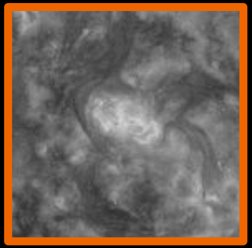


Trackovanie slnečných štruktúr

- Označenie „Area of Interest“ (AoI) - Template

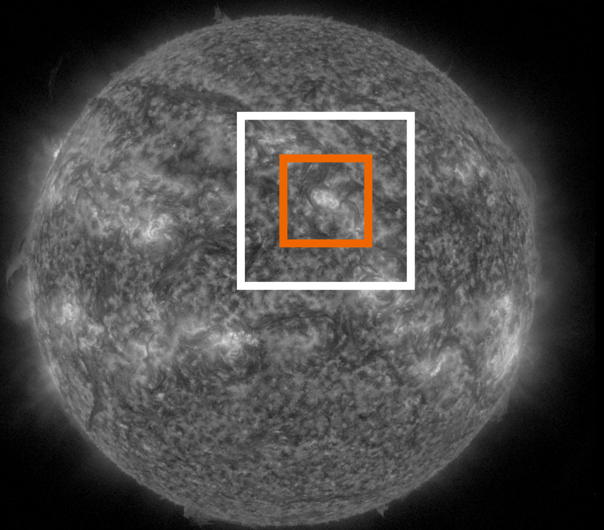


Templat



Trackovanie slnečných štruktúr

- Okno na nasledujúcom obrázku v sérií - Window



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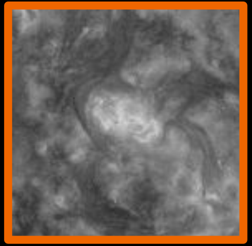
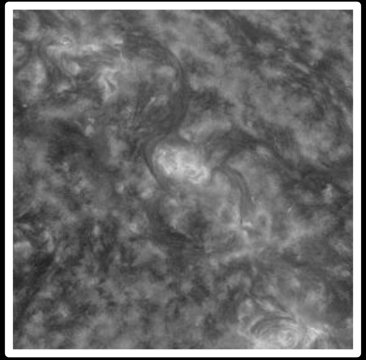
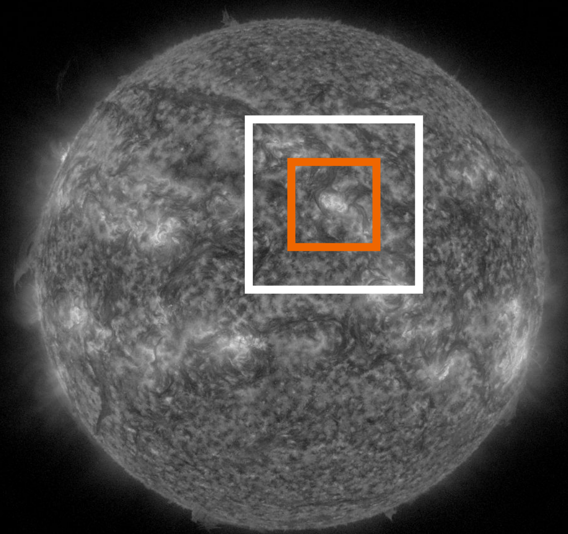


Window



Trackovanie slnečných štruktúr

- Po postprocessing-u vytvoríme mapu korelačného koeficientu



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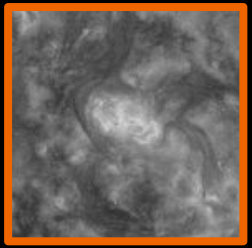

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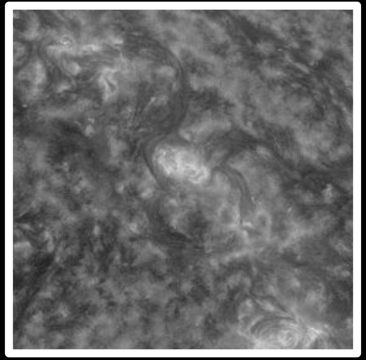
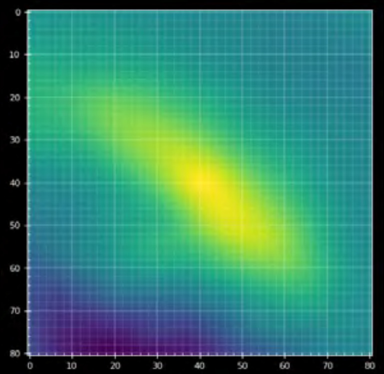
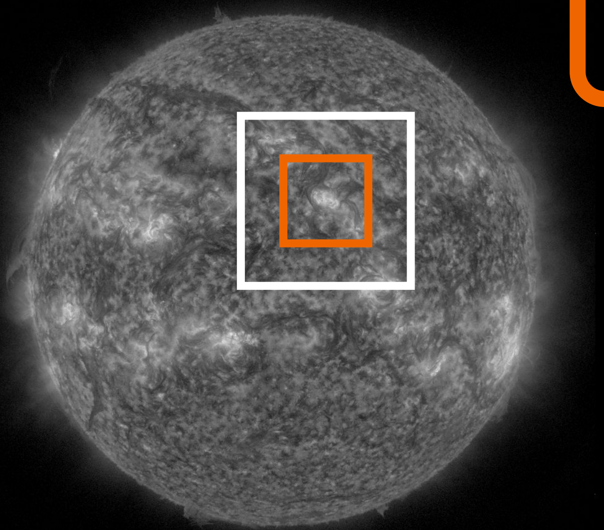


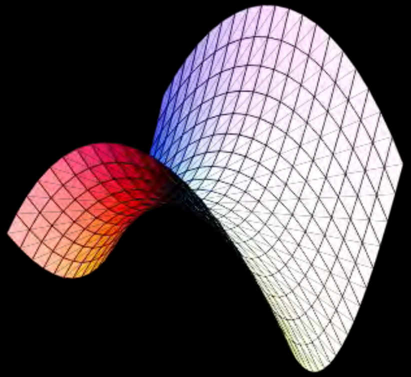
Normalizácia
Vyhladenie



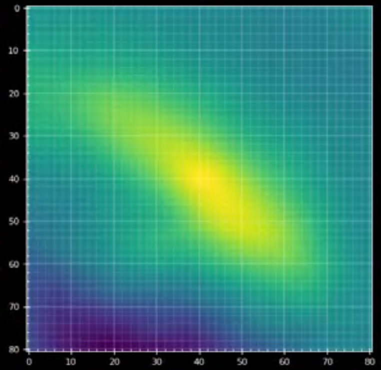
Trackovanie slnečných štruktúr - Výsledky

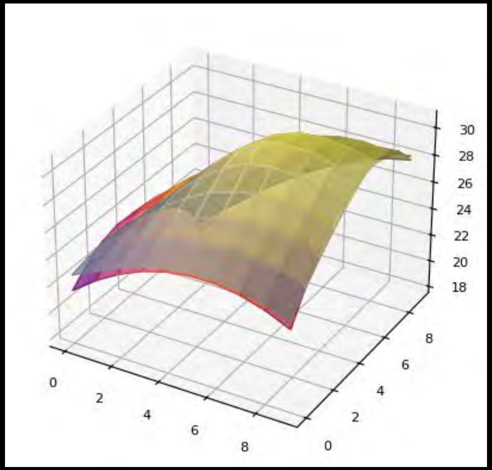
- Fitovanie kvadriky na korelačnú mapu

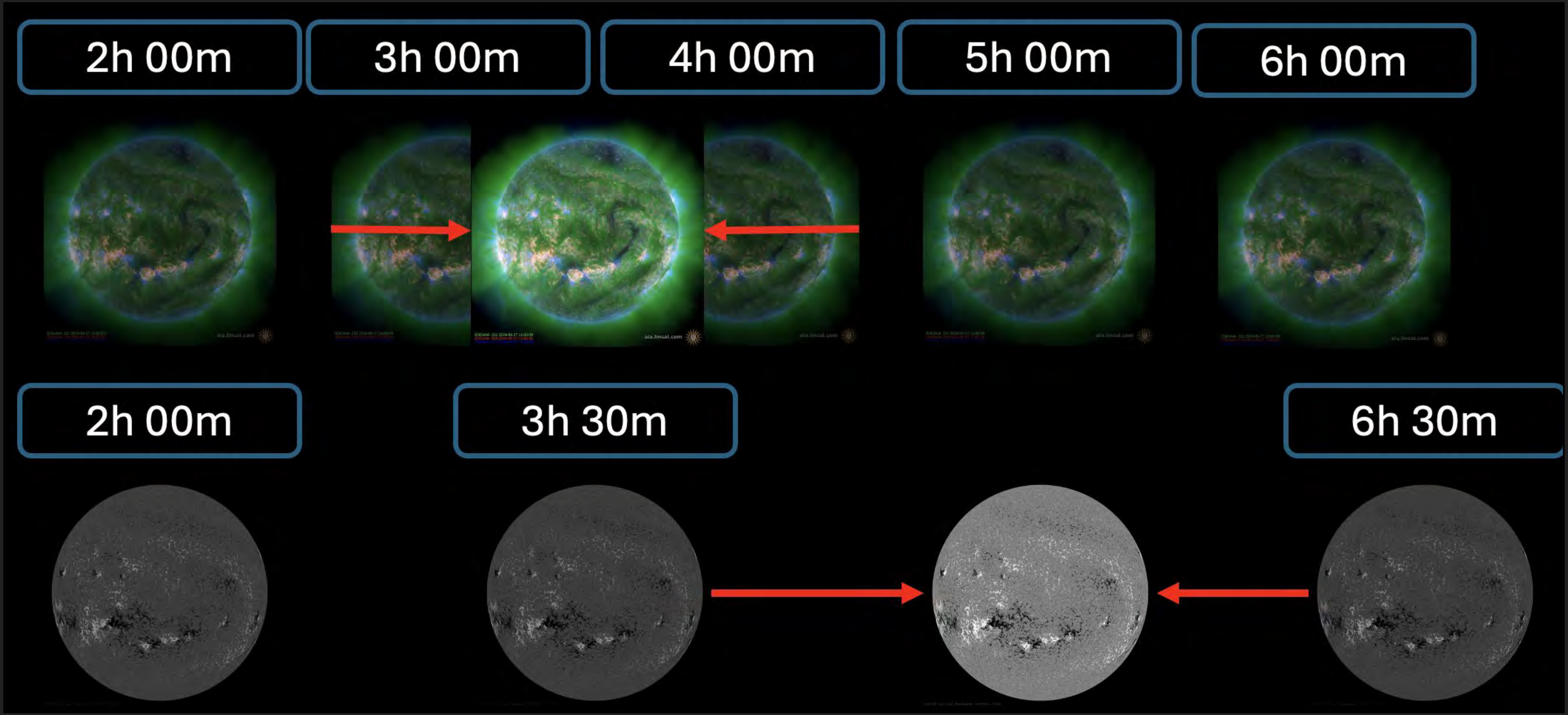


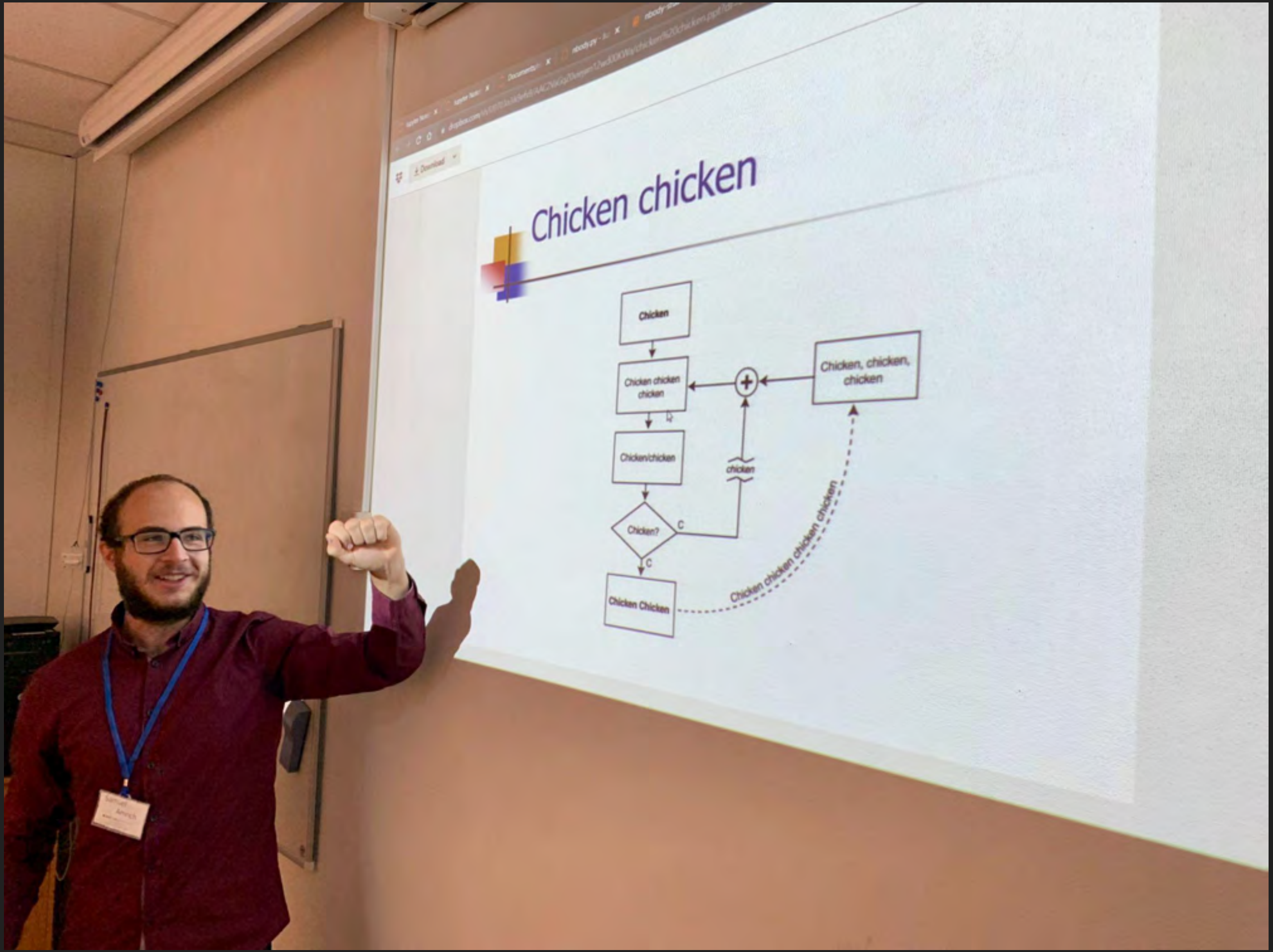


Normalizácia
Vyhladenie






2h 00m
3h 00m
4h 00m
5h 00m
6h 00m
2h 00m
3h 30m
6h 30m



SPACE::LAB summer school - Košice - 23. 8. 2022

SPACE::LAB summer school - Košice - 22. 8. 2022

Hackathon Act In Space - Košice - 19. 11. 2022

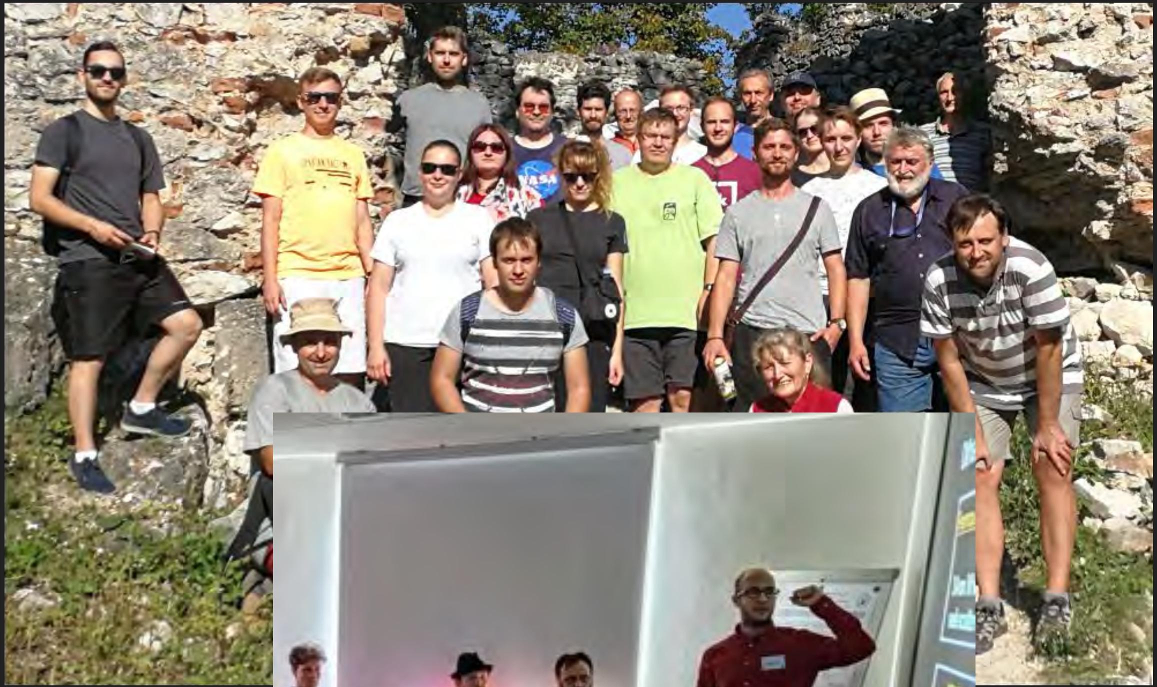
Demo Day - Bratislava - 9. 6. 2022

Košice - 22. 10. 2023

Praha - 25. 10. 2024


TRONOMICKÁ OLYMPIÁDA
SK
Jana Š
Radovan
Samuel


M 13


NASA


SAM O

Samo, navždy si ťa budeme pamätať!

Tu budeme na teba najviac spomínať

... a tu nám budeš aj najviac chýbať