

Archivy 2m dalekohledu

Od Reticonu k umělé inteligenci

Virtuální observatoř a Astroinformatika

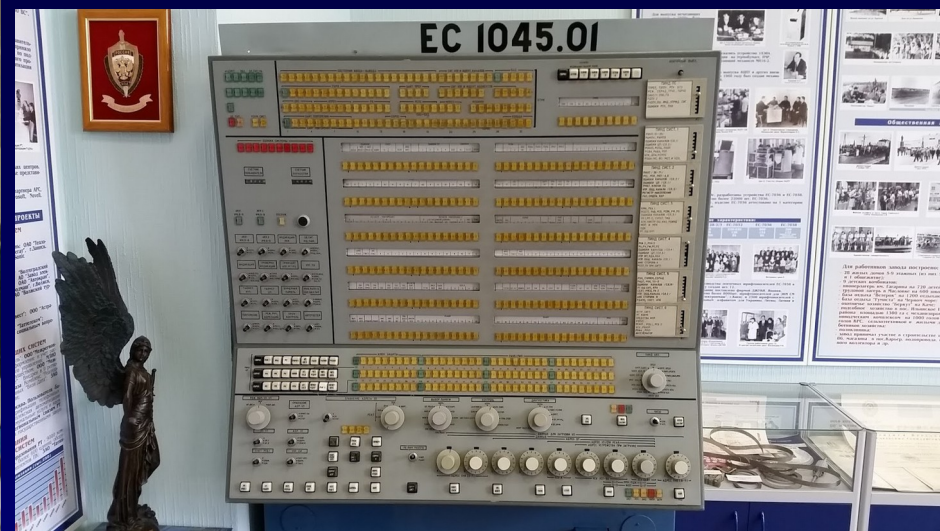
Petr Škoda

Astronomický ústav AVČR
Ondřejov ČR

Posezení k 50. výročí Perkova dalekohledu
Sídlo AVČR, Národní třída, Praha

Sálové počítače

- Teorie + zpracování měření EC1040 (<1MB)
 - EC 1045 – 4 MB – terminál sítě – TSO
 - Děrné štítky , pásky, mg pásky
- FORTTRAN66 (EXEC FORTGCLG, FORT SYSIN DD *)



Přechod k PC

- 1988 rekonstrukce TCS 2m – Villati - **1. PC !**
 - PC AT 6/10MHZ , 1MB RAM, EGA 640x350, 16c
- RS232 – komunikace s VILATI (TMS9900)
- Disky 8“ 360KB
- Totéž řízení 2m (ASCOL)

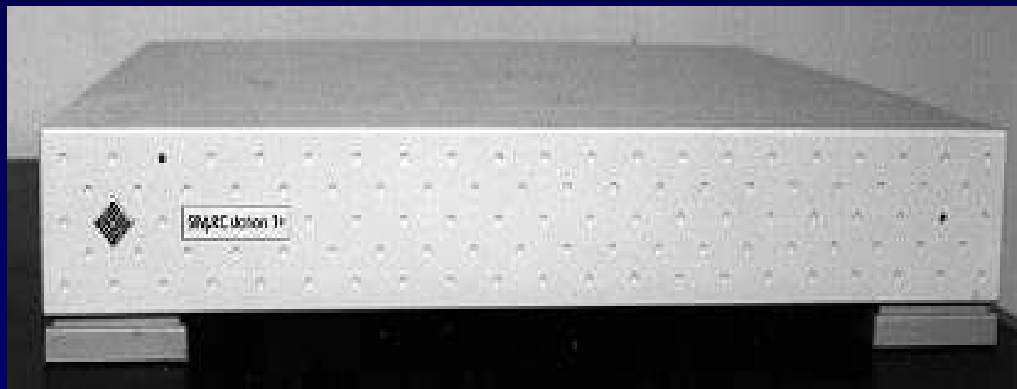


Rozvoj malé výpočetní techniky na AÚ

- 1989 (AÚ – Několik AT, XT, PP06), MS XENIX
- 1990 Několik AT + 386/33 MHz, 4M,
 - 80MB disk
 - Fireball (Cepřecha), PC MOS, Windows 2.0
 - LaTeX (ChiWriter, T602)
- Stelární - první LAN – 10Net (2linka 1Mb)
 - Mezi 3 PC AT

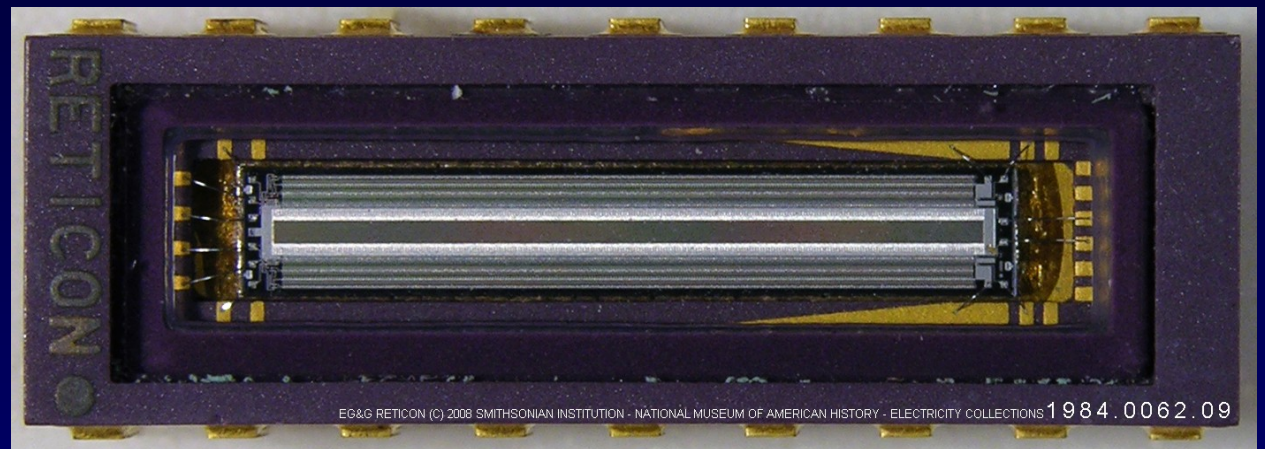
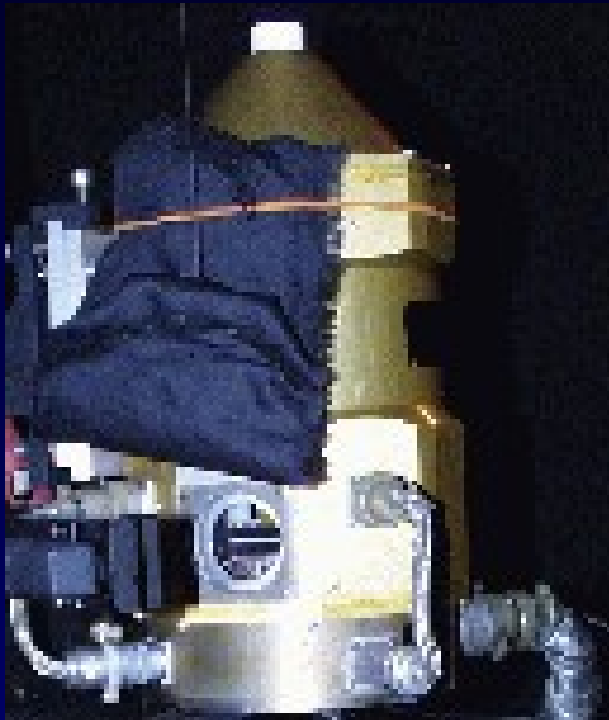
Rozvoj IT 2m - UNIX

- 1991 1 UNIX WS = Sun SPARC 1 CompuAdd
 - SPARC 20MHz, 16MB RAM, 210 MB SCSI
 - Ethernet – WD8003, 10Mb, koax , T 50 Ohm
 - PCTCP (DOS) + Syntax Lan Manager (SMB)
 - TCPIP LAN
 - Několik 486/66 + modem 2400 baud
 - Mail server – e-MAIL na IBM VM/SP Dejvice
 - EARN



Začátek digitální éry 2m

- 1992 Reticon 1872 AF (Lickova obs., S Vogt)



EG&G RETICON (C) 2008 SMITHSONIAN INSTITUTION - NATIONAL MUSEUM OF AMERICAN HISTORY - ELECTRICITY COLLECTIONS 1984.0062.09

Řídící SW Reticonu

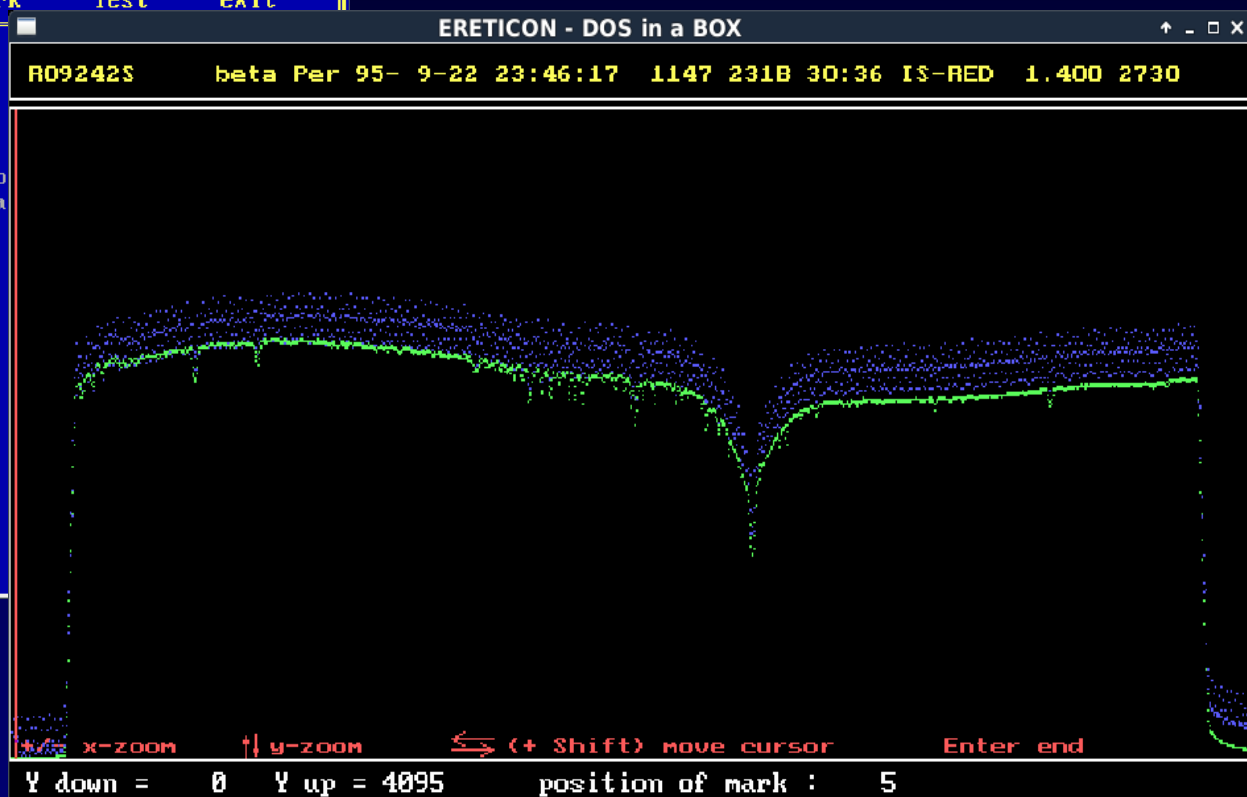
- Modifikace SPEFO (1988)
- Horn - RETICON.EXE, prosinec 1994 umírá
- ERETICON.EXE

```
ERETICON - DOS in a BOX
1:57:51  Offset  Flat  Comp  Star  Dark  Test  eXit

Star observed :          gamma Cas (HD 5394)
actual coordinates :      RA  0 57 44.2  DA  60
camera N. [1,2,3] :    1
grating N. :    1
angle of grating [deg] : 30  [min] : 15
band pass filter (N.) :  2  Entrance band pass mirror
slit (width x height or another description) [max 7 char]

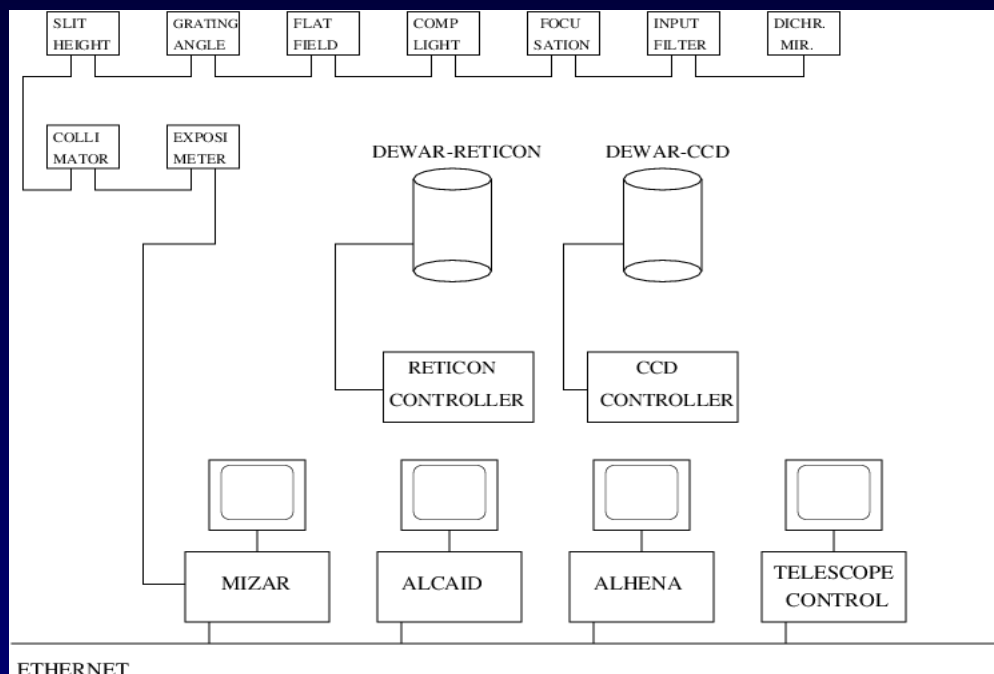
Exposure value preset [in Megacycles] : 5

START EXPOSITION ??? (Y/N)
```



Robotizace spektrografu 1996

- CRETICON.EXE
 - řízení coudé krabiček – Ing. Wudia
 - váhovaní seeingu , zaostření cross-korelací
- komunikace DOS-UNIX , centrální archív



BIAS -CCD LORAL 2720x256 – od 1996

SiTe 2000x800 -od 2000

BIAS CCD STATUS

```

Thu Nov 2 13:48:59 2000
TOT IM BEG BIN OVS CCD: IDLE
X T.total: 10.0 MULT: 5
Y
CCDtemp: 0.0 C AMPL: P_DEWAR: 4.6E-12 mb
REFtemp: 0.0 C GAIN:
LN2temp: 0.0 C MPP: AUTOSHOW ON
IMPATH: /data/ccd 649 Mb
REM_IMPATH: :
NEXT_FILE: jk020001.fit AUTOSAVE:ON REM_AUTOSAVE: OFF
FILE: jj300011.fit HIGHCUT:38426 LOWCUT:30243 ZOOM:1.00
OBJECT:
COUDE SPCT. PROCES:
EXP.FREQ.= 17, EXP.SUM.= 0.000000, EXP.PRESET= 99.999
  
```

BIAS CCD CONTROL

```

*****
PC_board Ram size = 4096 KByte
WARNING
Camera NOT responding
2000-11-02: logjk02.001 created for logging
BIAS>display
Filename : jj300012.fit
Image size: 2720 x 256
BIAS>display jj300011.fit
Image size: 2720 x 256
BIAS>display jj300010.fit
Image size: 2720 x 256
BIAS>display jj300011.fit
Image size: 2720 x 256
BIAS>
  
```

SAOimage for BIAS alhena

/data/ccd/jj300011.fit - (IRAF)

Scale Color Cursor Pan etc
linear wrap log sqrt histeq blink

Coude Spektrograf [Napoveda=F1]

FLAT FIELD	☐ Zarovka	Start	SROV. SP.	☐ Zarovka	Start
Cas 9	☐ Zrcatko	Stop	Cas 5	☐ Hranolek	Stop
CLONA KOLIMATORU	Stav		KOREKCI DESKY	Kamera 700 MEZIPOLOHA	
				Kamera 1400 ZASUNUTA	
UHEL MRIZKY	Stav 30 : 36 [st:min]		VYSKA STERBINY	Stav 0.30 [mm]	
DICHROICKE ZRCATKO	Stav 1		SPEKTRALNI FILTR	Stav 1	
OSTRENI - KAMERA 700	Stav 0 [imp]		OSTRENI - KAMERA 1400	Stav 0 [imp]	
EXPOZIMETR					
0.1 0.2 0.3 0.5 0.7 1 2 3 5 7 10 17 Frekvence 0 1.00 Soucet					

bash

```

drwxr-xr-x 2 tcsuser stelarni 4096 Aug 3 00:59 jg26
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 09:37 jj300001.fit
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 09:37 jj300002.fit
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 09:39 jj300003.fit
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 10:04 jj300004.fit
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 11:28 jj300005.fit
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 11:29 jj300006.fit
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 11:29 jj300007.fit
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 11:30 jj300008.fit
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 11:30 jj300009.fit
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 11:32 jj300010.fit
-rw-r--r-- 1 tcsuser stelarni 1048320 Oct 31 11:33 jj300011.fit
-rw-r--r-- 1 tcsuser stelarni 3257280 Oct 31 11:47 jj300012.fit
-rw-r--r-- 1 tcsuser stelarni 3008 Jul 27 00:54 log.jg26.001
-rw-r--r-- 1 tcsuser stelarni 4191 Jul 27 01:38 log.jg26.002
-rw-r--r-- 1 tcsuser stelarni 1565 Oct 31 11:37 log.jj30.001
-rw-r--r-- 1 tcsuser stelarni 68 Oct 31 11:38 log.jj30.002
  
```

Archiv součást RETICONu

ERETICON - DOS in a BOX

Select star for which you wish the list of observations :

Current obs log file : Reticon.obs

Esc : select no star

alfa And	358	7	2849	9256	1950	0 05 48	28 48 54
hd 358	358	13	5899	5960			
34 Psc	560	7	7147	9117	2000	0 10 02	11 08 45
gamma Peg	886	15	732	892	2000	0 13 14	15 11 0
zeta Cas	3360	2	6508	8594	2000	0 36 58	53 53 49
alpha Cas	3712	70	2525	9229	2000	0 40 31	56 32 0
omicron Cas	4180	16	315	8756	1950	0 41 56	48 00 40
gamma Cas	5394	188	3022	9270	1950	0 53 40.3	60 26 47
phi Per	10516	69	694	9223	1950	1 40 30.8	50 26 16
1 Per	11241	10	3560	7572	2000	1 51 59	55 8 51
beta Ari	11636	5	2859	6432	1900	1 49 06	20 19 00
alpha Ari	12929	9	6512	7391	2000	2	
4 beta Tri	13161	2	2855	6117	1900	2	
HR 894	18552	3	8727	9164	1950	2	
beta Per	19356	54	3517	9242	1950	3	
29 Per	20365	2	2894	2948	1950	3	
psi Per	22192	4	5688	8823	2000	3	

ERETICON - DOS in a BOX

List of observations of star 1 Per (HD 11241)

RA(2000) 1 51 59.0 DA(2000) 55 8 51

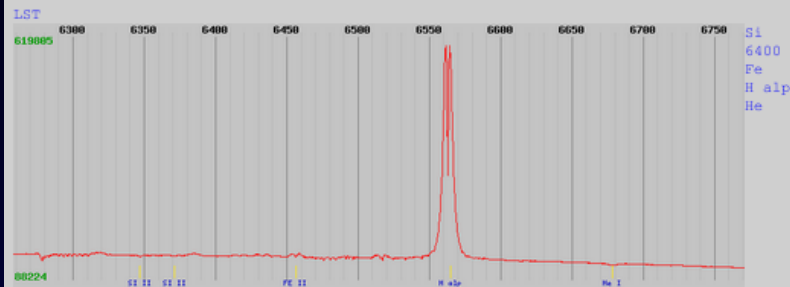
N.	date & UT start	exp[is]	angle	slit	ADU	J.D.hel.	RVcorr	observ
3560	93-12- 5 18:44:47	10000	231B	30:35	IS-RED	1598	49327.3429	-9.99 juzka
3615	93-12-29 21: 8: 4	6791	231B	30:35	IS-RED	647	49351.4227	-17.79 HorKa
6047	94- 9-23 21:57:39	11670	231B	30:35	IS-RED	2210	49619.4855	16.59 KouHa
7027	94-11-15 17: 8:10	6345	231B	30:36	IS-RED	1530	49672.2551	-2.00 SkoTl
7112	94-12- 1 16:30:18	10375	231B	30:36	IS-RED	1042	49688.2518	-8.28 SimHa
7203	94-12- 6 18: 2:58	7422	231B	30:36	IS-RED	812	49693.2989	-10.20 KouTl
7256	94-12- 8 17:39: 4	3138	231B	30:36	IS-RED	222	49695.2575	-10.87 HecHa
7303	94-12-15 18:30:21	7455	231B	30:36	IS-RED	269	49702.3178	-13.38 HecKa
7508	95- 2-12 21: 4:40	7201	231B	30:36	IS-RED	649	49761.4195	-23.12 KouTl
7572	95- 2-18 17:37: 9	5945	231B	30:36	IS-RED	570	49767.2677	-22.75 HecHa

List saved as file "1Per.lst" press any key_

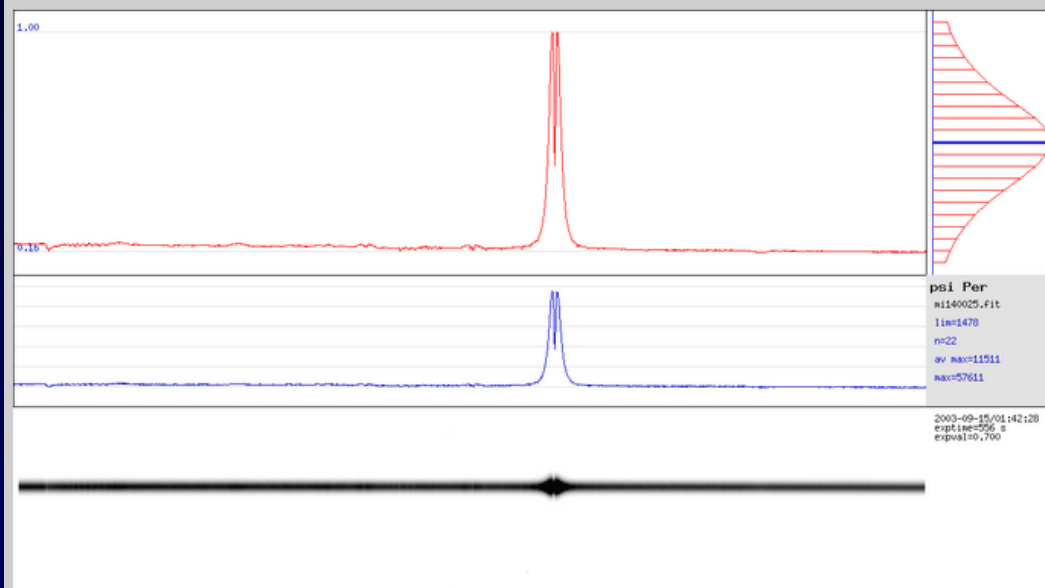
Spectra archive – raw + reduced

H alpha	2008-10-10/21:17	ti040001	a 30:15 2/1	150	4.388	42.43	20100718	psi Per	[Kraus, Fuchs]
H alpha	2010-07-19/01:43	ti040048	a 30:15 2/1	150	4.388	42.43	20100718	psi Per	[Kraus, Kotkova]
gaia	2010-09-04/20:17	ti040007	a 35:47 2/3	300	2.780	25.25	20100904	psi Per	[Kraus, Kotkova]
H alpha	2010-09-04/20:44	ti040012	a 30:15 2/1	200	3.755	28.28	20100904	psi Per	[Kraus, Kotkova]
gaia	2011-03-15/18:49	wei50011	a 35:47 2/3	900	16.881	54.52	20110315	psi Per	[Kraus, Sloup, Aret]
Ca II	2011-03-15/19:08	wei50013	a 32:8 2/3	1800	32.073	51.47	20110315	psi Per	[Kraus, Sloup, Aret]
H alpha	2011-12-07/20:21	u1070006	a 30:15 2/1	800	9.502	79.81	20111207	psi Per	[Kraus, Kotkova]
IR	2011-12-07/20:54	u1070023	a 36:0 2/3	1132	11.906	84.87	20111207	psi Per	[Kraus, Kotkova]
H alpha	2012-01-30/17:13	va300019	a 30:15 2/1	130	2.622	82.83	20120130	psi Per	[Koubsky, Fuchs]
H alpha	2014-08-15/09:14	a201408140051	a 30:15 2/1	1201	15.420	45.48	20140814	psi Per	[Kraus, Tlamicha]
H alpha	2014-08-15/09:36	a201408140053	a 30:15 2/1	901	11.149	48.50	20140814	psi Per	[Kraus, Tlamicha]
gaia	2014-08-15/09:54	a201408140055	a 35:47 2/3	1801	19.944	51.55	20140814	psi Per	[Kraus, Tlamicha]

List of files – main metadata



Reduced spectrum (if exists)



Raw spectrum – maximum in COP

Raw spectrum – averaged all COP

Raw spectrum – inverse image

Object: 'psi Per '
 File: ni140025
 Date start: '2003-09-15'
 UT start: '01:42:28'
 Telescope coordinates: '3:36:08.8' '48:12:14.3'
 Object coordinates: '3:36:29' '48:11:33'
 Observers: 'Stefl + Tlamicha'
 HJD: 2452897.5760
 Spectrograph configuration: CCD700 30:15 1/1 (10889)
 Detector: 'SiTe 2000x800'
 Spectral range [Å]: 6258 - 6771
 Exposure [s]: 556
 Expval: 0.700
 Integ: 7184
 WHelio [km/s]: 24.78
 checked - OK
 Observers: Stefl, Tlamicha

All metadata about frame

Lenka Šarounová-Kotková PHP

Internet v astronomii

- 1992 únor – Internet v ČSFR (EARN-> FERNET,CESNET)
- Na ASU – cca 1993 duben (brána EARN)
- Gopher, WAIS, Veronica, začátek WWW, Telnet
- Duben 1995 CDS Strasbourg

Weaving the Astronomy Web

- Použití WWW pro astronomii
- Databáze ADS
- Astrophysical Journal – on-line
- Proroctví o konci tištěné verze za 20 let
- NCSA Mosaic -> Netscape 1.0

WWW Archiv Reticonu

- ADASS – říjen 1995 – Tucson
 - komunita na celý život -SW, detektory, algoritmy
 - Školení IRAF, CCD laboratoř , prohlídka KPNO
- 1998 GRANT MŠMT INFRA2 LB98251
 - Budování archivu Reticonu
 - SQL Adabas, PostgreSQL, WDB (ESO 1995)
 - 2000 - Archiv 2M byl jedním ze 6 světových archivů pozemních dalekohledů na WWW
 - ESO, CFHT, AAO Okyama, LaPalma INT
 - +logy Asiago, OHP ELODIE
- 2005 Šárka Zehnalová UJEP - do Java Struts

Virtual Observatory : Key Definitions

- *“The Virtual Observatory will be a system that allows astronomers to interrogate multiple data centers in a seamless and transparent way, which provides new powerful analysis and visualization tools within that system, and which gives data centers a standard framework for publishing and delivering services using their data”.*
- Standardization of data and metadata, and of data exchange methods.
- Registry, listing available services and what can be done with them.

R.J.Hanisch, P.J.Quinn, in “IVOA – Guidelines for participation”

IVOA

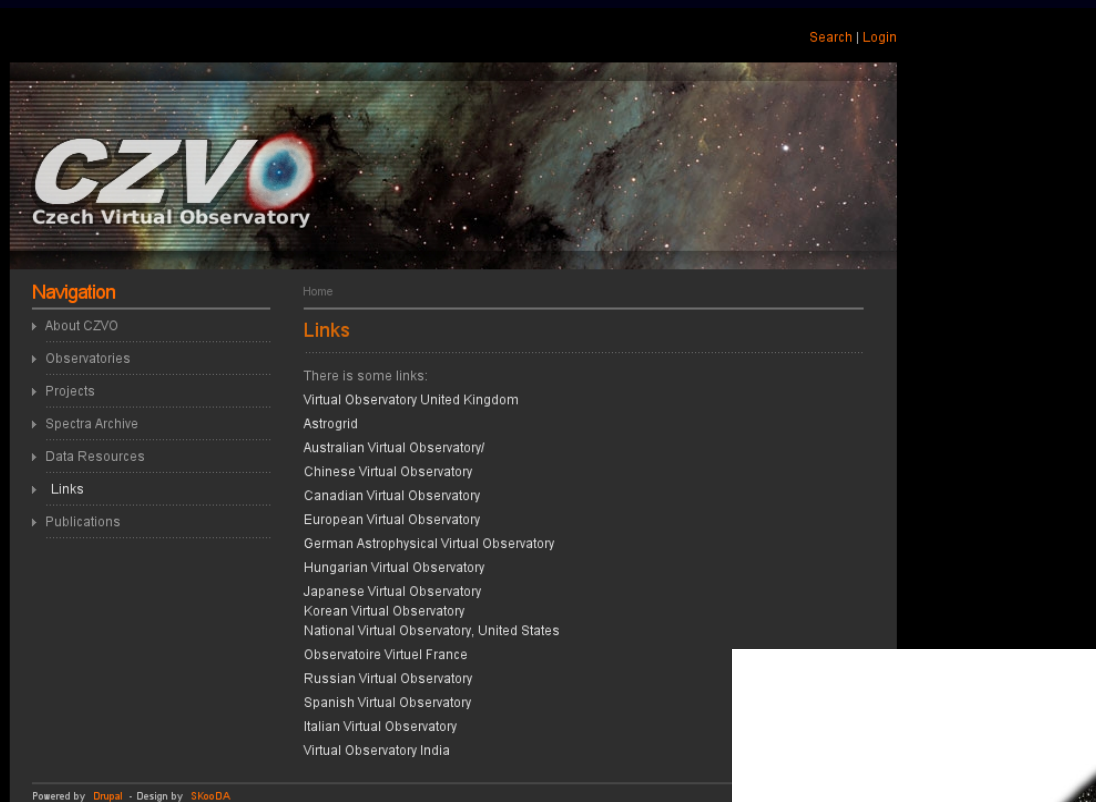


Czech VO - CZVO

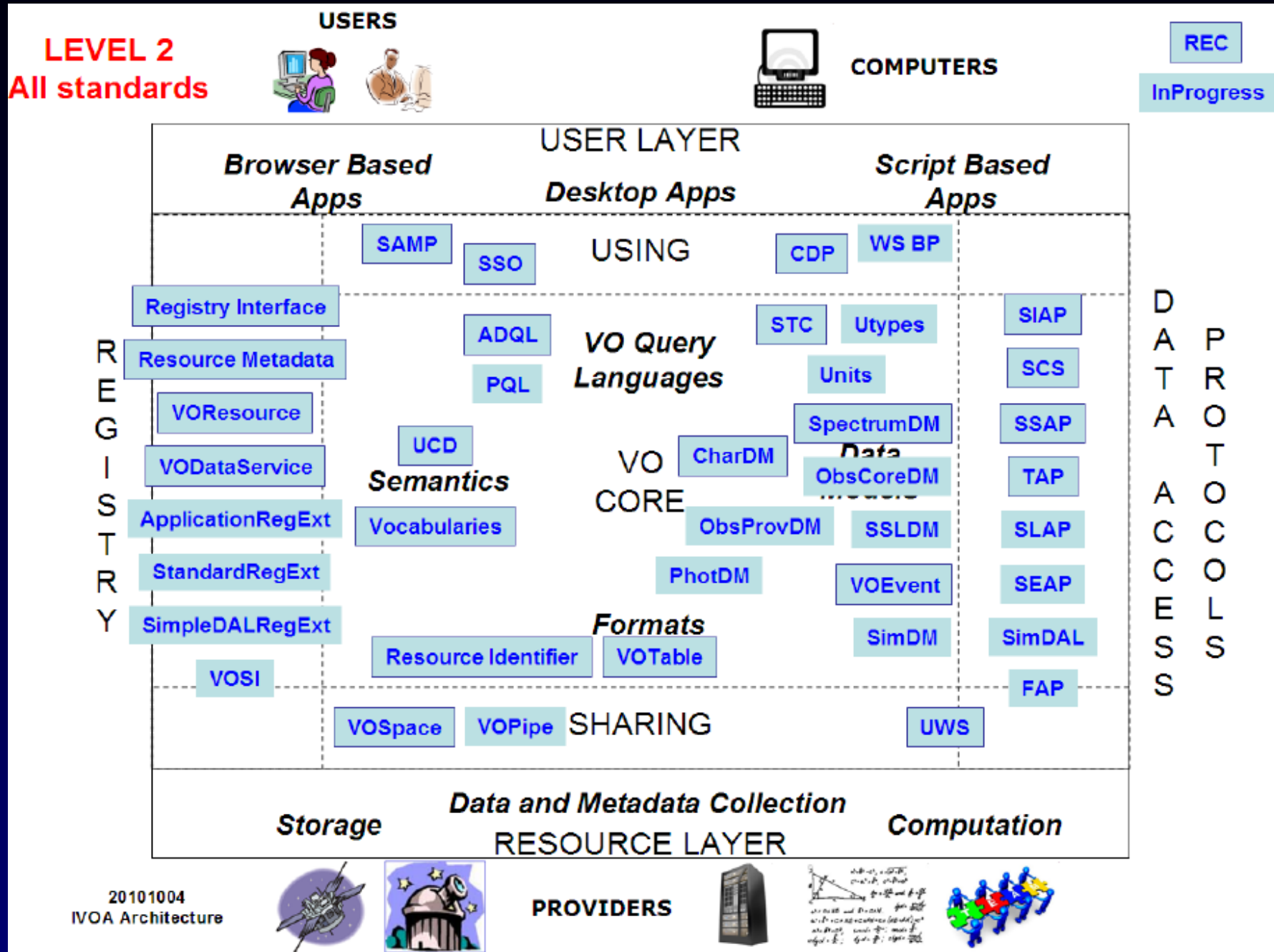
Od 2006 po IAU

Podpora EURO-VO

2008 HEROS archive
ve VO Prugniel OHP
Cutout server



Ecosystem of VO – level 2



Simple Spectra Access Protocol Spectral Data Model

Simple Spectral Access Protocol V1.04



*International
Virtual
Observatory
Alliance*

Simple Spectral Access Protocol

Version 1.04

IVOA Recommendation Feb 01, 2008

This version:

<http://www.ivoa.net/Documents/REC/DAI/SSA-20080201.html>

Latest version:

<http://www.ivoa.net/Documents/latest/SSA.html>

Previous version(s):

Version 1.03, December 2007
Version 1.02, September 2007
Version 1.01, June 2007
Version 1.00, May 2007
Version 0.97, November 2006
Version 0.96, September 2006
Version 0.95 May 2006
Version 0.91 October 2005
Version 0.90 May 2005

Editors:

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*International
Virtual
Observatory
Alliance*

IVOA Spectral Data Model

Version 1.03

IVOA Recommendation 2007-10-29

This version (Recommendation Rev 1)

<http://www.ivoa.net/Documents/REC/DM/SpectrumDM-20071029.pdf>

Latest version:

<http://www.ivoa.net/Documents/latest/SpectrumDM.html>

Previous versions:

<http://www.ivoa.net/Documents/PR/DM/SpectrumDM-20070913.html>

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VO access to spectra - Browser



AIASCR VO Services

Welcome to ASU CAS Data Center.

In addition to the services listed below, on this site you probably can access [numerous tables](#) using [TAP](#) or [form-based ADQL](#).

Please check out our [site help](#).

This project was supported by grant 13-08195S of Czech Science Foundation.

Services Available

By Title

By Subject

By Author

- ▶ [CCD700 Spectra Web Interface](#) [i](#) [Q](#)
- ▶ [HEROS Public Spectra Web Interface](#) [i](#) [Q](#)
- ▶ [LAMOST DR1 Spectra Web Interface](#) [i](#) [Q](#)

Spectra query - web browser



Czech Virtual Observatory

[Help](#)
[Service info](#)

Related
[CCD700 SSAP](#)

Metadata
Identifier
ivo://asu.cas.cz/ccd700/q/
Description
CCD700 public web interface
Keywords
Optical spectroscopy
Creator
[Logo]
Created
2014-05-09T10:57:00
Data updated
2016-06-14
Reference URL
[Service info](#)

[Try ADQL](#) to query our data.

Please report errors and problems to the [site operators](#). Thanks.
[Privacy](#) | [Disclaimer](#)
[Log in](#)

CCD700 Spectra Web Interface

CCD700 public web interface.

Object standard name

pmen
phicas
phiper
piaqr
psi09aur
psiper
pugem
pzgem
qqgem
qrul
rsanl

No selection matches all, multiple values legal.

Somewhat cleaned name of the target object as given in the file. The names should either be SIMBAD-resolvable or give a ref they are appreciated.

Location

Coordinates (as h m s, d m s or decimal degrees), or SIMBAD-resolvable object

Search radius for Location
[arcmin]

Search radius in arcminutes

Date Obs.
[\[?date expr.\]](#)

Midpoint of exposure

Type

☐ image/fits
☒ application/x-votable+xml

MIME type of the file served

Table
Sort by Limit to

100

 items.

Output format

HTML

Pop down field selector

☐ accsize -- Size of the data in bytes
☐ detector -- Detector used to capture spectrum
☐ embargo -- Date the data will become/became public
☒ expval -- Photon counts (Mcount)
☒ grat_angle -- Grating tilt
☐ instrument -- Instrument used to capture spectrum
☐ mime -- MIME type of the file served
☐ obj_name -- Unique identifier of 1 object.
☒ owner -- Owner of the data
☐ spg_setup -- Spectrograph setup (Dichroic mirror/Spectral filter)

Spectra in SPLAT-VO - query

Starlink SPLAT-VO: Query VO for Spectra

File Options Resolver Interop Help

Service selection options
Data Source
☒ Observed data ☐ Theoretical data

Wave Band
☐ Radio ☐ Millimeter ☐ Infrared
☐ Optical ☐ UV ☐ EUV
☐ X-ray ☐ Gamma-ray ☒ ALL

Tags
+ -

Search parameters:
Simple Query
Object: psi per Lookup Clear
RA: 03:36:29.38 Dec: +48:11:33.48
Radius: 10.0 MAXREC:
Band: 6530e-10 / 6580e-10
Time:
Query Format: votable
Wavelength calibration: None
Flux calibration: None

Optional Parameters
Use Name Value UCD
☐ REDSHIFT src.redshift
☐ TARGETCLASS src.class
☐ MTIME
☐ SPECPR spect.resolution;em.wl
☐ SPATRES pos.angResolution
☐ PUDDID
☐ CREATORDID meta.id
Select all Deselect all Update

SSAP Servers
short name title
BeSS Be Stars Spectra
califa ssa CALIFA DR2
castor Espadons/Narval leg...
castor+ Espadons/NARVAL le...
ccd700-voarchive ccd700 OND
ccd700-vos2
CDFSS SSAP Optical Spectroscop...
CENCOS-VVDS_DEEP CENCOS-VVDS_DEEP...
CENCOS-VVDS_DEEP+ CENCOS-VVDS_DEEP...
Cfa Hectospec Cfa Hectospec Spec...
dk154
dk154-extr15
dk154-extr15jan dk154
dk154-extr16jan dk154
DK154-SSA DK154 SSA
ELODIE ELODIE archive
ELODIEinterp Spectrum interpolat...
ESO SAF SSA ESO Science Archive...
EUVE Extreme Ultraviolet ...
extract_jul16 DK154
F/H Orders SSAP Flash/Heros Split-Or...
FEROS SSAP FEROS Public Spectra
Flash/Heros SSAP Flash/Heros SSAP
FUSE Far Ultraviolet Spect...
GALEX Galaxy Evolution Exp...
GIRAFFE GIRAFFE archive of r...
H.E.S.S. High Energy Stereos...
HEAVENS @ ISDC Mining the HEAVENS...
HEROS OND HEROS archive of On...
HEROS OND CUTOUT cutout server of HE...

Query: <SERVER>?REQUEST=queryData&POS=54.122416666666666,48.192633333333333&FORMAT=votable&SIZE=0.166666666666666&BAND=6530e-10/6580e-10

Query results:
CCD700-voarchive

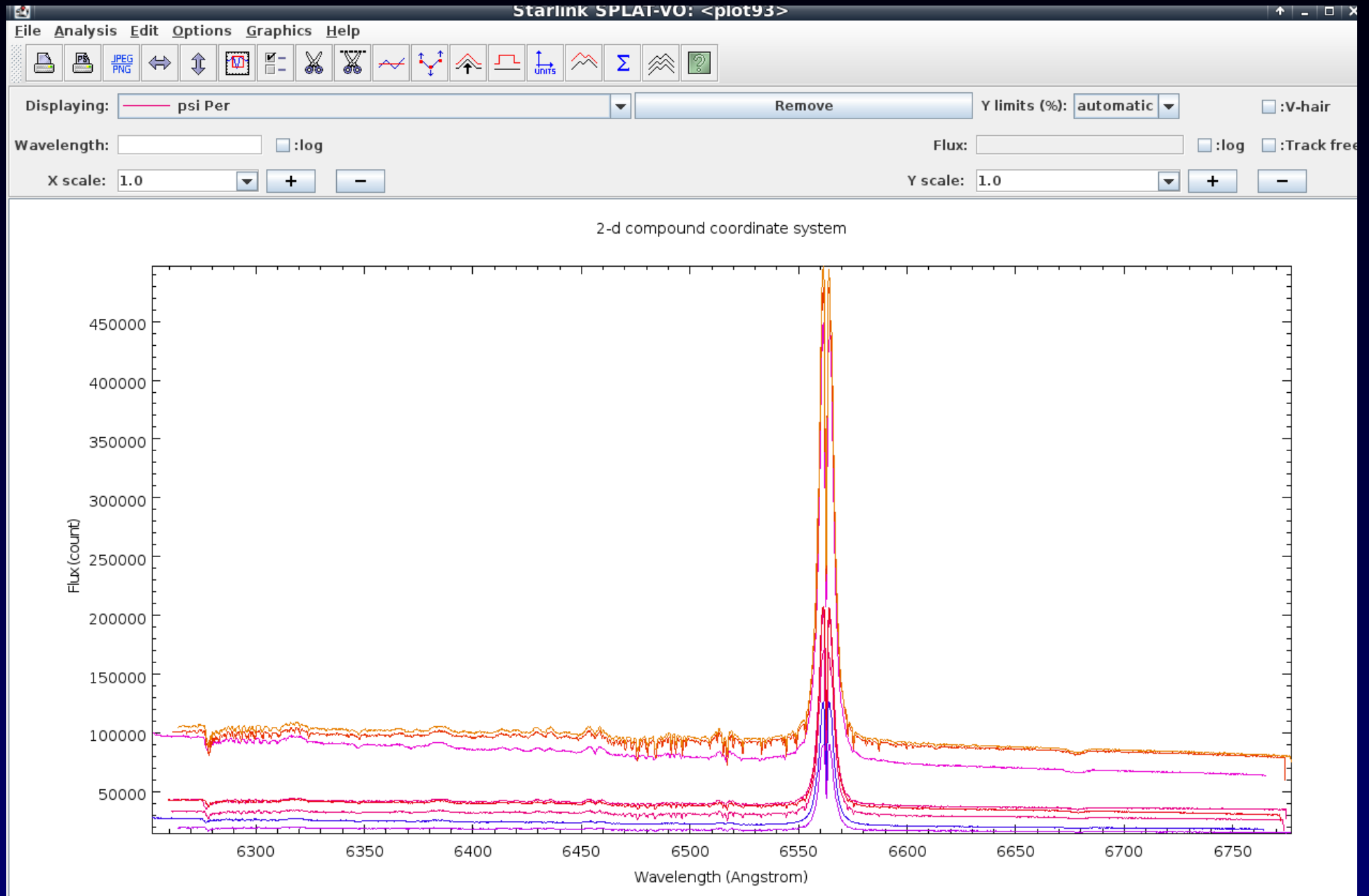
l...	ssa_specstart	ssa_specend	ssa_dstitle	ssa_targname	ssa_dateObs	ssa_timeExt	ssa_snr	ssa_length	accref	
12	6.26183E-7	6.77426E-7	ccd700/data/psiper/6255-676...	Psi Per	53216.0049	1800.		1997	http://voarchive.asu.cas.cz/ge...	appli
27	6.24978E-7	6.76217E-7	ccd700/data/psiper/6255-676...	psi Per	54701.97209	1333.19		1997	http://voarchive.asu.cas.cz/ge...	appli
13	6.25854E-7	6.77081E-7	ccd700/data/psiper/6255-676...	psi Per	52982.77964	1300.		1997	http://voarchive.asu.cas.cz/ge...	appli
31	6.26359E-7	6.73614E-7	ccd700/data/psiper/6260-673...	psi Per	56884.01015	1201.		2047	http://voarchive.asu.cas.cz/ge...	appli
30	6.26359E-7	6.73614E-7	ccd700/data/psiper/6260-673...	psi Per	56884.02565	901.		2047	http://voarchive.asu.cas.cz/ge...	appli
2	6.26234E-7	6.77466E-7	ccd700/data/psiper/6255-676...	psi Per	53451.88616	899.564		1997	http://voarchive.asu.cas.cz/ge...	appli
28	6.26587E-7	6.77822E-7	ccd700/data/psiper/6255-676...	psi Per	54209.80019	899.214		1997	http://voarchive.asu.cas.cz/ge...	appli
3	6.25267E-7	6.76496E-7	ccd700/data/psiper/6255-676...	Psi Per	55902.84843	800.		1997	http://voarchive.asu.cas.cz/ge...	appli
10	6.25163E-7	6.76402E-7	ccd700/data/psiper/6255-676...	psi Per	54757.88729	730.		1997	http://voarchive.asu.cas.cz/ge...	appli
6	6.26183E-7	6.77426E-7	ccd700/data/psiper/6255-676...	Psi Per	53216.02811	600.		1997	http://voarchive.asu.cas.cz/ge...	appli
14	6.24978E-7	6.76217E-7	ccd700/data/psiper/6255-676...	psi Per	54701.96266	600.		1997	http://voarchive.asu.cas.cz/ge...	appli
9	6.25809E-7	6.77051E-7	ccd700/data/psiper/6255-676...	psi Per	52897.07116	556.599		1997	http://voarchive.asu.cas.cz/ge...	appli
18	6.26587E-7	6.77822E-7	ccd700/data/psiper/6255-676...	psi Per	54209.81274	450.		1997	http://voarchive.asu.cas.cz/ge...	appli
20	6.25854E-7	6.77081E-7	ccd700/data/psiper/6255-676...	psi Per	52982.79788	350.		1997	http://voarchive.asu.cas.cz/ge...	appli
16	6.26235E-7	6.77492E-7	ccd700/data/psiper/6255-676...	psi Per	53475.85182	300.043		1997	http://voarchive.asu.cas.cz/ge...	appli
19	6.26401E-7	6.77640E-7	ccd700/data/psiper/6255-676...	psi Per	53249.01697	300.		1997	http://voarchive.asu.cas.cz/ge...	appli
23	6.25161E-7	6.76378E-7	ccd700/data/psiper/6255-676...	psi Per	54519.80405	300.		1997	http://voarchive.asu.cas.cz/ge...	appli
24	6.25161E-7	6.76378E-7	ccd700/data/psiper/6255-676...	psi Per	54519.7984	300.		1997	http://voarchive.asu.cas.cz/ge...	appli
7	6.26434E-7	6.77677E-7	ccd700/data/psiper/6255-676...	psi Per	53228.0436	218.373		1997	http://voarchive.asu.cas.cz/ge...	appli
11	6.25641E-7	6.76875E-7	ccd700/data/psiper/6255-676...	psi Per	55443.86444	200.		1997	http://voarchive.asu.cas.cz/ge...	appli
22	6.25161E-7	6.76378E-7	ccd700/data/psiper/6255-676...	psi Per	54519.81162	200.		1997	http://voarchive.asu.cas.cz/ge...	appli
25	6.25908E-7	6.77147E-7	ccd700/data/psiper/6255-676...	psi Per	52901.91749	194.574		1997	http://voarchive.asu.cas.cz/ge...	appli
15	6.25937E-7	6.77178E-7	ccd700/data/psiper/6255-676...	psi Per	52904.03609	180.		1997	http://voarchive.asu.cas.cz/ge...	appli
1	6.26100E-7	6.77340E-7	ccd700/data/psiper/6255-676...	psi Per	55396.07196	150.		1997	http://voarchive.asu.cas.cz/ge...	appli
4	6.25985E-7	6.76445E-7	ccd700/data/psiper/6255-676...	psi Per	55956.73746	130.		1997	http://voarchive.asu.cas.cz/ge...	appli

Display selected Display all Download selected Download all Deselect table Deselect all DataLink Services

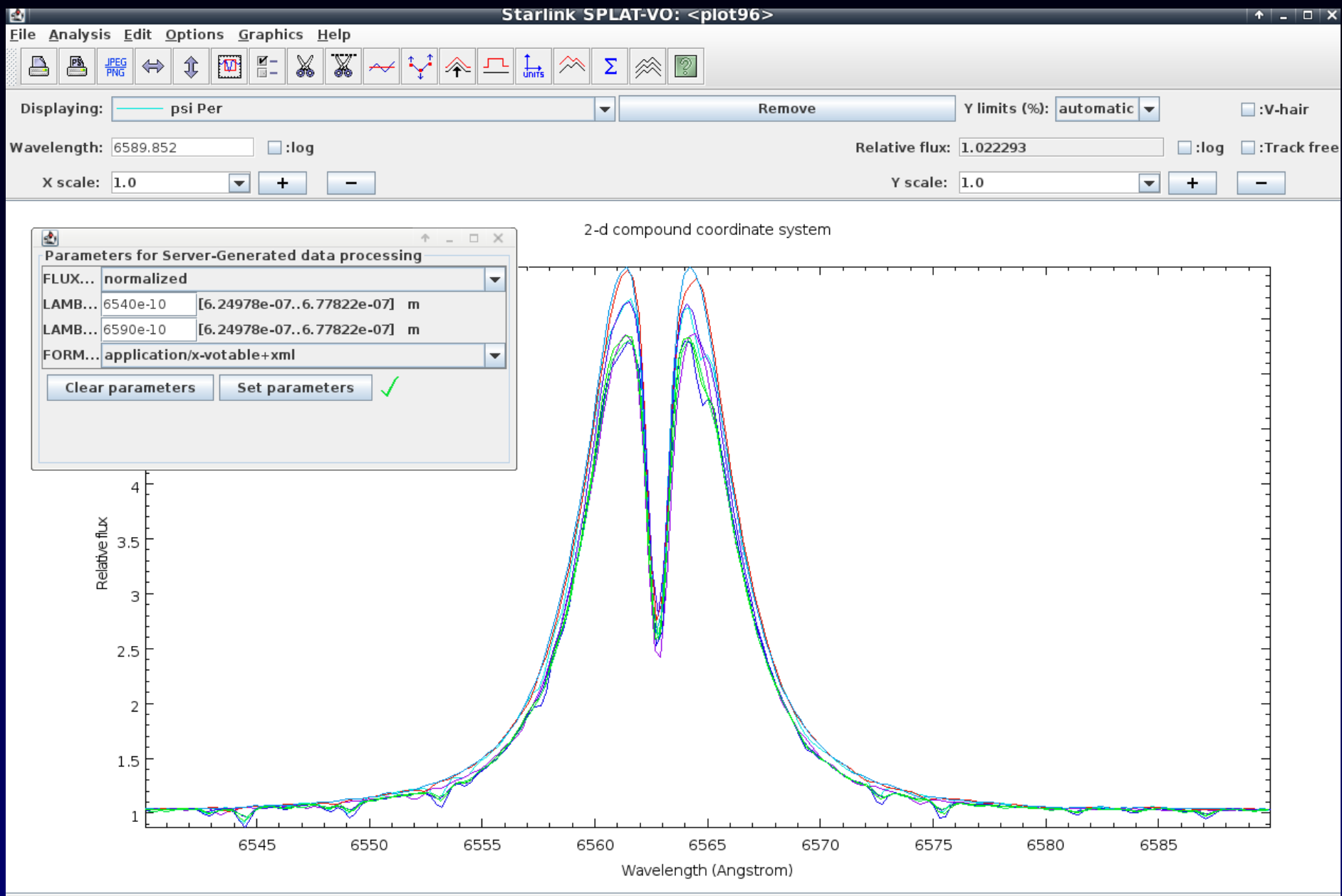
Save query results Restore query results Close

Select all Deselect all Query registry Add New Server

Spectra in VO – direct access plot



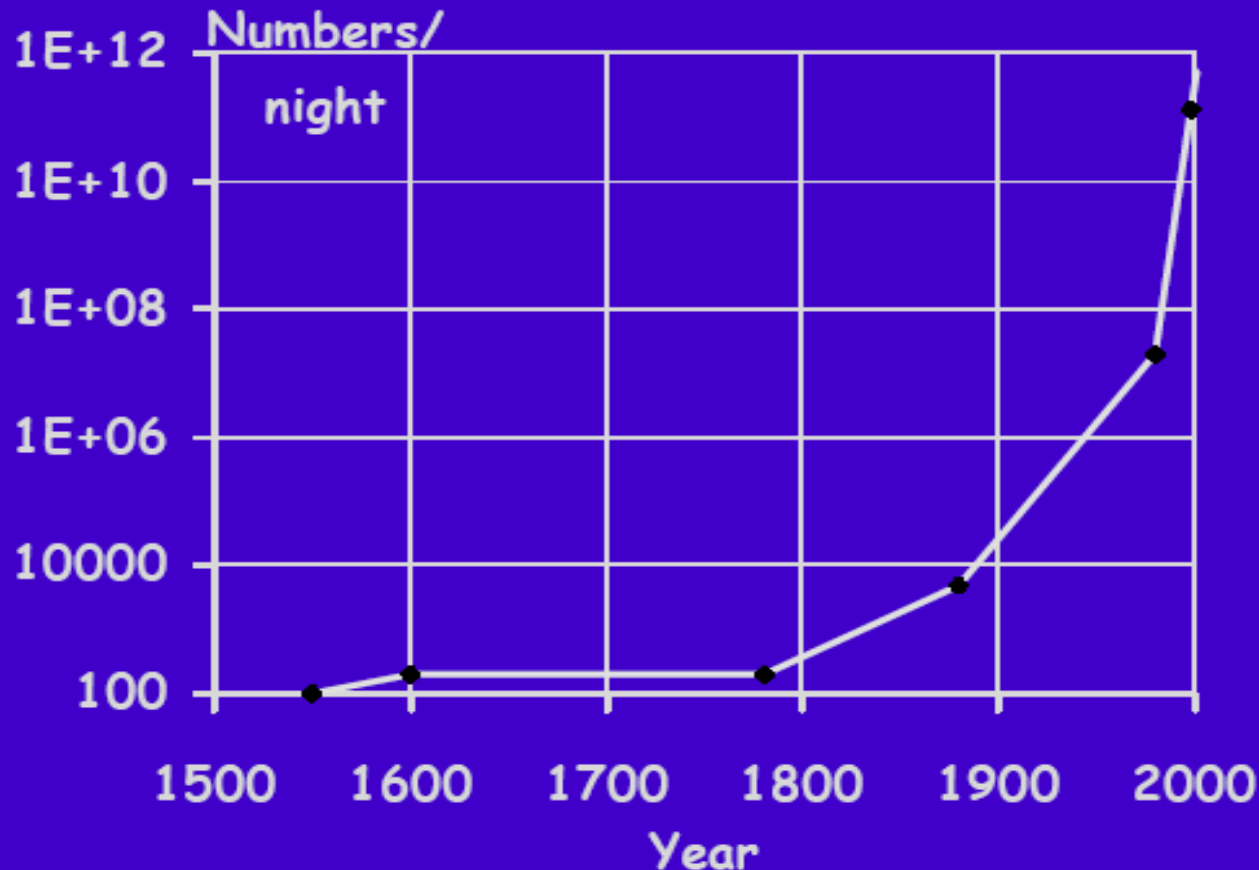
Spectra in SPLAT-VO - DataLink



Lavina dat

Moorův zákon chipy – zdvojení 1.5 roku (1000/10 let)

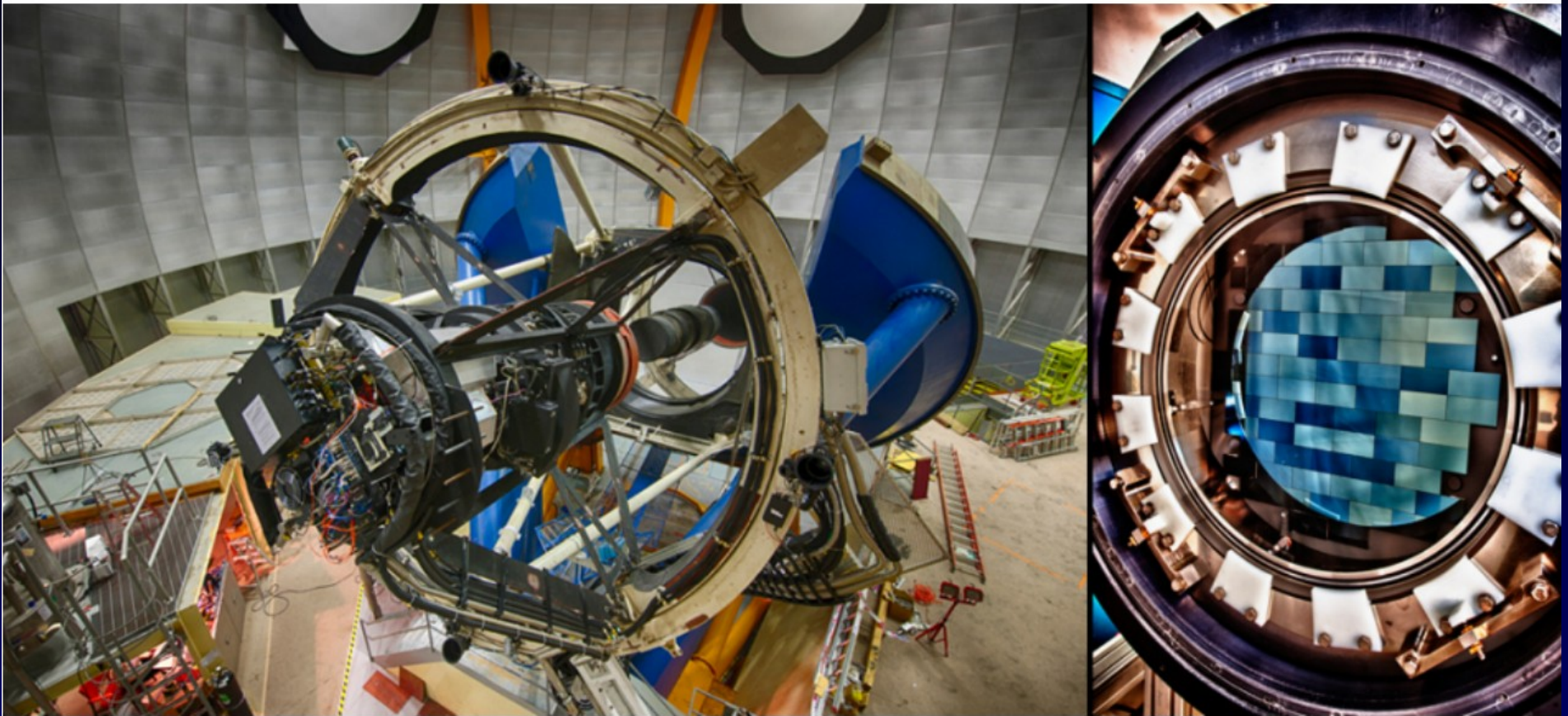
Data v astronomii – zdvojení < 1 rok !



$T_2 < 18$ mths
1990-2000

Dark Energy Survey Camera

Dark Energy Camera (DECam)



~ 0.4 PB/yr

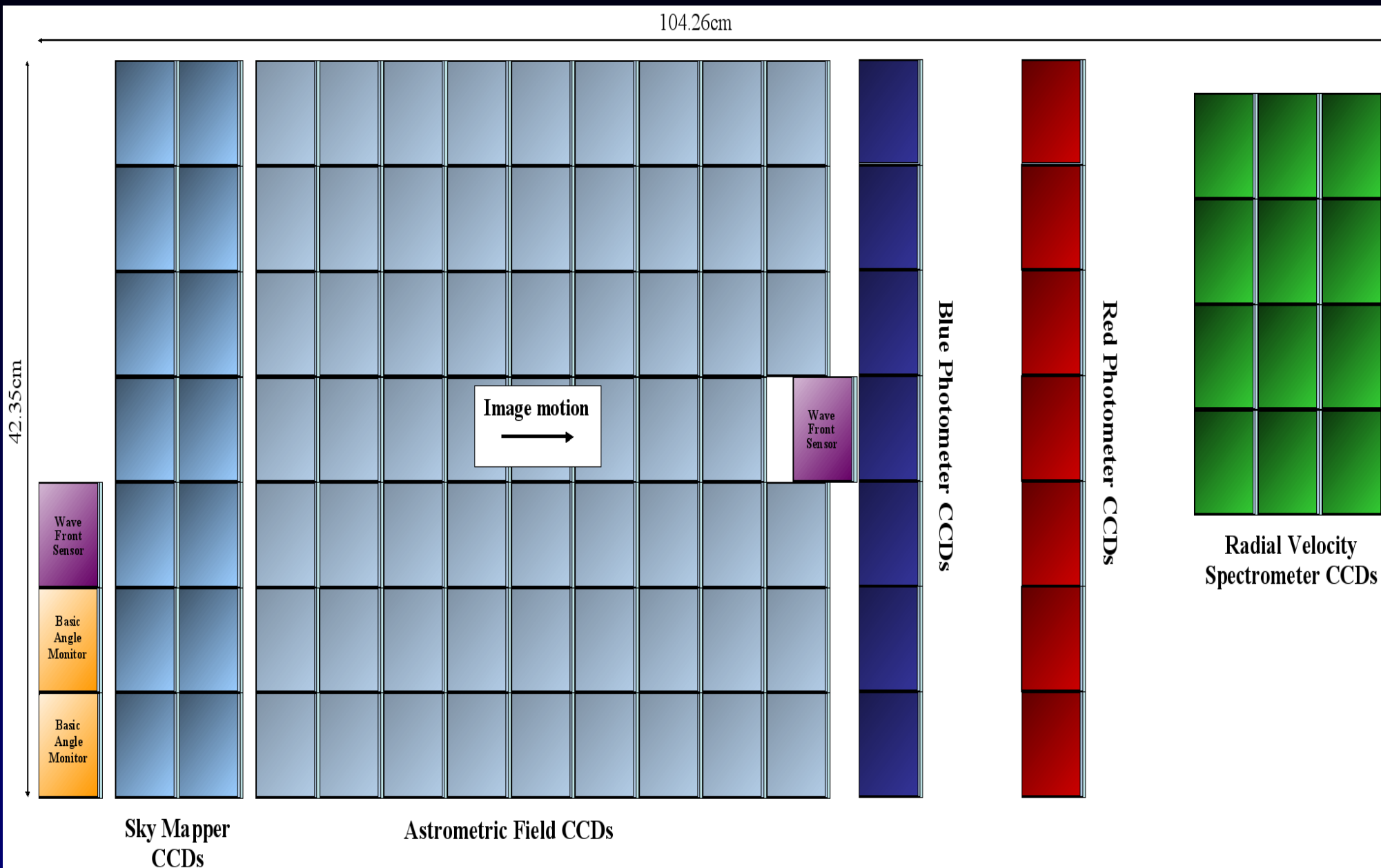
74 chips – 570 Mpixels - 4m Cerro Tololo

GAIA CCDs

106 CCDs

938 Mpix

2800cm²

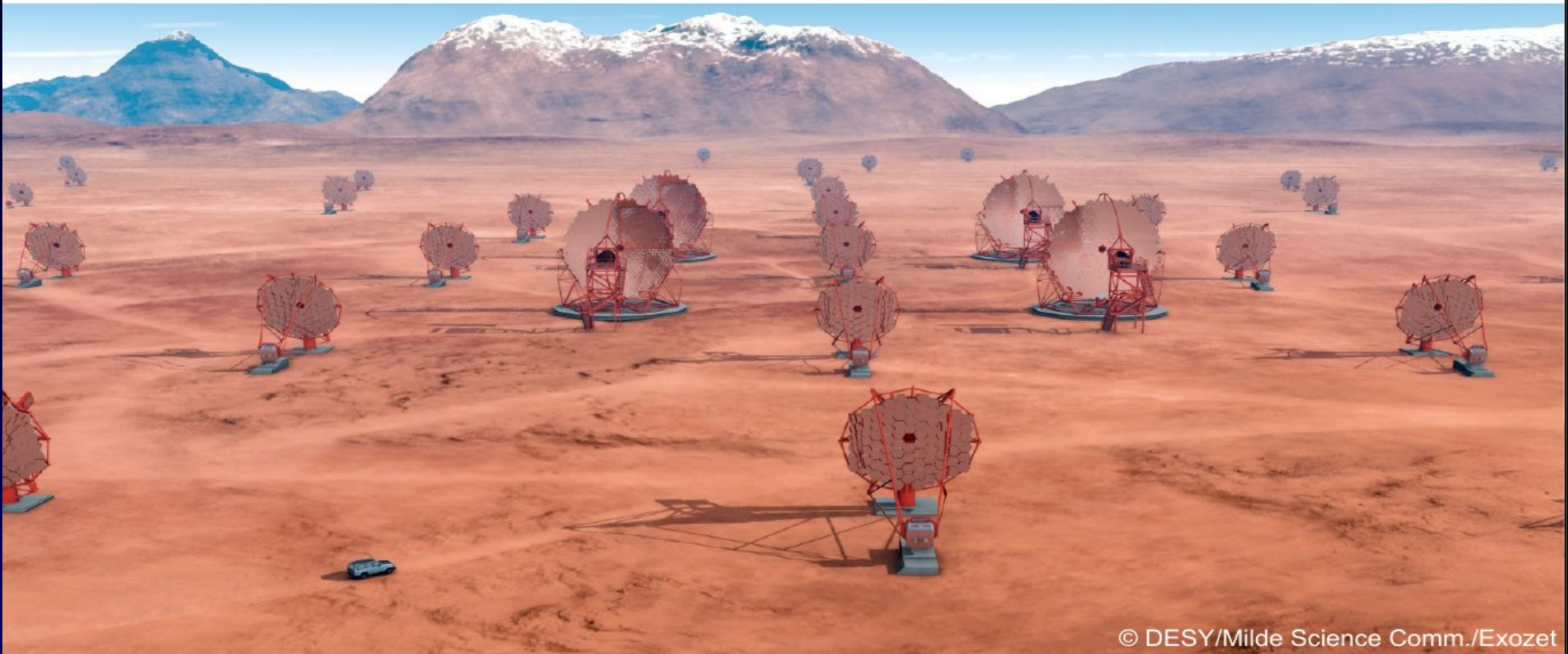


Cherenkov Telescope Array

Cherenkov Astronomy and CTA



- ◆ Two arrays of 100 (South) et 20 (North) telescopes
- ◆ July 2015: sites selection, Chile (ESO) and La Palma
- ◆ 2016: pre-production phase
- ◆ 2018-2013: production phase
- ◆ Observatory open to the community



© DESY/Milde Science Comm./Exozet

LOFAR network



	LOFAR	SKA
Raw Telescope	112 PB/yr	60 EB/yr
Archive Rate	6 PB/yr	100 PB/yr

SKA



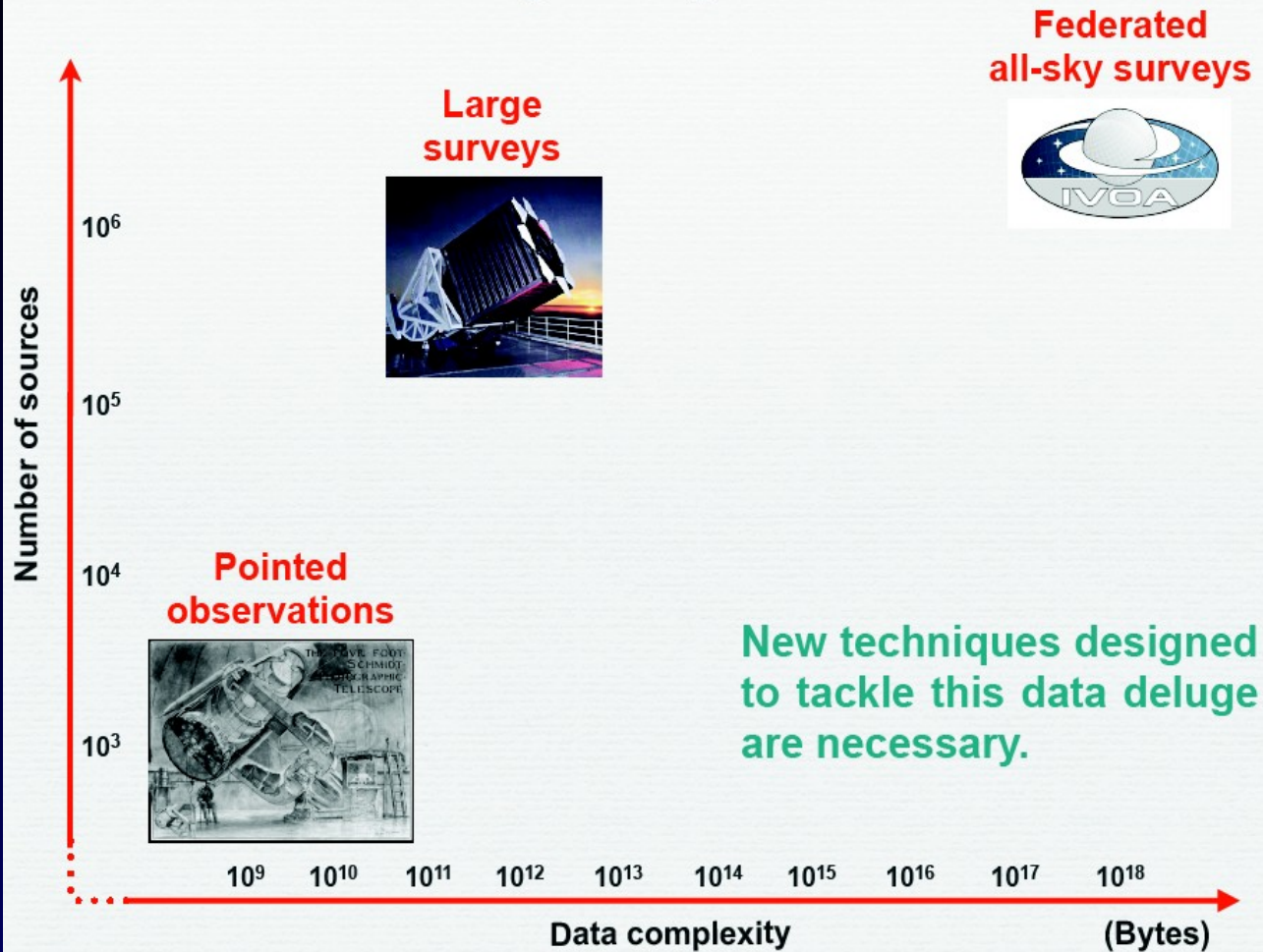
Dishes

SKA Archive Volumes

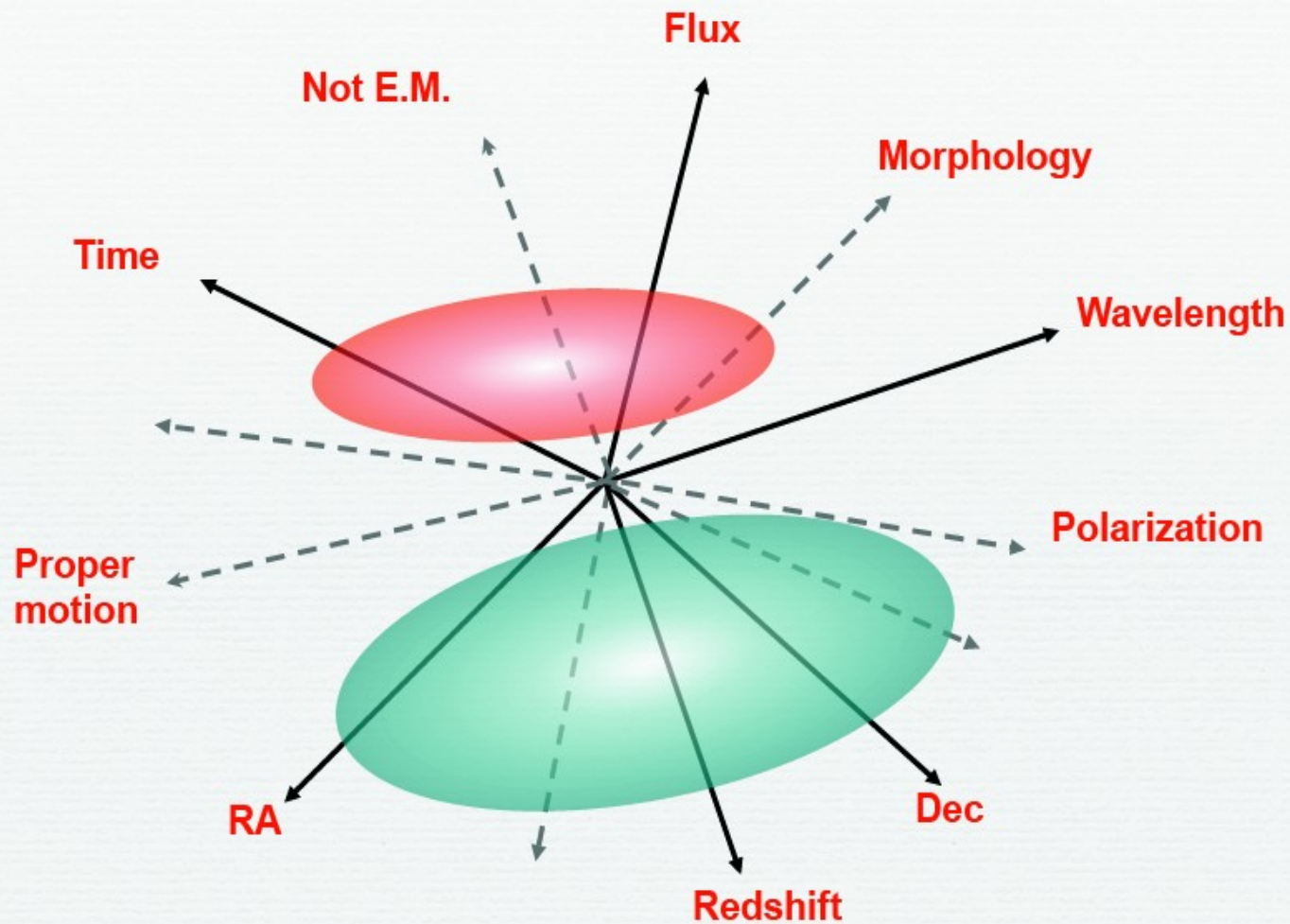
- ~0.5 – 10 PB/day of image data
- Source count $\sim 10^6$ sources per square degree
- $\sim 10^{10}$ sources in the accessible SKA sky, 10^4 numbers/record
- ~1 PB for the catalogued data

**100 Pbytes – 3 EBytes / year of fully
processed data**

A paradigm shift



A growing parameter space



Most discoveries were made in small regions of subspaces or along some of these axes

Need for a new science: Astroinformatics

Knowledge Discovery in Databases

Data Gathering (e.g., from sensor networks, telescopes...)



→ Data Farming:

Storage/Archiving
Indexing, Searchability
Data Fusion, Interoperability, ontologies, etc.

Database technologies

→ Data Mining (or Knowledge Discovery in Databases):

Pattern or correlation search
Clustering analysis, automated classification
Outlier / anomaly searches
Hyperdimensional visualization

Key mathematical issues

→ Data understanding

Computer aided understanding
KDD
Etc.

Ongoing research

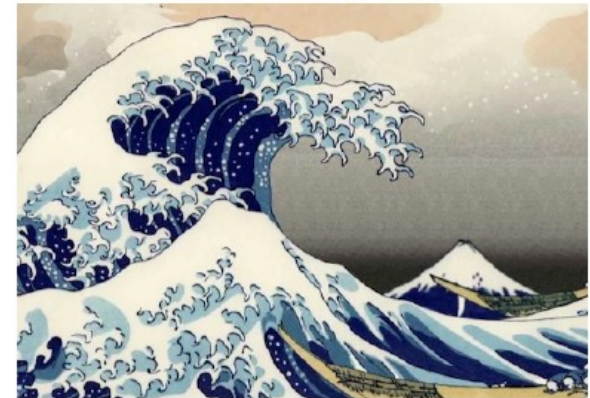
→ New Knowledge



Data Driven Science

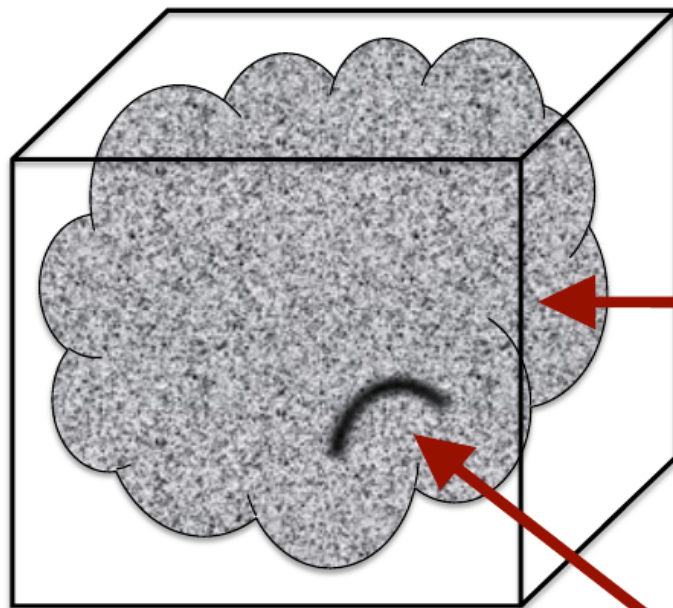
What is Fundamentally New Here?

- The *information volumes and rates* grow exponentially
→ *Most data will never be seen by humans*
- A great increase in the data *information content*
→ *Data driven vs. hypothesis driven science*
- A great increase in the *information complexity*
→ *There are patterns in the data that cannot be comprehended by humans directly*



Hidden Patterns in Data

Pattern or structure (Correlations, Clustering, Outliers, etc.) Discovery in High-Dimensional Parameter Spaces



$D \gg 3$ parameter
space hypercube

High-D data cloud:
mostly noise, of an
arbitrary distribution

But in some corner of
some sub-D projection of
this data space, there is
something $\neq$ noise

Visualization in Machine Learning

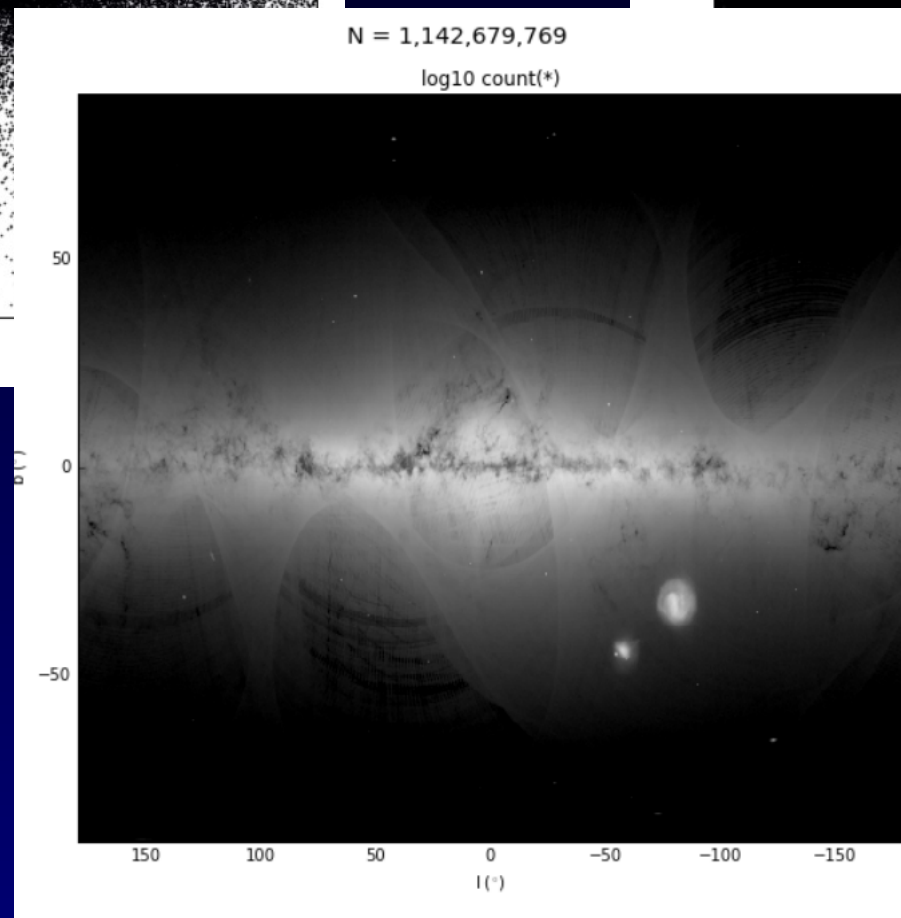
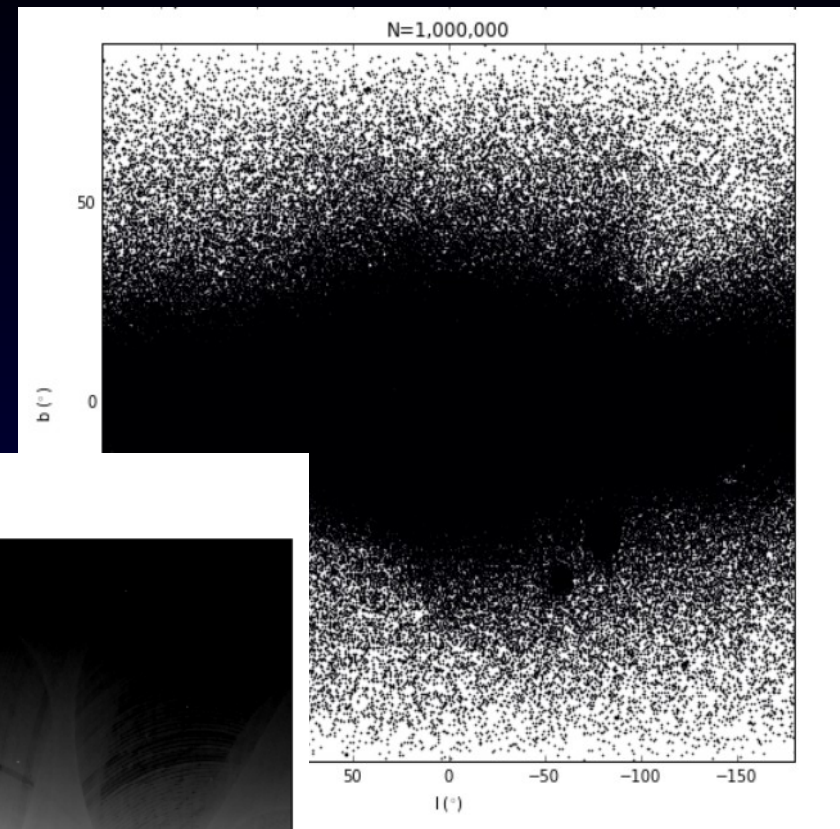
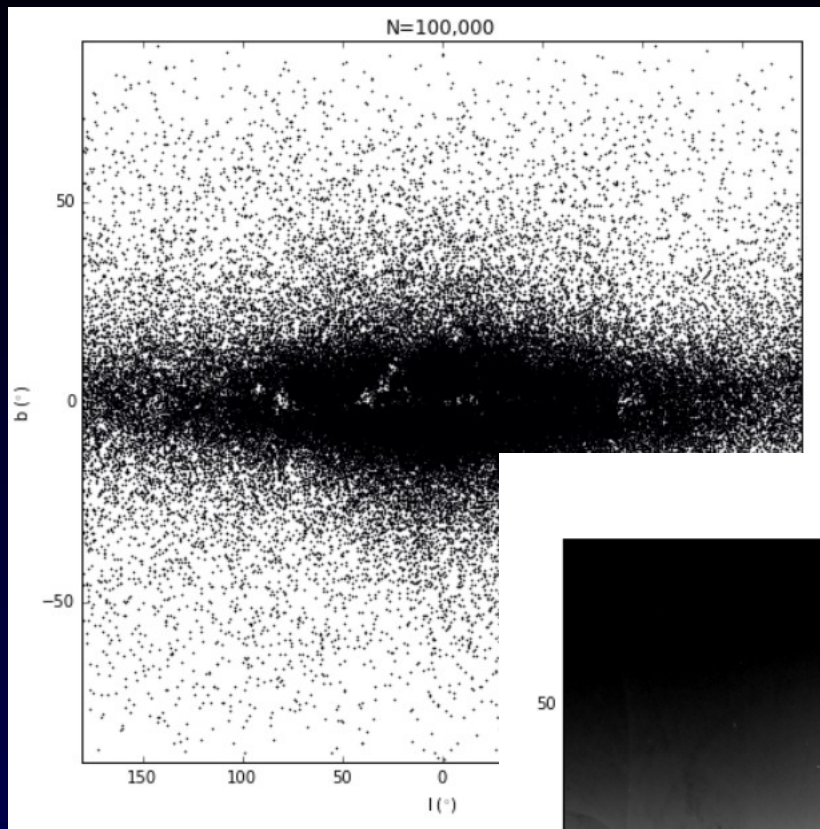
A Key Challenge: Visualising Multidimensional Data Spaces

- Hyperdimensional structures (clusters, correlations, etc.) may be present in many complex data sets, whose dimensionality may be $D \sim 10^2 - 10^4$, or higher
- It is a matter of ***data understanding***, choosing the right data mining algorithms, and interpreting the results
- We are biologically limited to perceiving up to $\sim 3 - 12(?)$ dimensions

What good are the data if we cannot effectively extract knowledge from them?

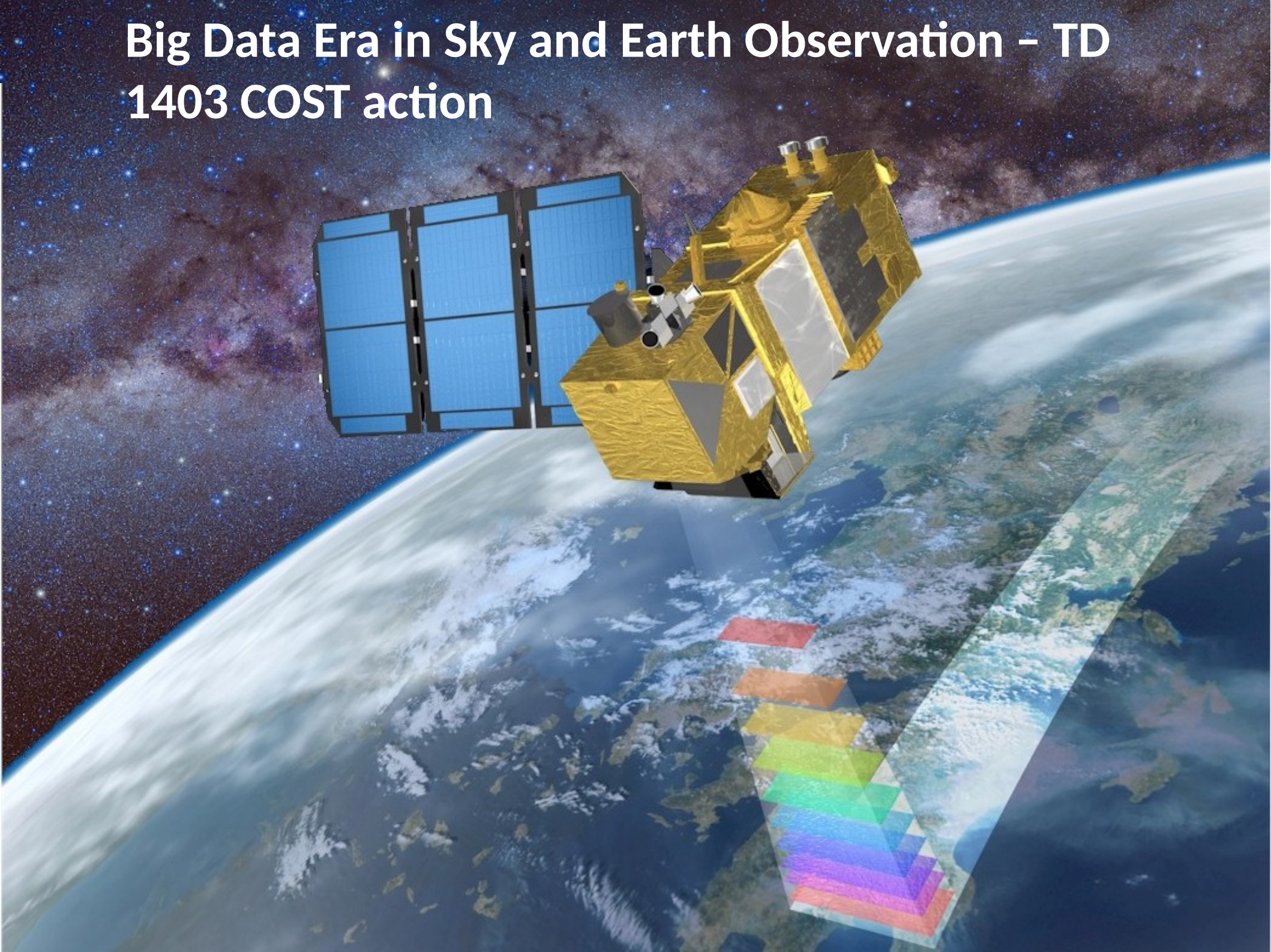


Visualization of 1 B points – Gaia DR1



10^9 points In 1 sec !

Big Data Era in Sky and Earth Observation – TD 1403 COST action

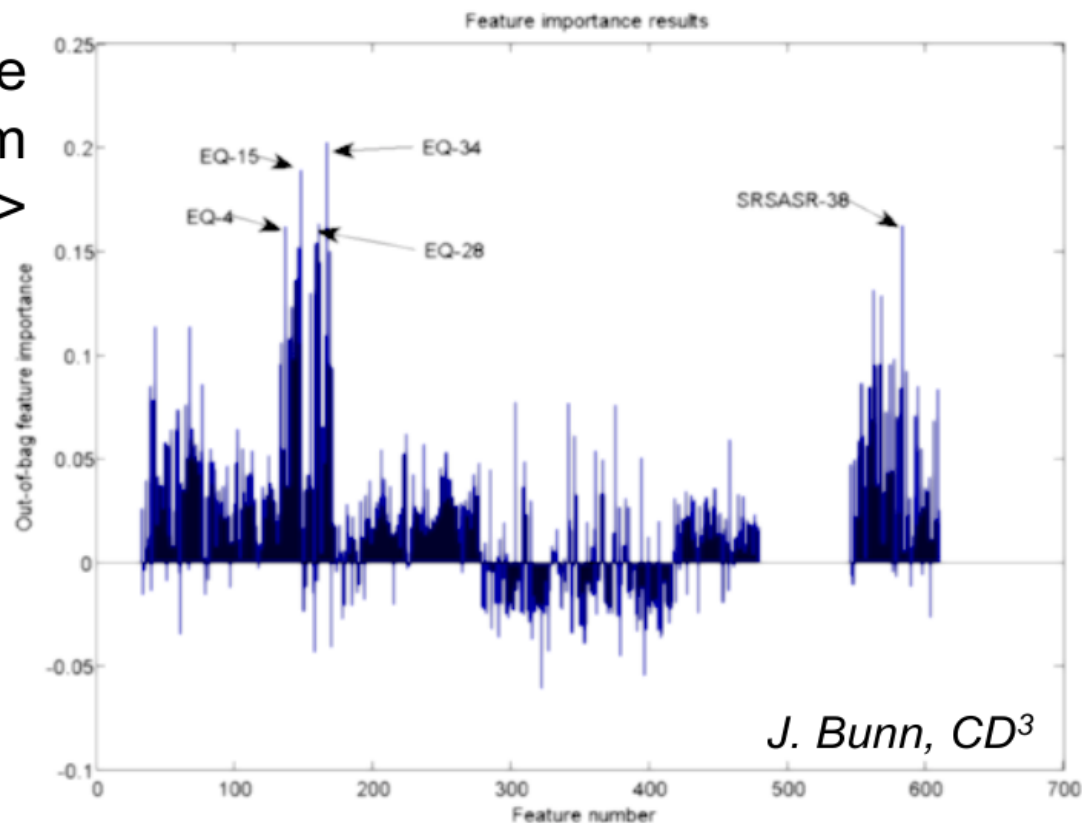


Astro-Neurology

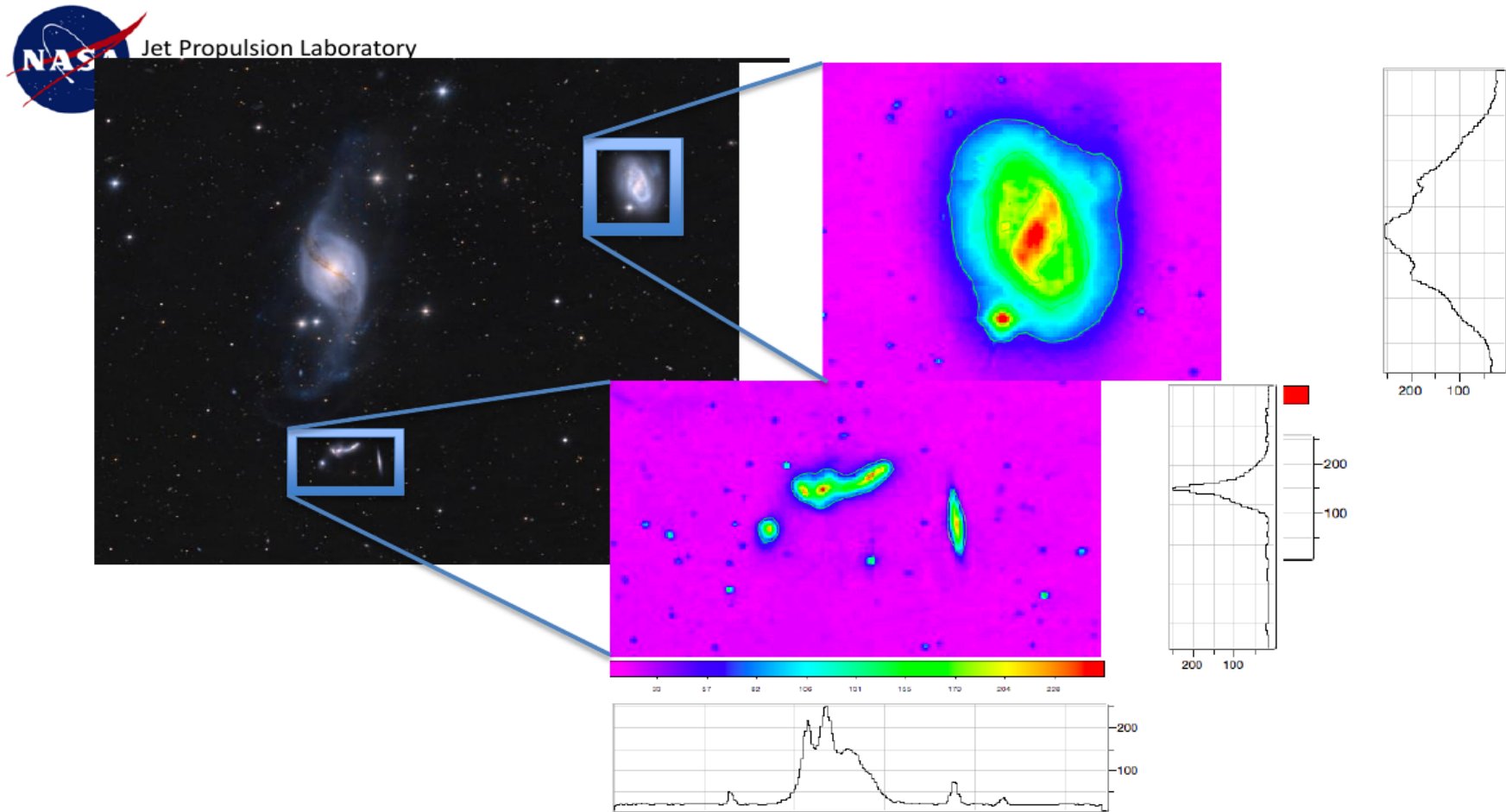
From Sky Surveys to Neurobiology

- Using the data analytics tools based on ML, developed for the analysis of sky surveys, to design a better diagnostics for autism
- Feature importance using random forests =>
 - Next: correlate with MRI scans

(with R. Adolphs et al.)



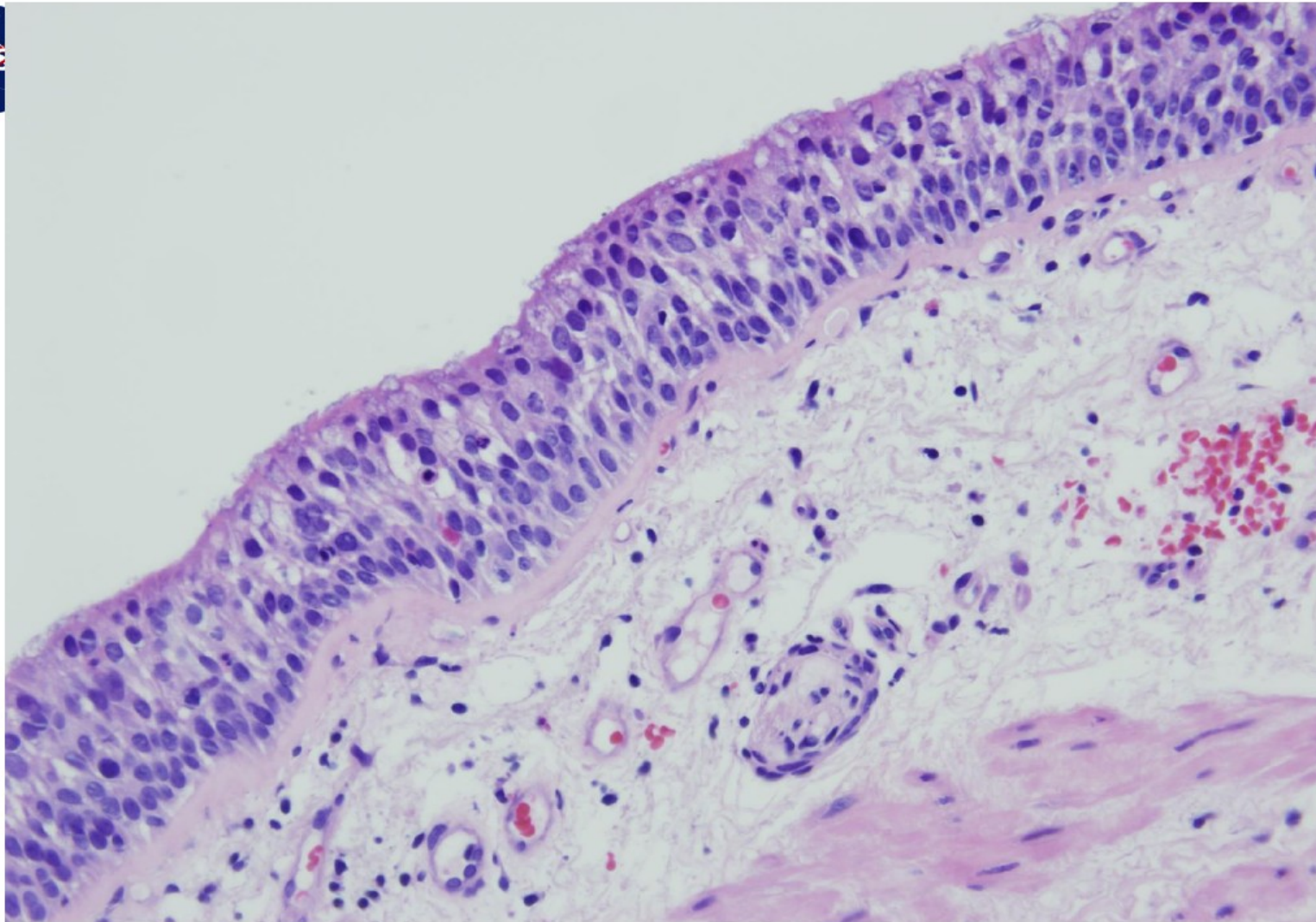
Finding Galaxies by Shape NASA



Description: Detecting objects from astronomical measurements by evaluating light measurements in pixels using intelligent software algorithms.

Image Credit: Catalina Sky Survey (CSS), of the Lunar and Planetary Laboratory, University of Arizona, and Catalina Realtime Transient Survey (CRTS), Center for Data-Driven Discovery, Caltech.

Finding Cancer Signatures NASA



Description: Detecting objects from oncology images using intelligent software algorithms transferred to and from space science.

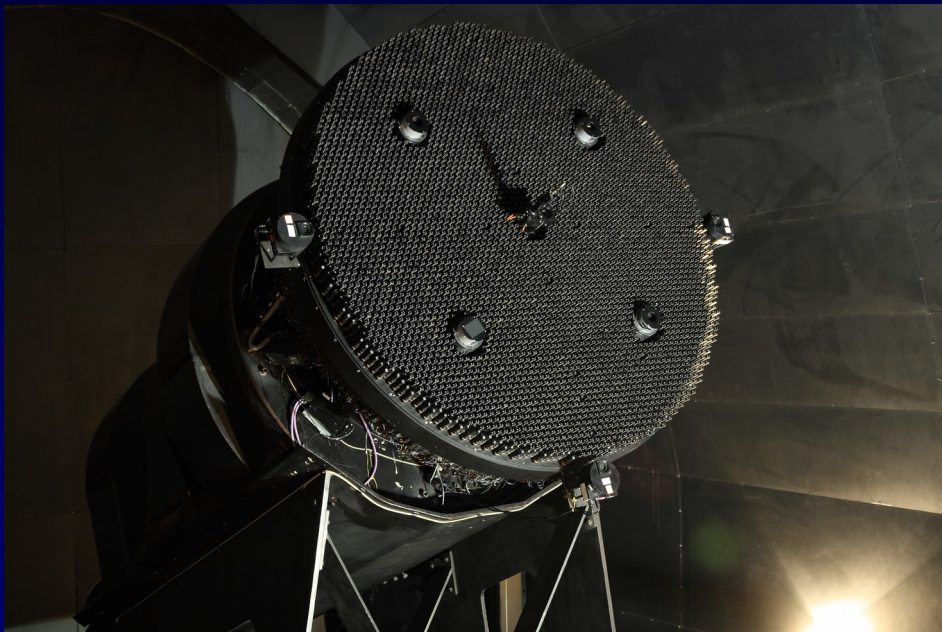
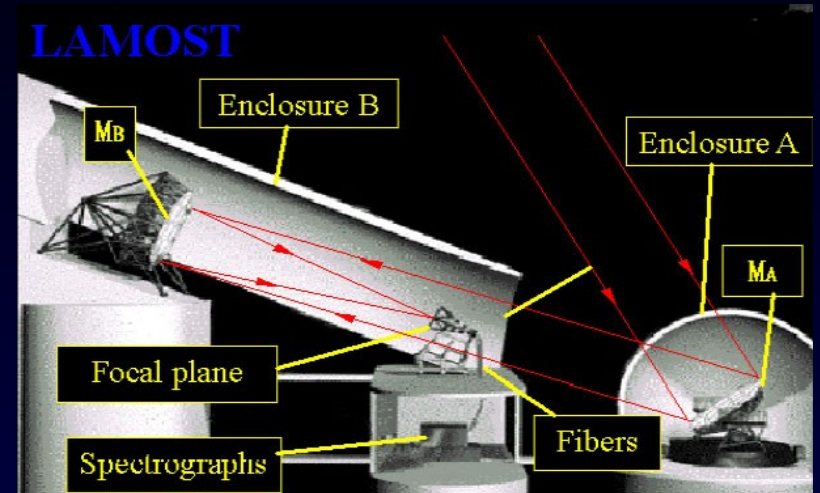
Image Credit: EDRN Lung Specimen Pathology image example, University of Colorado

BP a DP na FITs z astroinformatiky a VO

- FIT VUT Brno
 - 2011 1 BP (Random Forests in Astronomy)
 - 1 PhD – Wavelets Dimensionality Reduction (pending)
- VŠB-TU Ostrava
 - 2013+2015 1 BP + 1 DP - SPLAT-VO
- FIT ČVUT
 - 2012 2 BP (VO-Korel+SSA proxy)
 - 2013 2 BP (OSPS Image + Catalogue Server)
 - 2014 2 BP (Random Forests + SOM)
 - 2015 1 BP (VO-Cloud)
 - 2 DP (Clustering OSPS + Deep Learning)
 - 2016 2 DP (Semisupervised learning + Outlier finding)
 - 2017 1 DP (VO Cloud) + 1 BP (deep learning)+ 1 PhD (VO light curve)

LAMOST (Guoshoujing)

Xinglong- China
4m mirror (30 deg meridian)
4000 fibers
10 mil spectra / 5 yr
Automatic RV-z



LAMOST Spectral Surveys

DR1 (end 2013) **2 204 860** spectra
 1 085 404 stars

DR3 (half 2015) **5 755 126** spectra

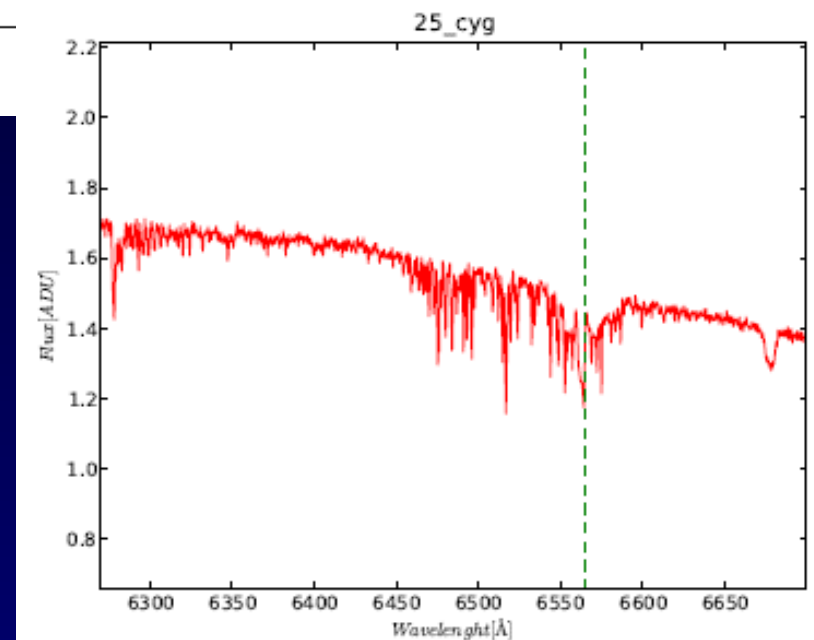
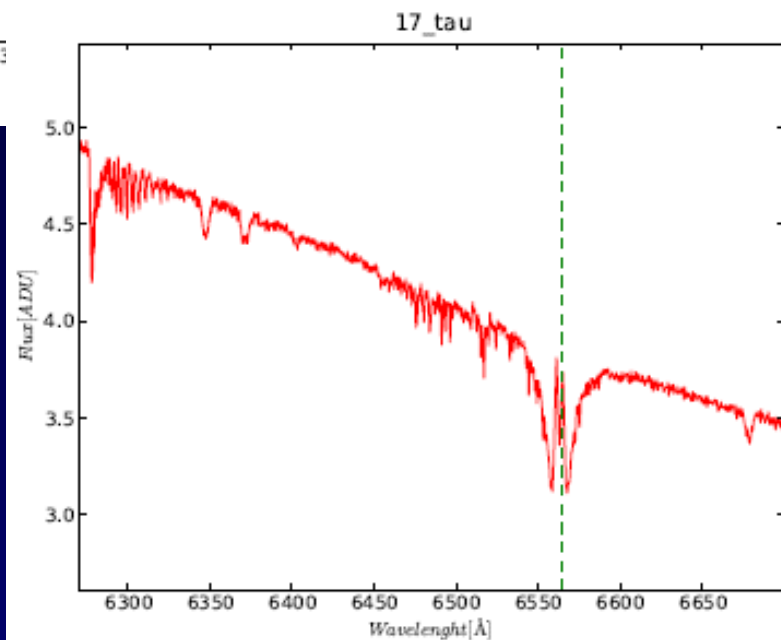
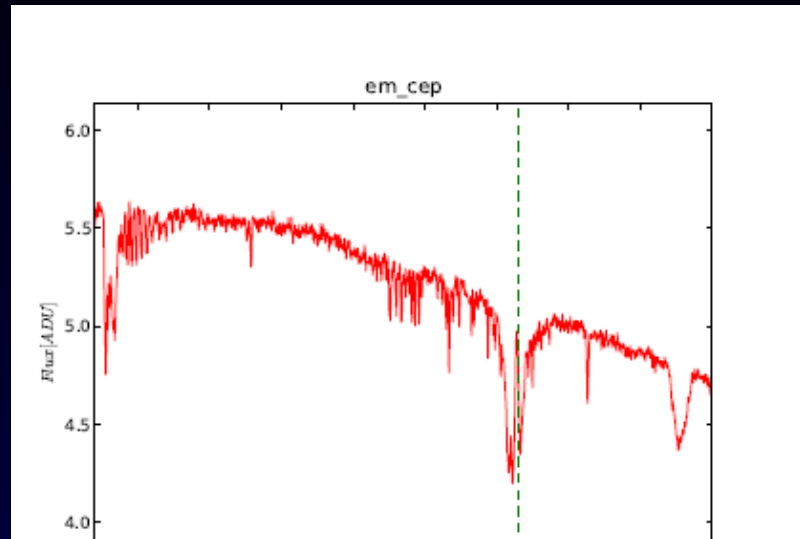
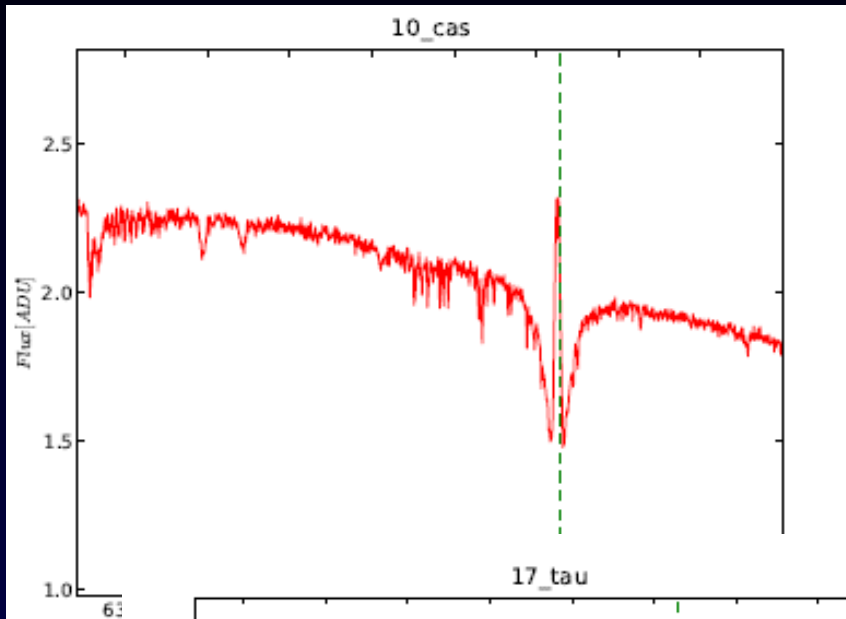
DR4 (Feb 2016) **+ 741 522**

Each Fiber – 2 motors
double arm 33mm circle

Fibre collects light from
3.3 arcsec circle on sky

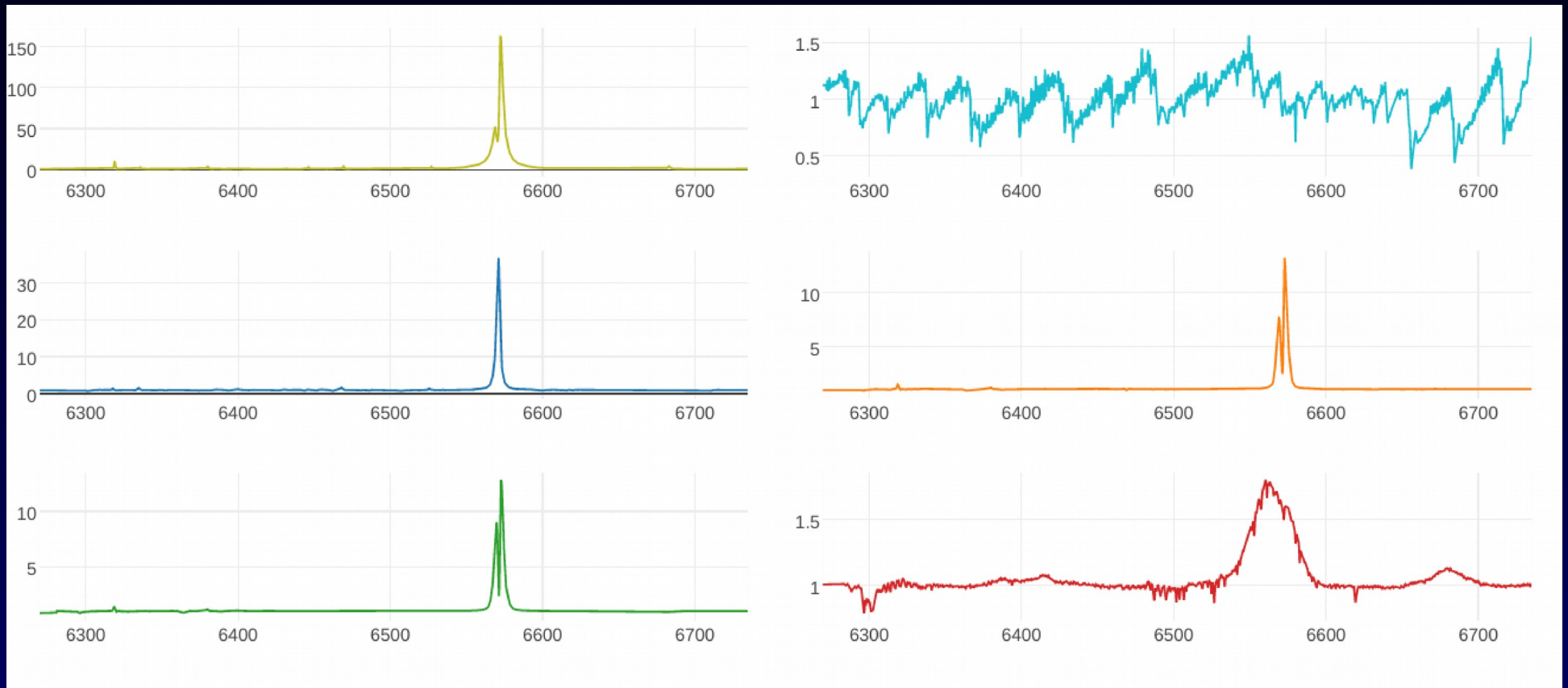


Be Stars : Emission in absorption

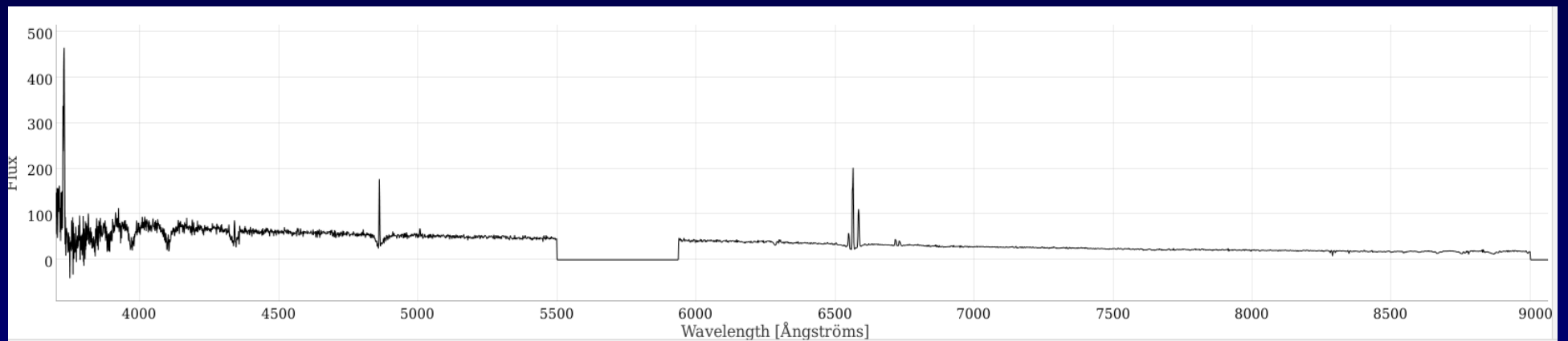
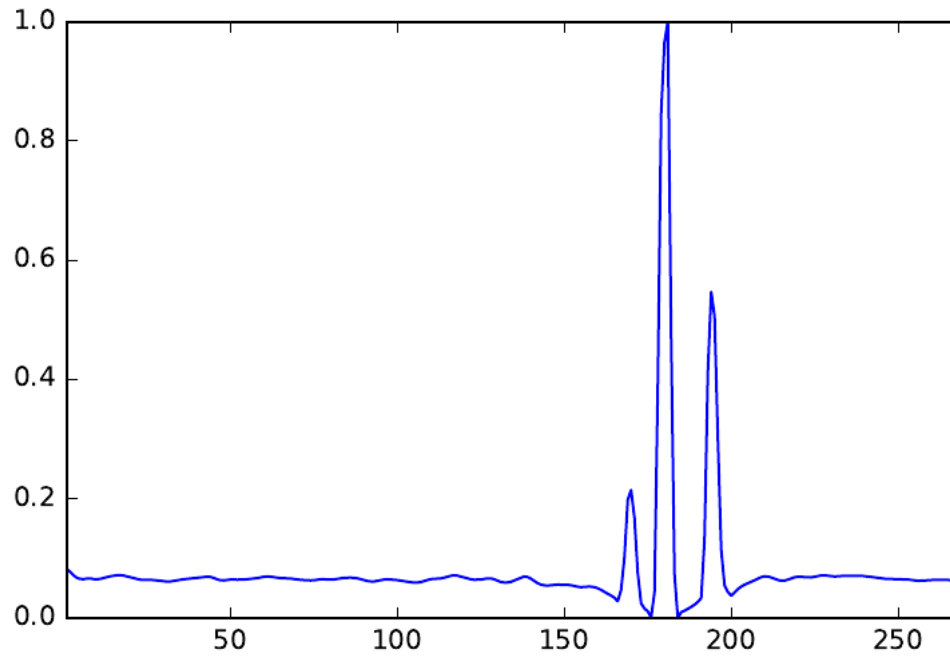


CCD700 Outliers

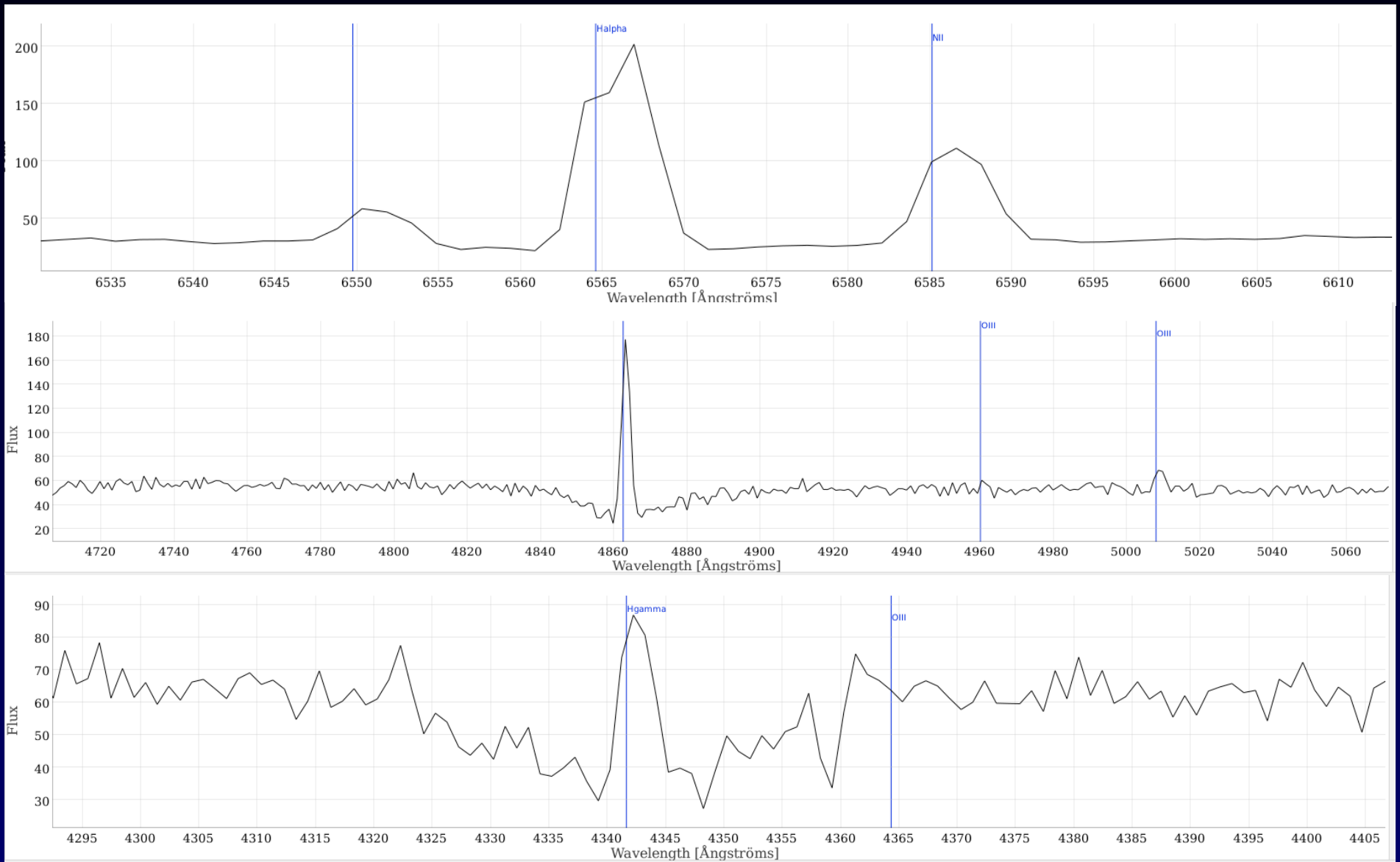
Unsupervised learning – Local Outlier Factor – LOF



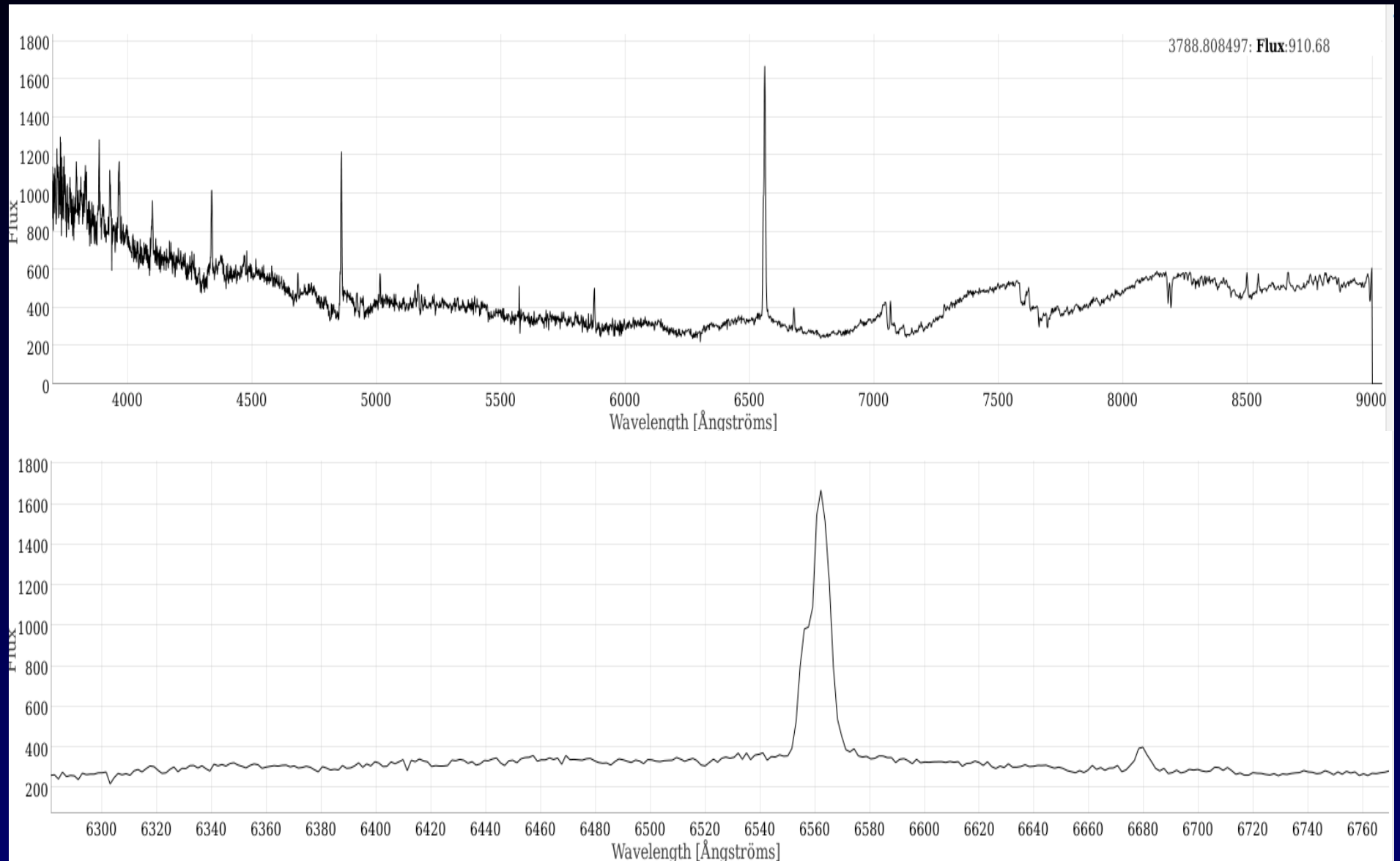
Be Candidates Foud



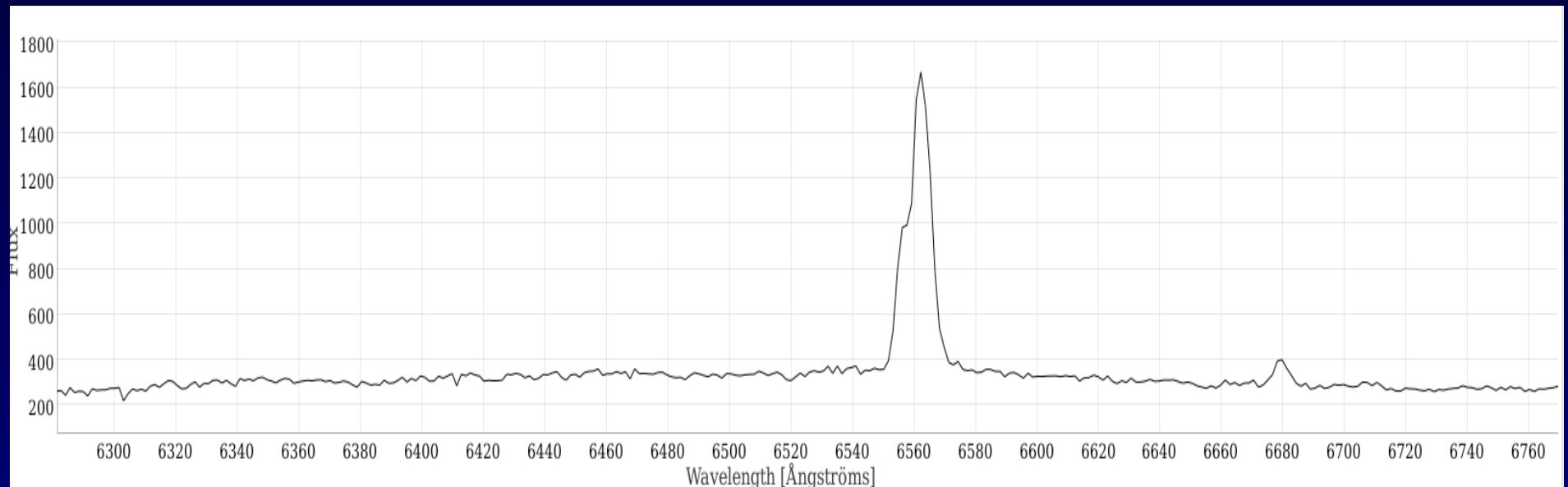
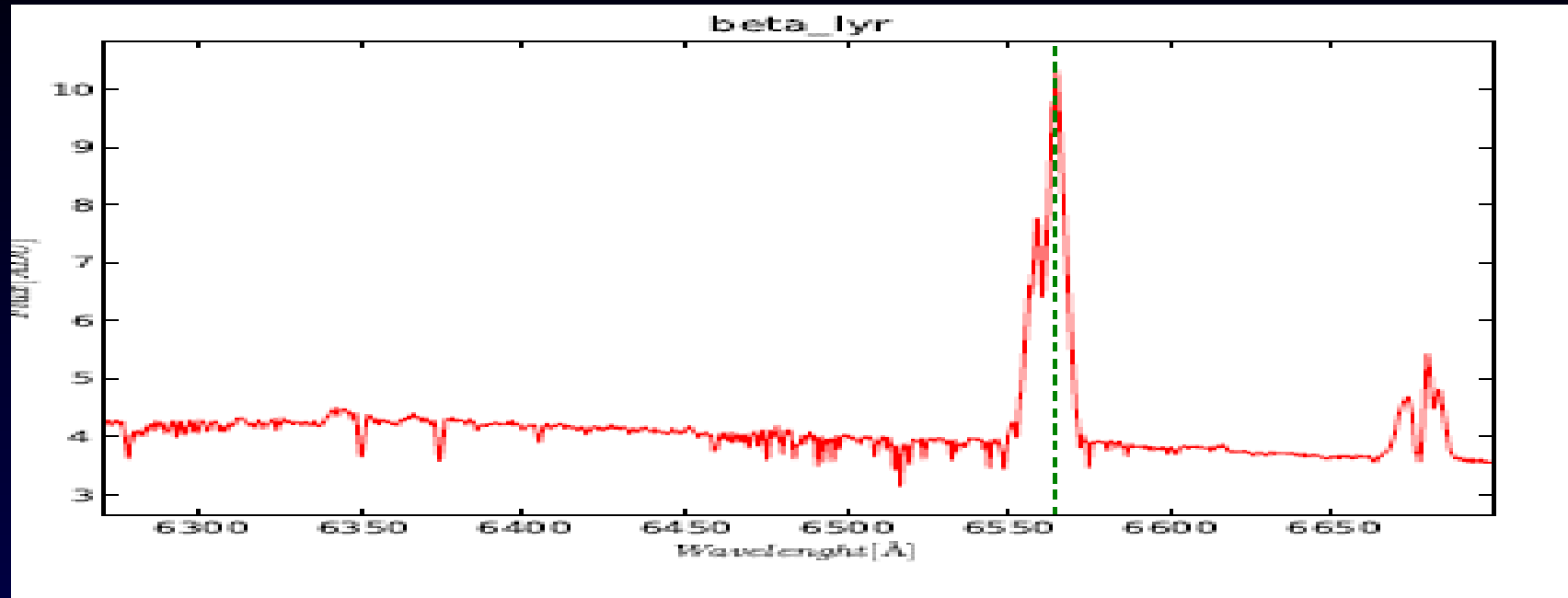
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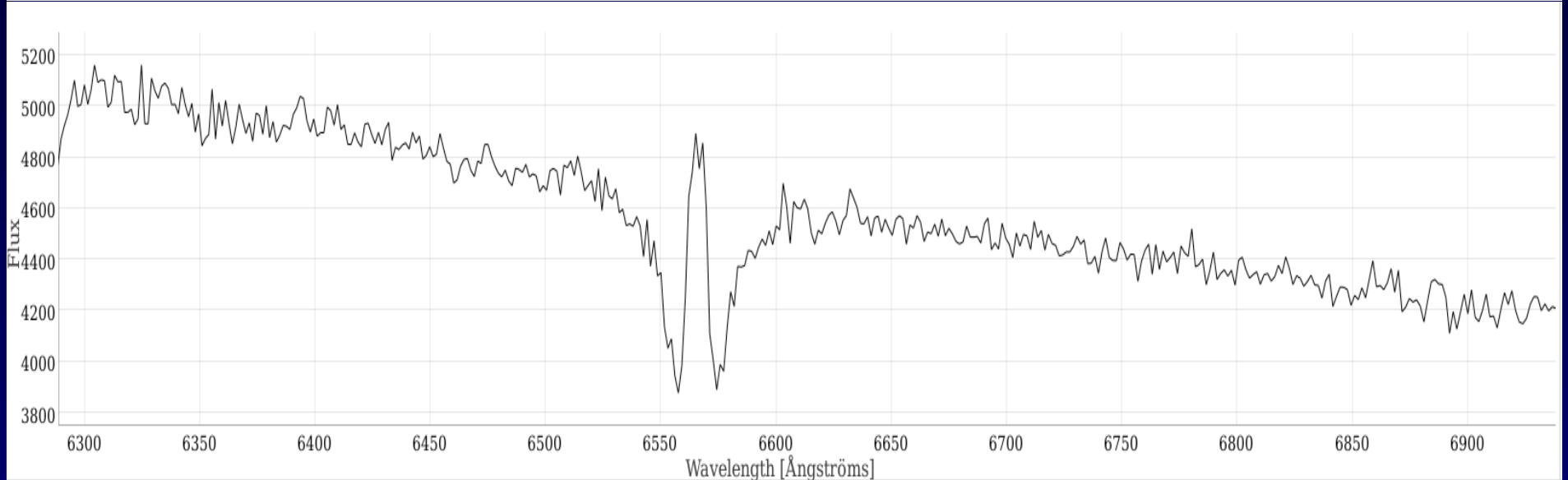
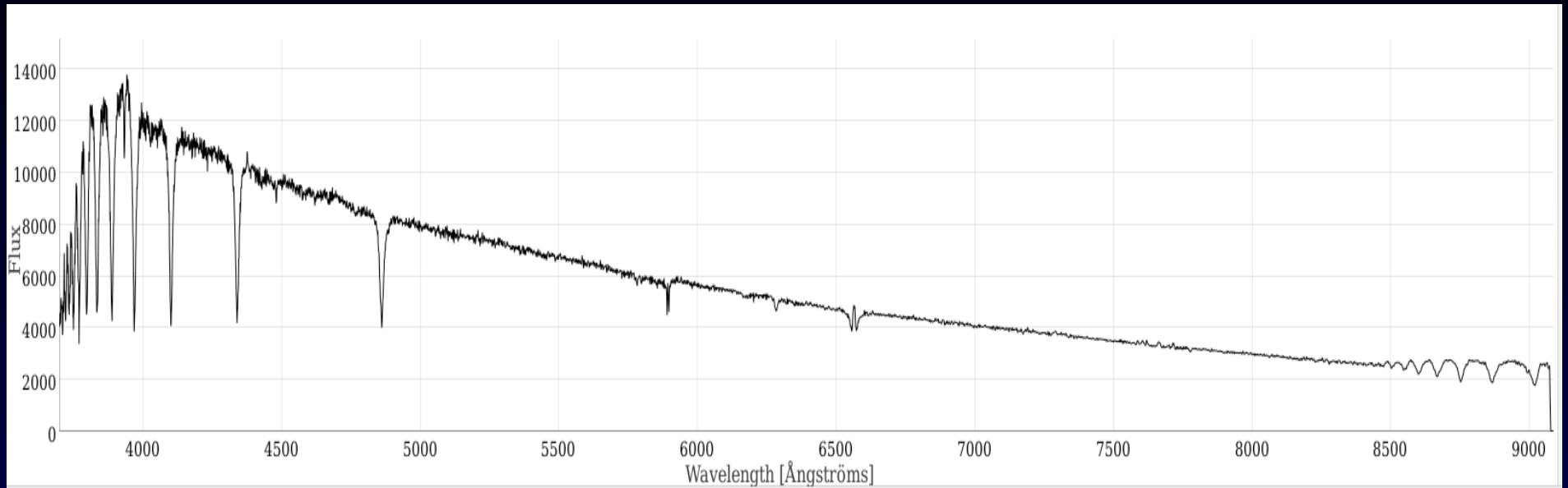
Be Candidates Found



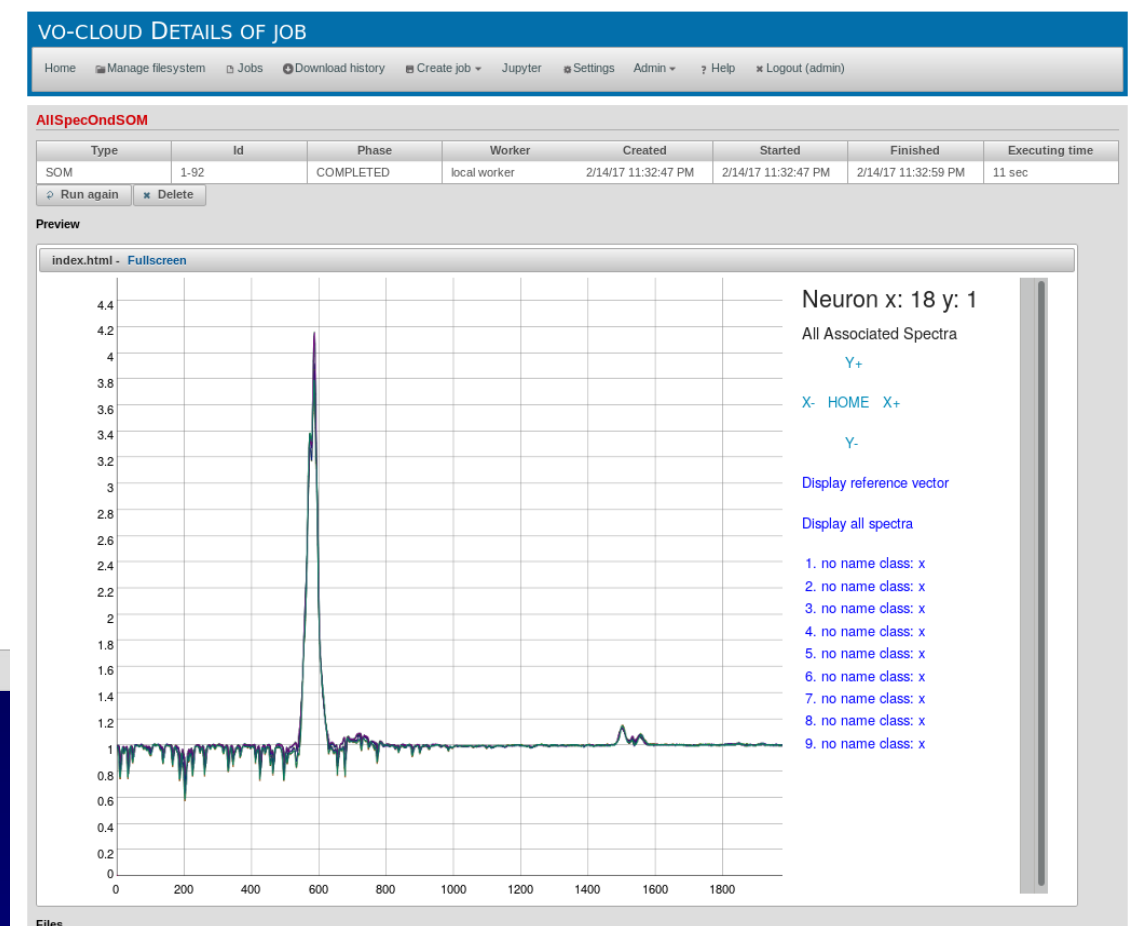
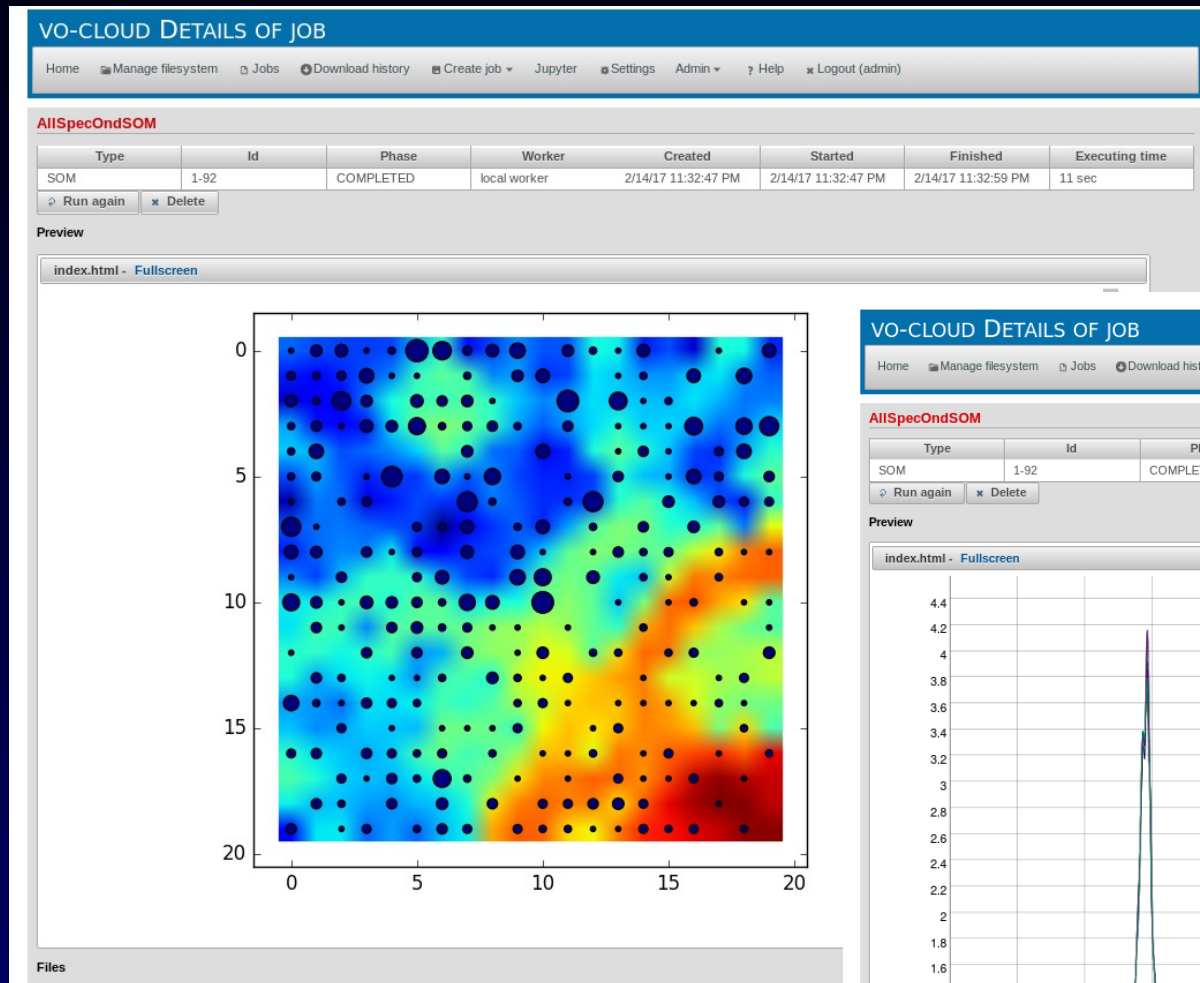
Be Candidates Found



Yet Unknown Be Star



Samoorganizační mapa (Kohonen)



VO-CLOUD vizualizace spekter



Budoucnost 2m

Určitě velmi moderní

V souladu s dobovými trendy

Moderní technologie

Mnoho produkce z archivu – followup, hledání zpět