Lunar and Planetary Science Conference, March 18th, 2015

COMMUNITY USER WORKSHOP ON PLANETARY LIBS (CHEMCAM) DATA

C-QUEST Software

<u>Agnes.cousin@irap.omp.eu</u>

A. Cousin, S. Maurice, O. Gasnault, O.Forni,R. Wiens and ChemCam team

18 Mar 2015

ChemCam Community Workshop

What is C-QuEST ?



Definition

- ChemCam Quick Element Search Tool
- Library of ChemCam emission lines for 32 elements

Why use it ?

- Search for specific element in spectral database
- Search for specific spectral range
- Visualize an elemental synthetic spectrum





LIBS emission lines database



Why doing an emission lines library ?







Emission lines are dependent on the experimental conditions (Pressure, Laser Energy, ..)

Need for a specific Martian database Subset of the NIST database



00								C-	QUEST	r - Che	emCam	ı - Qui	ick Ele	ment !	Search	Tool	v2.5.0	(16 A	ug 2012)								
File Help																												
Databases		V	Vavelen	igth (n	m)																_	Db	Elt	1	lonizati	Wavelen	Intens	ity
NIST Martian (Agnes	Cousin)	🔲 UV 🛞 Min	(240-3 0	(41)	VIS	(381-4	469) Max 1	000	R (471	-905)										4 *		4				ł	
Periodic Table																					-1							
nformations	H H K K Cs Fr	Ref. Mag. Ca. Sol. Ref. Ref.	ý ý La Ar	SELECT If Unit Ce Th	V Nb Ta Pa	Cr Mo W Utata	Mm Tc Re Mp	Tr Ru Ru Os Elun Fu	Co Rh Usa Eu Am	Ni N	race	Dy Cf.	nic (Cl Al Al T T Es	HNOPS)	N P As Sb N Md	her 0 5 5 7 7 7 No	F Cl At	He Ne Ar Xe Bn										
																						N	b lines : 0		Prir	t.	Spectra	1



Choice between NIST

••• • and ChemCam database C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012)

File Help																						
Databases	Waveler	ngth (n	m)															Db	Elt	Ionizati	Wavelen	Intensity
NIST	UV	(240-3	341)		(381-	469)		R (471	-905)								4					
Martian (Agnes Cousin)			151 0	_	1	Uny 1		1.5-		1							*					
Name of Street, or other	I MII	0				Max 1	,000															
Periodic Table	riodic Table																					
		SELECT	ALL	CL	EAR A	u_) (🗌 Majo	r 📃 T	race [Orga	nic (Cl	HNOPS)	Ot Ot	her								
н																Ha						
	Be)										B	C	N	0	F	Ne						
Na	Mg										AI	Si	P	s	CI	Art						
ĸ	Ca Se	Ті	v)	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Sc.						
Rb	Sr Y	Zr	Nb	Mo	Te	Ru	Rh	P.(Ag	Cd	În	Sn	Sb	Te	- t; "	Xe						
Cs	Ba La	H	(Tal)	W	Re	05	(ir)	16	Au	Hg	The	РЬ	8	Po	At	Ro						
Fr.	As As	Ling	. Her	Men	Unit.	Chris	100	-														
		Ce	Pr	Nd	Pm	Sm	Eu.	Gd .	Tb	Dy	Ho	Er	Tm	, Yb	Lu							
		Th	$p_{\rm B}$	U)	Np	Put	Am	Cm	Bk	Cf	E	Fm	Md	No	Ъ)	'n					
Informations																,	U.					
																		Nb	lines : 0	Prin	t][Spectra



000	C-QuEST - ChemCam - Qui	ick Element Search Tool v2.5.0 (16 Aug 2012)	
File Help			
Databases (Wavelength (nm)		Counch for a specific	Db Elt Ionizati Wavelen Intensity
UV (240-341) VIS (381-	469) 🔲 VNIR (471–905)	Search for a specific	4
Martian (Agnes Cousin)	Max 320	spectral range	
Periodic Table			_
SELECT ALL CLEAR A	II Major Trace Orga	nic (CHNOPS) Other	
Na Mg			
K Ca Sc Ti V Cr Mn	Fe Co Ni Cu Zn	Ga Ge As Se Br Ke	
Rb Sr Y Zr Nb Mo Tc	Ru Rh Rd Ag Cd	In Sn Sb Te I Xe	
Cs Ba La Hf Ta W Re	Ds b P Au Hg	Ti Pb, Bi Po At Re	
Fr Ra Ac Une Une Une Une	Uno Une Une		
Ce Pr Nd Pm	Sm Eu Gd Tb Dy	Ho Er Tm Yo Lu	
Th Pa U Np	Pu Am Cm Sk Cf	Er Fm Md Na Er	
Informations			
			Nb lines : 0 Print Spectra



000	C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012)			-	
File Help					
Databases Wave	length (nm)	Db	Elt	lonizati Wavele	n Intensity
 NIST ☑ Martian (Agnes Cousin) 	UV (240-341) VIS (381-469) VNIR (471-905) Min 300 Max 320 Search for a specific	4			-
Periodic Table	element –	·			
H H H H H H H H H H H H H H	SELECT ALL CLEAR ALL Major Trace Organic (CHNOPS) Other B C N 0 6 Major B C N 0 6 Major C N 0 6 Major Trace Organic (CHNOPS) Other B C N 0 6 Major Trace 0 6 Major C N 0 C N 0 C A 6 Major V C Major Trace Organic (CHNOPS) Other A	Nb	lines : 0	Print	Spectra
		IND .	mes. 0	FINE	spectra



000 C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012) File Help Wavelength (nm) Databases Db Elt loniza... Wavele... A Intensity ... Martian Fe 300.039 76.994 NIST UV (240-341) VIS (381–469) VNIR (471-905) Martian v П 300.207 522.527 Martian (Agnes Cousin) Min 300 Max 320 11.184 Martian Ni 300.337 т Martian 300.352 258.952 Fe П Martian Ni 300.451 236.055 Periodic Table Martian Mn 300.854 28.107 Martian 300.902 86.970 Fe SELECT ALL 🗹 Major 🗹 Trace 🗹 Organic (CHNOPS) 🗹 Other CLEAR ALL Martian Cu 301.172 8.228 Martian Mn 301.204 41.185 14 Ha Martian Mn 301.226 41.185 Ne Li Be Martian Ni 301.288 288.071 1 Martian 301.405 10.424 Fe ш Ar Mg CI Na AL. C) Martian Mn 301.555 43.700 т Kr Ca Sc Cr Ma Cu Zn As Br K Ti Fe Co Ni Martian Ti Ш 301.807 2.619 Martian 302.002 39.155 Cd Xe Ni т Rb St Zr Ag Sn Sb Martian Mn Ш 302.080 476.444 Pb Pt Bi Po. At Rn Cs Ba Hf Au Martian Fe 302.137 204.569 1 Ra Ac Martian 302.152 132.304 Fe 1 Martian Fe 302.195 132.304 Ce Pr Nd ТЬ Dy Er Tm Yb Lu Martian Mn 302.363 182.195 I Th Md No U Bk Em Martian Fe Т 302.672 60.710 Martian Ti н 303.061 2.221 Informations Martian 303.194 594.236 Mn н 303.433 886.474 Martian v П The most intense one is at 455.53 nm. There are some interferences with Ti lines, but no . 303.470 886.474 Martian v П confusion. This is the line that ensures the presence of Ba in a spectrum. Martian Mn 303.623 360.566 Ш Martian Zn 303.666 36.211 1 Martian Cu 303.698 8.539 58: Cerium 303.827 Martian Fe 46.509 Martian Ni 303.882 11.184 Martian Mn 304.148 334.049 28.551 Martian Fe 304.252 82: Lead 304.546 Martian Mn 209.186 304.757 Martian Ti П 1.760 304.793 209.186 Martian Mn 1 Martian 304.849 11.184 Fe 1 90: Thorium Martian v Ш 304.911 1,097.2.. Martian Mn Ш 305.154 349.718 Martian Ni 305.170 189.878 Martian v П 305.428 117.904 92: Uranium Martian Ni 305.520 41.308 Martian Mn 305.525 42.558 Ŧ Nb lines : 126 Print Spectra



000 C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012) File Help Wavelength (nm) Databases Db Elt Ionizati... Wavelen... Intensity ... NIST UV (240-341) VIS (381-469) VNIR (471-905) Martian (Agnes Cousin) Min 300 Max 320 **Periodic Table** SELECT ALL CLEAR ALL Major 📃 Trace 📃 Organic (CHNOPS) 📃 Other н 344 Li Be 0 Nr. В С N F Na Mg AL Si p s CI År. K Ca Sc Ti V Cu Zn Br Cr Mn Fe Co Ni As Kr. Rb Ag Cd Sr Zr Rd . NB. Mo Xe Shi Cs Ba 117 Ta Pt 71: 24 Au Pb R Ra Ac Ce \mathbb{P}_{Γ} Nd: Pra Smil Eu: Gd Tb Dy Ho Er Tm Wb the Th Ra Em Md No Er U. Cett 88 Informations Nb lines : 0 Print Spectra



000 C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012) File Help Databases Wavelength (nm) Db Elt Ionizati... Wavele... A Intensity ... Fe Martian 300.039 76.994 NIST UV (240-341) VIS (381-469) VNIR (471-905) Fe 300.352 258.952 Martian П Martian (Agnes Cousin) Min 300 Max 320 Martian Fe 300.902 86.970 Martian Fe ш 301.405 10.424 Martian Fe 302.137 204.569 Periodic Table Fe 302.152 132.304 Martian 302.195 132.304 Fe Martian 🚺 Major Trace Organic (CHNOPS) Other SELECT ALL CLEAR ALL Martian Fe 302.672 60.710 Martian Fe 303.827 46.509 н He 304.252 28.551 Martian Fe Li F Ne Be Ν 0 Martian Fe 304.849 11.184 Martian Fe 305.833 132.755 Na Ar Mg AL Si S CI Fe Martian 305.998 11.184 Ca Cr Cu Zn Br Kr ĸ Sc Ti V Mn Fe Co Ni Ga As Martian Fe 306.814 53.376 Zr Ag Cd Martian Fe 307.661 84.976 Rb Sr Xe Martian Al 308.305 797.742 Cs Ba La Hf РЬ Rn Pt Au Martian AI 308.941 44.827 Ra Ac Martian Fe 309.247 10.839 309.361 Martian AL 718.594 Ce Martian AL 309.374 1,369.8.. Md Lr Th Pa U Cm Bk Es Em Martian Ma 309.388 46.616 309.645 Martian Na 69.978 Informations Mq 309.779 94.835 Martian 88.149 Martian Fe 310.120 THE FOLDSTATE SHOWS AS WELLERARY & THES IT THE FIRST AGAIN TOCALED . nm. If these two lines are not observed, the sample does not contain K. Martian Na II 312.612 80.808 Martian Fe п 315.512 77.237 Martian Ca П 315.978 449.694 20: Calcium 4.460 Martian Fe ш 317.501 Ca shows several important lines. Martian Fe ш 317.893 37.426 Here are the most ones, observed for each spectral range : Martian Ca п 318.025 700.170 - UV : 315.978 nm and 318.025 nm Martian Fe 318.582 11.853 - VIS: 393.477 nm, 396.959 nm and 422.792 nm are the most important among others Fe 56.373 Martian 319.422 - VNIR : lot of Ca lines. The most easy ones to detect are the triplet at 610.441, 612.39 and Si Martian II 319.561 254.413 616.3 nm with an increasing intensity, and a second triplet at 644.085, 645.159 and 46.588 Martian Fe 319.785 646.436-646.557 nm with a decreasing intensity. All these lines are well defined with no interferences. The most important Ca lines in all the spectrum are those at 393.477 nm and 396.959 nm, but they can suffer some auto-absorption effects. 26: Iron Nb lines : 34 Print Spectra



000 C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012) File Help Wavelength (nm) Databases Db Elt Ionizati... Wavelen... Intensity ... NIST UV (240-341) VIS (381-469) VNIR (471-905) Martian (Agnes Cousin) Min 300 Max 320 **Periodic Table** SELECT ALL Major 📃 Trace 📃 Organic (CHNOPS) 📃 Other CLEAR ALL н 344 Li Be 0 Nr. В С N F Na Mg AL Si p s CI År. K Ca Sc Ti V Cu Zn Br Cr Mn Fe Co Ni As Kr. Rb Ag Cd Sr Zr Rd . NB. Mis Xe Shi Ba Cs 117 Ta Pt 71: 24 Au Pb Fr Ra Ac Ce \mathbb{P}_{Γ} Nd: Pra Smil Eu: Gd Tb Dy Ho Er Tm Wb the Th Ra Em Md No Er U. Cet 88 Informations Nb lines : 0 Print Spectra



C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012)					
File Help					
Databases Wavelength (nm)	Db	Elt	Ionizati	Wavele 🔺	Intensity
NIST UV (240-341) VIS (381-469) VNIR (471-905) ✓ Martian (Agnes Cousin) Min 300 Max 320	Martian Martian Martian	Al Al Al	1	308.305 308.941 309.361	797.742 44.827 718.594
Periodic Table	inter create	~		303.314	2,505.0
SELECT ALL CLEAR ALL Major Trace Organic (CHNOPS) Other					
H LU Be Al will be the example B C N O F No Na Mg K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn La Ga As So Br Kr					
Rb Sr Y Zr Nb Mo Tc Ru Rb Pd Ag Cd In Sa Sb Te I Ne Cs Ba La Hf Ta W Re Os fr Pi Au Hg Ti Pb Bi Por Ait Rn Fr Ra Ac Ump Unit List Unit Lint Lint					
Ce Pr Nd Pm Sm Eu Gd Th Dy Ha Er Tm. Yb Lu Th Pa U Np Pa Am Cm Bk Cf Es Fm Md Na Er					
13: Aluminium Al shows several lines in all the spectral range. The most characteristic lines are : - UV : 2 lines at 308.305 nm and at 309.36-309.37 nm which are neutral lines. These lines are often interfered by Ti lines, but are still well characterized. - VIS : 2 lines are observed, which are the 2 most important lines of the Al. They are observed at 394.512 nm and 396.264 nm (neutral lines). - VNIR : the most important ones are observed at 704.4 nm and 705.85 nm.					
	Nb I	ines : 4	Print		pectra



C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012)					
File Help					
Databases Wavelength (nm)	Db	Elt	Ionizati	Wavele 🔺	Intensity
NIST UV (240-341) VIS (381-469) VNIR (471-905) ✓ Martian (Agnes Cousin) Min 300 Max 320	Martian Martian Martian	Al Al Al	1	308.305 308.941 309.361	797.742 44.827 718.594
Periodic Table SELECT ALL CLEAR ALL Major Trace Organic (CHNOPS) Other					
Image: Sector					
[[]]	Nb	lines : 4	Print		Spectra

List of emission lines by database, element, ionization stage, wavelength or intensity

00	C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012))	1		
File Help				4	
Databases Wavelength (nn	m)		Dh Elt	t Ionizati	Wavele A Intensity
 NIST ☑ W (240-34) ☑ Martian (Agnes Cousin) ☑ Min 300 	(41) VIS (381-469) VNIR (471-905) Max 320		Martian Al Martian Al Martian Al Martian Al		308.305 797.742 308.941 44.827 309.361 718.594 309.374 1.369.8
Periodic Table					
SELECT H Li Be Na Mg K Ca Se Ti Rb Sr Y 2r CS Ba La iff Fr Ra Ac use Ce Th Informations I	ALL CLEAR ALL Major Trace Organic (CHNOPS) Other B C N 0 F He B C N 0 F He AL S P S C Ar V C Mn Fe Co Ni Cu Zn Ga GA Se Be Cr Nb Ma To Ru Rh Pd Age Cd In So So Be Cr Na Be Cr It Na Ru Ba Pd Age Cd In So So Ba Cr It Na Ru Ba Cr To It Na Ru Ru It Ba Cr To To V Hu Ru Na Eu Cr To V Hu Ru Na Eu So <	List o data	f the A base b	Al lines j etween 3	present in the 300 - 320 nm
			Nh lines	- 4 Pri	int Spactra



0 0	C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012)					
File Help						
Databases	Wavelength (nm)	Db	Elt	Ionizati \	Wavele 🔺	Intensity
 NIST ✓ Martian (Agnes Cousin) 	UV (240-341) VIS (381-469) VNIR (471-905) Min 300 Max 320	Martian Martian Martian	Al Al Al		308.305 308.941 309.361	797.742 44.827 718.594
Periodic Table		Maruan	~	·	509.574	1,509.8
H U Na K Cs	SELECT ALL CLEAR ALL Major Trace Organic (CHNOPS) Other He B C N O F Ne g B C N O F Ne g A1 S P S Cl Ar a Sc T1 V Cr Mn Fe Co Ni Cu Zn Ga Ge As Sa Br Kr a Sc T1 V Cr Mn Fe Co Ni Cu Zn Ga Ge As Sa Br Kr a La Hf Ta W Re Os Ir P Au Hg Tl PB Bi Po At Rn a La Hf Ta W Re Use Use					
Informations						
13: Aluminium Al shows several lines in a The most characteristic lin - UV : 2 lines at 308.305 often interfered by Ti lines - VIS : 2 lines are observe 394.512 nm and 396.264 - VNIR : the most importa	the spectral range. s are : im and at 309.36-309.37 nm which are neutral lines. These lines are but are still well characterized. l, which are the 2 most important lines of the Al. They are observed at nm (neutral lines). t ones are observed at 704.4 nm and 705.85 nm. To print the list o	f em	ission	lines		
		Nb	lines : 4	Print		opectra



00	C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012)				
File Help					
Databases Wavelength (nm)		Db	Elt	lonizati Wavele 🔺 In	itensity
 NIST UV (240-341) VIS (381-46 ● Min 300 Mattian (Agnes Cousin) 	9) VNIR (471-905) x 320	Martian Martian Martian Martian	Al Al Al Al	I 308.305 II 308.941 I 309.361 I 309.374 1	797.742 44.827 718.594 .369.8
Periodic Table					
SELECT ALL CLEAR ALL H Li Be Na Mg K Ca Sc Ti V Cr Mn Rb Sr Y Zr Nb Mo Tc Cs Ba La HH Ta W Re Fr Ra Ac Ung Unp Unh Unit Ce Pr Nd Prin Th Pa U Np	Major Trace Organic (CHNOPS) Other He B C N O F Ne All S P S Cl Ar Fe Co Ni Cu Zn Ga Ge As Se Br Kr Ru Rh Pd Ag Cd In Sn Sb Te 1 Xe Sn Eu Gd Tb Dy Ho Fr Tm Yb Lu Pu Am Cm Bk Cf Es Fm Md No Lr				
Informations 13: Aluminium Al shows several lines in all the spectral range. The most characteristic lines are : - UV : 2 lines at 308.305 nm and at 309.36-309.37 nm which are often interfered by Ti lines, but are still well characterized. - VIS : 2 lines are observed, which are the 2 most important lines of 394.512 nm and 396.264 nm (neutral lines). - VNIR : the most important ones are observed at 704.4 nm and 7	e neutral lines. These lines are f the Al. They are observed at 05.85 nm. To visualize the spectru database should be select	m/sp ed (N	ectra, 'IST or	only 1 Martian)	
		Nb	lines : 4	Print Sp	ectra













000 C-QuEST - ChemCam - Quick Element Search Tool v2.5.0 (16 Aug 2012) File Help Ionizati... | Wavele... A Intensity ... 000 Spectrum 797.742 308.305 🔘 Dirac 💿 Lorentz 🔵 Dirac & Lorentz Reset colors 308.941 44.827 309.361 718.594 Specific range Export image Reset Zoom 309.374 1,369.8.. 2,100 2,000 1,900 **Export Image** 1,800 1,700 1,600 r ân l IE \bigcirc agnescousin 1,500 Look In: ▼ 1 1,400 (j. 1,300 1,200 Applications **IDL** Libraries Mariage Intensity 1,100 1,000 IDLWorkspace81 Desktop Movies 900 800 Documents IDLWorkspace82 Music 700 Downloads Islanda Pictures 600 500 Dropbox Library Prograr 400 300 200 100 295 296 322 323 324 325 Lines_Al_300_320nm File Name: A Files of Type: Format .png (Portable Network Graphics) ▼ Cancel Export Nb lines: 4 Print Spectra



Example with several elements

0 0 0		C-QuE	ST - Ch	emCan	n – Qu	ick Ele	ment	Search	Tool	/2.5.0	(16 Au	g 2012)							
File Help																			
Databases	Waveleng	th (nm)											D	b	Flt	L.	Wavelen	Intensity	
AUGT				201 4	co) [0.053						2	Fe		382 891	123 040	
NIST	00 (2	240-341)		381-4	69) L		K (471	-905)					M	a	Ma	÷.	383.339	348.572	5
Martian (Agnes Cousin)	Min	380		М	ax 41	0							M	a	Fe	1	383.531	119.010	
													M	a	Mg	1	383.938	550.271	
Periodic Table													M	a	Fe	1	384.214	124.963	
													M	a	Fe	1	384.435	170.888	
CELECT A					T (M	a	Fe	1	384.789	180.731	
SELECT A			💌 мај	or 📃	i race (_ Org	janic (C	.HNOPS		ther			M	a	Fe	1	385.105	25.079	
н												He	M	a	Mg	Ш	385.148	27.250	
													M	a	Fe	1	385.191	25.079	
Li Be							В			0	Ľ	Ne	M	a	SI		385.711	97.816	
Na Mg							AI	Si	Р	s	CI	Ar	M	a	Fe	1	385.747	97.816	
K Ca Sc Ti	V Cr	Mn Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		a	Fe	1.	380.100	99.890	
	Nh Ma		Rh			C d			Ch			V.	M	d	Fe	1	387 360	29.405	
	mb mo				Ay	Lu								a	Fe	1.	387 912	42 953	
Cs Ba La Hf	Ta	Re Os	lr	Pt	Au	Hg		РЬ	Bi	Po	At	Rn	M	a	Fe	i -	387.967	87.629	
Fr Ra Ac Unq	Unp	Uns Uno	Une	Unn)								M	a	Fe	i -	388,738	87.009	
Ce	Pr Nd	Pm Sm	Eu	Gd	ть	Dv	Ho	Er	Tm	Yb	Lu		M	a	Fe	1	388.815	38.716	
													M	a	Fe	1	388.961	29.944	
Th	Pa	Np Pu	Am	Cm	Bk	Cf	Es	Em	Md	No	Lr	_	M	a	Mg	1	389.668	25.116	
Informations													M	a	Fe	1	389.676	11.379	
informations													M	a	Fe	1	390.081	16.824	
													M	a	Al	Ш	390.178	126.093	
													M	a	Fe	1	390.405	40.857	
19: Potassium													M	a	Si	1	390.663	92.265	
													M	a	Fe	1	390.759	7.718	
The Potassium shows us ge	nerally 2 lin	ies in the VN	IR doma	in, loca	ated at	766.7	0 nm a	nd at 7	70.11				M	a	Fe		392.137	17.891	
nm. If these two lines are n	ot observed	, the sample	does n	ot cont	ain K.								M	a	Fe	1	392.402	21.324	
												-	M	a	Fe		392.903	27.216	Y
20. Calcium												•		Nb li	ines :	59	Print	Spectra	
18 Mar 2015				Ch	emCa	m Co	mmu	nity W	orksh	on			1					77	



Example with several elements



TIPS



- To visualize a synthetic spectrum, it is better to select only 1 spectral range (UV, VIS or VNIR) :
 - Data acquired with commercial spectrometers without a demultiplexer (each spectral range acquired separately)
 - Total intensity from one domain to another can be different

Backup slides



Ground Station

ChemCam

- <u>Mast Unit</u>: Engineering & Qualification Model (EQM)
- <u>Body Unit</u>: Commercial spectrometers (same resolution as flight Model)



Mars

- 6 mbars
- Mars atmosphere (95.7 % CO₂, 2.7 % N₂, 1.6 % Ar)



Emission Lines Database Creation







Type of target	Pure targets	Geological targets	Specific Atmospheres
Elements (Increasing Z)	C, Al, Si, Ti, Mn, Fe, Ni, Cu, Pb	H, Li, Be, B, F, Na, Mg, P, S, Cl, K, Ca, V, Cr, Zn, As, Rb, Sr, Cs, Ba	N, Ar O

32 elements, 1336 emission lines