MFK2 Multi-function Kappabridge User Guide

This guide is intended for use by scientists and technicians to quickly get started measuring samples on the MFK2 Multi-Function Kappabridge on the JOIDES Resolution. The MFK2 can be run at three frequencies: 976 (F1), 3904 (F2) and 15616 (F3) Hz. For more in depth information please refer to the Agico manuals for the MFK2 unit (MFK2 User Manual) and for the Safyr7 User Manual software.

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MFK2-FA Kappabridge (JR Pmag lab)

Getting started

Selecting a holder

The 3D holder, aka 3D rotator, can measure the AMS and bulk susceptibility in approximately 1.5 minutes whereas the 2D classic holder (or 1-axis rotator) takes approximately 3 minutes to complete the full set of measurements. Another benefit to the 3D holder is the sample has to be handled only one time and therefore there is less chance for positioning errors. The 2D holder requires the sample to be measured in 3 positions.

The **3D** holder should not be used for samples with a low susceptibility. The 3D holder has a susceptibility of approximately -30×10^6 SI on Frequency 1 and the susceptibility is higher at Frequency 2 and 3. Agico indicates that samples with low degree of anisotropy and/or those with bulk susceptibility below 100 X 10⁻⁶ SI or over 1 X10⁻³ SI will be measured more precisely with the classic rotator (2D holder) or manual holder than with the 3D holder. Please review the "Limitations" section of the Agico 3D rotator application note for more information (here: 3D rotator Manual).

Starting the MFK2

- 1. Turn on power switch on the back of the MFK2 control unit
 - a. A Green light will appear on the front of the MFK2 control unit (Figure 1) and on the pick-up unit (Figure 2).



2. Select Safyr7 Software on the desktop (Figure 3) and the program will launch.



Measuring samples

Activating the MFK2 for measurements

- 1. Ensure the sample holder is empty and clean.
- 2. Select the Activate button at the bottom left of the window main Safyr 7 window (Figure 4)

				Measur	ements					
ame							Anisotropy			
ampling Ang Azimuth Volume	lles Dip 8	Orienta P1 12 Den	P2 P3 P4 0 12 0 nag. Factor NO	ANISO ANISO ANISO ANISO	Rg 1	Cos	Sin	Amp	Error	Error [%]
	Foliation		Lineation	_		Bu	Ik Susceptibilit	у		
Code Di	p Dir. Dip	Code	Trend Plung	BULK	Rg	Kre		Kim	F	'hase
Me:	an Susceptibility			F-Test			Princip	al Directions		
Km	Std. E	rr. [%]	F	F12	F23	Coordinate System SPEC	Kmax Dec Inc	Kint Dec	Inc De	Kmin : Inc
Normed P	Kint	Kmin	Kmax	Kint I	Kmin	GEO				
Kmax						PALEO #1 TECTO #1				
Kmax		Anisotrony	Factors							
Kmax	E P	Anisotropy Pi	Factors T U	0	E	PALEO #2				
Kmax	F P	Anisotropy Pj	Factors T U	Q	E	PALEO #2 TECTO #2				
L	F P	Anisotropy Pj	Factors T U ANISO1		E	PALEO #2 TECTO #2 ANISO3	BULK			SAVE
L	F P	Anisotropy Pj	Factors T U ANISO1		E	PALEO #2 TECTO #2 ANISO3	BULK			SAVE

3. The instrument settings window will open (*Figure 5*) and the user can adjust the measurement mode. Once the instrument mode has been set, select **OK**.

🕻 Instrument Settings	ID3EUFOMORIE -
Measuring Mode	Field Intensity
 Anisotropy (AMS) 	Field <2 to 700 A/m> 200
 Automatic (Rotator) 	(Peak Values)
🗖 Field Dependence	
 Manual (15 Directions) 	
O Bulk Susceptibility T Enhanced	
Individual Measurements	Operating Frequency
C Field Dependence	F1 976 Hz <2 to 700 A/m>
C Temperature Dependence	
C Low Temp (Cryostat)	
👁 High Temp (Furnace)	
Temperature Rate	Temperature Limits
C Slow (ca. 9 °C/min)	Tpeak <90 to 700 °C> 700
C Medium (ca. 12 °C/min)	Tend <40 to 100 °C> 50
C Fast (ca. 14 °C/min)	Linger @ Tpeak <0 to 120 s> 0
C Extra Fast (ca. 42 °C/min)	Repeated Cycles
<pre>Medium Rate Starts @ 600 <50 to 600 °C></pre>	Number of Cycles 2
	Increment of Tpeak 100 <0 to 600 °C>
	ОК
	CANCEL

Figure 5: Instrument Settings window

4. Wait for initialization of instrument. Instrument status (Figure 6) will be displayed on screen as initialization is completed.

	Time	Action	Response	Duration
	10:12:54	-> SEARCH FOR PC CONNECTION	INSTRUMENT CONNECTED TO COM4	0.67 :
1	10:12:55	-> READ FIRMWARE VERSION	** MFK2-FA_27-Fer-2019_c28724 IN1_Ser. No: 18020	0.62 :
	10:12:58	-> READ INSTRUMENT TEMP	T: IWC23 32 31	0.02 :
1	10:12:58	-> READ MAXIMUM FIELD VALUES	** MAXFIELD 0714 0360 0223	0.05 :
	10:12:59	-> SET AUTO RANGE	** AUTO RANGE	0.62 :
	10:13:01	-> SET FREQUENCY	FREQ F1 (976 Hz)	4.10 s
	10:13:06	-> SET FIELD	** FIELD 200 A/m	1.13 (
	10:13:08	-> TEST 25-PIN CABLE	25-PIN CABLE CONNECTED	0.25 s
	10:13:14	-> MANIPULATOR UP	* POSITION SET 14	3.44 s
	10:13:20	-> ZEROING	** END OF ZEROING	2.39 s
	10:13:24	-> SET ROTATOR SUPPLY	** ROT.Supply 1490	16.78 :
	10:13:41	-> TEST ROTATOR PERIOD	** SPEED 2344 ms	2.93

Figure 6: Instrument Activation Window during activation process

5. Select **OK** when complete (Figure 7).

	Time Action			Response					Duratio
	10:12:54	-> SEARCH FOR PC CONNECTION	N	INSTRUMEN	IT CONNE	CTED TO CO	M4		0.67
	10:12:55	-> READ FIRMWARE VERSION		MFK2-FA 2	27-Fer-2019	c28724 IN1	Ser. No: 180	20	0.62
	10:12:58	-> READ INSTRUMENT TEMP		T: IWC23 32 31				0.02	
	10:12:58	-> READ MAXIMUM FIELD VALUES	S	** MAXFIELD	0714 036	0223			0.05
	10:12:59	-> SET AUTO RANGE		** AUTO RAN	NGE				0.62
	10:13:01	-> SET FREQUENCY		** FREQ F1 (976 Hz)					4.10
	10:13:06	-> SET FIELD		** FIELD 200	A/m				1.13
	10:13:08	-> TEST 25-PIN CABLE	_	25-PIN CABL	E CONNE(TED	_		0.25
	10:13:14	-> MANIPULATOR UP	Instrument Config	guration		×			3.44
	10:13:20	-> ZEROING							2.39
	10:13:24	-> SET ROTATOR SUPPLY	INSTRI	UMENT MODEL:	MFK2-FA				16.78
_	10:13:41	-> TEST ROTATOR PERIOD	MEAS	URING MODE: AN	ISOTROPY	3D ROTATOR			2.93
	10:13:44	-> SET ROTATOR INITIAL POSITIO	FIELD	INTENSITY: 200 A	/m				5.35
_	10:13:50	-> SET 3D INSERT POSITION	OPERA	TING ERECUENC	Y: 976 Hz				0.12
_			Cr Lio	and medorine					
-									
-						OK			
-									
-									
-									
-									
-									

Figure 7: Instrument Activation Window when activation is completed

6. Wait for the instrument to stabilize for 10 minutes (Figure 8).

- a. Notes on stabilization:
 - i. "Stabilization helps to eliminate the coil drift and it is especially necessary in case of the low-susceptibility specimens with iii. The computer will 'chime' to indicate the stabilization is complete if the box *Ring when finished* is checked.
 - iii. AGICO default stabilization time upon instrument start up is 10 minutes. This time can be reduced using the Reduce Waiting button (by 1 min increment).
 - iv. If the software is closed or crashes but the pick- up unit has not been powered down, it is not necessary to wait the 10 minutes for stabilization.
 - v. When changing the frequency of the pick-up unit the user should allow time for the instrument to stabilize. Wait for 10 minutes is good practice.

Execute Settings About							
execute settings About		Monsuro	monte				
lamo		measure	ments		Anisotrony		
laine			Da		Anisotropy		
rientation Angles	Orientation Parameter	ers	ĸg				
Azimuth Dip	P1 P2 P3 F	ANISO					
Volumo 10	Domog Easter						
	Demag. Factor	ES					
Foliation	Lineation	_		E	ulk Susceptibility		
Code Dip Dir. Dip	Code Trend Plun	ge	Rg	Kre		Kim	Phase
#1		BULK					
#2							
sults		Instrument Stabili	zation	×			
Mean Susceptibility		WAIT TO STABILIZ	E THE INSTRUM		Principal I	Directions	
Km Std. E	rr. [%] F	0	0.57		Kmax	Kint	Kmin
		U	0:07		Dec Inc	Dec Inc	Dec Inc
Normed Principal Suscepti	bilities Cor	REDU	CE WAITING	abad. 54			
Kmax Kint	Kmin E12	E23 E	13 GE	EO			
			P/	ALEO #1			
	Aniantany Frantsa		TE	ECTO #1			
L E D	Anisotropy Factors	0	E 0/	NI EO #2			
				CTO #2			
NEW SPECIMEN		ANISO		1	BULK		SAVE
				⊠ A	uto BULK	_	
			STOP			_	CANCEL
Inet	trument Control				Data Vie	wing	
11130							

Figure 8: Instrument Stabilization Window

Configuring the Instrument

User should verify that the Measuring Mode, Field Intensity, and Operation Frequency are properly set before beginning measurements. The instrument automatically detects the type of sample holder (3D or 2D) installed on the unit.

NOTE: If the sample holders are switched the instrument should be turned off before disconnecting the holder.

1. Select Settings: Instrument Settings or press F12 to open the Instrument Settings window (Figure 9).

🔇 Instrument Settings	
Measuring Mode Anisotropy (AMS) Automatic (Rotator) Field Dependence Manual (15 Directions) Bulk Susceptibility Field Dependence Field Dependence Competitive Dependence	Field Intensity Field <2 to 714 A/m> (Peak Values) FIELD SEQUENCE Operating Frequency © F1 976 Hz <2 to 714 A/m> C F2 3904 Hz <2 to 360 A/m> C F3 15616 Hz <2 to 223 A/m>
Temperature Rate C Slow (ca. 9 °C/min) C Medium (ca. 12 °C/min) © Fast (ca. 14 °C/min) C Extra Fast (ca. 42 °C/min) Medium Rate Starts @ 600 <50 to 600 °C> 600	Temperature Limits Tpeak <90 to 700 °C> Tend <40 to 100 °C> 50 Linger @ Tpeak <0 to 120 s> Repeated Cycles Number of Cycles <2 to 9> Increment of Tpeak 100 <0 to 600 °C>
	ок
	CANCEL

Figure 9: Instrument Settings Window (when 3D rotator is used)

2. Verify the measurement mode (default is automatic).

3. Select sample shape, either cube or cylinder when using the 3D rotator (this option does not exist with the 1-axis rotator). IODP cubes with rounded corners can be used with either shape as long as the sample is loaded into the automatic holder as depicted in the user interface. Cylinder setting is however recommended.

a. When changing the sample shape, Safyr will set the sample volume to a default. This volume can be changed later in the Settings tab under Volume/Mass Susceptibility. For example, the default volume for cylinders is 10cc. If you wish to run the rounded corner cubes as a cylinder, be sure to change the volume to 7cc. A 2x2 cm saw-cut cube has a volume of 8 cc.

4. Set Field Intensity. This value defaults to 200 A/m on start up. Recommended default field intensity is **425 A/m**. This value corresponds to the root mean square 300 A/m used as default on the previous KLY4 Kappabridge model used aboard the JOIDES Resolution.

- 5. Verify the operating frequency. Default value F1 (976 Hz) is recommended for basic measurements.
- 6. When finished, select OK
- 7. When the Instrument Configuration window appears (Figure 10), verify configuration is correct and select OK.
- 8. Instrument will stabilize for a few seconds (about 10 s) after changes are made.

Time	Action		Response					Duration
10:35:15	→ SET FIELD		TIELD 425	A/m				1.47 s
		Instrument Confi	guration		>	<		
			UMENT MODEL:	MFK2-FA				
		FIELD	URING MODE: AN INTENSITY: 425 A	IISOTROPY 3D √m	ROTATOR			
		OPER	ATING FREQUENC	Y: 976 Hz				
					OK			

Figure 10: Instrument Configuration Confirmation Window

9. The orientation parameters should be set to **12/0/12/0**. Go to **Settings: Anisotropy Settings: Orientation Parameters** to check the orientation parameters and to modify them if needed (*Figure 11*).

Orientation Parameters						
_ Orien	Orientation Parameters					
P1	P2	P3	P4			

Figure 11: Orientation Parameters Window

10. Select **Settings: Volume/Mass Susceptibility** to input a sample volume and select volume or mass normalization (*Figure 12*). Default is Volume-Normalized. IODP cubes without the corners (aka J-cubes) have a volume of approximately 7 cc. Cubes cut on the rock saw are approximately 8 cc. Cylinders (minicores) are 10 cc. Select **OK** when done.

	•				
🧕 Volume / Mass Susce	eptibility ×				
_ Normalization Mo	de				
 Volume-Normaliz 	ed				
C Mass-Normalized					
Default Volume / M	Mass				
Volume [ccm]	7.00				
Mass [g]	30.00				
ОК	CANCEL				

Figure 12: Volume and Mass Susceptibility Window

Calibration and Holder Correction

When starting measurements each day a user should measure the holder and calibration standard. This should also be done if the HCORR or CALIB status at the bottom of window are red, indicating they need to be remeasured. If the calibration is out of date, Safyr will automatically prompt the user to calibrate.

1. Select Execute: Instrument Calibration or press F3 to open the Instrument Calibration window (Figure 13).

Thistrument Ca	libration 200	A/m 976 Hz			2	×
Calibration S	Standard Val	ues				
Maximum	3.071E-03					
Minimum	2.002E-03					
Calibration C	Constants —					
	Bulk	Gain Bulk	Gain Aniso	Delta		
Old	2.002E-03	2.8972	2.9634	-6.5		
Measured						
New						
-> Check Calibr -> Mount Calibr	ration Standa ation Standar	rd Values rd Horizontally Into Ro	tator			
		START			SAVE	
		STOP			CANCEL	
INSTRUMENT	CALIBRATIC	N OK LAST CALIBR	ATION: 28-01-2021 (1	ODAY)		

Figure 13: Instrument Calibration Window

2. Place the AGICO standard in the holder. Position of the calibration standard varies by the holder used, see photos below for proper orientation for each holder (*Figures 14 to 16*).



3. Ensure nothing is blocking the sample holder and press **START** of the Instrument Calibration window.

4. If calibration finishes successfully the status bar at the bottom of the window will be green (*Figure 17*). Select **SAVE**. If the calibration is not good, the status bar will be red and the user should repeat the procedure. If the 3D rotator is used, correct values of the calibration constants must fall within the limits of the table in *Figure 18*.

TINSTRUMENT Calibration | 200 A/m | 976 Hz

-Calibration	Standard Val	ues			
Maximum	3.071E-03				
Minimum	2.002E-03				
	_				
-Calibration	Constants —				
	Bulk	Gain Bulk	Gain Aniso	Delta	
Old	2.002E-03	2.9002	2.9662	-6.5	
Measured	2.004E-03	2.9002	2.9662	-6.5	
New	2.002E-03	2.8972	2.9634	-6.5	
		START			SAVE
		STOP			CANCEL
NSTRUMENT		NSUCCESSEUL			

 $\times \mid$

Figure 17: Calibration Window after a successful calibration

Constant	Value range
Gain, Frequency 1	1.82 ÷ 3.75
Gain, Frequency 2	0.16 ÷ 0.33
Gain, Frequency 3	0.43 ÷ 0.87
Delta, all Frequencies	-15 ÷ -5

Figure 18: Agico provided table of acceptable calibration values from the 3D rotator application manual

5. Holder values will be cleared after saving a new calibration. The user will see a pop up window. Select OK (Figure 19).

Instrument Calibration	\times
THE INSTRUMENT WAS RE-CALIBRATED. ALL HOLDER CORRECTION VALUES WERE ZEROED.	
ОК	

Figure 19: Warning window after saving calibration indication the holder values have been zeroed.

6. The HCORR will turn red at the bottom right of the window (Figure 20), warning the user that the HCORR is not up to date.

ecimen -						Me	asuren	ents							
ame										Anisotro	ру				
Orientation Azimuth Volume	Angles Dip 10		Orie P1 12 D	P2 P 0 1 emag. Fac	rameters 2 P4 2 0 tor YES	4	ANISO	Rg		Bulk Suscen	tibility				
Code	Dip Dir.	Dip	Code	Trend	Plunge			Rg	Kre	baik Suscep	K	im		Pha	se
H [BULK							-	
isults	Mean Susc	ptibility			F-	Test		27		Pri	ncipal Di	irection	15		
Кп	n	Std. Er	т. [%]	F	F	-12	F2	3	Coordinate System	Kma Dec	Inc	Ki Dec	nt Inc	Km Dec	in Inc
Normed	Principal	Susceptit	ilities		Confiden	ce Ellip	ses		SPEC						
Kmax	Kin		Kmin	E1	2 E	23	E1	3	GEO PALEO #1						
			Anisotroj	y Factors					TECTO #1						
L	F	P	Pj	T	U	Q		E	PALEO #2 TECTO #2						
NEW SPEC	CIMEN		1			ANIS	0			BULK				SA	/E
			1				S	TOP		NOID DOLL				CAN	CEL
		Inst	rument (Control							Data View	ing			
IOTOL IL IT							425 A	976		BOT 3D	CALI	R	0000	-	10

Holder Correction Indicator

Figure 20: Main Safyr7 window with an invalid holder correction value. Note the red HCORR at the bottom of the window.

- 7. Remove the Calibration Standard from the holder.
- 8. Select Execute: Holder Correction or press F4 to open the Holder Correction window (Figure 21).

pecimen			Mea	sureme	nts				 	
ame							Anisotro	γ		
Holder Correction 4	25 A/m 976 Hz									
Current Holder Valu	es									
ĸ	Klm	Aniso	Jerks	-						
Monsured Holder V	luor									
# K	Re Kim	Aniso	Jerks							
#1										
# 2				-						
Average				-						
Average										
Std. Dev.										
Std. Dev.										
Std. Dev.										
Std. Dev.	Re Kim	Aniso	Jerks							
Std. Dev.	Re Kim BE EMPTY AND CLEA	Aniso	Jerks							
New Holder Values	Re Kim BE EMPTY AND CLEA	Aniso	Jerks	STA	RT]	SAVE	
New Holder Values	Re Kim BE EMPTY AND CLEA	Aniso	Jerks	STA	RT P]	SAVE	
New Holder Values	Re Kim BE EMPTY AND CLEA	Aniso	Jerks	STAR	RT]	SAVE CANCE	L
New Holder Values	Re Kim BE EMPTY AND CLEA	Aniso	Jerks	STAI	RT P	<u>ज</u>	Auto BULK]	SAVE	L
New Holder Values	Re Kim BE EMPTY AND CLEA	Aniso	Jerks	STO	RT P DP	ম	Auto BULK		SAVE CANCE	L

Figure 21: Holder Correction Window

9. Select START.

a. Holder will lower into MFK2 pick up unit and anisotropy will be measured automatically in 3 positions (Figure 22).



Figure 22: 3D Holder Correction Window during measurement

10. If successful (*Figure 23*), select **SAVE**. If the holder values are suspicious a window will appear to warn the user (*Figure 24*). Holder correction should be repeated until it is successful. However, the ship environment/noise always creates suspicious values for the holder correction. It is at the user's discretion to accept or not the holder correction values.



Measuring a Sample

There are some methods that vary depending on the holder used for AMS measurements. The differences are mainly in the positioning of the sample in the holder and the orientation values entered. **Make sure to follow the instructions for the holder in use.**

1. Select **New Specimen** (green button at the bottom left corner of the Safyr7 main window, Figure 20) and the New Specimen window will open (Figure 25).

New Specimen	×
File	
Name Cube95494971	n
Orientation Angles	Orientation Parameters
Azimuth Dip	P1 P2 P3 P4
0 9¢ Volume 7.00	12 0 12 0 Demag. Factor NO
Foliation	Lineation
Code Dip Dir. Dip	Code Trend Plunge
#1	
#2	
ОК	CANCEL

Figure 25: New Specimen Window

- 2. Enter the Cube ID (e.g., CUBE9594971) or use the bar code scanner gun.
 - a. This ID will be translated into Exp-Site-Hole-Core-Section-Half- Interval after upload to LIMS/LORE.
- 3. Enter the orientation angles (also called Sampling Angles). This corrects for the orientation of the sample in the holder.
 - a. If using the 3D holder (aka 3D rotator), enter an Azimuth of 0 and a dip of 90.
 - b. If using the 2D holder (aka 1-axis rotator), leave the Azimuth and Dip fields blank.

4. Select OK.

- 5. Secure the sample in the holder.
 - a. When using the 3D holder, position the sample in the holder as specified in the user interface (*Figures 26 and 27*). There are two possible positions: cylinder (*Figure 26*) and cube (*Figure 27*). This will be the only position the discrete sample will be placed in. Cyli nder position (Z axis vertical) is recommended because it reduces uncertainty on the angle of the Z axis in the sample holder.



Figure 27: Sample in 3D Holder using the Cube setting

b. When using the 2D holder, the cube will be placed in three positions (Figure 28).



Figure 28: Sample positions for 2D holder

6. Measure the anisotropy.

- a. When using the 3D holder, select the big green AN/SO button at the bottom of the Safyr7 window (*Figure 29A*).
 b. When using the 2D holder, select the green AN/SO button at the bottom of the Safyr7 window corresponding to the position of the sample in the holder (e.g., ANISO1 for the first position) (Figure 29B).

If the 'Auto BULK' box is selected, the measurement will be fully automated and the bulk magnetic susceptibility measurement will be taken immediately following the anisotropy measurement at the third position.

Instrument status will be displayed at the bottom of the screen during measurements.



Figure 29: Safyr7 Window when using the (A) 3D holder or (B) 2D holder after new specimen information has been entered. Note the 'Aniso' button is green when the instrument is ready.

- 7. When the measurements are complete, select SAVE.
 - a. If a file is already open, the data will be saved to the open file. The current file is displayed at the top of the window.
 - b. If no file has been opened prior to measurement, the user will be prompted to create a file or select a file to append the data to (*Figur* e 30).

🖤 Save Data									>	×
	>	This	s PC	> Local Disk (C:) > Agico > Data > Acto	on v	ر Sea	rch Acton		<i>م</i>	
Organize 🔻 Ne	w fo	lde	r						?	
E. Desktop	*	^	Na	me	Date modifie	d	Туре		Size	^
👆 Downloads	*			Beth-File-Tests	12/10/2020 12	2:45 PM	File folder			
Documents	*			Beth-File-Tests2	12/10/2020 2:	38 PM	File folder			
Pictures	*			Figures	1/13/2021 2:1	5 PM	File folder			
BethTesting				New folder	12/11/2020 2:	08 PM	File folder			
Data] 1	6/4/2017 10:0	4 PM	AMS File			
ScreenShots				Empty-AMS-MFK2-3D-Rotator-2021	1/13/2021 2:1	0 PM	AMS File			
SigmaTect				FH12E-AMS	6/6/2017 9:39	PM	AMS File			
Sigmalest				FH12E-AMS-2020-12-11	12/11/2020 2:	29 PM	AMS File			
This PC				FH12E-AMS-MFK2-3D-Rotator-2021-01-07	1/7/2021 3:25	PM	AMS File			
- Network		١.		FH12E-MFK2-Tests-2020-12-01	12/4/2020 1:0	1 PM	AMS File			¥
- Network		~	<						>	
File name:	37	5sar	nples							\sim
Save as type:	An	isot	ropy	Files (*.ams)						~
∧ Hide Folders							Save	Can	cel	

Figure 30: Safyr7 Save data prompt

8. The user can then continue measuring samples by clicking the NEW SPECIMEN button at the bottom left of the Safyr7 main window.

a. Azimuth and Dip should remain in the fields (Sampling Angles) as long as the "Retain specimen data" box is checked in the New Specimen window.

Bulk Only measurements

Bulk only measurements should be performed with the manual holder for the best measurements. The manual holder can be used with or without the up/down manipulator. It is recommended to use the up/down manipulator as it is more precise when inserting the holder into the pickup coils.

- 1. Go to Settings: Instrument Settings.
- 2. Select Bulk Susceptibility: Individual Measurements (Figure 31).

🔀 Instrument Settings	×
Measuring Mode	Field Intensity
Anisotropy (AMS) Automatic (Rotator) ☐ Field Dependence Manual (15 Directions) Bulk Susceptibility Enhanced Individual Measurements Field Dependence Temperature Dependence C Low Temp (Cryostat)	Operating Frequency C F1 976 Hz 425 0 FIELD SEQUENCE 0
Temperature Rate C Slow (ca. 9 °C/min) C Medium (ca. 12 °C/min) Image: Fast (ca. 14 °C/min) C Extra Fast (ca. 42 °C/min) Medium Rate Starts @ 600 600 <50 to 600 °C> 600	Temperature Limits Tpeak <90 to 700 °C> Tend <40 to 100 °C> 50 Linger @ Tpeak <0 to 120 s> © Repeated Cycles Number of Cycles <2 to 9> Increment of Tpeak 100 <0 to 600 °C>
0	ĸ
CAN	CEL

Figure 31: Instrument Settings window with Bulk Susceptibility Individual Measurements selected

3. Select OK.

4. A configuration window will appear (Figure 32). Verify the settings and select OK.

Time	Action		Response				Duration
		Instrument Configurat INSTRUME MEASURIN FIELD INTE OPERATING	ion NT MODEL: MFK2-FA G MODE: BULK INDIVIDUAI NSITY: 425 A/m F REQUENCY: 976 Hz	L MEASUREMENTS	×		
				OK			

Figure 32: Instrument Settings verification window

5. A warning that a manual holder should be used for bulk only measurements will appear on the screen (Figure 33). Select OK.



Figure 33: Warning indicating that the manual holder should be used for bulk susceptibility measurements.

6. Select *Execute: Auxiliary Commands* and disable the Up/Down manipulator. Remove the rotator assembly from the up/down manipulator so it is out of the way.

NOTE: Do not disconnect the rotator without first turning off the instrument.

7. Fix the manual holder insert in the up/down assembly and attach the manual holder to the insert. Push the manual holder all the way down so that the conical top piece fits into the insert (*Figure 34*).



Figure 34: Manual holder insert fixed to the up/down manipulator

8. If the up/down manipulator is disabled, the white plastic cylinder (*Figure 35*) needs to be inserted into the pick-up coil prior to measurements. This is to ensure the specimens are placed at the correct height. The sticky kappabridge cleaning stick works best for inserting and removing the cylinder.



Figure 35: White plastic cylinder insert for bulk susceptibility

9. Select *Execute: Holder Correction* and measure the manual holder. The holder correction routine consists of three consecutive measurements. The procedure differs depending on if the up/down manipulator is enabled or not. **IMORTANT: When switching from** anisotropy mode to bulk only measurements, you must always run a new holder correction measurement. Safyr7 saves separate holder values for anisotropy mode and bulk only mode, even if you are using the same holder.

- a. If the up/down manipulator is enabled, click START (Figure 37). The routine will be performed automatically.
- b. If the Up/Down manipulator is disabled, a warning box will appear notifying the user to insert the white plastic cylinder into the pick up coils (*Figure 36*). Click **OK**. Click **START** and wait for a long beep, then manually insert the holder into the pickup coils so that it rests on the white plastic cylinder in the center of pickup coils. Remove the holder when you hear a short beep. The holder will need to be inserted and removed 3 times.



Figure 36: Warning box when up/down manipulator is disabled

Specimen			Results			
lame			KRe_Vol	Kim_Vol	Phase	Range
Holder Correc	tion 425 A/m 976	Hz		1.7	1.1	
Current Holde	r Values					
	KRe	Klm				
Measured Ho	Ider Values					
#	KRe	Kim				
#1	-3.0353E-06	-0.2048E-06				
#2	-2.9846E-06	0.1691E-06				
#3	-3.0896E-06	0.1523E-06				
Average	-3.0365E-06	0.1754E-06				
Std. Dev.	0.0525E-06	0.0268E-06				
New Holder \	alues					
	KRe	Kim				
	-3.0365E-06	-0.1754E-06				
			STADT			SAVE
			JIAN			
			STOP			CANCEL
HOLDER COR	RECTION SUCCE	SSFULLY FINISH	ED			
Auto NEW		Auto S	START		□ Aut	o SAVE
			STOP			CANCEL

Figure 37: Bulk Susceptibility only window after holder correction measurement

11. Select **SAVE** if you are satisfied with the holder correction.

You are now ready to begin measuring.

1. Select NEW SPECIMEN and a new specimen window will open (Figure 38).

and the second se													
acimen			Results										
ne				KRe_Vo			к	lm_Vol		P	hase	R	ange
ume		_											
e											- 44		
Name	Field	Freq	KRe_Vol	KIm_Vol	Phase	Range	Volume	Mass	Time	Date	Note		
			New Speci	imen									
			Specim	en Name	CUBE 112	41551							
			Volume	· · · ·	7.0								
			Note										
			Note Auto Re	peat [1 4	ł							
			Note Auto Re	peat [1 ÷								
			Note Auto Re	peat [OK	1 ÷	СА	NCEL						
			Note Auto Re	peat [OK	1 🗄	CA	NCEL						
			Note Auto Re	peat [1	CA	NCEL						
			Note Auto Re	peat [1 🗄	CA	NCEL						
			Note Auto Re	peat [1 🗄	CA	NCEL						
			Note Auto Re	peat [1 🗄	CA	NCEL]					
			Note Auto Re	peat [1 .	CA	NCEL					SA	VE
NEW SPECIMEN			Note Auto Re	peat [1	CA	NCEL]			5	SA Auto SAV	VE
NEW SPECIMEN		F A	Note Auto Re	∏ peat ∏ OK	1 ÷	с л रा ₽	NCEL					SA Auto SAV CAN	VE FE CEL

Figure 38: New specimen window

- a. Scan or enter the sample name in the Specimen Name box.
- b. Enter the volume of the sample in cubic centimeters. Plastic cubes with rounded corners are 7cc, hard rock cubes are 8cc, cylinders are generally 10cc.
- c. You have the option to add a note in the box.
- d. Enter the number of measurement repetitions in the Auto Repeat box.
- e. Select OK
- 2. Insert the sample into the specimen holder in the desired orientation.
- 3. Select START
 - a. The instrument will first take a measurement of the empty coils to zero the instrument.
 - b. If the up/down manipulator is enabled the holder will automatically be moved into the pick up coil
 - c. If the up/down manipulator is disabled, wait for a long beep then insert the sample into the pick up coil until it rests on the white
- plastic cylinder. When you hear a short beep indicating that the measurement is complete, remove the sample from the pickup coil. 4. Select **SAVE**

File Outputs

There are 4 files generated when a user saves AMS data. These are the binary .ran and .ams files and the text .asc file, and a .csv file. A separate . bulk file is generated when measuring bulk only measurements. The files are written to C:\Agico\Data or C:\data\in.

AMS file types

- 1. .csv file- csv file formatted for upload to LIMS database.
- 2. .ams file- binary data file intended for use in the Anisoft5 software
- 3. .ran file- standard binary file for use in the Anisoft4 software
- 4. .asc file- text file meant as a log file for completed measurements

Bulk Only file type

1. .bulk file- space delimited text file in a fixed format

Data Upload

To upload MFK2 AMS data to the LORE database, use the recent version of MUT, called MegaUploadaTron2 (MUT2) installed on the KAPPA computer of the Pmag lab (*Figure 39*). Four files are needed for upload. They are the .ams, .ran, .asc, and a .csv. These files can be copy/paste from C:\agico\Data to C:\data\in (like done formerly with the KLY4 files). The .ran file is no longer required to upload to the LORE database. However, it is recommended to upload it along with the three other files.



Figure 39: MegaUploadaTron2 to upload MFK2 data to the LORE database

In the LORE expanded report, the *Instrument Name* is MFK2 and the 1-axis rotator (or 2D holder) appears as "classic" in the *Holder Type* column (*Figu re 40*). The 3D rotator sample holder appears as "3D" in the *Holder Type* column.

•	Instrument	Holder type	
	MFK2	Classic	(

Figure 40: Extract of a LORE Report for MFK2 data

Editing MFK2 AMS data with Anisoft 5

If any corrections need to be made to the data before uploading (fix azimuth and dip information, etc.), these can be made in Anisoft5.

1. Open Anisoft5 software. The most recent (beta) version, Anisoft5beta (released on May 20, 2022) is installed on the KAPPA computer (*Figure 41*).



Figure 41: Icon of the Anisoft5 software on the KAPPA computer desktop

2. Select File>Open Data File(s). In the browser window, select the .ams file for the data to be uploaded and select Open (Figure 42).



Figure 42: Open File(s) window of Anisoft5

3. Select Edit>Edit Data. Make the desired changes in the table (every cell is editable) then click SAVE (Figure 43).



Figure 43: Edit Data window in Anisoft5

Change the display to Geographic by clicking on 'Geographic Coordinates' (*Figure 44*) if the samples are oriented. If this step is skipped Anisoft will only export the Specimen coordinate data.



4. Select *File>Export Data File* and export .csv file by selecting **IODP file (.csv)** format (*Figure 45*). Do not choose Comma-separated values text file (.csv) format.



Figure 45: Export Data File window to save edited data with Anisoft5

5. Open MegaUploadaTron2 (MUT2). Ensure the .asc, .ams, .ran, and .csv file all have the **same** file name and are in the *in* data folder. Select **Upload** and check the LORE report.

Troubleshooting

- The azimuth and dip information for a sample was entered wrong at the time of measurement (most common mistake).
- 1. Open the .ams file in Anisoft5.
- 2. Select Edit>Edit Data
- 3. Adjust the Sampling Angles (Azimuth=Alpha and Dip=Phi) or Orientation Parameters
- 4. Select Save
- 5. Export the edited data file in IODPcsv format.
- There is a typo in the sample name.
- 1. Open the .ams file in Anisoft5.
- 2. Select Edit>Edit Data
- 3. Edit the Sample name column
- 4. Select Save

- 5. Export the edited data file in IODPcsv format.
- Purple question marks appear in MUT2
- 1. Check that all 4 files for AMS measurements are in the correct folder (i.e., C:\data\in)
- 2. Ensure the file names are **identical** for the 4 files
- 3. Make sure the .csv file has been exported to the correct file location (i.e., C:\data\in)

LIMS Component Table

A N L Y S IS	T A B LE	NAME	ABOUT TEXT
K A P PA	S A M P LE	Exp	Exp: expedition number
K A P PA	S A M P LE	Site	Site: site number
K A P PA	S A M P LE	Hole	Hole: hole number
K A P PA	S A M P LE	Core	Core: core number
K A P PA	S A M P LE	Туре	Type: type indicates the coring tool used to recover the core (typical types are F, H, R, X).
K A P PA	S A M P LE	Sect	Sect: section number
K A P PA	S A M P LE	A/W	A/W: archive (A) or working (W) section half.
K A P PA	S A M P LE	text_id	Text_ID: automatically generated database identifier for a sample, also carried on the printed labels. This identifier is guaranteed to be unique across all samples.
K A P PA	S A M P LE	sample _number	Sample Number: automatically generated database identifier for a sample. This is the primary key of the SAMPLE table.
K A P PA	S A M P LE	label_id	Label identifier: automatically generated, human readable name for a sample that is printed on labels. This name is not guaranteed unique across all samples.
K A P PA	S A M P LE	sample _name	Sample name: short name that may be specified for a sample. You can use an advanced filter to narrow your search by this parameter.

K A P PA	S A M P LE	x_samp le_state	Sample state: Single-character identifier always set to "W" for samples; standards can vary.
K A P PA	S A M P LE	x_proje ct	Project: similar in scope to the expedition number, the difference being that the project is the current cruise, whereas expedition could refer to material/results obtained on previous cruises
K A P PA	S A M P LE	x_capt_ loc	Captured location: "captured location," this field is usually null and is unnecessary because any sample captured on the JR has a sample_number ending in 1, and GCR ending in 2
K A P PA	S A M P LE	location	Location: location that sample was taken; this field is usually null and is unnecessary because any sample captured on the JR has a sample_number ending in 1, and GCR ending in 2
K A P PA	S A M P LE	x_samp ling_tool	Sampling tool: sampling tool used to take the sample (e. g., syringe, spatula)
K A P PA	S A M P LE	change d_by	Changed by: username of account used to make a change to a sample record
K A P PA	S A M P LE	change d_on	Changed on: date/time stamp for change made to a sample record
K A P PA	S A M P LE	sample _type	Sample type: type of sample from a predefined list (e.g., HOLE, CORE, LIQ)
K A P PA	S A M P LE	x_offset	Offset (m): top offset of sample from top of parent sample, expressed in meters.
K A P PA	S A M P LE	x_offset _cm	Offset (cm): top offset of sample from top of parent sample, expressed in centimeters. This is a calculated field (offset, converted to cm)
K A P PA	S A M P LE	x_botto m_offse t_cm	Bottom offset (cm): bottom offset of sample from top of parent sample, expressed in centimeters. This is a calculated field (offset + length, converted to cm)
K A P PA	S A M P LE	x_diam eter	Diameter (cm): diameter of sample, usually applied only to CORE, SECT, SHLF, and WRND samples; however this field is null on both Exp. 390 and 393, so it is no longer populated by Sample Master
K A P PA	S A M P LE	x_orig_l en	Original length (m): field for the original length of a sample; not always (or reliably) populated
K A P PA	S A M P LE	x_length	Length (m): field for the length of a sample [as entered upon creation]
K A P PA	S A M P LE	x_lengt h_cm	Length (cm): field for the length of a sample. This is a calculated field (length, converted to cm).

K A P PA	S A M P LE	status	Status: single-character code for the current status of a sample (e.g., active, canceled)
K A P PA	S A M P LE	old_stat us	Old status: single-character code for the previous status of a sample; used by the LIME program to restore a canceled sample
K A P PA	S A M P LE	original _sample	Original sample: field tying a sample below the CORE level to its parent HOLE sample
K A P PA	S A M P LE	parent_ sample	Parent sample: the sample from which this sample was taken (e.g., for PWDR samples, this might be a SHLF or possibly another PWDR)
K A P PA	S A M P LE	standard	Standard: T/F field to differentiate between samples (standard=F) and QAQC standards (standard=T)
K A P PA	S A M P LE	login_by	Login by: username of account used to create the sample (can be the LIMS itself [e.g., SHLFs created when a SECT is created])
K A P PA	S A M P LE	login_d ate	Login date: creation date of the sample
K A P PA	S A M P LE	legacy	Legacy flag: T/F indicator for when a sample is from a previous expedition and is locked/uneditable on this expedition
K A P PA	T E ST	test change d_on	TEST changed on: date/time stamp for a change to a test record.
K A P PA	T E ST	test status	TEST status: single-character code for the current status of a test (e.g., active, in process, canceled)
K A P PA	T E ST	test old_stat us	TEST old status: single-character code for the previous status of a test; used by the LIME program to restore a canceled test
K A P PA	T E ST	test test_nu mber	TEST test number: automatically generated database identifier for a test record. This is the primary key of the TEST table.
K A P PA	T E ST	test date_re ceived	TEST date received: date/time stamp for the creation of the test record.
K A P PA	T E ST	test instrum ent	TEST instrument [instrument group]: field that describes the instrument group (most often this applies to loggers with multiple sensors); often obscure (e.g., user_input)
K A P PA	T E ST	test analysis	TEST analysis: analysis code associated with this test (foreign key to the ANALYSIS table)
K A P PA	T E ST	test x_proje ct	TEST project: similar in scope to the expedition number, the difference being that the project is the current cruise, whereas expedition could refer to material/results obtained on previous cruises

K A P PA	T E ST	test sample _number	TEST sample number: the sample_number of the sample to which this test record is attached; a foreign key to the SAMPLE table
K A P PA	R E S U LT	offset (cm)	Top offset (cm): position of the measurement expressed in cm from top of section
K A PA	C A L C U L A T ED	Top depth CSF-A (m)	Top depth CSF-A (m): position of observation expressed relative to the top of the hole.
K A PA	C A L C U L A T ED	Bottom depth CSF-A (m)	Bottom depth CSF-A (m): position of observation expressed relative to the top of the hole.
K A P PA	S A M P LE	sample _volume	SAMPLE sample volume (mL): lookup of the sample's volume from the SAMPLE table
K A P PA	R E S U LT	field	RESULT measurement field (A/m): the set field that the specimen was measured in
K A P PA	R E S U LT	frequen cy	RESULT measurement frequency (Hz): the frequency that the specimen was measured in
K A P PA	R E S U LT	azimuth	RESULT azimuth (deg.): directional value entered by the user at the time of measurement: horizontal angle
K A P PA	R E S U LT	dip	RESULT dip (deg.): directional value entered by the user at the time of measurement: vertical angle
K A P PA	R E S U LT	holder_ value	RESULT holder susceptibility (SI): magnetic susceptibility of the holder without sample
K A P PA	R E S U LT	mean_s uscepti bility	RESULT Mean susceptibility (SI): average of the absolute values of the principal susceptibilities, $(K1 + K2 + K3) / 3$.
K A P PA	R E S U LT	bulk_su sceptibil ity	RESULT Bulk susceptibility (SI): total susceptibility of a specimen corrected for specimen volume.
K A P PA	R E S U LT	max_no rm_prin cipal_su sceptibil ity	RESULT Kmax susc (SI): K1, the susceptibility of the maximum axis.

K A P PA	R E S U LT	int_nor m_princ ipal_sus ceptibility	RESULT Kint susc (SI): K2, the susceptibility of the intermediate axis.
K A P PA	R E S U LT	min_nor m_princ ipal_sus ceptibility	RESULT Kmin susc (SI): K3, the susceptibility of the minimum axis.
K A P PA	R E S U LT	max_ei genvect or_decli nation	RESULT Kmax dec (deg): declination of the maximum (K1) principal susceptibility in specimen coordinates
K A P PA	R E S U LT	max_ei genvect or_incli nation	RESULT Kmax inc (deg): inclination of the maximum (K1) principal susceptibility in specimen coordinates
K A P PA	R E S U LT	int_eige nvector _declin ation	RESULT Kint dec (deg): declination of the intermediate (K2) principal susceptibility in specimen coordinates
K A P PA	R E S U LT	int_eige nvector _inclinat ion	RESULT Kint inc (deg): inclination of the intermediate (K2) principal susceptibility in specimen coordinates
K A P PA	R E S U LT	min_eig envecto r_declin ation	RESULT Kmin dec (deg): declination of the minimum (K3) principal susceptibility in specimen coordinates
K A P PA	R E S U LT	min_eig envecto r_inclin ation	RESULT Kmin inc (deg): inclination of the minimum (K3) principal susceptibility in specimen coordinates
K A P PA	R E S U LT	max_ei genvect or_decli nation_ geo	RESULT Kmax geo dec (deg): declination of the maximum (K1) principal susceptibility in geographic coordinates with correction applied for entered azimuth and dip
K A P PA	R E S U LT	max_ei genvect or_incli nation_ geo	RESULT Kmax geo inc (deg): inclination of the maximum (K1) principal susceptibility in geographic coordinates with correction applied for entered azimuth and dip
K A P PA	R E S U LT	int_eige nvector _declin ation_g eo	RESULT Kint geo dec (deg): declination of the intermediate (K2) principal susceptibility in geographic coordinates with correction applied for entered azimuth and dip
K A P PA	R E S U LT	int_eige nvector _inclinat ion_geo	RESULT Kint geo inc (deg): inclination of the intermediate (K2) principal susceptibility in geographic coordinates with correction applied for entered azimuth and dip
K A P PA	R E S U LT	min_eig envecto r_declin ation_g eo	RESULT Kmin geo dec (deg): declination of the minimum (K3) principal susceptibility in geographic coordinates with correction applied for entered azimuth and dip
K A P PA	R E S U LT	min_eig envecto r_inclin ation_g eo	RESULT Kmin geo inc (deg): inclination of the minimum (K3) principal susceptibility in geographic coordinates with correction applied for entered azimuth and dip
K A P PA	R E S U LT	lineatio n_value	RESULT lineation value (L): user-entered value for lineation, L

K A P PA	R E S U LT	foliation _value	RESULT foliation value (F): user-entered value for foliation, F
K A P PA	R E S U LT	anisotro py_degr ee	RESULT anisotropy degree (P): user-entered value for anisotropy degree, P
K A P PA	R E S U LT	correcte d_aniso tropy	RESULT corrected anisotropy degree (P'): user-entered value for the corrected anisotropy degree, P' \ensuremath{P}
K A P PA	R E S U LT	normali zed_ten sor_k11	RESULT K11 tensor: K11 tensor value
K A P PA	R E S U LT	normali zed_ten sor_k12	RESULT K12 tensor: K12 tensor value (numerically equal to the K21 tensor)
K A P PA	R E S U LT	normali zed_ten sor_k13	RESULT K13 tensor: K13 tensor value (numerically equal to the K31 tensor)
K A P PA	R E S U LT	normali zed_ten sor_k22	RESULT K22 tensor: K22 tensor value
K A P PA	R E S U LT	normali zed_ten sor_k23	RESULT K23 tensor: K23 tensor value (numerically equal to the K32 tensor)
K A P PA	R E S U LT	normali zed_ten sor_k33	RESULT K33 tensor: K33 tensor value
K A P PA	R E S U LT	standar d_devia tion	RESULT standard deviation (SI): standard deviation of the bulk susceptibility measurement
K A P PA	R E S U LT	orientati on_para m_1	RESULT orientation parameter P1: clock value of the orientation of the fiducial mark drawn on the front side of the cylinder. Standard JRSO value = 12
K A P PA	R E S U LT	orientati on_para m_2	RESULT orientation parameter P2 (deg.): P2 = 0 if the dip of the frontal side (psi1) is measured; 90 if the plunge of the cylinder axis (psi2) is measured. Standard JRSO value = 0
K A P PA	R E S U LT	orientati on_para m_3	RESULT orientation parameter P3: clock value of the direction which is measured in the field (visualize by arrow, which need not neccesarily be drawn). Standard JRSO value = 12
K A P PA	R E S U LT	orientati on_para m_4	RESULT orientation parameter P4 (deg.): P4 = 0 means that azimuth of dip and dip of mesoscopic foliation are measured; 90 means that strike (right oriented) and dip are measured. Standard JRSO value = 0
K A P PA	R E S U LT	demagn etizatio n_factor	RESULT demagnetization factor (unit varies): degree of demagnetization (may be mT of A/F demag, deg. C of thermal demag, NRM, or other)

K A P PA	R E S U LT	run_as man_id	RESULT run ASMAN_ID: serial number of the ASMAN link for the run file
K A P PA	R E S U LT	run_file name	RESULT run filename: file name of the run file
K A P PA	R E S U LT	ams_as man_id	RESULT AMS ASMAN_ID: serial number of the ASMAN link for the AMS file
K A P PA	R E S U LT	ams_fil ename	RESULT AMS filename: file name of the AMS file
K A P PA	R E S U LT	asc_as man_id	RESULT ASC ASMAN_ID: serial number of the ASMAN link for the ASC file
K A P PA	R E S U LT	asc_file name	RESULT ASC filename: file name of the ASC file
K A P PA	R E S U LT	ran_as man_id	RESULT RAN ASMAN_ID: serial number of the ASMAN link fo the RAN file
K A P PA	R E S U LT	ran_file name	RESULT RAN filename: file name of the RAN file
K A P PA	R E S U LT	timesta mp	RESULT timestamp: date/time stamp of the actual measurement time
K A P PA	R E S U LT	instrum ent	RESULT instrument: name of the instrument that made the measurement (for IODP, only KLY-4 or MFK2)
K A P PA	R E S U LT	holder_t ype	RESULT holder type: type of holder used (e.g., "classic")
K A P PA	R E S U LT	softwar e_source	RESULT software source: the software used to reduce the data (either SUFAR or AMSSpin)
K A P PA	S A M P LE	text_id	SAMPLE Text_ID: lookup of the sample's text_id from the SAMPLE table
K A P PA	T E ST	test_nu mber	TEST test number: automatically generated database identifier for a test record. This is the primary key of the TEST table. (This is a repeat of the test number field above.)
K A P PA	S A M P LE	sample descript ion	SAMPLE comment: contents of the SAMPLE.description field, usually shown on reports as "Sample comments"

K A P PA	T E ST	test test_co mment	TEST comment: contents of the TEST.comment field, usually shown on reports as "Test comments"
K A P PA	R E S U LT	result comme nts	RESULT comment: contents of a result parameter with name = "comment," usually shown on reports as "Result comments"

Archived Versions

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