

SEIF ALIX

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TRL/DRL (to be filled out by FP-coordinator)

Mission	AMADEE-24 (to be filled out by FP-coordinator)	
0.1.EXPERIMENT NAME AND BASIC INFORMATION		
Acronym	ALIX	
Long Name	Astronaut Localisation Interferometry eXperiment	
Type of Experiment (technical, geological, biological, medical...)	Technical	
Mini Description (1-2 lines)	ALIX performs localisation of astronauts or surface vehicles in 2D by using a mobile transmitter and receiving the signal at multiple ground stations. Through phase difference measurements, movement can be tracked using interferometry.	
0.2.PRINCIPAL INVESTIGATORS		
	Primary Contact	Secondary Contact
Names of PIs	Christiaan Brinkerink	Niels Vertegaal
Institution	Radboud Radio Lab, dept. of Astrophysics/IMAPP, Radboud University	dept. of Electrical Engineering, Eindhoven University of Technology
E-mail	c.brinkerink@astro.ru.nl	c.j.c.vertegaal@tue.nl
Phone (institution)	+31-24-3652824 (TO BE CHECKED)	
Phone (mobile)	+31-6-11302497	
Skype address		
Experiment team members in the field? <div><input type="radio"/> YES <input checked="" type="radio"/> NO <input type="radio"/> TBD</div> <div>To avoid breaking the simulation, PIs are only admitted to the field in special cases. However, even in those situations their stay is limited to the preparation phase of the mission. No external partners are permitted in the field during the isolation phase.</div>		
	Availability of PIs during the mission: (e.g. MSC, remotely, ...)	<div>We will design ALIX to minimise the necessary involvement from people outside the simulated mission, but ALIX PIs shall be available for support during thefull extent of the campaign. Both MSC and remote options are open, with remote preferred.</div> <div>Please provide here dates and locations, in case there is not enough space here, please provide an additional document and mention it in section 0.5 "Reference Documents".</div>

0.3.FP-COORDINATOR (TO BE FILLED OUT BY FP-COORDINATOR)	
Name	
Availability during mission	
E-mail	
Phone	
Skype address	
0.4.RSS-COORDINATOR (TO BE FILLED OUT BY FP / RSS-COORDINATOR)	
Name	
Availability during mission	
E-mail	
Phone	
Skype address	
0.5.REFERENCE DOCUMENTS	
List of additional documents (Procedures etc.)	Procedures_ALIX_v2 – Version number:2 – procedures for the ALIX mission in the AMADEE24 mission Additional technical documents will be produced together with the systems they describe. .
Make sure to refer to the most recent version valid of each reference document. Therefore, if you submit a new version of the experiment procedures, update this document as well!	
format: “file name – version number – short description”	

1. Experiment Description

1.1.SCIENTIFIC RATIONALE	
Brief Description (5-8 lines)	Interferometry using radio signals is a technique commonly used in radio astronomy. We aim to use this technique to provide local localisation capability using a mobile transmitter and multiple static receiver stations. The phase information from the receiver stations is combined to provide phase difference measurements, which are used in the localisation algorithm that is part of ALIX. The resulting location information, limited to a 2D X/Y position, can be shared within the AMADEE campaign infrastructure in close to real time.
Hypothesis	We expect ALIX to be able to provide a localisation accuracy of ~1 meter within an area of ~2 square kilometres, tracking a single transmitter and using a minimum of 3 receiver stations.
Objectives	Our aim is to demonstrate the functionality of interferometry-based localisation on this local scale with the accuracy stated. We wish to gain insight into the reliability of our location reconstruction solutions, and into landscape features that may affect this performance.
Successful Experiment Run	A successful experiment run for ALIX consists of at least one successfully tracked excursion, for which we can match the recorded position over time from GPS with the location as reconstructed by ALIX in a meaningful way. An excursion starts at a reference location close to the habitat, and reaches a distance of max ~1 km from the habitat. Time scales for excursions are thought to cover a few hours at most.

1.2.EXPERIMENT READINESS AND COLLABORATIONS			
Technology Readiness Level (TRL; 1-10)		<div></div>	- to be filled out by FP-coordinator; see FP Handbook for detailed definitions
Documentation Readiness Level (DRL; 0-6)		<div></div>	
Collaboration with other experiments?		<div><input type="radio"/> YES</div>	<div><input type="radio"/> NO</div>
		<div><input checked="" type="radio"/> TBD</div>	- to be filled out by FP-coordinator
	If Y, which? - to be filled out by FP-coordinator		
	If Y, how? - to be filled out by FP-coordinator		
1.3.NUMBER OF RUNS/SAMPLES			
In order to meet objectives...	How many runs? run...a closed, repeatable part of the experiment, can be divided into specific parts (sections)	How many samples? sample...collected during an experiment; e.g. a geological sample could be a rock	
Minimal required	1	N/A	
Optimal	3 (but more is better)	N/A	
Comments on runs/samples (2-3 sentences)	Runs (excursions) under varied conditions and in varied terrain types provide valuable data into the performance of ALIX. However, in order to demonstrate the measurement concept successfully only a single run is required at minimum.		
1.4.PACKING INFORMATION – EXPERIMENT SIZE AND WEIGHT			
	Pre-mission	Post-mission	
Number of packing cases/ boxes	2	2	
If you have more than one packing case/box, please provide the following properties for each of them.			
In case your hardware contains dangerous goods (e.g. batteries), please make sure that they are properly packed for sea freight!			
Size [cm*cm*cm]	100 x 60 x 60 60 x 60 x 60	100 x 60 x 60 60 x 60 x 60	
Weight [kg]	20 25	20 25	
Fragile (Y/N)	Y (electronics components)	Y (electronics components)	
Comments	Numbers to be updated following ALIX design maturation		

2. Experiment Requirements

2.1.TIME AND PERSONNEL REQUIREMENTS

Number of people required for experiment execution and the time they are needed for:

Please fill out the following table in the format "location: number of people x duration" (e.g. "H: 2 persons x 10 min"). "Location" refers to whether the activity is to be conducted in the habitat (H) or out in the field (F) on EVA.

If one of the fields below is not needed, please enter 0 or n/a

The times given here need to be compatible with the experiment procedures! Make sure to update this table in particular each time the procedures are altered! Otherwise your experiment cannot be accommodated appropriately in the Activity Plan.

	1-time preparation ³	Experiment preparation (to be done prior to each run ⁴)	Sole experiment time per run ^{4,5}	Experiment breakdown (to be done after each run ⁴)	1-time breakdown ⁶
Analog Astronaut(s) in the suit ¹	1 person x 30 min (estimate, transmitter placement tbd)	1 person x 5 min	1 person x 5 min	1 person x 5 min	1 person x 20 min
Unsuited Analog Astronaut(s) ²	1 person x 30 min (estimate, transmitter placement tbd)	1 person x 5 min	1 person x 5 min	1 person x 5 min	1 person x 20 min
Unsuited field crew member(s) ²	2 person x 3h 20min	–	–	–	2 person x3h 20min
Total number of people required	4	2	2	2	4

¹ Currently in total two functional suits are available; please be aware of possible short-notice changes (operational constraints).

² If possible, during an experiment run outside the habitat these options should be avoided as they cause a discontinuity in the simulation. Only certified analog astronauts are allowed to wear the OeWF analog suits. Not every member of the field crew is an analog astronaut. For "Unsuited field crew member(s)" it is irrelevant if the person doing the task is a trained analog astronaut or not.

³ This refers to any preparatory activities to be conducted only once per mission, typically in the beginning.

⁴ See definition of run in section 1"Experiment Description".

⁵ The time and personnel needed to conduct the "pure science part" of the experiment.

⁶ This refers to any breakdown activities to be conducted only once per mission, typically in the end.

2.1 TIME AND PERSONNEL REQUIREMENTS (CONTINUED)		
Break time between two runs?		<input checked="" type="radio"/> Break required <input type="radio"/> Does not matter <input type="radio"/> No break allowed <input checked="" type="radio"/> TBD
	If required, how long?	several hours (see below)
	If not allowed, why? If required, why? Are there specific tasks that need to be performed during the break (e.g. recharging batteries)?	Sufficient time is needed to remove, recharge and replace the battery packs for the transmitter, and if applicable the receiver stations.
Can the experimenter do other experiments/tasks in parallel or are they needed exclusively?		<input type="radio"/> Exclusive <input checked="" type="radio"/> Not exclusive <input type="radio"/> TBD - to be filled out by FP-coordinator
	Explanation / comments to statement above - to be filled out by FP-coordinator	The transmitter is a 'commensal' payload, to be carried on excursions that involve other work being done. They do not require interaction beyond being switched on and off.
Comments on this section (2.1)		

2.2.TERRAIN REQUIREMENTS	
What types of slopes and terrain are required for the experiment, and which locations may be dangerous to the experiment (information to include: sizes of stones, maximum slope, slope stability, moisture content; sand/rocks/cliffs/snow/ice/water...). If possible, please provide examples of specific locations (coordinates) in the proximity of the field camp.	
Best terrain	Flat terrain with no line-of-sight obstacles or metal structures nearby
Possible terrain	Hilly terrain with features or elevation differences of up to 10 meters in size
Not useful terrain	Caves, places with large metal structures
Dangerous terrain	N/A
Specific coordinates available?	<input type="radio"/> YES <input checked="" type="radio"/> NO <input type="radio"/> TBD
If Y – Coordinates	Locations of the groundstations are being determined using DEM data from the site. Once a first set has been determined its coordinates will be included here. coordinate format: WGS 84 (EPSG:4326, “GPS coordinates”), decimal degrees If you specify multiple locations, please provide a ranking which of those are most ... least important.
	In case of more detailed information (multiple locations, etc.), please provide them in an additional document and mention it in section 0.5 “Reference Documents”.

2.3.WEATHER REQUIREMENTS				
Preferable weather conditions (conditions outside those ranges are unsuitable for the experiment)				
Unsuitable weather situations (e.g. rain, thunderstorm, snow...)	Rain (places extra requirements on weather-proofing the ALIX hardware), Thunderstorms may interfere with the radio measurements and lightning strikes may damage the ALIX components.			
Temperature	Lower limit [°C]	0	Upper limit [°C]	50
Humidity	Lower limit [%]	0	Upper limit [%]	100
Max. wind speed	Steady [km/h]	50		
	Gusts [km/h]	70		
Required ground conditions (e.g. dry, wet, frozen, rime, snow cover...)	Max snow depth should still allow for placement of receiver stations and beacons. Estimated allowable snow depth is 30cm, but this number depends heavily on the state of the snow (packed, loose...).			
Required lighting conditions	Not driven by operation of ALIX, but by visibility required for outdoor astronaut activities.			
Hazardous weather conditions (conditions outside those ranges are dangerous for the experiment and/or the persons operating it)				
Dangerous weather situations (e.g. rain, thunderstorm, snow...)	Thunderstorms			
Temperature	Lower limit [°C]	-20	Upper limit [°C]	60
Humidity	Lower limit [%]	0	Upper limit [%]	100
Max. steady wind speed	Steady [km/h]	70		
	Gusts [km/h]	100		
Required ground conditions (e.g. dry, wet, frozen, rime, snow cover...)	Hazardous: ground incapable of supporting the receiver and beacon supporting structures (loose soil/snow/gravel)			
Light requirements	N/A			
Additional Information				
Additional weather requirements (not mentioned above)				
In case of unstable weather, what is the time necessary to break up the experiment? [min]		3h 20 min (retrieval of beacons and receivers into storage)		

2.4.POWER REQUIREMENTS					
Power [W]					
Is AC required?		<input checked="" type="radio"/> YES	<input type="radio"/> NO	<input type="radio"/> TBD	
	If Y, is the equipment compatible with a 230V/50Hz power grid?		<input checked="" type="radio"/> YES	<input type="radio"/> NO	<input type="radio"/> TBD
	If N to question above:				
	Voltage [V]			Frequency [Hz]	
	Are plugs compatible with German Schuko (CEE 7/3 socket & CEE 7/4 plug; Type F)?		<input checked="" type="radio"/> YES	<input type="radio"/> NO	<input type="radio"/> TBD
	If N, please provide the necessary converters!				
Is DC required?		<input checked="" type="radio"/> YES	<input type="radio"/> NO	<input type="radio"/> TBD	
	If Y, is the DC provided by batteries?		<input checked="" type="radio"/> YES	<input type="radio"/> NO	<input type="radio"/> TBD
	If Y to question above:				
	Type of batteries	COTS Li-Polymer powerbanks			
	Number of batteries	3 per receiver, 1 per transmitter/beacon (19 minimum in total, + 5 spares)			
	Capacity per battery [Wh]	~2000 Ah (receivers), ~2500Ah (transmitters/beacons)			
	Net weight per battery [kg]	~450g (receivers). ~60g (transmitters/beacons)			
	Serial numbers of batteries	TBD			
	Please make sure that batteries are properly packed for sea freight!				
	Maximum battery run time [min]	1500 min			
	Are the batteries rechargeable?		<input checked="" type="radio"/> YES	<input type="radio"/> NO	<input type="radio"/> TBD
	If Y to question above:				
	Max. battery charge time [min]	~5 hours per battery, 15 hours per receiver if charged sequentially			
	Avg. # of runs conductible with fully charged battery	1-2			
	Avg. charge time after 1 run [min]	~5 hours			
	Please, mind the questions about AC power supply above concerning the chargers!				

2.4 POWER REQUIREMENTS (CONTINUED)			
Comments		Note that these figures are subject to change with maturation of the ALIX system design, and are provided here for general guidance.	
2.5.COMMUNICATION REQUIREMENTS			
Do you intend to connect to the network infrastructure?		<input checked="" type="radio"/> YES	<input type="radio"/> NO <input type="radio"/> TBD
If Y, do you intend to use wireless OeWF network infrastructure? (currently 5GHz 802.11a/n WLAN)		<input checked="" type="radio"/> YES	<input type="radio"/> NO <input type="radio"/> TBD
	If Y, required bandwidth on the wireless connection [kbit/s] (if approx. constant, otherwise see below)	50 kb/s	
	If not approx. constant, what are the peak and average values?	Peak [kbit/s]	
		Average [kbit/s]	
Static IP addresses required?		<input checked="" type="radio"/> YES	<input type="radio"/> NO <input type="radio"/> TBD
	If Y:		
	Number in field	5 (min) outside, 1 in habitat	
	Number in MSC	1, but TBD depending on ways available to connect to field	
	Is an independently managed subnet preferred?	<input type="radio"/> YES	<input checked="" type="radio"/> NO <input type="radio"/> TBD
	If Y, minimum size		
Remote network access to devices in field/MSc required? (i.e. VPN access required) (i.e. PI neither at field nor MSC, but needs to access some devices)		<input type="radio"/> YES	<input type="radio"/> NO <input checked="" type="radio"/> TBD

2.5 COMMUNICATION REQUIREMENTS (CONTINUED)	
Does the experiment include radio equipment? (except equipment for interfacing with the ÖWF network)	<input checked="" type="radio"/> YES <input type="radio"/> NO <input type="radio"/> TBD
<div>If Y:</div>	
Frequency range(s)	45-55 MHz (not continuous, but CW at discrete frequencies in band)
Corresponding effective transmission power	0 dBm
If the experiment includes <u>any</u> telecommunication equipment: serial numbers of respective devices.	
Comments	Transmission power to be determined following ALIX field tests in Q3/Q4 2023
2.6.DATA REQUIREMENTS	
Total storage required for data stored on ÖEWF equipment (file servers)	Minor (several tens of MB)
Data acquisition rate (How much data per unit time is generated when the experiment is running?)	1 kb/s
Does this data need to be transferred during the mission? (‘no’ implying that it is returned to MSC with the field crew at the end of the mission)	<input checked="" type="radio"/> YES <input type="radio"/> NO <input type="radio"/> TBD
<div>If Y, does it need to be transferred as soon as available? (else it will be sent in the evening)</div>	<input type="radio"/> YES <input checked="" type="radio"/> NO <input type="radio"/> TBD

2.7.HARDWARE SPECIFICS						
– contents of cases/boxes specified in section 1.4 “Packing Information – Experiment Size and Weight”						
No. ¹	Tool/Consumable/Hardware part	Weight [kg]	Size [cm*cm*cm]	Quantity	Consumption Rate ² (per experiment or run)	Serial number (where available) (esp. for batteries and telecommunication devices)
1	Groundstation processing unit	2.5	15 x 15 x 20	5	N/A	See below
2	Receiver antenna	0.1	1 x 1 x 20	10	N/A	
3	tripods	1	150 x 30 x 30	10	N/A	
4	Transmitter electronics box	1	10 x 5 x 15	2	N/A	
5	Transmitter antenna	0.1	1 x 1 x 20	2	N/A	
6	Beacon electronics box	1	10 x 10 x 15	2	N/A	
7	Beacon antenna	0.1	1 x 1 x 20	2	N/A	
8	Beacon support structure	1	150 x 30 x 30	2	N/A	
9	Data processing computer	2	40 x 30 x 5	1	N/A	
10	Cabling	5	30 x 30 x 20	1	N/A	
11	Battery charging equipment	2	20 x 10 x 15	1	N/A	
12						
13						
14						
15						
16						
17						
¹ If you require more lines to specify all of your experiment's tools/consumables/hardware parts, please provide a separate document with a similar table as this one. In case you need to do so, please, do not forget to mention this in section 0.5 “Reference Documents”. ² In case your experiment consumes some amount of some substance (e.g. alcohol for sterilizing tools) per run (or in some interval of time), please give here an estimate of the average amount consumed. This will tell the Flightplanning team how often your experiment can be scheduled before the consumables run out.						

One receiver station has 1 Raspberry pi 4 and 1 Limesdr. The serial numbers of each component follow below

- Raspberry 4 #1: 1000000061d99546
- Raspberry 4 #2: 100000007973094c
- Raspberry 4 #3: 10000000C0EB36F5
- Raspberry 4 #4: 10000000C78A1F14
- Raspberry 4 #5: TBD

- NanoVNA #1: 20100346
- NanoVNA #2: 20100381
- NanoVNA #3: 20100530
- NanoVNA #4: H4_22070371

- LimeSDR #1: 90726074D0516
- LimeSDR #2: 9070602433199
- LimeSDR #3: TBD
- LimeSDR #4: TBD
- LimeSDR #5: TBD

Every receiver has 3 batteries, and every transmitter/beacon has 1. Their serial numbers are TBD

2.8.STORAGE REQUIREMENTS		
Hardware Storage		
Can the hardware be stored in an assembled state?	<input checked="" type="radio"/> YES	<input type="radio"/> NO <input checked="" type="radio"/> TBD
	If N, please remember to provide detailed packing instructions.	
Does any part of the hardware or any consumable require a specific temperature?	<input type="radio"/> YES	<input checked="" type="radio"/> NO <input type="radio"/> TBD
	If Y, which parts/consumables and which temperatures [°C]?	
Does any part of the hardware or any consumable need to be protected from rain/frost/etc.?	<input checked="" type="radio"/> YES	<input type="radio"/> NO <input type="radio"/> TBD
	If Y, which parts/consumables and from which environmental conditions?	Electronics boxes, antenna assemblies and spare batteries will need to be protected from rain/frost/moisture. This may be possible by design to a certain extent, but safest is to not expose them to these conditions at all.
Are there any other special hardware/consumable storage requirements?	<input checked="" type="radio"/> YES	<input type="radio"/> NO <input type="radio"/> TBD
	If Y, of which kind are they?	Storage temperature should be in range of battery specs (0 - 40 C)

Sample Storage		
Are there samples that have to be stored?		<input type="radio"/> YES <input checked="" type="radio"/> NO <input type="radio"/> TBD
	If Y, how many and of which kind?	
	Do the/some samples require a specific temperature?	<input type="radio"/> YES <input checked="" type="radio"/> NO <input type="radio"/> TBD
	If Y, which samples at which temperatures [°C]?	
	Are there any other special sample storage conditions required (Light, humidity, etc.)?	<input type="radio"/> YES <input checked="" type="radio"/> NO <input type="radio"/> TBD
	If Y, which?	
Sample Shipment		
Please note that in general the experiment's PI is responsible to cover transportation costs and organize transportation logistics. Details (e.g. the location the shipment has to be organized from) vary on a mission basis, and will be communicated in time. In case of questions, please contact your responsible FP coordinator.		
	If samples are taken, where should they be shipped after the mission (recipient/point of contact incl. phone number/e-mail if not given in section 0.2 “Principal Investigators” + postal address)	
	Do the samples have to be shipped under any specific conditions (temperature, etc.)?	<input type="radio"/> YES <input checked="" type="radio"/> NO <input type="radio"/> TBD
	If Y, which?	

2.9.EXPERIMENT SPECIFIC REQUIREMENTS
If necessary, please provide in this section any other requirements your experiment might have, that were not covered in the previous sections.
<div></div>

3. Risk Assessment

Please fill in the lines with the point of view of the Analogue Astronaut operating your experiment in mind. Hazards are sources for potential accidents, endangering the Analogue Astronaut and/or the suit or other adjacent equipment. Please provide sketches and/or photographs if necessary and mention them in section 0.5 “Reference Documents”.

A hazard is applicable, when the Analogue Astronaut is exposed it during a mission, but it might also be applicable if this is not the case: e.g. a sharp part, which is normally hidden from access during operations is not applicable. A pressure vessel for some pressurized gas present during the mission always forms an applicable hazard.

If an hazard is applicable to your experiment, please offer a brief description below the following table (incl. the number of the hazard the description is referring to), or, if there is not enough space there, provide it in an additional document (referred to in section 0.5 “Reference Documents”). Also explain a hazard mitigation procedure in the experiment's procedures document (referred to in section 0.5 “Reference Documents”).

No.	Hazard	Applicable to the experiment?	If Y, reference to procedure
		- check box if YES	(e.g. section, step no.)
1	Unprotected moving Parts	<input type="checkbox"/> YES	
2	Parts with sharp or abrasive surfaces	<input type="checkbox"/> YES	
3	Trip hazard, falling, twisting	<input checked="" type="checkbox"/> YES	AA’s should not go near groundstation coax wires
4	Electrical discharge / arc discharge / high voltage	<input type="checkbox"/> YES	
5	Electrostatic discharge	<input type="checkbox"/> YES	
6	Dangerous substances	<input type="checkbox"/> YES	
7	Incorporation of health hazardous substances	<input type="checkbox"/> YES	
8	Exposure to bio-hazardous substances	<input type="checkbox"/> YES	
9	Combustible substances	<input type="checkbox"/> YES	
10	Pyrotechnical Devices	<input type="checkbox"/> YES	
11	Hot/Cold Surfaces	<input type="checkbox"/> YES	
12	Excessive Noise	<input type="checkbox"/> YES	
13	Ultrasound / Infrasound	<input type="checkbox"/> YES	
14	Excessive Vibration	<input type="checkbox"/> YES	
15	Non-Ionizing radiation (Laser, UV, IR sources)	<input type="checkbox"/> YES	

No.	Hazard	Applicable to the experiment? - check box if YES	If Y, reference to procedure (e.g. section, step no.)
16	Ionizing Radiation	<input type="checkbox"/> YES	
17	Electromagnetic Interference (EMI)	<input checked="" type="checkbox"/> YES	Documentation to be written
18	Pressure Vessels	<input type="checkbox"/> YES	
19	Low/High external pressure	<input type="checkbox"/> YES	
20	Inadequate Lighting / Glare	<input type="checkbox"/> YES	
21	Oxygen deprivation / Excessive Oxygen Release	<input type="checkbox"/> YES	
22	Increased work load – Human-Machine interface	<input type="checkbox"/> YES	
23	Increased work load – Excessive Information	<input type="checkbox"/> YES	
24	Heavy physical work / exhaustion	<input type="checkbox"/> YES	
25	Interface malfunction to other mission items	<input type="checkbox"/> YES	
Description of applicable hazards			