

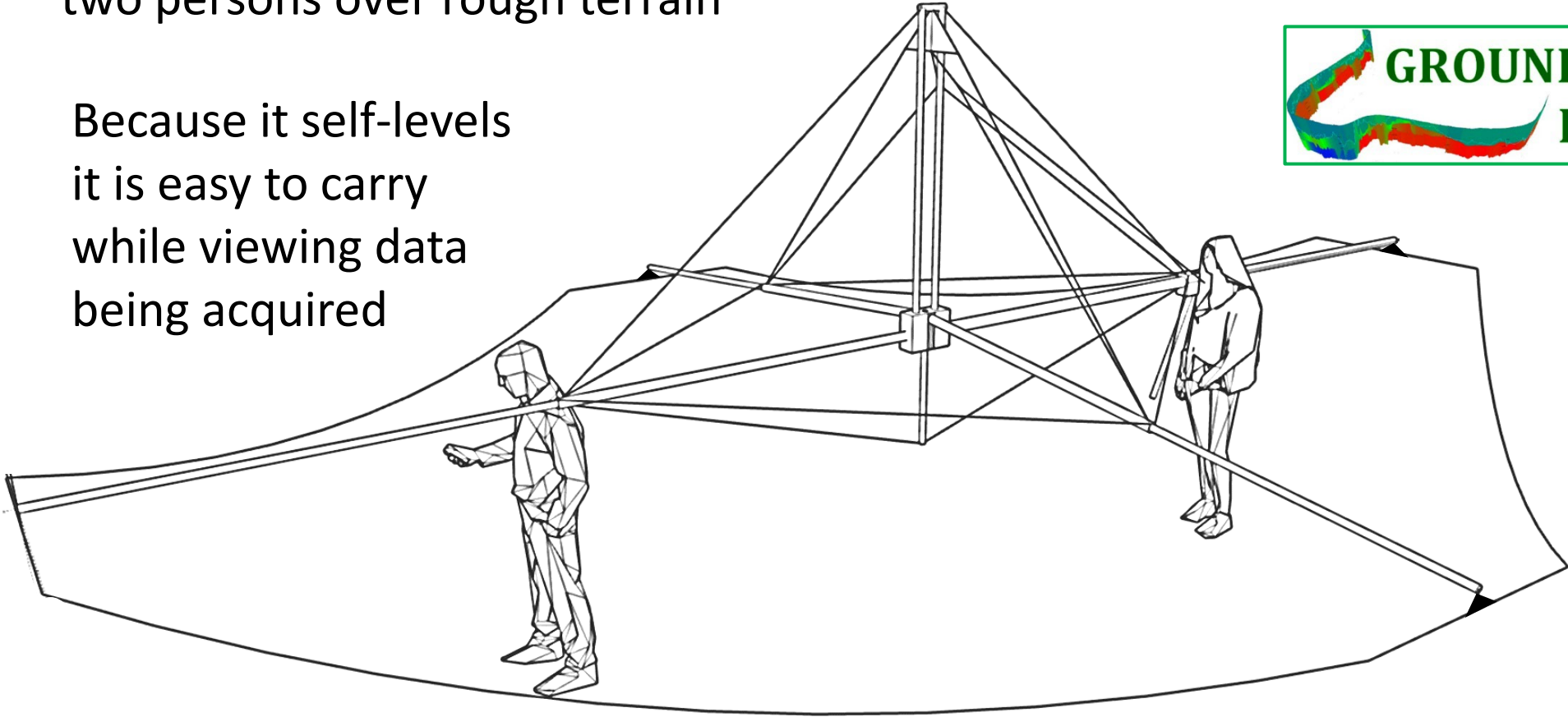


AgTEM-Wallaroo Concept

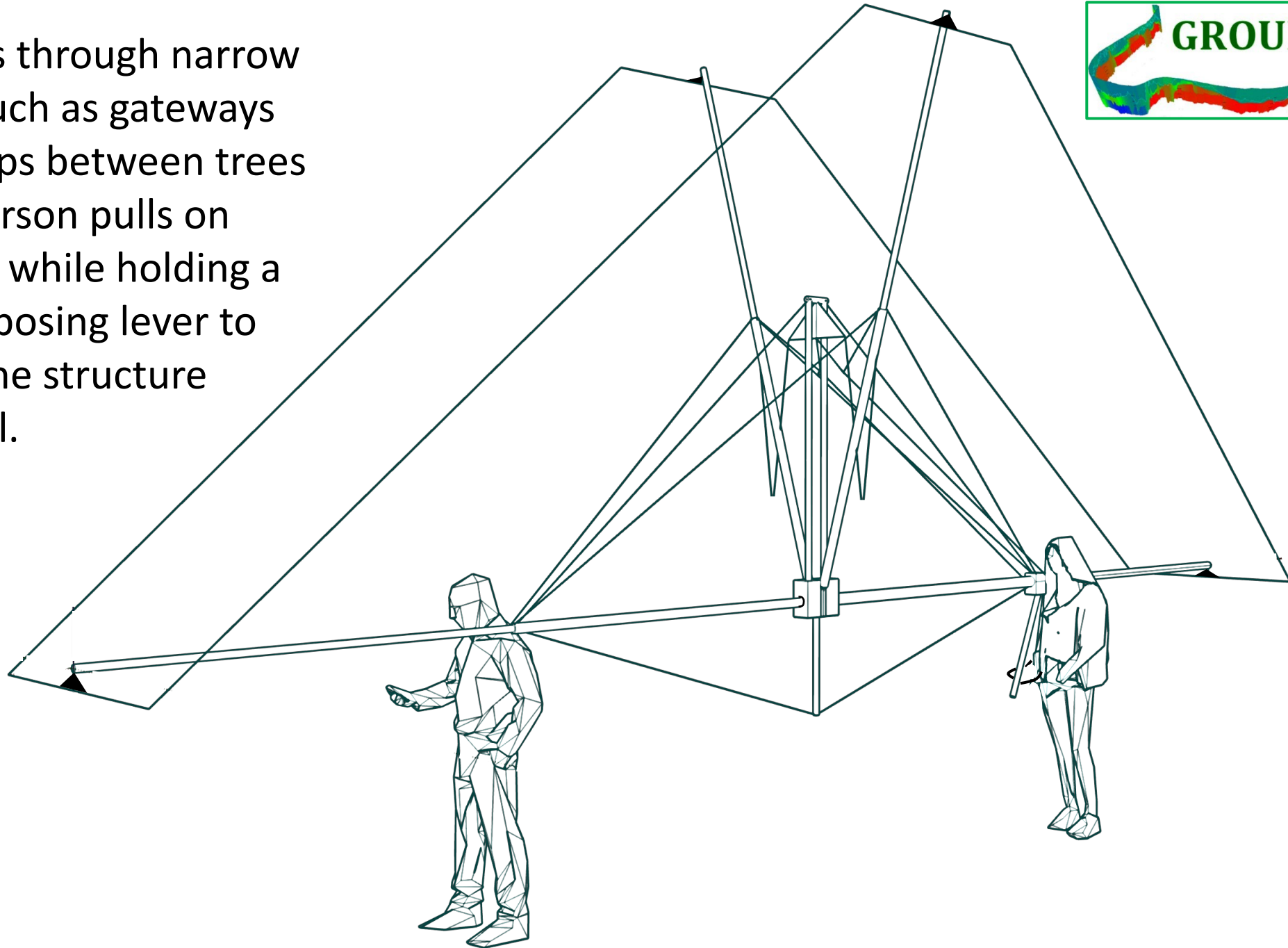
Aka AgTEM-Trek/Joey
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Patent Pending January 2022

A walked Wallaroo loop is 29m² in area per turn yet can be carried by two persons over rough terrain

Because it self-levels
it is easy to carry
while viewing data
being acquired



To pass through narrow gaps such as gateways and gaps between trees one person pulls on rigging while holding a roll opposing lever to keep the structure vertical.



AgTEM-Wallaroo is power efficient



With low loop resistance, most efficient transmission is possible.

For example:

2 turns at 45 Amps provides a moment of **2610 Amp.m²**

Driven by a DCDC converter outputting at 5V, this requires less than two 12.8V 7A.hr batteries per hour of continuous transmission.

These can be carried as air luggage.



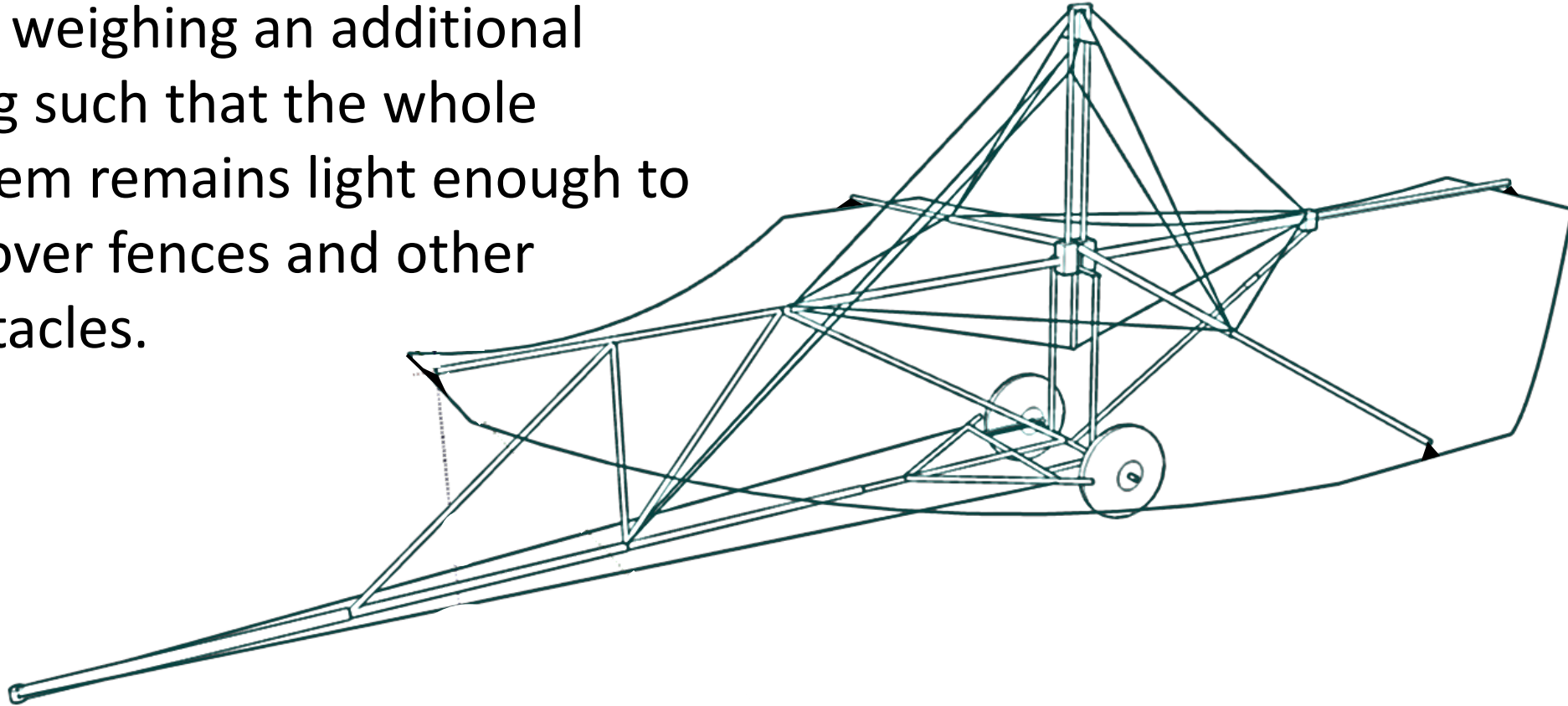
AgTEM-Wallaroo – walked – at concept stage



Raising lateral booms to pass through a narrow gap.



For survey of navigable terrain Wallaroo can be placed on a cart weighing an additional 15kg such that the whole system remains light enough to lift over fences and other obstacles.



The inaugural Wallaroo test



 **GROUNDWATER
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Booms raised for passing narrow gaps



 **GROUNDWATER
IMAGING**

Suggested equipment for AgTEM-Wallaroo towed survey

Wallaroo – quickly folded for transport



SwinCar (dual seat version) for towing over undulating ground. Will not tip nor light dry grass like a quadbike



Delivery van which permits secure overnight storage while charging at motel carpark.



<https://www.youtube.com/watch?v=jDNGGa3u-B8>





Suggested equipment for AgTEM-Joey walked survey

Wallaroo – quickly folded for transport



Shipping boxes



Two healthy persons

2023 electronics



Electronics is being modified presently and already is far more compact than shown



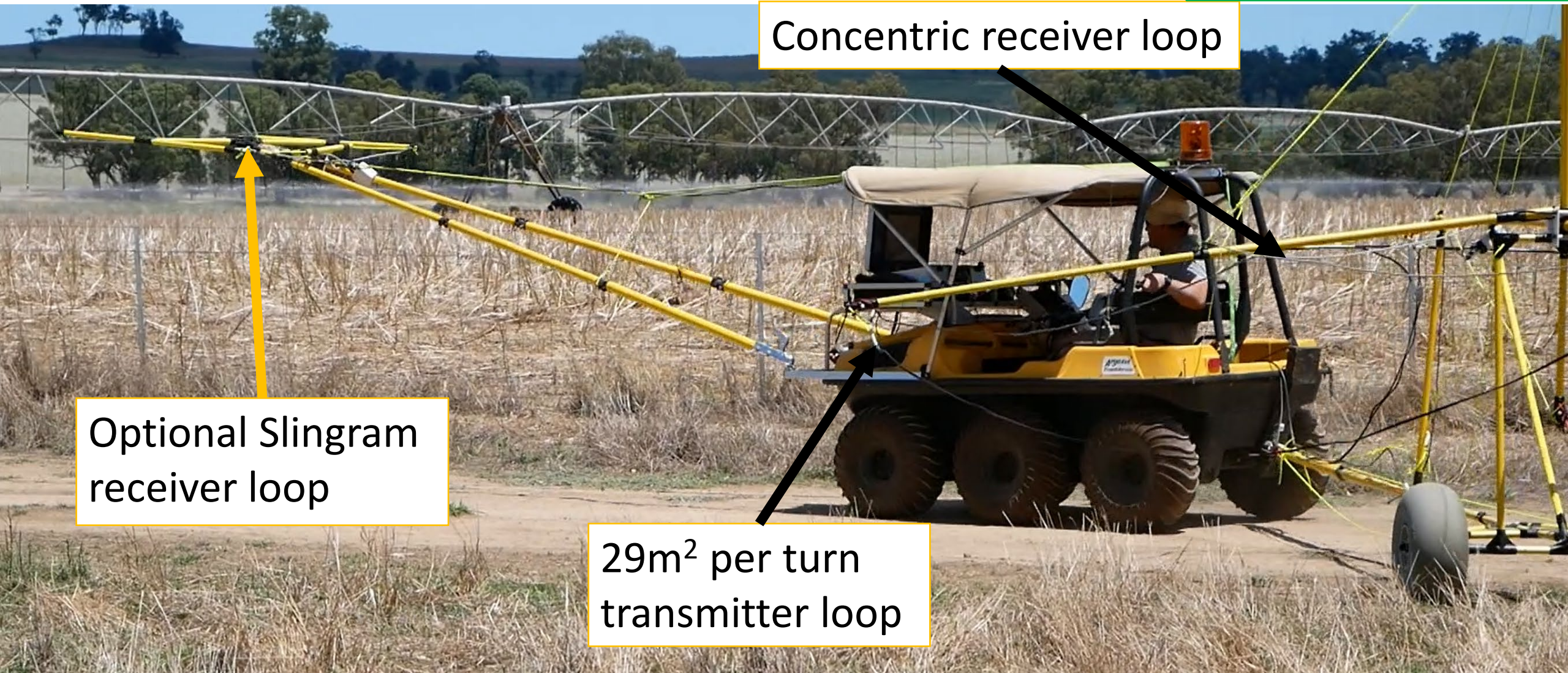
Receiver loop options suite both shallow and deep exploration

Optional Slingram receiver loop

Concentric receiver loop

29m² per turn transmitter loop





Optional Slingram receiver loop

Concentric receiver loop

29m² per turn transmitter loop

Note that the Argo is a poor choice of vehicle for the Slingram loop as it bobs forward and back around its centre axle. If the front booms are shortened then the bobbing problem is reduced – they can be practically shortened about 1.5m.

Slingram loop for walked surveys

Concept only at
this stage.

Even on the most
difficult terrain it is
possible to image
deeply with walked
AgTEM-Wallaroo as a
Slingram loop can be
walked a distance
away well away from
the high intensity
area of primary field.

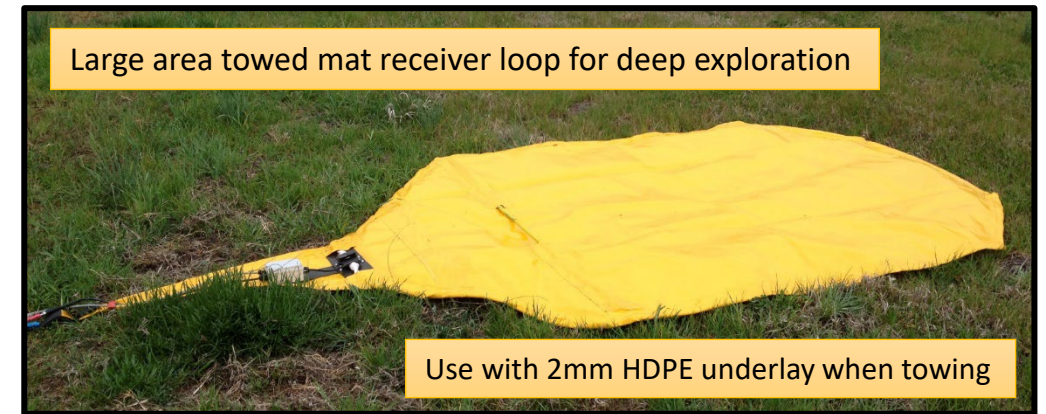


This loop can be
supported hands
free by a pouch and
straps while walking

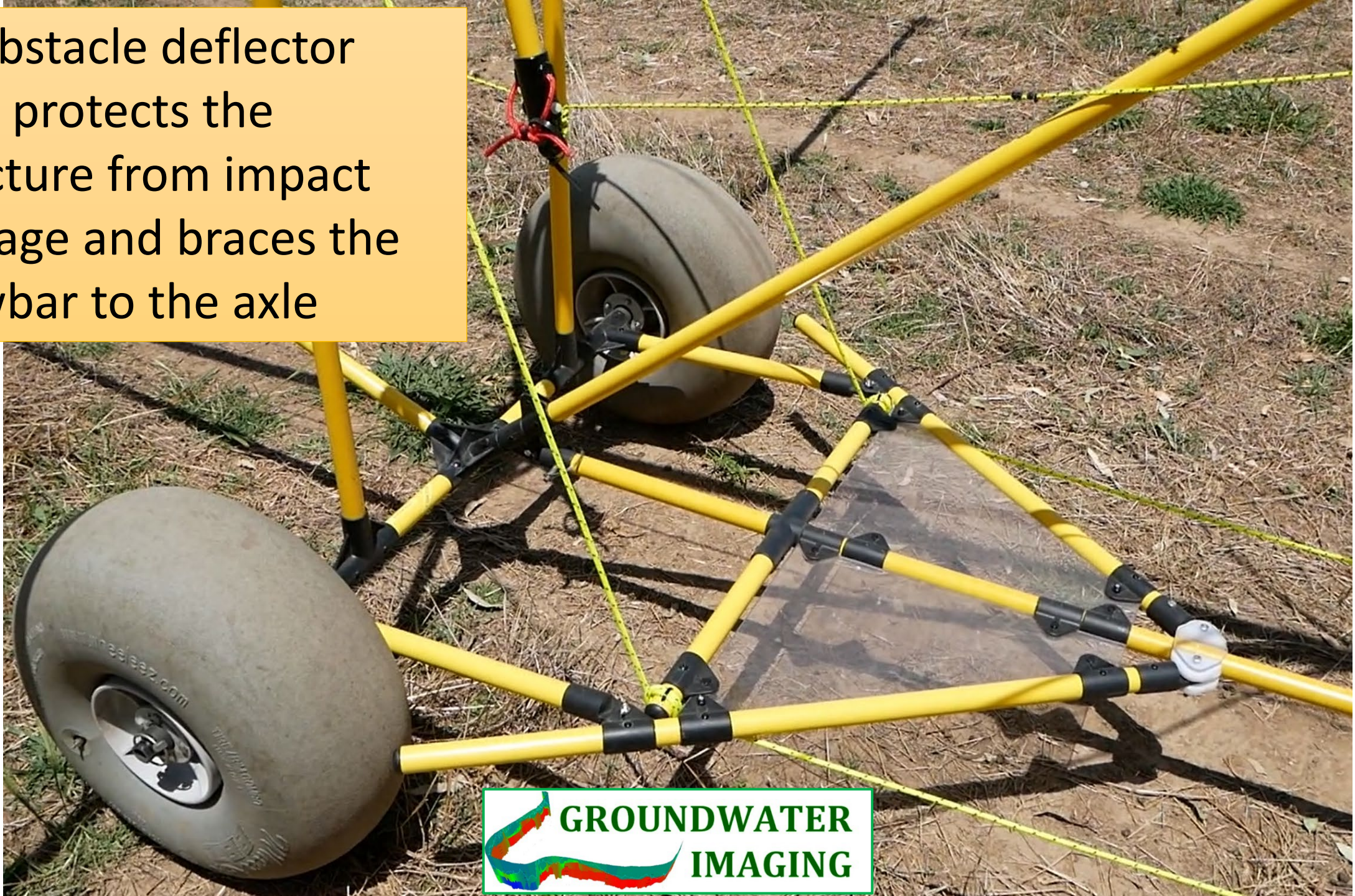
Slingram
sled loops
for walked
surveys
Concept only at
this stage.



Towed loops on sleds or mats are a nuisance as their umbilical cords catch on and wrap around obstacles such as gate posts but they do allow AgTEM-Joey to be walked, acquiring Slingram data, with just two persons and they can pack away compactly.



An obstacle deflector both protects the structure from impact damage and braces the drawbar to the axle



For passing through orchards, loop width can be changed by telescoping lateral boom lengths.

When hand carried the structure can be slung from shoulders, beneath the tree canopy level.



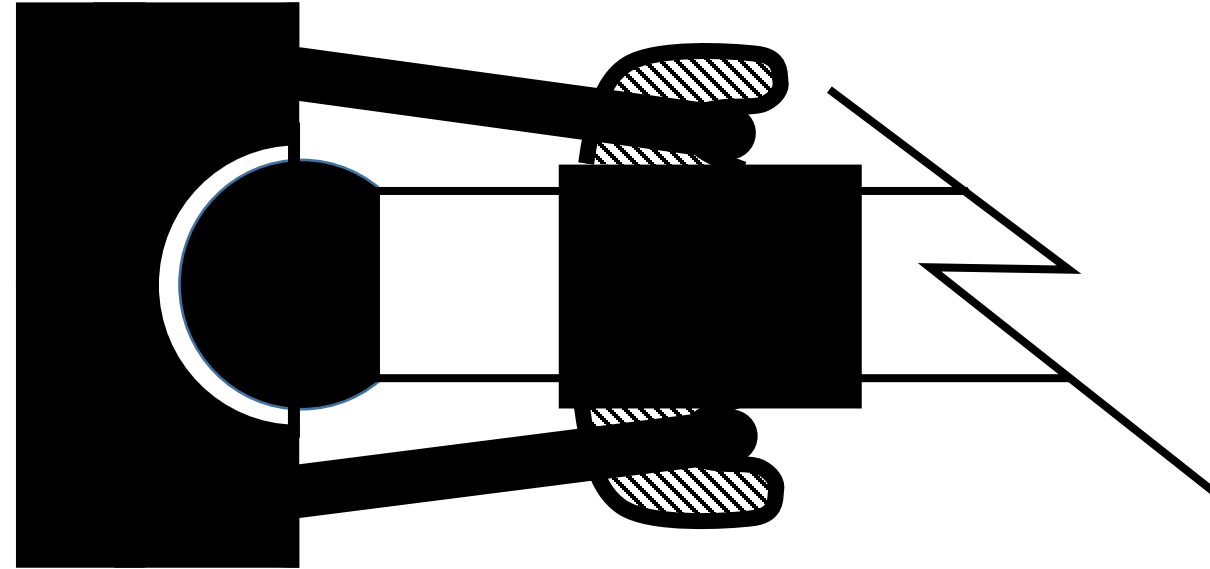
Adjustment of loop tension
– shown loose here, will
improve data quality



Lateral booms pivoting



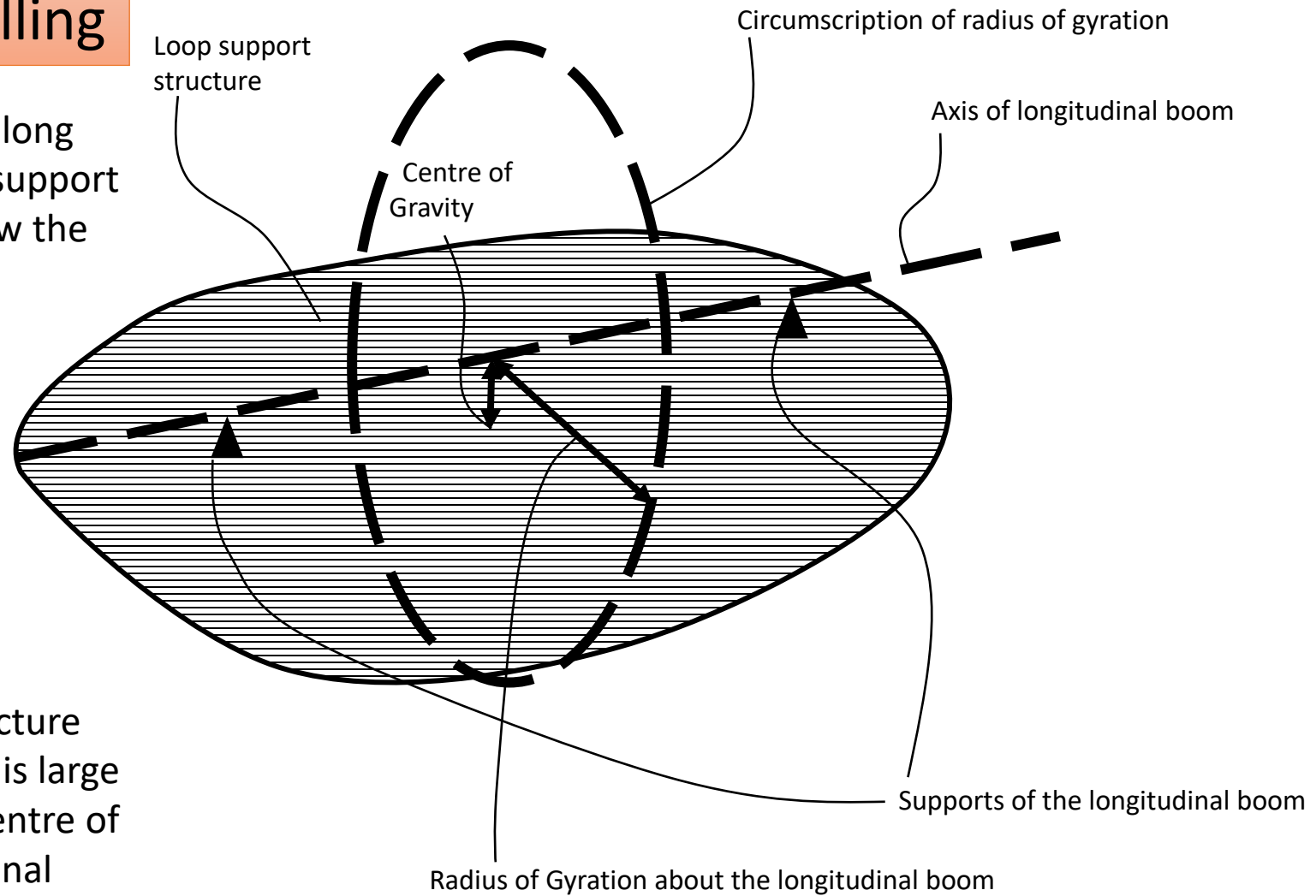
Pivoting booms are held in by elastic tendons. If strained too far they simply pop out.
The transmitter loops is tethered via weak links (cable ties)



AgTEM-Wallaroo levelling

When AgTEM-Joey is supported along the longitudinal boom. The loop support structure centre of gravity is below the axis of the boom so it self levels.

Approximate direction of travel

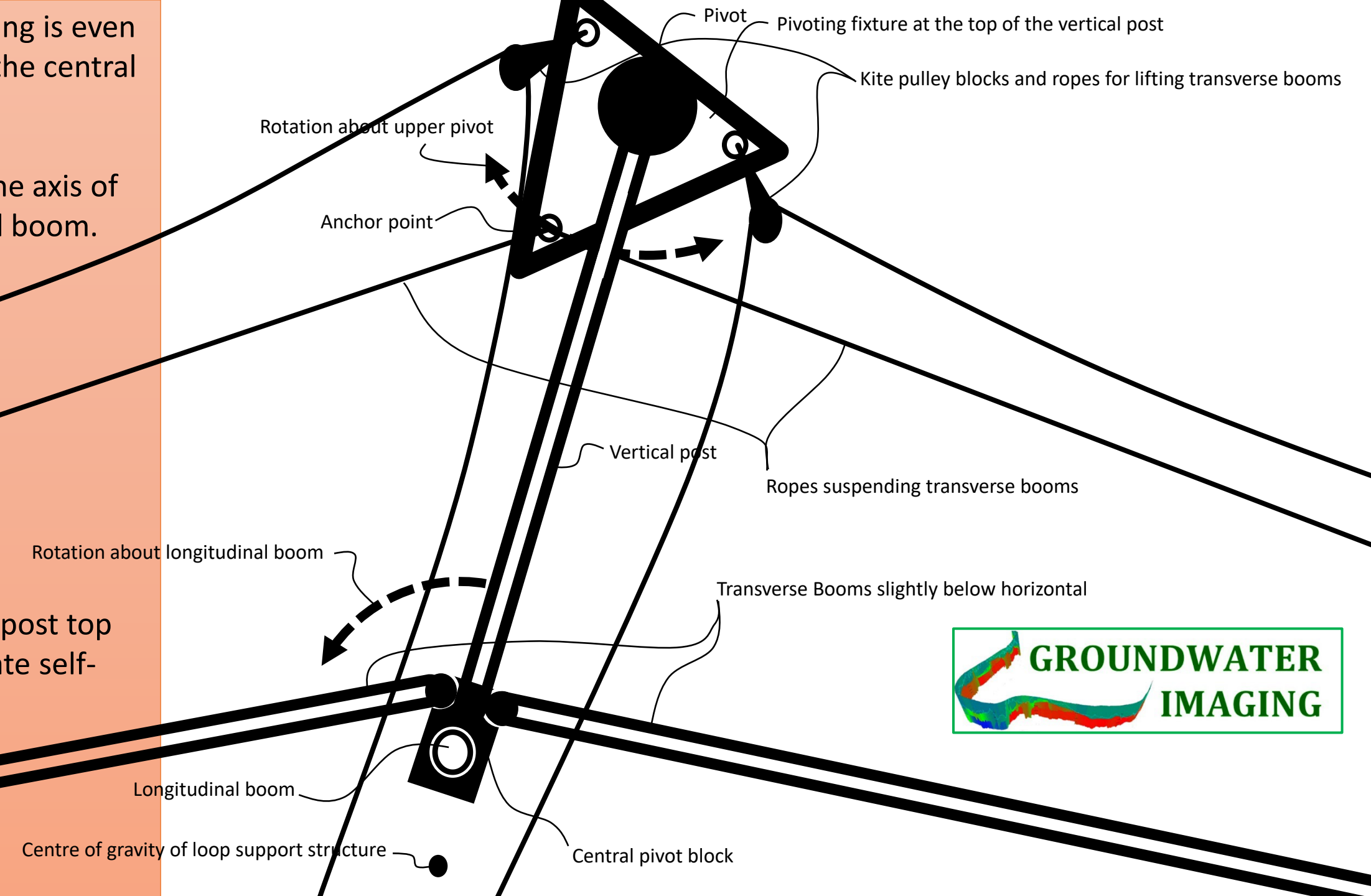


The radius of gyration of this structure about the longitudinal boom axis is large compared to distance from the centre of gravity to the axis of the longitudinal boom. This damps loop tilting motion as the support vehicle is jolted around by movement over undulating ground.

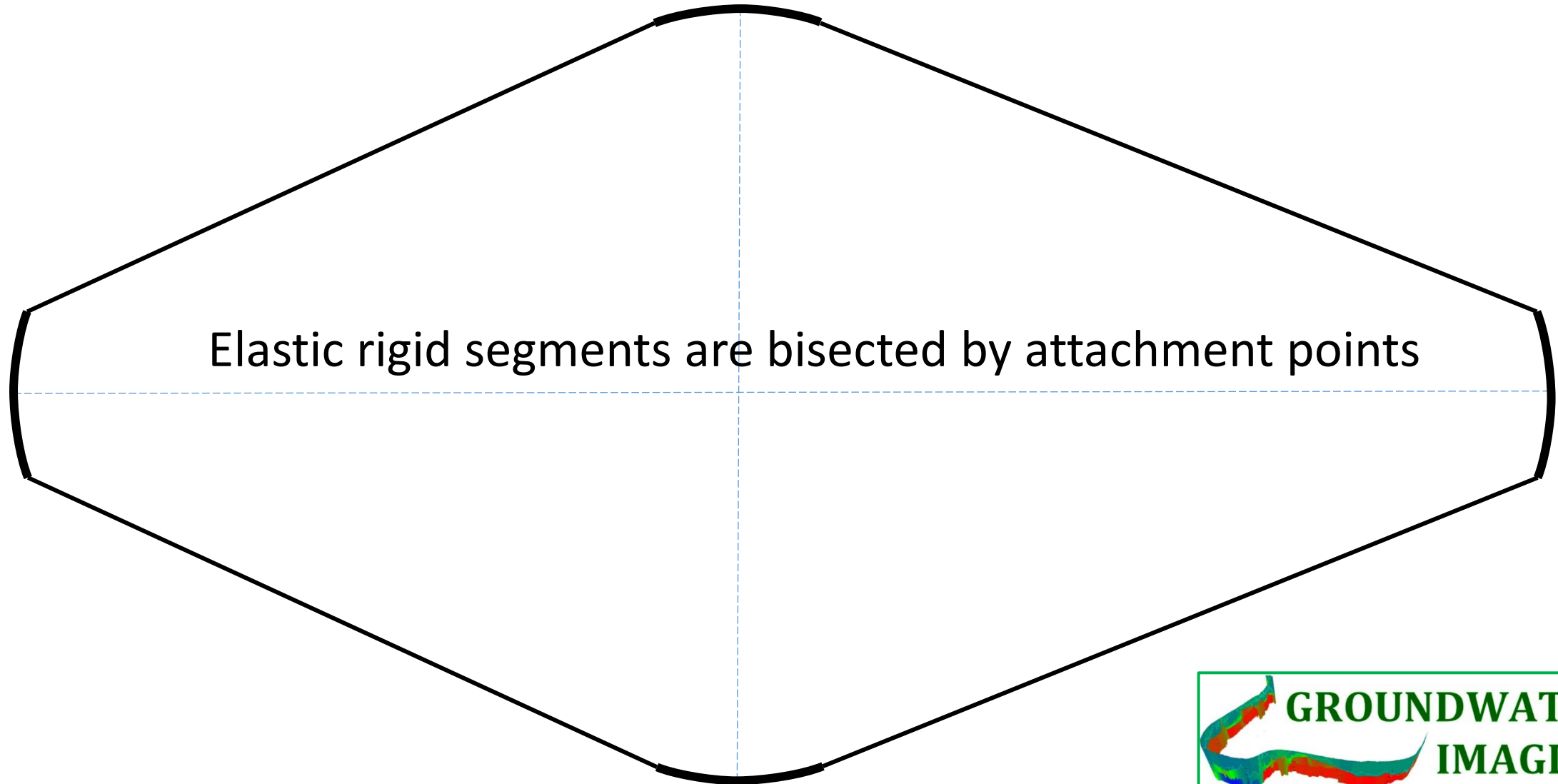
Loop-self-levelling is even possible when the central post is tilted.

Viewed along the axis of the longitudinal boom.

A fixture at the post top pivots to facilitate self-levelling.

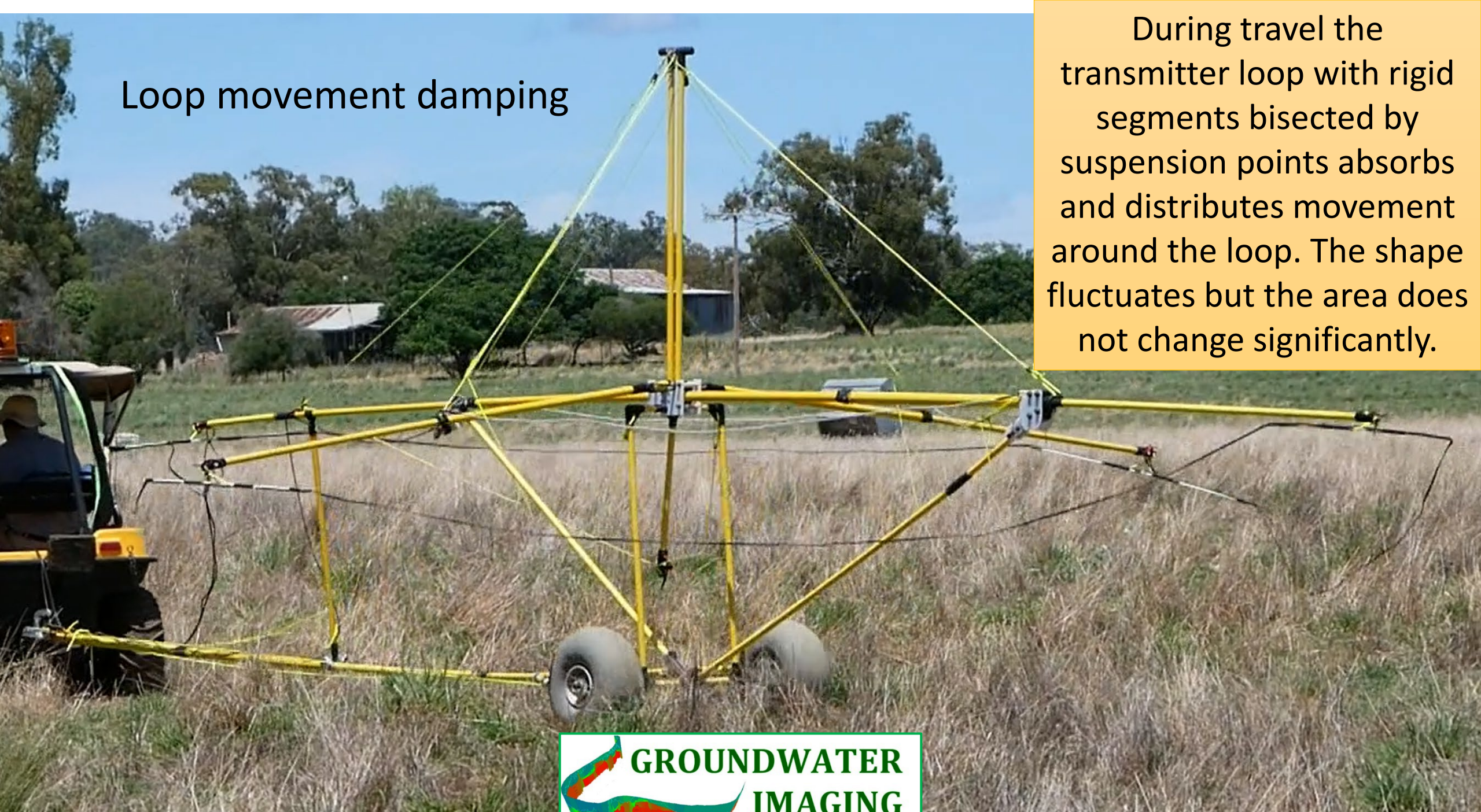


AgTEM-Wallaroo loop is of approximately polygonal shape



Loop movement damping

During travel the transmitter loop with rigid segments bisected by suspension points absorbs and distributes movement around the loop. The shape fluctuates but the area does not change significantly.



Front loop support booms are the same as for AgTEM-Wallaby, yet on low metal content vehicles, smaller lighter booms could be used.



An entire all-options-included packed AgTEM-Wallaroo system consisting of the loop support structure, transmitter loop, concentric receiver loop, a front loop with booms, electronics, batteries, chargers, a towed sled receiver loop and spare parts



AgTEM-Wallaroo explores 10's of metres deep quickly and easily, with only minor setup.

- Electromagnetic (EM) survey works more efficiently with large transmitter loops so a lightweight loop carrying device like AgTEM-Wallaroo is needed.
- A self-levelling device does not create violent jolting forces when crossing rough terrain. AgTEM-Wallaroo is self levelling.
- AgTEM-Wallaroo, is a smaller version of AgTEM-Wallaby relying on 24bit acquisition to acquire within the strong primary field of the transmitter coil rather than relying on mutual inductance nulling present in AgTEM-Wallaby which incidentally uses the same 24 bit electronics.
- Wallaroo can be carried by 2 walking persons – 15kg + electronics
- Wallaroo can be towed behind a SwinCar – 30kg + electronics + car
- Wallaroo can be folded during travel to pass through gaps less than 1m wide
- Even though Wallaroo is 6m wide it weighs less than EM systems of smaller size that cannot see anywhere near as deep. It has a peak moment 10x that of tTEM and 25x that of Loupe.
- Wallaroo also packs up very compactly.



AgTEM-Wallaroo

High efficiency transmission keeps battery consumption down for deep exploration

Ground moisture Exploration to 10's of metres deep.

- Survey anywhere.
- Lightweight structure.
- AgTEM electronics.
- For orchard surveys, sling under canopy.
- Transmit up to 50 Amps.
- Fold to pass through narrow gaps.
- Focused &/or deep exploration.

Remains level because of low centre of gravity

February 2022

29m² x 1 or 2 turn transmitter loop



Small concentric receiver loop close to ground for very focused & shallow exploration

Compact freight

Generous case sizes permit versatile battery options

AgTEM-Wallaroo folds into a vertical plane on-the-go

Stabilizing handle

Development is ongoing & configuration will change. Many receiver options not shown are feasible.

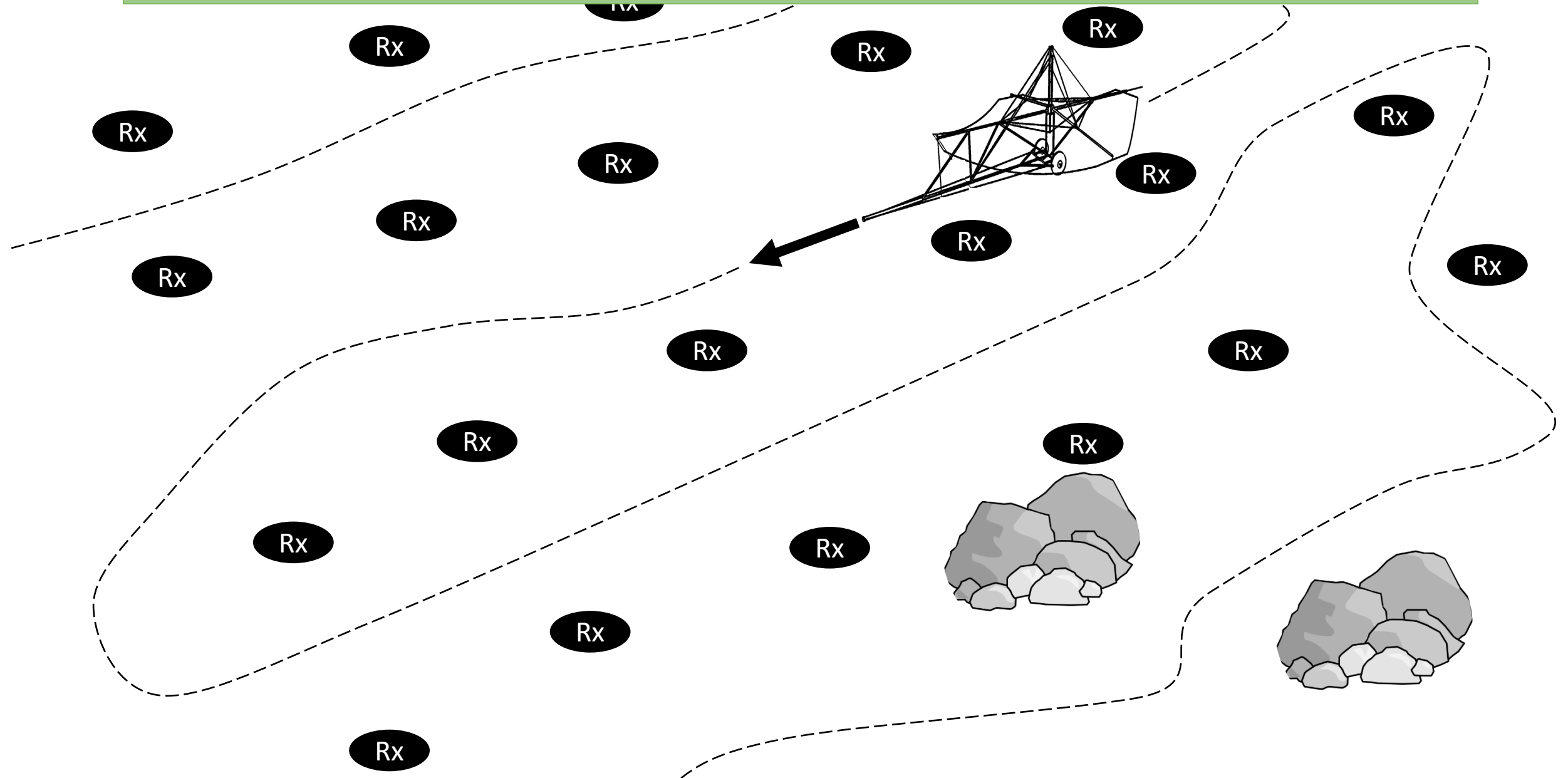
Patent pending.

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AgTEM-Wallaroo may also be towed with a receiver loop ahead of the towing vehicle

AgTEM roving transmitter and static receivers concept



AgTEM roving transmitter and static receivers concept

- Allows for full TENSOR 3D modelling of the substrate
- Deep imaging is possible once 3D modelling deciphers and removes the influence of shallow features.
- Has advantage in that synchronously stacked data from receivers with near no movement noise can be expertly processed to remove noise collectively
- Requires GPS sync from receivers to transmitter
- Multiple receiver coils can be connected in sets of three to 3 component receivers.
- Footprint of influence of the transmitter is limited so it is practical to leap-frog a limited set of receiver coils.
- Difficult terrain can be walked, the rest surveyed by towing behind a SwinCar.
- All equipment can be arbitrarily positioned when positions are logged by GNSS.

Competing systems comparison

- **AgTEM-Wallaby and AgTEM-Wallaroo** offer **peak moments**, in routine mode of use, that are **10 to 25 times greater** than peak moments of competing systems
- AgTEM-Wallaby and AgTEM-Wallaroo are the only systems that operate on wheeled platforms
- AgTEM-wallaby productivity is typically 40km/day as for tTEM and AgTEM-Wallaroo-towed in open terrain, while Loupe and AgTEM-Wallaroo-walked can expect 10km/day because they are walked systems.
- tTEM has great early time performance but wastes it by using a Slingram loop that geometrically cannot sample shallow ground exclusively.
- AgTEM-Wallaby and AgTEM-Wallaroo are the only products offering a sub 10m footprint (and sub 2m footprint for conductive shallow 3D items such as UXOs and saline moisture plumes).
- Each system uses different methods of stabilizing motion and orientation over rough ground:
 - AgTEM-wallaby uses a long drawbar, wide wheel separation, and long travel suspension combined with system flexure to stabilize,
 - AgTEM-Wallaroo uses a large ratio of gyration radius to distance of centre of gravity beneath support points as well as gentle motion of walking support persons or impact absorption of extremely low pressure balloon wheels,
 - Loupe uses the gentle, actively levelling motion of walking support persons,
 - tTEM uses sleds which average perturbations of motion caused by undulating ground.
- Each system, and its operators, have different endurance:
 - AgTEM-wallaby is designed to continue operation day after day with minimal maintenance and operator fatigue (in air conditioned towing vehicles).
 - tTEM is a sled that will need to avoid gravel and sealed roads that is operated behind a quadbike (fatigue, safety).
 - AgTEM-Wallaroo is designed for towing only by very low power, light vehicles and the SwinCar is the recommended towing vehicle which provides a smooth ride even on rough ground.
 - Loupe and AgTEM-Wallaroo-walked use extra operators and create fatigue due to walking while carrying weight, however, considering weight of batteries consumed to achieve the same signal coupling with the substrate, weight of AgTEM-Wallaroo, carried for all day operation, can be much lower than that of Loupe. Walking of the Loupe will require 2 persons while AgTEM-Wallaroo with a Slingram receiver loop added is best conducted with three persons rotating roles.
- Each system handles movement noise and system response differently. AgTEM keeps loops floppy to transfer noise to low frequencies exceeding the system timebase such that they can be removed. AgTEM-cart relies on mutual inductance nulling, the other instruments and AgTEM-wallaby Slingram mode rely on Tx – Rx loop separation. Loupe firmly fixes metal electronics and cooling components, that create system response, close to the transmitter loop.
- AgTEM and, to an extent, tTEM, use large air core receiver loops stabilized to make them less susceptible to movement noise while Loupe relies on considerable pre-amplification of very small coils and the relatively gentle motion of the walking operator to stabilize noise.

	AgTEM-Wallaby	AgTEM-Wallaroo	tTEM	Loupe
Tx effective area (m ²)	32/64/96/128/160 +1.6x2 (opposing loops)	Approx 29/58	8	4.538
Tx loop turns	1/2/3/4/5 (Turns may be doubled up for efficient high current transmission)	1 / 2 standard – can carry more	1	13
Current (A)	1 to 45 Amps (limited to 50)	1 to 45 Amps Decisions on exact limit are ongoing ~90% of above is likely.	2.8/30	20
Peak moment (A.m²)	1600/3200/4800/6400 /8000 (practically limit to 90% of these values)	1300/2600/more (practically limit to 90% of these values)	22.4/240	90.76
Repetition rate (Hz)	25/100/200 30/120/240 200 and 240Hz rates require further refinement.	25/100/200 30/120/240 200 and 240Hz rates require further refinement.	2110/660	25-150
Turn-off time (uS)	~2.5-~6 (1 turn) ~28 (2 turn) Improved measurement anticipated	~2.5-~6 (1 turn) ~28 (2 turn) Improved measurement anticipated	~2.5/~4	~8
Rx components	1 (z)	1 (z) standard 3(optional)	1 (z)	3 (x,y,z)
Rx bandwidth (kHz)	60 standard	60 standard	600	100

Figure adopted from:

van Dam, R. L., Maude, G., Jenke, G., Duncan, A., Fullagar, P. K., 2022, Efficient conductivity mapping using the operator-carried time-domain electromagnetic Loupe TEM system. *FastTimes Feb 2022, VOL 25,4 Mine Site Geophysics*
<https://fasttimesonline.co/efficient-conductivity-mapping-using-the-operator-carried-time-domain-electromagnetic-loupe-tem-system/>

Please understand that AgTEM-Joey and AgTEM-electronics are in the prototype stage where parameters are frequently being adjusted.

Selection of the right AgTEM for the job

Wallaby

- Mobilization by road of whole system on float trailer. (By air only with disassembly).
- Tow using 4WD pickup or ATV/UTV/SxS.
- One operator. Comfortable for 10 hour days (25 to 100 km per day).
- Setup 1hr, Pack up 1hr only with specialized float trailer.

Wallaroo

- Mobilization in compact form on a 4WD pickup, van, or freight and hire vehicle.
- Hand carry or tow using 90kg electric motorcycle, 100kg electric walk-beside tractor, Swincar, 10kg tow ball dolly or a quadbike.
- One operator for small jobs or two for larger ones or hand carrying. (10km to 80km per day).
- Setup 1hr, Pack up 1 hr from boom-retracted flatpack form. Triple that for most compact shipping form.

AgTEM Comparison

Wallaby

- AgTEM electronics, <45Amps
- 32 m² per loop turn
- Tow with large vehicles
- High initial cost
- Transport almost in survey form on special float trailer.

Wallaroo

- AgTEM electronics <45Amps
- 29 m² per loop turn
- Hand carry or tow with low metal content light vehicles.
- Low initial cost
- Fold up and retract booms to Pack flat to transport .