Integrated Seismic Systems…"All-In-One"

More of the same quality or better data for less effort and cost

Well, almost…

Totally…

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Why build integrated systems?

- Present systems requiring dry vaults don't meet the use case for PIC's portable deployment mission
- Present BB systems are based on 25-10 year old technology
  - Easy to damage, hard to repair and some components are EOL
- Apply the lessons learned through the years to improve and lower cost of operating the systems
- Take advantage of many technical advances and new software development

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Why have the energy exploration companies embraced the concept?

- Lower Cost
- Higher Reliability
- More Flexibility
- Easier permitting
- Less FTEs required
- Less environmental impact
- Less HSE issues
- Less “stuff” to deal with…Really!

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Most of the major and some smaller vendors have an integrated system on offer...

- Geospace
- Sercel
- Fairfield
- GTI

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Goals of a Vaultless BB Integrated Seismic System

- Increase ruggedness and reliability
- Reduce time needed to deploy
- Simplify and standardize deployments
  - Reduce install variability
  - Reduce user errors(limit the range of options)
  - Reduce metadata issues
- Lower system cost
- Lower number of failure scenarios
- reduce experiment logistics
  - Less volume
  - Less weight
  - Less FTEs needed
  - Less garbage generated
  - Smaller impact on environment

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Typical Alaska Hole

Problem

Solution

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Current Portable BB station

- Large Weight and Volume
  - 50 Kg and 319 L per station
- Time Consuming Installation
  - Large station footprint
  - 2 hour installation time
  - Telemetry issues
  - 9 cables per station
  - High power consumption (2W + 4W telemetry)
  - Not rugged or waterproof

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Development going well...

Plans for test deployment at Taku Glacier, Alaska late summer of 12 systems, should be final hardware configuration for both Compact and PHQ based systems.

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GeoIce Power System Options – Seasonal Deployments

Meridian Compact broadband seismometer with integrated data logger with an average power draw less than 1.2W.

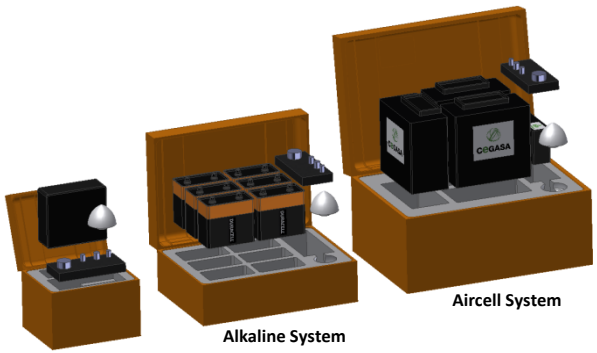
Meridian Compact deployed at the SPRESSO site ~10km away from the South Pole

Short term power systems – designed for 0°C operation

- Operates for **two weeks** with no solar panel required
- Many battery options to suit a wide variety of budget and logistical constraints

Short Term Systems

Battery Type	Total weight (lbs)	Total Volume (ft3)	Cost (USD)	Number in a Twin Otter
Alkaline (Duracell MN918 6V, 27Ah, x6)	41	1.7	$460	34
Aircells (CEGASA 4AS10, 6V, 600Ah, x3)	86	3.0	$1,010	16
Lithium Primary (Tadiran custom pack)	25	1.4	$655	56
AGM (SunExtender, 12V, 42Ah, x1)	68	4.2	$360	21
LiFePO4 (SmartBattery, 12V, 35Ah, x1)	30	1.5	$660	47



Lithium Primary System

Alkaline System

Aircell System

*Number in Twin Otter assumes 1750 lbs payload and 284ft³ volume
**Weights, volumes and costs are estimates only and may change during design implementation. Cost is for batteries, enclosure and solar panel only. Sensor and auxiliary sensor equipment is not included.

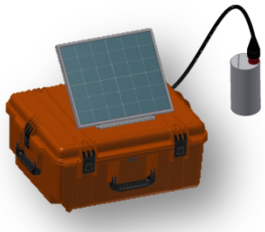
Summer solar systems - designed for 0°C operation

- Operates **all summer** with a small rechargeable battery and a small solar panel
- Lithium-Ion battery or AGM battery options

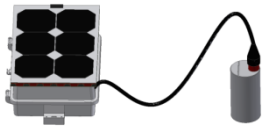
Summer Solar Systems

Battery Type	Total weight (lbs)	Total Volume (ft3)	Cost (USD)	Number in a Twin Otter
AGM (SunExtender, 12V, 34Ah, x1)	66	4.2	$526	21
LiFePO4 (SmartBattery, 12V, 20Ah, x1)	30	1.5	$660	47

Summer Solar System with $LiFePO_4$ Battery, 20W Solar Panel and pole



MEVO System - AGM Battery and 10W solar panel installed directly on the ground



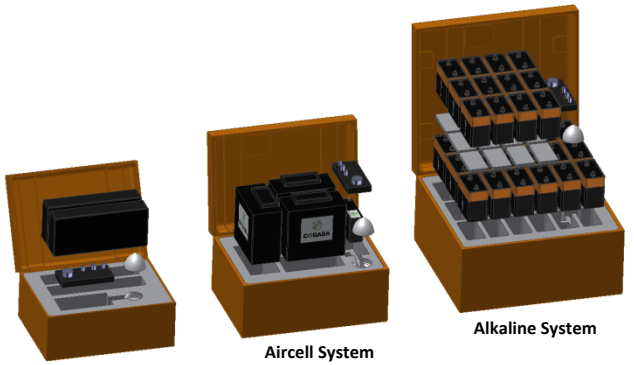
Summer solar system with $LiFePO_4$ battery and 20W solar panel installed directly on the ground

Three month autonomous system - designed for 0°C operation

- Operates for **three months** with no solar panel required
- Many battery options

Three Month Autonomous System

Battery Type	Total weight (lbs)	Total Volume (ft3)	Cost (USD)	Number in a Twin Otter
Alkaline (Duracell MN918 6V, 27Ah, x30)	127	5.4	$1,220	11
Aircells (CEGASA 4AS10, 6V, 600Ah, x3)	86	3.0	$1,010	16
Lithium Primary (Tadiran custom pack)	47	2.7	$1,965	30
AGM (SunExtender, 12V, 108Ah, x3)	261	7.5	$1,340	5
LiFePO4 (SmartBattery, 12V, 200Ah, x1)	102	4.0	$3,045	14



Lithium Primary System

Aircell System

Alkaline System

GeoIce Power System Options – Overwinter Deployments

Hybrid winter over systems – Designed for -20°C operation

- Runs all year
- Small rechargeable battery for summer operation
- Non rechargeable primary batteries for 6 months of winter operation when no solar power is available

Hybrid Winterover System				
Battery Type	Total weight (lbs)	Total Volume (ft3)	Cost (USD)	Number in a Twin Otter
Alkaline (Duracell MN918 6V, 27Ah, x99)	367	10.6	$3,920	4
Aircells (CEGASA 4AS10, 6V, 600Ah, x6)	161	5.9	$2,205	9
Lithium Primary (Tadiran custom pack)	69	2.3	$4,370	20

Lithium Primary System

Aircell System

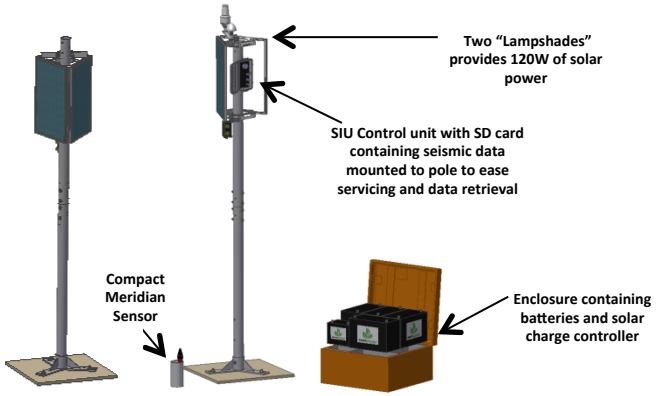
LiFePO4 Rechargeable System

*Number in Twin Otter assumes 1750 lbs payload and 284ft³ volume
**Weights, volumes and costs are estimates only and may change during design implementation. Cost is for batteries, enclosure and solar panel only. Sensor and auxiliary sensor equipment is not included.

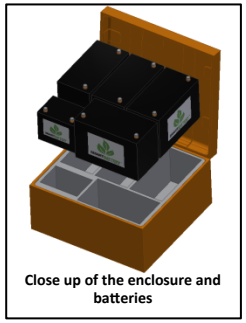
Winter over rechargeable system- Designed for -20°C operation

- Large bank of rechargeable batteries allows for deployments lasting many years

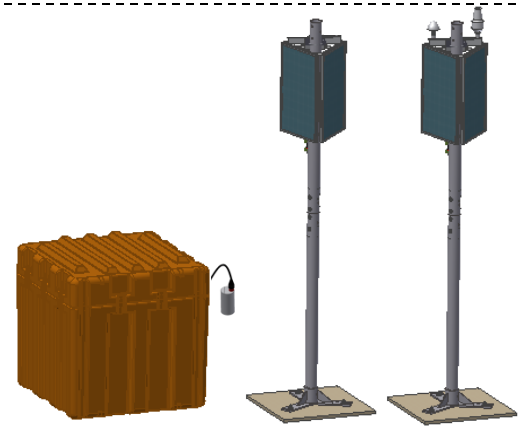
Rechargeable Winterover System				
Battery Type	Total weight (lbs)	Total Volume (ft3)	Cost (USD)	Number in a Twin Otter
AGM (SunExtender 12V, 108Ah, x6.2)	646	63.1	$ 9,425	2
LiFePO4 (SmartBattery, 12V, 100Ah, x4.3)	388	42.3	$14,220	4



Rechargeable Winterover System with LiFePO4 Batteries



Close up of the enclosure and batteries



Rechargeable Winterover System with AGM Batteries

Current Development at PIC, GEOICE!

Partnership between Central Washington University and IRIS to develop new instrumentation specifically for polar regions. Will include a mixed phase array consisting of broadband and intermediate band seismometers complete with power systems and enclosures. The goal is 125 BB integrated systems based on Trillium T120 PHQs and Compacts.

Integrated digitizer and Trillium Compact
Deployed at SPRESSO

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Contact the PIC for more info and discussions, we are still defining the types of SOH and other operations in collaboration with the Nanometrics engineers.

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