



UC Berkeley

# Geotechnical Field and Laboratory Testing Capabilities

Information Package

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Berkeley Geosystems Consortium  
<https://geotechnical.berkeley.edu/>

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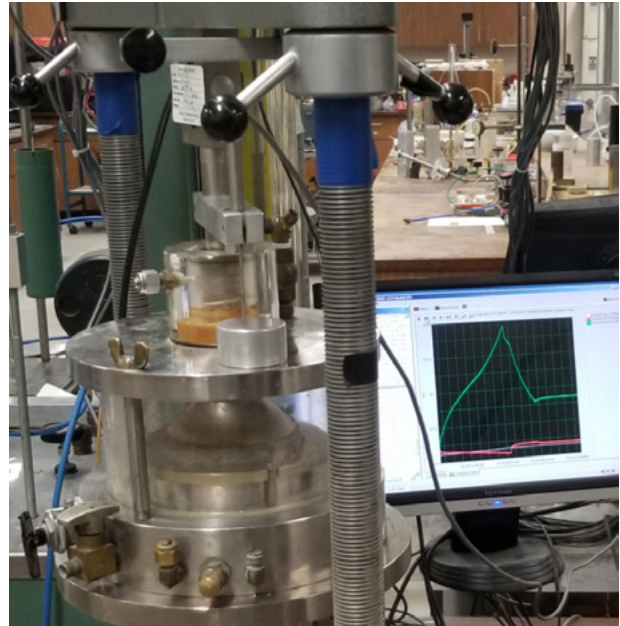
# **Laboratory Testing Equipment**

*Soil Testing*

# CONSOLIDATION TESTING

## Constant Rate of Strain

- Continuous data collection
- Specimen diameters 2.5" to 4"
- Stresses ranging from 1 kPa to over 10 MPa
- Back pressure capability for true saturation
- Slow loading rates for fully drained consolidation of plastic clays (for optimal determination of  $e$ -log  $P'$ ) or faster to evaluate  $C_v$



## Incremental Loading

- Traditional constant load increments
- Pneumatic piston loading
- Specimen diameters 2.5" to 6"
- Stresses ranging from 5 kPa to over 700 kPa





## LABORATORY VANE SHEAR TESTING

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Vane Shear tests provide a direct assessment of undrained shear strength of cohesive soil deposits either in the field, or on high-quality samples within their tubes in the laboratory.

- Instrumented beam load cell for torque measurement
- Continuous torque recording through peak & residual
- Adjustable, steady rotation rate using electric motor



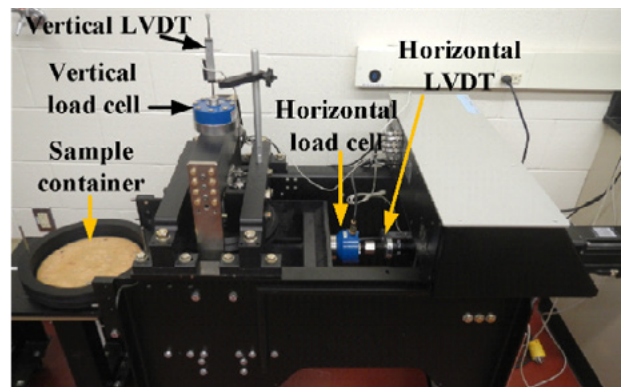
## SIMPLE SHEAR TESTING

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Four different Stress- and Strain-controlled Direct Simple Shear Test Systems, capable of performing customized multi-stage testing including consolidation, cyclic and monotonic shearing stages.

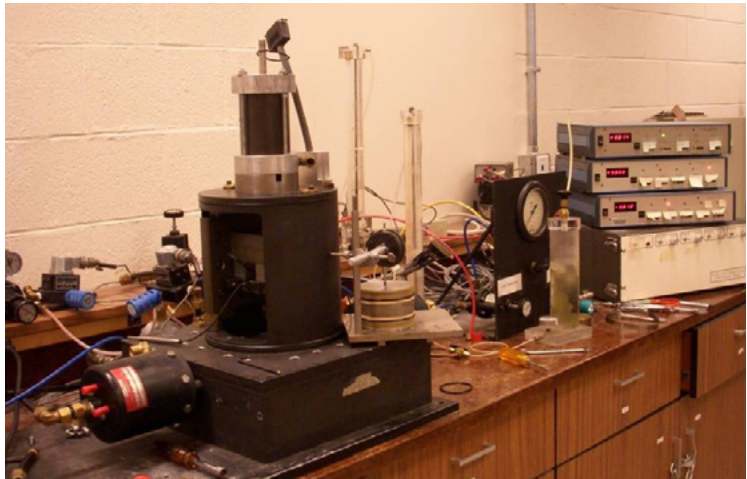
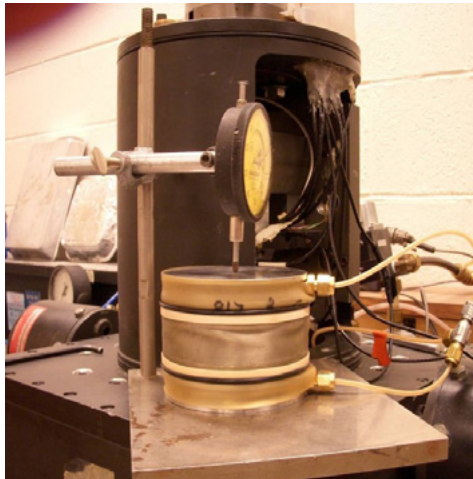
### Large Diameter Direct Simple Shear

- Vs measurements available
- Specimen diameter of 300 mm
- Vertical stress up to 550 kPa
- Monotonic or Cyclic sinusoidal (0.01-1 Hz)
- Modifiable to a 300-mm square Monotonic or Cyclic Interface Direct Shear



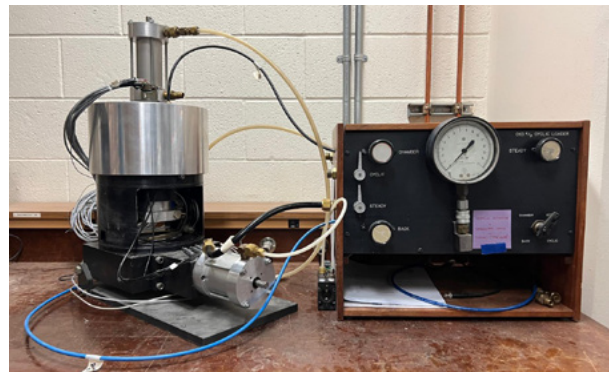
## Bi-directional simple shear

- Specimens up to 4" diameter
- Equipped with chamber and back pressure for saturation and lateral stress control
- Vertical effective stress ranges from 30 to 700 kPa
- Monotonic & Cyclic loading with frequencies from 0.01 to 1 Hz



## CKC unidirectional simple shear

- Specimens up to 4" diameter
- Equipped with chamber and back pressure for saturation and lateral stress control
- Vertical effective stress ranges from 30 to 700 kPa
- Monotonic and Cyclic loading with a frequency ranges from 0.01 to 1 Hz



## Constant Volume Direct Simple Shear Testing

- Specimen diameters of 2.5" and 4.0"
- Vertical stress up to 3000 kPa (D=2.5 in.) and 1000 kPa (D=4.0 in.)
- Monotonic shearing or Cyclic sinusoidal (0.033 to 1 Hz) or any irregular user-defined waveform



# TRIAXIAL SHEAR TESTING

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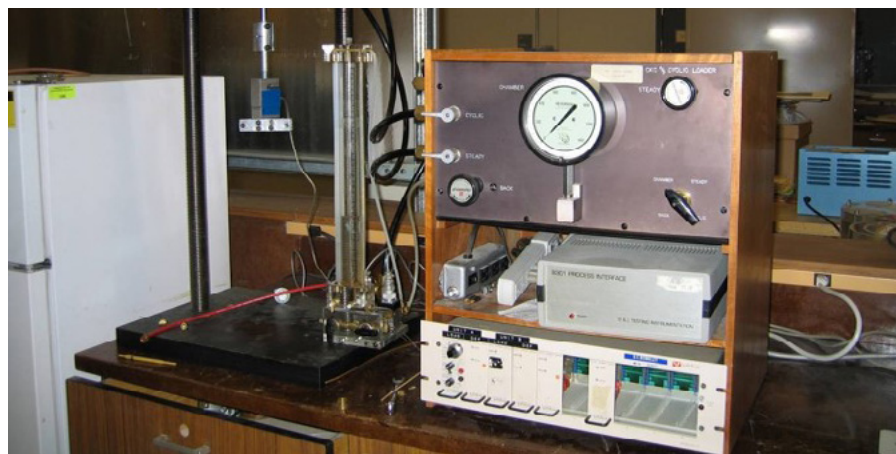
## Large-scale Triaxial Test System

- Specimen diameter of 12 inches
- Isotropic consolidation effective stress up to 700 kPa
- Monotonic and Cyclic loading with frequency up to 0.1 Hz



## CKC Electropneumatic Automated Triaxial Test System

- Specimen  $d = 1.4, 2.8$  and  $4.0$  inches
- Effective stress: 30- 500 kPa
- Monotonic and Cyclic loading with frequency up to 1 Hz
- Adapted for small strain levels with modular stress and strain instrumentation
- Augmented with Vs measurements for Gmax





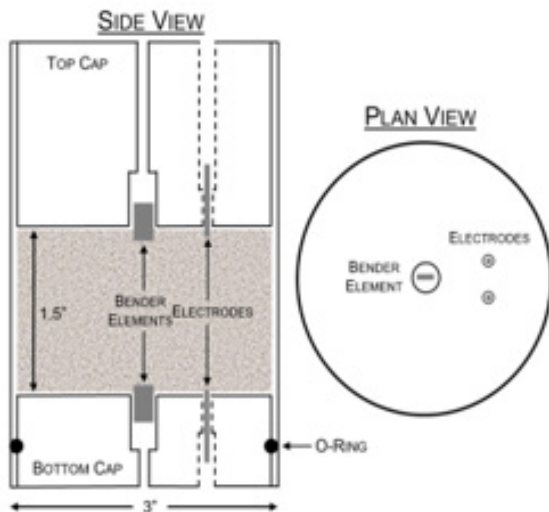
## COMBINED SOIL ELECTRICAL RESISTIVITY AND $V_s$ MEASUREMENT

Custom electrical resistivity apparatus using a Precision GW INSTEK LCR-6300 LCR Meter that can operate at 10 Hz to 300 kHz. This equipment allows for measurements of electrical resistivity of soil samples.

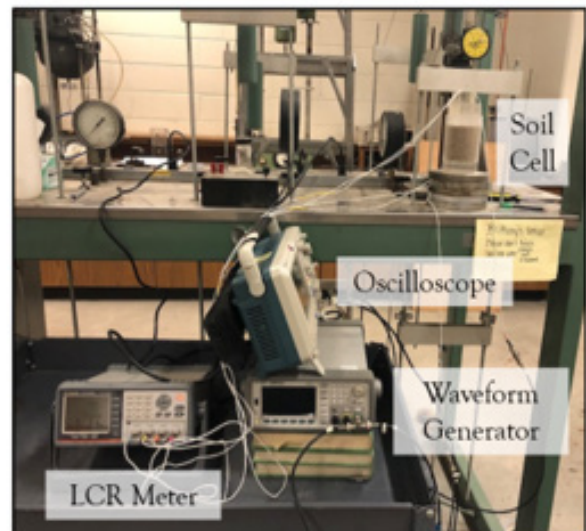
Testing setup combined with bender element testing for shear wave velocity testing of the soil specimen.

Custom apparatus can be adjusted for stress state and moisture conditions.

Cell Schematic



Lab Setup





# **Laboratory Testing Equipment**

*Rock Testing*

## TABLE SAW AND ROCK CORING

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*Rock Coring for Hard Rock specimen Preparation*

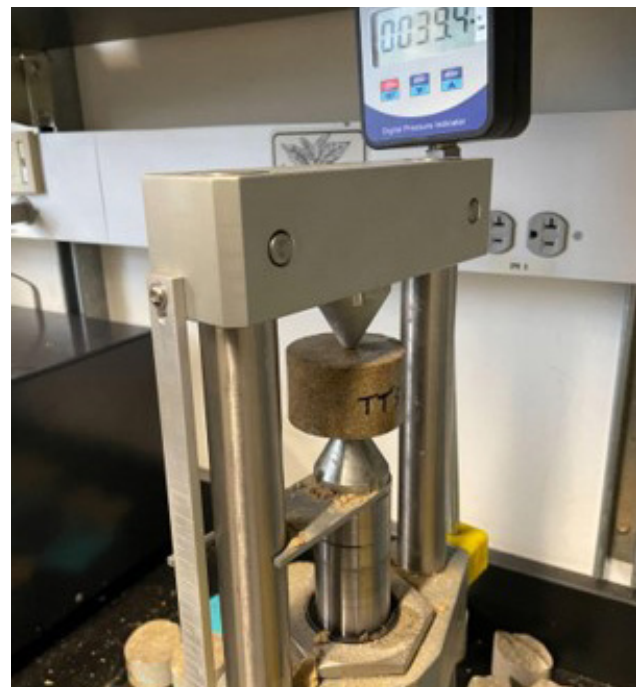


*Table Saw for Hard Rock specimen Preparation*

## POINT LOAD TESTING

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The point load tester can determine the intact strength of a rock sample in the field or laboratory. Load frame with 55kN capacity via mounted hydraulic ram and digital display showing load. Can be used to test cores up to 4 inches in diameter.



## LABORATORY ULTRASONIC VELOCITY TESTING APPARATUS

The ultrasonic velocity testing apparatus allows for compressional and shear wave velocity measurements in laboratory rock specimens. This apparatus consists of a Agilent 33500B Series Waveform Generator and a Tektronix MSO 2012 Mixed Signal Oscilloscope in conjunction with various transducers.



Direct contact transducers for velocity measurements:

- Vp Compressional - 150 kHz - 28mm diameter - Proceq
- Vs Shear - 250 kHz - 25mm diameter - Olympus
- Vs Shear - 1 MHz - 13mm diameter - Olympus

## ELECTRICAL RESISTIVITY TESTING FOR ROCKS

Custom electrical resistivity apparatus using a Precision GW INSTEK LCR-6300 LCR Meter that can operate at 10 Hz to 300 kHz. This equipment allows for measurements of electrical resistivity of rock samples.





# **Field Testing & Sensing Equipment**

## FIELD VANE SHEAR

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- Digital torque wrench with output to computer
- Rotation applied manually
- Deployed up to 10m depth with custom drill rod
- Variety of vane shapes and H/D options



## DYNAMIC PENETRATION TESTING

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### In-borehole Dynamic Penetration Testing (DPT)

- Well-suited for in-situ characterization of coarse-grained soils such as gravelly soils, rockfills, tailings and waste materials
- Operated in a similar manner as SPT



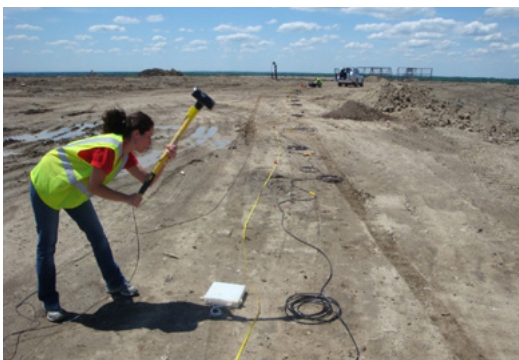
## Dual-Mass Dynamic Cone Penetration Testing (DCP)

- Manual and portable
- For shallow (<5') penetration resistance assessments

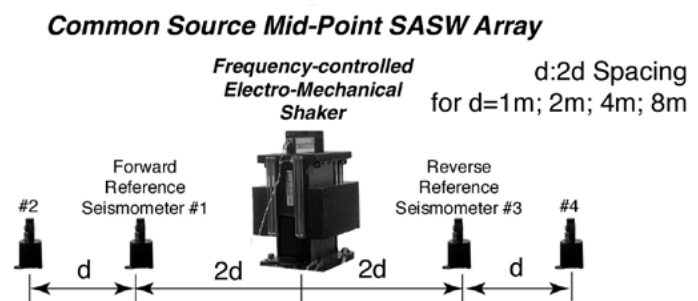


## MULTICHANNEL ANALYSIS OF SURFACE WAVES (MASW) AND MICROTREMOR ANALYSIS METHOD (MAM) EQUIPMENT

1-D and 2-D Multichannel Analyses of Surface Waves (MASW) and Microtremor Analysis Method (MAM) seismic geophysics techniques using an array of 24 4.5Hz or 2 Hz geophones.



MASW measurements at Arbor Hills landfill



Active Frequency-Controlled Source SASW capabilities



## ELECTROMAGNETIC INDUCTION

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Geophex GEM2 Frequency domain electromagnetic induction (FDEM) device. 1.66m fixed length with simultaneous transmission of up to 10 frequencies from 30 Hz to 96 kHz.

Trimble Nomad 900 or microsoft surface data logger. Multiple GPS configurations; Garmin GNSS or Emlid RS2+ for RTK.



## UNCREWED AERIAL VEHICLES (UAVs)

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UC Berkeley Geosystems maintains a fleet of UAVs of different sizes and configurations that can be deployed for a variety of applications and appropriate sensors.



*Aurelia X8*



*Phantom 4 RTK*



*DJI Matrice 300 RTK*



*DJI Mavic 2 Pro*

## UAV SENSORS

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### GreenValley LiAir V70 LiDAR

An integrated sensor unit consists of a Livox Avia LiDAR and a Sony A5100 visible-light camera. The LiDAR is operating at the 905 nm wavelength (near-infrared range) with a field of view of 70.4° (horizontal) by 4.5° (vertical).



### DJI Zenmuse XT2 Thermal Camera

An integrated unit consists of a FLIR thermal infrared camera and a visible-light camera. The thermal camera operates at the spectral band of 8 – 14  $\mu\text{m}$ .



### MicaSense RedEdge-MX Multispectral Camera

An imaging sensor that can capture images in five distinct spectral bands, centering at 475 nm (blue), 560 nm (green), 668 nm (red), 717 nm (red edge), and 840 nm (near infrared).



## TERRESTRIAL ROBOTS

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### Boston Dynamics SPOT

- Max Speed is 1.6 m/s
- Max Slope:  $\pm 30^\circ$
- Average Runtime: 90 mins
- Payload capacity: 14 kg (30.9 lbs)
- SPOT has mounting interface  
Mounting area is 850 mm (L)  $\times$  240 mm (W)  $\times$  270 mm (H)
- SPOT can be equipped with sensors needed for specific activities



## REAL TIME KINEMATIC GPS

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### Emlid High Precision GNSS Receivers

- Used for surveying, RTK, PPK, and GNSS
- NTRIP compatible
- Continuous data collection for full PPK corrections or integrated application for easy point collection and "stakeout" capabilities
- Simultaneous multi-constellation connectivity
  - GPS
  - BeiDou
  - GLONASS
  - Galileo
  - QZSS
  - SBAS



### 4 Emlid RS units

single frequency receivers

### 2 Emlid RS2 & 1 Emlid RS2+ units

multi frequency receivers



### 1 Reach M2

RTK GNSS module for UAVs



## TERRESTRIAL LIDAR SCANNERS

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### Trimble X9 Terrestrial Scanner

Versatile laser scanner, offering intermediate range, high accuracy and short scan times with higher sensitivity for peak performance

- Scanning Range: 0.6-150 m
- Scan time: <1 min - 6 min





## PORTABLE WEATHER STATION

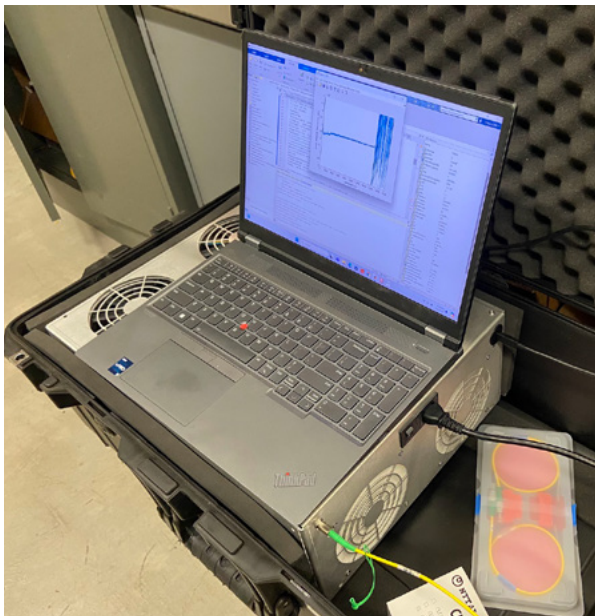
- Dimensions: 7.5 × 0.75 × 4.5 inches
- Batteries: 3 AAA required
- Frequency: Every 5-minute
- Sensors: Wind speed & direction, Solar/UV light, Precipitation, Barometric pressure
- Data acquisition: Can download real time weather data in IoT server



## DISTRIBUTED FIBER OPTIC SENSING (DFOS)

Distributed Fiber Optic Sensing (DFOS) is at the forefront of infrastructure performance monitoring of strain, temperature, vibrations, and sound along fiber optic cables over long distances at a high spatial and temporal resolution. Typical techniques include Distributed Strain Sensing (DSS), Distributed Temperature Sensing (DTS), and Distributed Acoustic Sensing (DAS).

TECHNOLOGY	DISTRIBUTED FIBER OPTIC SENSING (DFOS)			
	Strain and Temperature		Temperature	Acoustic
	BOTDR	OFDR	ROTDR	COTDR
Manufacturer	UC Berkeley	LUNA	VIAVI	OptaSense
Model	-	ODiSI 6000	FTH-9000	ODH4
Range	5km	100m	80km	10km
Resolution	20με or 1°C	1με or 0.1°C	0.1°C	-
Repeatability	20με or 1°C	-	-	-
Accuracy	±30με or ±3°C	±30με or ±2.2°C	±0.5°C	-
Sampling Rate	>0.01 Hz	10Hz	>0.03Hz	10kHz
Gauge Pitch	2cm	0.65mm	0.32m	1m
Spatial Resolution	1m	0.65mm	0.5m	2.1m



# WIRELESS SENSOR NETWORK (WSN)

The Geosystems program has experience with deploying Wireless Sensor Networks for a variety of research projects. An example of such a network is shown below.

TECHNOLOGY	WIRELESS SENSOR NETWORK (WSN)				
	VW Interface	Tiltmeter	Soil Moisture	Gateway	Camera
Manufacturer	Wisn Innovation				
Model	6A07	6305	6C01 w/ EC5	6005	3002 w/ X1
Connectivity	LoRaMesh	LoRaMesh	LoRaMesh	LoRaMesh & LTE	LTE
Range	400 to 6000Hz	-90° to 90°	0 to 100%	Coverage 2km	H: 93° V: 50°
Resolution	<0.05Hz	0.0001°	0.1 to 0.25%	-	3840 × 2160
Accuracy	0.015%	0.05%	<±3%	-	-
Sampling Rate	>0.5Hz	1Hz	1Hz	1Hz	>0.01Hz
IP Rating	IP66	IP66	IP66	IP66	IP66





# METHANE LASER SENSORS

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## Tunable Diode Laser (TDL) sensor

- Device: Inspectra
- Detection gas: Methane (CH<sub>4</sub>)
- Measurement range: 0 ~ 10,000 ppm
- Resolution: 1 ppm
- Weight: 2.7 kg with batteries
- Dimensions: 10.3 × 4.4 × 5.5 inches
- Communication via an external Bluetooth device
- Data frequency: 1 sec



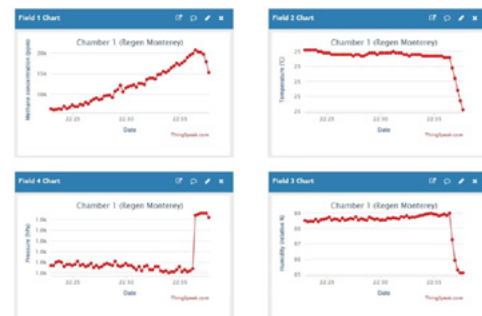
# PROTOTYPE SENSOR DEVELOPMENT: METHANE FLUX CHAMBERS

The UC Berkeley Geosystems staff have experience on the development of prototype sensor nodes that can be used for a variety of applications. An example of a recent prototype sensor development is shown in this section.

- Components of Methane Flux chamber
  - Microcontroller (ESP32 with LTE modem)
  - Non-dispersive infrared Methane sensor (0-50,000 ppm range)
  - Three functional sensor to measure Temperature, Barometric Pressure, and Humidity
- Data transmission to IoT server (Real-time and every second)
- Fully-autonomous and Solar self-powered
- Enable to collect continuous and diurnal methane emission data
  - Can analyze seasonality of surface methane emission



Channel Stats  
Created: 8/20/2024  
Last entry: 10/24/2024 10:00 AM  
Entries: 42953



Motor Driver module



Power distribution



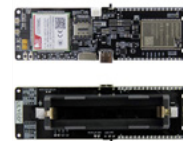
Waterproof plastic box



MicroSD card, Sim card and IoT server



Methane and Three function sensors



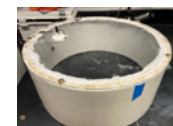
ESP32 with 4G modem



Air pump



Solar panel and Rechargeable battery



Chamber hardware

# Geosystems Engineering Group

For questions regarding the University of California Berkeley Geosystems Engineering facilities and equipment, please contact any of the Geosystems Engineering Group Faculty.



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# UC Berkeley

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*Vers. 1 November 2024*