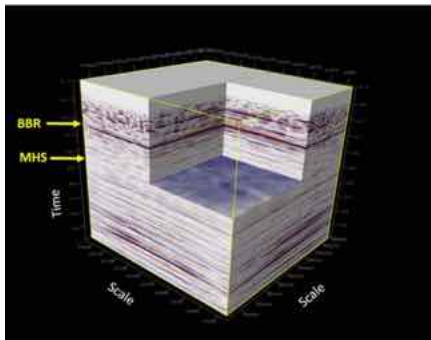


CaMI Field Research Station (FRS)

Lessons Learned from First Phase of Injection and Monitoring

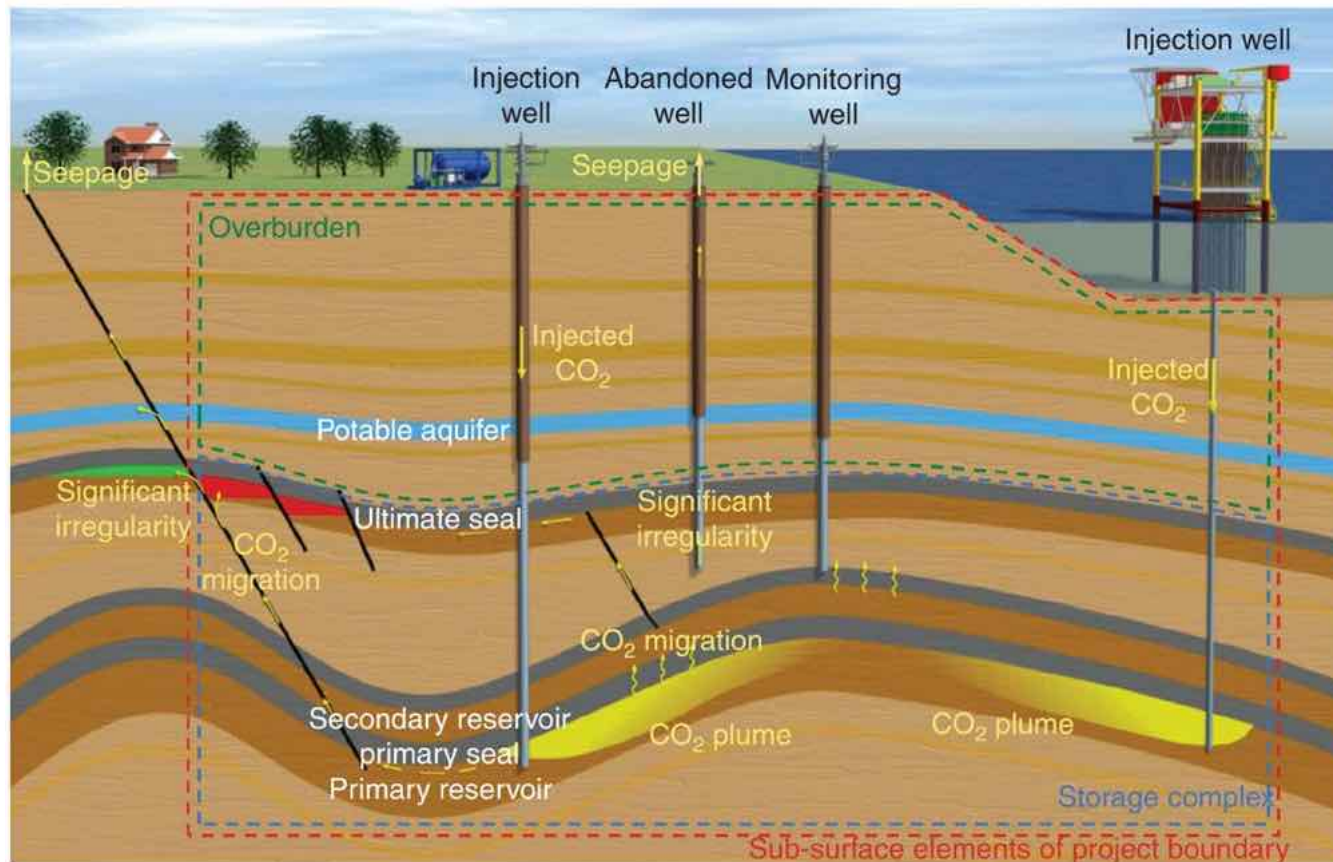
Amin Saeedfar¹, Don Lawton^{1,2}, and Kirk Osadetz¹

***¹Containment and Monitoring Institute (CaMI) & ²University of Calgary
CANADA***



CMC – CaMI Field Research Station (FRS)

- An experimental site for demonstration of MMV technologies
- CO₂ injection from above to simulate leakage from below



Ref. : Jagger & Dorison, Geological Storage of CO₂, 2013



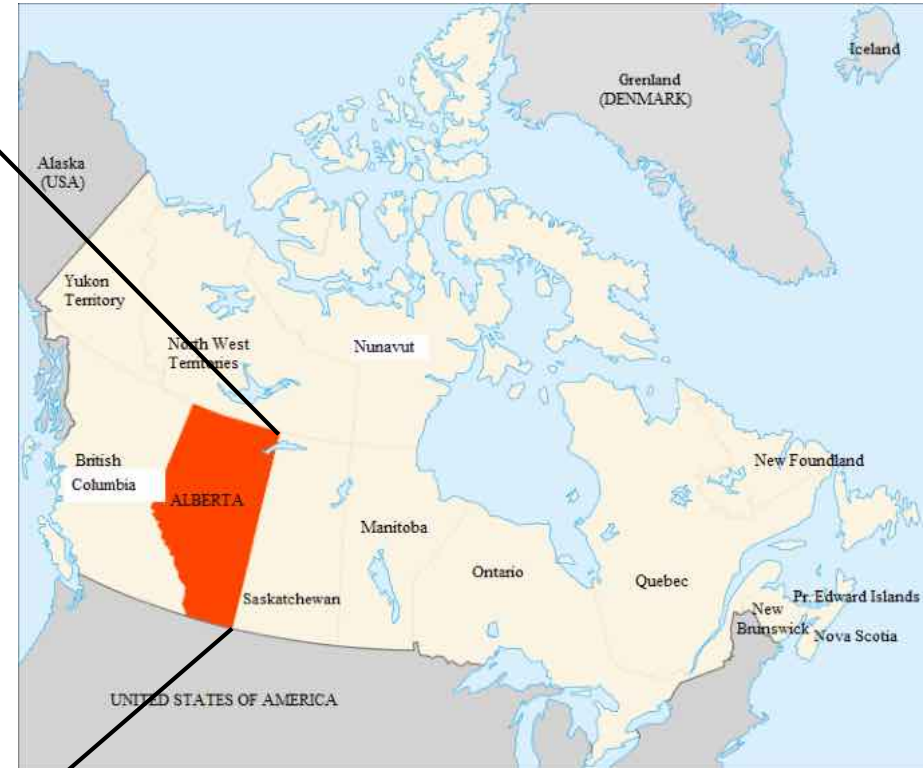
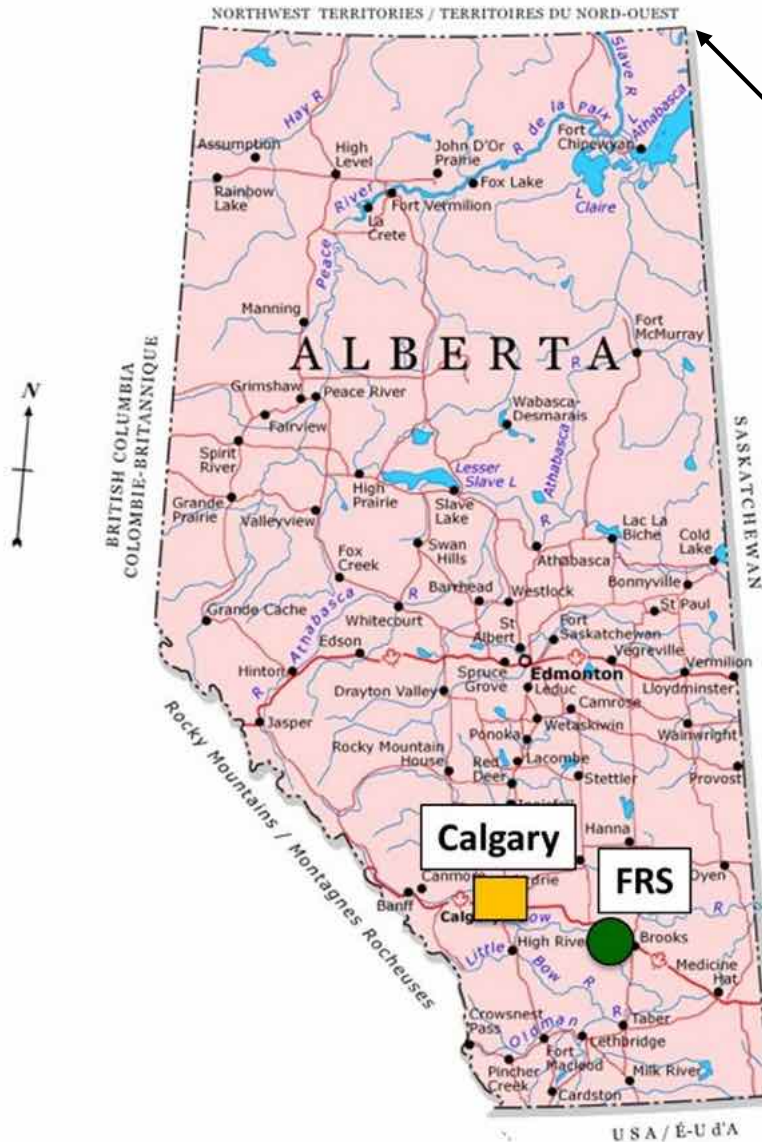
CMC – CaMI Field Research Station (FRS)

■ Technical Objectives:

- Controlled CO₂ release at 300 m depth; ~600 t/year
- Subsurface containment and conformance monitoring:
 - ❑ Fate of CO₂ & its detection thresholds
 - ❑ Tracking the CO₂ plume and cap-rock integrity
 - ❑ CO₂ migration at shallow depth
 - ❑ Impact on groundwater



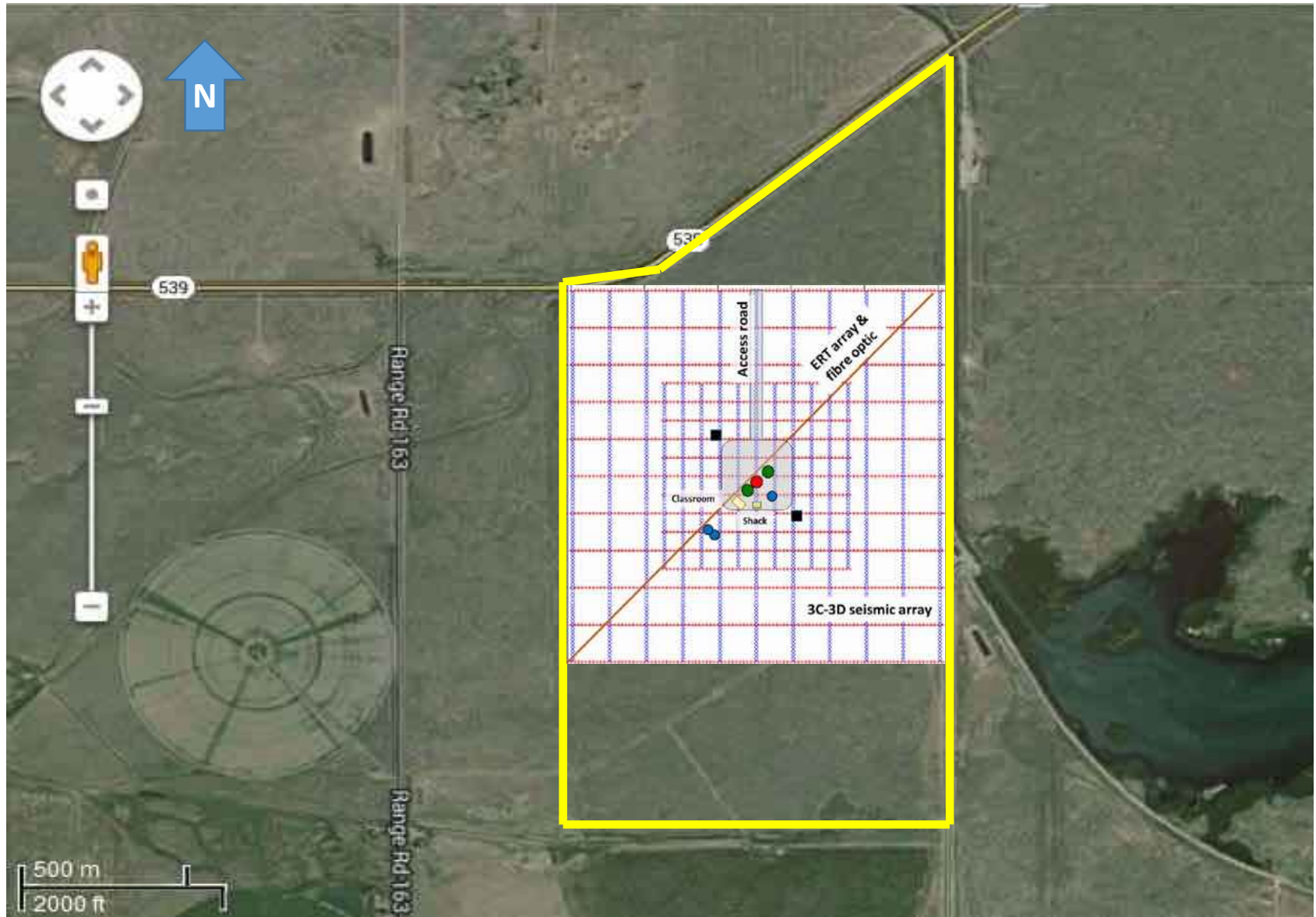
Field Research Station (FRS) : Location



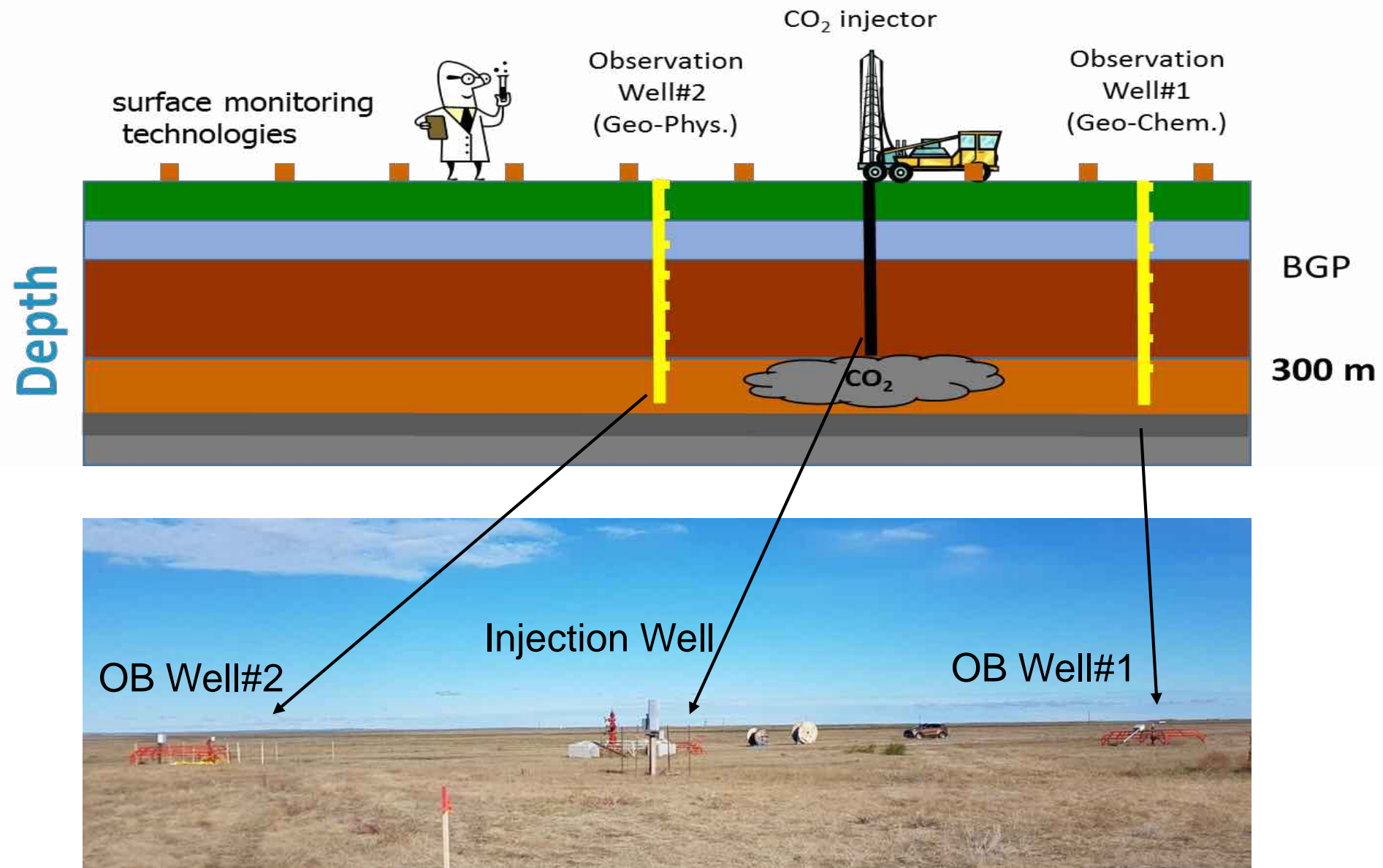
Land leased from
Torxen Energy



FRS Platform



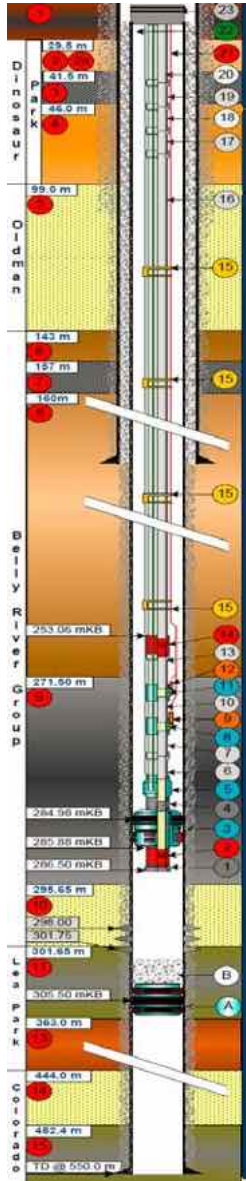
FRS Schematic



Sep. 2016



CO₂ Injection Well



- 550m deep
- Bridge plug : 305m
- Perforated : 295m-to-301m
- Chrome casing at injection zones
- CO₂ resistant cement
- Bottom of injection tubing: 286m
- Tubing P-T gauges
- Fiber optic DTS outside tubing



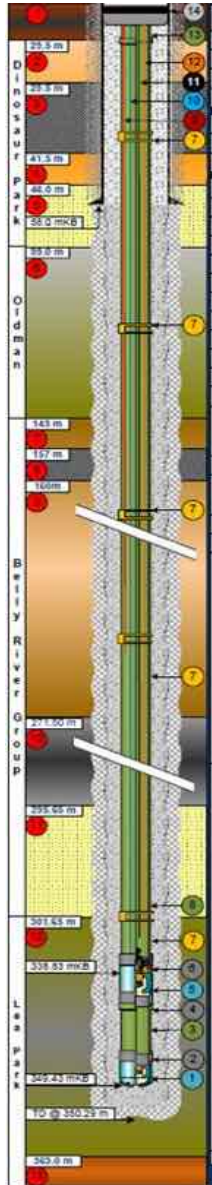
Observation Well#1 at FRS



- 350m deep
- 30m from injection well
- Steel casing
- Sand-pack: 293 m to TD
 - Open to injection zone
- Stainless steel U-tube for reservoir fluid sampling
- Integrated fibre optic cables(DAS, DTS)
- Heat-pulse cable



Observation Well#2 at FRS



- 350m deep
- 20m from injection well
- Fibreglass casing
- Integrated fibre optic cable (DAS, DTS)
- Heat-pulse cable
- Experimental helical-wound fibre optic cable
- 16-level electrical resistivity cable (ERT)
- 24-level geophone array



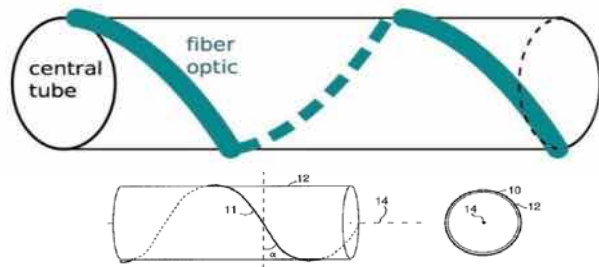
Convnetional Geophones at FRS



- 100 surface geophones:
 - 1m below surface, 90m×90m
- 24 borehole geophones in obs. well#2
 - From 195m to 310m, 5m apart



Fibre Optic Sensors at FRS



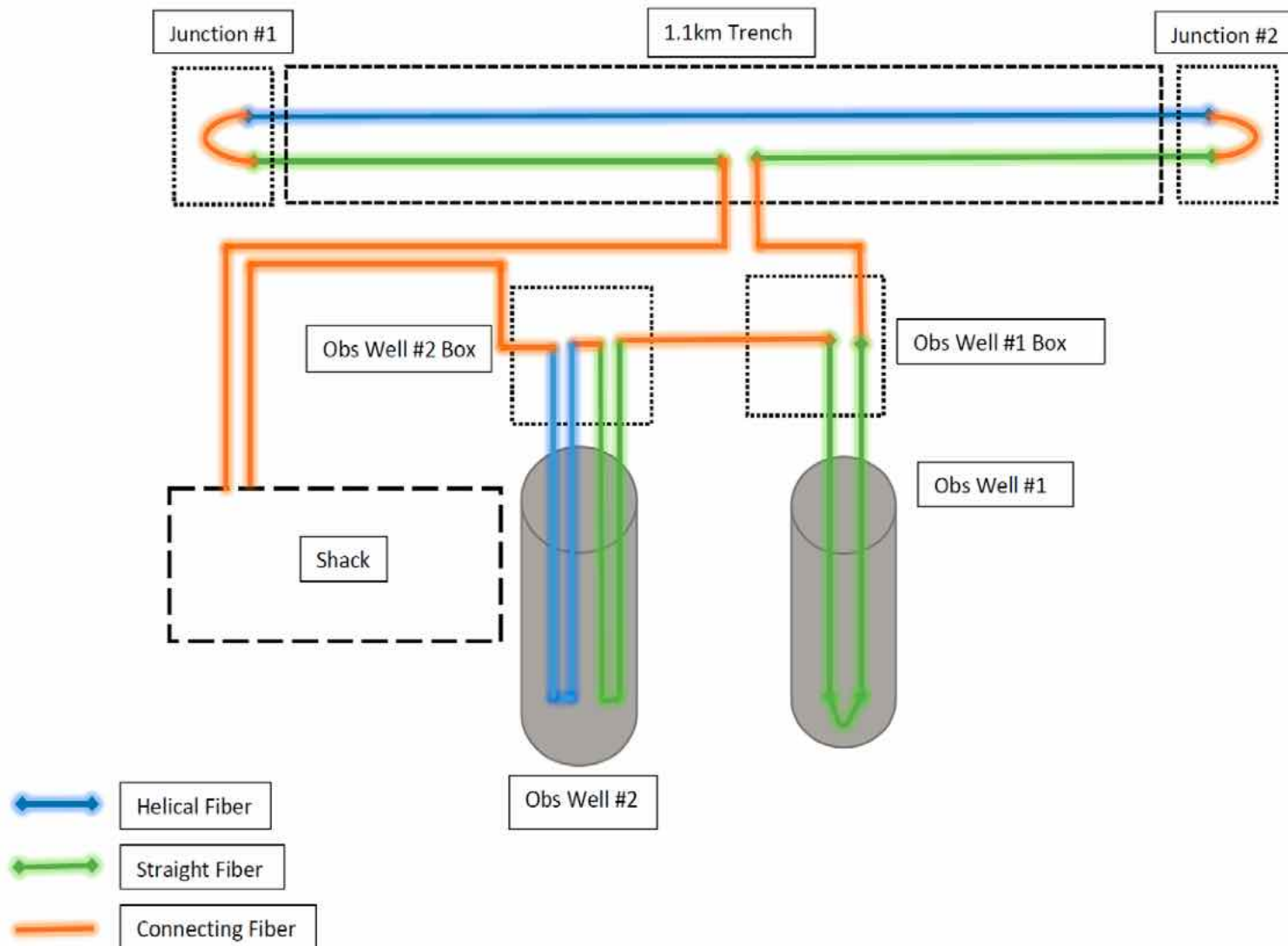
Helical Fiber Optic Cable

(Shell's patent US0344588)

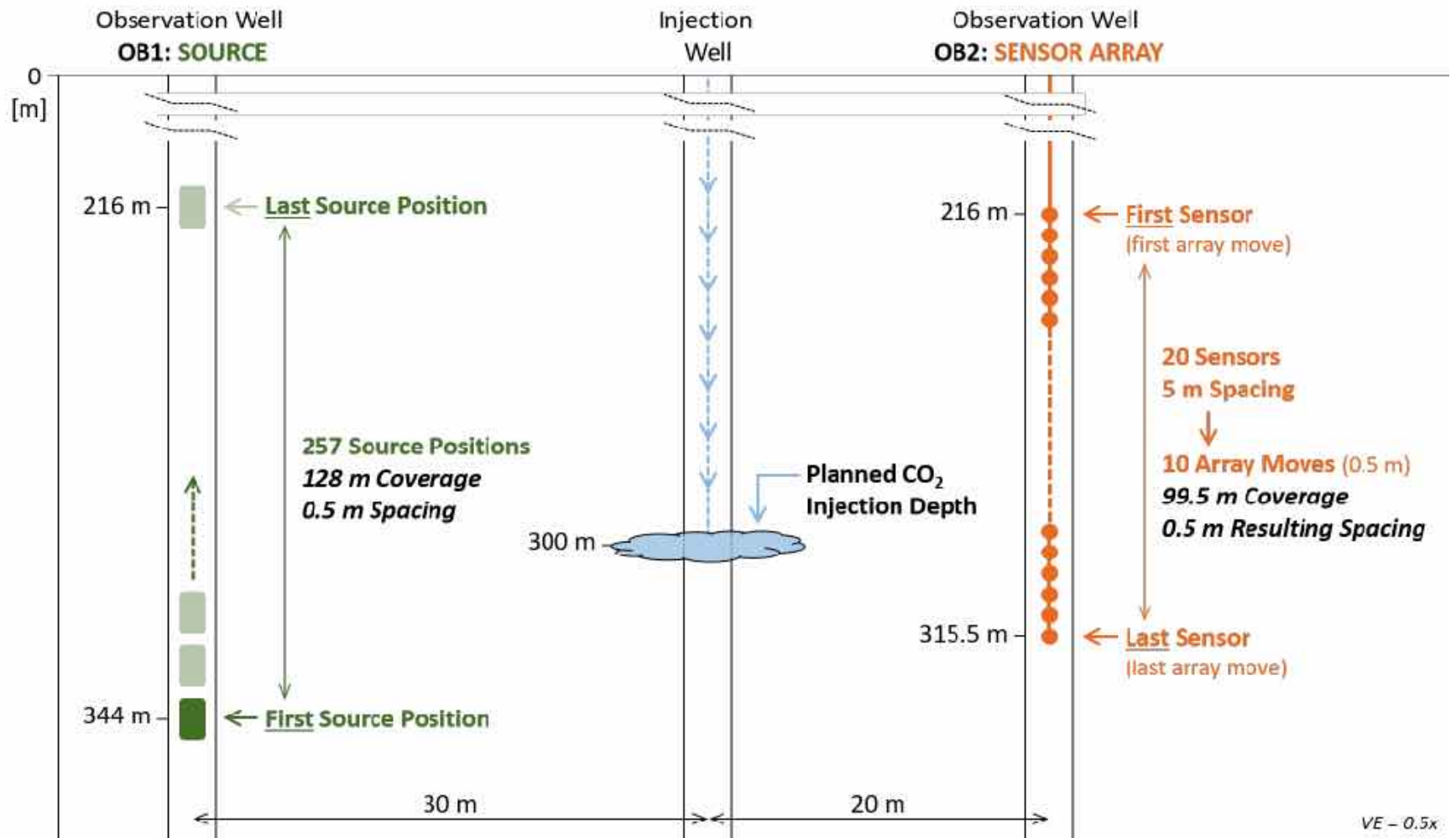
- Straight optical fiber:
 - 1.1 km trench and both obs. wells
- Helical optical fiber:
 - trench and obs. well#2



Fibre Optic Sensors Setup at FRS



Cross-well Seismic survey at FRS



Tom Daley, US-LBNL



Cross-well Seismic survey at FRS



Piezoelectric Source

sweep: 300-2500 Hz

Hydrophone Array



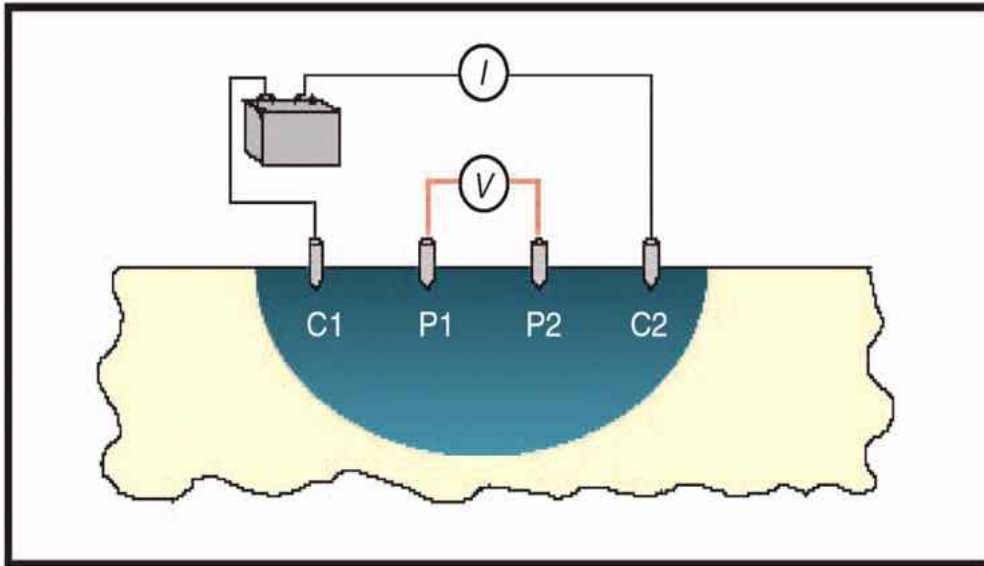
Observation Well #2



Observation Well #1



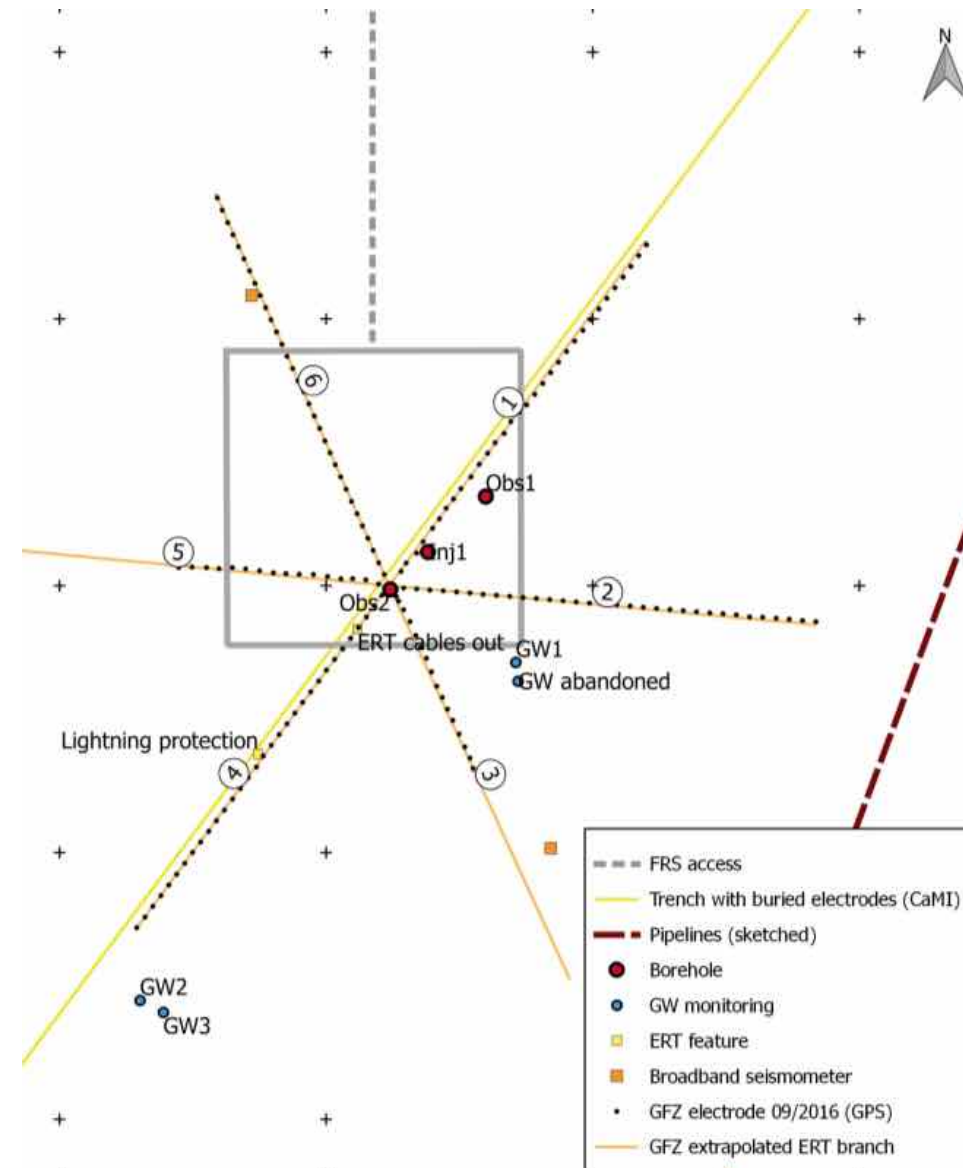
Electrical Resistivity Tomography (ERT)



- Surface aperture:
 - 112 electrodes, 10m apart
 - 1.11 km long, 1m below surface
- Borehole aperture (obs. well#2):
 - 16 electrodes, 5m apart
 - From 250m to 325m
- 250W/950V p-p ERT system



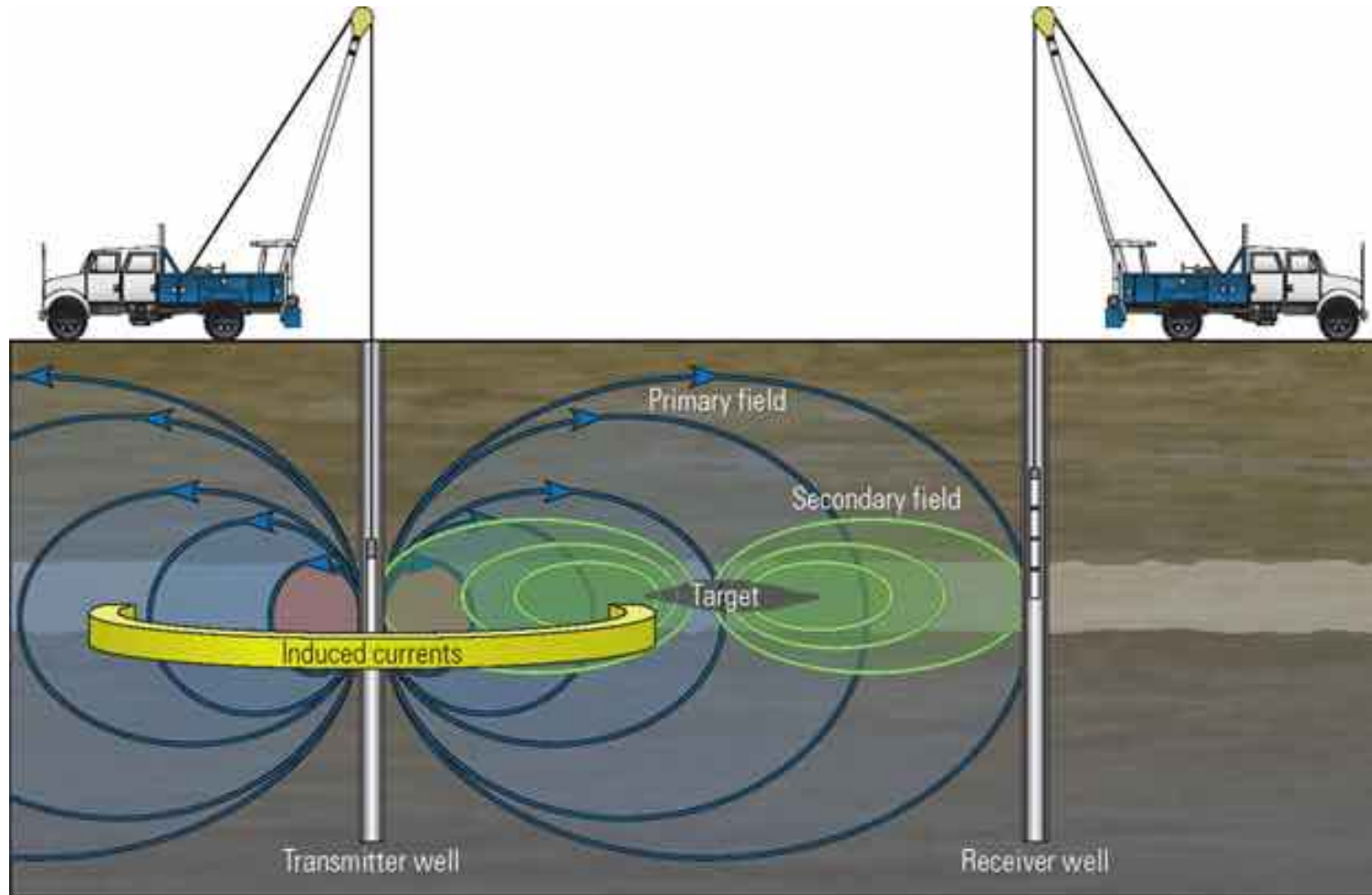
Portable ERT Survey : Borehole-to-Surface



Portable ERT system at FRS
(GFZ-Germany)



Cross-well EM survey at FRS



- Wells separation : 50m
- Source frequency : 100Hz-450Hz



Cross-well EM survey at FRS

Observation Well #2



Observation Well #1

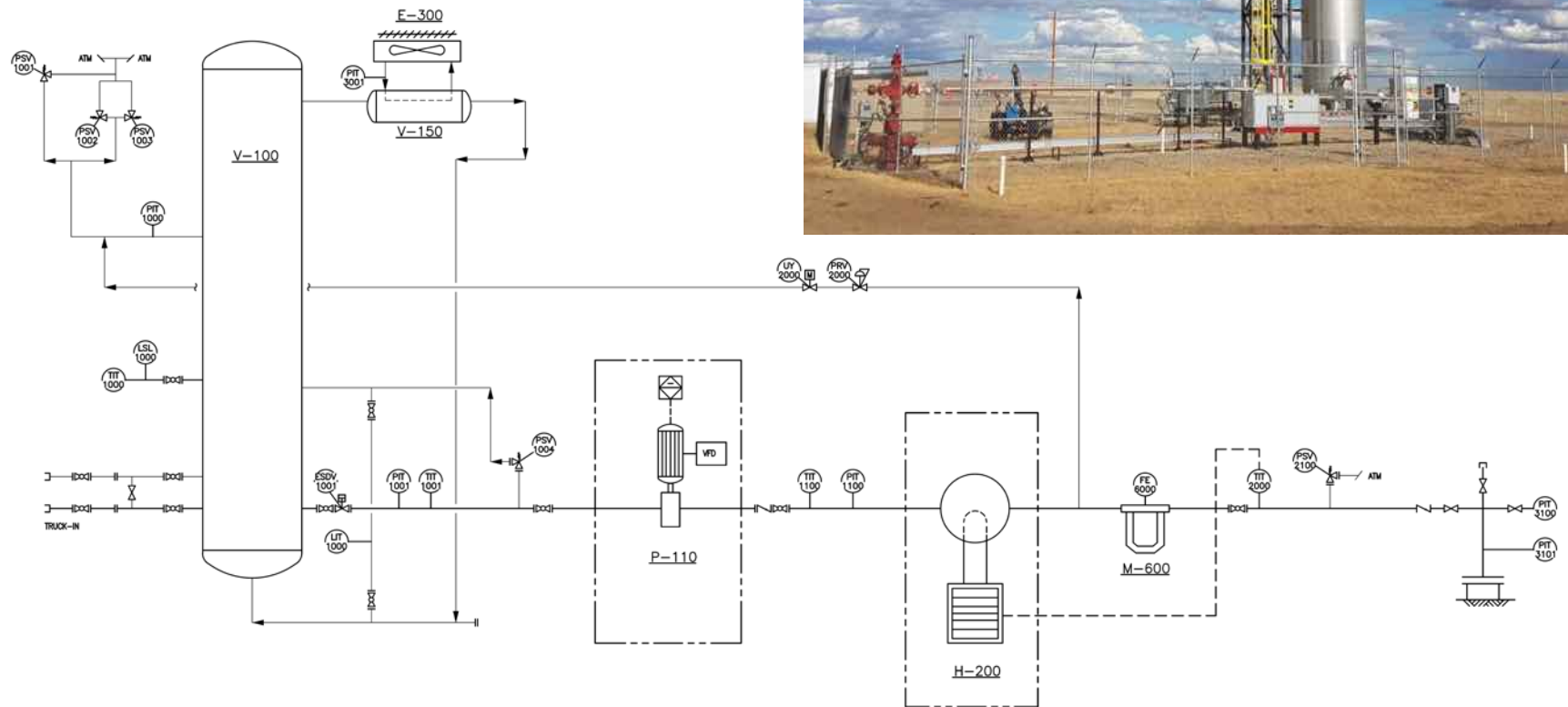


EM-Source

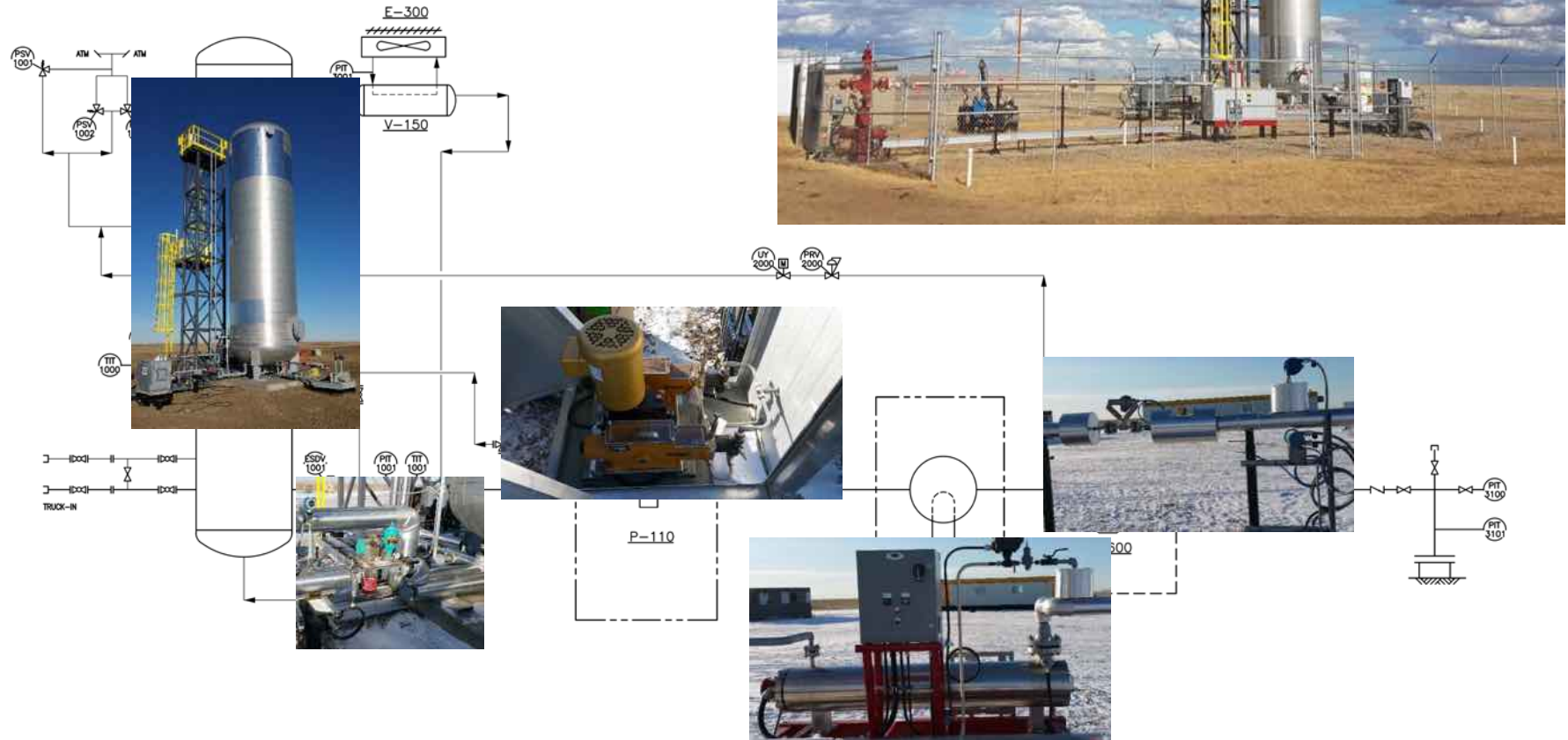
EM-Receivers



CO₂ Injection Plant at FRS



CO₂ Injection Plant at FRS



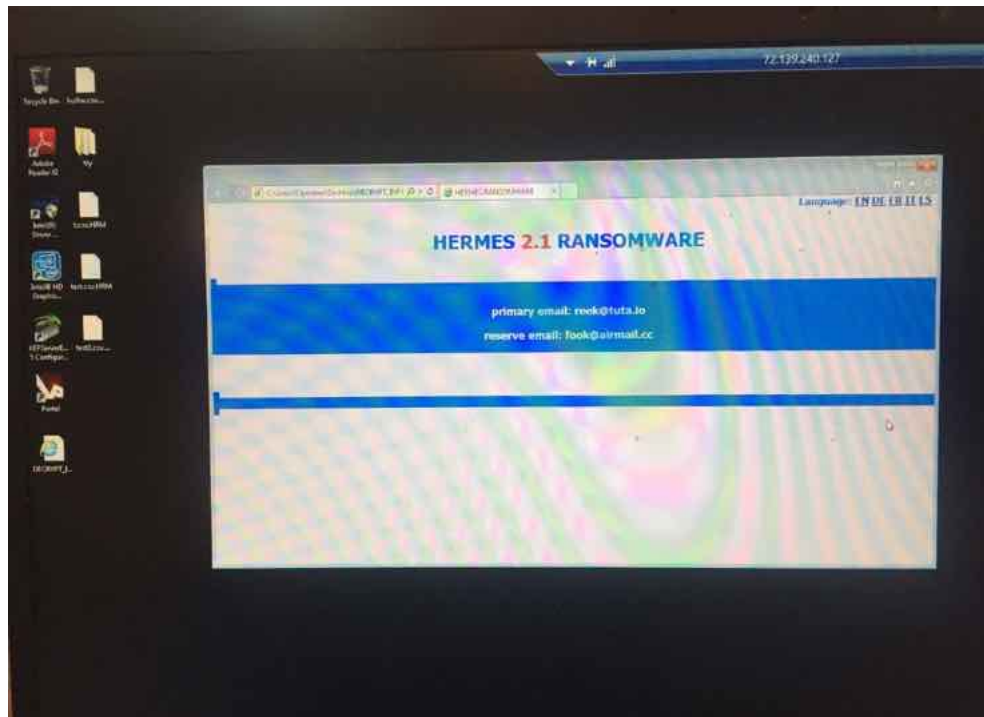
Low Injection Rate: Pump Vapor-lock Prob.



- 40°C and its Consequences...



On March 24th 2018...



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- Germany : GFZ, UT-Friberg
- UK CCS Research Center
- Norway : CLIMIT, SINTEF, NTNU,CMR
- **Industry CaMI JIP subscribers :**
 - Shell International (2016, 2017,2018)
 - Klohn Crippen Berger (2016)
 - RITE-Japan (2017,2018)
 - Statoil ASA (2017,2018)
 - Chevron (2018)
 - Cenovus (2017)

