Near Surface Leakage Monitoring for the Verification and Accounting of Geologic Carbon Sequestration Using a Field Ready ^{14}C Isotopic Analyzer

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U.S. Department of Energy

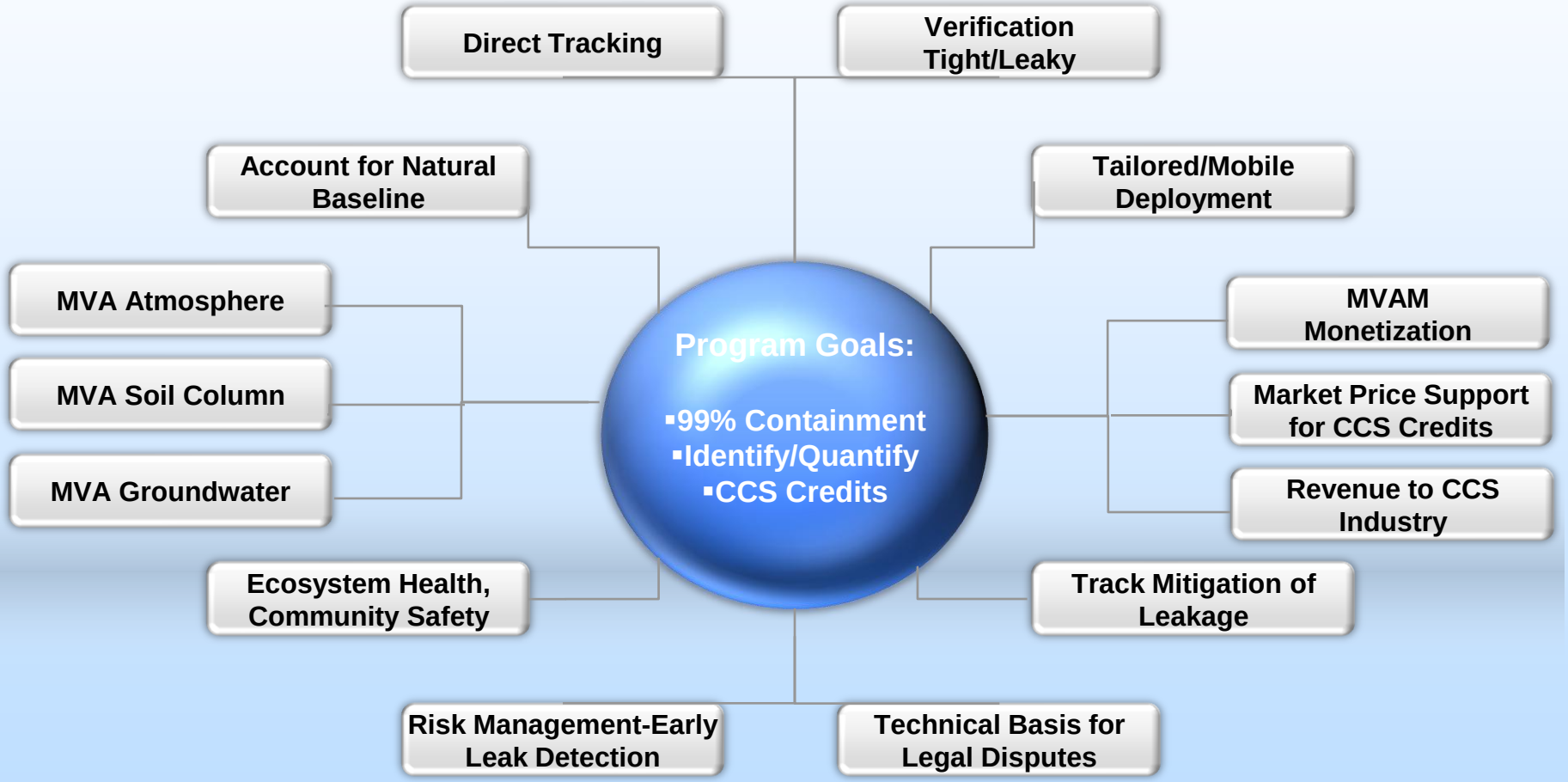
National Energy Technology Laboratory

Carbon Storage R&D Project Review Meeting

Developing the Technologies and Building the Infrastructure for CO_2 Storage

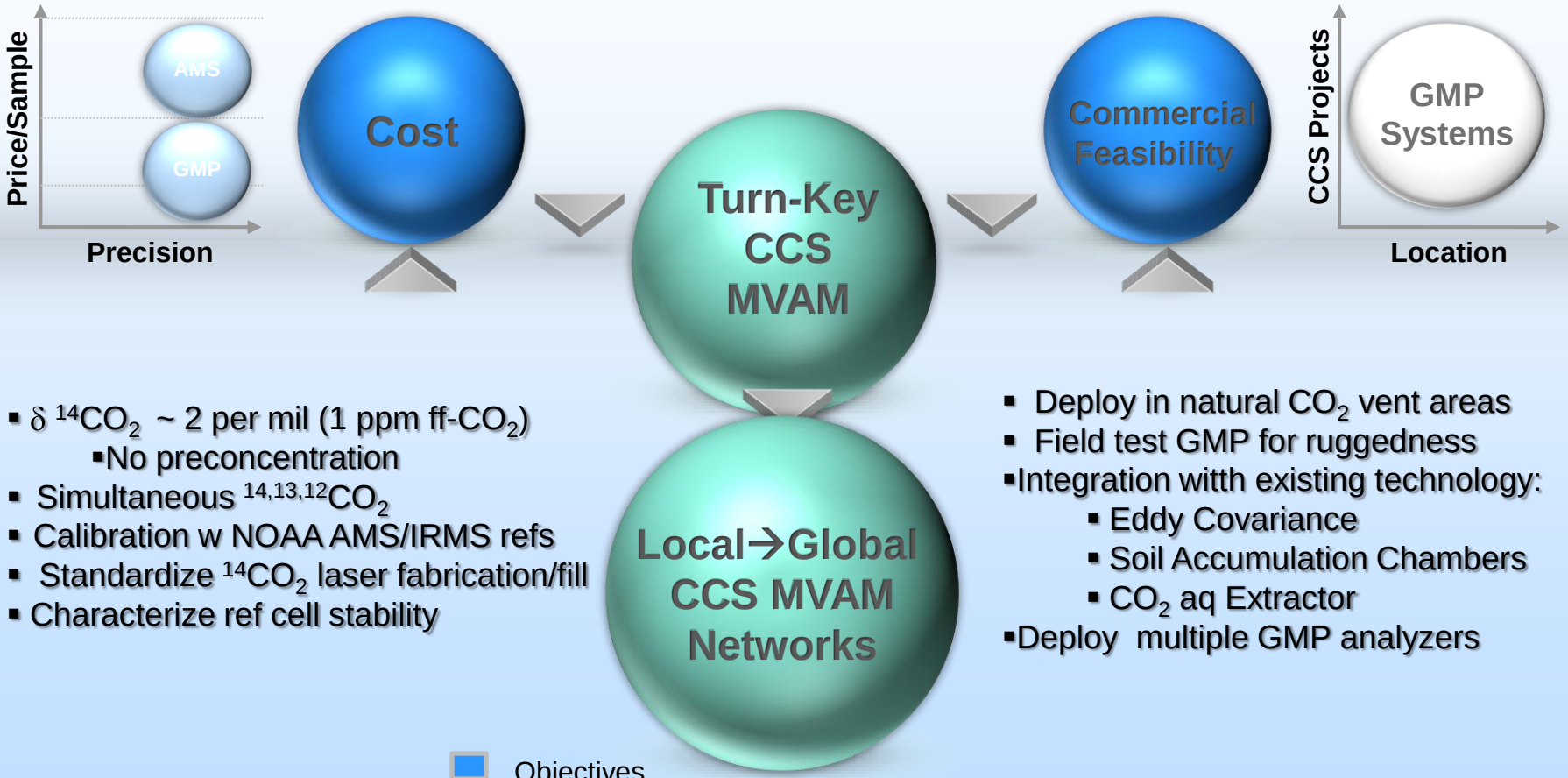
August 21-23, 2012

Benefits of a $^{14}CO_2$ Field Analyzer to DOE MVA Program Goals



Project Goals & Objectives

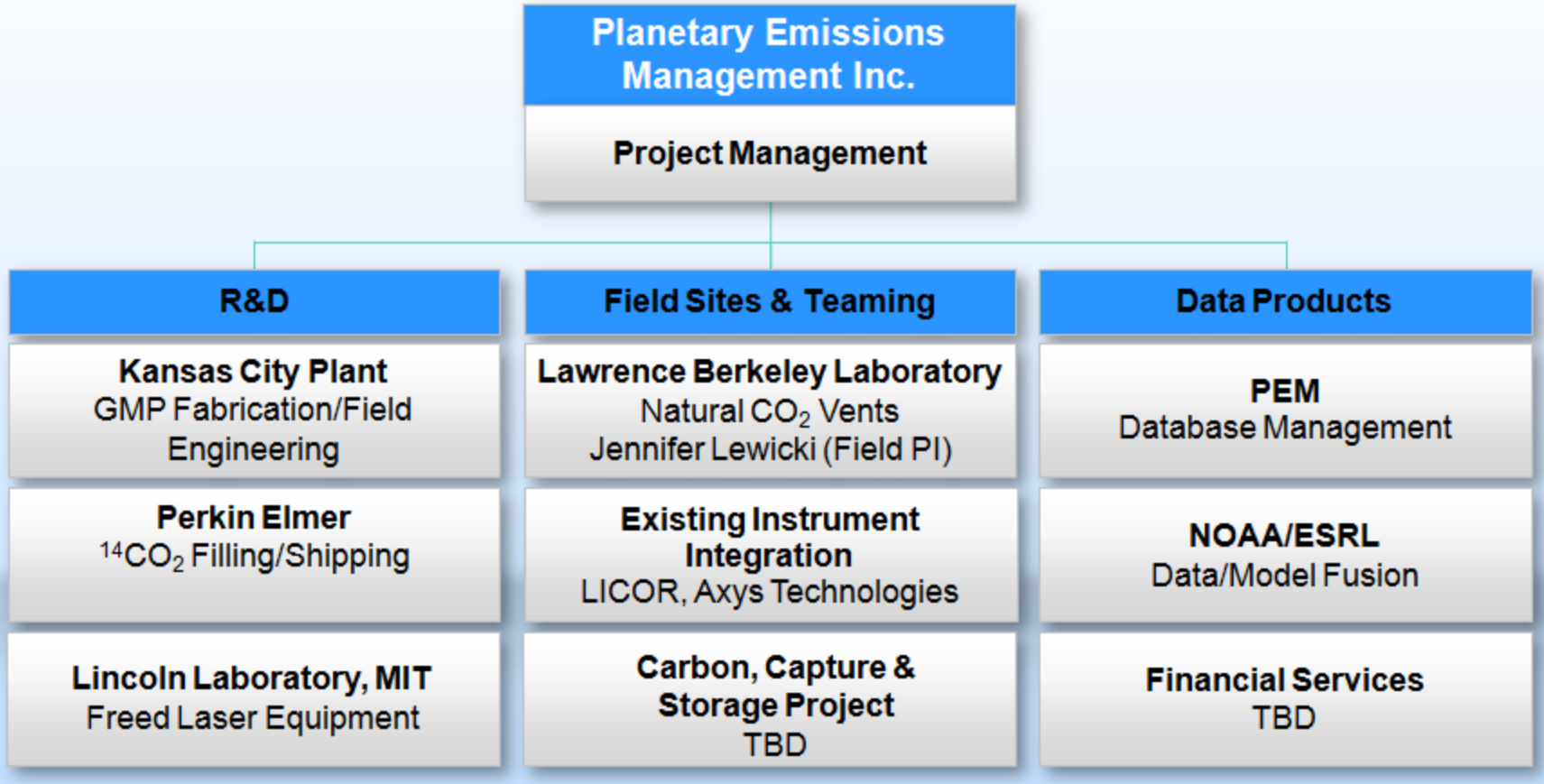
Monitoring, Verification, Accounting & Monetization



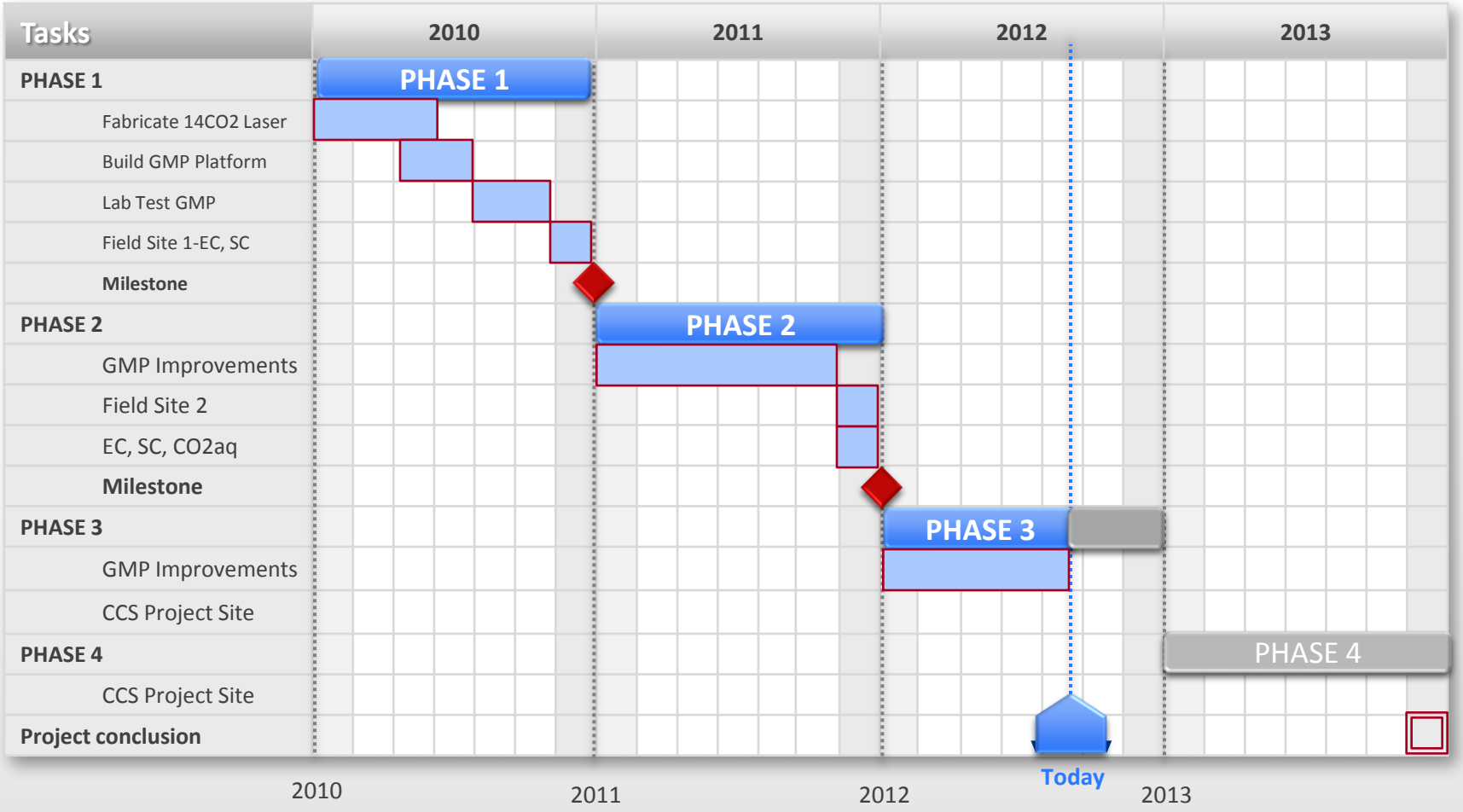
- $\delta\ ^{14}CO_2$ ~ 2 per mil (1 ppm ff-CO_2)
  - No preconcentration
- Simultaneous $^{14,13,12}CO_2$
- Calibration w NOAA AMS/IRMS refs
- Standardize $^{14}CO_2$ laser fabrication/fill
- Characterize ref cell stability

- Deploy in natural CO_2 vent areas
- Field test GMP for ruggedness
- Integration witth existing technology:
  - Eddy Covariance
  - Soil Accumulation Chambers
  - CO_2 aq Extractor
- Deploy multiple GMP analyzers

Project Organization



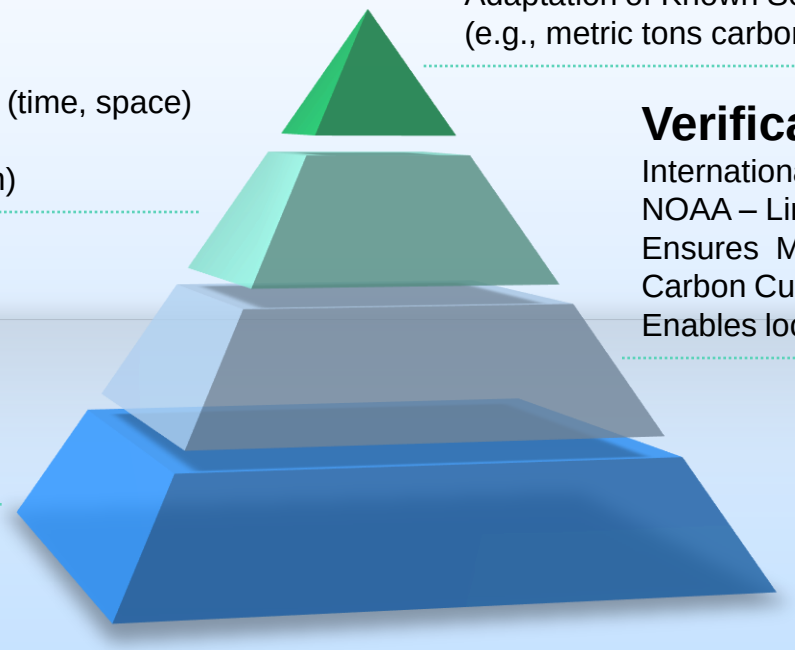
Appendix 2: Project Timeline



Project Architecture: MVAM

Monetization
Adaptation of Known Security Structures to Carbon Flux
(e.g., metric tons carbon sequestered/hecatar)

Accounting
Flux Measurements Acrosss Scales (time, space)
Data & Model Fusion
Qantification (e.g., metric tons carbon)



Verification
International Reference Gas Standards
NOAA – Linked
Ensures Measurement Comparability
Carbon Currency Equivalency
Enables local-to-global Networks

Monitoring (Measurement)
Global Monitor Platform
Multi-isotopic Field Analyzer

Selected Accomplishments

R & D

- Successful fabrication of multiple $^{14}CO_2$ lasers with line specific emission profile
- Successful fabrication of sealed laser reference cells with 1+ year stabilty
- Laboratory and field calibration using NOAA AMS and IRMS measured reference gases
- Simultaneous measurement of $^{14, 13, 12}CO_2$ in the field
- Demonstrated $\delta^{14}CO_2$ precision ~ 2 per mil

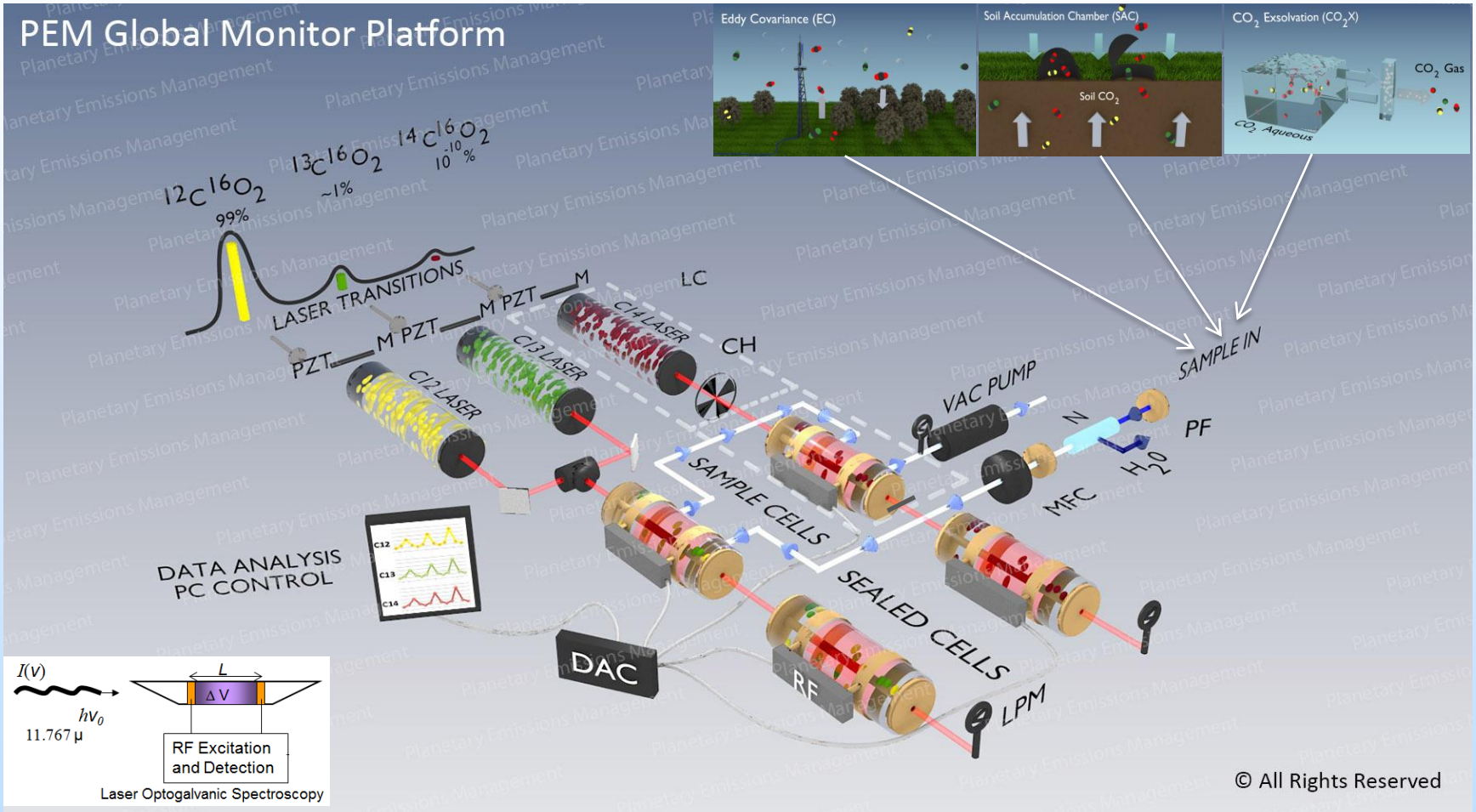
Field Sites & Teaming

- Integration of GMP with Eddy Covariance, soil accumulation chambers and $CO_{2\ (aq)}$ extractor
- Results are consistent with AMS/IRMS measurements—analysis continuing, manuscripts in preparation
- GMP demonstrated ruggedness and stability in the field
- Model studies (data/fusion) underway

Data Products

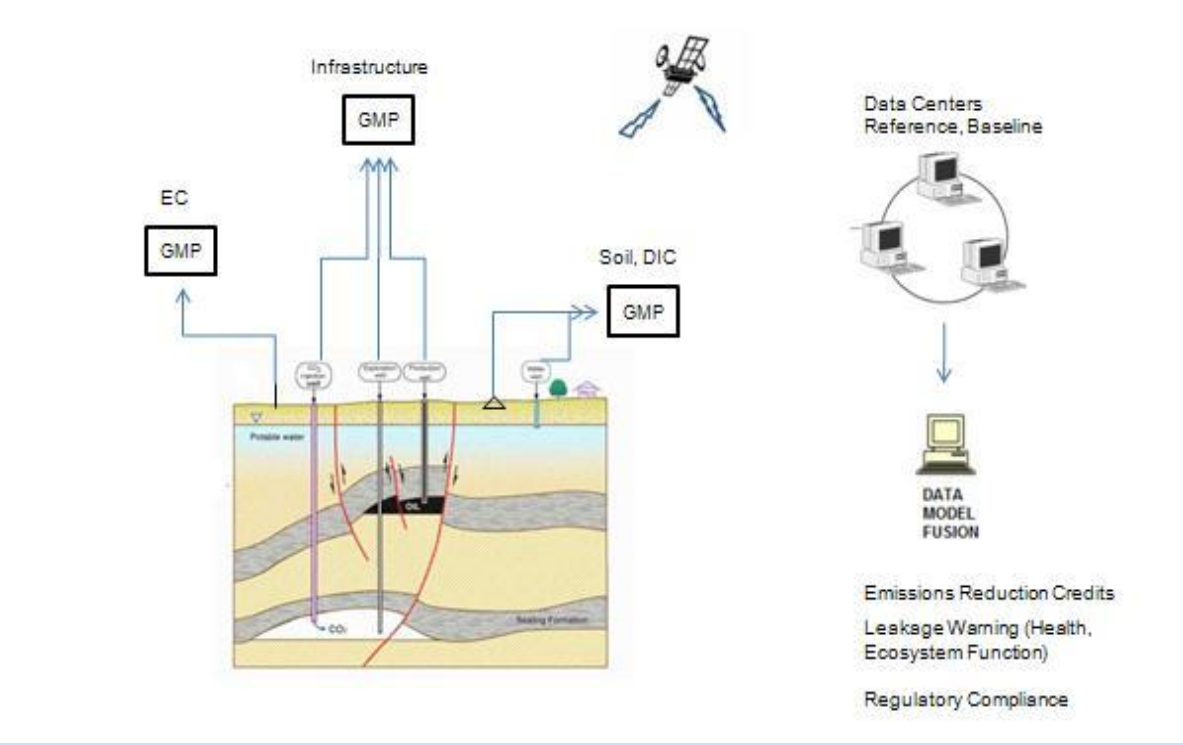
- Database management plan, quality control and archive protocols estalblished
- Basic structure for monetization established
- Application of model results to financial mechanism underway
- Simulation within an active CCS project is feasible

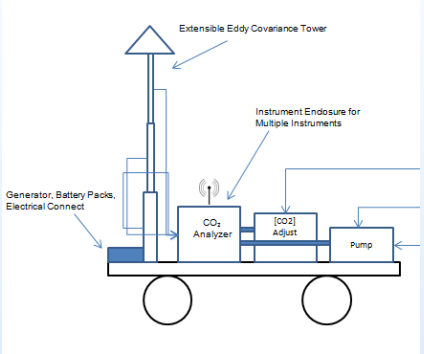
GMP Overview

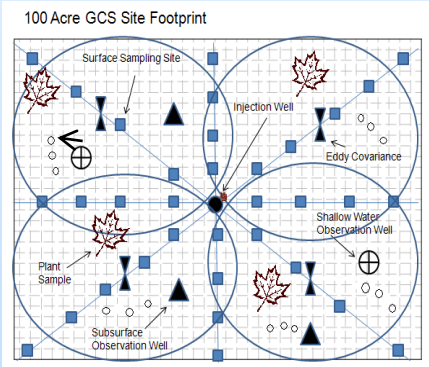


N.B.: Manuscript in preparation, Subject to Revision

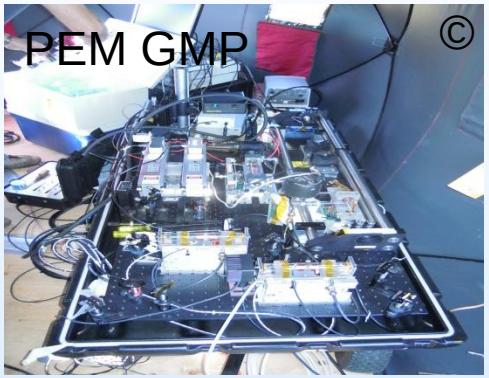
GMP CCS Application



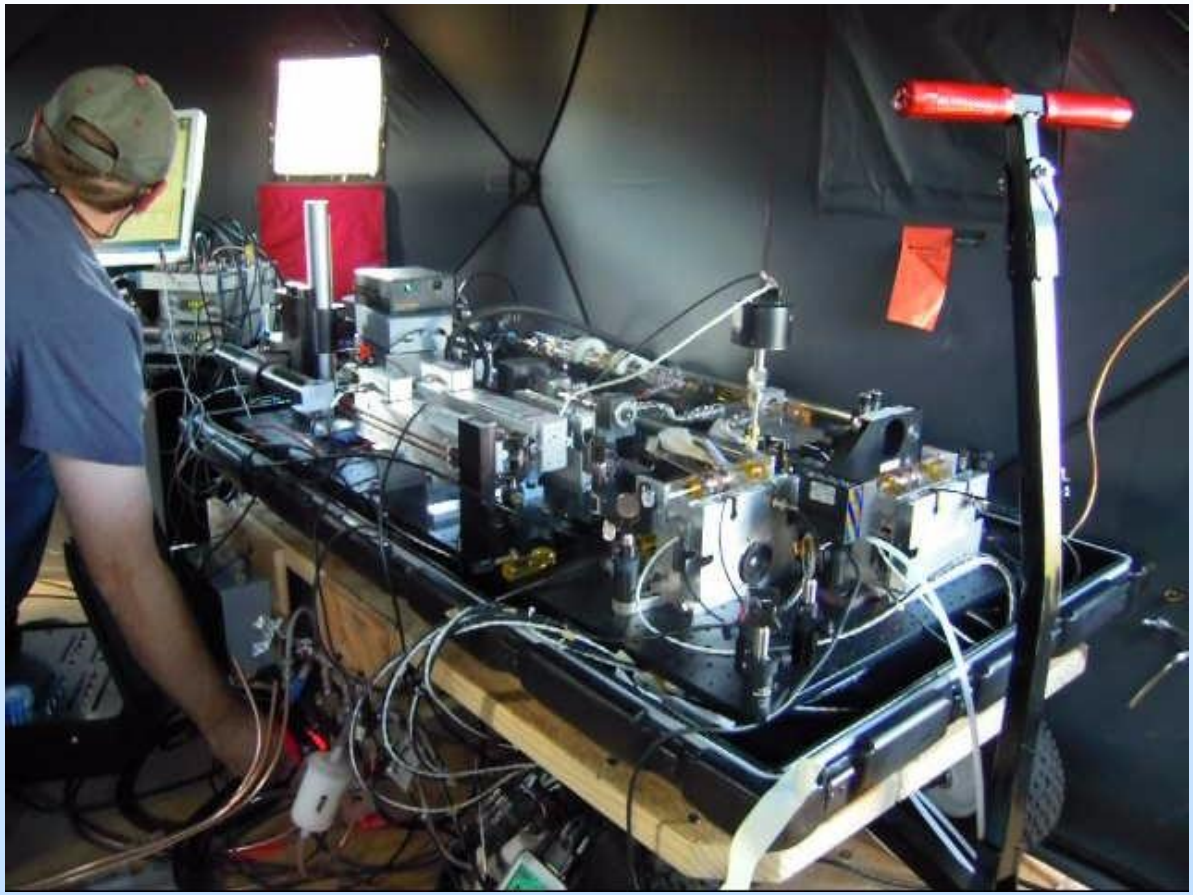




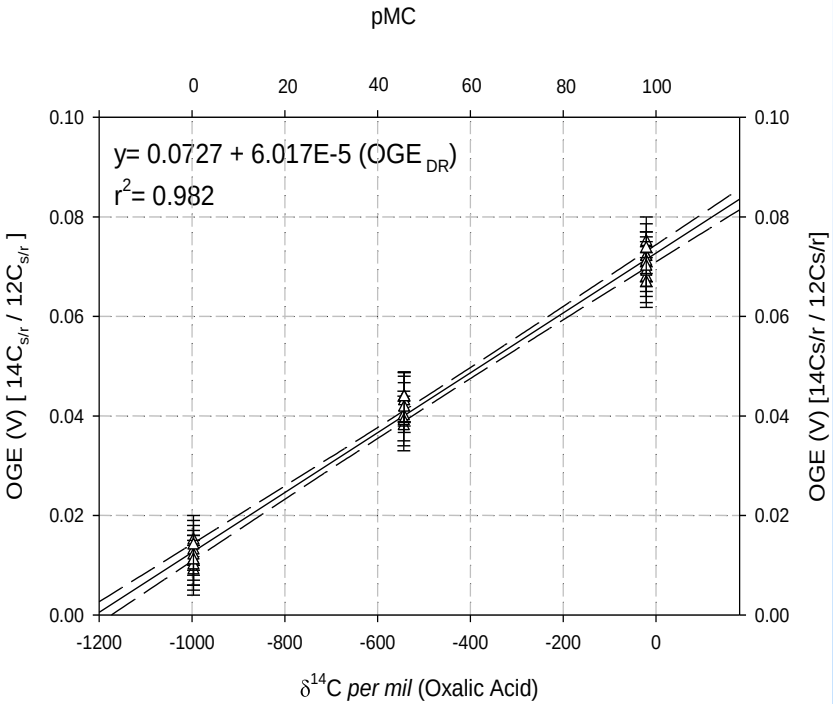
Soda Springs, Idaho

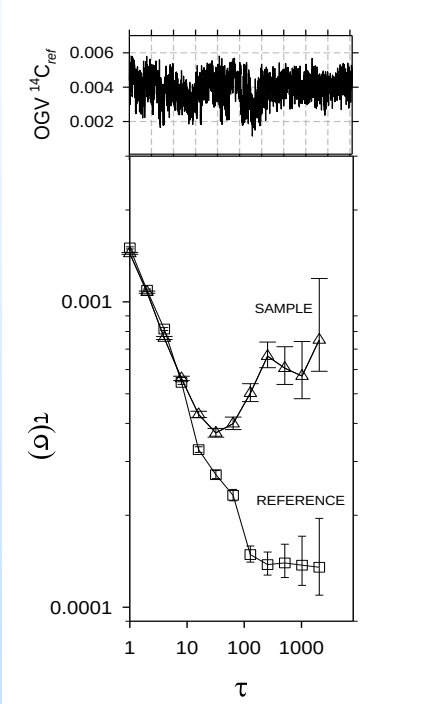


GMP Field Operation



GMP $^{14}CO_2$ Results





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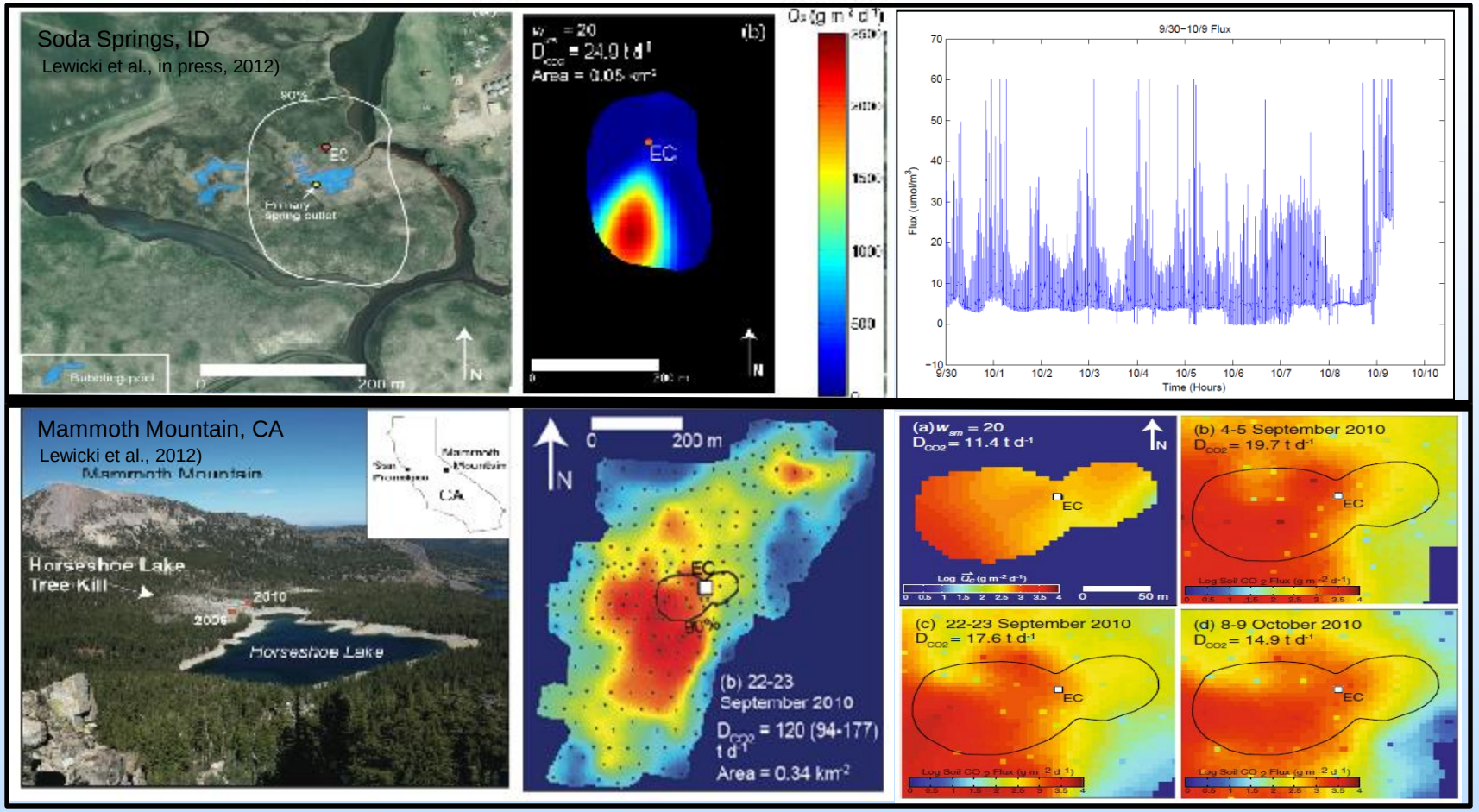
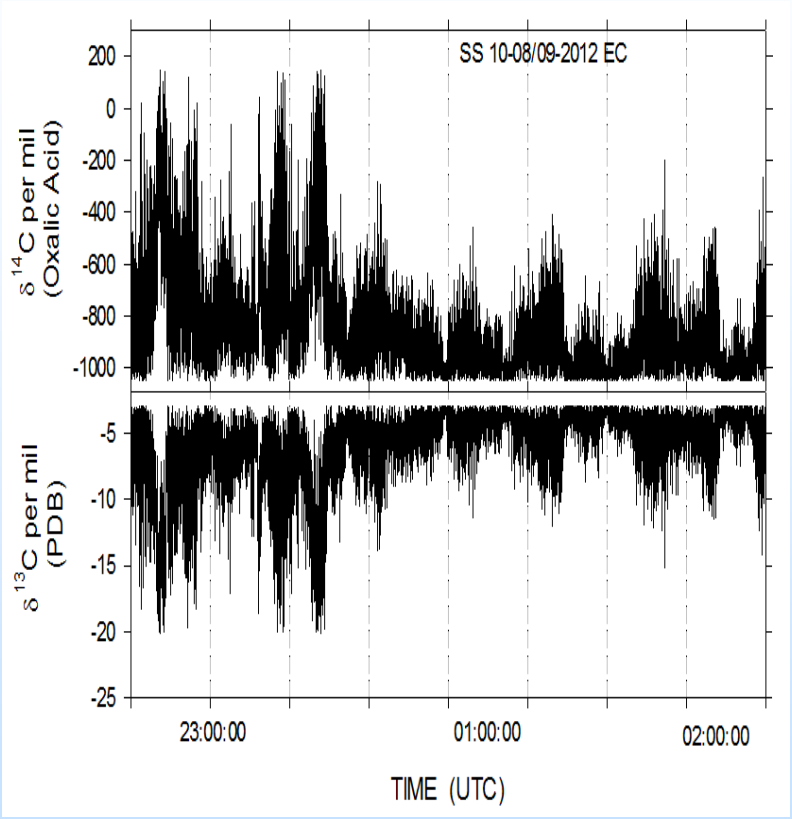
GMP Field Deployments, 2010, 2011

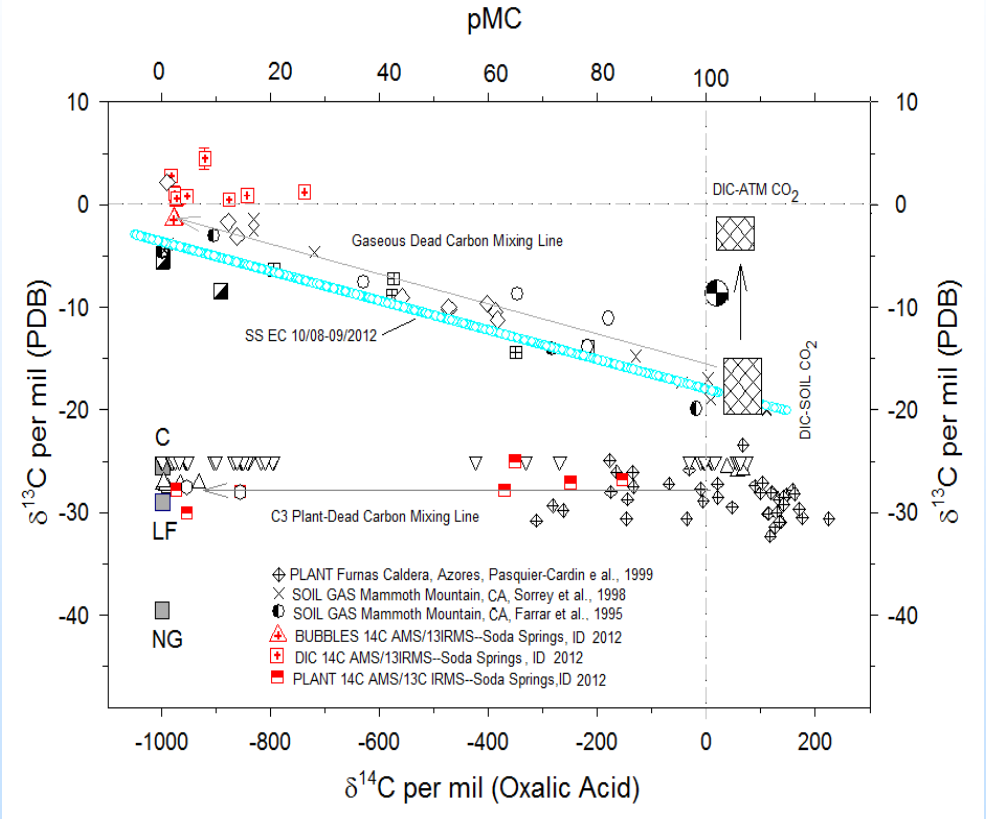


Soda Springs Site hosted by Travis McLing, Idaho National Laboratory

GMP Soda Springs, ID



SS Eddy Covariance



Comparative Data

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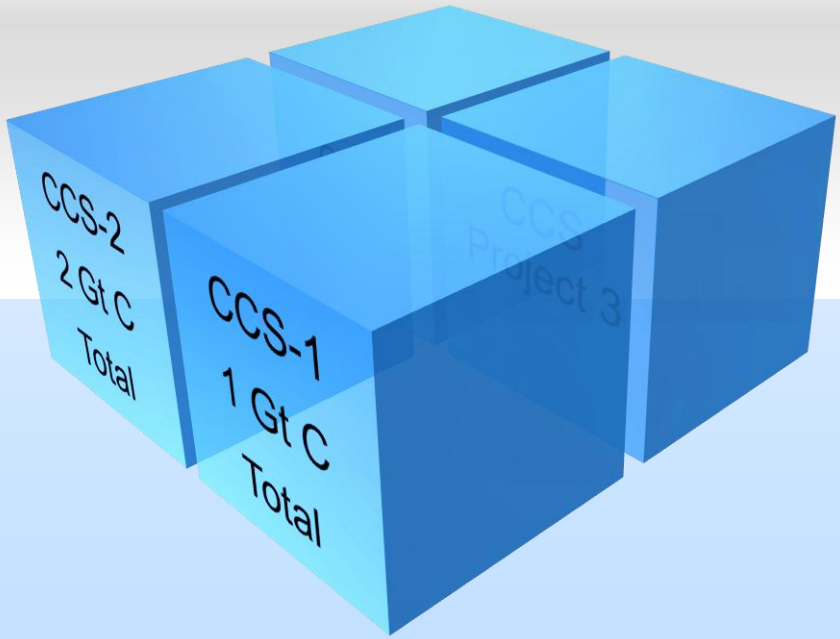
Carbon in a Box: A Proposed CCS Carbon Financial Instrument (CCS-CFI)

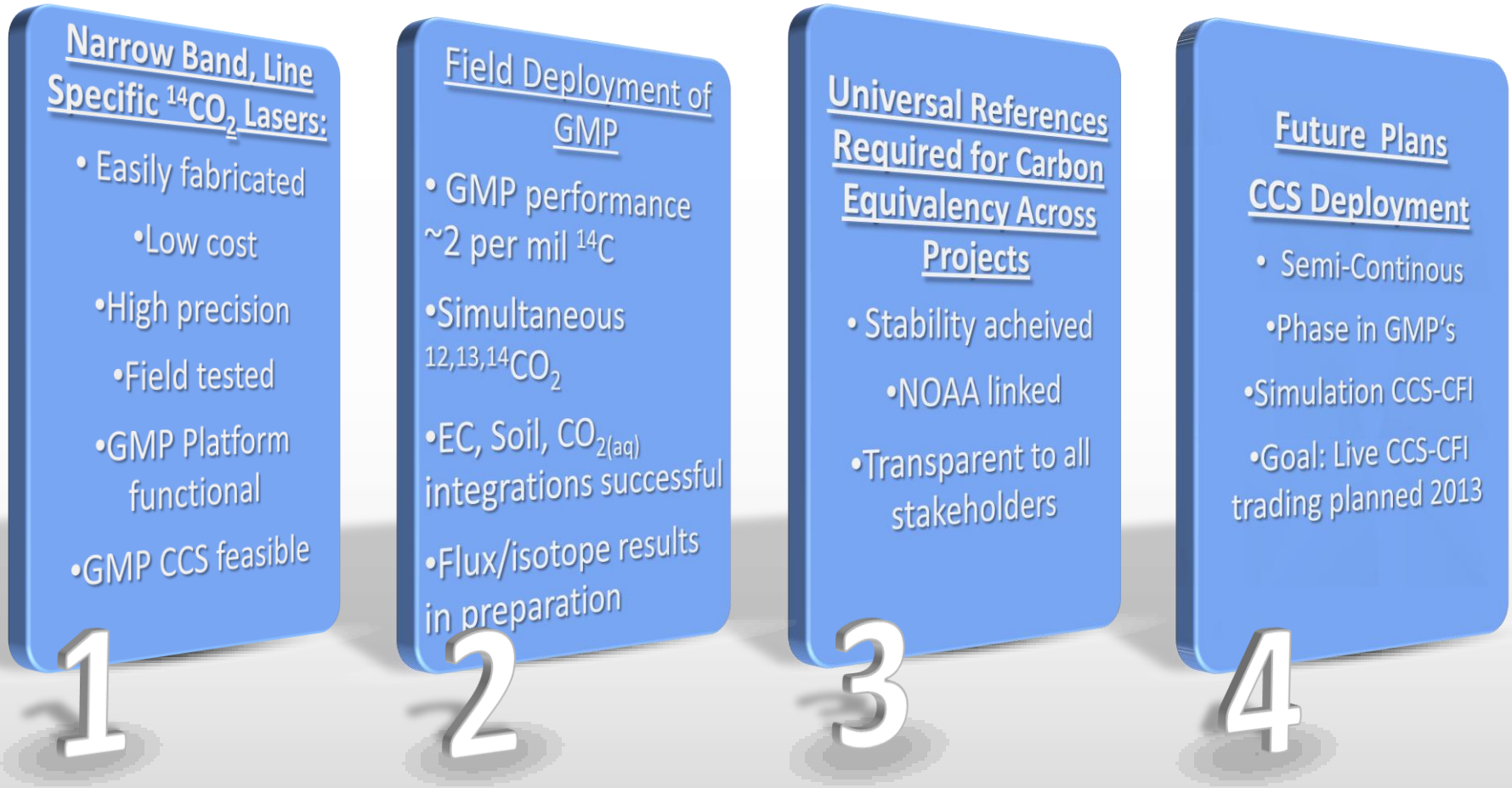
- Mechanism to catalyze monetization of CCS "secured carbon"?
- Adapt existing securities structures to biogeochemical features of carbon sinks—including CCS.
- Hypothetical Example: Geologic CO_2 reservoir capacity: ~ 1 Gt C (1 billion metric tons)

▪Securities approach: pre-sell storage capacity (e.g., blocks of 100 metric tons carbon @ \$10 mt^{-1}) => \$100M

▪Manage CCS investment risk in the context of modern portfolio theory



Project Summary & Future Plans



Appendix 1: Bibliography

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