In-Situ Non-Invasive Soil Carbon Measurement

DOE
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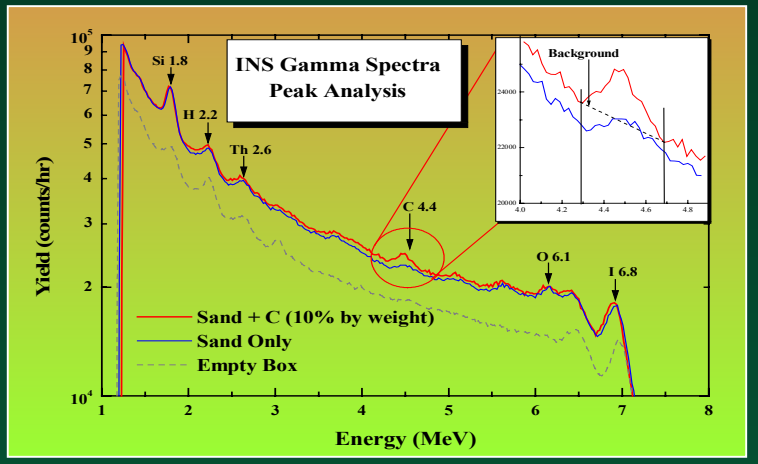
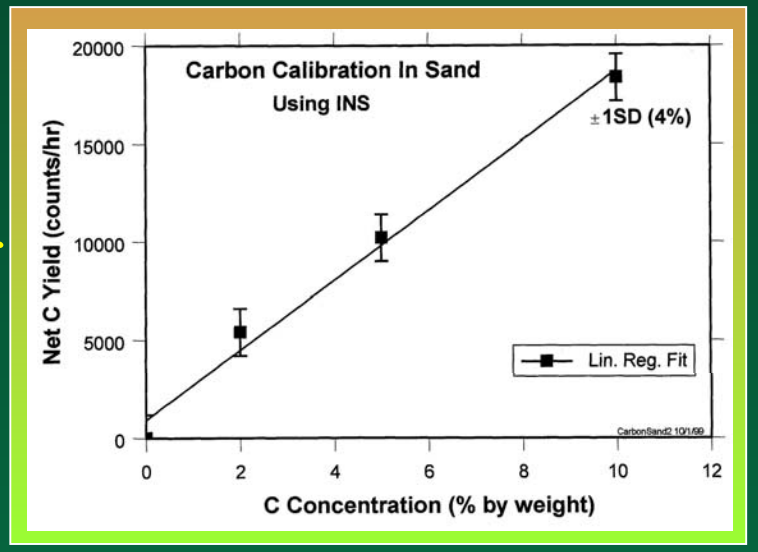
ISSCM

In- Situ Soil Carbon Measurement (ISSCM) is based on inelastic scattering of 14 MeV neutrons from the carbon nucleus in soil, and measuring the carbon characteristic 4.4 MeV gamma radiation.

ISSCM Proof-Of-Principle



Using clinical facility to measure carbon, shown above, carbon spectra, top right, from 70 lb soil samples (placed instead of a subject) and the resulting calibration line demonstrates the feasibility to measure carbon in soil.



ISSCM New Facility

Construction of an experimental aluminum box (5'x4'x4') to hold sand with an adjustable wall to 4', 5', and 6'.

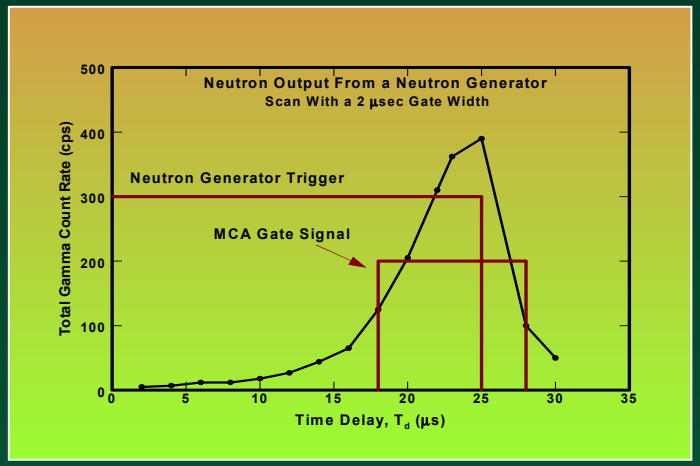
Positioning of the neutron generator, outlined in red, together with the primary shielding that consists of iron and borated water covered with borax.

ISSCM New Facility

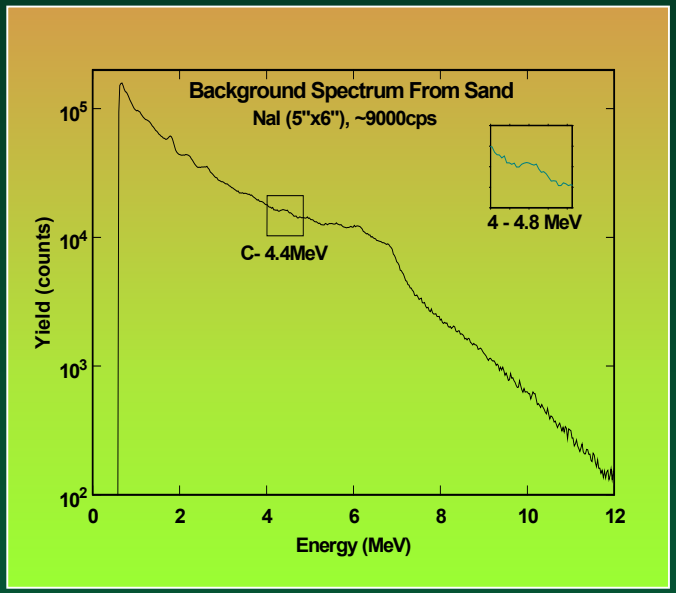
Preliminary Experimental Setup

Neutron
Generator

ISSCM Results

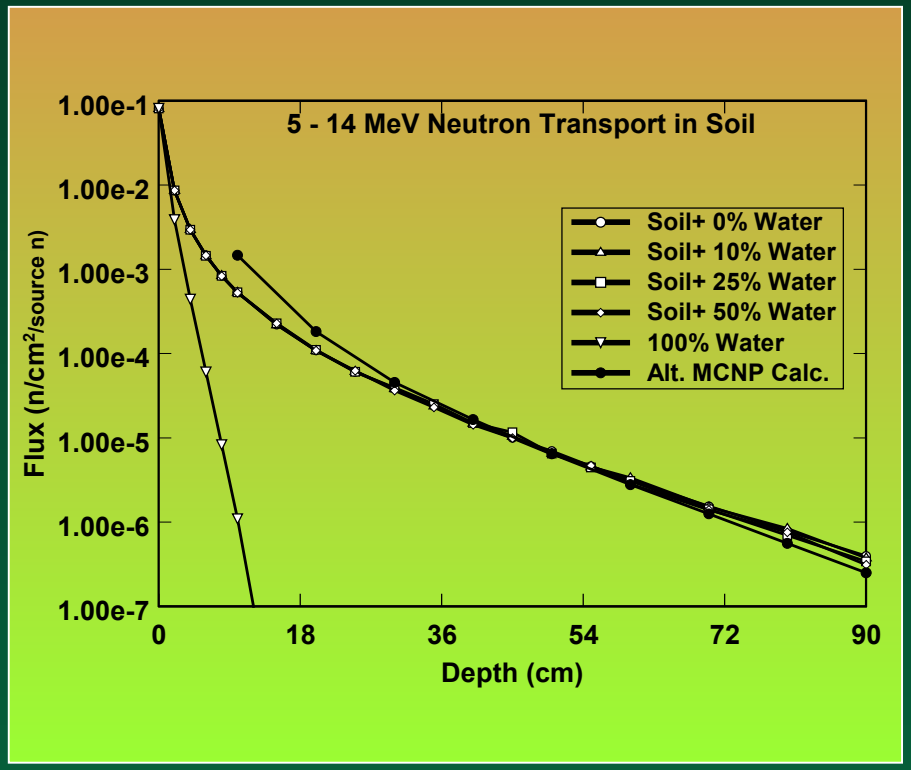


Optimization of the Multi Channel Analyzer gate signal. NG trigger pulse, the results of the scan and the final selection of the gate width are plotted in the graph above.



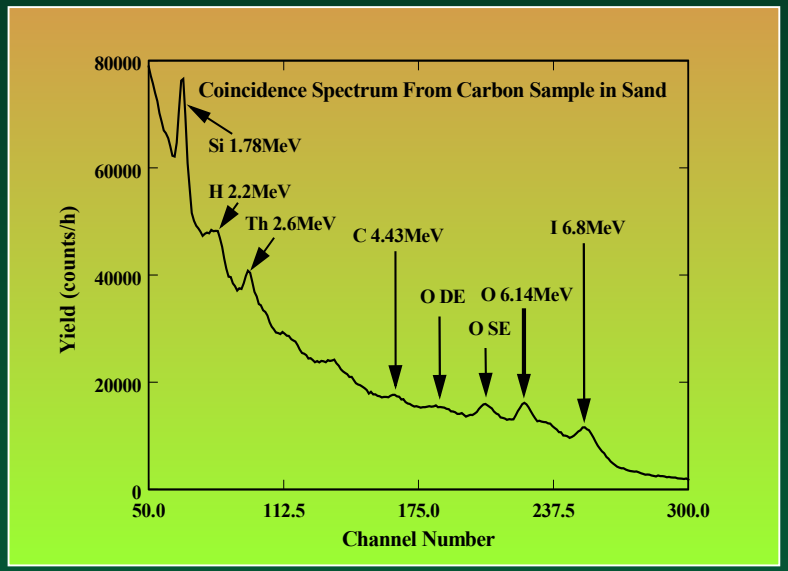
High count rate background spectrum derived from sand using the current set-up. There is some carbon peak visible in the background.

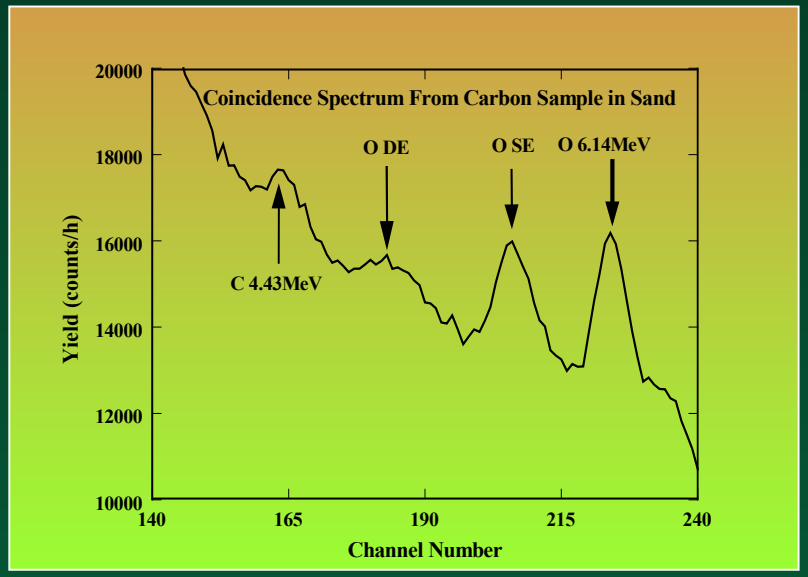
ISSCM Results



MCNP calculation revealed that neutrons with energies above the threshold for inelastic interaction with carbon are not affected by the presence of water. Graph on left shows the same results using two independent MCNP calculations.

ISSCM Results

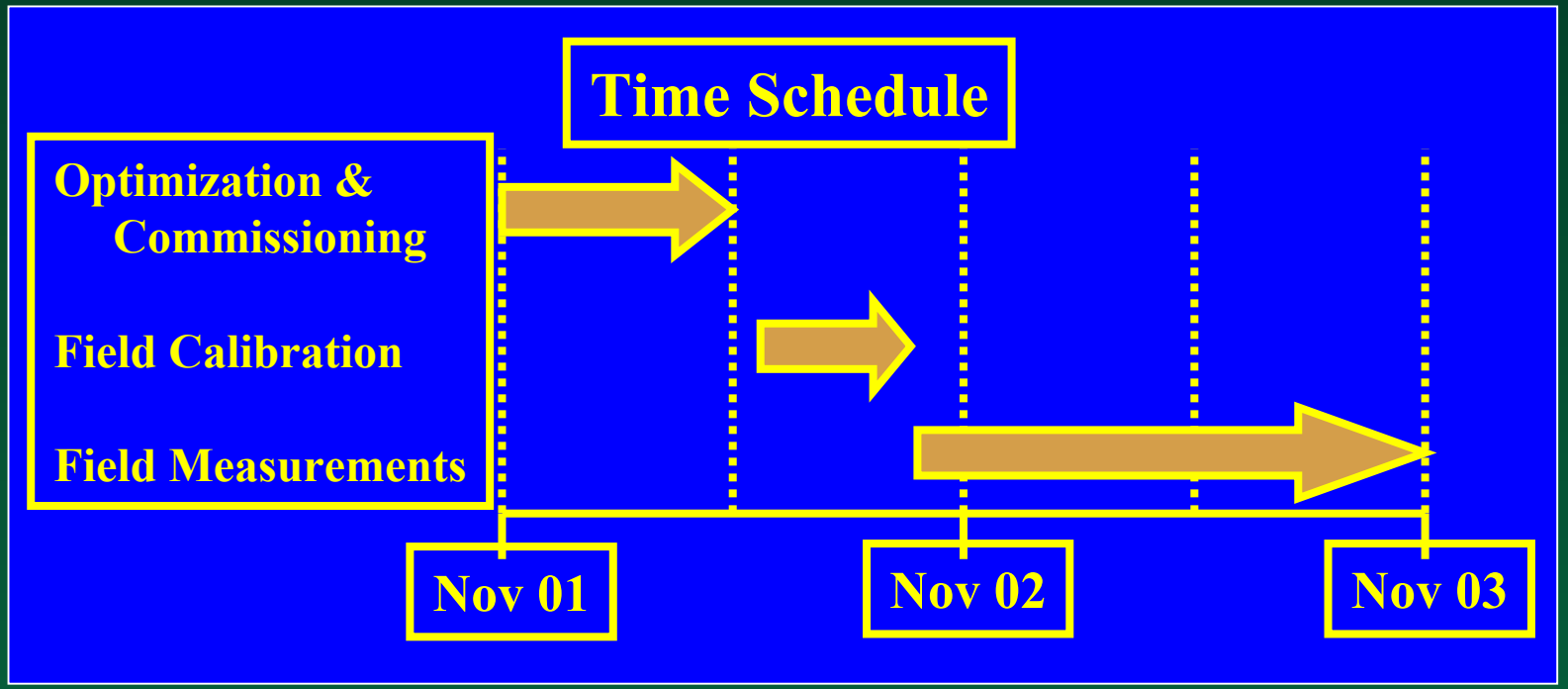




Improved spectrum with a lower count rate from a sand box containing a small carbon sample (~7 lb) distributed at a concentration of 10% by weight.

Section of the spectrum demonstrating the C peak. With a single detector 6000±180 net counts in the C peak yield a detection limit of about 2%. Design objective of the minimum detection limit is about 0.1%.

ISSCM Results



ISSCM Results

SUMMARY:

- **It is demonstrated that the proposed geometry for carbon detection in soil is viable.**
- **At 18" distance between the detector and the source the count rate must be lowered to reduce pile-up.**
- **With improved optimization and additional detectors should approach the design parameters of the system.**
- **MCNP calculations indicate that transport of the high energy neutron group does not depend on the soil moisture content, that would needs to be verified experimentally.**
- **"Radiation Area" posting is limited to about 4 feet from the NG.**
- **A system for field calibration is being prepared.**