



**Beta Analytic**

Determining biomass in  
blended alternative fuels  
using radiocarbon dating

# ***Carbon 14, what is it and how is it measured?***

Quantifying Biomass Content of Materials Using ASTM-D6866

**Alex Shroff**

Beta Analytic Inc.

November 15, 2011

Future Proofing Thermal Treatment

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## Beta Analytic

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using radiocarbon dating

Background of  
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Use in international  
regulations

Application of  
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Conclusion

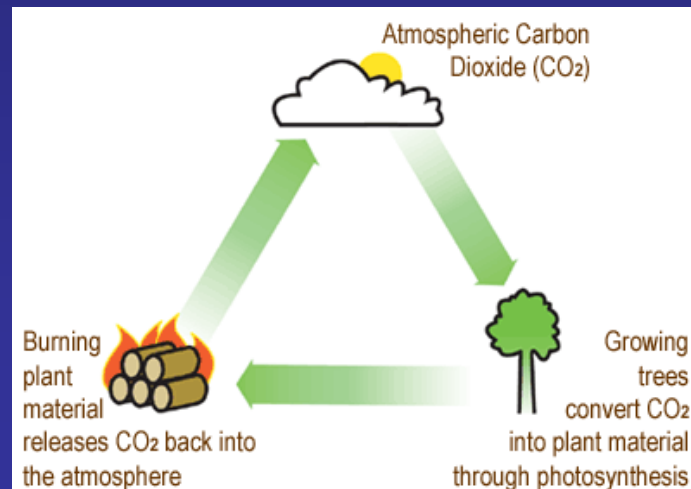
# Overview

- Background of ASTM D6866
- Use in international regulations for emissions
- Applications of ASTM D6866
- Background of Beta Analytic
- Conclusion

# Carbon Neutral CO<sub>2</sub>

## *(Biogenic CO<sub>2</sub>)*

- *Recently respired CO<sub>2</sub>*
- *Plants recently removed it from the air*
- *A by-product of biomass incineration*
- *Can be subtracted from GHG inventories*
- *Has value in the trading markets*



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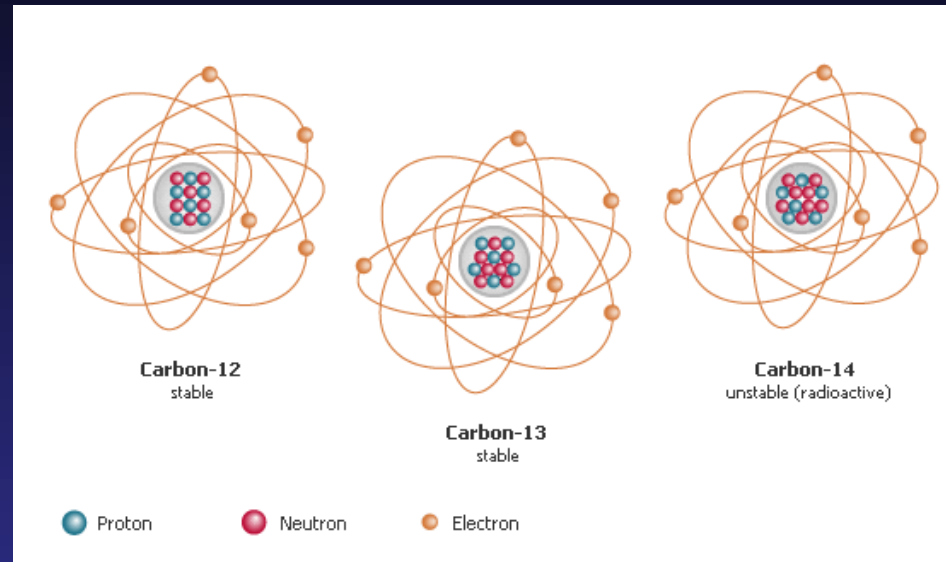
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# Carbon-14



*Naturally occurring  
in all biomass,  
absent in fossil fuels*

**ASTM D6866 measures it.**



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**Carbon-14 is ubiquitous in all living things.**

**But it doesn't stick around.**

**It slowly and gradually decays away after death, so that by 50,000 years there's none left.**

**Coal and fossil-derived materials do not have any carbon-14 whereas biomass does.**



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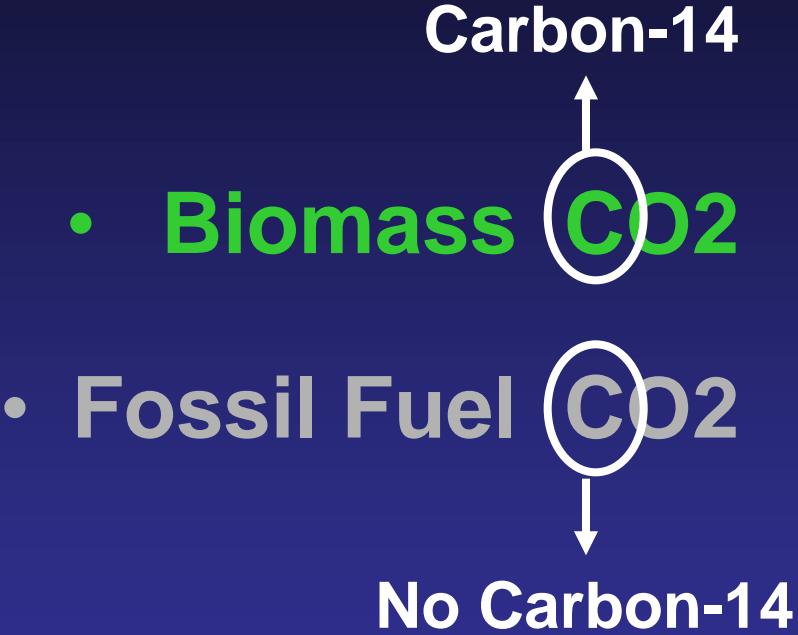
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# Take a good look, Identical?



They're NOT the same!



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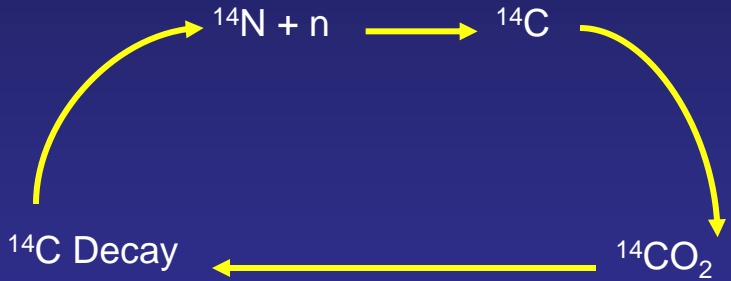
# The Radiocarbon Cycle

## STEP 1: Ongoing formation and decay of radiocarbon within the atmosphere

Nitrogen ( $^{14}\text{N}$ ) + cosmic neutrons  $\longrightarrow$  Radiocarbon ( $^{14}\text{C}$ )

Radiocarbon immediately oxidizes  $\longrightarrow$  Carbon dioxide ( $^{14}\text{CO}_2$ )

The radiocarbon immediately starts to decay ( $T^{1/2} = 5730$  years)



“Constant” amount of radiocarbon in the atmosphere as  $\text{CO}_2$

## STEP 2: Radiocarbon is removed from the atmosphere by plants

## STEP 3: Disequilibrium begins upon “death”

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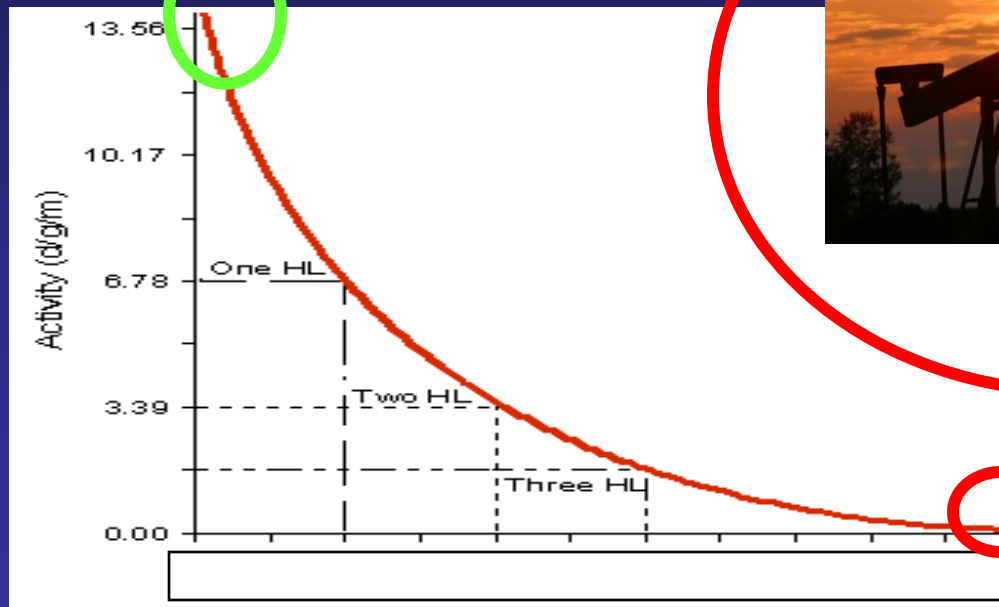
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# Conventional biomass – CO2 inventory accounting

(Stationary Combustion Sources – e.g. Co-firing, Biomass, Waste, etc.)

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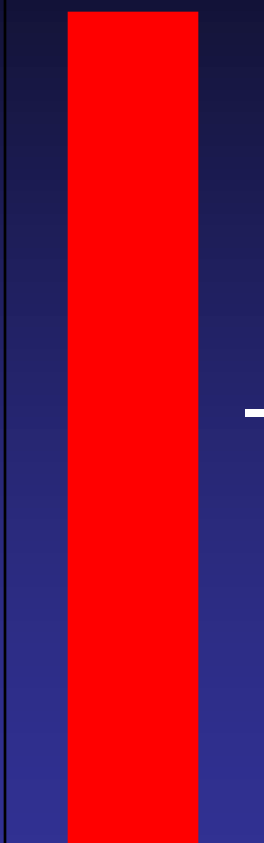
Application of ASTM D6866

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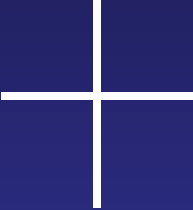
Conclusion



T  
O  
N  
S



CO<sub>2</sub>



Complicated physical characterization of the feed stock

Sorting, cutting, sectioning, and weighing raw fuel

Labor intensive, expensive, burdensome



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Determining biomass in blended alternative fuels using radiocarbon dating

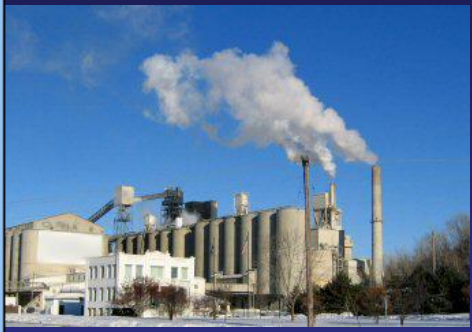
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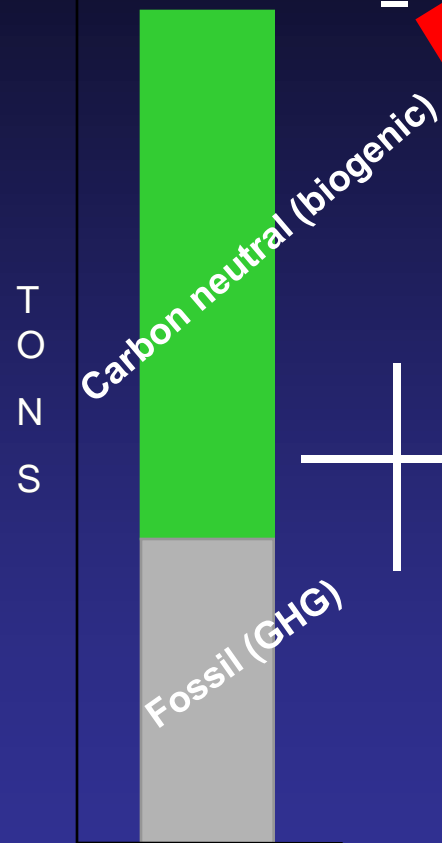
Conclusion



# ASTM D6866 biomass – CO2 inventory accounting

(Stationary Combustion Sources – e.g. Co-firing, Biomass, Waste, etc.)

## Measure CO<sub>2</sub> in the stack effluent



CO<sub>2</sub>

+

~~Complicated physical characterization of the feedstock~~

~~Sample cutting, sectioning and weighing~~

~~Labor intensive, expensive, burdensome~~



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ASTM-D6866 is a standardization of radiocarbon dating methods used by archaeologists to determine the age of fossils.

Methods that have been in use for 60 years (mature technology)

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**and being a mature industry . . .**

- **Expertise**
- **Laboratories**
- **Well-known sources of error**
- **Supply Lines**
- **Venders**
- **Instrumentation**
- **Raw materials**

**Complete pre-existing infrastructure**

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## Alternative fuel biomass determination: C14 Dating internationally recognized

### ASTM International

- Standardized through ASTM D6866

### CEN (European Committee for Standardization)

- Standardized through CEN 15440 (CEN 15747)

### EU-ETS (EU Emission Trading Scheme)

- Recommends CEN 15747 for refuse-derived fuels

### ROCs (Renewable Obligation Program UK)

- Approved for use in FMS procedures
- Program based on energy instead of CO<sub>2</sub>.

### US EPA (Environmental Protection Agency)

- Required to report carbon-neutral CO<sub>2</sub> in waste and blended alternative fuels
- Required for waste derived biofuels and recommended for imported blended biofuels

### ARB (California Air Resources Board)

- Required to report carbon-neutral CO<sub>2</sub> in waste and blended alternative fuels

### TCR (The Climate Registry)

- Measuring biogenic emissions from biofuels, waste fuels, and biomass co-firing.

### WCI (Western Climate Initiative)

- For combustion units using mixed fuels and waste-derived fuels

### Australia Greenhouse and Energy Reporting

- Determine the amounts of each kind of fuel in blended liquid or solid fuels.

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## *EPA Mandatory Greenhouse Gas Reporting Rule*

“Carbon dioxide emissions from the combustion of biogenic fuels shall be excluded from the calculations.”

“Perform the ASTM D7459–08 sampling and the ASTM D6866–08 analysis at least once in every calendar quarter in which MSW is combusted in the unit.”

“ASTM D6866–08 and ASTM D7459–08 may be used to determine the biogenic portion of the CO<sub>2</sub> emissions in every calendar quarter in which biomass and non-biogenic fuels are co-fired in the unit.”

## ASTM D6866 and EN 15440

- ASTM D6866 is part of the mandatory reporting requirements of California's AB 32, Western Climate Initiative, The Climate Registry and the EPA's GHG protocol.
- The European Union allows the use of ASTM D6866 for monitoring various types of heterogeneous fuels.
- The Australian government has recommended the use of ASTM D6866 for blended fuels.
- The Renewable Obligation Certificate program in the United Kingdom has included this method for monitoring biomass energy production.
- EN 15440 is used to monitor refuse-derived fuels for the European Union's Emission Trading Scheme.

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# UN CDM- AM0025

Avoided emissions from organic waste through alternative waste treatment processes

- United Nations Clean Development Mechanism (CDM)
- The UN CDM has developed AM0025 – a methodology applicable to solid waste management projects
- Version 11 released in 2008
- ASTM D6866 – required testing to estimate fraction of fossil carbon in total carbon of waste type such as municipal solid waste.
- As a minimum, sampling should be undertaken four times per year.



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# ISO 13833

“Stationary source emissions -- Determination of the ratio of biomass (biogenic) and fossil-derived carbon dioxide -- Radiocarbon sampling and determination”

- International Organization for Standardization
- Radiocarbon dating-based standard for stationary sources emissions
- Combines concepts of ASTM D6866 and D7459
- Requires proportional sampling
- Internationally recognized
- Committee draft to be completed summer 2011

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# ASTM D7459

Standard Practice for Collection of Integrated Samples for the Speciation of Biomass (Biogenic) and Fossil-Derived Carbon Dioxide Emitted from Stationary Emissions Sources

- Established for the EPA Mandatory Greenhouse Gas Reporting Rule
- Outlines the proper technique in collecting gas samples from stacks
- Specifically developed for ASTM D6866
- Included as a requirement in AM0025
- Used as basis for international ISO standard under development

## Considerations in using ASTM-D6866

- All carbon components must be either fossil or contemporary (respiring carbon within last 10 years)
- The reported result will be unique to the actual material analyzed
- Ensure a representative sample is analyzed
- Consider the homogeneity of your fuel



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# Tire-Derived Fuel (TDF)

- Some regulators incorrectly believe tires are 100% petroleum based
- Tires can range from 5% to 30% biomass carbon
- 2009 study by Aliapur (Bridgestone, Continental, Dunlop Goodyear, Kléber, Michelin and Pirelli) analyzed TDF using ASTM D6866 to verify this claim

Parameter	Used Passenger Car Tires	Used Truck Tires	Coal	Petroleum Coke
<b>Biomass</b>	<b>17-20.3%</b>	<b>28.6-29.7%</b>	<b>0%</b>	<b>0%</b>
Carbon	67.5 – 70.1%	59.7-62.6%	64-68%	84-97%
NCV (MJ/kg)	29.5 – 30.6	26.1 – 26.7	26	32

- Biomass content combined with a high BTU value significantly reduces greenhouse emissions over coal

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# Reporting

Simple Visual Report

Easy Inter-comparison

Instinctively Obvious



ISO-17025 Accredited Testing Laboratory

PJLA ISO-17025/IEC 17025:2005 Testing Accreditation # 59423

Beta Analytic Inc.  
4985 SW 74 Court  
Miami, Florida 33155 USA  
Tel: 305-662-7760  
Fax: 305-663-0964  
info@betalabservices.com  
www.betalabservices.com

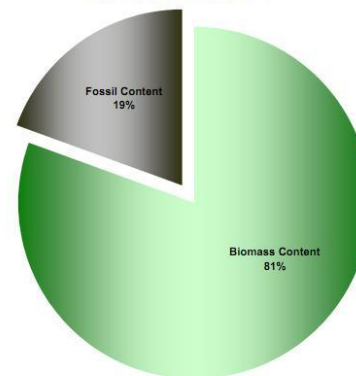
### Report of Biobased Content Analysis using ASTM-D6866

Submitter: XYZ Inc.  
Submitter Label: A  
Laboratory Number: BETA-0001  
Material Analyzed: LIQUID  
Date Received: October 5, 2010  
Date Reported: October 9, 2010

Example

Mean Biobased Result: **81% \***

Proportions Biobased vs. Fossil Based indicated by <sup>14</sup>C content



\* ASTM-D6866 cites precision on The Mean Biobased Result as +/- 3% (absolute). This is the most conservative estimate of error in the measurement of complex biobased containing solids and liquids based on empirical results. Real precision for readily combustible and homogenous materials (e.g. gasoline) and especially samples received as CO2 (e.g. flue gas or CEMS exhaust) can be as low as +/- 0.5-2%. The result only applies to the analyzed material. Fluctuations in carbon content within a batch of product, gasoline or flue gas must be determined separately (e.g. averaged measurements of multiple solids or liquids, and single measurement of the combination of gas aliquots collected over time). The accuracy of the result as it applies to the analyzed product, fuel, or flue gas relies upon all the carbon in the analyzed material originating from either recently respired atmospheric carbon dioxide (within the last decade) or fossil carbon (more than 50,000 years old). "Percent biobased" specifically relates % renewable (or fossil) carbon to total carbon, not to total mass or molecular weight. Mean Biobased estimates greater than 100% are assigned a value of 100% for simplification.



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# Time and Cost

How long does it take to get a result?

**4-7 Business Days**

How much does it cost?

**£395 per analysis**

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# ISO 17025

- Highest level of recognized quality any testing laboratory can attain
- Recognized by every major certification program
- Beta Analytic was awarded the ISO/IEC 17025: 2005 accreditation
- Only provider of radiocarbon determinations in the world with ISO 17025 Accreditation



Quality is Assured



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# *Company Background*

- Over 30 years in business, considered the leader of our field
- Fast turn-around times (as little as 24 hours)
- Confidentiality of all results
- Large throughput operation [52 LSC counters, 2 mass spectrometers, 4 accelerator mass spectrometers, 16 chemistry lines]
- 20 dedicated full-time professionals, no part-time students learning on your samples
- ISO/IEC 17025:2005 accredited





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- Carbon-14 is present in biomass and absent in fossil fuels
- ASTM D6866 is recognized internationally as a method to measure renewable carbon in CO<sub>2</sub> emissions.
- This method can be used on solids, liquids, and gas samples.
- AM0025 CDM methodology for Waste to Energy requires ASTM D6866

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**WWW.BETALABSERVICES.COM**

### European Facility

Beta Analytic Limited  
London BioScience Innovation Centre  
2 Royal College Street  
London NW10NH  
United Kingdom  
Tel: +(44) 020 7617 7490  
Email: [info@betalabservices.com](mailto:info@betalabservices.com)

### Japan Representative

Chikyu Kagaku Kenkyusho Corp.  
1-608 Ueda-Honmachi  
Tenpaku-ku  
Nagoya 468-0007  
Japan  
Tel: +(81) 52 802 0703  
Email: [geoinfo@geolab.co.jp](mailto:geoinfo@geolab.co.jp)  
Website: [www.betalabservices.com/jp](http://www.betalabservices.com/jp)

### United States (HQ)

4985 SW 74 Court  
Miami, Florida 33155  
Tel: +1 305 662 7760  
Info@betalabservices.com

### China Forwarding Facility

Beta Analytic Inc.  
5/F South Block Tower C, Raycom InfoTech Park  
No.2 KeXueYuan South Road, Haidian District,  
Beijing 100190  
China  
Tel: +(86) 10 8418 1950  
Email: [info@radiocarbon.cn](mailto:info@radiocarbon.cn)  
Website: <http://www.radiocarbon.cn>

### India Forwarding Facility

Beta Analytic Inc.  
4th Floor, Rectangle 1  
Commercial Complex D4  
Saket, New Delhi 110017  
India  
Tel: +(91) 9013020788  
Email: [info@radiocarbon.in](mailto:info@radiocarbon.in)

### Latin American Forwarding Facility

Beta Analytic Inc.  
Avenida das Nações Unidas, nº 12.551 - 9º andar  
Cep: 04578-000 - São Paulo  
Brazil  
Tel: +(55) 11 3958 8586  
Email: [info@radiocarbon.eu](mailto:info@radiocarbon.eu)

### Australia Forwarding Facility

Beta Analytic Inc.  
1, Pacific Highway, Level 12,  
North Sydney NSW 2060  
Australia  
Tel: +(61) 2 82053107  
Fax: +61 2 9959 3003

**Alex Shroff**  
**Ashroff@betalabservices.com**