



## SPECTRUM TRACER SERVICES

*Spectrum Tracer Services, LLC (STS) is a provider of oilfield tracer chemicals and RA tracers with over a combined 90 years' experience within the oil and gas industry.*

Spectrum Tracer Services, LLC (STS) is a provider of oilfield tracer chemicals and RA tracers with over a combined 90 years' experience within the oil and gas industry.

President, Steve Faurot, P.E., has a background as a fracture design engineer along with expertise in tracer diagnostics with major service providers. Our Vice-President, Dr. Jon LaRue, comes from a management, reservoir engineering, and operations background.

Spectrum's corporate office is located in Tulsa, Oklahoma, along with its state of the art chemical testing facility. STS operates in 18 states and Canada.

**"They did a great job  
—simple prop tag with one isotope.  
Their professionalism, safety, and  
protocol were excellent."**

Joel Fox  
Encana Natural Gas



SPECTRUM  
TRACER  
SERVICES

# SERVICE IS WHO WE ARE AND WHAT WE DO.

Currently, we have traced over 3,500+ wells in 18 states and Canada. Since 2010, we have been the industry leader in advancing downhole tracer technology. Our unique patent pending products, combined with our continuing R&D efforts, place us in the vanguard of downhole completion diagnostics. We continue to improve and expand our product lines in order to provide oil and gas producers information they can use to improve their bottom line.

## **TEST, DON'T GUESS!**

The Spectrum team is an innovative company that meets the challenges placed before them. Creating a value difference for our customers is our hallmark. Spectrum continues to increase knowledge and opportunities for operators by creating innovative technologies.





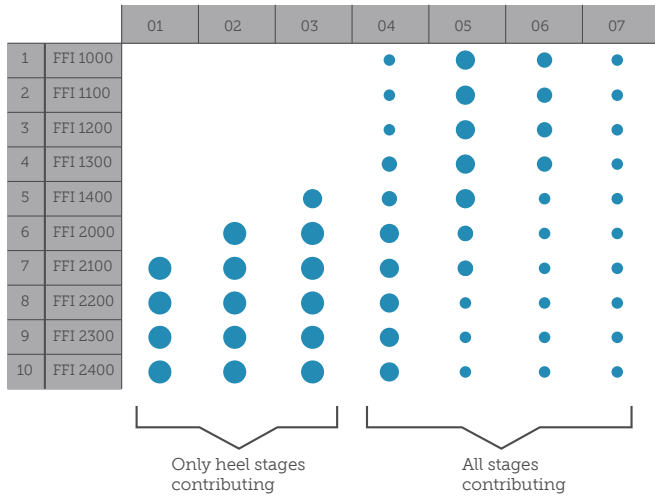
# FRAC FLUID IDENTIFIER

## WATER SOLUBLE TRACERS

- 2-3 DAY TURNAROUND •
- \*ON ANALYSIS ONCE SAMPLES RECEIVED AT TULSA LAB

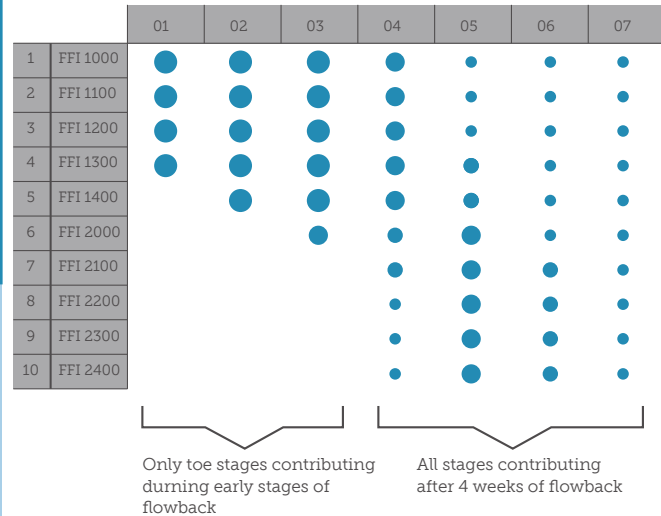
### EARLY HEEL STAGE PRODUCTION & LATE TOE STAGE ARRIVAL

Subject well flowing back post-frac, with FFI™ tracer data indicating only heel area stages initially contributing to production.



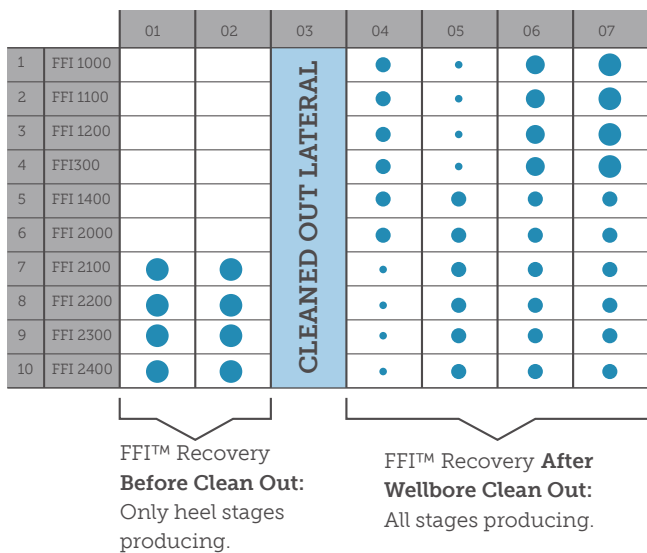
### EARLY TOE STAGE PRODUCTION & LATE HEEL STAGE ARRIVAL

Subject well flowing back post-frac, with FFI™ tracer data indicating only toe area stages initially contributing to production.



### FRAC FLUID IDENTIFIERS (FFI™)

Subject well flowedback 30 days post frac, FFI™ tracer data indicating no production from the toe section of lateral. Well cleaned out, and post-cleanout tracer data confirmed all stages producing.



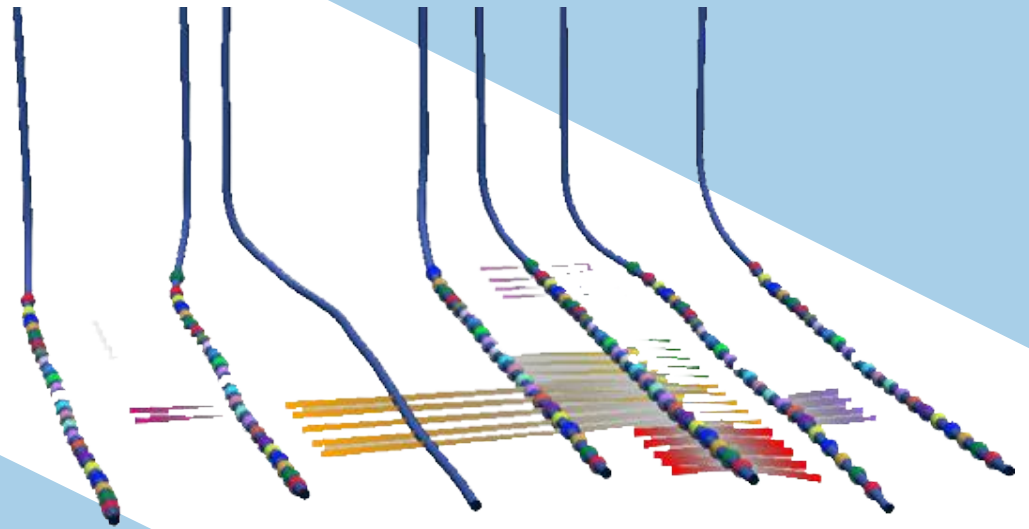
STS recently added several series of Fracture Fluid Identifiers (FFI™) increasing our selection of FFIs™. We anticipate additions within each new series, and continue to work diligently testing other FFI™ prospects to increase our range of inventory. The development of these unique fluid identifiers provide clients with qualitative analysis of fracture fluid returns from multiple stage completions.



SPECTRUM TRACER SERVICES

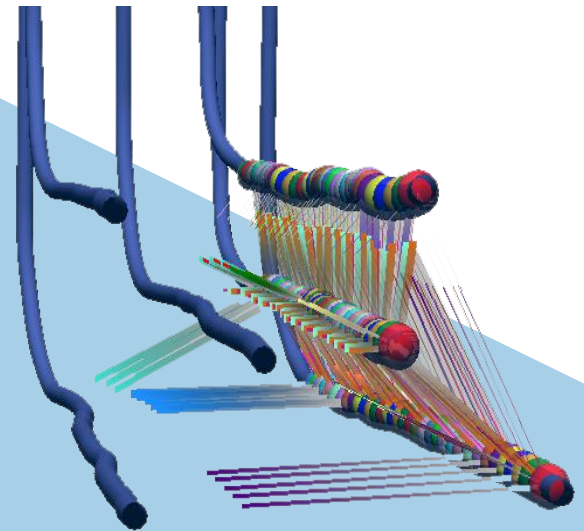


# Well Communication

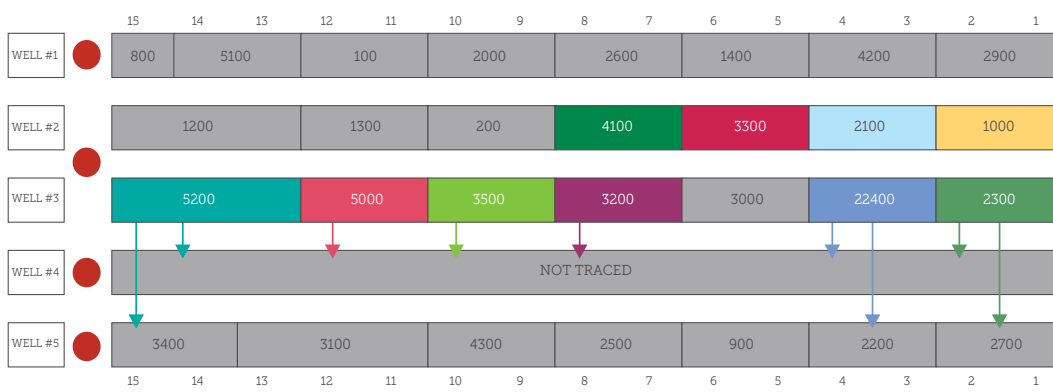


## FirstView™ 3-D Reporting

Since April 2014, Spectrum Tracer Services' FirstView™ reporting software has set the standard in user friendly, 3-D downhole visualization reporting. Our FirstView™ software is provided free of charge along with hard copy reports for each and every project. Regardless of completion type, FirstView™ software accurately presents active visualization of chemical tracer recovery, and well to well fluid communication. Our sample analysis, and quick reporting turnaround time, continue to be the shortest in the industry. The style of our presentations, and the quickness of our reporting, allows operators to take immediate and full advantage of the diagnostic information we generate.



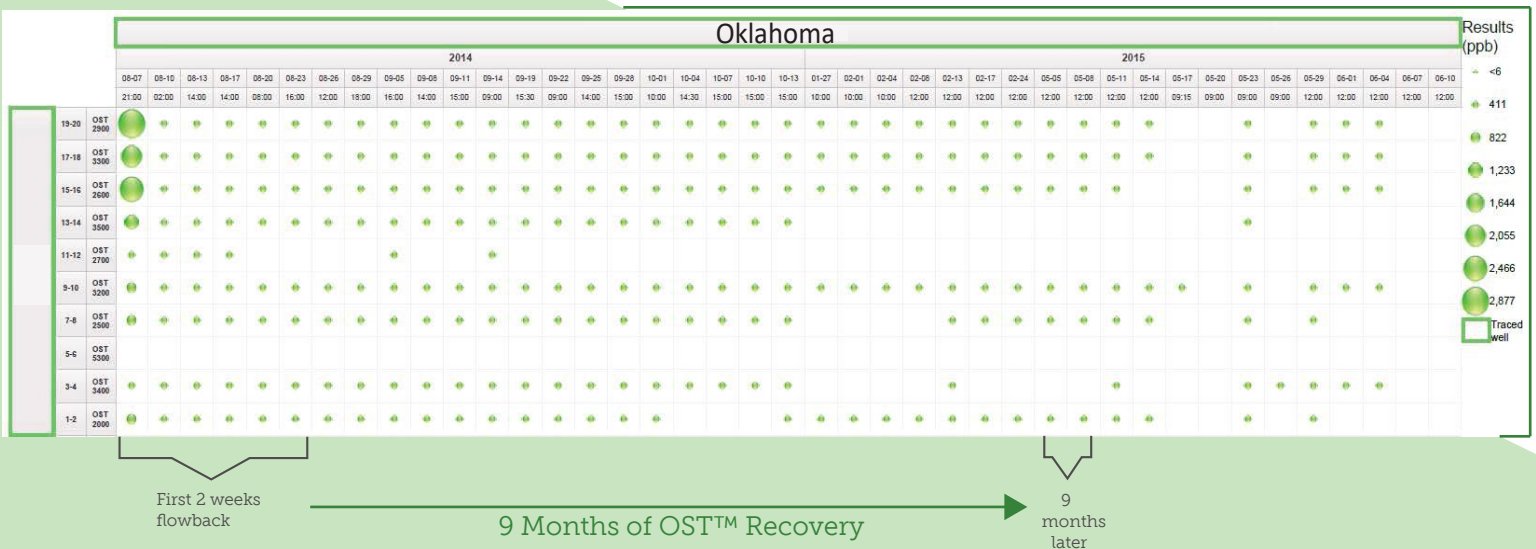
FFI™ BASED WELLBORE COMMUNICATION DIAGRAM





**OIL SOLUBLE TRACERS**  
 • 7-10 DAY TURNAROUND •  
 \*ON ANALYSIS ONCE SAMPLES RECEIVED AT TULSA LAB

**Long Term Oil Data Recovery  
 9 Months of OST™ and counting**



OSTs™ allow for diagnosis of multi-zone oil flow efficiency and is uniquely designed to deliver results for up to a year. Spectrum has designed a tracer chemical delivery system like no other. The design allows for delayed release of the OSTs™ chemicals during oil production. This provides the opportunity for extended sampling and long term analysis of production.

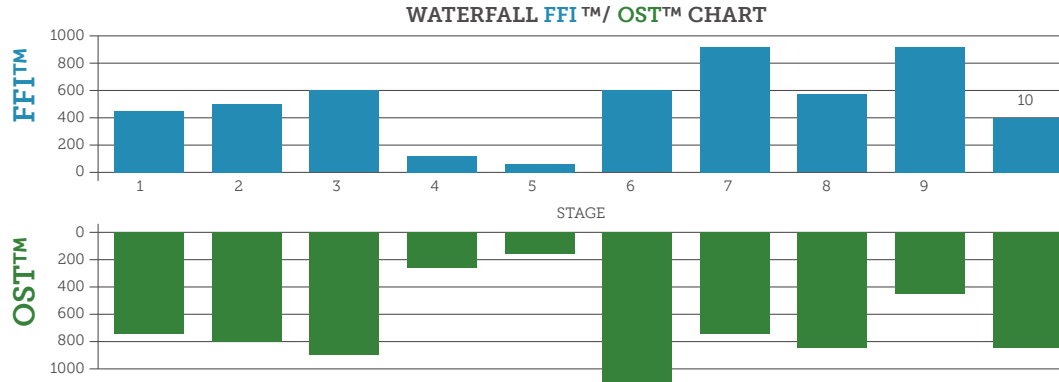
The development of these unique oil tracers provide clients with a qualitative analysis of the production fluid return from multiple stage completions; whether vertical, or horizontal completion. Utilizing its state-of-the-art equipment, STS provides prompt sample analysis; allowing for rapid decision making.



# FFI™/OST™ Combination Well

## POOR MIDDLE STAGES CONTRIBUTIONS

Subject well flowing back post-frac, with FFI™ (1) and OST™ (2) tracer data indicating middle stages not significantly contributing to production. Wellbore likely drilled out of target zone for stages 4 & 5.



## MIDDLE LATERAL STAGES NOT CONTRIBUTING

Subject well flowing back post-frac, with FFI™ and OST™ tracer data indicating middle stages not significantly contributing to production. Wellbore likely drilled out of target zone for stages 4 & 5.

**1 (FFI™)** sample number

stage		01	02	03	04	05	06	07
1	FFI 1000	●	●	●	●	●	●	●
2	FFI 1100	●	●	●	●	●	●	●
3	FFI 1200	●	●	●	●	●	●	●
4	FFU1300	●	●	●	●	●	●	●
5	FFI 1400	●	●	●	●	●	●	●
6	FFI 2000	●	●	●	●	●	●	●
7	FFI 2100	●	●	●	●	●	●	●
8	FFI 2200	●	●	●	●	●	●	●
9	FFI 2300	●	●	●	●	●	●	●
10	FFI 2400	●	●	●	●	●	●	●

**2 (OST™)** sample number

stage		01	02	03	04	05	06	07
1	OST 2000	●	●	●	●	●	●	●
2	OST 2100	●	●	●	●	●	●	●
3	OST 2200	●	●	●	●	●	●	●
4	OST 2300	●	●	●	●	●	●	●
5	OST 2400	●	●	●	●	●	●	●
6	OST 2500	●	●	●	●	●	●	●
7	OST 2600	●	●	●	●	●	●	●
8	OST 2700	●	●	●	●	●	●	●
9	OST 2800	●	●	●	●	●	●	●
10	OST 2900	●	●	●	●	●	●	●

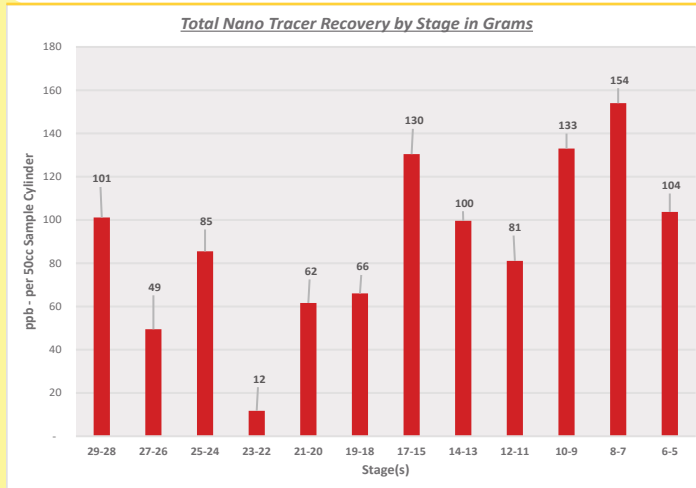


**NANO TRACERS**  
◦ 7 DAY TURNAROUND ◦

The ability to chemically trace natural gas at reservoir conditions using

Spectrum's NanoTracer™ products is our latest technical innovation. We currently utilize gas tracer chemical compounds, which, like our OSTs™, are deployed deep into the formation during hydraulic fracturing. The NanoTracers™ are inert volatile chemicals which partition into the gas phase in-situ. Gas samples are collected at the surface, then analyzed in our new, state-of-the-art, Tulsa, OK laboratory. NanoTracer™ compounds are not found in

nature, and as such, can be detected at incredibly low concentration levels in natural gas. This allows the potential of generating long-term tracing data trends by zone and stage, and aids in reservoir characterization.



RECOVERY TREND													1,490.0
Avg. Recovery (g)	3.0	1.5	2.5	0.3	1.8	1.9	3.8	2.9	2.4	3.9	14.2	3.1	3.1
Total Recovery (G)	101	49	85	12	62	66	130	100	81	133	154	104	1,159.9
% Recovery Per Stage	6.79%	3.32%	5.74%	0.79%	4.13%	4.43%	8.75%	6.68%	5.44%	8.93%	10.34%	6.96%	77.85%
% Inj. Recovery	5.06%	2.47%	4.27%	0.59%	3.08%	3.30%	4.35%	4.98%	4.05%	6.65%	7.70%	5.19%	Total Rec.
Stage % of Total	0.35%	0.17%	0.29%	0.04%	0.21%	0.23%	0.45%	0.34%	0.28%	0.46%	0.53%	0.36%	4.00%

Due to the unique chemistry of NanoTracers™, a very small amount of certain NanoTracers™ naturally dissolve into the oil phase of the reservoir. Spectrum Tracer Services, LLC is actively developing techniques to calibrate this behavior to reservoir conditions in order to calculate stage specific, pseudo-Gas Oil Ratios.



**TAGS** **TRACER ANALYSIS GAMMA SURVEY**

STS is proud to offer our Tracer Analysis Gamma Survey logging services (TAGS) which include a live tool and a memory tool. This service can be combined with our tracer services, or performed as an individual service. The logging tool acquires real time spectral gamma ray signatures, and with analysis, provides a three isotope gamma log.

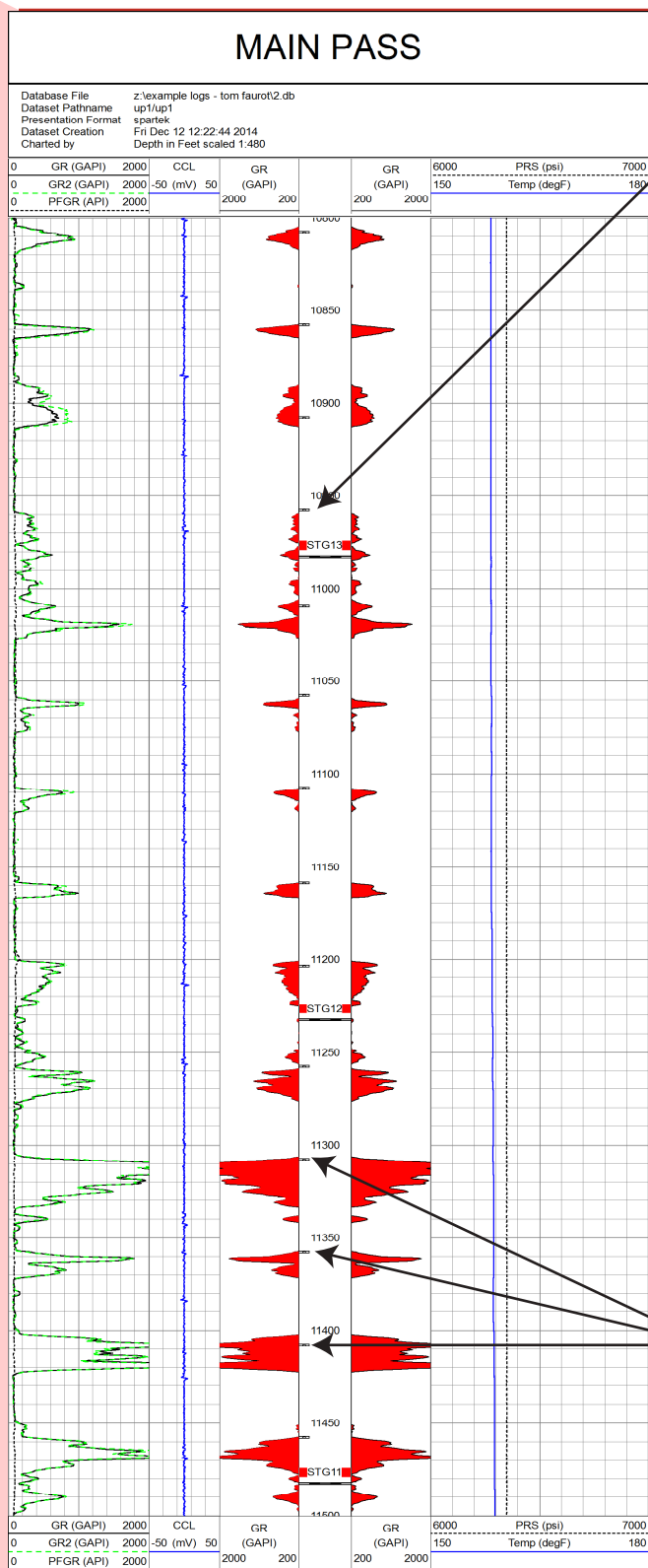
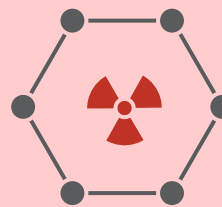
Currently, we have two different logging tools; a live tool and a memory tool. The live tool is a spectral gamma ray surface read-out only tool. Its measurements are 1-11/16" OD X 7' Length with a "Go" box connection (standard E-line). The methods of operation consist of E-line, E-coil, or Tractor. This tool has the ability to log multiple isotopes. The memory tool can be relayed by virtually any method; i.e. Coiled Tubing, Slick Line, E-Line, and E-coil. Its measurements are 1.375" X 72" Length with a Sucker Rod Pin connection. This tool can log multiple isotopes, but processes only as a single isotope.

Analyzing and processing of logs consists of a standard 1-2 day turn-around time. The logging division stands true to the "service" in Spectrum Tracer Services, and strives for customer satisfaction on location and the follow-up of final log results.

<b>DSGR - 1 11/16"</b>	
Length:	82.76"
Weight:	31 lbs
Diameter:	1.69"
Measuring points (from bottom):	
	CCL: 12"
	TEMP: 28"
	SGR: 69"
Working voltage:	100 V
Current:	65-75 mA
Spectrometry:	256/512 energy channels.
Surface equipment:	WARRIOR STIP panel
Tool usability:	Natural Gamma spectrometry, Isotope tracer
Software:	Warrior acquisition software
Temperature range:	350F - 2 hours, 300F - 3.5 hours







Minimal gamma signal at perf cluster suggests under stimulated section of reservoir.

**Case History**

STS utilizes the three standard RA tracer materials: (1) Iridium, (2) Scandium, and (3) Antimony. Tracing a well with radioisotopes gives the client the ability to determine proppant placement in perf clusters, and aids in fracture geometry identification.

The horizontal well pictured indicates an isotope in which STS pumped into all stages. The isotope was injected with proppant during each frac stage. As seen in the log example, a standard GR analysis gives a qualitative answer of prop placement in multiple perf clusters within the same stage of completion. By utilizing the standard gamma ray tool, the customer receives a better value than using a spectral gamma ray tool, and receives the same results.

This horizontal well does not have traced proppant within detection limits of gamma ray tool in all perf clusters. The Gamma log indicates some perf clusters without adequate placement of proppant. Those perf clusters would be described as under stimulated or worst case, unstimulated. Large sections of pay may be left behind and reserves uncaptured. Better perf placement, or better perf schemes, may lead to better prop distribution along laterals and enhance overall well performance.

Gamma amplitude at perf clusters suggests good proppant placement. No clusters in this Stage(11) were missed or untreated.