ORTEC®

NaI-SS

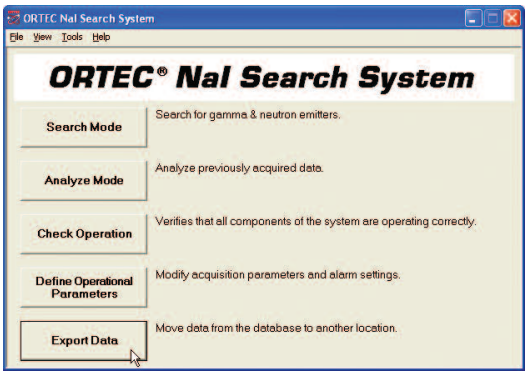
Radiation Search System

"Real Time Gamma and Neutron Source Location from the Ground or the Air."

AMETEK®
ADVANCED MEASUREMENT TECHNOLOGY

Nal-SS

- **Locates illicit transportation or lost sources.**
- **Omni-directional sensitivity.**
- **Integral GPS and Mapping software provides precise location of sources and historical record of area covered.**
- **Advanced data collection technique (list mode) means no “dead spots.”**
- **Clear and flexible data presentation.**
- **Compact and Modular: flexible packaging solutions to match application need.**
- **Powerful analysis of Gamma-ray spectra..**



The Nal-SS system was first developed in the aftermath of 9-11 to respond to the requirement for a compact and easily portable system capable of LOCATING neutron and/or gamma-ray sources from a moving vehicle. First generation versions of these systems are in everyday use in situations around the world.

The Need

There is an ongoing need for radiation detection instruments for Homeland Security applications in general, and in particular for mobile systems with high sensitivity capable of being used to detect radioactive sources in a "drive-by" or "fly-by" mode. These instruments must be capable of detecting and identifying radioactive materials that could be used in an Improvised Nuclear Device (IND) or Radiological Dispersion Device (RDD). There is also concern over so-called "orphan" sources, that is, lost or undocumented sources that could be used for malicious purposes.

The source of interest may be stationary, e.g. in a building or present in a moving vehicle or vessel. Mobile radioactive material search systems have the advantage that they can be employed quickly to find elevated activity from gamma-emitting, radioactive sources. To increase the probability of detection and unambiguous identification, Sodium Iodide (NaI) detectors offer high efficiency (sensitivity) and better resolution (selectivity) than systems based upon plastic scintillators.

Special Nuclear Material, (SNM), used to fabricate an IND, can also be identified by detection of spontaneous fission neutron emission. These neutrons are detectable even when the gamma emissions are shielded by heavy metal, but may be confused with neutrons in the environmental background. The detection of neutrons is generally useful for confirmatory purposes.

The ORTEC Nal-SS Solution

The ORTEC Nal-SS is a Gamma-Neutron search system that offers high sensitivity to gamma and neutron radiation, and is conveniently packaged in one or more rugged plastic "pelican type" containers. For automotive use, the system may be placed inside the luggage space or installed in a conventional roof top carrier.

The system provides visual and audible indicators of neutron and gamma count-rates displayed on a GPS-based surface map in real time as the vehicle moves. Data is gathered continuously and assembled in 1 second "slices," which can be displayed in a variety of formats, or passed to an advanced analysis "engine" (included) for further processing, either for a single slice or group of slices covering an interval when the visual display was indicating an in range source. Historic data may be recalled for re-analysis.

System Hardware

- Modular configurations based upon ORTEC standard components.
- Gamma-only configurations available.
- Multiple gamma and/or neutron detector modules if required.
- Flexible packaging options.

The basic NAI-SS gamma detection hardware consists of a single large volume NaI(Tl) detector (4x4x16 inch), supported by an ORTEC digiBASE. Systems employing much larger or multiple NaI detectors may also be configured on request. ORTEC digiBASE[1] electronics offer unmatched stability and use the latest digital signal processing technology. The digiBASE itself is widely used in Homeland Security and other industrial applications of NaI detectors because of its unique combination of features, overall reliability and performance. It combines high voltage and digital MCA support for the NaI detector(s), and the neutron counter input in a small package. Gamma-ray data are gathered in "list mode," streaming data event-by-event to the system laptop computer. This eliminates any "blind spots" due to data transfer[2] as the vehicle or aircraft moves over the terrain. The neutron detector consists of two large-volume, moderated ^{3}He detectors. These detectors increase the sensitivity to Special Nuclear Material by detecting the neutron signature even when heavy metal shielding has been used to suppress the gamma emissions. An electronic module provides high voltage and signal pickoff from the ^{3}He detectors. The output is counted by the digiBASE. An optional four detector neutron sub-system is also available. Multiple neutron subsystems may be integrated in a single NaI-SS if the application requires it.

The system GPS records the position and height of each data slice, once per second.

Data transfer and hardware control via wireless networking is available as an option, making the system ideal for use in operations that require data to be interpreted by an expert at a remote location.

The system hardware is packaged in Pelican type cases, or for roof top automotive use, in a conventional car top carrier and shock mounted within a plastic foam cocoon. The system is controlled via a laptop computer. The entire system can operate from 12 V DC, as supplied from an automobile power outlet. The communications and control use high speed USB for fast information updating and accurate data monitoring.

Use In Other Measurement Tasks

The NaI-SS is primarily designed to be a search system. However, based on operational experience on incident simulation exercises, it is apparent that when packaged in the discrete containers inside the luggage space of a vehicle, it may be advantageous to be able to set up an ad-hoc contamination monitor or whole body monitor in the case of a radioactive release incident. The NaI(Tl) detector module(s) may be operated easily in this mode, and the ORTEC ScintiVision analysis software (included in the NAISS-B32 software suite) is available for spectral analysis.

System Software

The NAISS-B32 system software in version 2.5 includes a large number of enhancements over previous versions. Gamma-ray and neutron data are presented in a number of useful ways, including overlaying the data on a terrain or street map to identify the exact location of the source. The concept is to give an unfamiliar operator something easily understood. The activity values and location are recorded in an Access-compatible database. The gamma spectra are stored in standard ORTEC spectrum file format, and may be later analyzed with ScintiVision software, which is supplied with the system.

The system has integral data storage and every one-second "slice" is time stamped and stored to disk. Count rate monitoring and alarm signals are provided for both Neutron and Gamma channels.

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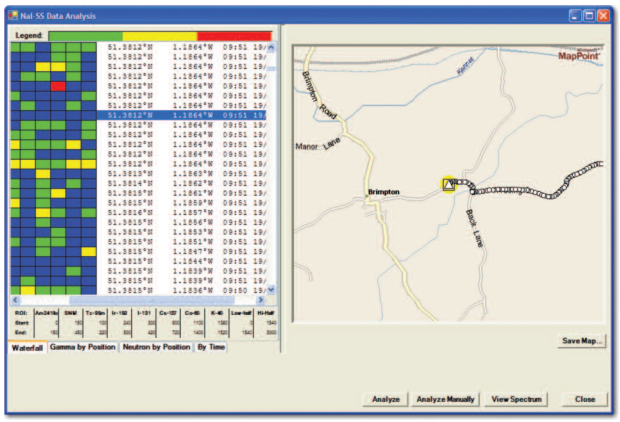
[1]The ORTEC digiBASE electronics are specially designed for high performance with NaI detectors. The digiBASE is a complete PMT-mounted digital Multichannel Analyzer (MCA) with high voltage, preamp, and computer interface in a small package. The digiBASE connects to an external computer using USB communication protocols. The digiBASE uses DSP technology to provide stability over a range of input count rates and temperature changes. As is well-known, NaI detectors are sensitive to drift due to external temperature changes. By using digital technology and a built-in gain stabilizer, the digiBASE can correct for such changes, making it an ideal MCA for this application. An input from the neutron counter tubes (TTL level) is used to centralize processing of pulses from both detector types with a minimum of hardware. In addition to using USB communications, the digiBASE also includes a list mode whereby the data can be collected in an event-driven manner. Throughput for counting increases substantially in this mode. Moreover, the data can be retrieved and integrated in smaller increments of time (down to milliseconds) than in traditional histogramming mode. See the digiBASE brochure for more information.

[2]If list mode was not employed there would be a loss of data during the "save-transfer-restart" cycle.

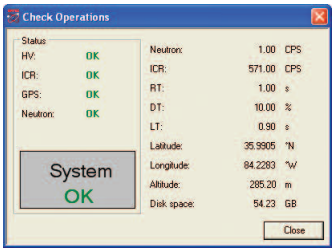
NaI-SS

Key Display Features

- Real-time tracking of gamma-ray and neutron count data "event-by-event" through hardware list mode, linked to GPS position data, with event alarms.
- Flexible real-time displays:
  - Waterfall plot
  - Count rate by position
  - Count rate by time
  - Spectrum by position
- Historical displays:
  - It is possible to "scroll backwards in time" to review previously acquired data. The map includes "breadcrumbs" which mark the route taken. This makes it easy to examine and analyze previously recorded events.
- Each data set contains the following information:
  - Acquisition Start Time.
  - GPS Position and Height.
  - Total Acquisition Duration (Real time).
  - Neutron Gross Counts for the ^{3}He detectors.
  - Complete 1024 channel Gamma Spectrum with acquisition time.



Historical Display.



Check Operations Page.

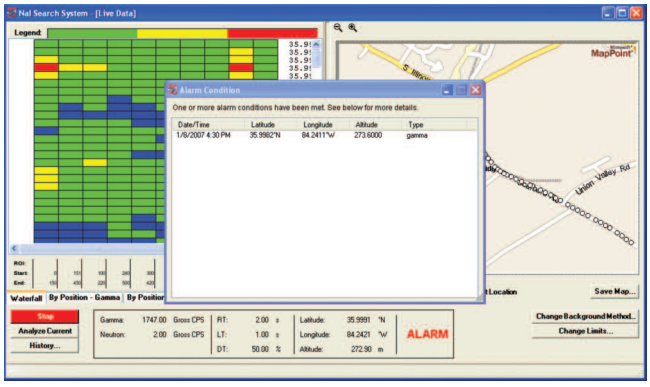
NaI-SS in Search Operation

NaI-SS is started from an intuitively simple user interface.

The "Check Operations" page allows a simple means of system verification. Search mode allows both neutron and gamma count rates to be displayed along with the GPS-derived physical position map in a variety of formats.

Waterfall Plot

The "waterfall plot" shows gamma-ray ROI[3] data along with integrated GPS Mapping. Ten ROIs are displayed and updated every second with current status (newest data at the top). In the figure, green indicates normal state, and yellow indicates increasing count rates until a red warning appears (ALARM). When a warning occurs, a pushpin is displayed on the map to indicate the location of the alarm. The map display may be zoomed in to provide more location detail. Locations in the map may be annotated and notes may also be added to the waterfall plot entries.



Waterfall Plot.

A "trail of breadcrumbs" is left on the map to show where the system has previously been. A history button allows previous data to be retrieved and displayed.

A single or sequential group of records in the waterfall plot (for example at a point where an alarm has been triggered) may be selected, summed in the case of multiple records, and passed to the ScintiVision analysis engine for quantitative analysis. . . all with just a few mouse clicks.

[3]ROI: Region-of-Interest within a gamma-ray spectrum. Typically these regions are defined as spanning energy regions in which expected nuclide peaks will be present. The current ROI energy limits are displayed at the bottom of the screen.

NaI-SS

Waterfall Plot Color Schemes

In order to fit with operational needs and to improve visibility, three choices of color scheme for the waterfall plot are available: "hot metal," running from white to black in 16 shades of color, grayscale, and “traffic light” green/yellow/red.

Count-Rate vs. Position Plot

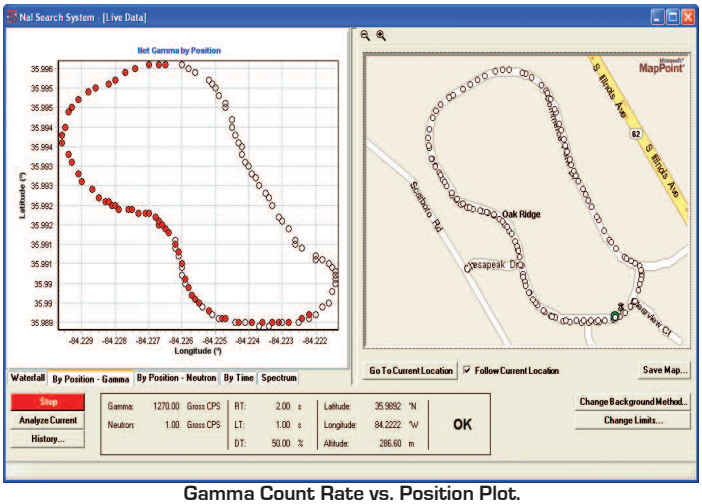
Net gamma and neutron count rates may be plotted versus the two GPS coordinates. (Longitude and latitude.)

Spectrum at a Position Plot

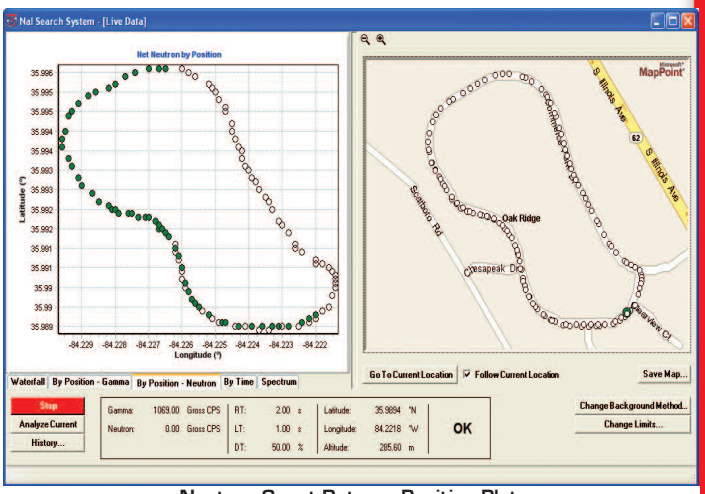
A Gamma Spectrum may be plotted for the current position. The complete spectrum of gamma ray energies collected at this point is displayed along with the position in the integrated map. The display is updated every second. A moveable cursor is provided.

Count-Rate vs. Time Plot

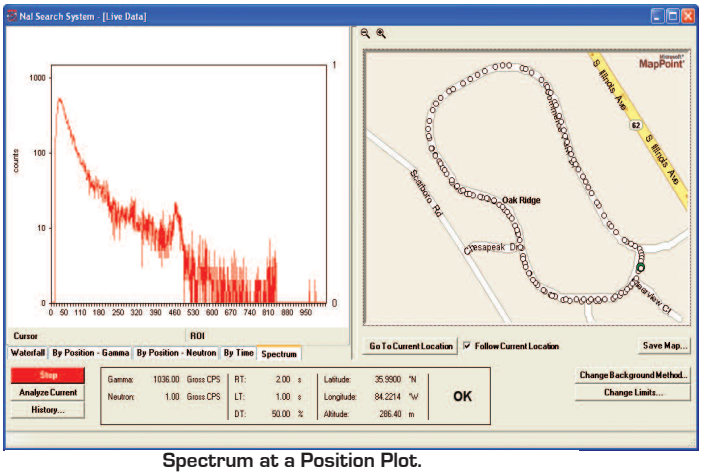
Gross or Net gamma and neutron count rates may be plotted versus time. Data is accumulated in real time in increments as short as 1 second (newest data point on the far left of the screen).



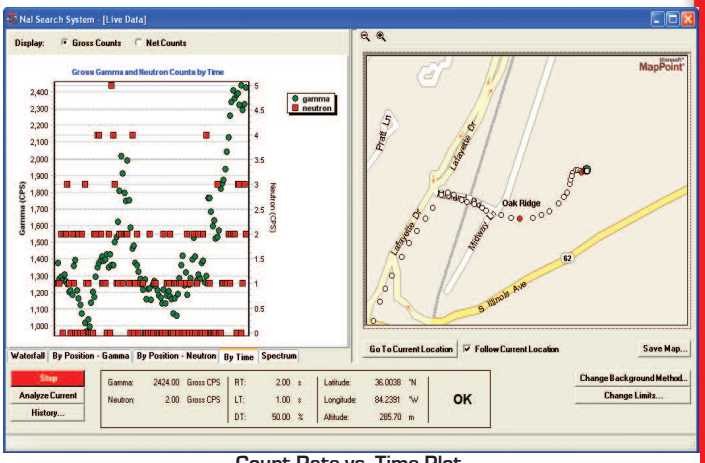
Gamma Count Rate vs. Position Plot.



Neutron Count Rate vs. Position Plot.



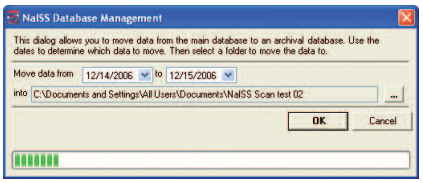
Spectrum at a Position Plot.



Count Rate vs. Time Plot.

Data Export for Off-Line Analysis

An Export Data function may be used to save data for future analysis so more data can be recorded on the laptop hard disk. The time limits for the data to be archived are user selectable.



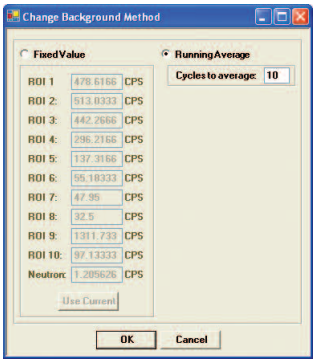
Data Export for Off-Line Analysis.

Background Methods

Because the system is likely to be used in a variety of situations, the background may be determined in different ways:

1. A fixed value in counts per second may be subtracted from each ROI value. These values may be entered in a table or measured by the system in an area of representative background.
2. A rolling average background may be computed based on a user-settable number of cycles.

Method 2 is better able to deal with fluctuating backgrounds but the rolling average may be higher than the actual count-rate immediately after a source has been passed and until that data "falls out" of the rolling average. If this occurs, the waterfall plot region is automatically colored BLUE to indicate this situation. Method 1 is then a better approach, at least until the rolling average returns to "normal." These methods can be used interchangeably without interrupting the flow of data taking.



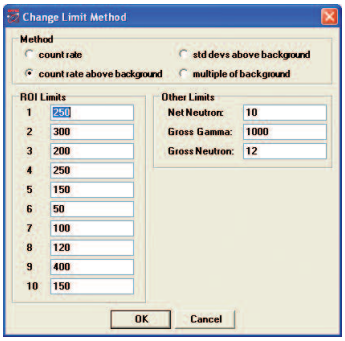
Background Methods.

Alarm Thresholds

Alarm thresholds may be set to trigger in a variety of conditions:

Count RATE in an ROI over background count rate.
Count RATE in an ROI.
Net ROI count rate as a multiple of background.
Net count rate as a multiple of the background standard deviation.

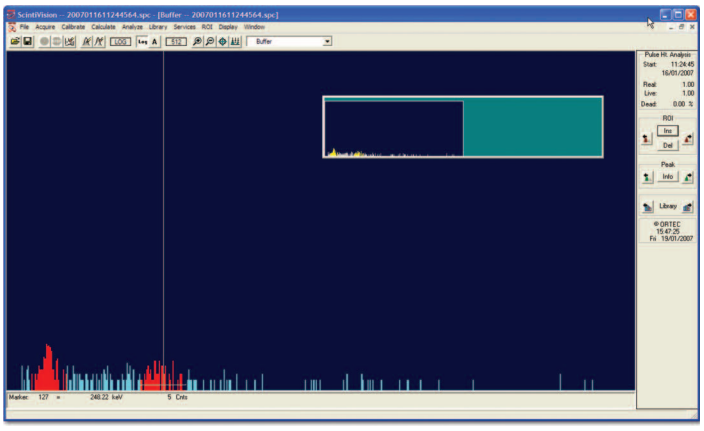
There is also an ROI ratio threshold which can be used to suppress spurious alarms due to NORM.



Alarm Thresholds.

ScintiVision Analysis

ORTEC ScintiVision analysis software may be initiated directly from the live or historical display and used to provide quantitative analysis results if an estimate of efficiency is available. A separate ScintiVision data sheet is available.



ScintiVision Analysis.

NaI-SS

NaI-SS Standard Hardware Specifications

These specifications represent minimum configurations. Larger configurations with multiple detectors are now available.

- 1 ea. 4"x4"x16" NaI(Tl) detector.
  The integrated 14-pin PMT provides optimum light collection with good energy resolution.
  Resolution: 10.0% FWHM at 662 keV.
  Housing: thin aluminum for optimum efficiency at ^{241}Am.
  Photon energies: 59.5 keV.
  Up to 4 NaI detectors may be configured on a single NaI-SS system.
- 1 ea. ORTEC digiBASE electronics integrating both NaI and neutron pulse counting in a single device. One digiBASE is required for each NaI detector.
- 2 ea. ^{3}He tubes for high neutron detection efficiency. (4 ea. ^{3}He tube version available.)
  4" Polyethylene (HDPE) moderator.
  In multiple detector systems, one neutron detector module per digiBASE may be configured.
- 1 ea. Laptop computer with expansion slots for extra devices, e.g,. wireless networking.
  1 GB memory.
- GPS with USB interface (Delorme Earthmate).
- Waterproof housing and wiring.
- 12 V power adapter for laptop and electronics.
- All cables.

Communications

If connected to a wireless network, the ORTEC CONNECTIONS architecture allows remote control of the system hardware. The data may be inspected in real time and downloaded to a remote computer for real time decision making. When in the wireless network mode or connected directly to the host computer, data may be transferred for further analysis after collection.

Detection Sensitivity

The detection sensitivity of the NaI-SS system depends on a multitude of factors:

- The speed at which the source is moving relative to the instrument.
- The amount of shielding.
- The ambient radioactive background.

The table on the right indicates the system performance for a system with a single NaI detector and a 4 tube neutron detector module:

Typical Detection Sensitivity: 3.25σ, 10 mph			
Source	Radiation	Approximate Strength (μCi)	Detection Range (m)
^{137}Cs	Gamma-Ray	10	3
^{60}Co	Gamma-Ray	17	6
^{252}Cf	Neutron	36	5

Weight

Depends on configuration. In Car Top Carrier format, NaI-SS-4 weight is approximately 110 lb (50 kg).

NaI-SS

Ordering Information

Standard "minimum configurations." Contact the factory for multi-detector or custom packages.

Model	Description
NAI-SS	NaI-based Gamma and Neutron Radiation Search System utilizing 1 ea. 4x4x16 inch NaI(Tl) detector, 2 ea. 25 mm diameter x 500 mm long ^{3}He neutron counters with poly moderator, digiBASE MCA, car mounted carrier, laptop PC, comprehensive data acquisition and analysis software with integrated global positioning sensor, mapping software and accessories.
NAI-SS-4	Same as NaI-SS, but with optional 4-neutron detector module for higher sensitivity.
NAI-SS-DX	NaI-based Gamma Radiation Search System utilizing 1 ea. 4x4x16 inch NaI(Tl) detector, digiBASE MCA, car mounted carrier, laptop PC, comprehensive data acquisition and analysis software with integrated global positioning sensor, mapping software and accessories.
NAI-SS-P	NaI-based Gamma and Neutron Radiation Search System utilizing 1 ea. 4x4x16 inch NaI(Tl) detector, 2 ea. 25 mm diameter x 500 mm long ^{3}He neutron counters with poly moderator, digiBASE MCA, laptop PC, comprehensive data acquisition and analysis software with integrated global positioning sensor, mapping software and accessories. NaI(Tl) and ^{3}He detectors are individually packaged in rugged plastic Pelican type cases and supplied with interconnecting cables.
NAI-SS-4-P	Same as NAI-SS-P, but with optional 4-neutron detector module for higher sensitivity.
NAI-SS-P-DX	NaI-based Gamma Radiation Search System utilizing 1 ea. 4x4x16 inch NaI(Tl) detector, digiBASE MCA, laptop PC, comprehensive data acquisition and analysis software with integrated global positioning sensor, mapping software and accessories. NaI(Tl) detector is packaged in rugged plastic Pelican type case.
NAISS-B32	Software only. Comprises NaI-SS software and ORTEC ScintiVision. Minimum prerequisites for software only purchase: NaI(Tl) detector and digiBASE with MAESTRO software. Delorme "Earthmate" GPS or equivalent MicroSoft Map Point 2006 High performance Laptop Computer with Windows XP operating system and at least the following: 1.66 GHz processor 1 GB RAM 40 GB hard disk 2 USB ports (one for the digiBASE and one for the GPS unit).

Specifications subject to change
100913

ORTEC®
www.ortec-online.com
Tel. (865) 482-4411 • Fax (865) 483-0396 • ortec.info@ametek.com
801 South Illinois Ave., Oak Ridge, TN 37831-0895 U.S.A.
For International Office Locations, Visit Our Website

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