
A SEARCH FOR THE LOST IDCSP CONSTELLATION

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? IDCSP Constellation Provides Unique Challenge ? Family of Known US Spacecraft ? Distinctive Orbital Characteristics ? At Limit of Current Capabilities ? Recovery Will Provide Measure of New Sensor Performance

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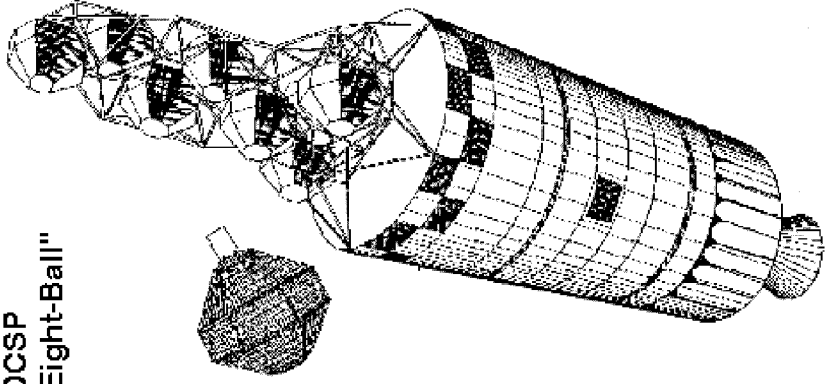
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IDCSP: A “Lost” Constellation

- **Initial Defense Communication Satellite Program**
 - 4 Launches Between 1966 and 1968
 - 34 Objects Placed Into Sub-Geosynchronous Orbits
 - 27 IDCSP Spacecraft
 - 3 Piggyback Satellites
 - 4 Transtages
- **IDCSP Spacecraft Infrequently Tracked**
 - Small, Faint Payloads
 - Occasional Optical and Radar Detections
 - Track Frequency Less Than “Lost” Criteria
 - Element Sets Periodically Propagated to New Epoch
 - Transtages and Piggyback Payloads Better Maintained
 - Possible Mistagging

Initial Defense Communications System Program (IDCSP)

IDCSP
"Eight-Ball"



- **US Military Constellation**
 - 19-month Development
 - Contractor: Philco-Ford
 - Viet Nam Theater Comm
- **Four Launches 1966-68**
 - "8" Spacecraft per Launch
 - 27 IDCSPs, 3 Other S/C, and 4 Transtages
 - One Failed Launch, Aug '66
- **Sub-Geosynchronous Orbits**
 - 22.2-hr Period (33,760-km)
 - 30° / day West to East Drift
 - 1° to 12° Initial Inclinations

IDCSP Spacecraft

- **Small Payloads**
 - 45-km (100#) Mass
 - ~0.8-m (32") Diameter
 - 26-Sided Polygons
 - 24 Sides Solar Arrays
 - One X-Band Transponder with Horn Antenna
 - Telemetry Antenna on top
 - Spin Nozzles on Equator
- **Faint Objects**
 - Nominal 17th Magnitude
 - Expect Solar Panel Flashes



IDCSP Launch 16 Jun 66

Int Desgn 1966-053	Number	Name	EI Set Age (yrs) as of 15 July 99
A	2207	GGTS	4.10
B	2215	IDCSP 1	1.94
C	2216	IDCSP 2	4.10
D	2217	IDCSP 3	4.10
E	2218	IDCSP 4	4.10
F	2219	IDCSP 5	4.10
G	2220	IDCSP 6	4.10
H	2221	Transtage 11	0.01

IDCSP Launch 18 Jan 67

Int Desgn 1967-003	Number	Name	EI Set Age (yrs) as of 15 July 99
A	2645	IDCSP 08	4.10
B	2649	IDCSP 09	4.10
C	2650	IDCSP 10	4.10
D	2651	IDCSP 11	4.10
E	2652	IDCSP 12	4.10
F	2653	IDCSP 13	5.50
G	2654	IDCSP 14	4.10
H	2655	IDCSP 15	0.02
J	2655	Transtage 13	3.99

IDCSP Launch 1 Jul 67

Int Desgn 1967-066	Number	Name	EI Set Age (yrs) as of 15 July 99
A	2862	IDCSP 16	0.00
B	2863	IDCSP 17	1.47
C	2864	IDCSP 18	1.65
D	2865	IDCSP 19 (DATS)	1.23
E	2866	LES 5	0.01
F	2867	DODGE	0.01
G	2868	Transtage 14	0.01

IDCSP Launch 13 Jun 68

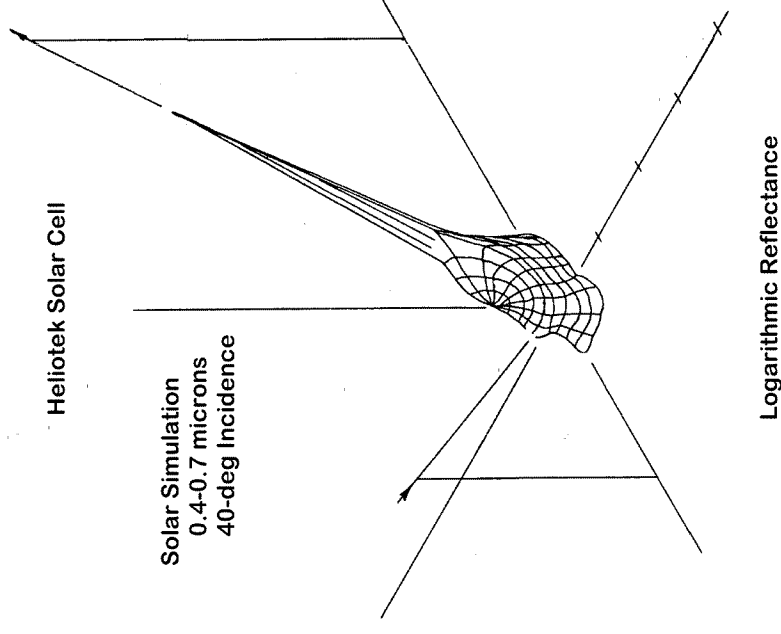
Int Desgn 1968-050	Number	Name	EI Set Age (yrs) as of 15 July 99
A	3284	IDCSP 20	1.10
B	3285	IDCSP 21	4.10
C	3286	IDCSP 22	4.10
D	3287	IDCSP 23	4.10
E	3288	IDCSP 24	4.10
F	3289	IDCSP 25	2.18
G	3290	IDCSP 26	4.10
H	3291	IDCSP 27	4.10
J	3292	Transtage 16	0.00

Attempting Optical Recovery of the IDCSP Constellation

- **IDCSPs Below Nominal SSN Optical Sensitivity**
 - Less Than 1 Meter Diameter
 - Generally Fainter Than 16th Magnitude
- **New Sensors Provide Increased Capability**
 - NASA/JSC CCD Debris Telescope (CDT): 17 Mv
 - JPL NEAT Camera on MSSS 1.2-m Mount: 20 Mv
 - AF Research Laboratory (AFRL) Raven Telescopes: 16.5 Mv
 - Planned Deep Stare Upgrade for GEODSS: ~18 Mv
- **Examine CDT and Raven UCT Detection Data**
 - Identify Candidate Objects From Nightly UCT Detections
 - Correlate Night-to-Night Detections To Generate Orbits
 - Target Observations With Sensitive Sensors
- **Effort is a “Work in Progress”**

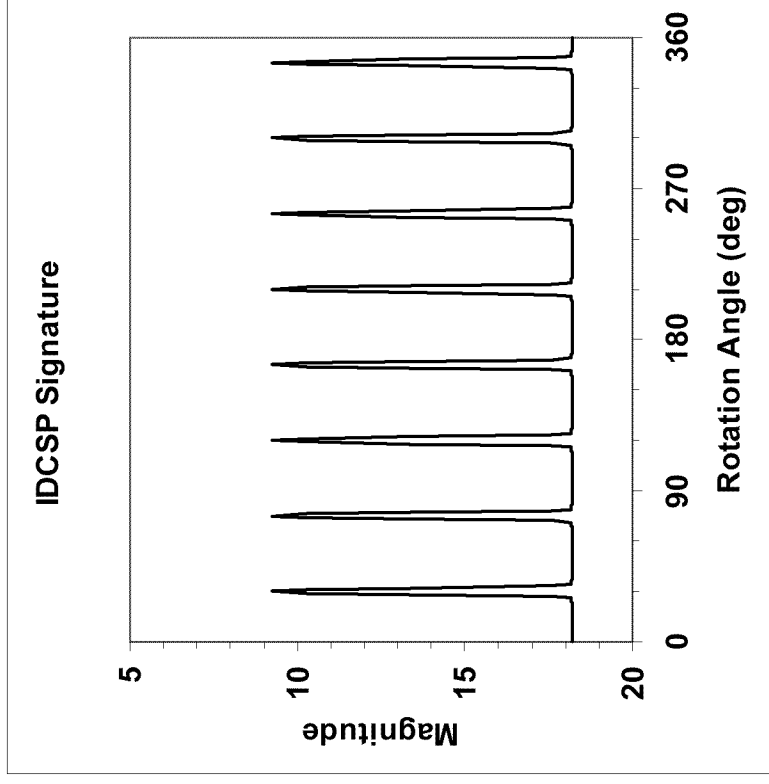
Detailed Signature Modeling

- **Model Solar Panel Glints**
- **Utilize Measurement Data**
 - Era Production Solar Panel
 - Individual Solar Cell Bi-Directional Reflectances
 - Full Panel Solar Cell Normal Orientations
 - Determination of Satellite Observables Study. SAMSO TR 73-291
- **Full Panel Characterized**
 - Individual Cells Combined
 - Near Gaussian 1.97° FWHM
 - 0.10 Albedo (CCD Band)
 - 0.1-m² IDCSP Solar Panels



IDCSP Signature Prediction

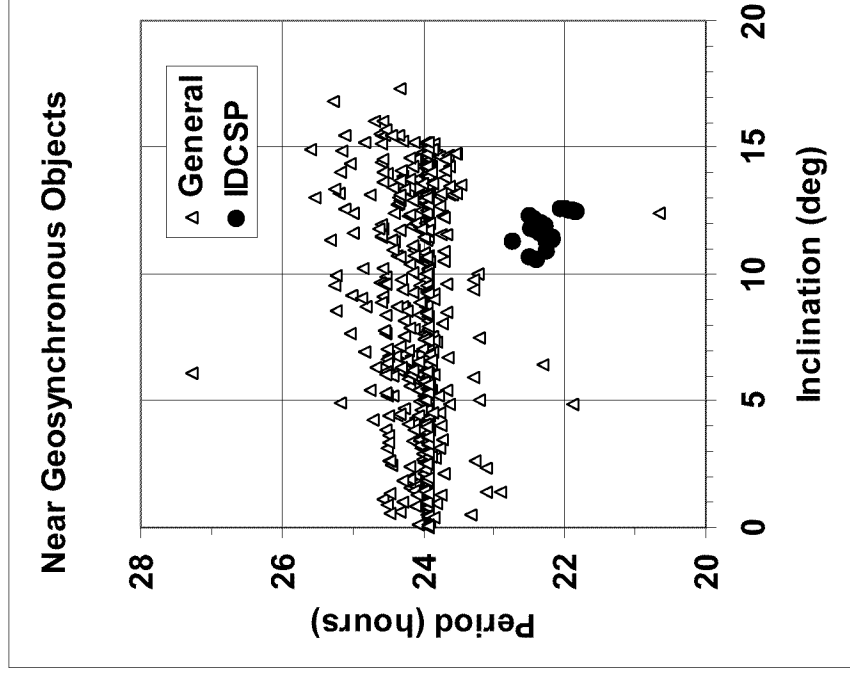
- **Signature Characteristics**
 - Maximum Glint 9th Magnitude
 - Base Level 18th Magnitude
 - Above 16th mag for 5° Rotation
- **Glint Occurrence is Highly Geometry Dependent**
 - Monte Carlo Simulations
 - 0 to 8 Glints / Rotation Possible with Decreasing Probability
 - > 50% Cases Observe No Glints
 - Average < 1 Glint per Rotation
- **Very Stressing Target!**
 - Low Intrinsic Brightness
 - Infrequent, Short Glints
 - Spin Rate Unknown



Modeled Equatorial Glint Sequence

IDCSPs Are Unique Orbital Group

- Planes Well Characterized
 - Long Term Perturbations
 - Occasional IDCSP Observations
 - Transtages & Other Payloads
- IDCSP Orbit Characteristics
 - Periods: 22.2 ± 0.2 hrs
 - Inclinations: 11.8 ± 0.5 deg
 - RAANs: 347 ± 10 deg (subsets)
- Search CDT / Raven UCT Data
 - Search Night-by-Night Detections
 - Identify Correlated Detections
 - Examine UCT Period, Inclination, and RA of Ascending Node
 - Identify High Probability UCT Candidates for Detailed Study

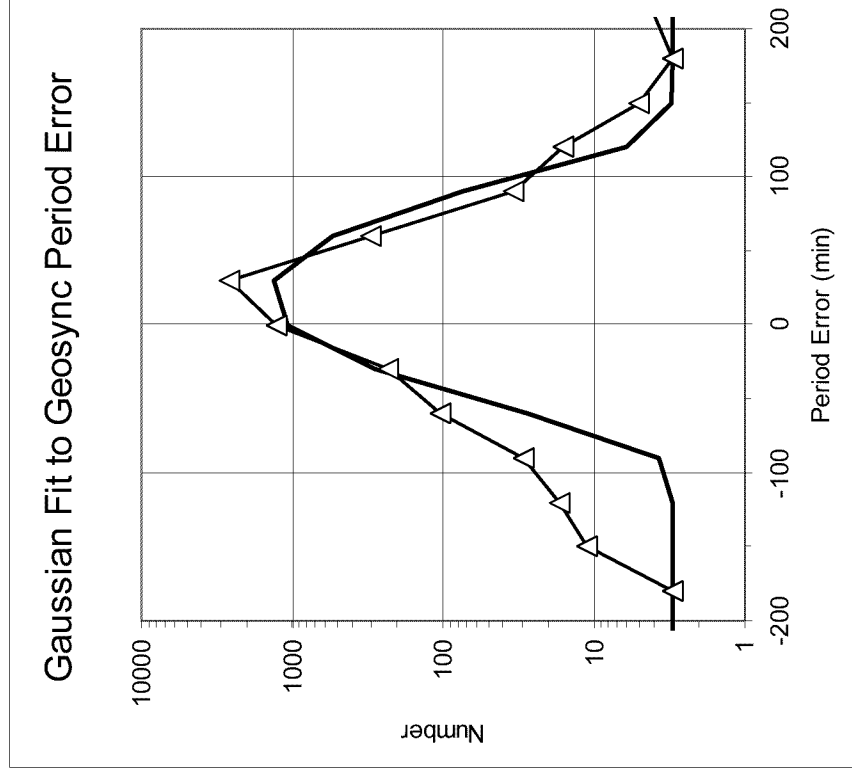


CDT / Raven Detections

- **NASA CDT Searches Are Primary Data Source**
 - 3 Years of Nightly Geosynchronous Belt Searches
 - Thousands of Correlated and Uncorrelated Detections
- **Estimate UCT Orbits from Motion**
 - Period And Inclination Computed For All Detections
 - Orbital Determination Accuracies From Correlated Targets
 - Period: 21 +/- 28 minutes
 - Inclination: 0 +/- 3 degrees
 - No Night-to-Night Correlations Performed
- **AFRL Raven Data Analysis Underway**
 - Processing Similar to CDT
 - Eight Months of Observations From AF Demos Available
 - Operational Raven on Haleakala In Near Future

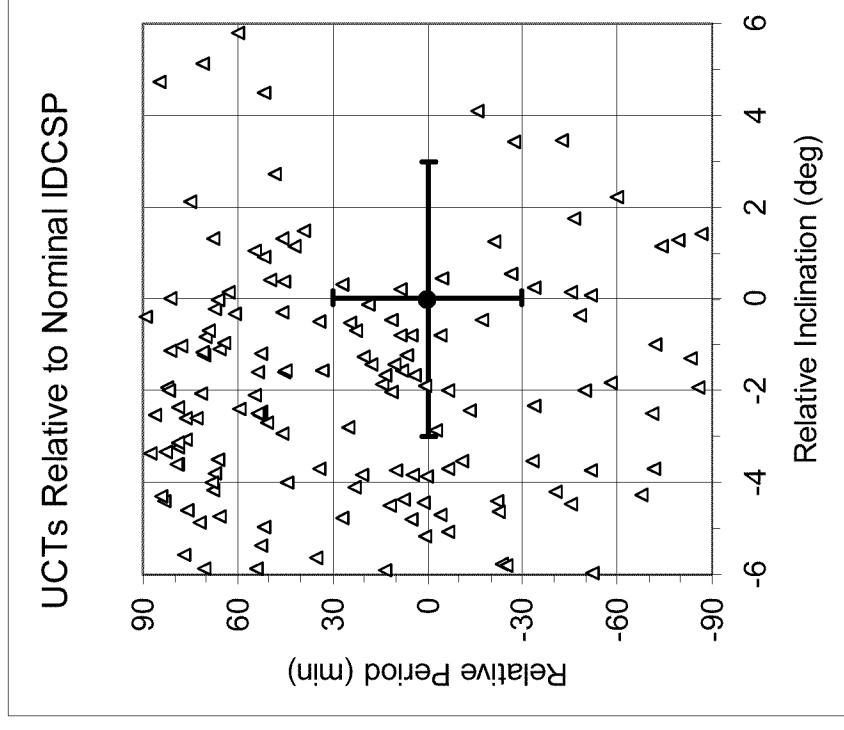
Detection Orbital Accuracy

- **Orbit for Each Detection**
 - Circular Orbit Approximation
 - Short Arcs: 125 sec Median
- **Examine Near-GEO Objects**
 - Correlated CDT Detections
 - Period 0.9 to 1.1 Days
 - Inclinations 0 to 20 Degrees
 - Eccentricities < 0.1
 - 4,634 Detections from '98 & '99
- **Orbital Uncertainties**
 - Period: 21 ± 28 minutes
 - Inclination: 0 ± 3 degrees



Associate UCTs with IDCSPs

- **Assign Probability of Being IDCSP to Each UCT**
- **Intrinsic IDCSP Scatter**
 - Average and St. Dev.
 - Period: 1334 ± 12 minutes
 - Inclination: 11.8 ± 0.5 deg
- **Observational Uncertainty**
 - Bias and St. Dev.
 - Period: 21 ± 28 minutes
 - Inclination: 0 ± 3 degrees
- **One Sigma UCT Bounds**
 - Period: 1313 ± 30 minutes
 - Inclination: 12 ± 3 degrees



Pursue IDCSP Candidates

- **Expect 99.7% of IDCSP Detections Within 3 sigma**
 - 166 UCTs Identified for Further Study
 - Some Detections Are Unrelated Objects
- **Detailed Analyses Underway**
 - Comparing to Expected RA of Ascending Node Distribution
 - Examining Temporal and Spatial Distributions
 - Pursuing Potential Long Term Correlations
 - Associate Individual Detections into Orbits
- **Conduct Searches Based on Updated Orbits**
 - JPL NEAT Camera on MSSS 1.2-m Mount
 - Phoenix Baker-Nunn with CCD
 - MSSS Raven

MSSS Scheduling IDCSP Observations

- **Some Detections Have Correlated to IDCSPs**
- **Maui Space Surveillance System (MSSS) Is Now Scheduling IDCSP Observations**
 - In Addition to Statistical UCT Analysis
 - Using Published Space Command Element Sets
 - Assigned to NEAT Sensor as Available
 - Included in Nightly MSSS Raven Schedule
- **Above and Beyond AFSPC Tasking to MSSS**
- **Report Detections Through Appropriate Channels**

Conclusions

- **IDCSP Constellation Provides Unique Challenge**
 - Family of Known US Spacecraft
 - Distinctive Orbital Characteristics
 - At Limit of Current Capabilities
- **Recovery Will Provide Measure of New Sensor Performance**

IDCSP RAAN Distribution

