

# AMSAT Station and Activities at K3TU

Dennis Silage K3DS

[www.temple.edu/k3tu](http://www.temple.edu/k3tu)



The logo for K3TU Temple University Amateur Radio Club. It features the call sign "K3TU" in large red letters, followed by the Temple University logo (a red "T" in a square) and the text "TEMPLE UNIVERSITY" and "AMATEUR RADIO CLUB". To the right is the Temple Owls logo, featuring a red owl and the text "Go, Temple Owls! BIG EAST CONFERENCE". At the bottom, it says "College of Engineering Philadelphia, Pennsylvania 19122 U.S.A." and "GRID FM29 - PHILADELPHIA COUNTY". There are two small TUARC logos at the bottom corners.

# Temple University Amateur Radio Club (TUARC) has held the callsigns K3JKI (1960), WA3TVT (1973) and K3TU (1996)



# TUARC is a University club and open to licensed students, staff, faculty and alumni.



# K3TU

**TEMPLE**  
**UNIVERSITY**  
AMATEUR RADIO CLUB



*Go, Temple Owls!*  
BIG EAST CONFERENCE



College of Engineering  
Philadelphia, Pennsylvania 19122 U.S.A.

GRID FM29 - PHILADELPHIA COUNTY



**The Temple University Amateur Radio Club (TUARC) K3TU has a long history of AMSAT activities.**

**TUARC WA3TVT worked OSCAR 6 in 1973.**



**Starting in 1984 TUARC became a laboratory for EE education and was supported with new equipment and antennas.**



**The AMSAT station at WA3TVT in 1988 was a brand new 144 MHz ICOM IC271 and 440 MHz IC471. There was also a rare 1296 MHz IC1271.**



**TUARC at first used an unsophisticated ICOM CT-16 Satellite Interface Unit to lock the IC271 and IC471 together for uplink and downlink but not doppler shift correction.**



**The AMSAT antennas were KLM cross polarized Yagi for 144 and 440 MHz with a manual Yaesu/Kenpro azimuth-elevation (Az-El) rotor.**



**However this manual tracking configuration for AMSAT was hard to operate.**

**EE students have a capstone senior design project and TUARC sponsored the development of a microcomputer for automatic control of Az-El tracking.**



The EE design project used a Z80 8-bit microcomputer to calculate the Az-EI location for satellite tracking in ZBASIC.



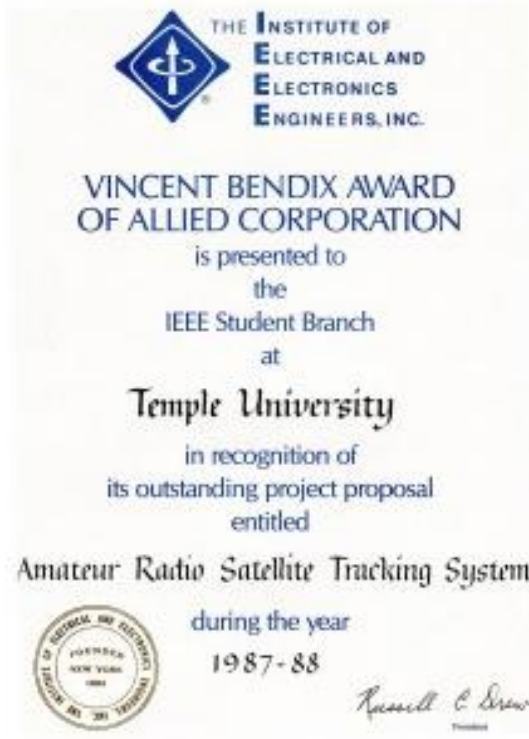
**Keplerian data is used for Az-El tracking. However, getting the data was difficult before the Internet and the microcomputer had a 3 MHz clock and no floating point co-processor.**



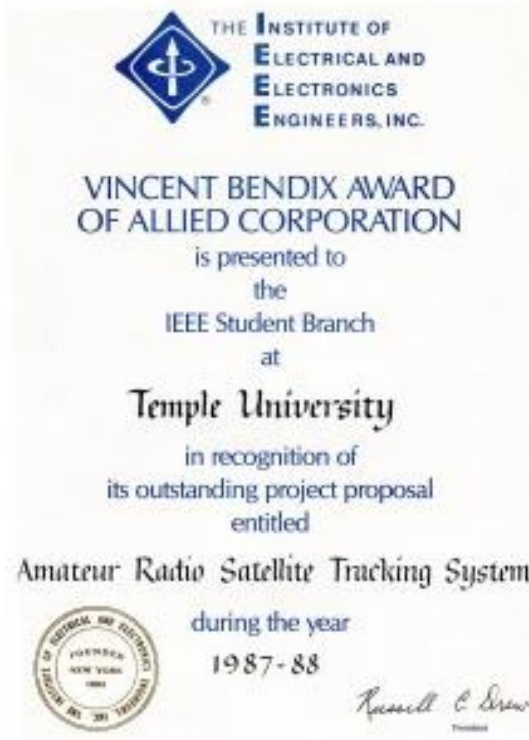
**The Az-EI calculations were done before the satellite pass in non-real time and stored in battery-backup SRAM memory.**



The IEEE sponsored a Region 2 (Middle Atlantic states) award for senior design projects. The Temple teams bested every other school two years in a row (1987-88 and 1988-89).



**The 1987-88 Bendix Award was for the initial Az-El tracking microcomputer.  
The 1988-89 Bendix Award added doppler shift correction.**



The Az-El tracking calculations set the initial Yagi position and operated the Up/Down (elevation) and Left/Right (azimuth) rotor switches.



The doppler shift correction was also done in non-real time and stored in SRAM. The correction voltage was

applied to the RIT of the ICOM transceiver.



# These days Keplerian elements are sent by bulletins:



SB KEP @ ARL \$ARLK028  
ARLK028 Keplerian data

ZCZC SK28  
QST de W1AW  
Keplerian Bulletin 28 ARLK028  
From ARRL Headquarters  
Newington, CT April 7, 2020  
To all radio amateurs

SB KEP ARL ARLK028  
ARLK028 Keplerian data

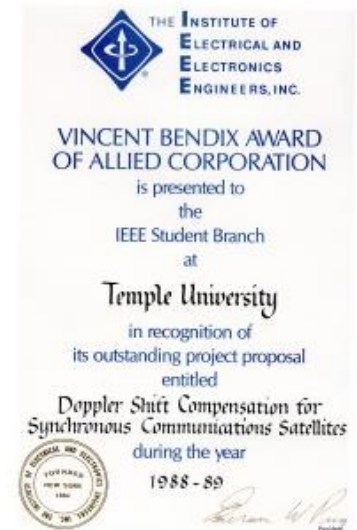
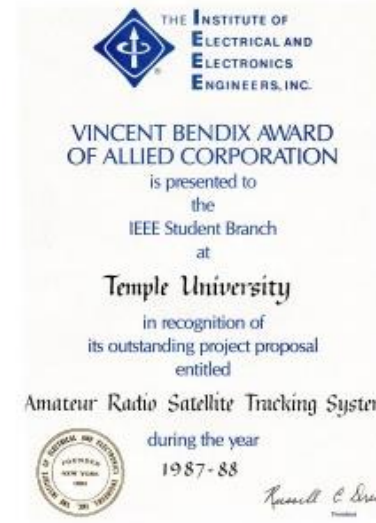
Decode 2-line elsets with the following key:

1 AAAAAU 00 0 0 BBBBBB.BBBBBBBB .CCCCCCC 00000-0 00000-0 0 DDDZ  
2 AAAAA EEE.EEEE FFF.FFFF GGGGGGG HHH.HHHH III.IIII JJ.JJJJJJ KKKKKKZ  
KEY: A-CATALOGNUM B-EPOCHTIME C-DECAY D-ELSETNUM E-INCLINATION F-RAAN  
G-ECCENTRICITY H-ARGPERIGEE I-MNANOM J-MNMOTION K-ORBITNUM Z-CHECKSUM

0 AO-07  
1 7530U 74089B 20098.54802910 -.00000052 +00000-0 -41359-4 0 9996  
2 7530 101.7929 068.7058 0012377 139.1122 338.5097 12.53642901077102



# AEA/Timewave produced the functionally similar ST-1 Satellite Tracker in 1998.



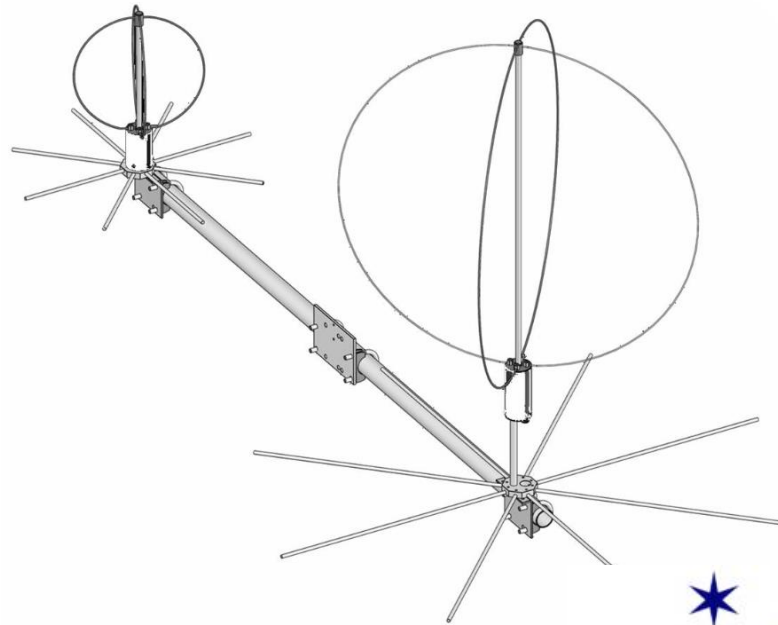
**The large Az-El satellite array was heavy and subjected to high wind loads. From 1988 to 2009 the array was rebuilt four times due to damage.**



**In 2014 the last damage to the Az-El satellite array caused its reconfiguration. The array was replaced by M2 *windmill* antennas for 144 and 440 on the same tower.**



**The M2 satellite antennas only have a gain of 5.5 dBic but are omnidirectional. The KLM Yagi had a gain of  $> 15$  dbic.**



**Received signal strength was increased  
by in-line RF switched (up to 160 W)  
GaAsFet preamps with 24 and 16 dB gain  
and  $NF \approx 5.5$  dB.**



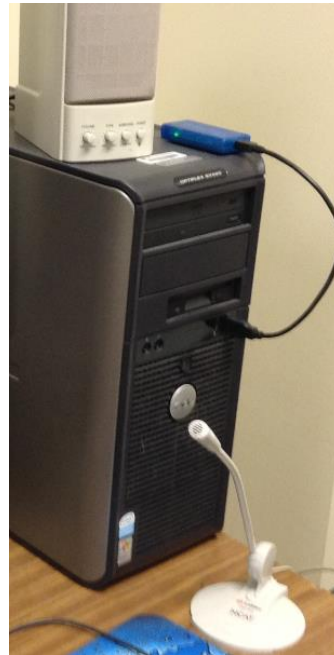
**The loss of transmit signal (10 dB) was not a problem since  $\approx 5\text{ W}$  was used with the Az-EL Yagi and  $> 50\text{ W}$  was available from the Kenwood TS-2000 transceiver.**



**The Kenwood TS-2000 transceiver replaced the ICOM transceivers and has built-in 144 MHz and 440 MHz satellite capability.**



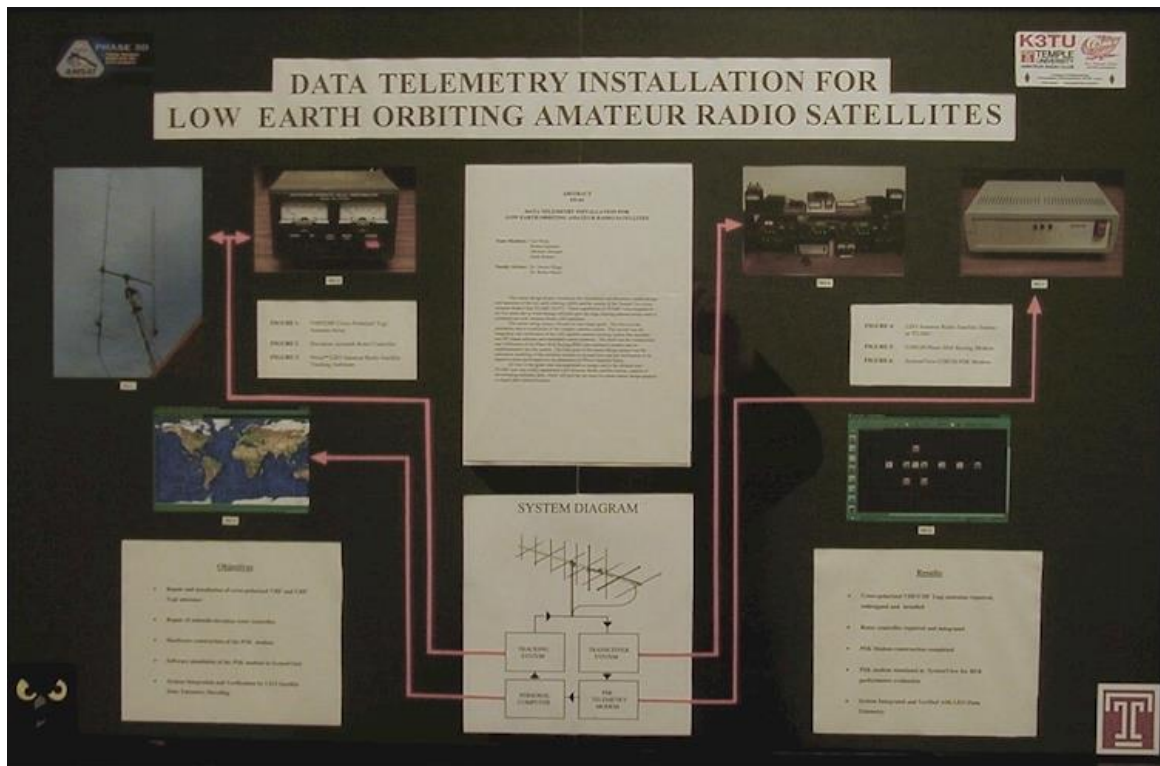
**The Diamond X300A on the same tower is used to work 144 and 440 analog FM and digital (D-STAR and C4FM) repeaters**



**The Diamond X300A antenna was struck by lightning and destroyed but K3TU has Polyphaser arrestors and grounding.**



# Capstone EE senior design projects have continued with the development of experimental modems for satellite telemetry.



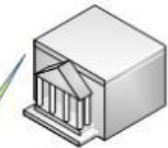
# TUARC supports the FUNCube satellite telemetry project initiated by AMSAT UK.



Laptop  
receives voice,  
pictures  
and data



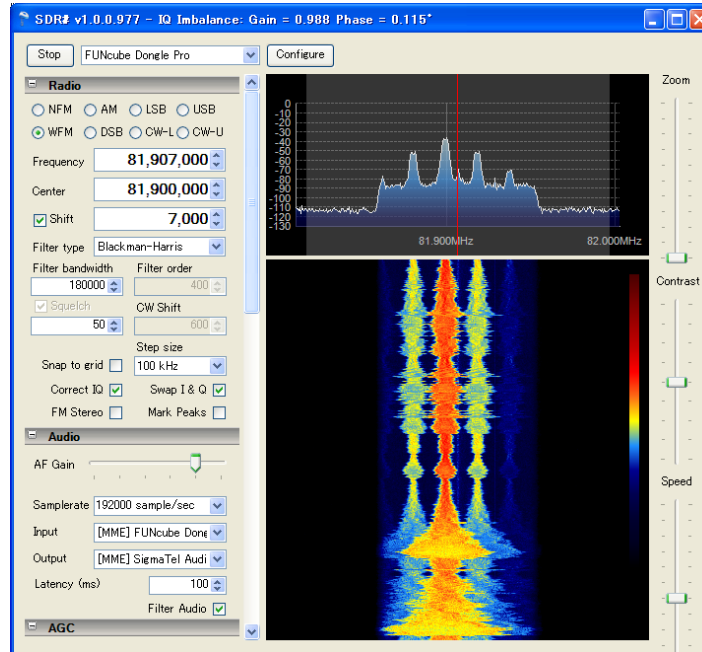
Internet



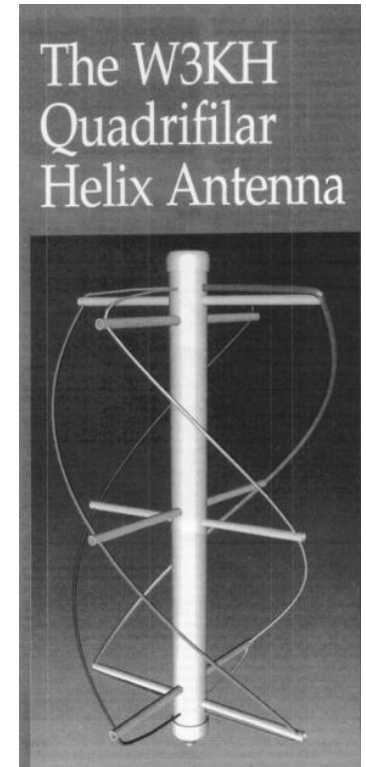
Telemetry  
datawarehouse



# The FUNCube dongle uses freeware software such as SDR#.



# A homebrew quadrifilar antenna is use for reception.



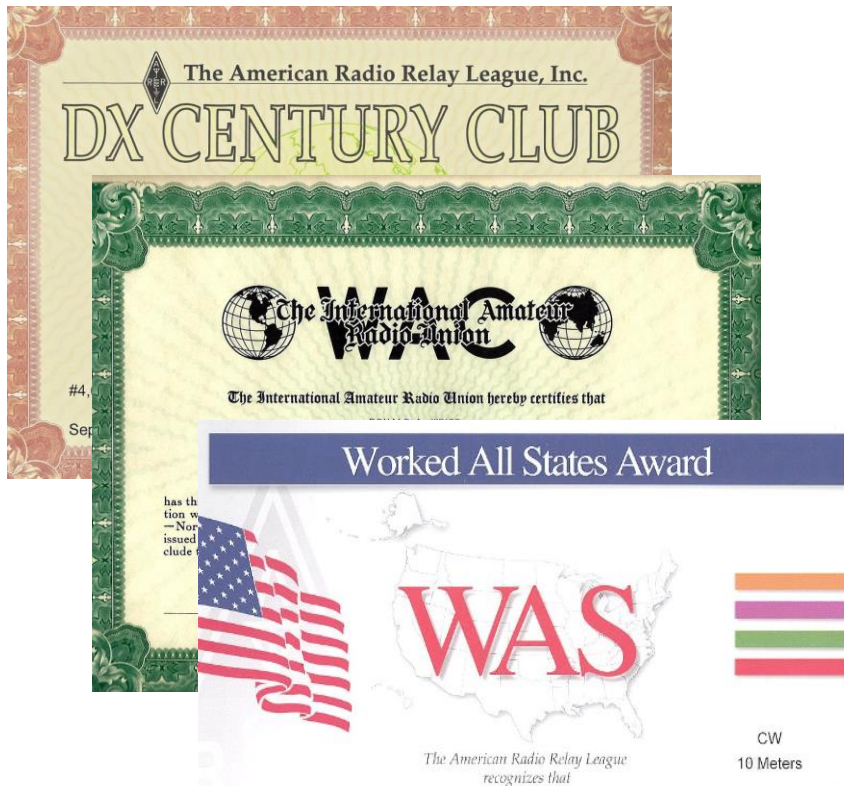
# TUARC has other station activities.



# The Kenwood TS-2000 AMSAT Station at K3TU doubles as the primary HF station.



# TUARC is active on HF and has a big signal with the Mosley CL-33-M Yagi at 130 feet.



# 144 MHz, 440 MHz and 1296 MHz all-mode station



# Linked cross-band 224.8 MHz and 442.8 MHz analog FM repeaters



**144.39  
MHz  
APRS  
station**



**RF spectrum analysis:  
ICOM  
R7000  
HP  
8558B**



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