

# Cosmic ray muon tracking telescope – tracks astronomical objects in elevation and azimuth

QCC-CUNY Physics dept. (Armendariz) - 2024

Parts:

3 plastic scintillators mated to 3 PMTs

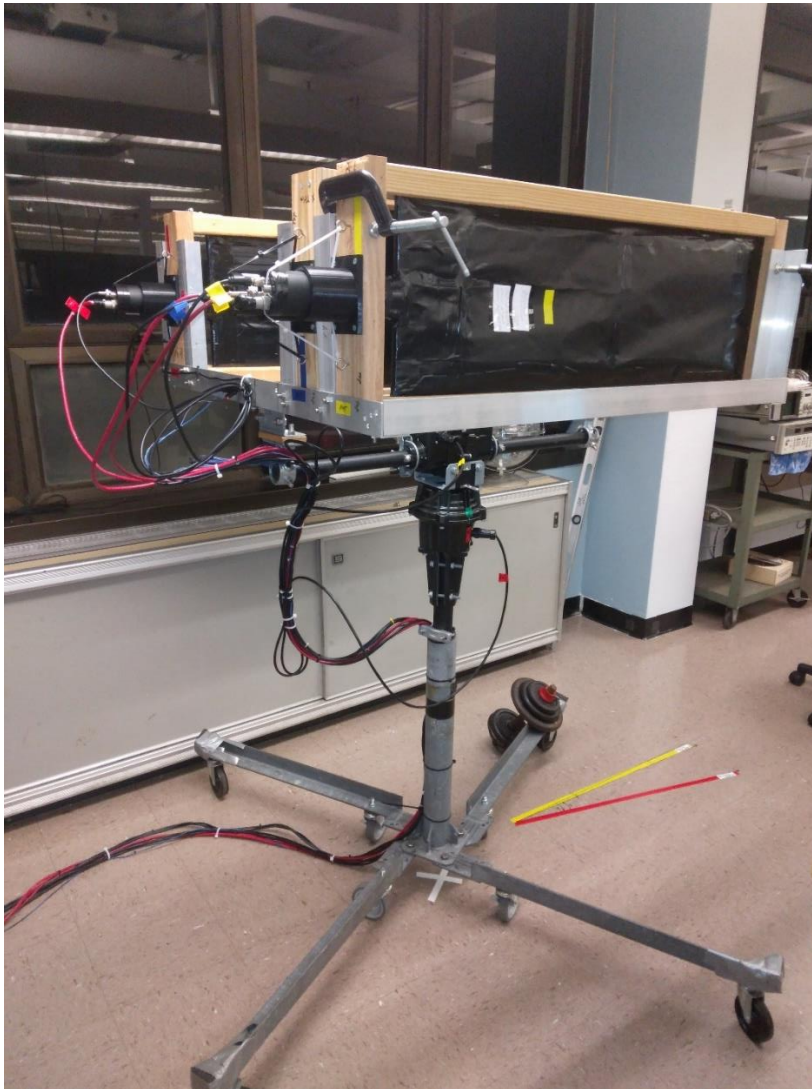
Yaesu G-5500 Elevation/Azimuth Controller to rotate axes

EATX ARS-USB controller to drive Yaesu controller to rotate telescope axes

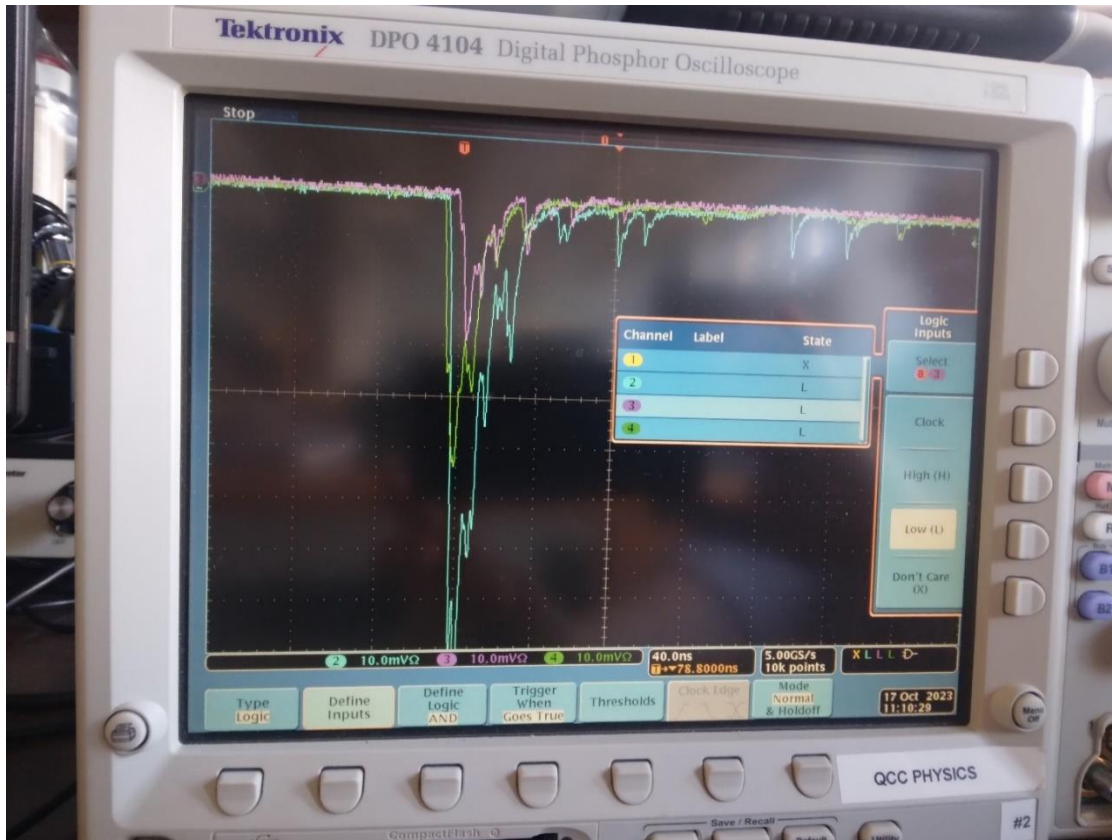
NOVA for Windows software to stream astronomical coordinates to EATX ARS-USB to Yaesu G-5500

XP Emco G30 voltage converters to power PMTs; LM317 variable voltage regulators to power converters

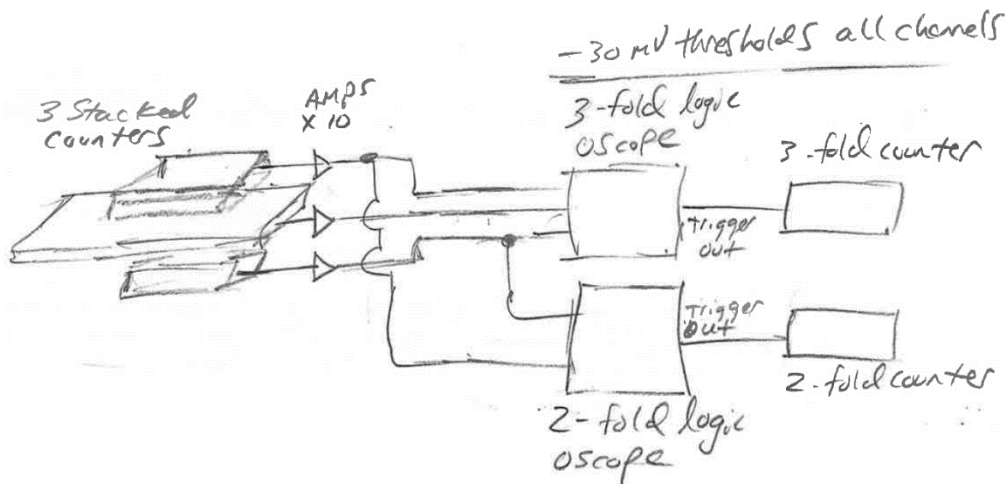
Proximity sensor kill-switch to cut power to ARS controller if telescope moves close to its mounting pole





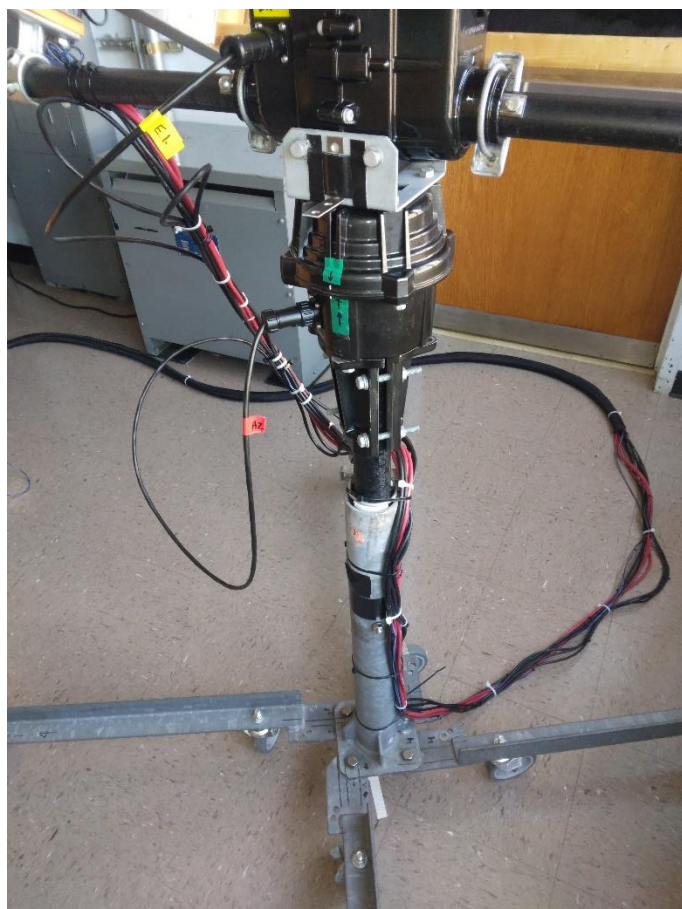


Cosmic ray telescope 3-fold coincidence signal from scintillators-PMTs displayed on oscilloscope



Wiring diagram for 50 Ohm coax signal lines from 3 counters' PMTs to two oscilloscopes, one for a 2-fold coincidence measurement and the other for a simultaneous 3-fold coincidence measurement

## Yaesu G-5500 Elevation/Azimuth rotator axes



**YAESU**  
The radio

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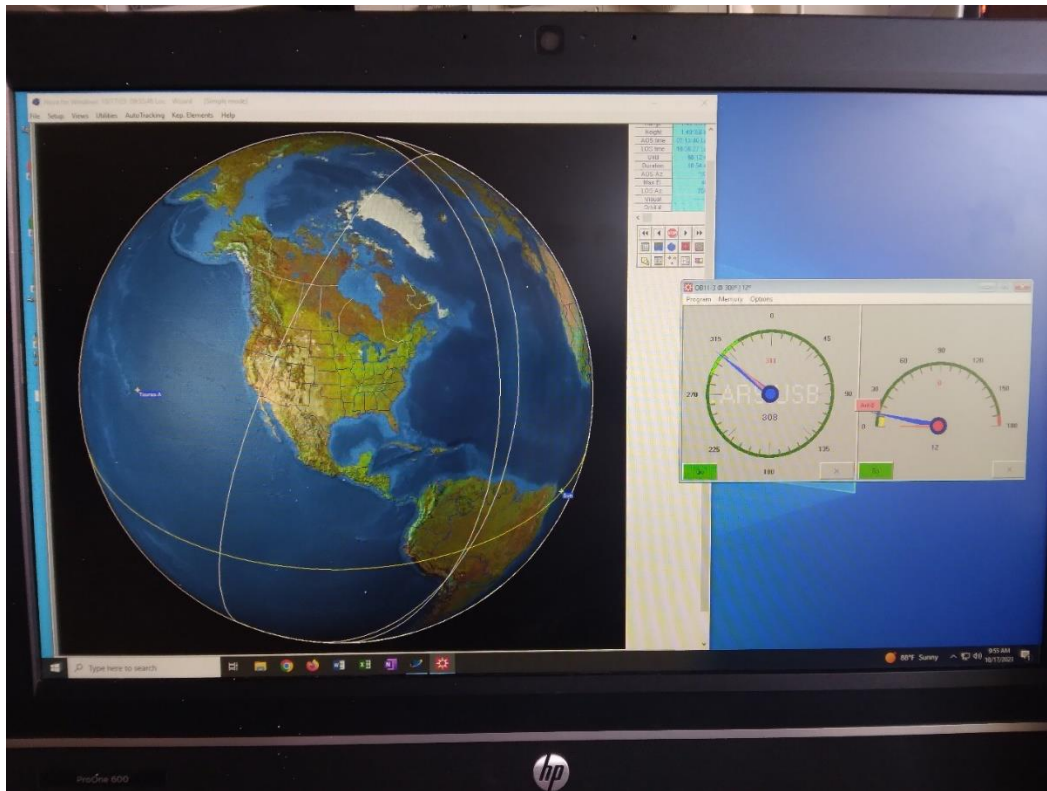
### **G-5500** Instruction Manual

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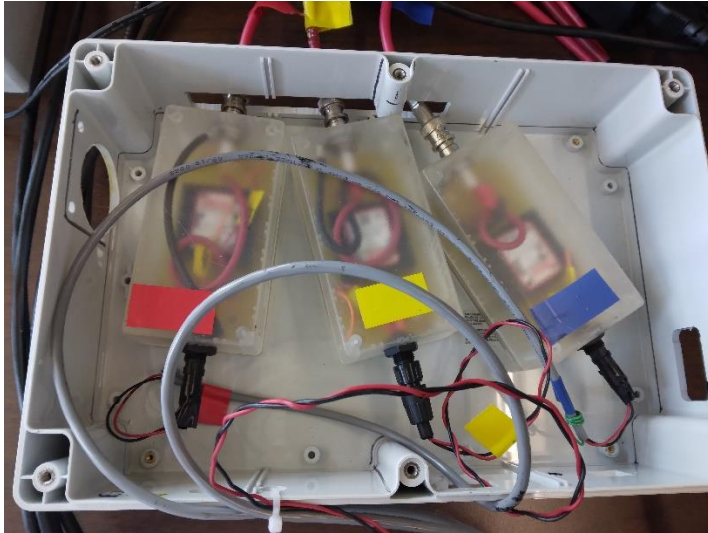
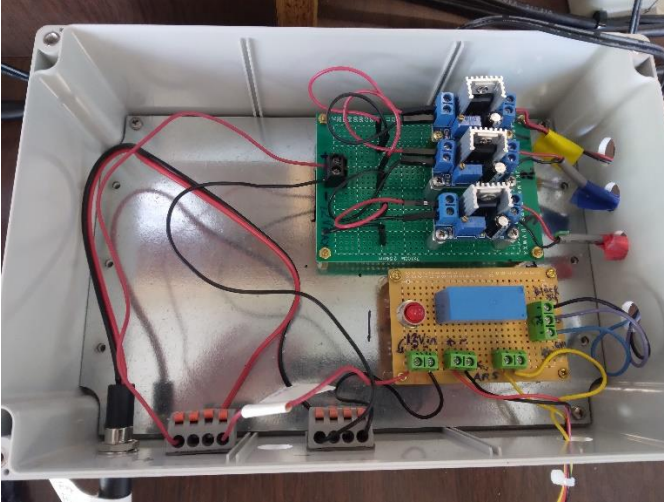


Yaesu G-5500 Elevation/Azimuth Controller to rotate axes (top), and EATX ARS-USB controller (bottom) to stream astronomical coordinates from computer (using NOVA for Windows) to Yaesu controller



NOVA for Windows program used to stream astronomical coordinates to the telescope's tracking Alt/Az axes in real time

## Electronics boxes for PMT power and proximity sensor relay



🔗 Taiss/ 2Pcs M18 Proximity Sensor NPN NO (Normally Open) 6-36VDC 8mm Detective Approach Sensor Inductive Proximity Switch LJ18A3-8-Z/BX

Visit the Taiss Store  
4.2 ★★★★★ 13 ratings

\$11.99

Get Fast, Free Shipping with Amazon Prime  
FREE Returns

- Product Name : Inductive Proximity Switch;Model : LJ18A3-8-Z/BX;Wire Type : DC 3 Wire Type (Black, Brown, Blue);Switch Appearance Type : Cylinder Type
- Theory : Inductive Sensor;Output Type : NPN NO(Normal Open);Thread diameter : 18mm ; 18mm;Detecting Distance : 8mm
- Supply Voltage : DC 6-36V;Current Output : 500mA;Detect Object : Iron
- Operating Temperature : -25C to +55C (Non-freezing Condition);Size : 7 x 3cm/2.8" x 1.2" (L\*Max. Dia);Cable Length : 103cm / 40.55"
- External Material : Plastic, Alloy;Net Weight : 160g;Package Content : 2 x Inductive Proximity Switch



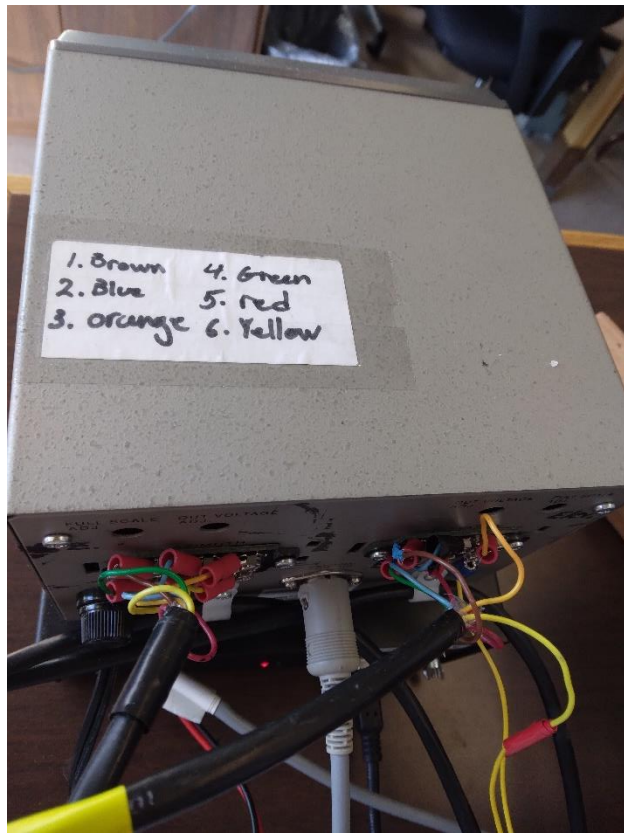
Top pic: Electronics box with 3 LM317s to power DC-to-DC converters for PMTs; and a relay circuit used to cut power to rotator if ever a proximity sensor on telescope gets close to mounting pole

Middle pic: Power box containing 3 low-voltage Emco DC-to-DC converters to power up 3 PMTs

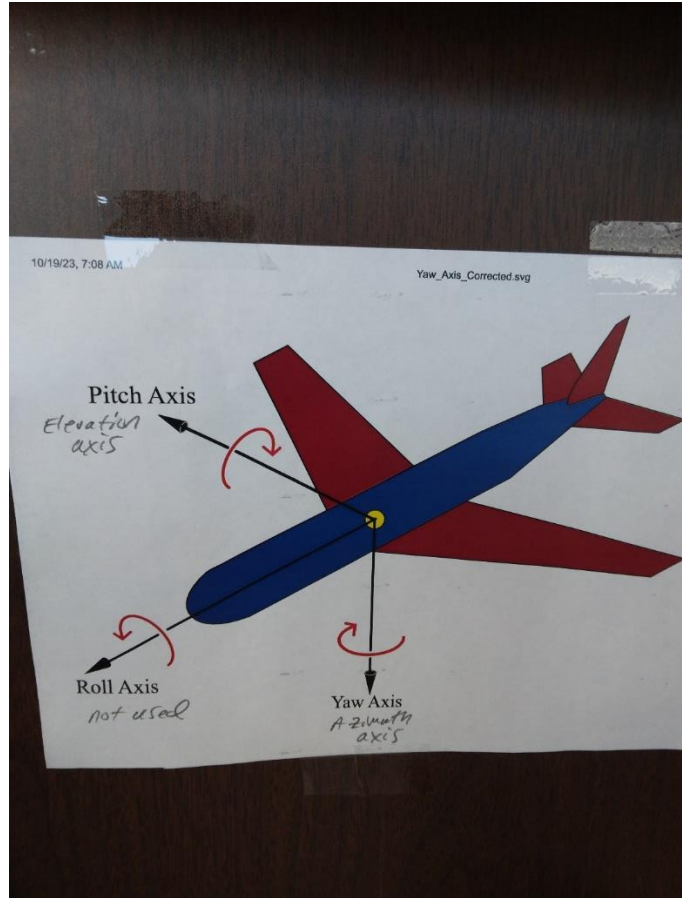
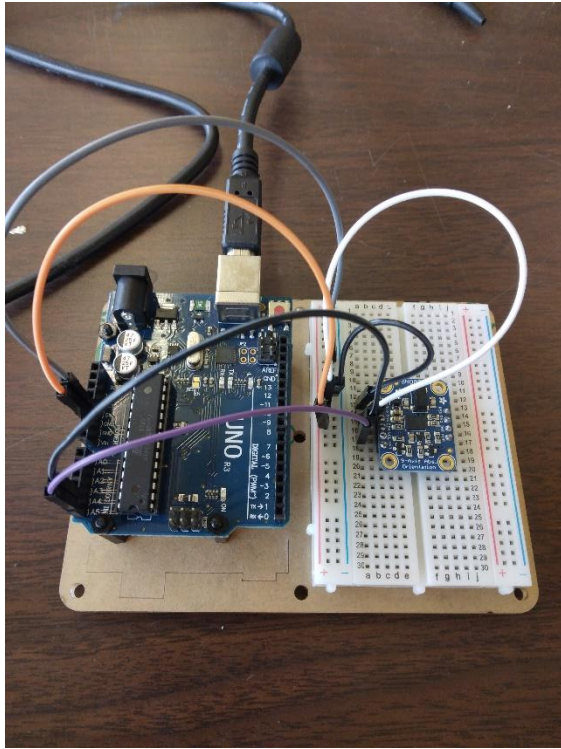
Bottom pic (left): proximity sensor kill-switch mounted on telescope



Left pic: small blue proximity sensor shown mounted on telescope frame



Right pic: Yaesu G-5500 controller wiring



Left pic: Adafruit BNO055 9-DOF absolute orientation IMU sensor - may be mounted on telescope frame to measure telescope's elevation tilt angle (i.e. pitch axis); it works with Arduino UNO microcontroller

<https://www.adafruit.com/product/2472>

Right pic: Illustration of pitch axis (elevation axis) and Yaw axis (azimuth axis). There is no Roll axis.



# Muon Telescope ~ 20230801

RGS8 Signal cables		PMT'S	Scintillator's	HV cables
Yellow	50'	PMT 24 AA1336 HV 2150V @ $10^6$ gain DR = 269 Hz @ 2200V	20230320 91 x 31 x 1 cm <sup>3</sup>	34'9" <del>49'4"</del> <del>49'4"</del>
Blue	50'	PMT 9 AA2073 HV 1800V $10^6$ gain DR = 26 Hz	20230321 91 x 30.5 x 0.9 cm <sup>3</sup>	24'8" + 9'9" + 1" = 34'6"
Red	~ 49'9"	PMT 58 <del>AA120</del> AA 720 HV 2000V @ $1.5 \times 10^6$ gain DR = 100 Hz	20220701 91 x 30.5 x 0.9 cm <sup>3</sup>	24'8" + 9'9" + 1" = 34'6"

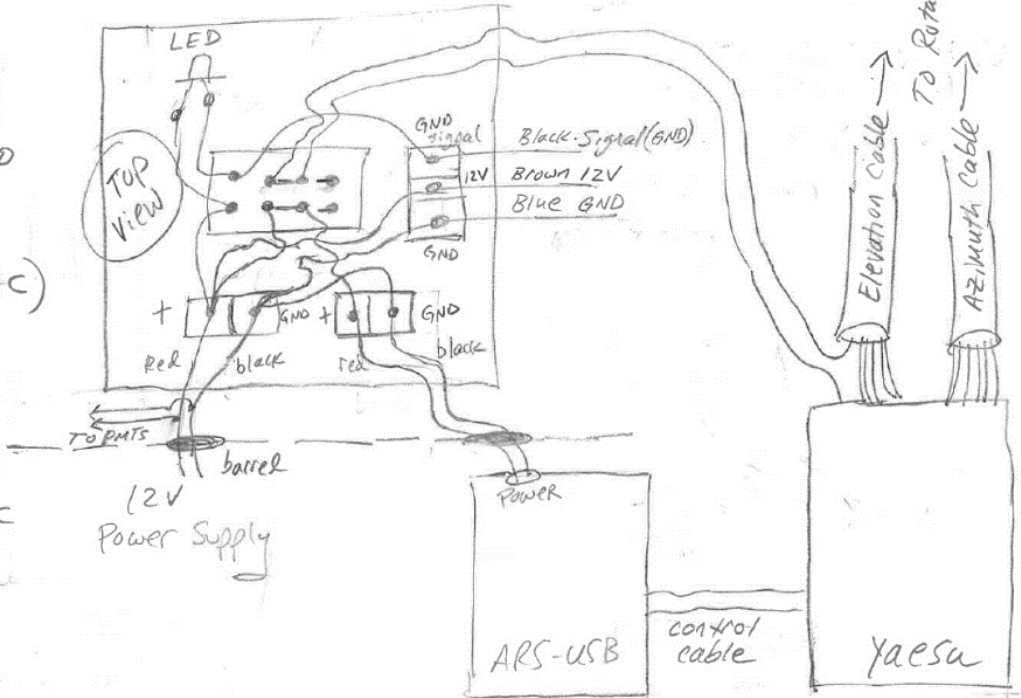
Proximity sensor wire, ~ 49'6", purple is "brown" = 12V  
 black = ~~PM~~ Signal (GND)  
 blue = Gnd (common)

Telescope information: lengths of PMT signal and power cables, PMT high voltage, gain, and dark rates, scintillator area sizes

① Kill Switch interlock - Proximity sensor NPN-NO 6-36VDC  
 Taiss LT18A3-8-2/BX 300 mA

② SANYOU  
 SMI-8-2J2D  
 12VDC DPDT  
 Relay  
 (5A, 250 VAC)

③ Red LED  
 built-in resistor  
 13.3 mA Max  
 0.7 12V DC

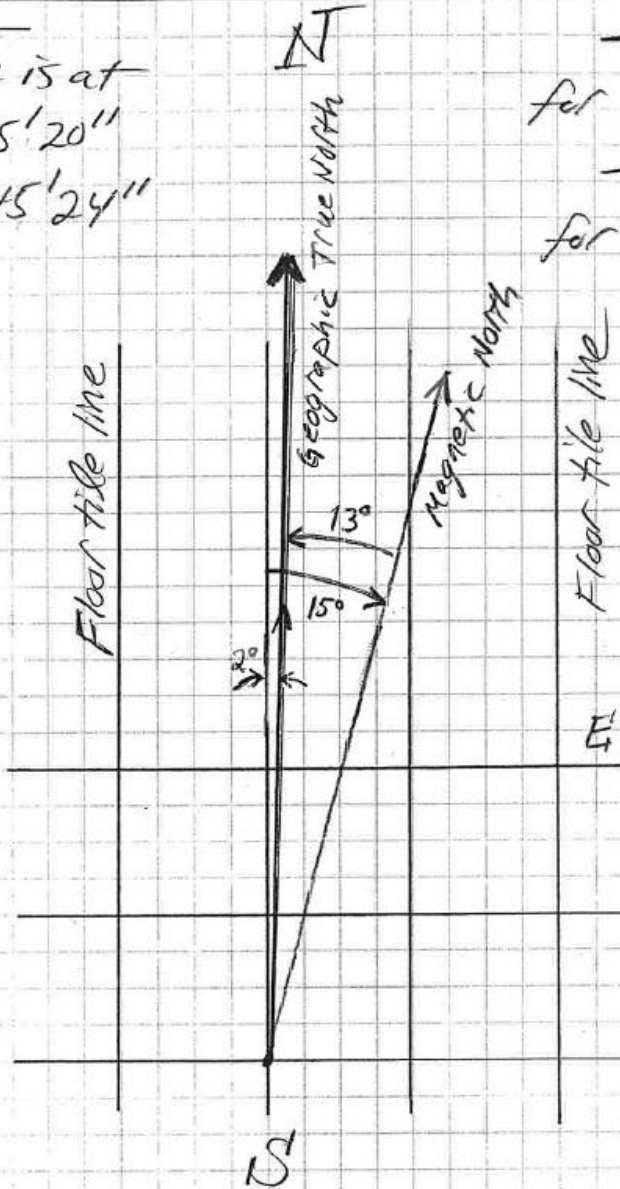


Wiring diagram for proximity sensor kill-switch relay circuit

QCC is at  
 $40^{\circ} 45' 20''$   
 $73^{\circ} 45' 24''$

$-12.9^{\circ}$   
 for Lat  $40^{\circ}$  Long  $73^{\circ}$   
 $-12.7^{\circ}$   
 for Lat  $41^{\circ}$   
 Long  $74^{\circ}$

Lab Room  
 S-309



$15^{\circ} \pm 2^{\circ}$  compass  
 measurements made  
 in 5 locations:

- ① S309A 3' from  $\frac{1}{2}$  door
- ② S309A on top of big table by North wall, near center of table
- ③ S309 in between tables 1, 2, 3, 4
- ④ S309 in between tables 3, 4, 5, 6
- ⑤ IN hallway in between offices S340 and S342

CONCLUSION Magnetic North is  $\sim 15^{\circ}$  East of floor-tile lines

True North is  $\sim 2^{\circ}$  East of floor-tile line.

Uncertainty is  $\pm 2^{\circ}$  in

To Page No. —

essed & Understood by me,

Date

Invented by:

Recorded by:

compass measurements  
 and protractor/ruler placement

Drawing of magnetic north direction measurement (shown relative to floor-tile lines) made in lab S-309 using compass; true north calculated using NOAA magnetic deflection for QCC latitude & longitude





More pictures of cosmic ray telescope

