New capabilities of the Jicamarca radar and its cluster of instruments

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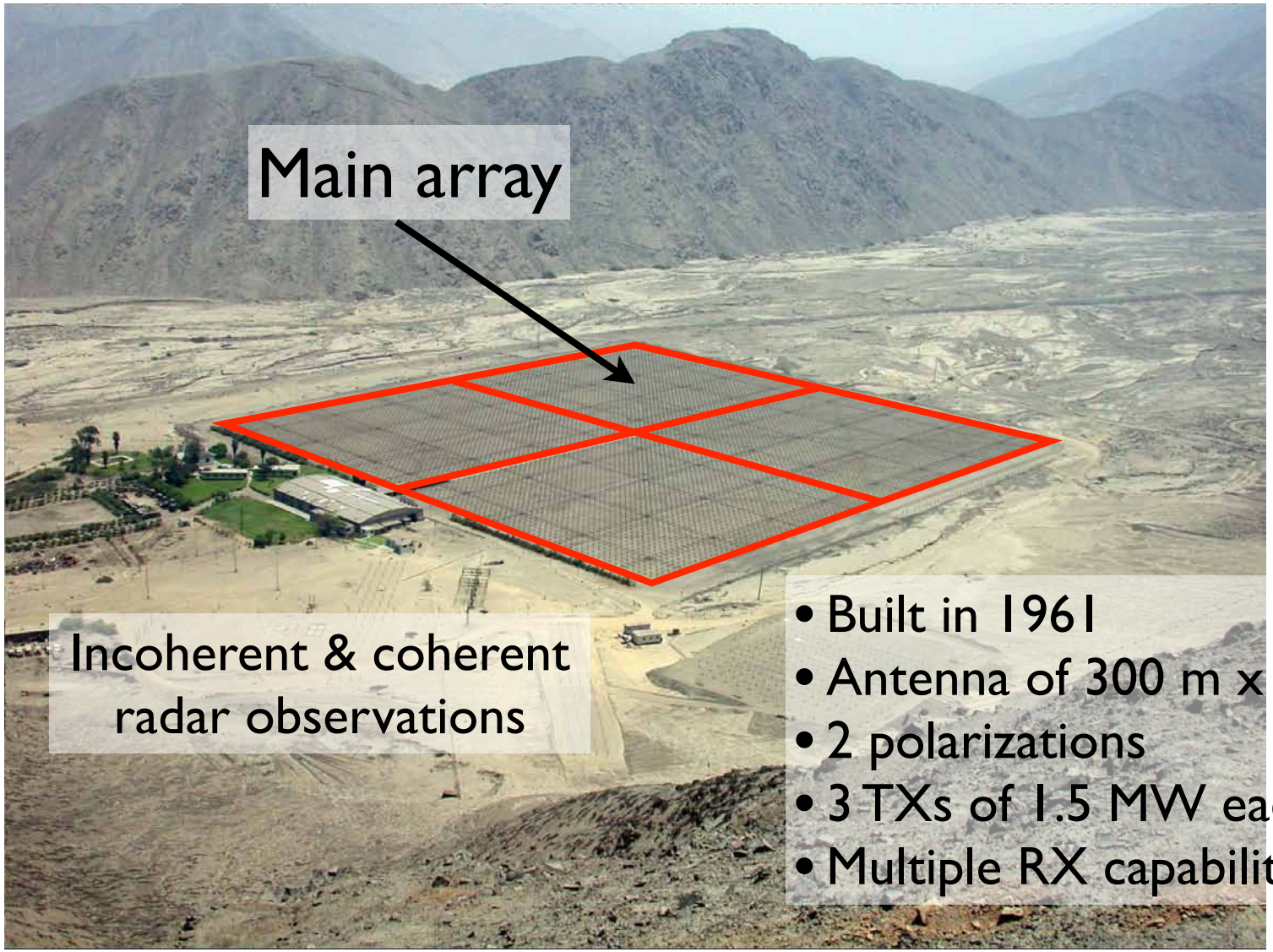
The Meeting of the Americas (AGU)
8 to 12 August 2010, Foz do Iguassu, Brazil

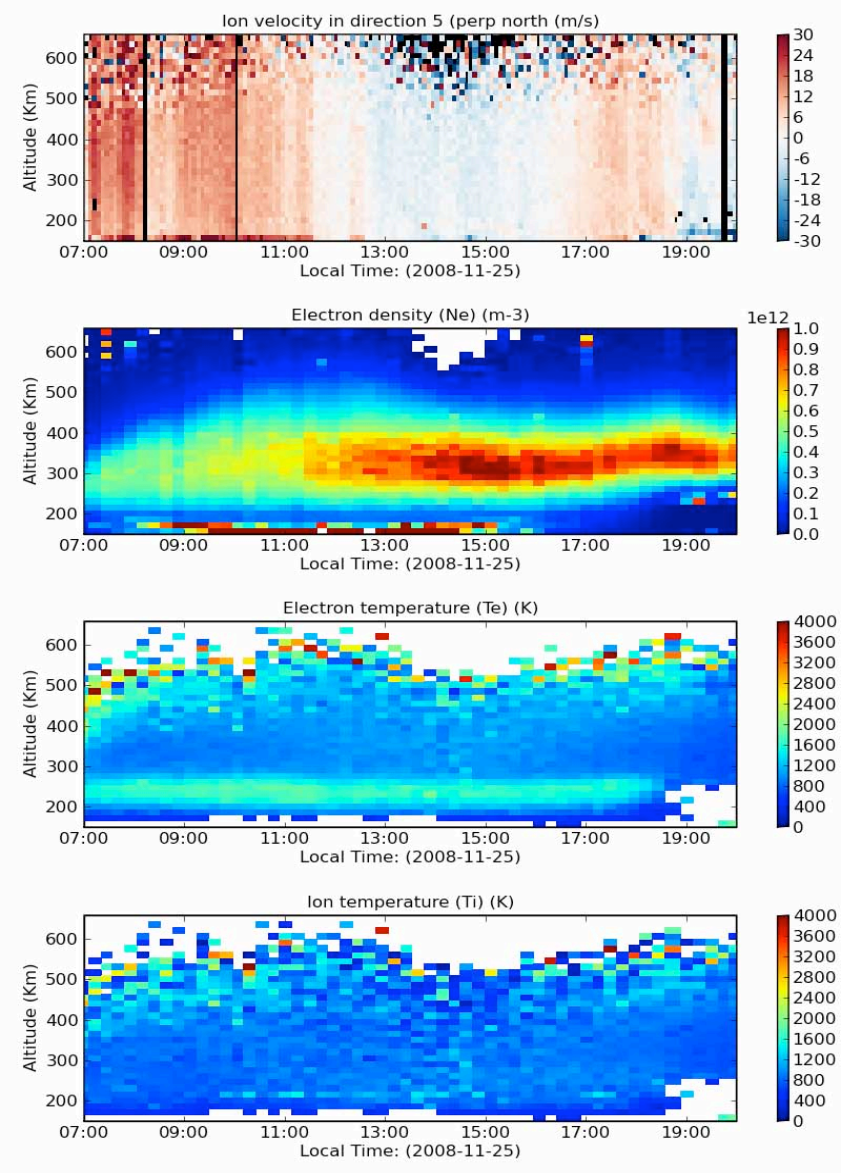
Outline

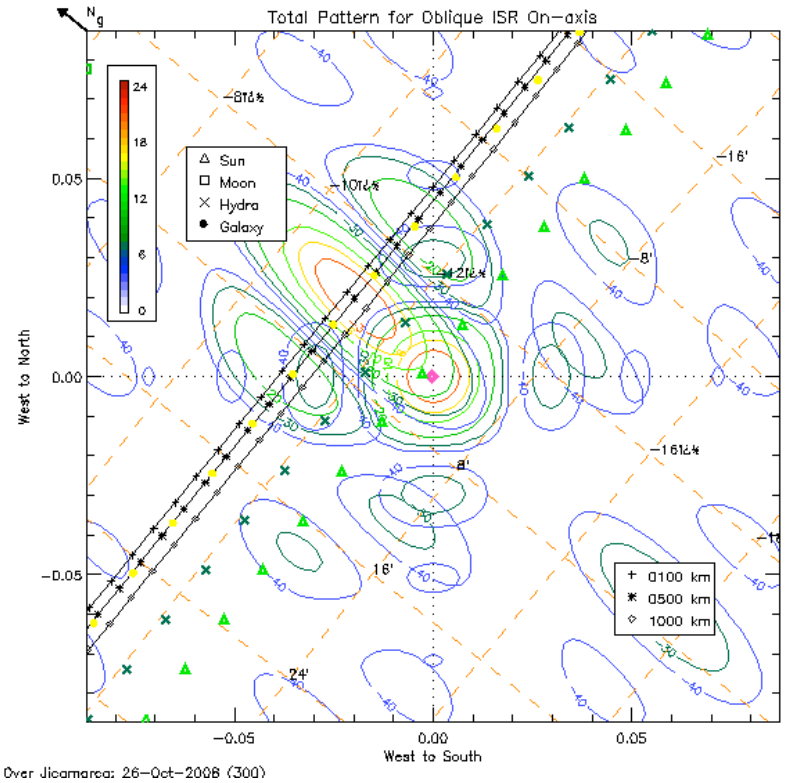
- Jicamarca IS radar
  - Electronic antenna beam steering system
  - New solid-state TR switch
  - 8-channel digital receiver system
- VIPIR ionosonde
- Optic devices: FPI and OH imager at the MeriHill
- GPS network and database center
- Magnetometers built at Jicamarca
- Other radar systems: SOUSY, Bi-static JRO-Paracas

Jicamarca main antenna array



ISR Oblique + Perpendicular Mode

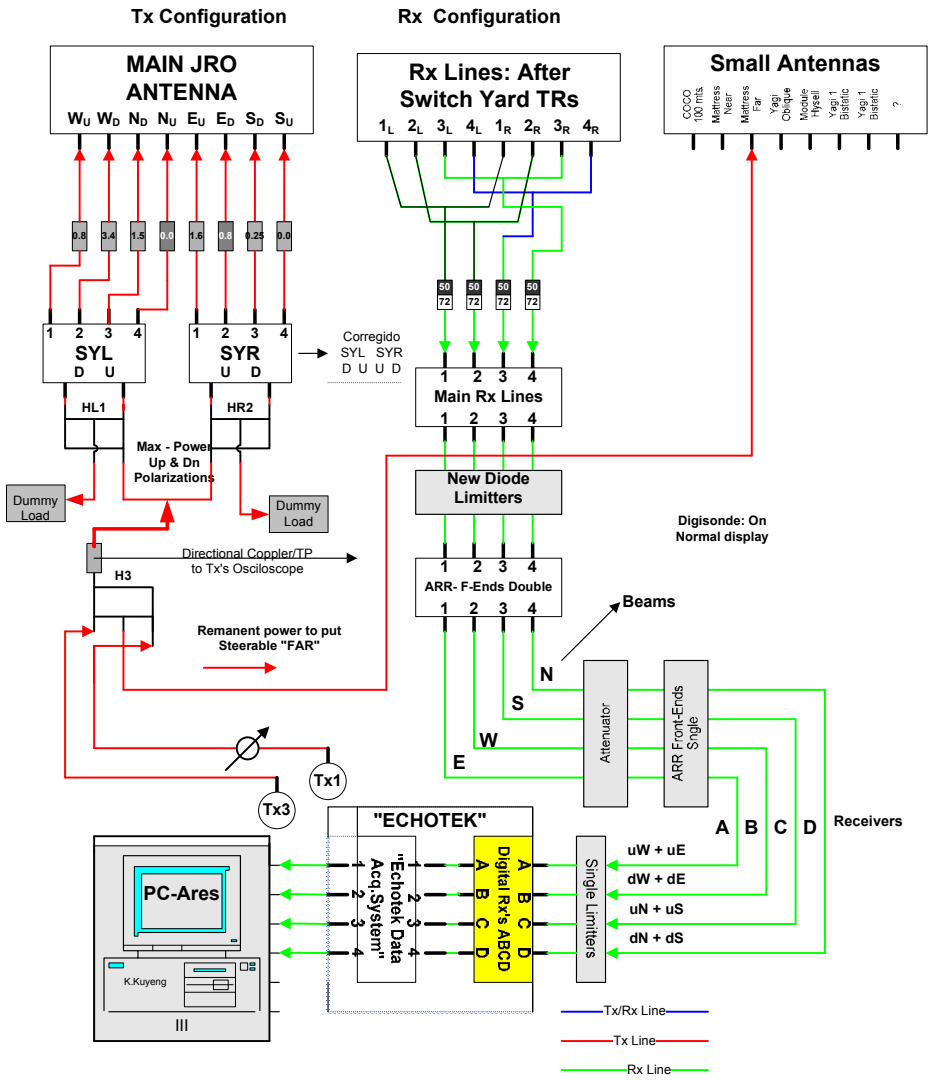




Oblique: Two TXs, two polarizations, NS quarters

Perpendicular: One TX, two polarizations, EW quarters

Typical antenna diagram and connections



Antenna: 4 Beams
Dave Fritts (Original)

North Quarter

4 4.29	5 3.55	2 2.82	3 2.08
5 2.94	2 2.20	3 5.44	4 4.70
2 5.56	3 4.82	4 4.09	5 3.35
3 4.20	4 3.47	5 2.73	2 2.00

East Quarter

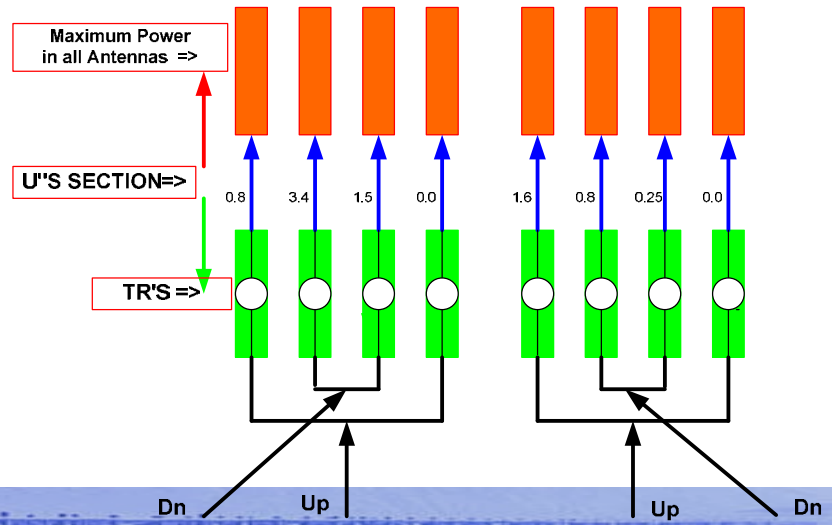
2 2	3 5	3 3	3 2
5 3	2 2	2 4	2 3
3 3	4 2	4 4	4 3
2 4	3 3	3 5	3 4

West Quarter

4 4	5 3	5 5	5 4
3 5	4 4	4 2	4 5
5 5	2 4	2 2	2 5
4 2	5 5	5 3	5 2

South Quarter

4 4.29	5 3.55	2 2.82	3 2.08
5 2.94	2 2.20	3 5.44	4 4.70
2 5.56	3 4.82	4 4.09	5 3.35
3 4.20	4 3.47	5 2.73	2 2.00



Antenna group in action

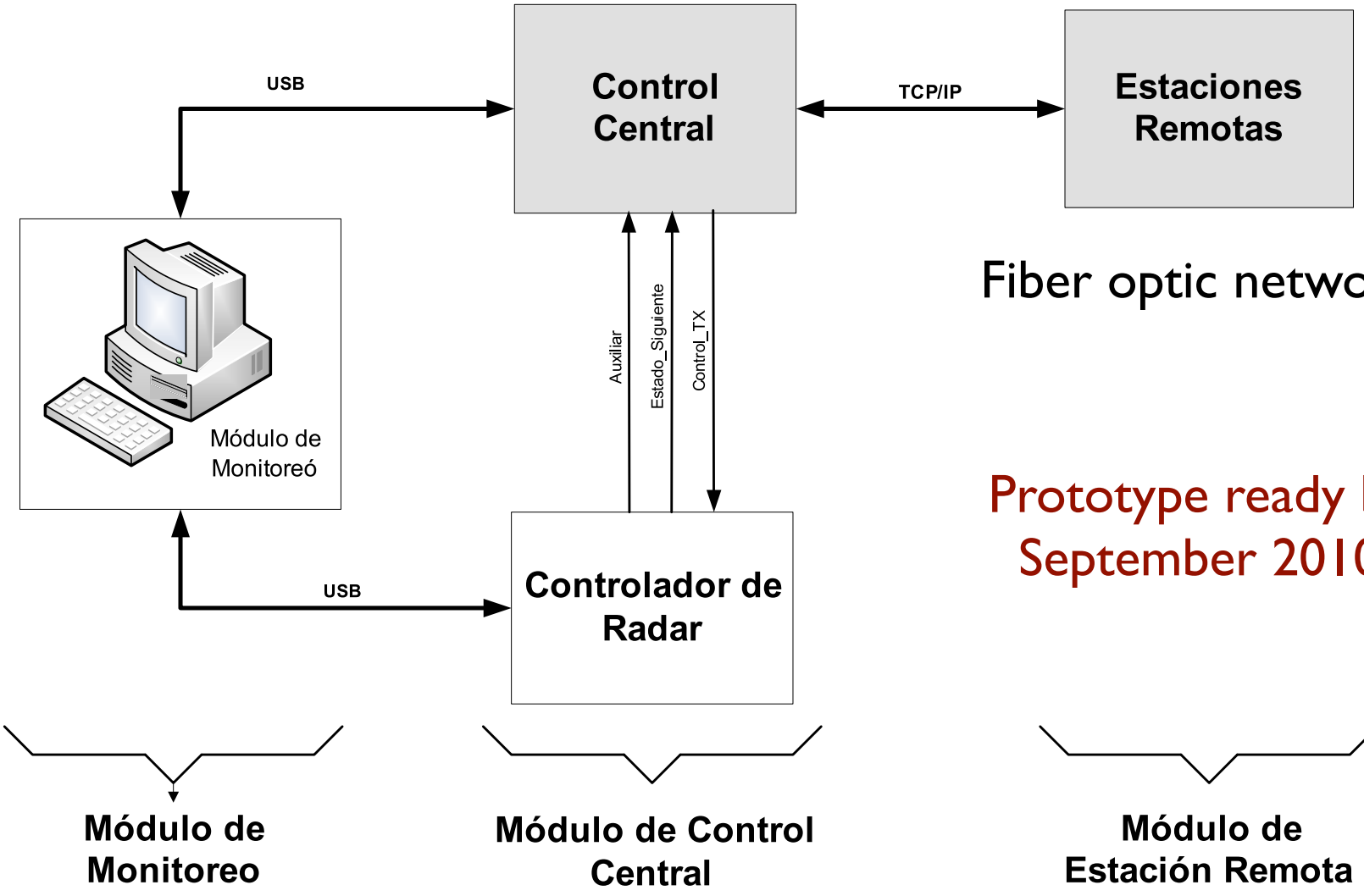
Connections have to be changed manually.

Antenna beam steering (ABS) system

An ABS system has been developed, built, and installed in the south quarter of the antenna.

Parameter	Current	New
Switching	Manual	Electronic
Quarters	Four	One
Time for switching	2-4 hours	10 ms
Positions	2-bits	3-bits
Use of Ues	Yes	No
Peak power per module	100 kW	50 kW
Control	Manual	Electronic
Verification	Manual	Electronic

ABS Control - Diagram



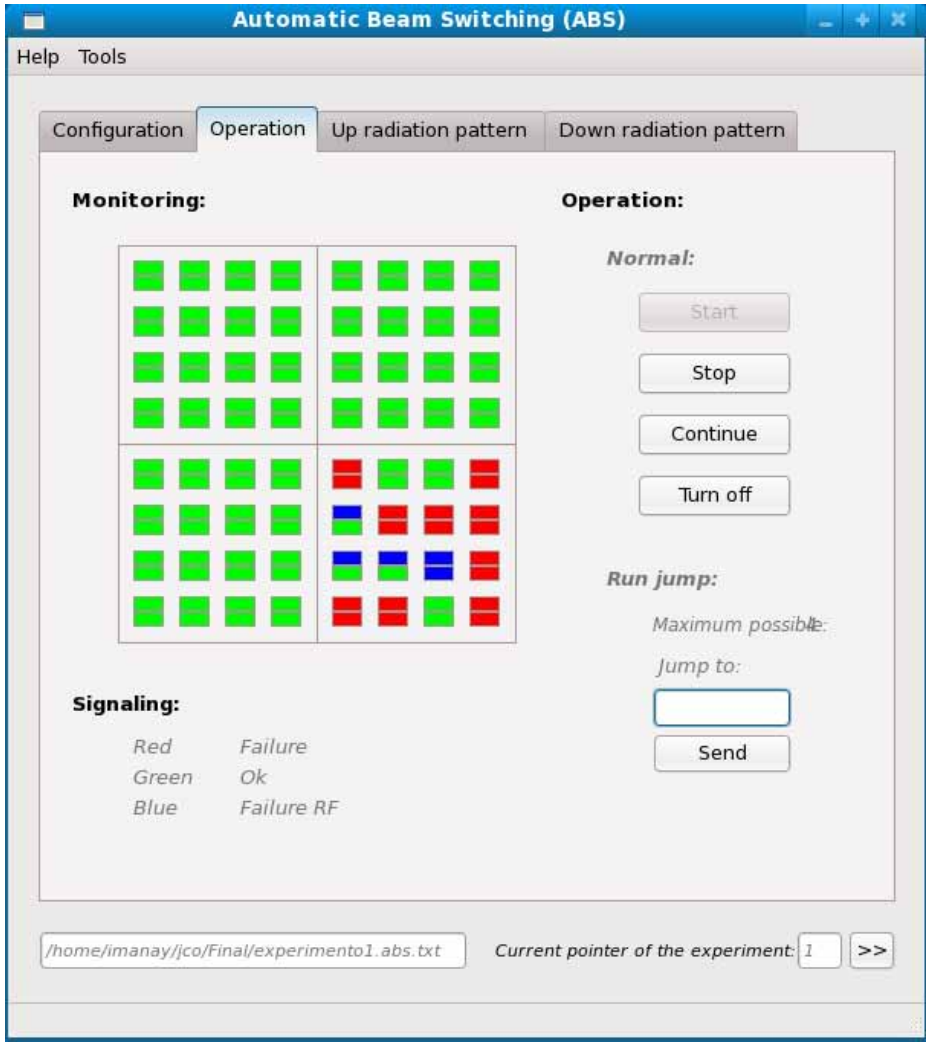
Fiber optic network

Prototype ready by September 2010

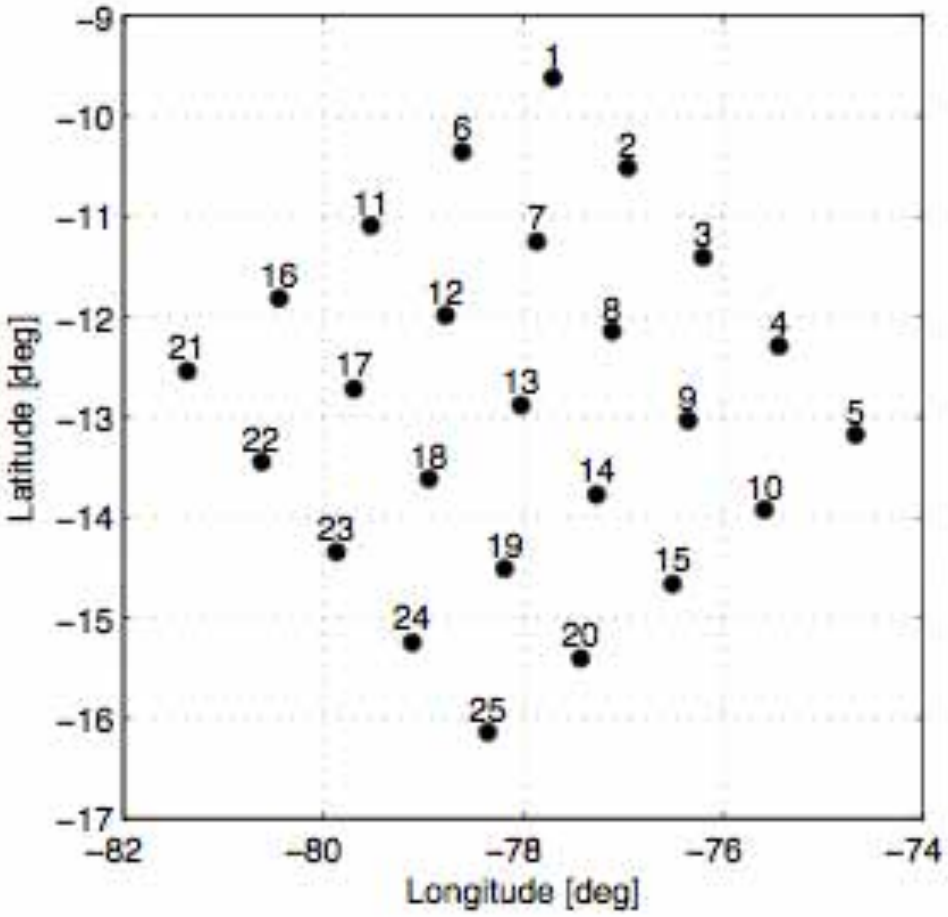
ABS Control - Monitoring Module

Color code:

Green: OK
Blue: Control Pointing failure
Orange: RF Failure
Red: Total failure

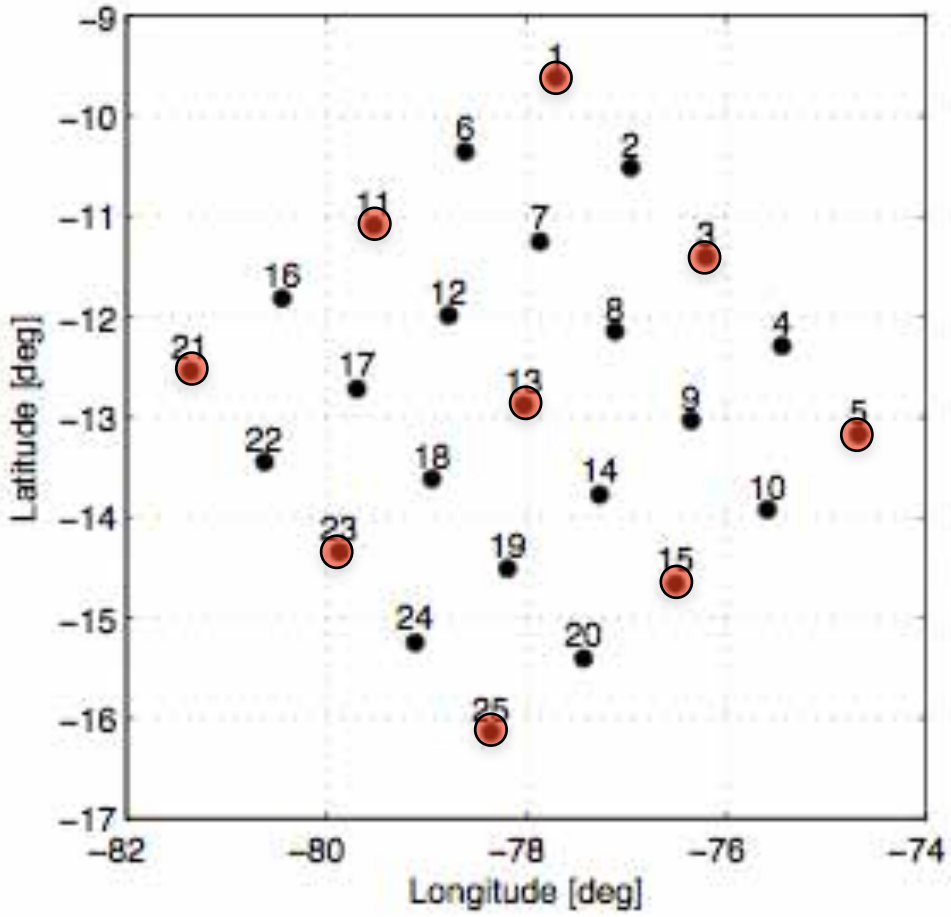


ABS system - New antenna positions



	Declination	Hour Angle	Angle off ⊥	2W-Direc [dB]	ABS [m^2]
1	$-9.62°$	$-3^m20.1^s$	3.27°	85.44	15591.6
2	$-10.51°$	$0^m20.5^s$	2.59°	86.83	21048.6
3	$-11.40°$	$2^m40.4^s$	2.31°	87.29	23369.2
4	$-12.29°$	$5^m42.6^s$	2.59°	86.83	21048.6
5	$-13.17°$	$8^m46.2^s$	3.27°	85.44	15591.6
6	$-10.36°$	$-6^m57.8^s$	2.59°	86.83	21048.6
7	$-11.25°$	$-3^m58.4^s$	1.64°	88.22	28444.2
8	$-12.14°$	$0^m57.6^s$	1.16°	88.69	31593.8
9	$-13.03°$	$2^m4.4^s$	1.64°	88.22	28444.2
10	$-13.92°$	$5^m7.7^s$	2.59°	86.83	21048.6
11	$-11.09°$	$-10^m36.7^s$	2.31°	87.29	23369.2
12	$-11.99°$	$-7^m37.5^s$	1.16°	88.69	31593.8
13	$-12.88°$	$-4^m37.0^s$	0.00°	89.15	35098.5
14	$-13.77°$	$-1^m35.2^s$	1.16°	88.69	31593.8
15	$-14.66°$	$1^m27.8^s$	2.31°	87.29	23369.2
16	$-11.82°$	$-14^m16.8^s$	2.59°	86.83	21048.6
17	$-12.72°$	$-11^m17.9^s$	1.64°	88.22	28444.2
18	$-13.61°$	$-8^m17.7^s$	1.16°	88.69	31593.8
19	$-14.51°$	$-5^m16.2^s$	1.64°	88.22	28444.2
20	$-15.40°$	$-2^m13.4^s$	2.59°	86.83	21048.6
21	$-12.54°$	$-17^m58.2^s$	3.27°	85.44	15591.6
22	$-13.44°$	$-14^m59.5^s$	2.59°	86.83	21048.6
23	$-14.34°$	$-11^m59.6^s$	2.31°	87.29	23369.2
24	$-15.24°$	$-8^m58.4^s$	2.59°	86.83	21048.6
25	$-16.14°$	$-5^m55.9^s$	3.27°	85.44	15591.6

ABS system - New antenna positions



	Declination	Hour Angle	Angle off ⊥	2W-Direc [dB]	ABS [m^2]
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8	$-12.14°$	$0^m57.6^s$	1.16°	88.69	31593.8
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13	$-12.88°$	$-4^m37.0^s$	0.00°	89.15	35098.5
14	$-13.77°$	$-1^m35.2^s$	1.16°	88.69	31593.8
15	$-14.66°$	$1^m27.8^s$	2.31°	87.29	23369.2
16	$-11.82°$	$-14^m16.8^s$	2.59°	86.83	21048.6
17	$-12.72°$	$-11^m17.9^s$	1.64°	88.22	28444.2
18	$-13.61°$	$-8^m17.7^s$	1.16°	88.69	31593.8
19	$-14.51°$	$-5^m16.2^s$	1.64°	88.22	28444.2
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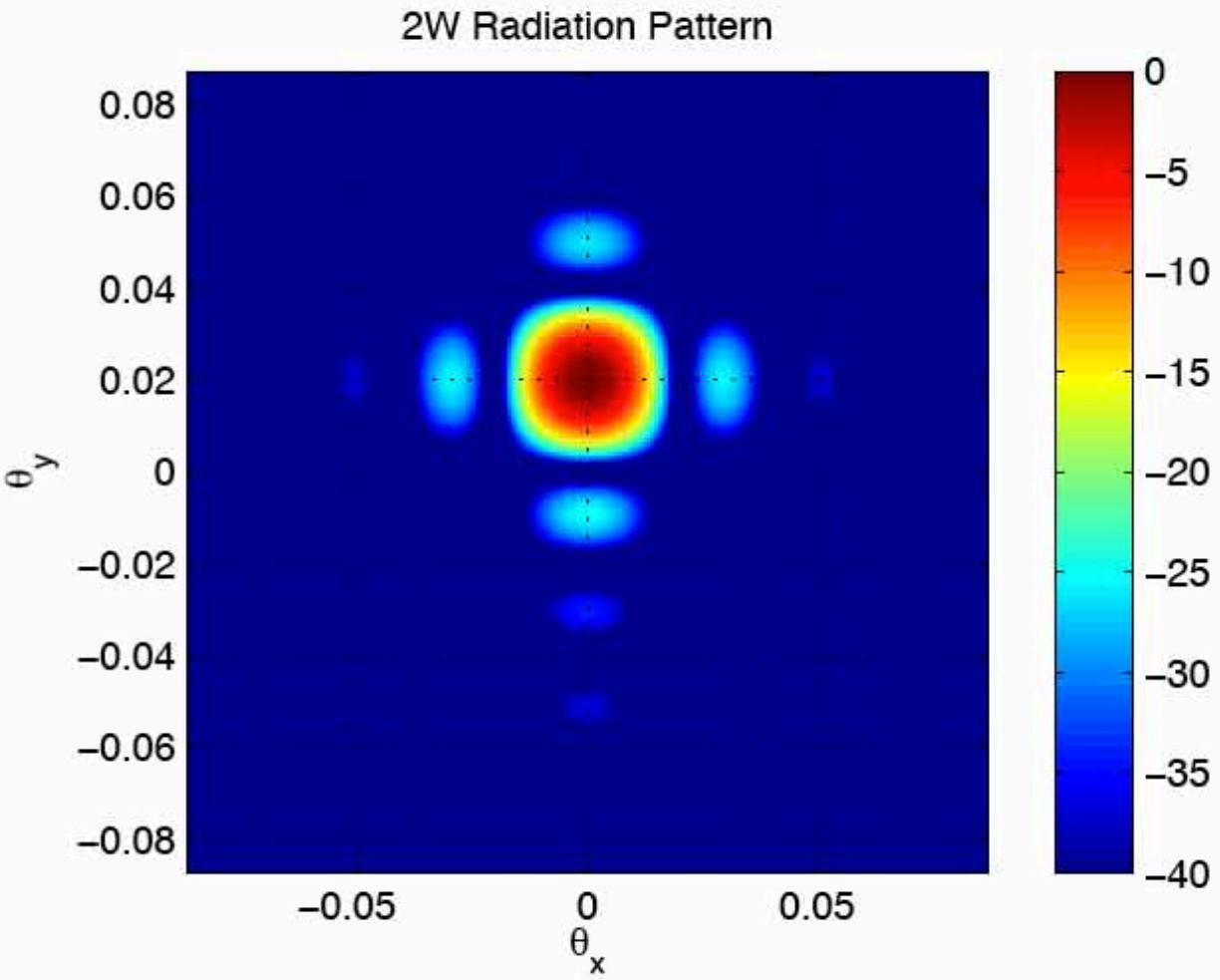
22	$-13.44°$	$-14^m59.5^s$	2.59°	86.83	21048.6
23	$-14.34°$	$-11^m59.6^s$	2.31°	87.29	23369.2
24	$-15.24°$	$-8^m58.4^s$	2.59°	86.83	21048.6
25	$-16.14°$	$-5^m55.9^s$	3.27°	85.44	15591.6

ABS system - Antenna Pattern Example

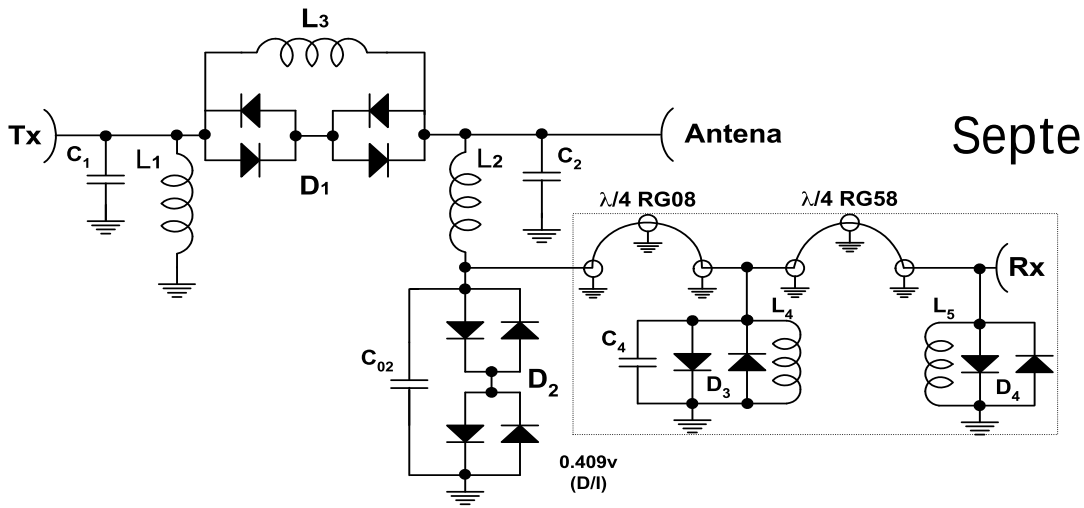


Antenna Position: 8
Longitude: $-77.11°$
Latitude: $-12.14°$
Hour Angle: $0^{m}57.6^{s}$
Angle off $\perp$: $1.16°$
2W-Directivity = 88.69 dB
ABS factor = $31593.8\,m^2$
Phase Configuration:

3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

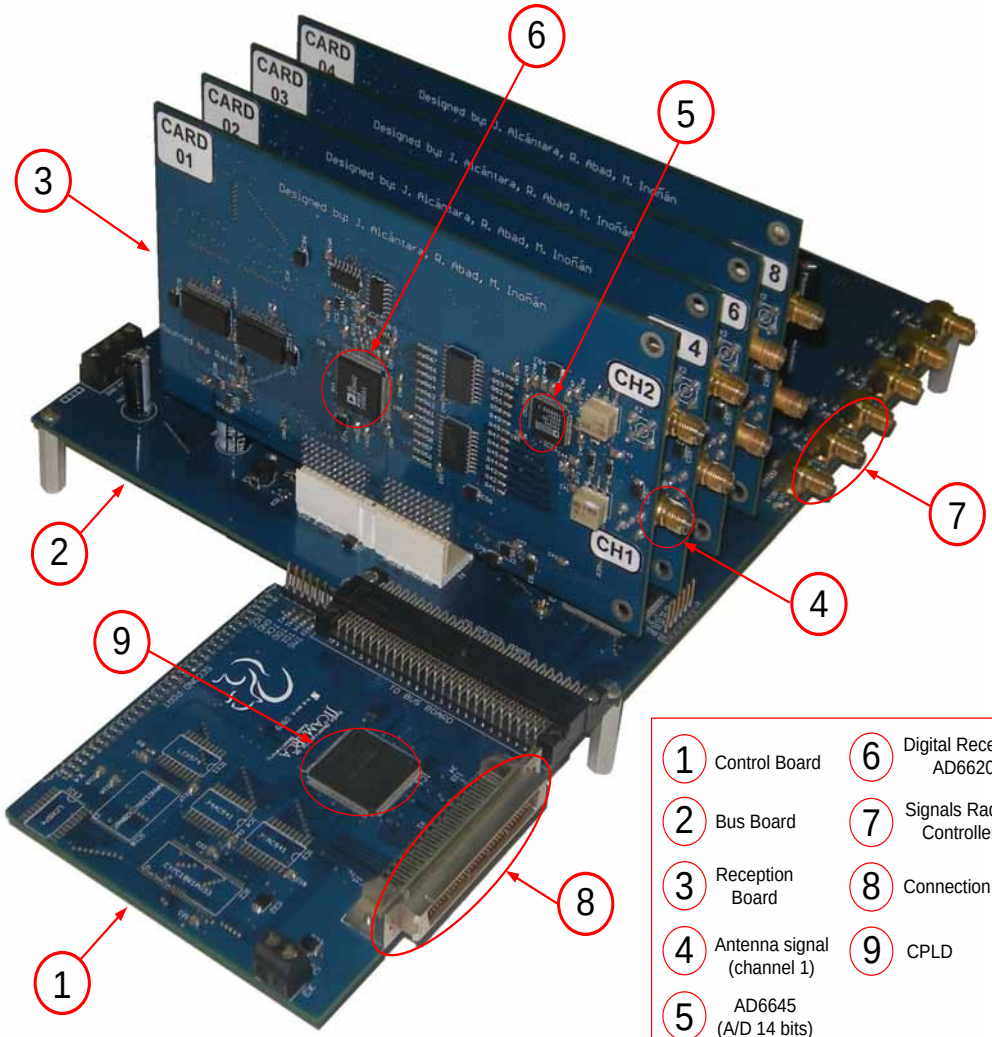
Solid State TR Switch

Parameter	Old	New
Technology	“Spark Gaps”	Solid state
Tuning	Manual	None
Isolation Tx/Rx	40 dB	60 dB
Time response	180 ns (b) 2 us (e)	6 ns (b) 0.2 us (e)
Peak Power	1000 kW	800 kW
Duty cycle	6%	6%

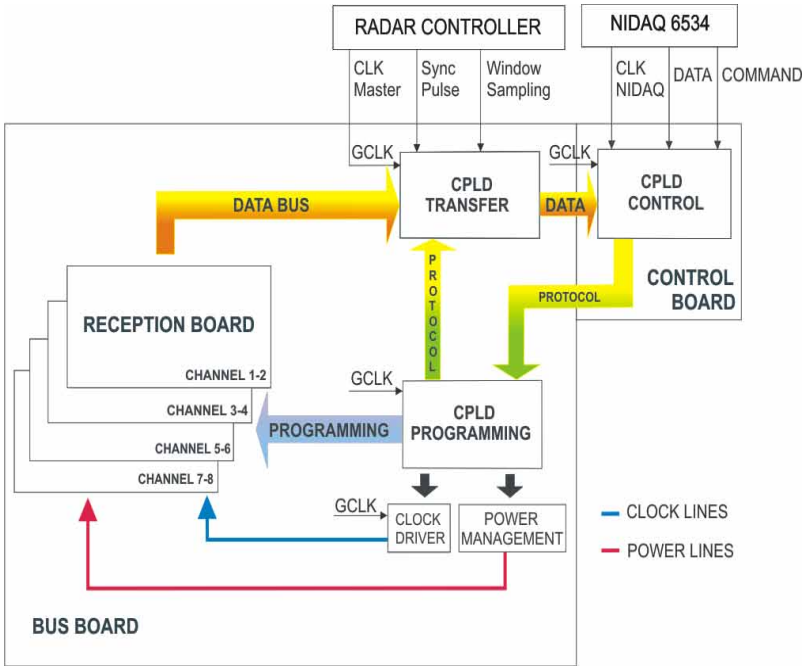


September 2010

JARS - Jicamarca Acquisition Radar System

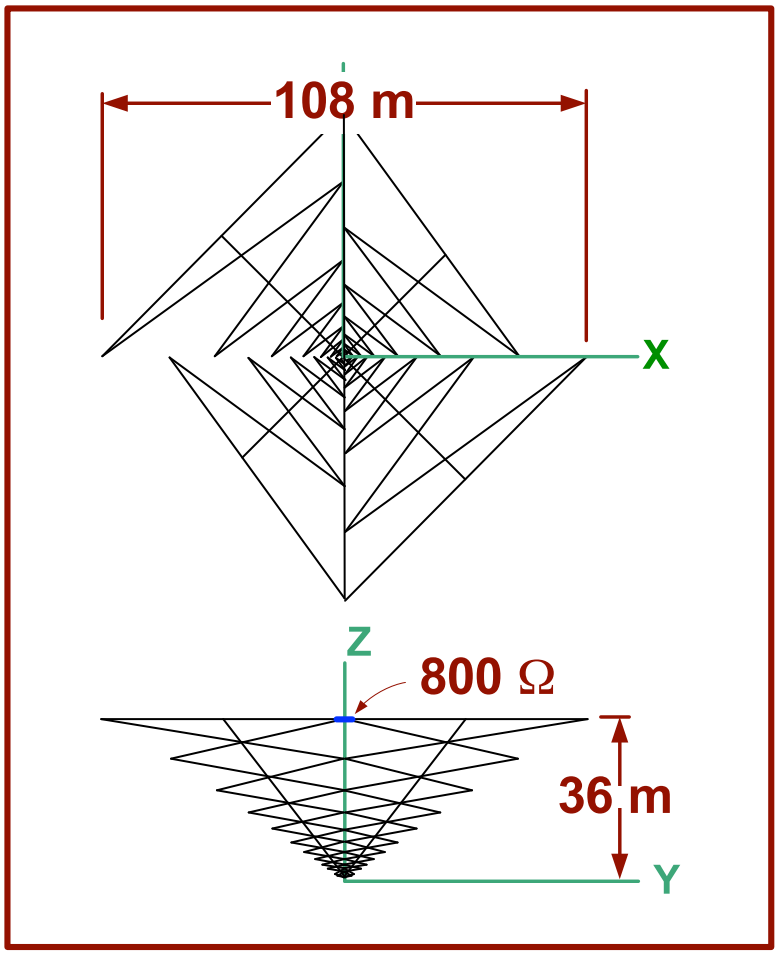


1. Control Board
2. Bus Board
3. Reception Board
4. Antenna signal (channel 1)
5. AD6645 (A/D 14 bits)
6. Digital Receiver AD6620
7. Signals Radar Controller
8. Connection to PC
9. CPLD



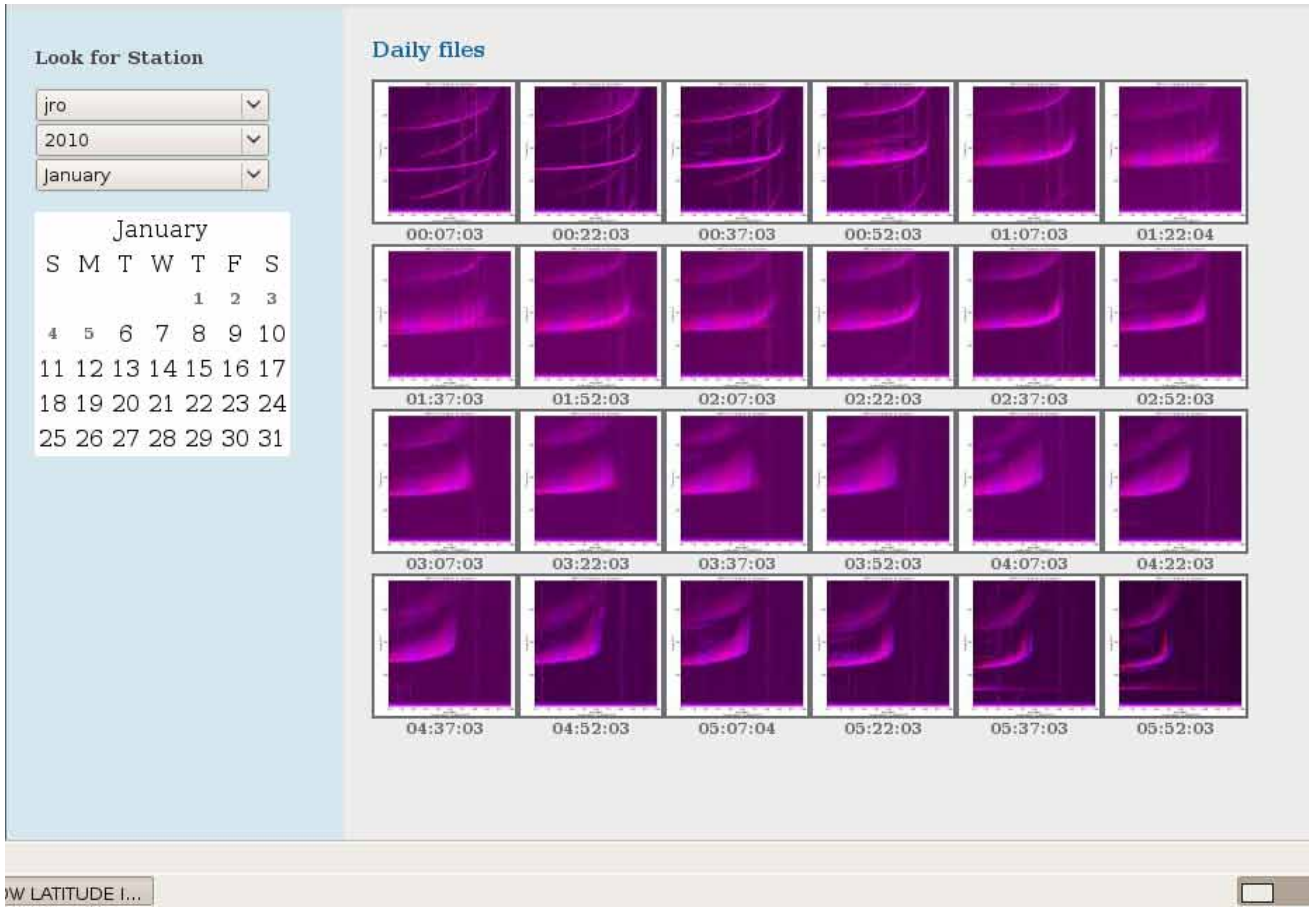
8 digital receivers @ 1MHz
ADC 14 bits (84 dB)

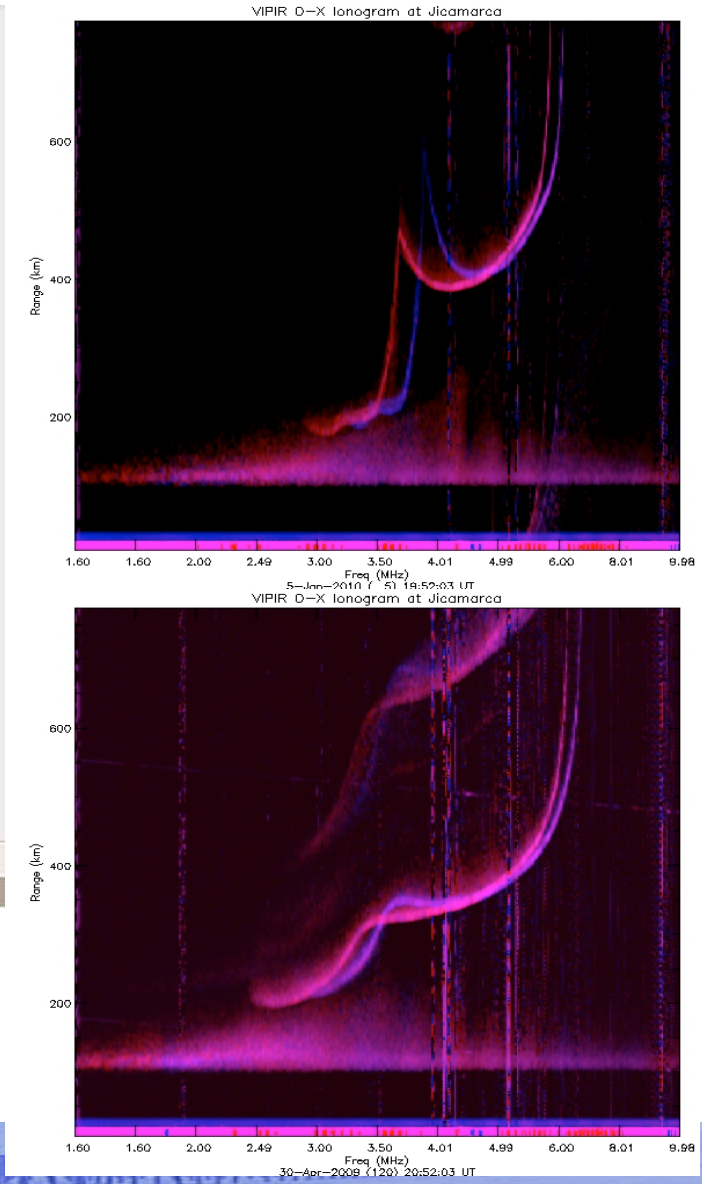
VIPIR ionosonde



8 RX + 1 TX (0.3 - 30 MHz)

VIPIR ionograms & database

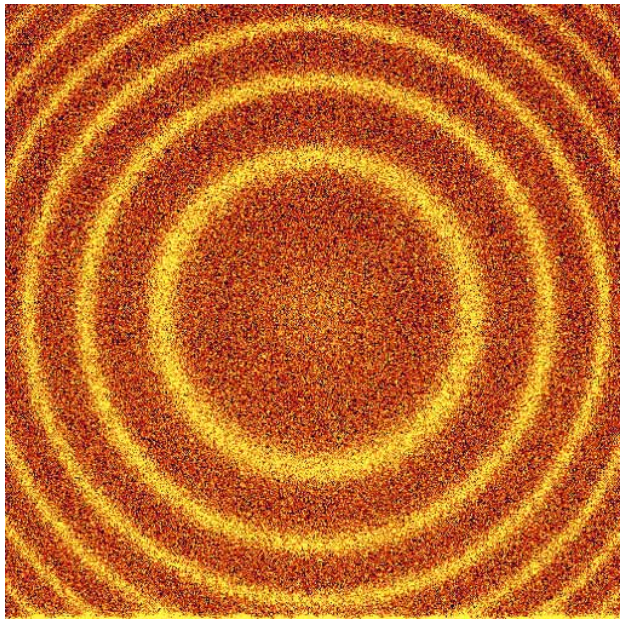


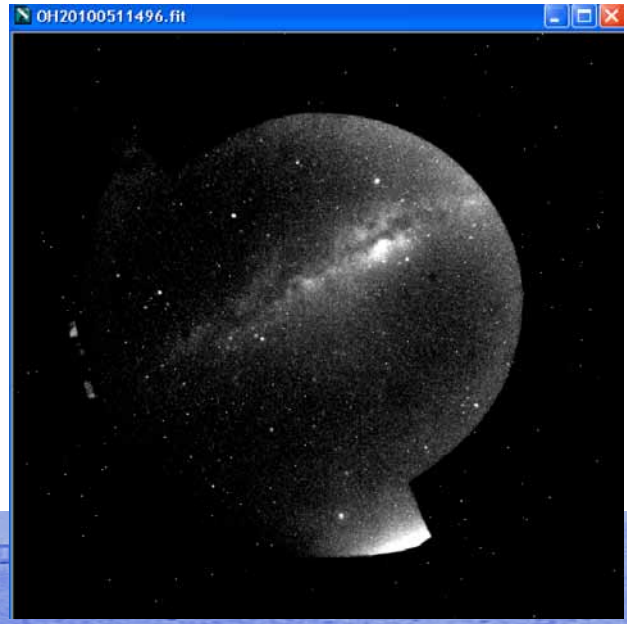


http://200.60.148.173/lisn/ionosonde/

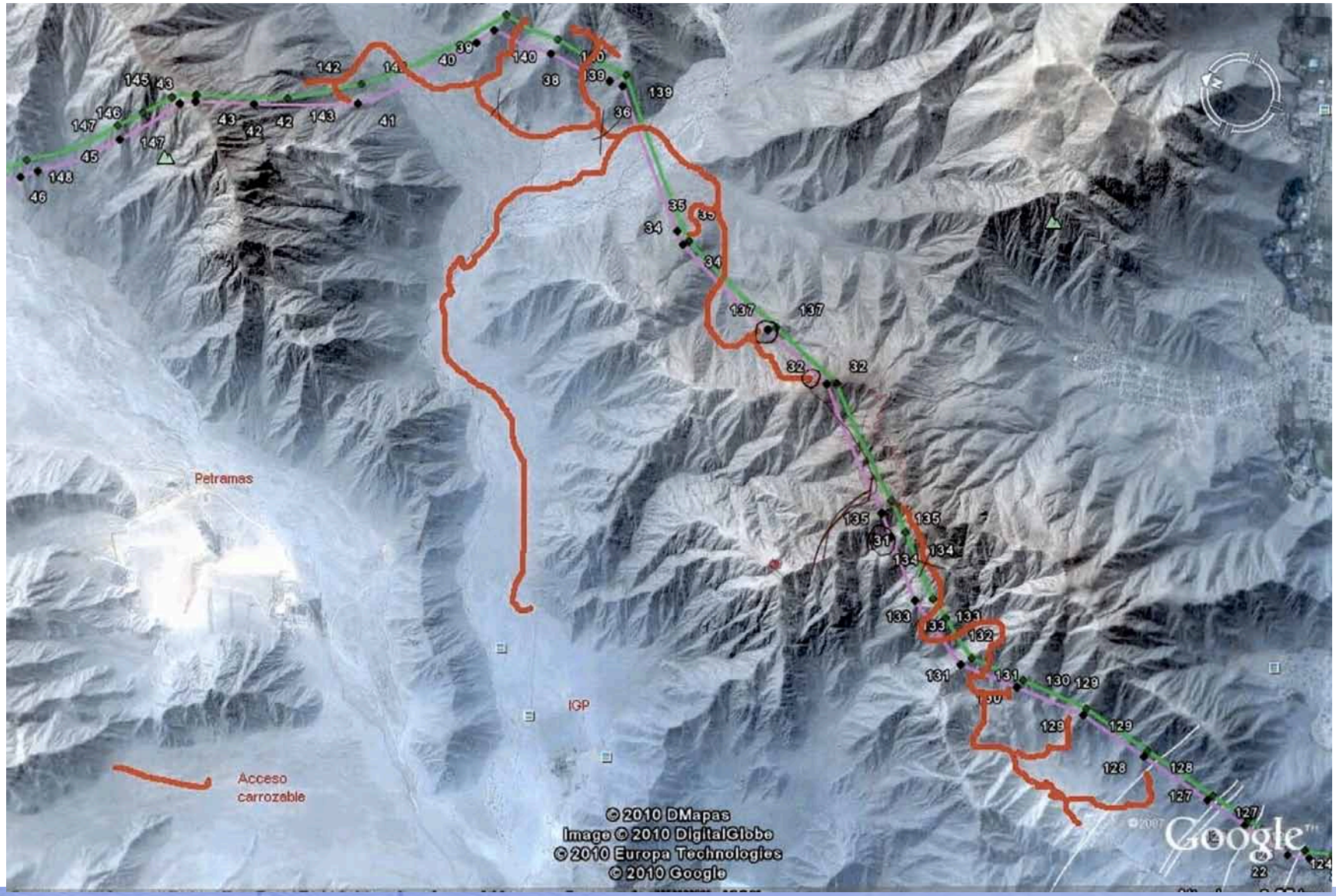
Optical instruments at the MeriHill

- Opening of MeriHill Observatory (Aug 15 2009):
  - MRH-FPI (F region filter)
  - All-sky Imager – Mesospheric filter (UIUC)
- Operation of FPI at Arequipa
- FPI SOFDI at Huancayo

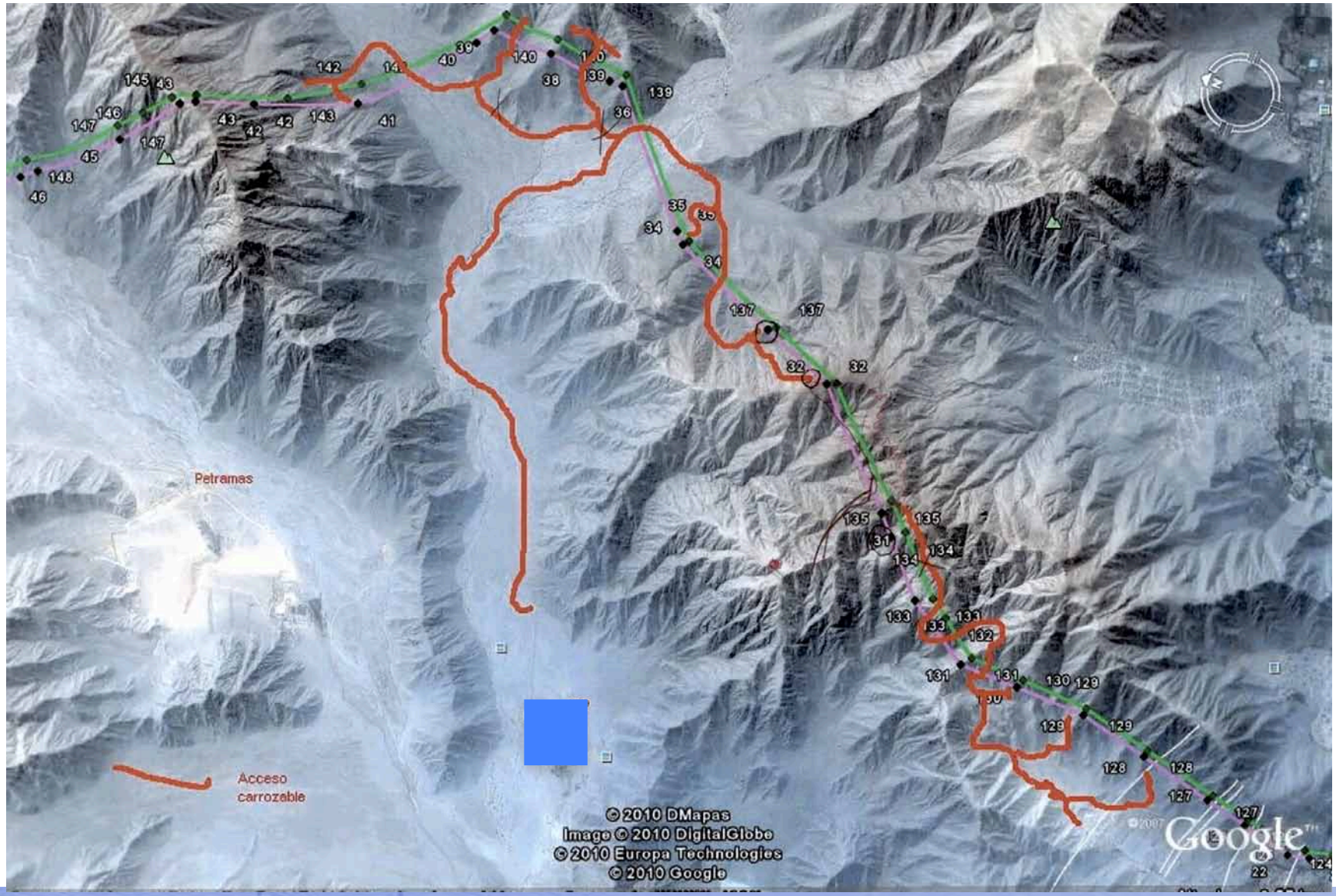




MeriHill Observatory: New road



MeriHill Observatory: New road

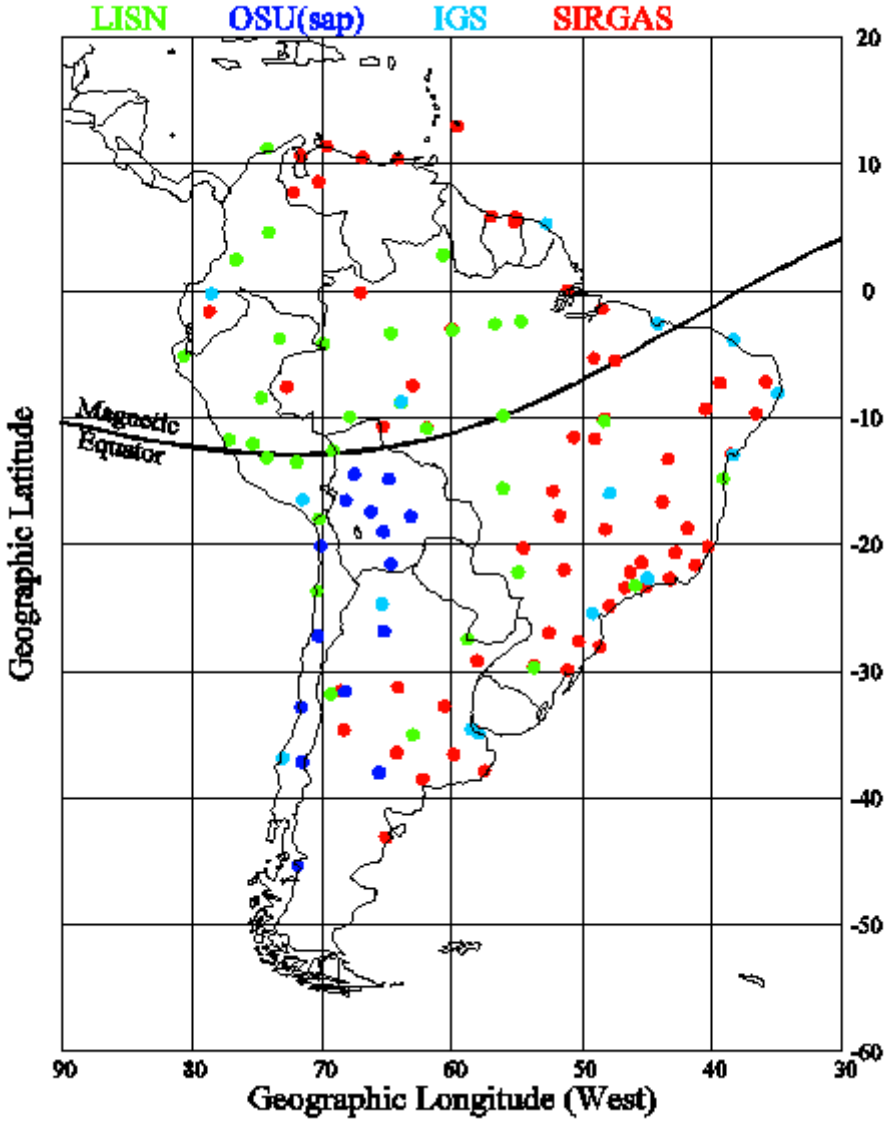


MeriHill Observatory: New road

MeriHill Observatory: New road

LISN headquarters at Jicamarca

- Instruments:
- VIPIR ionosondes (5, 1 installed)
- GPS receivers (70, 40 installed)
- Magnetometers (5, 3 installed)



LISN GPS + Database

Stations // Status

Select a Network

LISN

Select an Instrument

Show all instruments

Jicamarca

Lat : -11.952395
Lon : -76.8757134

GPS

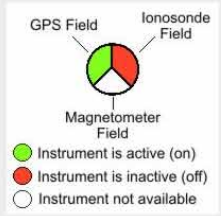
Status:
View latest TEC plot
Last Update: 2010-06-15 13:14:59 (UT)

Magnetometer

Status:
View latest magnetogram
Last Update: 2010-06-15 08:08:31 (UT)

Ionosonde

Status:
View latest ionogram
Last Update: 2010-01-20 00:37:03 (UT)



Animated flag images by 3DFlags.com

Data // GPS

Login

Username
Password
Login

You can only browse the GPS database, to download files you need an account.

Look for Station

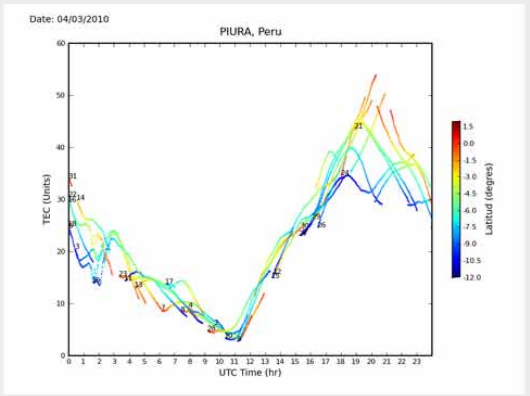
LISN
Peru
Piura
2010
March

March

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

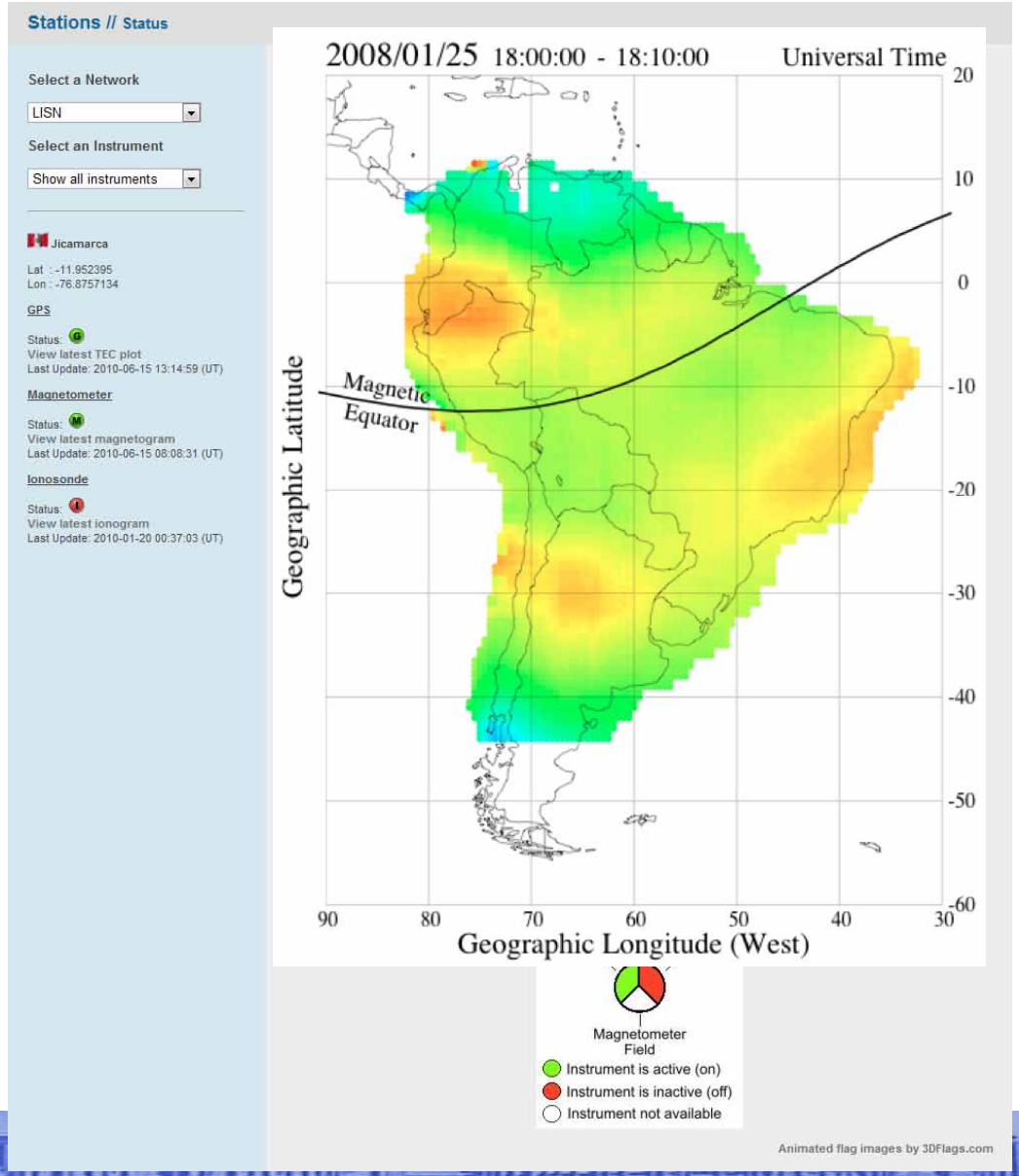
Daily files

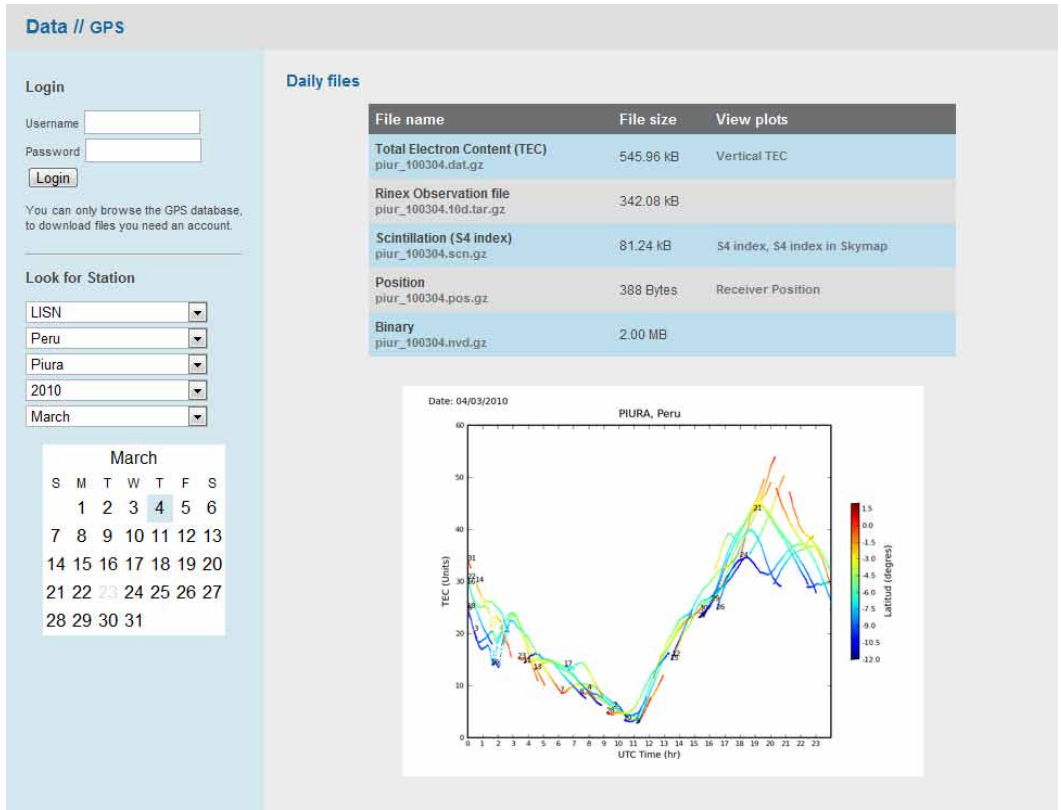
File name	File size	View plots
Total Electron Content (TEC) piur_100304.dat.gz	545.96 kB	Vertical TEC
Rinex Observation file piur_100304.10d.tar.gz	342.08 kB	
Scintillation (S4 index) piur_100304.scn.gz	81.24 kB	S4 index, S4 index in Skymap
Position piur_100304.pos.gz	388 Bytes	Receiver Position
Binary piur_100304.nvd.gz	2.00 MB	



http://200.60.148.173/lisn/gps

LISN GPS + Database

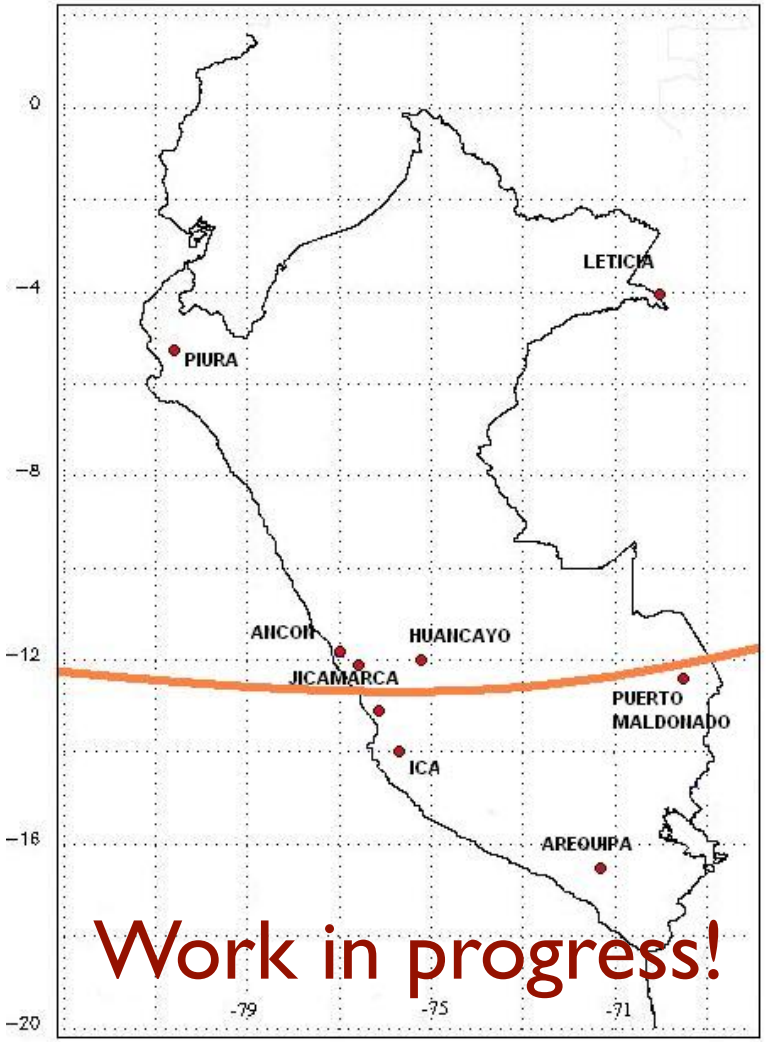




http://200.60.148.173/lisn/gps

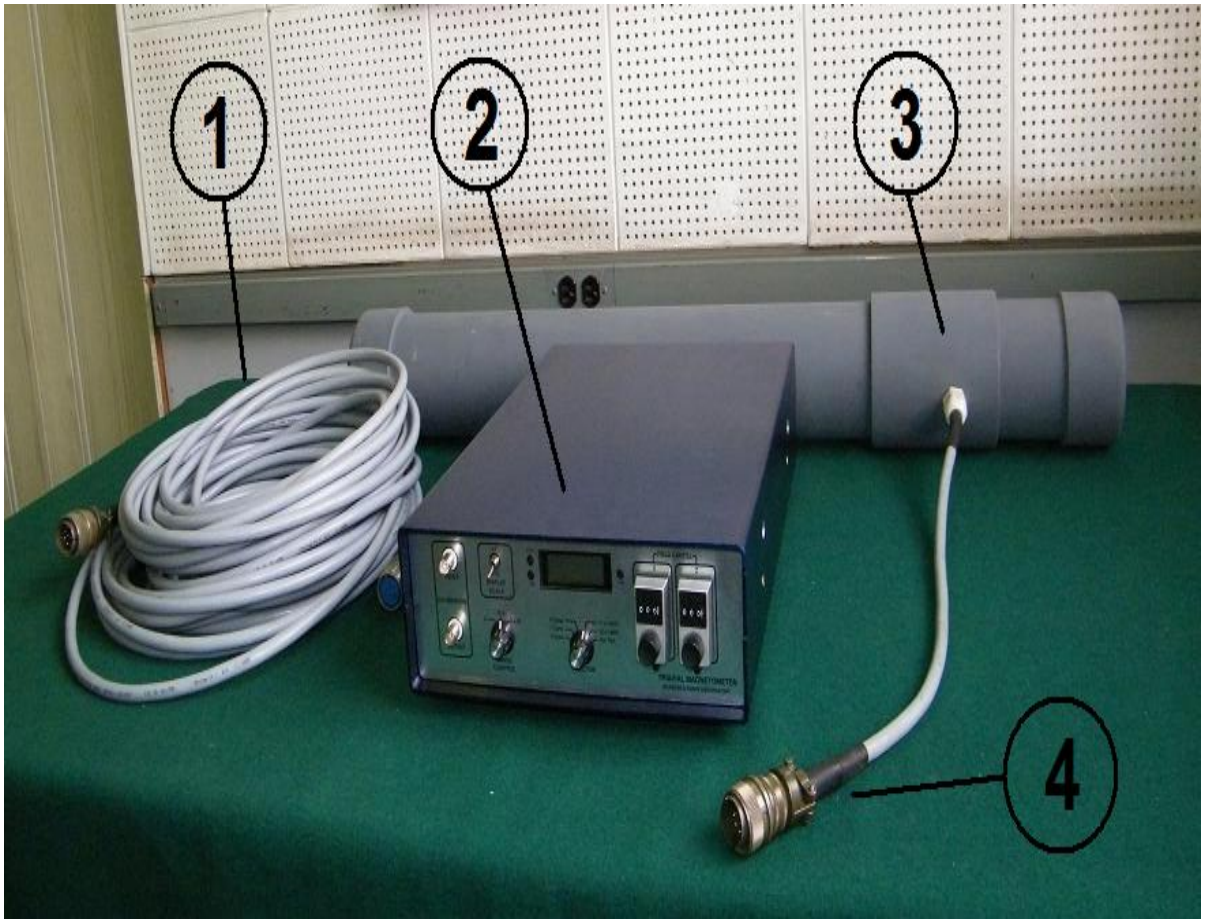
Network of magnetometers in Peru

PIURA (-5.17 –80.67)	XYZ Fluxgate (Tromso-IGP)
ANCON (-11.77 -77.14)	XYZ Fluxgate (MAGDAS) HDZ Fluxgate (Tokyo Univ.-IGP)
HUANCAYO (-12.03 -75.32)	H,D,Z Eschenhagen (DTM) HDZ Fluxgate (GRL-Tokyo-IGP) XYZ Fluxgate (ERI Tokyo) PPM (OHBM)*
JICAMARCA (-11.56 -77.03)	XYZ Fluxgate (UCLA-IGP)
CAÑETE (-13.11 -76.38)	XYZ Fluxgate (KYU Univ.) CPMN Project
ICA (-13.98 -75.77)	XYZ Fluxgate (KYU Univ.) CPMN Project
AREQUIPA (-16.46 -71.49)	H,D,Z La Cour, Photographic, (UNSA)
PTO. MADONADO (-12.58 – 69.18)	XYZ Fluxgate (LISN – IGP)
LETICIA (-4.19 -69.94)	XYZ Fluxgate (LISN-Colombia)



http://jro.igp.gob.pe/database/magnetometer/html/magdata.htm

Magnetometers made at Jicamarca

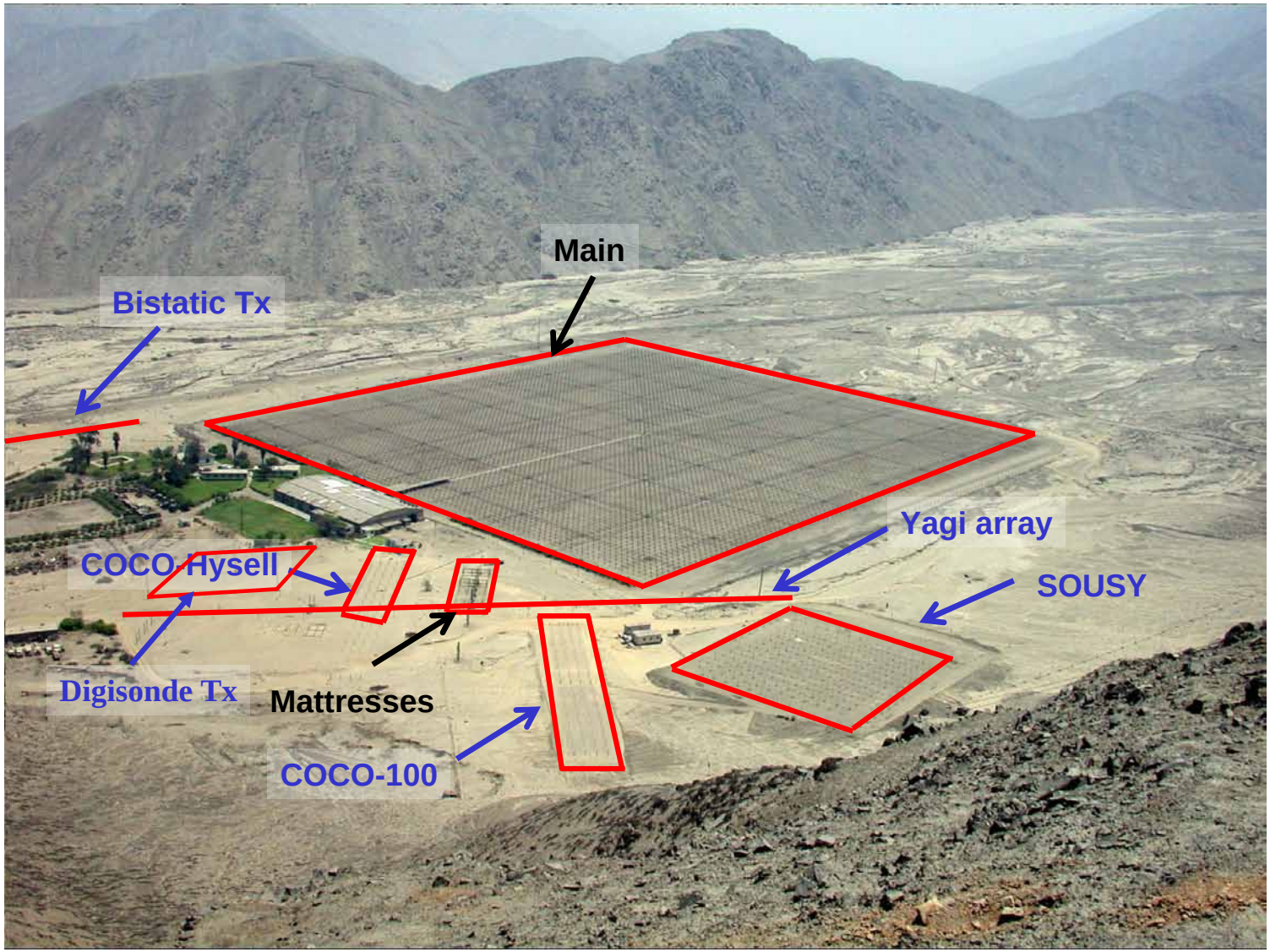


1) 25m cable 2) Control and acquisition unit
3) Magnetic sensor 4) Output conector

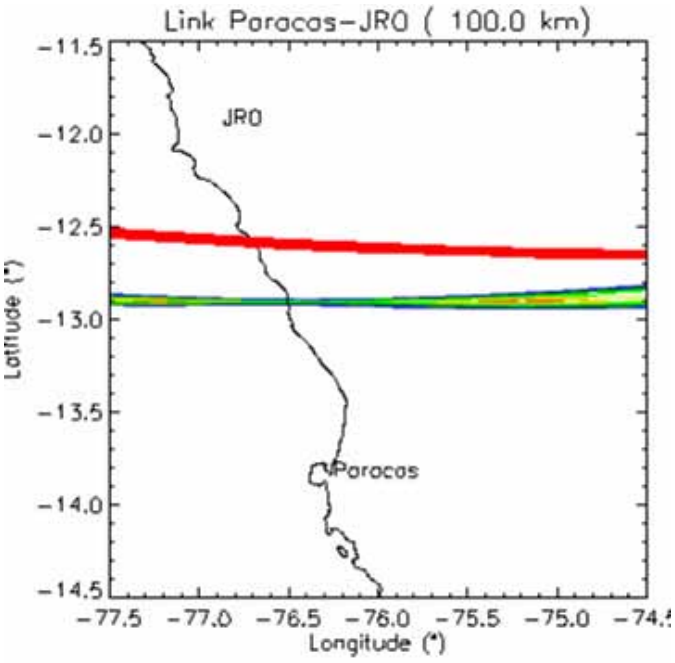
Specifications
Total range : +/- 75000 nT
3 Dynamic ranges
- **Rango 1X :** +/- 2500 nT
- **Rango 2.5X :** +/- 1000 nT
- **Rango 10X :** +/- 250 nT

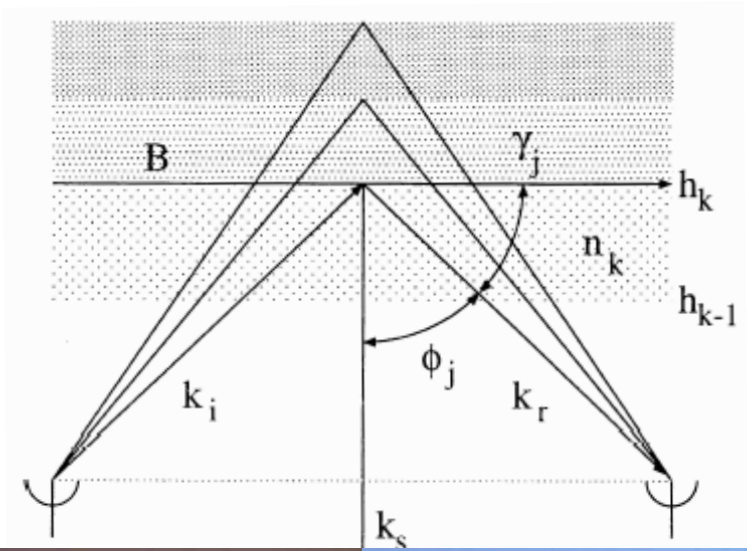
Sensitivity : 2.5mV/nT
Resolution : 0.1 nT
Accuracy : 0.25%
Supply voltages : 12Vdc/ 220Vac
Current : +320 mA
Output voltage : +/- 2.5 V full scale
Digital output : USB

Other antennas & radar systems

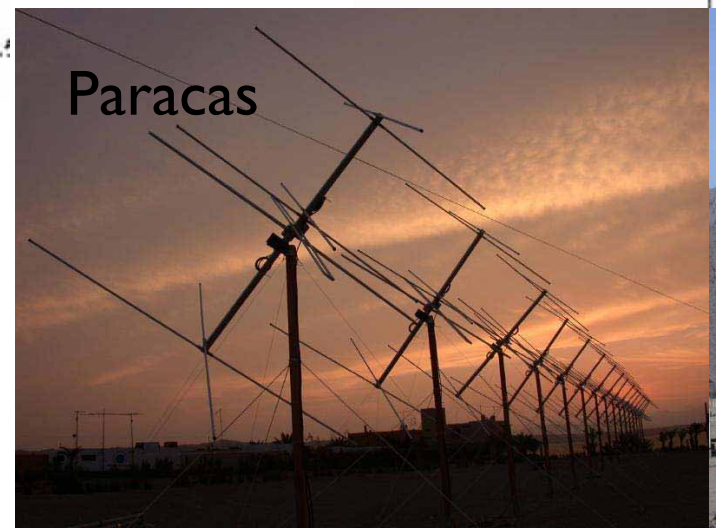


Bistatic radar: JRO-Paracas





E-region densities are obtained by measuring the Faraday rotation of the scatter signal.



JRO & Cluster of Instruments

Instrument	Parameter	Region	Time Coverage	Annual Coverage	Regional Coverage
ISR	Ne, Te, Ti, Vz, Vx, %	Ionosphere	24	1000 hours	JRO
MST	U,V,W	Troposphere, Stratosphere, Mesosphere	24 (T,S), daytime (M)	> 10 days	JRO
JULIA	Irregularity intensity, Vz, Vx	Ionosphere	24	4000 hours	JRO
JULIA-150	Vz	Ionosphere	Daytime	150 days	JRO
FPI (AQP, SOFDI, MRH)	U,V, Tn	Bottom *F* region	Nighttime Daytime (SOFDI)	> 100 days	Peru
Magnetometers (JRO, LISN)	Vz	Ionosphere	Daytime	365 days	77º, 75º, 69º, 56º West
LISN GPS	TEC, scintillations	Ionosphere	24	365 days	South America
Ionosondes (JRO, LISN)	TEC, scintillations	Ionosphere	24	365 days	77ºW, 69ºW
JASMET-Meteors	U, V	Mesosphere	24	Campaigns	JRO, Piura, HYO (*)

Thank you for your attention!