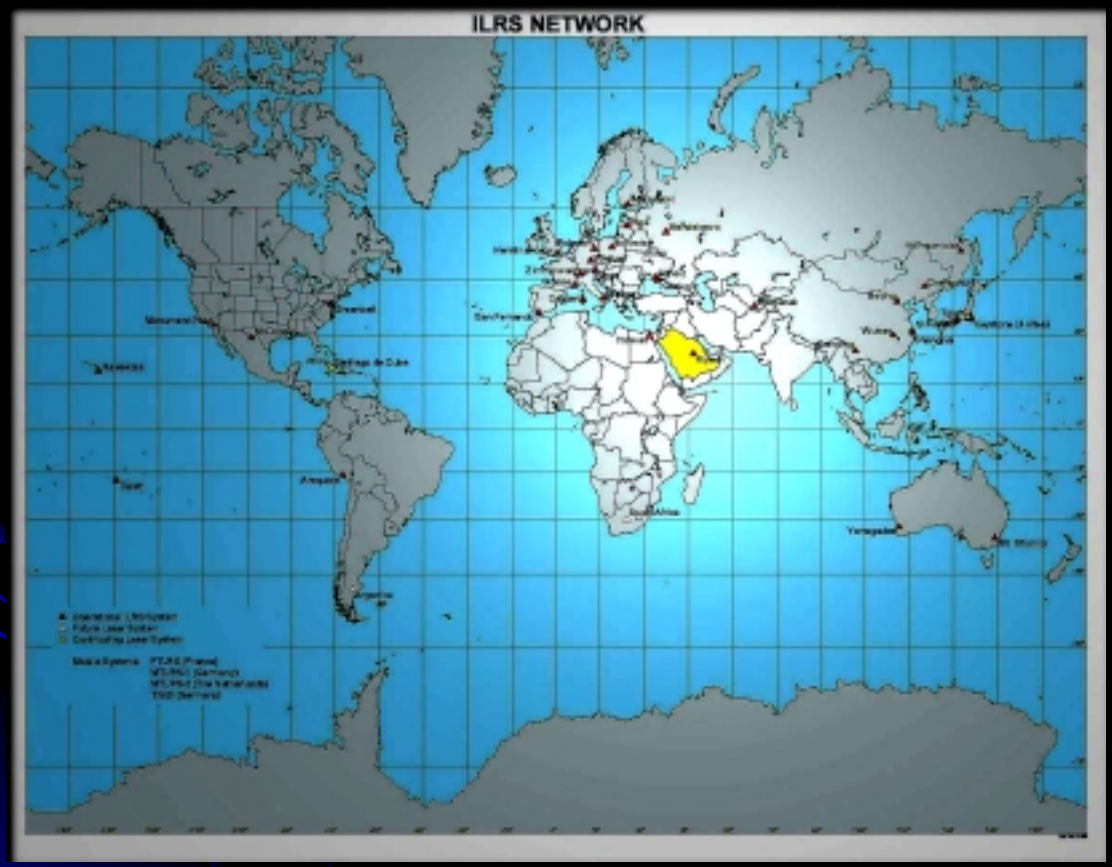
Slide 1


SALRO
Status of KACST SLR Program
Past, Present and Future
Turki S. M. Al-Saud, Abdallah M. Azzeer, Attieh A Al-Ghamdi
and John Guilfoyle
Space Research Institute
King Abdulaziz City for Science and Technology

Slide 2

SALRO

Where are we?



Slide 3

SALRO

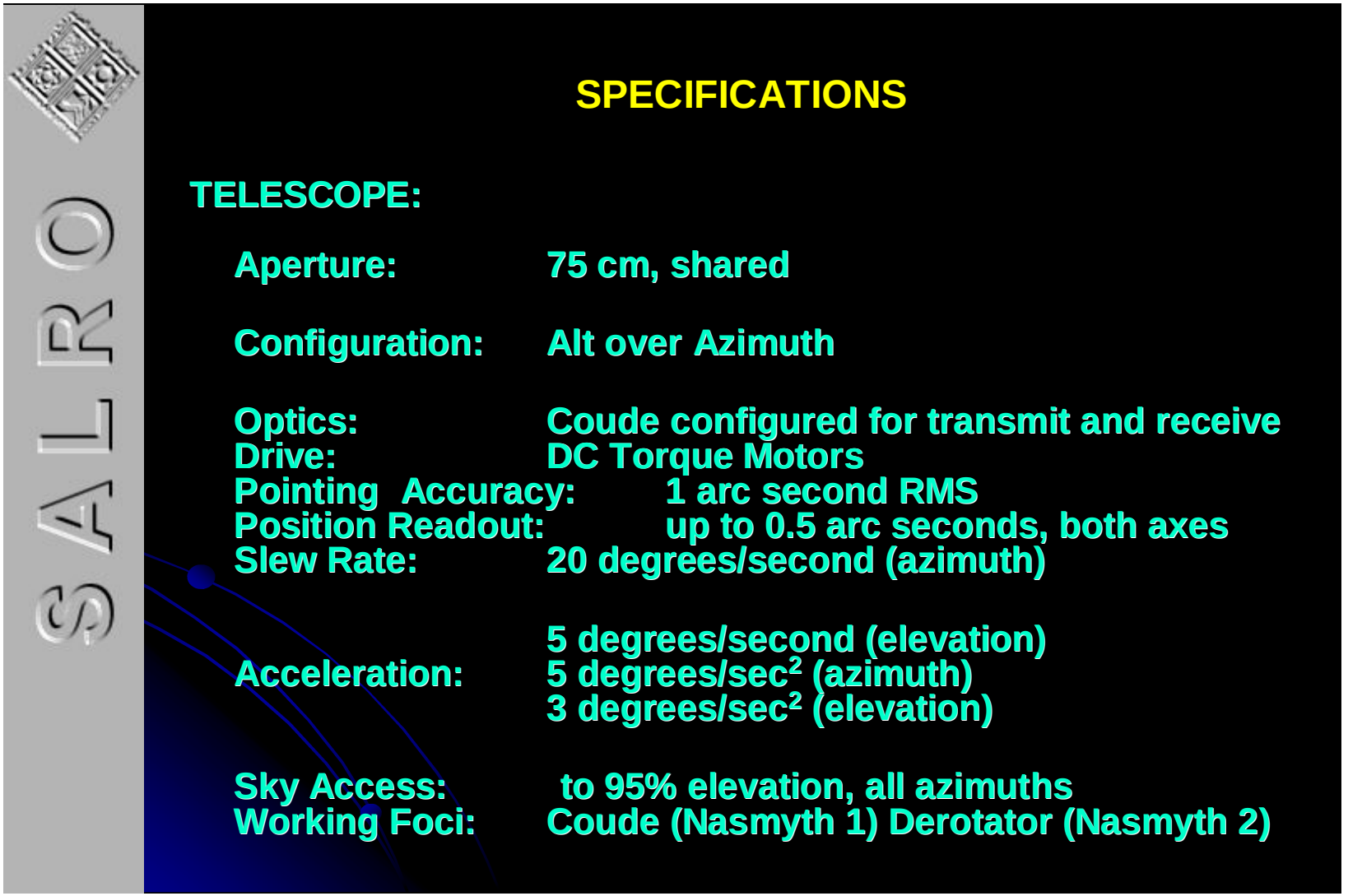
Saudi Arabia Laser Ranging Observatory

SALRO

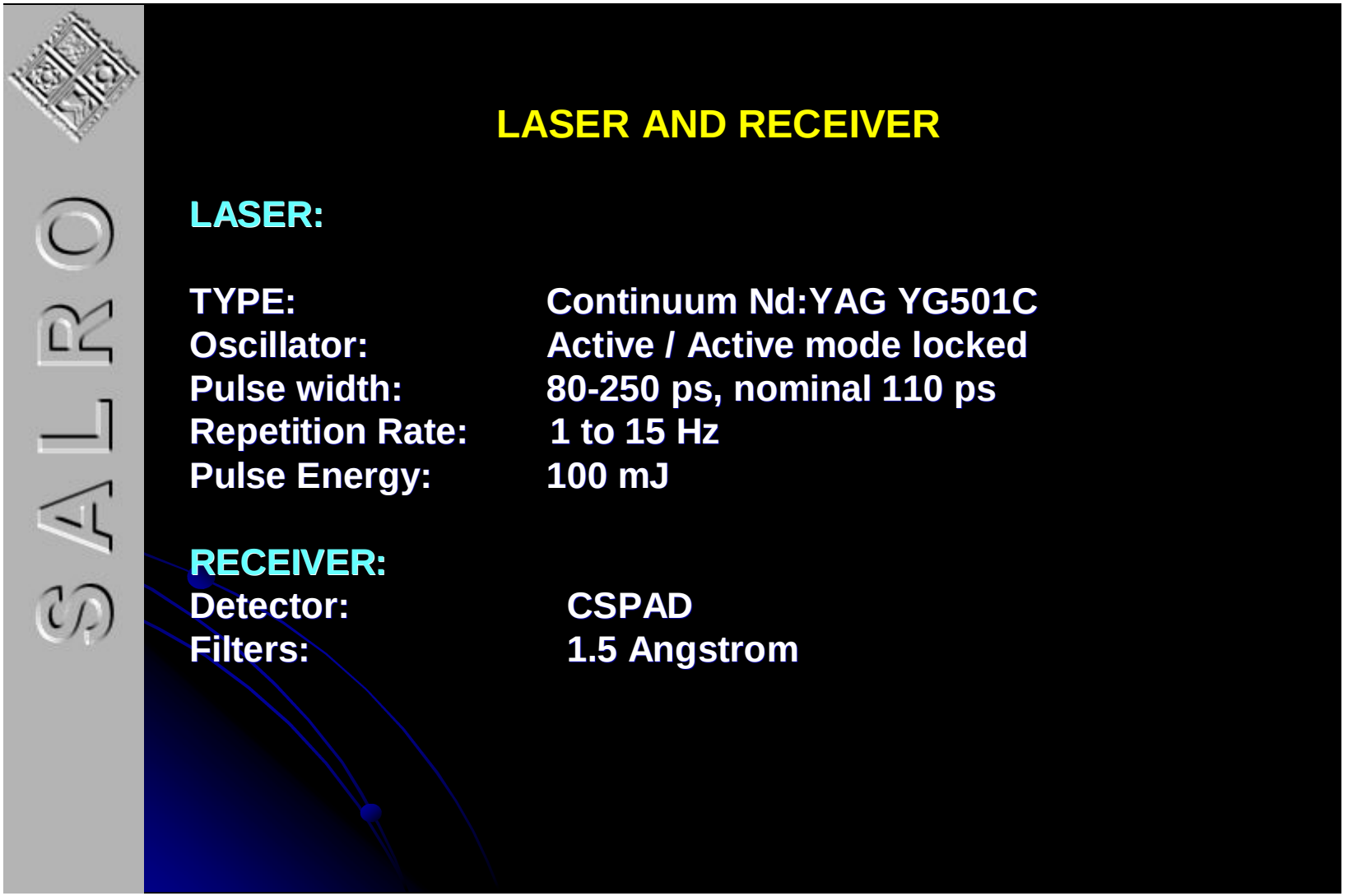
The SALRO site Solar Village, Saudi Arabia.

Solar Village is some 45 km north west of Riyadh. Photography date is July 9, 2002, whilst tracking Etalon 2 Satellite after dusk. The site is currently operated primarily during daylight and early evening.

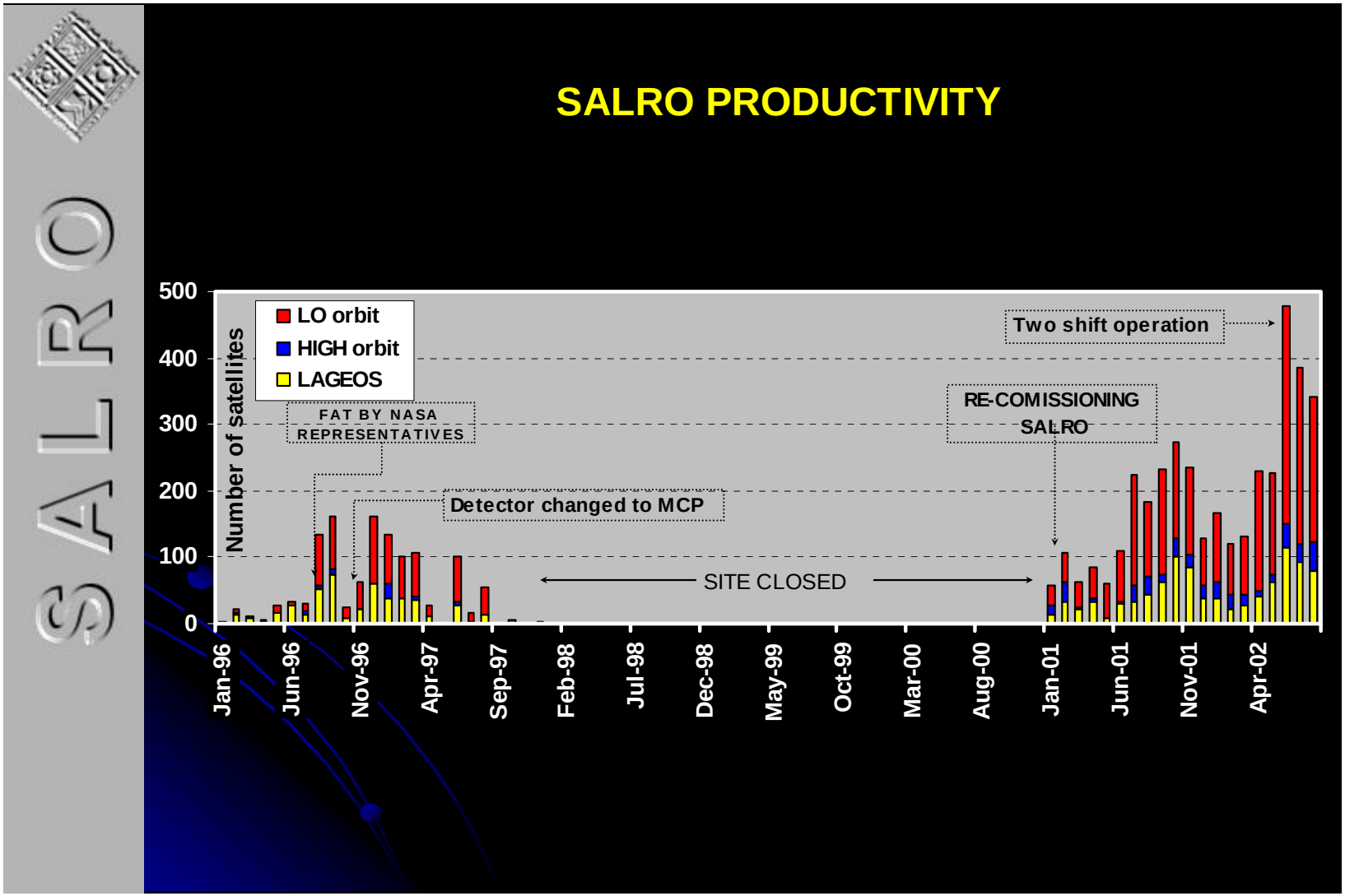
Slide 4


SALRO
SPECIFICATIONS
TELESCOPE:
Aperture: 75 cm, shared
Configuration: Alt over Azimuth
Optics: Coude configured for transmit and receive
Drive: DC Torque Motors
Pointing Accuracy: 1 arc second RMS
Position Readout: up to 0.5 arc seconds, both axes
Slew Rate: 20 degrees/second (azimuth)
5 degrees/second (elevation)
Acceleration: 5 degrees/sec² (azimuth)
3 degrees/sec² (elevation)
Sky Access: to 95% elevation, all azimuths
Working Foci: Coude (Nasmyth 1) Derotator (Nasmyth 2)

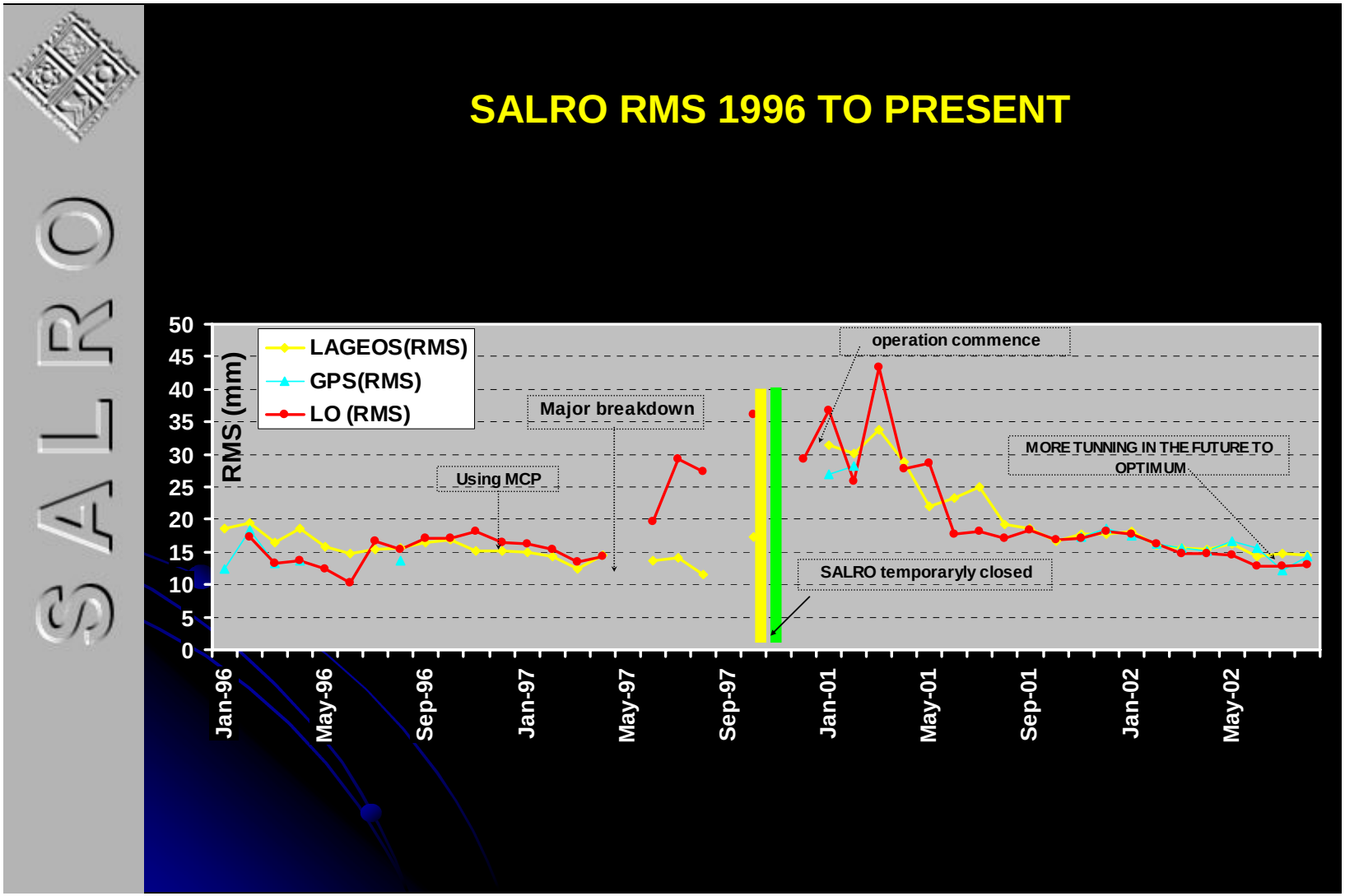
Slide 5


SALRO
LASER AND RECEIVER
LASER:
TYPE: Continuum Nd:YAG YG501C
Oscillator: Active / Active mode locked
Pulse width: 80-250 ps, nominal 110 ps
Repetition Rate: 1 to 15 Hz
Pulse Energy: 100 mJ
RECEIVER:
Detector: CSPAD
Filters: 1.5 Angstrom

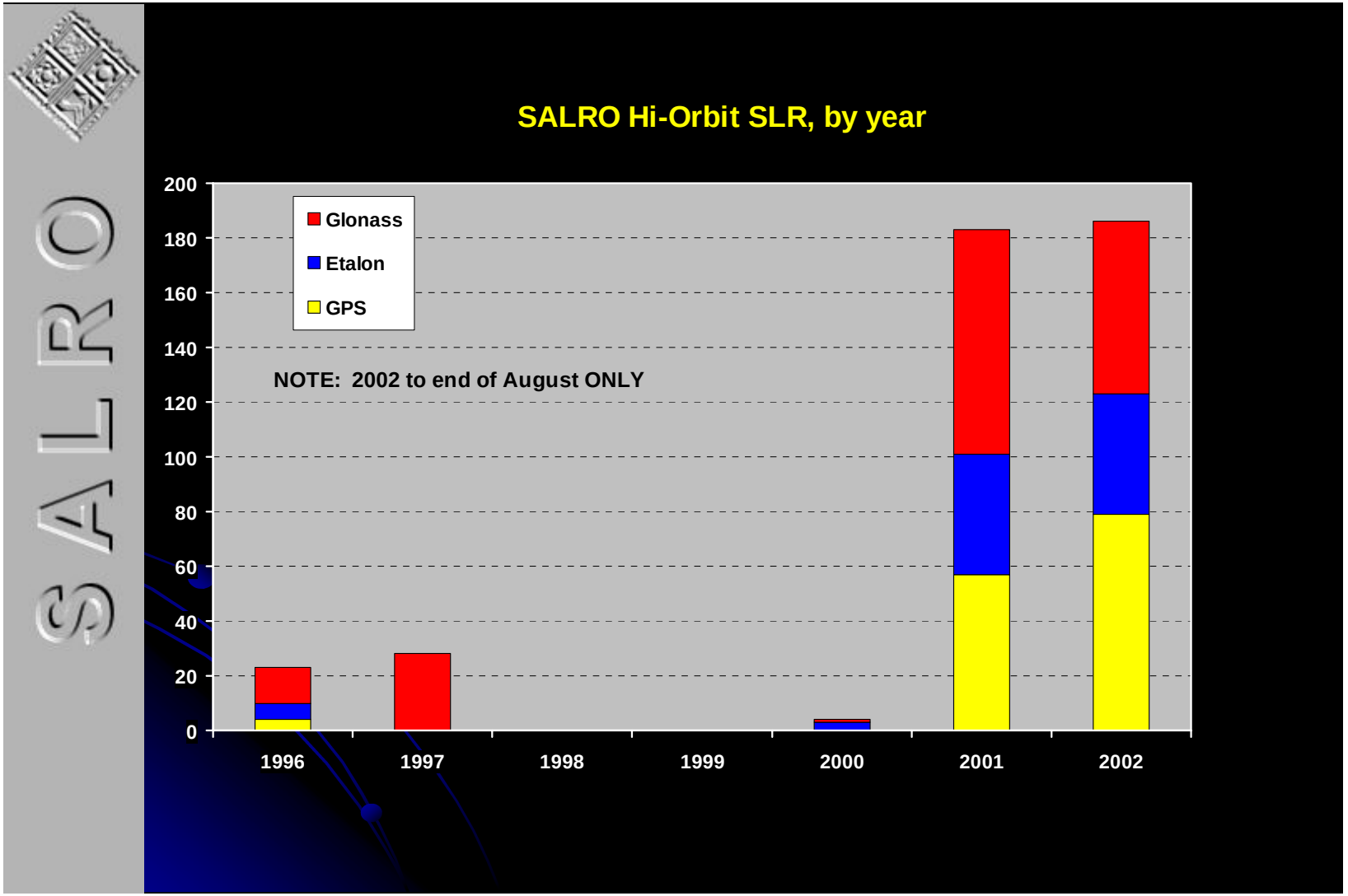
Slide 6


SALRO
SALRO PRODUCTIVITY
Number of satellites
500
400
300
200
100
0
LO orbit
HIGH orbit
LAGEOS
FAT BY NASA REPRESENTATIVES
Detector changed to MCP
SITE CLOSED
RE-COMISSIONING SALRO
Two shift operation
Jan-96
Jun-96
Nov-96
Apr-97
Sep-97
Feb-98
Jul-98
Dec-98
May-99
Oct-99
Mar-00
Aug-00
Jan-01
Jun-01
Nov-01
Apr-02

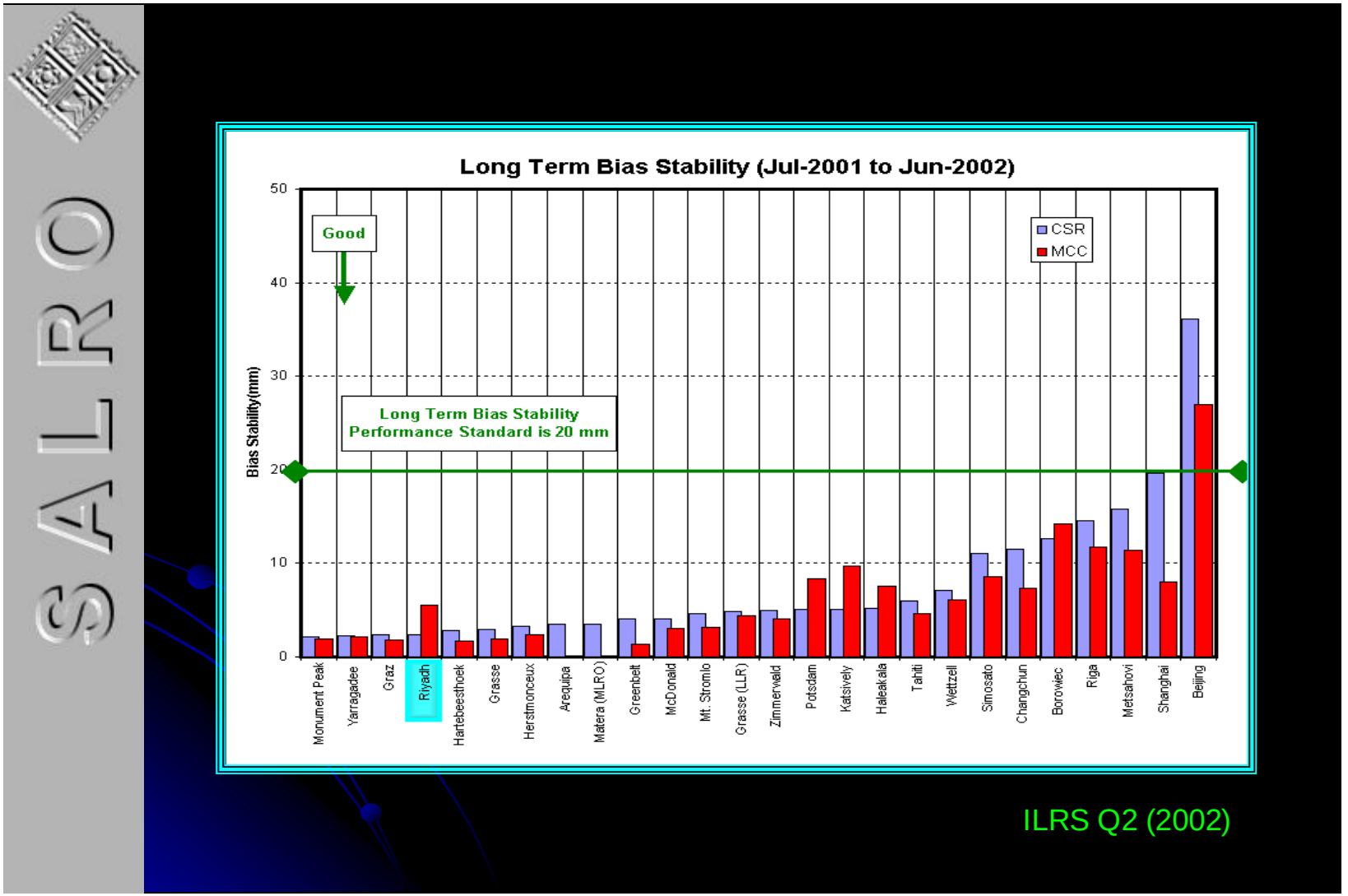
Slide 7


SALRO
SALRO RMS 1996 TO PRESENT
RMS (mm)
50
45
40
35
30
25
20
15
10
5
0
LAGEOS(RMS)
GPS(RMS)
LO (RMS)
Major breakdown
Using MCP
operation commence
MORE TUNNING IN THE FUTURE TO OPTIMUM
SALRO temporaryly closed
Jan-96
May-96
Sep-96
Jan-97
May-97
Sep-97
Jan-01
May-01
Sep-01
Jan-02
May-02

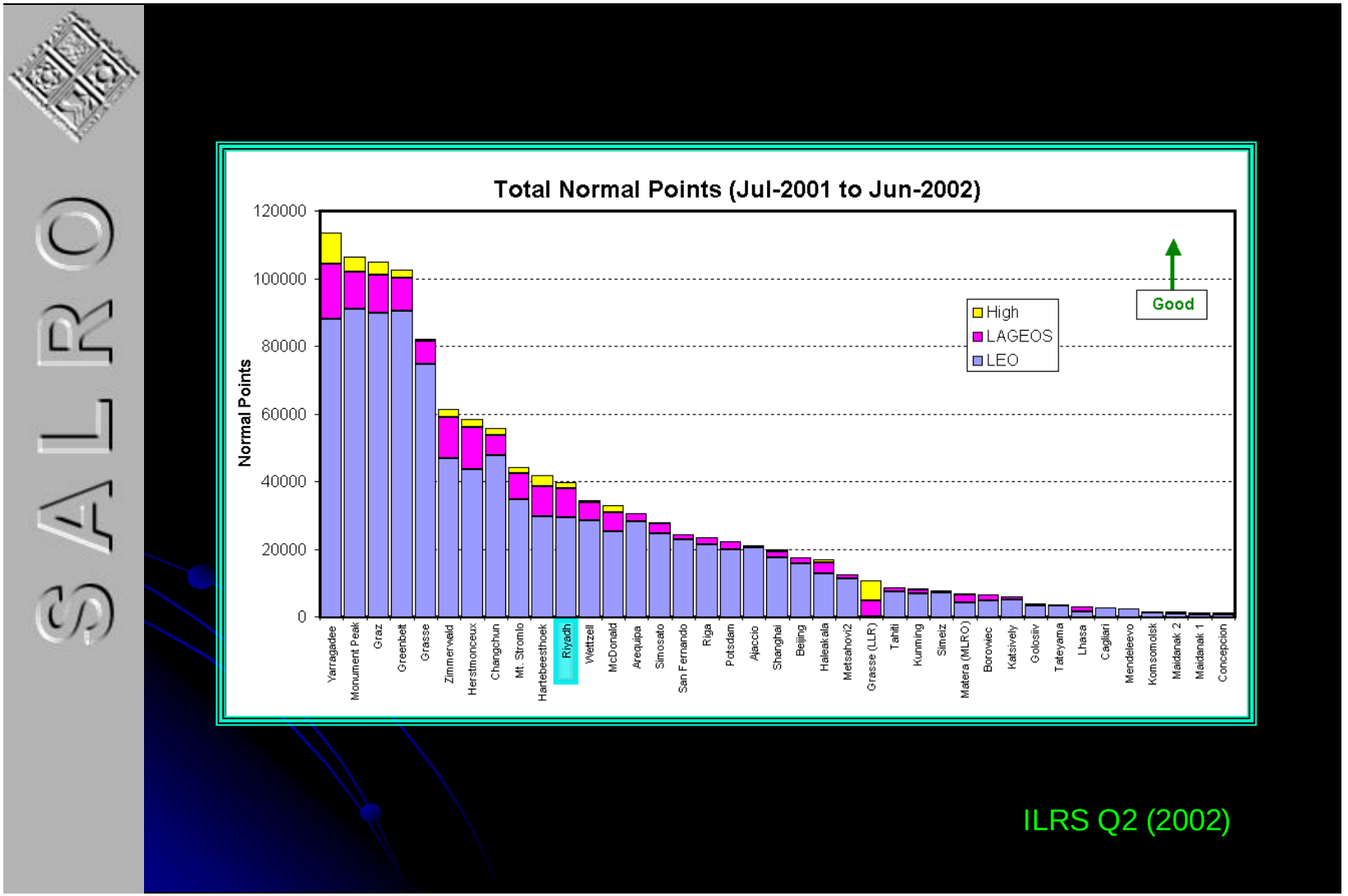
Slide 8


SALRO
SALRO Hi-Orbit SLR, by year
Glonass
Etalon
GPS
NOTE: 2002 to end of August ONLY
200
180
160
140
120
100
80
60
40
20
0
1996
1997
1998
1999
2000
2001
2002

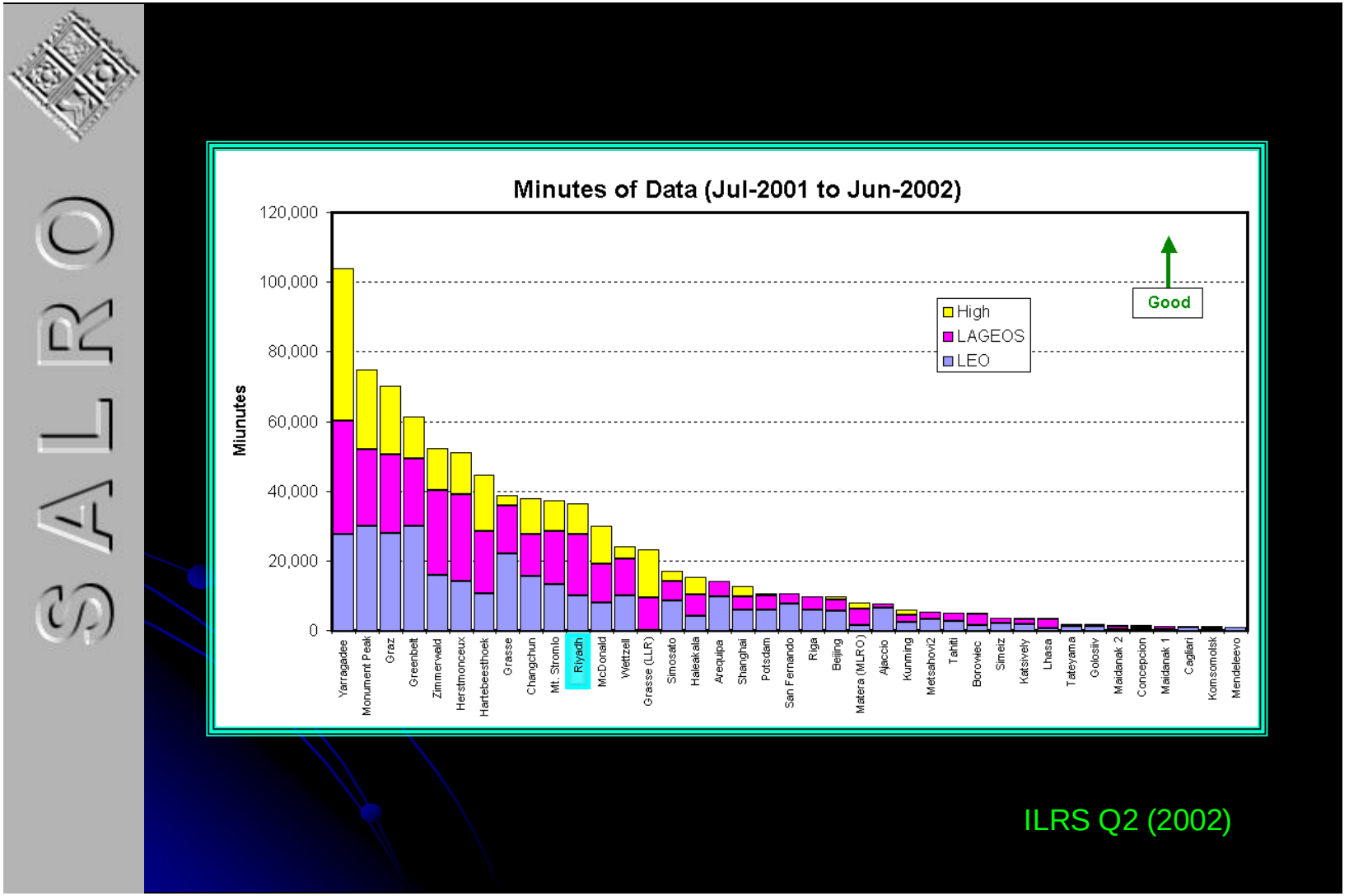
Slide 9


SALRO
Long Term Bias Stability (Jul-2001 to Jun-2002)
Bias Stability(mm)
50
40
30
20
10
0
Good
Long Term Bias Stability
Performance Standard is 20 mm
CSR
MCC
Monument Peak
Yarragadee
Graz
Riyadh
Hartebeesthoek
Grasse
Herstmonceux
Arequipa
Matera (MLRO)
Greenbelt
McDonald
Mt. Stromlo
Grasse (LLR)
Zimmerwald
Potsdam
Katsively
Haleakala
Tahiti
Wettzell
Simosato
Changchun
Borowiec
Riga
Metsahovi
Shanghai
Beijing
ILRS Q2 (2002)

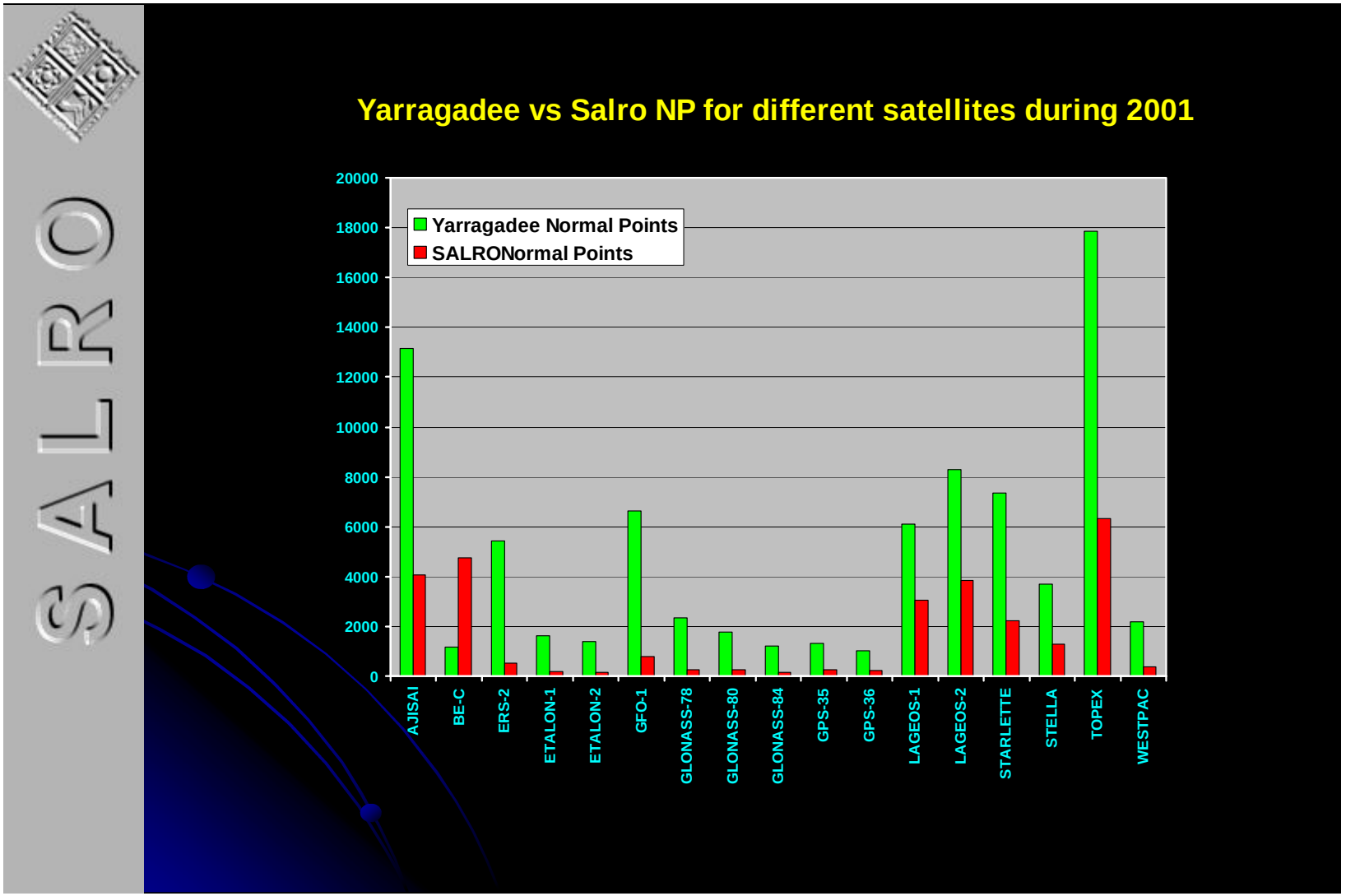
Slide 10


SALRO
Total Normal Points (Jul-2001 to Jun-2002)
Normal Points
120000
100000
80000
60000
40000
20000
0
High
LAGEOS
LEO
Good
Yarragadee
Monument Peak
Graz
Greenbelt
Grasse
Zimmerwald
Herstmonceux
Changchun
Mt. Stromlo
Hartebeesthoek
Riyadh
Wettzell
McDonald
Arequipa
Simosato
San Fernando
Riga
Potsdam
Ajaccio
Shanghai
Beijing
Haleakala
Metsahovi2
Grasse (LLR)
Tahiti
Kunming
Simeiz
Matera (MLRO)
Borowiec
Katsively
Golosiiv
Tateyama
Lhasa
Cagliari
Mendeleevo
Komsomolsk
Maidanak 2
Maidanak 1
Concepcion
ILRS Q2 (2002)

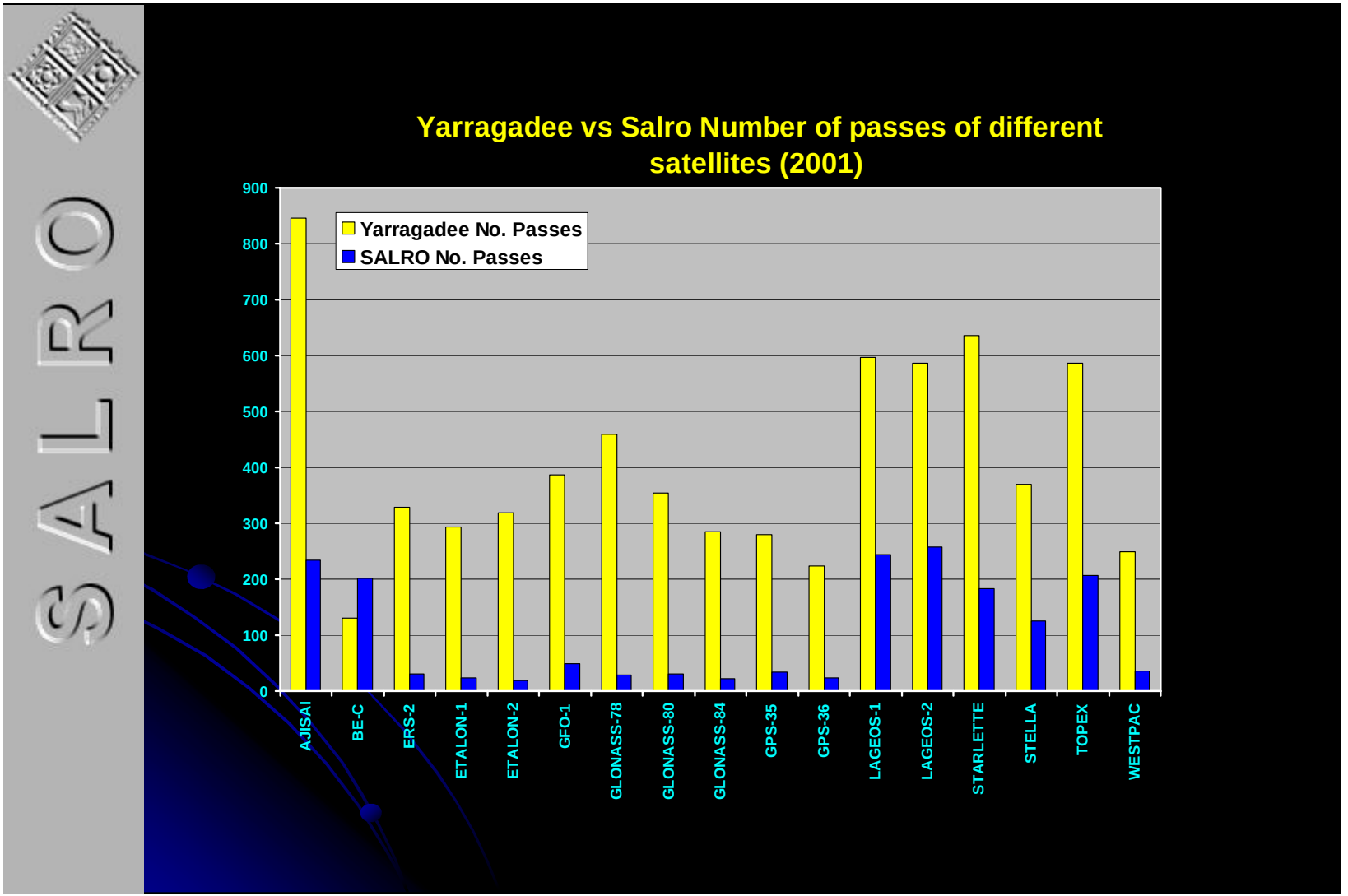
Slide 11

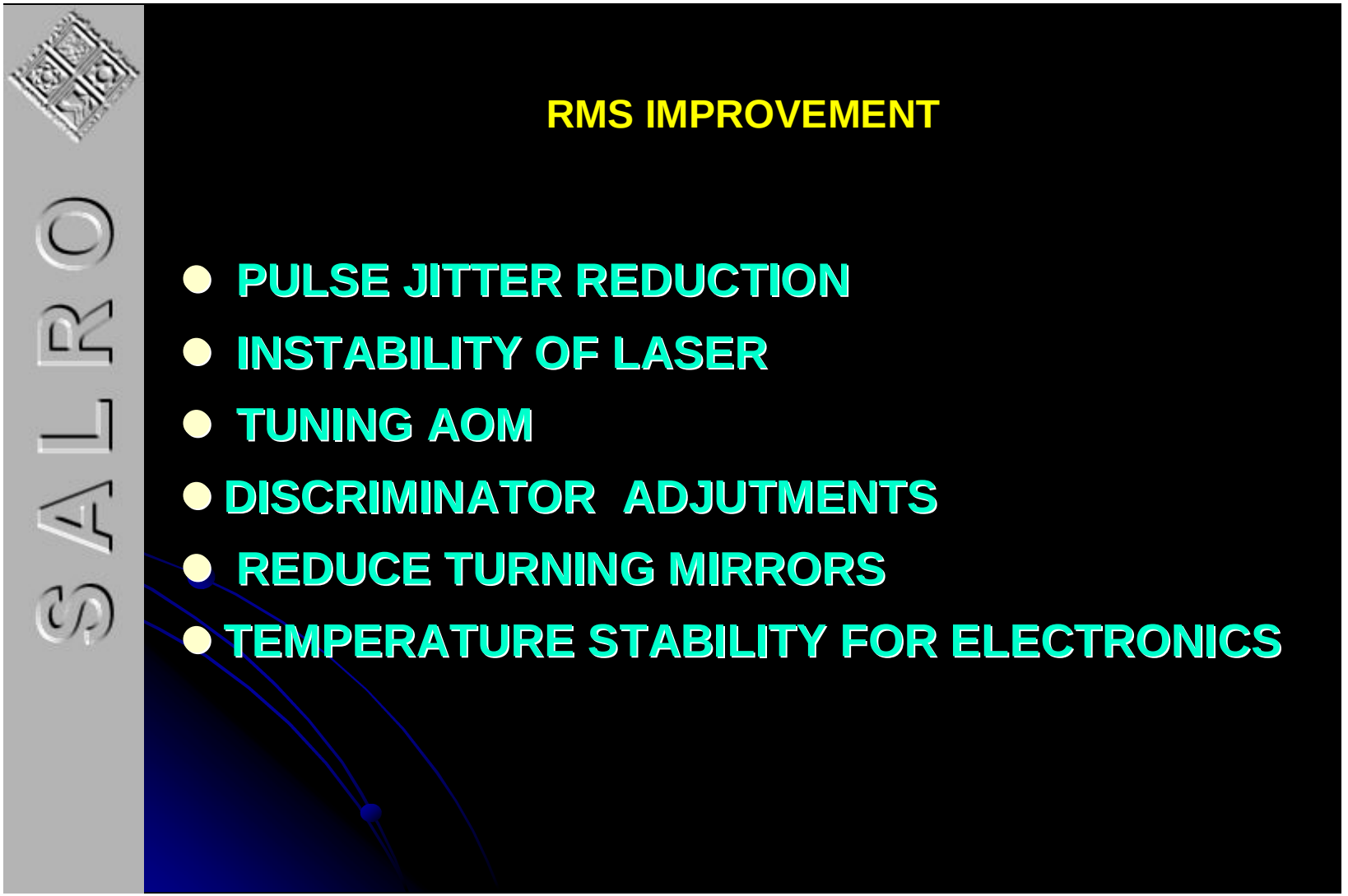

SALRO
Minutes of Data (Jul-2001 to Jun-2002)
Miunutes
120,000
100,000
80,000
60,000
40,000
20,000
0
High
LAGEOS
LEO
Good
Yarragadee
Monument Peak
Graz
Greenbelt
Zimmerwald
Herstmonceux
Hartebeesthoek
Grasse
Changchun
Mt. Stromlo
Riyadh
McDonald
Wettzell
Grasse (LLR)
Simosato
Haleakala
Arequipa
Shanghai
Potsdam
San Fernando
Riga
Beijing
Matera (MLRO)
Ajaccio
Kunming
Metsahovi2
Tahiti
Borowiec
Simeiz
Katsively
Lhasa
Tateyama
Golosiiv
Maidanak 2
Concepcion
Maidanak 1
Cagliari
Komsomolsk
Mendeleevo
ILRS Q2 (2002)

Slide 12

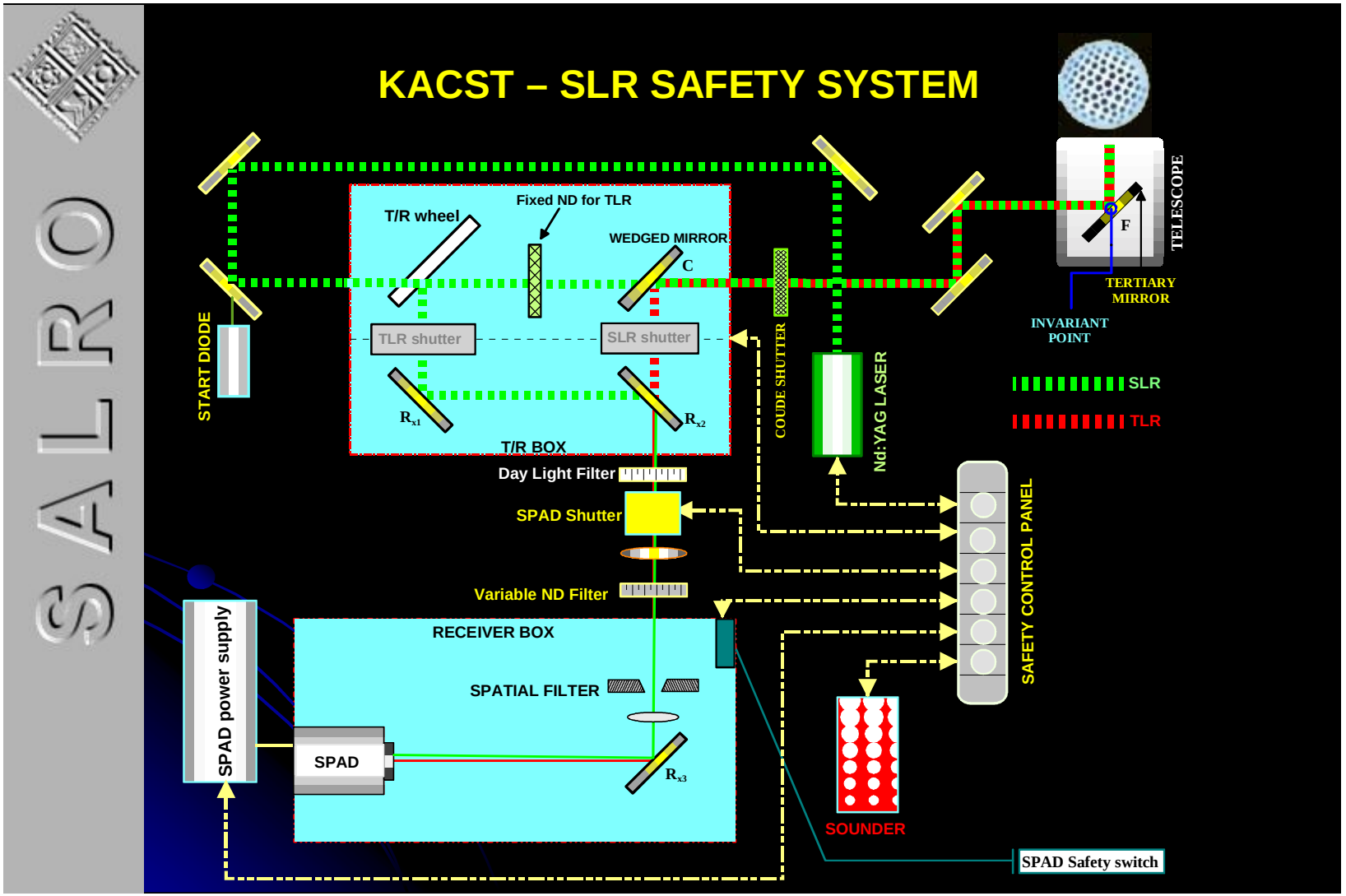

SALRO
Yarragadee vs Salro NP for different satellites during 2001
Yarragadee Normal Points
SALRONormal Points
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
AJISAI
BE-C
ERS-2
ETALON-1
ETALON-2
GFO-1
GLONASS-78
GLONASS-80
GLONASS-84
GPS-35
GPS-36
LAGEOS-1
LAGEOS-2
STARLETTE
STELLA
TOPEX
WESTPAC

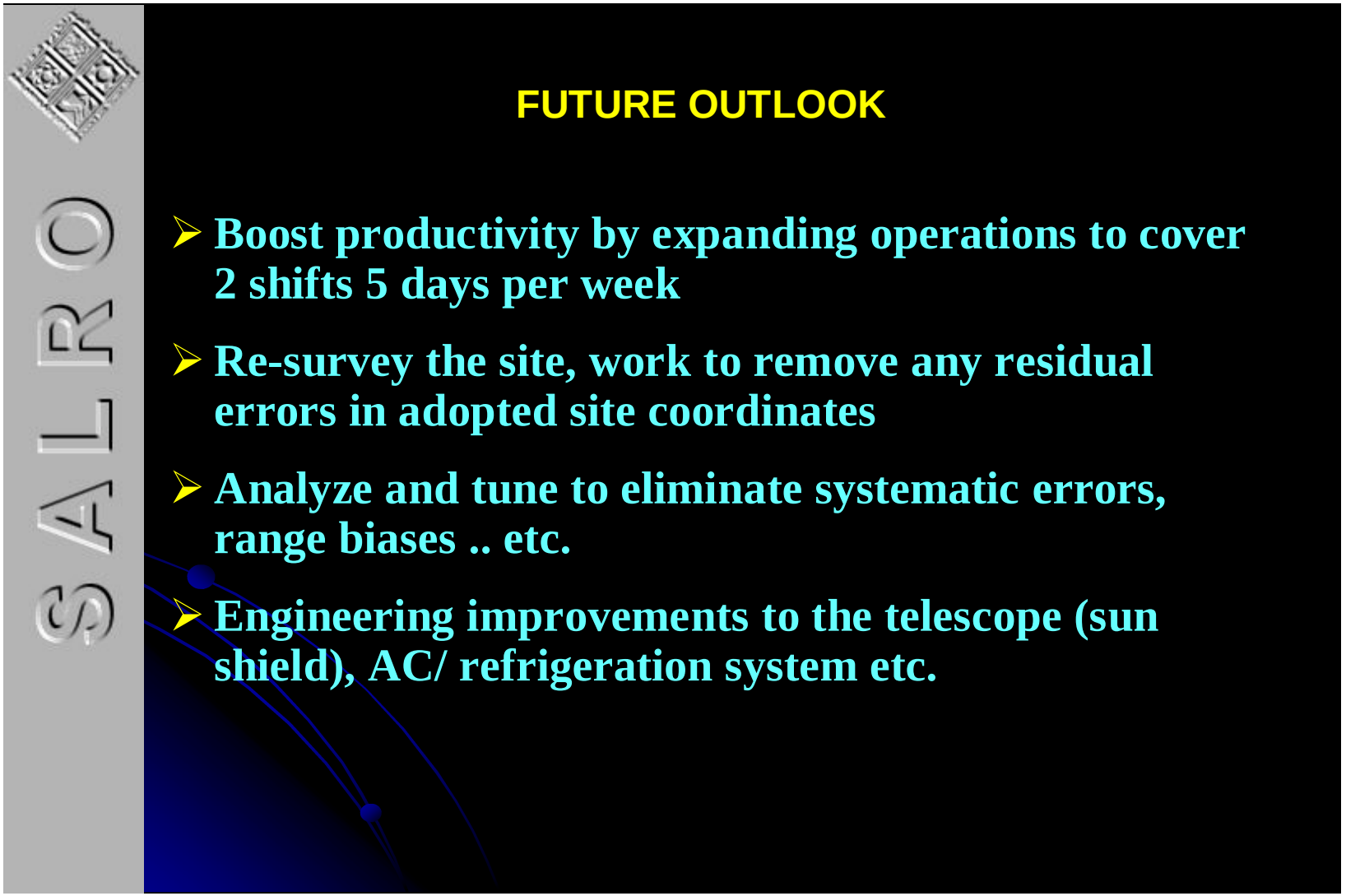
Slide 13

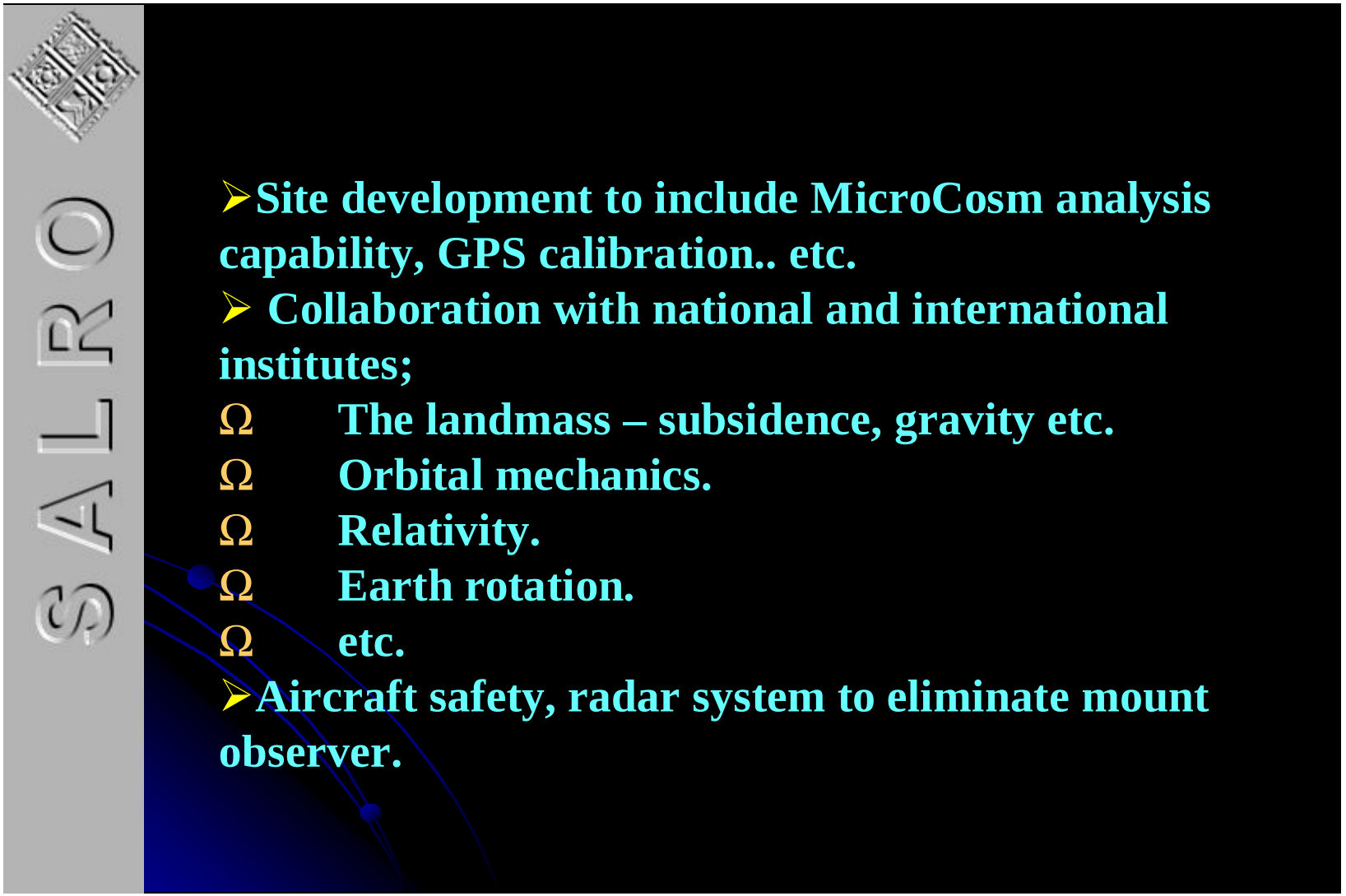

SALRO
Yarragadee vs Salro Number of passes of different satellites (2001)
Yarragadee No. Passes
SALRO No. Passes
900
800
700
600
500
400
300
200
100
0
AJISAI
BE-C
ERS-2
ETALON-1
ETALON-2
GFO-1
GLONASS-78
GLONASS-80
GLONASS-84
GPS-35
GPS-36
LAGEOS-1
LAGEOS-2
STARLETTE
STELLA
TOPEX
WESTPAC


SALRO
RMS IMPROVEMENT
PULSE JITTER REDUCTION
INSTABILITY OF LASER
TUNING AOM
DISCRIMINATOR ADJUTMENTS
REDUCE TURNING MIRRORS
TEMPERATURE STABILITY FOR ELECTRONICS

Slide 15


KACST – SLR SAFETY SYSTEM
SALRO
Fixed ND for TLR
T/R wheel
WEDGED MIRROR
C
TLR shutter
SLR shutter
START DIODE
R_{x1}
R_{x2}
T/R BOX
COUDE SHUTTER
Nd:YAG LASER
TELESCOPE
F
TERTIARY MIRROR
INVARIANT POINT
SLR
TLR
Day Light Filter
SPAD Shutter
Variable ND Filter
SAFETY CONTROL PANEL
RECEIVER BOX
SPATIAL FILTER
SPAD power supply
SPAD
R_{x3}
SOUNDER
SPAD Safety switch


SALRO
FUTURE OUTLOOK
Boost productivity by expanding operations to cover 2 shifts 5 days per week
Re-survey the site, work to remove any residual errors in adopted site coordinates
Analyze and tune to eliminate systematic errors, range biases .. etc.
Engineering improvements to the telescope (sun shield), AC/ refrigeration system etc.


SALRO
➢Site development to include MicroCosm analysis capability, GPS calibration.. etc.
➢ Collaboration with national and international institutes;
Ω The landmass – subsidence, gravity etc.
Ω Orbital mechanics.
Ω Relativity.
Ω Earth rotation.
Ω etc.
➢Aircraft safety, radar system to eliminate mount observer.

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SALRO

THANK YOU