RATAN-600 as the Adaptive Array

1. Phase stability of the Panels Array
2. Accuracy of the Wave front control
3. Time scales of the shape variations
4. Sensitivity limits for single PS and for Backgrounds

RATAN-600 as the “TRANSIT ALMA”?

Results of the last 40 years investigations

- Zverev
- Stotskij
- Stotskaja
- Zhekanis
- Pinchuck
- Khaikin
- Venger
- Gosachinskij
- Soboleva
- Berlizev
- Majorova,
- Kajdanovskij
- Parijskij
- Sinjanskij
- Et al…

К 40 ЛЕТ
1.
Хайкин
Корольков
Берлин
Нижельский
Цыбулев
Кратов
Фото!
2. История РАТАН-600? Первое
3.мм, фара, голография
«International Workshop, SAO RATAN-600 N.Arkhys’90; Holography Testing of Large Radio Telescope»
Ref
V.Khaikin “Microwave Holography measurements techniques for the RATAN-600 Radio Telescope in the near field region, p71, fig1, 0.5hours 100micron
V.Sinuanskii, A.A. Stotskii p 67, 34GHz, 0.05mm-0.08mm R, 20” angles
Pinchuk G.A., “The Radioholography method for adjustment of the RATAN-600 Radio Telescope”, p.67. Atmosphere correction, fig 1 p67
Pinchuk G.A., Sinyanskii, V.I., Stotskii A.A., Khaikin V.B.. “Use of Autocollimation radioholographic methodf for the testing of RATAN-600 Radio Telescope Testing”
p.64. fig1a, 2b, fig2 rms 0.12 mm., beam 3mm (before, after!)

Stotskii A.A., Pinchuk G.A., Stotskaya I.M., “Radio Methods of the RATAN-600 Radio Telescope multielement reflector adjustment”, p56 (circle, fig1), stability un time, fig3 p.60
G.A.Pinchuk, Yu.N.Parijskij, D.V.Shannikov, E.K.Majorova. “Multibeam Working regime at the RATAN-600 Radio Telescope. p.113, fig1 p.114 . Двумерные карты и пр.- нет сомнений в целесообразности ….
Романов Г., Треховитский О., Хайкин В., Голография с H2O мазером, Изв.САО т27, 5, 1989
Госачинский И.В., Майорова Е.К., Парийский Ю.Н. «Результаты исследования радиотелескопа РАТАН-600 на волне 3.2мм. по наблюдения Луны и Юпитера»
Сообщ. САО вып. №63, стр 38.
Табл. Стр. 41.

Масштаб	Доля рассеянной мощности
<50’	<3%
50’	16% (панели сами)
13’	13% (пузыри?)
6’	24% (юстировка)

Суммарная ср.кв. ошибка по Луне и Юпитеру 0.28мм Ядро 4.4 сек. дуги
Эффективность по протяженным источникам 0.77; кип 0.25?

Ю.К.Зверев, С.Я. Голосова. «Геодезическое Обеспечение наблюдений в миллиметровом диапазоне длин волн на РАТАН-600. . Сообщения САО вып. 63 стр 8
Улучшение вторичного зеркала до 0.12мм
Было 0.09мм-0.15мм , радиусы кривизны были 296-440
Дрейф от 0.14мм до 0.72мм
Панели обл рис 4 стр 15

PANELS IMPROVEVMENT

- 1mm -0.2mm rms, insert fig.

RATAN-600 GAIN, $G=4\pi S/\lambda^2$

- With σ=0.2mm r.m.s. x $\cosh_{element}$, $\lambda_{Gmax}=4\pi\sigma=2.4$mm for h=0, or 1.7mm for ZENITH

(Corresponds to Ta max for “Black Body” type spectra: Planets an satellites, SSA, GPS, early AGN activity, SZ “negative Black Body” CMB drops etc)

Secondary mirror (№1) panels

r.m.s. errors ~0.1mm. Phase error are less, due to factor cosθ and primary feed pattern,

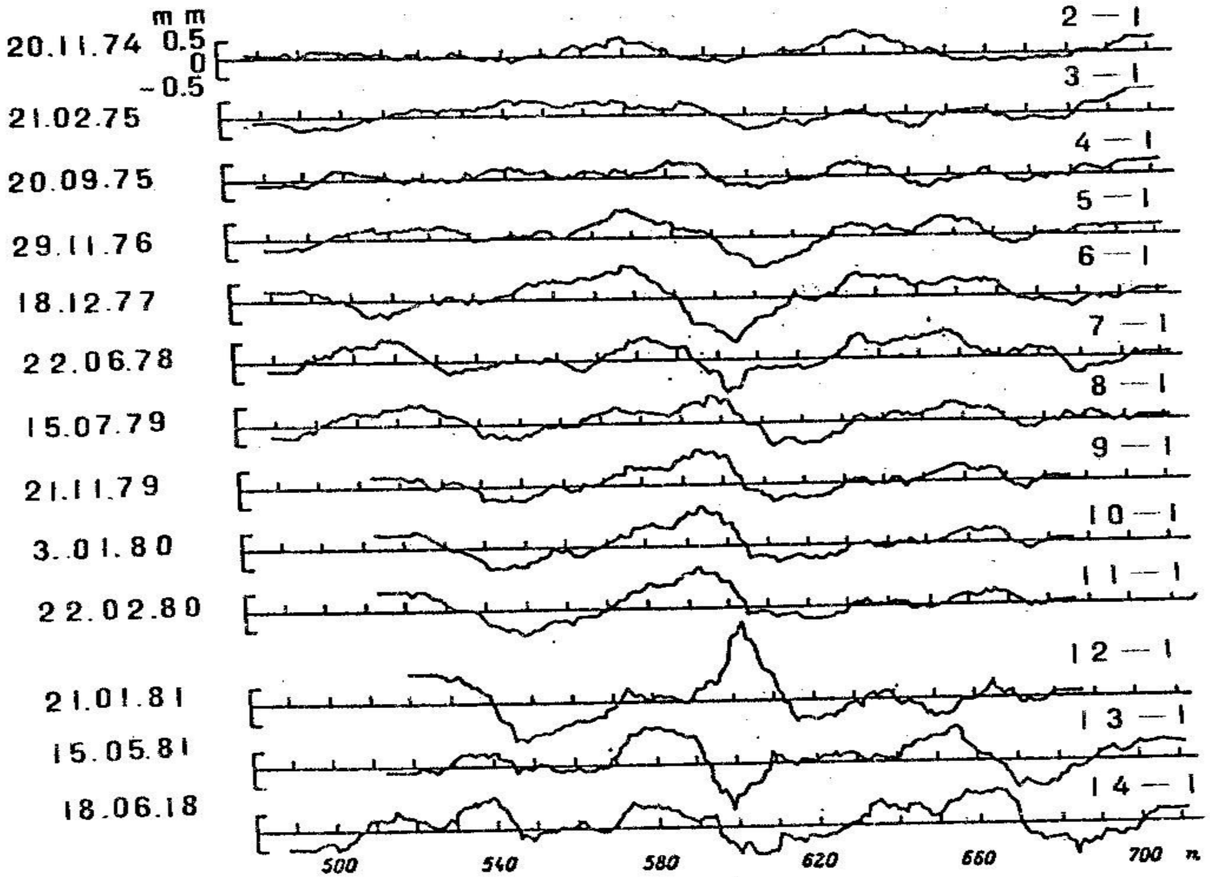
0.06 (0.26)	0.07 (0.08)
0.06 (0.20)	0.10 (0.26)
0.08 (0.12)	0.08 (0.11)
0.08 (0.16)	0.11 (0.27)

Рис. 4 – значения ср. кв. ошибок поверхности панелей в центральной части вторичного зрекала.

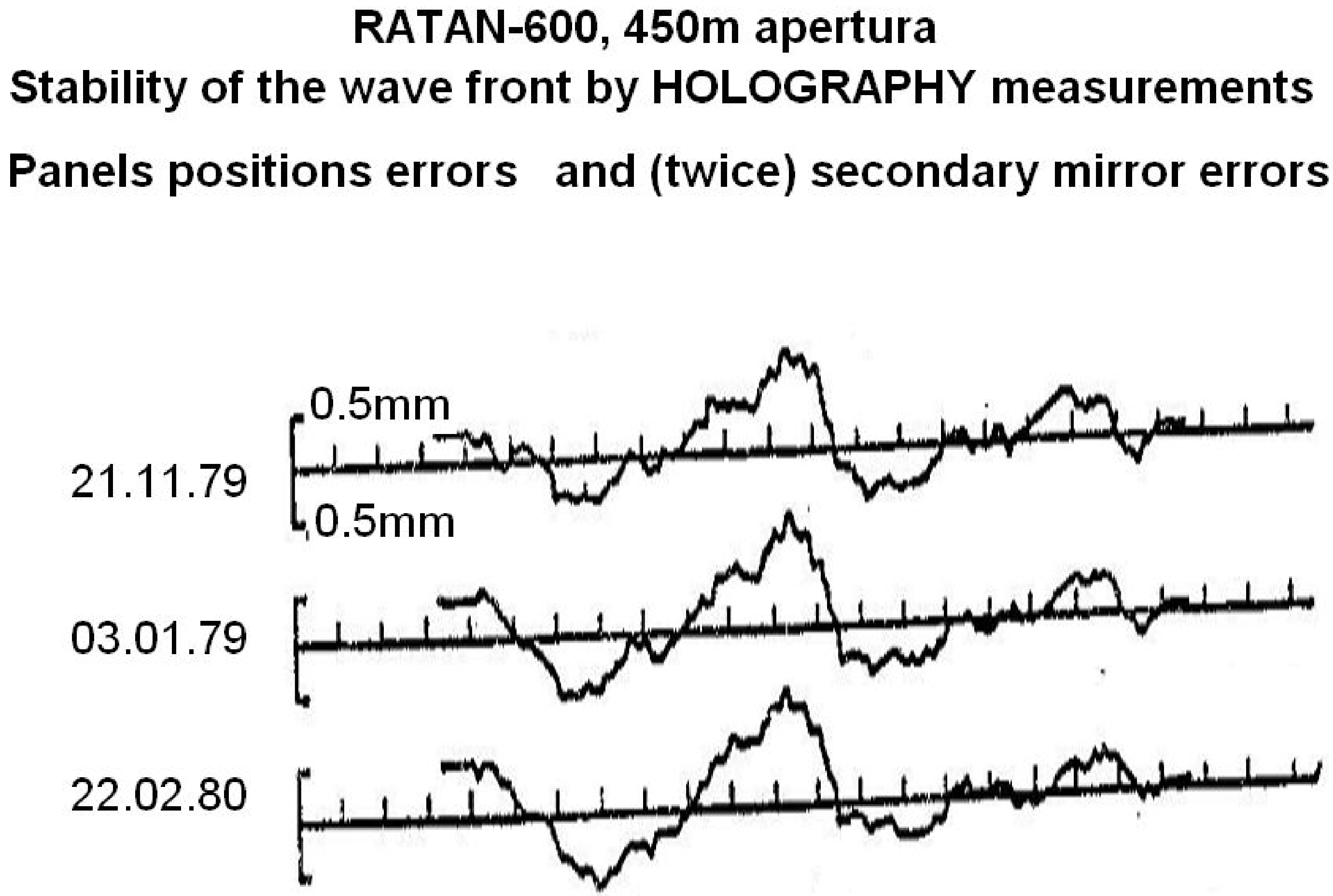
On the stability of the main surface Inside 1 month r.m.s. difference ~0.1mm

.ity.

Fig. 3
Large-scale deformations of the main reflector.



~50micron surface stability case



RATAN-600 at λ=3mm. HOLOGRAPHY correction, with internal and distant reference wave front

formed with the help of separate dish. Such a RH method at 8 mm wave is under exploitation now at the RATAN-600 for support of observations at 3 mm.

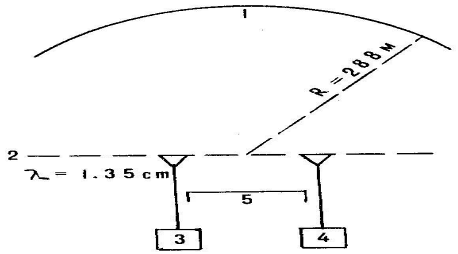


Fig.1a.

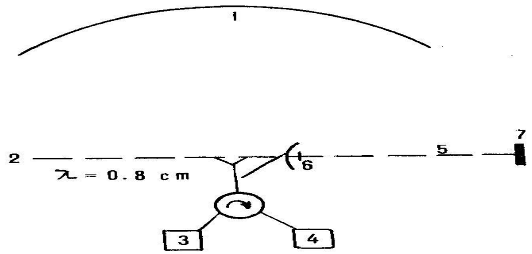
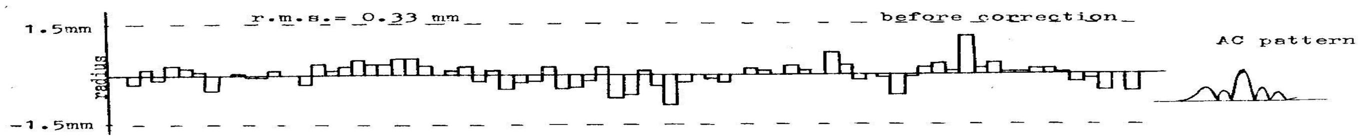


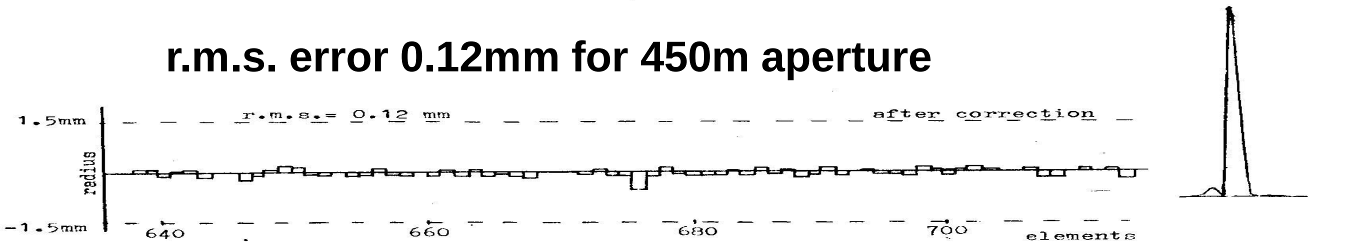
Fig.1b.

1 – main mirror;
3 – transmitter;
5 – reference signal;
7 – reflecting shield.
2 – secondary mirror's focal line;
4 – receiver;
6 – additional antenna;



Beam at 3mm before correction

r.m.s. error 0.12mm for 450m aperture



Beam at 3mm after correction

Fig.2

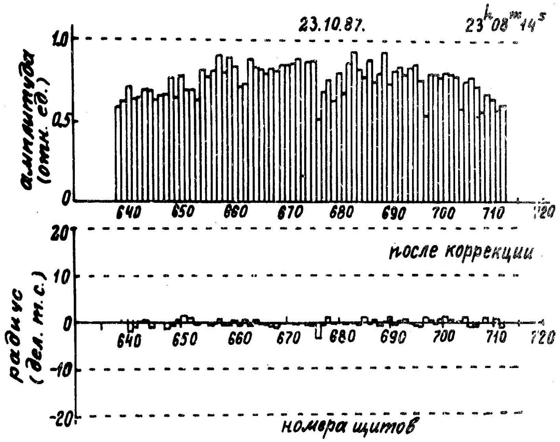


Рис. 6. Положение элементов антенны после коррекции.

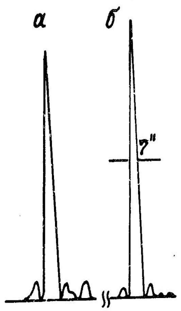


Рис. 7. АК фокальные пятна до и после коррекции на волне 8.8 мм.

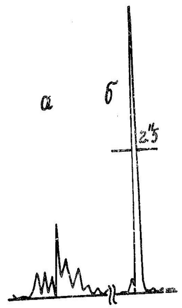


Рис. 8. АК фокальные пятна до и после коррекции на волне 3.2 мм.

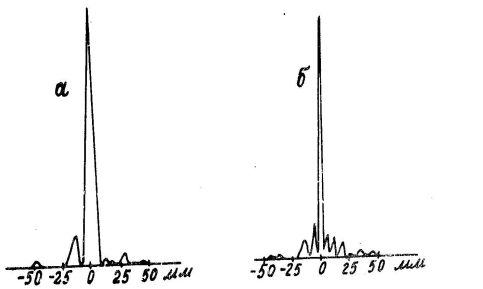
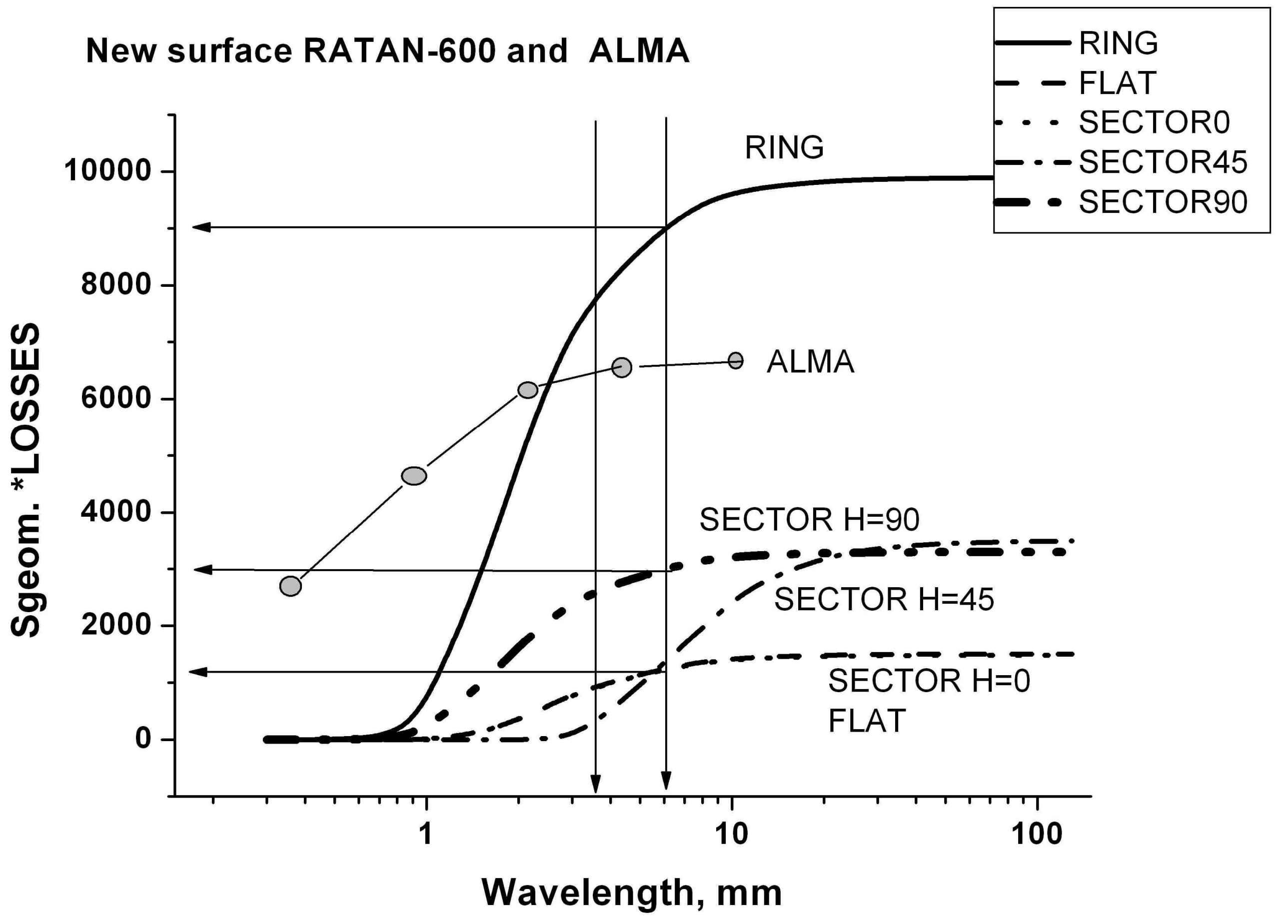


Рис. 9. Характер распределния энергии поля в АК режиме вдоль фокальной линии до коррекции антенны: а) волна 8.8 мм; б) волна 3.2 мм.

Restoration of the wave front by HOLOGRAPHY.

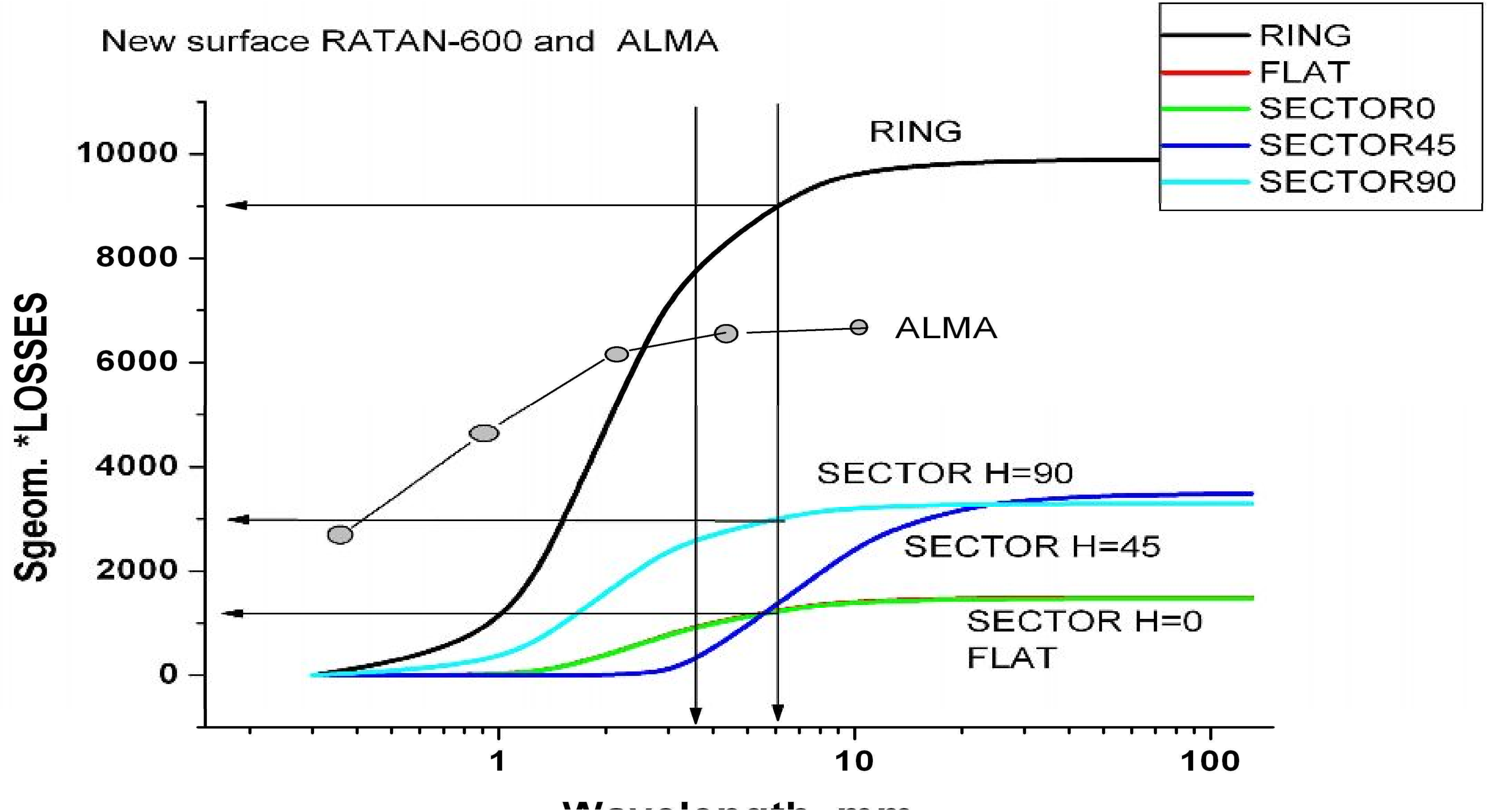
See middle, left fig., $\lambda = 3$mm case Before and after correction

RATAN-600 and ALMA Geometrical surface, with ROSE losses only



RATAN-600 and ALMA

Only PANELS (0.2mm. R.m.s.)accuracy included



Result of the comparison

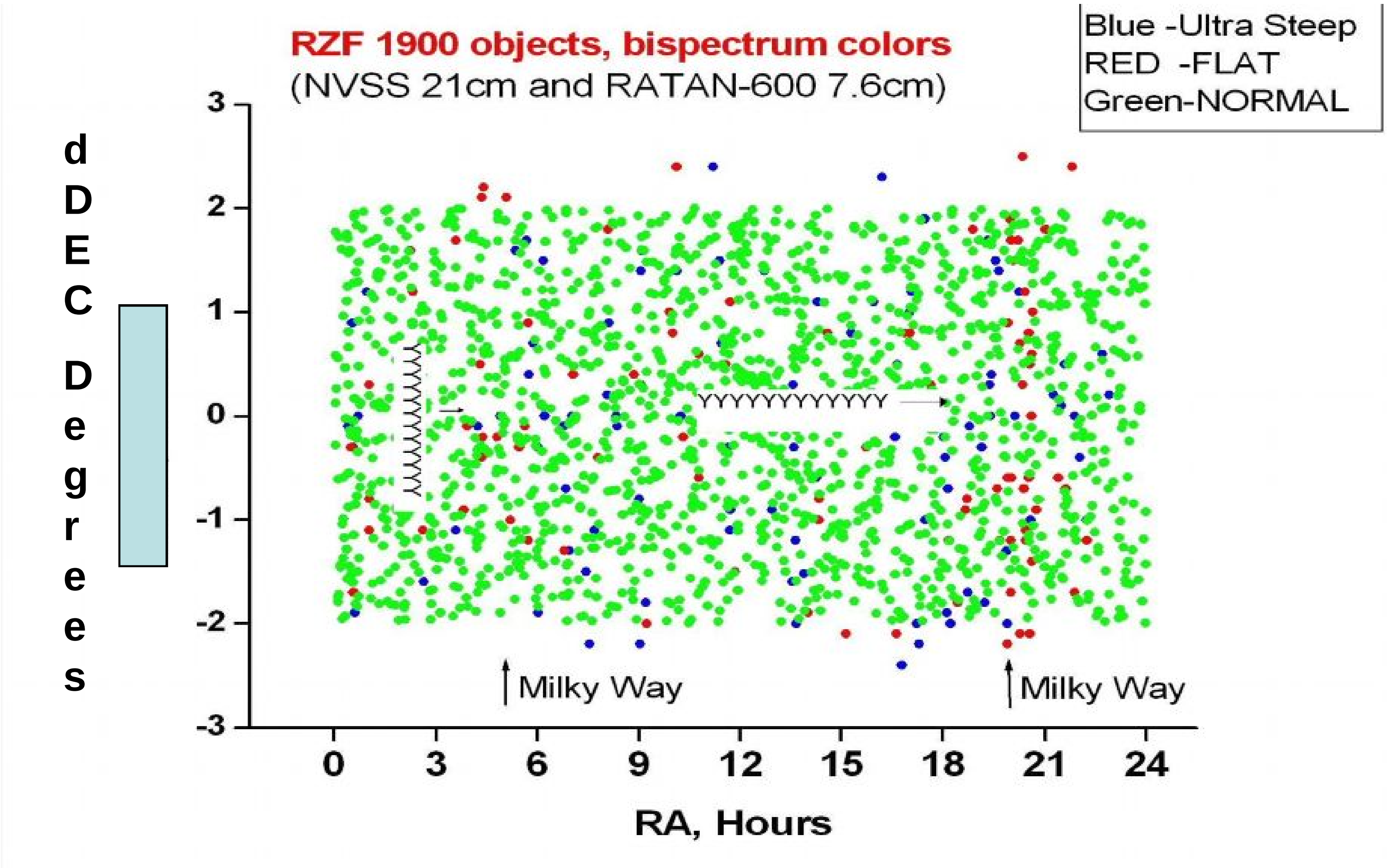
- Collecting surfaces at “MARS” frequency (30GHz) are comparable, with flux density sensitivity/1sec. integration of RATAN-600 better than ALMA due to wider bandwidth and multi-receivers solution

- Brightness temperature sensitivity of RATAN-600 is by several orders above ALMA due to D^2 / S_{eff} factor

- But small integration time is the problem for RATAN-600 in the standard “single object” mode!

- “Transit Surveys” modes are possible, better than with ALMA. (Blind SKY surveys, CMB anisotropy, Galaxy BGR etc). Only TOTAL OBSERVING TIME is of importance in this mode.

RZF field in two receivers array modes: “for DEPTH” and for WIDTH”



Focal Phased Array project.
8-elements were tested in1991

from 8 of the input horns is just enough.

The optimal distance between horns is about 40 mm. It follows from two demands: to increase the antenna gain and to decrease the level of sidelobes.

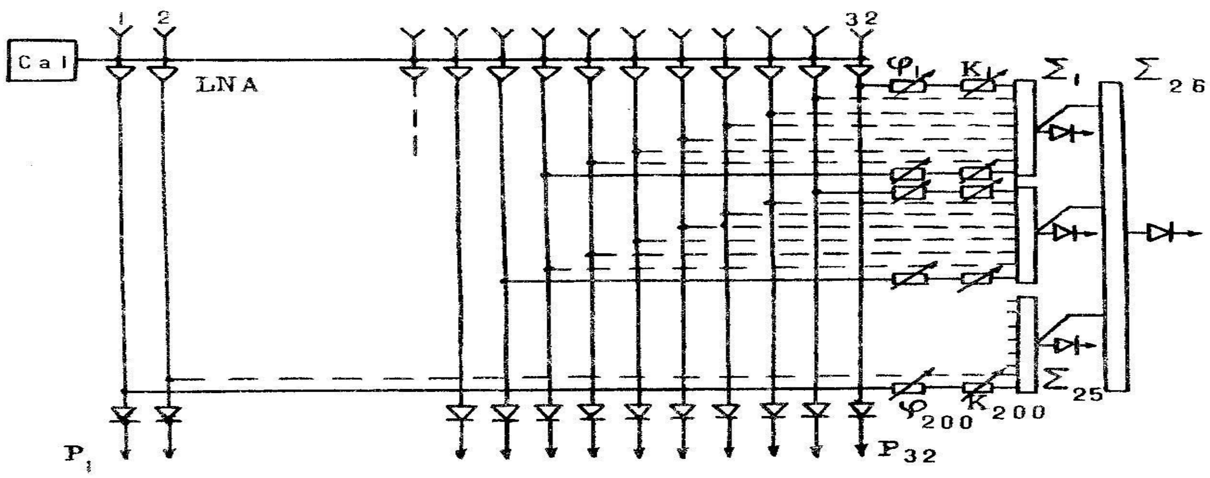


Fig.1

φ - phaseshifters, K - attenuators, Σ - summators.

The system permits to control the beam orientations both in horizontal and in vertical planes.

The acceleration of radio-sky deep surveys and restoration of extended objects in passage regime of telescope, the increase of coordinate facilities and sensitivity of system, the ability to use the simple atmospheric compensation methods, etc. - all these advantages of hybrid antennas make the question of use of the suggested system at the RATAN-600 radio telescope beyond any doubt.

From ZENITH field
to ALL Sky
(Possible ways)

- 1.From “two horns/one receiver” to “one horn/two receivers” (4-times less size)
- 2.From single to multi-focal line solution
- 3.From simple RECEIVERS array to focal PHASED ARRAY, with aberration correction

From “Wide” to “Compact” arrays

YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY

MARS-3 version now

(One receiver/two feeds)

YYYYYYYY “OCRA” solution

(Two receivers/1 feed)

YYYY

YYYY Multi-focal line solution

See “Cosmological Gene” Project

Secondary mirror with focal phased array as an “electronic LENS”

- This may be used to change the position of the focal point on the Rail Tracks and the position of the beam in **DECLINATION**.

- “Multi-phase delays” system can form the Multi-beam pattern in **DEC**