

43 MHz North Polar Sky Region Survey DEC >70 deg discrete sources

super synteza apertury - radioteleskop o średnicy 700m

Projekt realizowany w Obserwatorium Astronomicznym UMK
w Piwnicach w latach 1969-1973,
autorstwa Andrzeja Kusa,

zrealizowany w Zakładzie Radioastronomii Instytutu Astronomii UMK,
pod kierunkiem prof. dr hab. Stanisława Gorgolewskiego

Obserwacje wykonano od stycznia do czerwca 1973 r. w roku obchodów 500. rocznicy urodzin
Mikołaja Kopernika

A RADIO SURVEY OF THE NORTH POLAR REGION WITH A 4.5 MINUTE OF ARC PENCIL-BEAM SYSTEM

M. Ryle and Ann C. Neville

(Received 1962 July 16)

Summary

A series of observations has been made in order to test a new and more powerful method of aerial synthesis. An East–West interferometer of variable spacing is used, and observations over a period of 12 hours at each spacing are combined to provide the same resolution as a circular aperture having a diameter equal to the maximum spacing used.

In the present tests, small sections of the 178 Mc/s interferometric system were used in pairs to provide different East–West spacings. Since the individual sections could not be steered in hour angle, the observations were restricted to an area of diameter 8° centred on the North Pole.

The observations when combined provided a pencil-beam response 4.5 arc in width, a resolution equivalent to that of a uniformly-excited circular aerial 3 400 ft in diameter.

Although the observations were intended primarily as a test of the new method, they have also provided information of astronomical interest, by allowing the detection of individual sources having flux densities $S \geq 0.25 \times 10^{-26} \text{ w.m.}^{-2} (\text{c/s})^{-1}$, about 1/8th of that of the weakest sources observed individually in the main 178 Mc/s synthesis programme. The positions of sources having $S \geq 0.5 \times 10^{-26} \text{ w.m.}^{-2} (\text{c/s})^{-1}$ could be determined with an accuracy of $\pm 15''$ in each coordinate. The new results have been useful in extending the number/flux density relationship.

1. Introduction.—The Cambridge 178 Mc/s interferometer (1, 2) has been used in a new way to provide, over a limited area of sky near the North Pole, a very high resolving power. The method of observation represents an extension of the principles of aerial “synthesis” which have already been described (3) but in the present case use is made of the rotation of the Earth to provide a large two-dimensional aperture from observations made with a two-aerial interferometer of variable spacing on an East–West axis. The new Cambridge radio telescope which is now under construction (4) is based on this type of aerial synthesis, and the main purpose of the present observations was to explore the technical difficulties in the observations and in the subsequent computing programme.

Owing to the restrictions set by the structure of the aerial system which was used in these tests, the performance is inferior to what should be obtainable with a specially designed instrument and, in particular, a strong grating sidelobe is present. It has nevertheless been possible to obtain a resolution of 4.5 at a frequency of 178 Mc/s, a figure which would have required the use of a paraboloid some 3 400 ft in diameter. The observations have allowed the detection of radio sources very much weaker than those which can be observed individually in the normal use of the 178 Mc/s interferometer and the results obtained are therefore of considerable astronomical interest.

Inspiracija projektu 43 MHz

Downloaded from <http://mnras.oxfordjournals.org/> at Universytet Mikolaj Kopernika w Toroniu on May 30, 2014

Mon. Not. R. astr. Soc. (1967) 135, 149–174.

A RADIO SURVEY OF THE SKY NORTH OF DECLINATION 70° AT A FREQUENCY OF 81.5 Mc/s

N. J. B. A. Branson

(Communicated by Professor Sir Martin Ryle)

(Received 1966 June 29)

Summary

A survey has been performed at a frequency of 81.5 Mc/s using the technique of two-dimensional aerial synthesis. Two small aerials were constructed pointing at the North Pole and forming an East–West interferometer whose spacing could take all values up to a maximum of 3000 ft. The aerials themselves could not be steered in hour angle and so the observations are restricted to a region of sky centred on the North Pole and having a diameter of 40° .

The observations when combined provided a pencil-beam response $10'$ arc in width which has enabled the detection of individual sources having flux-densities $S_{81.5} \geq 1.0 \times 10^{-26} \text{ w.m.}^{-2} (\text{c/s})^{-1}$. The results have enabled the spectral indices of sources to be obtained down to this level of flux-density, and are of some cosmological interest.

1. Introduction. The technique of two-dimensional aerial synthesis was first used by Ryle & Neville (1) to synthesize a 3400-ft radio telescope at a frequency of 178 Mc/s. In this technique two aerials are mounted on an East–West axis and pointed at the region of sky to be observed. Because of the rotation of the Earth one aerial describes about the other in space a circular strip of radius equal to the aerial spacing and of width equal to the width of one aerial; by observing on successive days with the aerials at all positions along a given baseline and by suitably combining the results an instrument can be synthesized equivalent to a uniformly illuminated circular aperture of diameter equal to the maximum spacing used. For observations away from the Pole the resolving power is decreased in declination by a factor $\sin \delta$. This technique is now used in the Cambridge 1-mile radio telescope (2) and has enabled sources to be detected with flux-densities down to $S_{408} = 0.025 \times 10^{-26} \text{ m.k.s.}$ (3).

It is important that faint sources should be observed at a number of frequencies so that their spectra can be determined. It is also particularly interesting to study the spectra of sources at low frequencies since certain sources including many quasars have curved spectra at these frequencies due to effects such as synchrotron self-absorption (4). It now seems clear (5, 6) that the observed number–flux–density relation (7) must be attributed to evolutionary change in the nature of radio sources, and it is therefore interesting to see if any change in the spectra of sources occur as one goes to fainter and fainter sources.

The main difficulty in observing faint sources at low frequencies is that to obtain the high resolving power needed large aerials have to be constructed or synthesized. Furthermore irregularities in the electron density in the ionosphere cause random phase errors to occur across the aerial aperture. This effect depends on the degree of sunspot activity, and experiments by Mrs Clausing using an East–West interferometer (8) have shown that at a frequency of 81.5 Mc/s

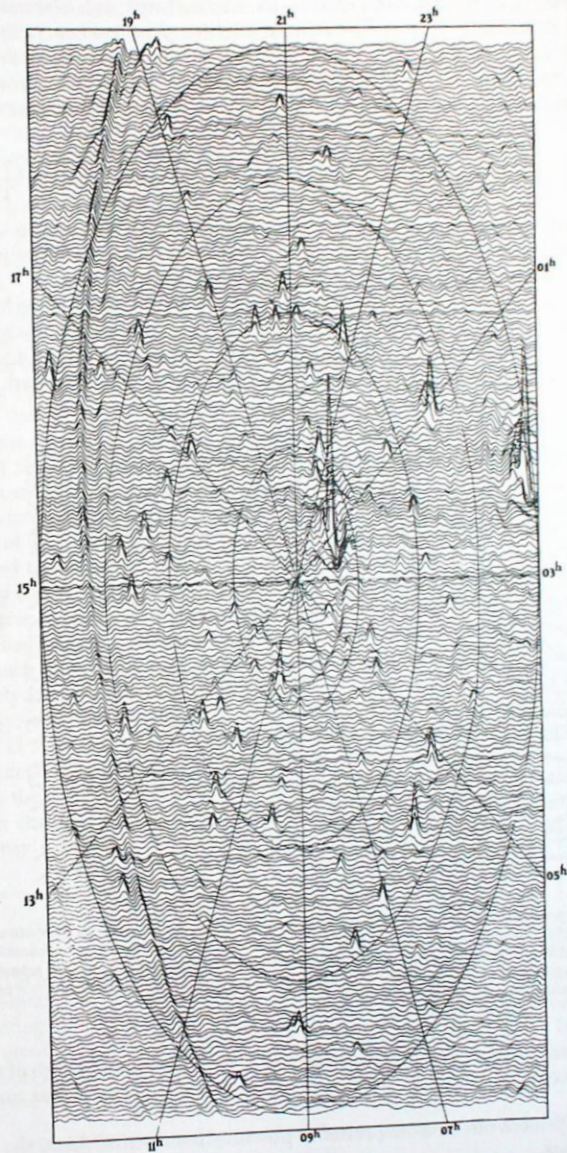
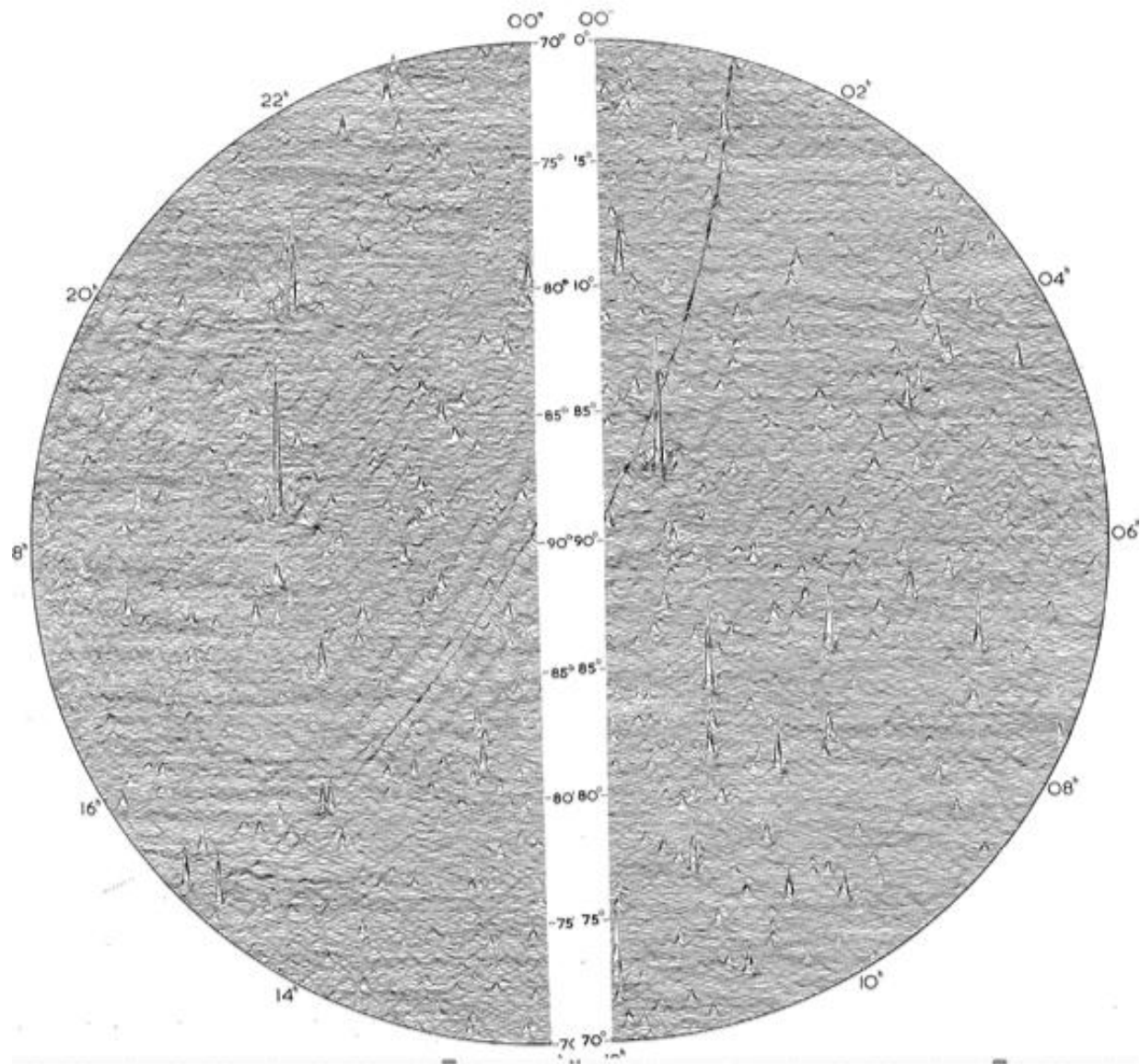


FIG. 6.—Tracing of 48 photographs similar to that shown in Fig. 5. The map is centred on the North Pole and the Y-axis is parallel to $\alpha=21^{\text{h}} 00^{\text{m}}$. In order to allow sufficient detail in the intensity coordinate, successive cuts have been displaced perpendicular to the X-axis so that the map is distorted and circles become ellipses; the ellipses marking North polar distances of 1° , 2° , 3° and 4° are shown.



The principle of the new method is described in Section 2. In the present observations different sections of the 178 Mc/s interferometer were used in pairs to provide spacings up to 608λ . Each of the sections produces a reception pattern which is approximately circular with an angular width to half intensity of 5° and the area observed is a circular region of diameter 8° centred on the North Pole.

2. *The principles of the new method of synthesis.*—The method by which the reception pattern of a large aerial aperture can be reproduced by means of two small elements which are moved so that they occupy in turn all the relative positions present in the large aperture has been described by Ryle and Hewish (3). The method is indicated in Fig. 1, which shows how one of the elements can be fixed whilst the other moves over an area approximately twice that of the equivalent aperture.

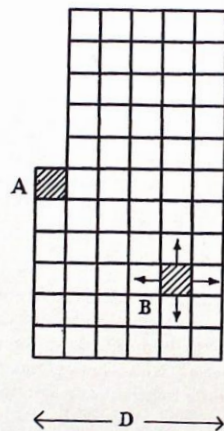


FIG. 1.—The synthesis of a square aperture of side D ; the element A is fixed and B is moved successively to all the positions shown.

The two-dimensional motion of the element B in Fig. 1 may be inconvenient in practice and alternative ways of varying the relative positions of the two elementary aerials have been considered; one method makes use of two mutually perpendicular railway tracks each carrying one of the elements but, as has been discussed (4), the time required to complete an observation of a particular area of sky with this system may be inconveniently long. An alternative method makes use of the rotation of the Earth to alter the direction of a single railway track relative to the sky so that extended observations made with different spacings between the aerial elements provide all the relative positions which are required.

The method is illustrated in Fig. 2. During each rotation of the Earth the projection of the interferometer axis $A-B$ on to the equatorial plane turns through one complete revolution relative to the sky, so that for a particular spacing one of the aerials describes a circle around the other.

By altering the spacing between the aerials on successive days, it is then possible to obtain all the spatial frequencies present in a disk parallel to the equatorial plane. Since observations over any 12-hour period provide information identical with that obtained over the other 12-hour period with the aerial elements interchanged, it is only necessary to make observations for 12 hours at each aerial spacing.

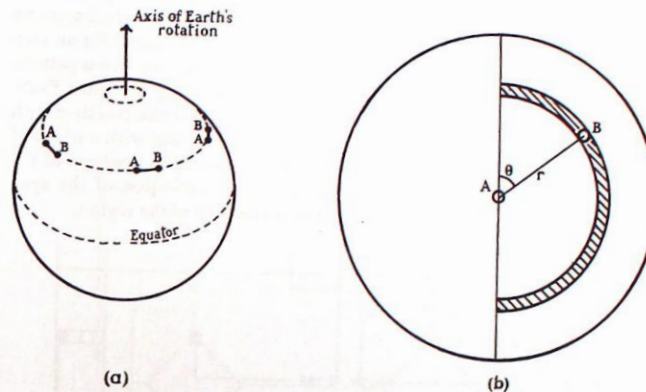


FIG. 2.—Diagram showing (a) the relative positions of two aerials, A and B , mounted on an East-West line as the Earth rotates; (b) the projection of the relative positions on to the equatorial plane.

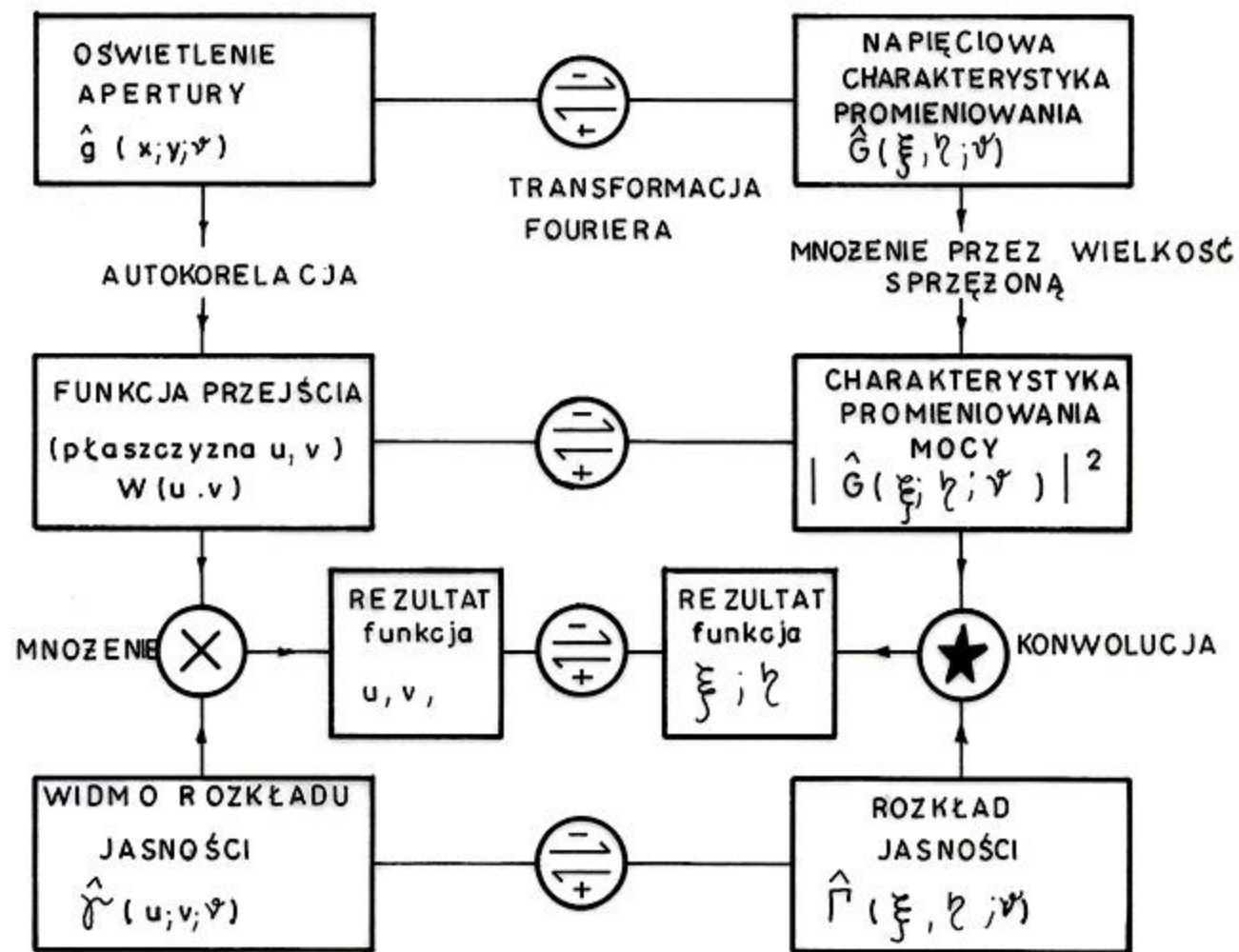
The area of sky observed is, of course, determined by the size of the elementary aerials and, except for observations near the Pole, the aerials must be steered so that they are directed at the same point in the sky for 12 hours. For areas near the Pole the equivalent synthesized aperture is circular; at other declinations it is elliptical, with the minor axis diminished by a factor $\sin \delta$.

The use of observations made over a range of hour angle in order to produce a varying position angle of an interferometer axis was first used by O'Brien (5) to synthesize a two-dimensional grating aerial for determining the distribution of radio brightness across the solar disk; both North-South and East-West axes were used in O'Brien's observations. The method was subsequently applied to the observation of radio sources by Högbom (6), who demonstrated the feasibility of the method for synthesizing a single beam instrument. Högbom used two small aerials at $\lambda = 3.7$ m on a North-South axis.

If a North-South axis is used, the observations provide a rotation of the projected direction of the interferometer axis ξ which is given by:

$$\cot \xi = \cos \delta \cot \phi \operatorname{cosec} h + \sin \delta \cot h$$

where δ and h are the declination and hour angle of the source and ϕ is the latitude of the aerial system. It is only possible to achieve the 180° rotation needed to synthesize the full aperture if observations are extended over a longer period than 12 hours; this extension is only possible for areas of sky at high declinations and for observatories situated at high latitudes.



ZALĘŻNOŚCI POMIĘDZY WIELKOŚCIAMI MIERZONYMI A PARAMETRAMI ANTENY

super synteza apertury

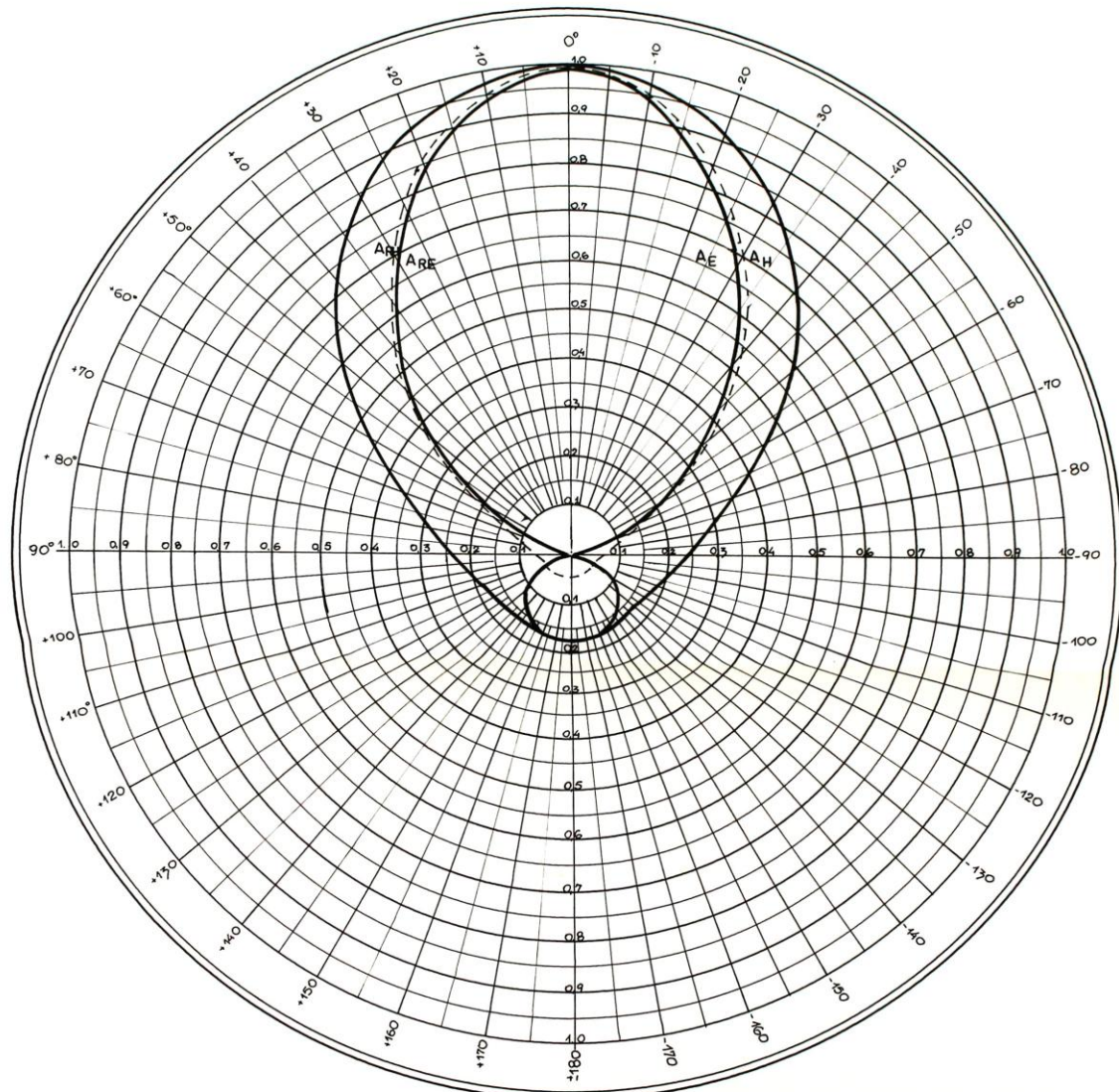


0.85λ

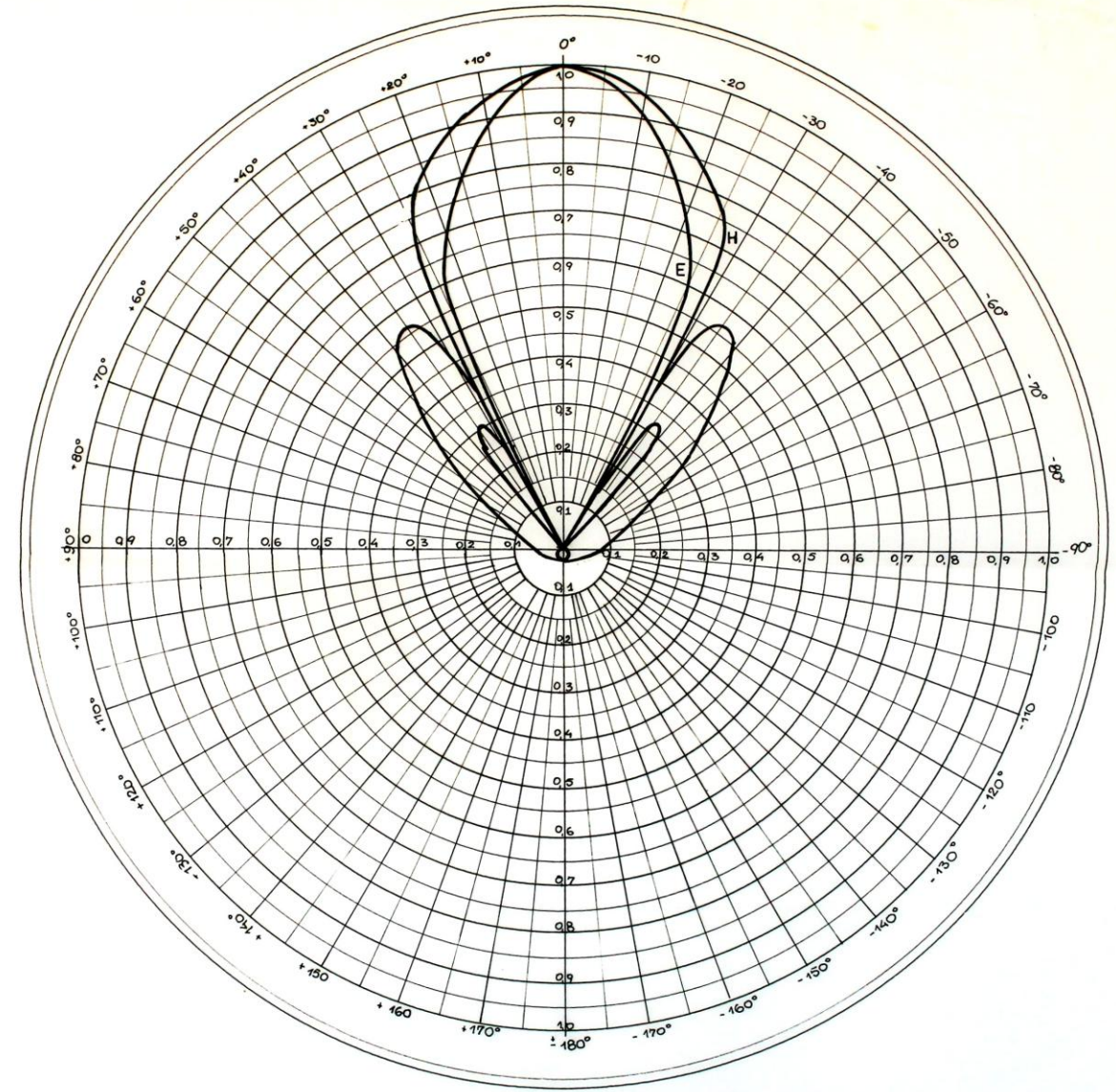
Radiowy przegląd okolicy bieguna
na częstotliwości 43 MHz

Antena przestawiana - ruchoma



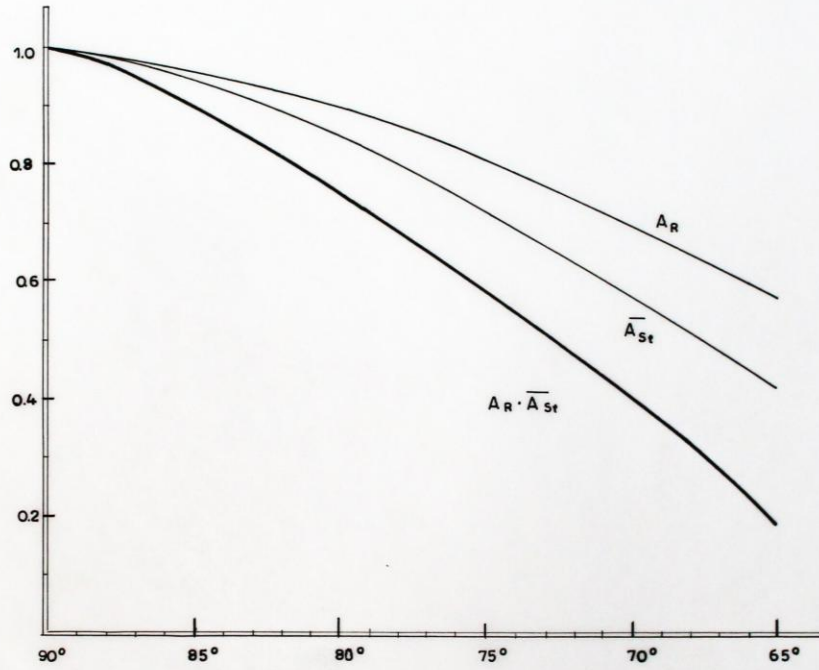


CHARAKTERYSTYKI PROMIENIOWANIA ANTENY PODSTAWOWEJ A
ORAZ A_R



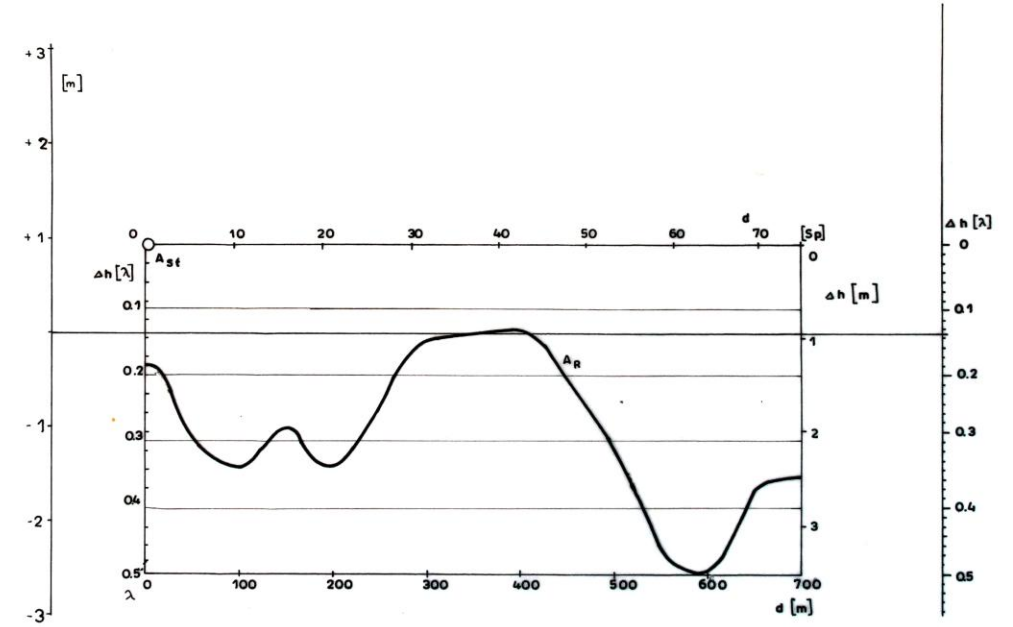
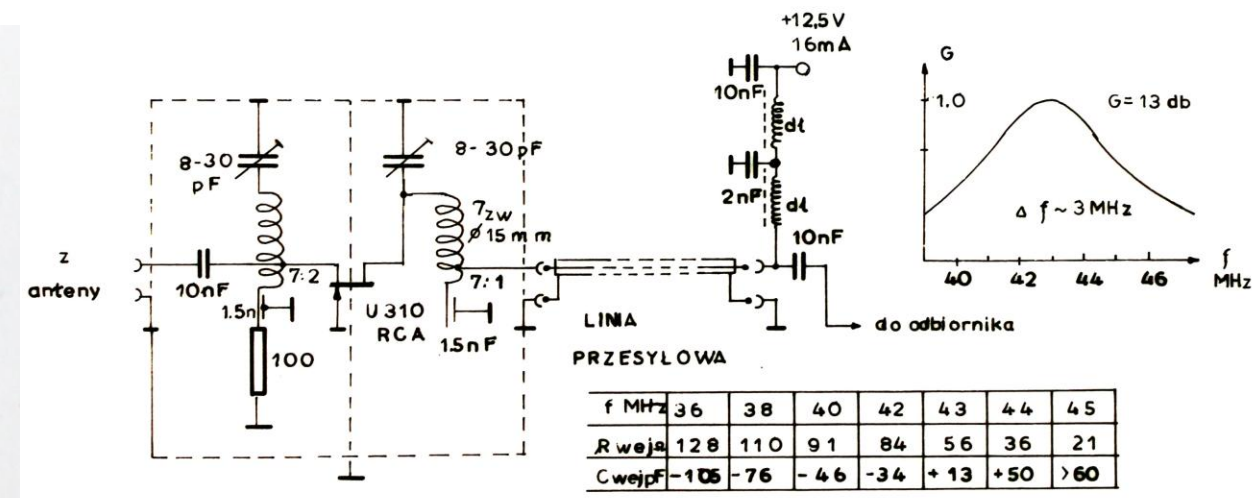
CHARAKTERYSTYKA PROMIENIOWANIA A_{ST}

PRZEDWZMACNIACZE ANTENOWE



DEKLINACJA

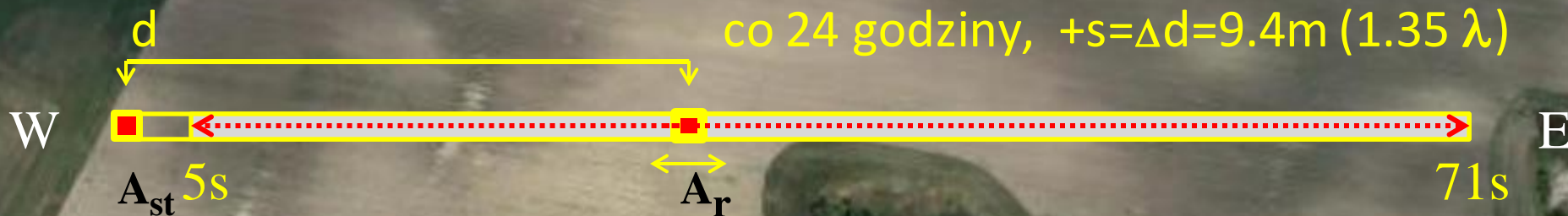
CHARAKTERYSTYKI PROMIENIOWANIA MOCY \bar{A}_{St} , A_R ORAZ SUMARYCZNA W OBSERWOWANYM POLU



WYSOKOŚĆ A_R W STOSUNKU DO A_{St} W FUNKCJI DŁUGOŚCI BAZY

$$f=43,1 \text{ MHz} \Rightarrow \lambda = 6,97\text{m}$$

Zmieniana długość bazy interferometru, od 50m do 690m,
co 24 godziny, $+s=\Delta d=9.4\text{m} (1.35 \lambda)$



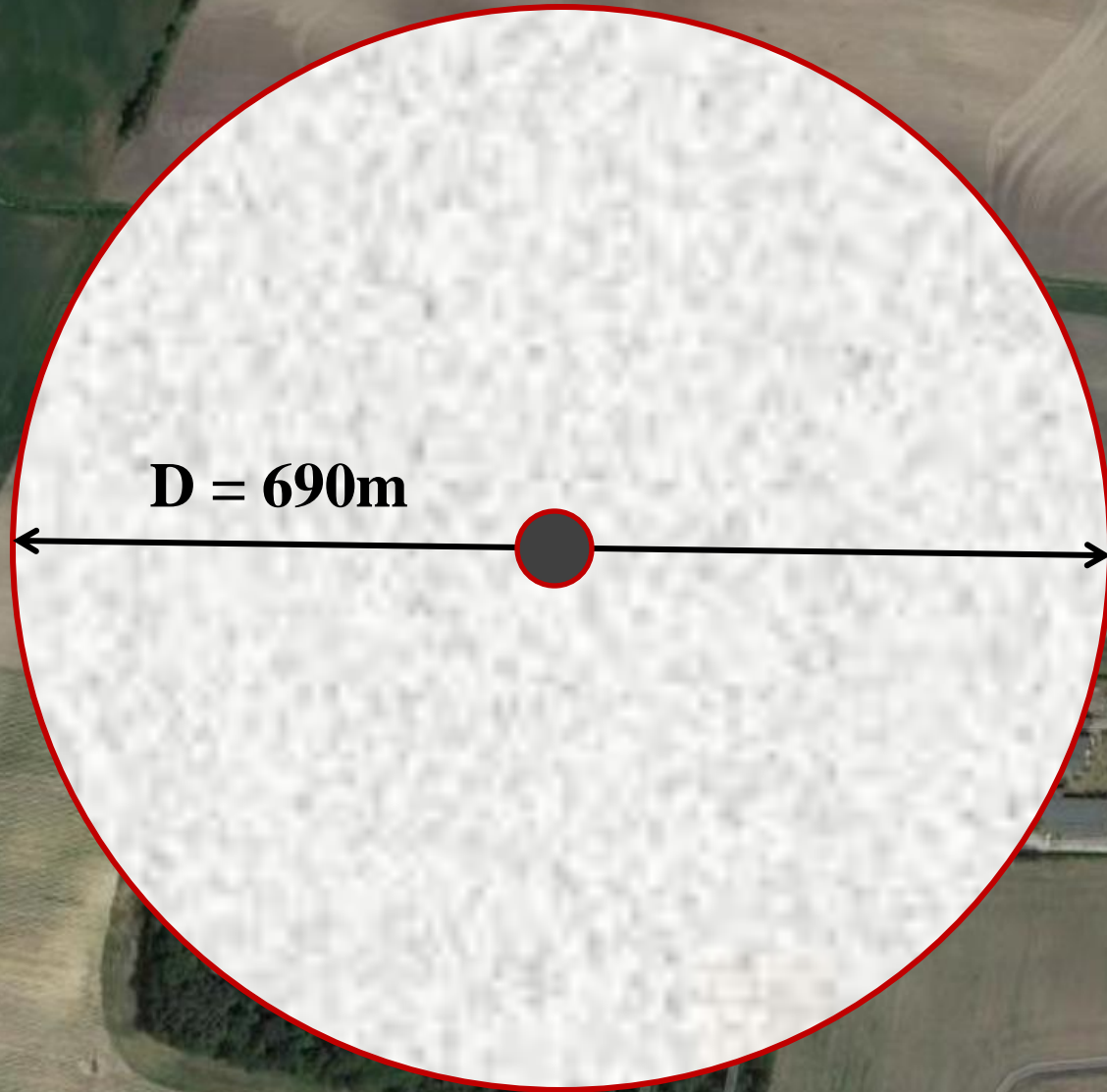
66 pozycji anteny ruchomej
(i tyle samo niezależnych interferometrów), skok (s) co $1,35 \lambda$

90 nocy obserwacyjnych od stycznia do końca kwietnia 1973 roku
+ powtórzone 20 obserwacji

$D = 690\text{m}$

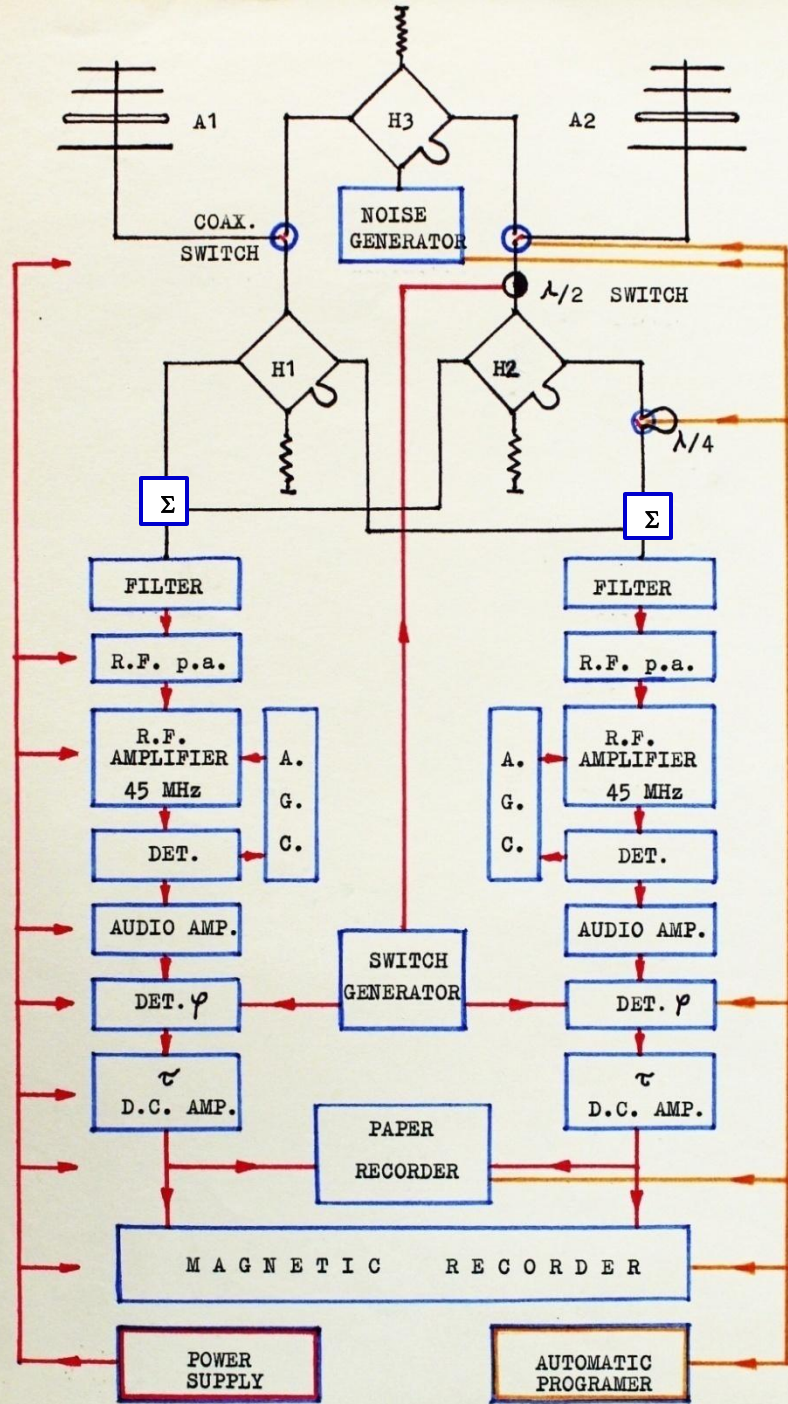
Obserwatorium
Astronomiczne w...

Google

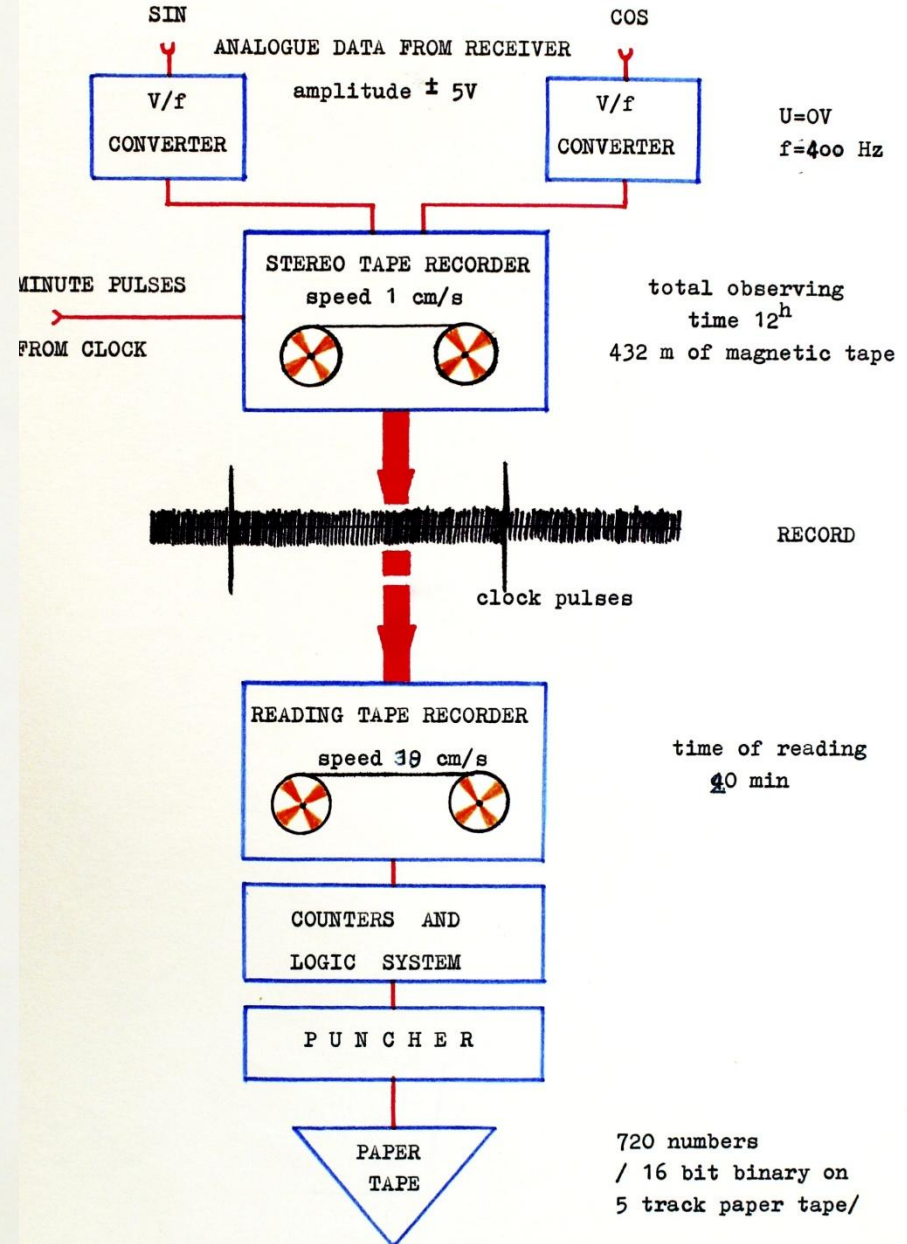


Obserwatorium
Astronomiczne w...

Google



RECORDING SYSTEM



Zapis danych na taśmie magnetycznej audio dwa kanały „cos i sin”

Prędkość taśmy przy zapisie 1 cm/s

- Przetworniki napięcie - częstotliwość (analog => digital)
- Integracja sygnału w przedziałach jednocminutowych

Odczyt na magnetofonie ZK 140 z prędkością 19 cm/s

Przetwornik ZAMP-72K - zestaw liczników i interfejs do „paper tape puncher” (perforator taśmy papierowej)

Przykładowe rejestracje z taśmy magnetycznej poniżej

1



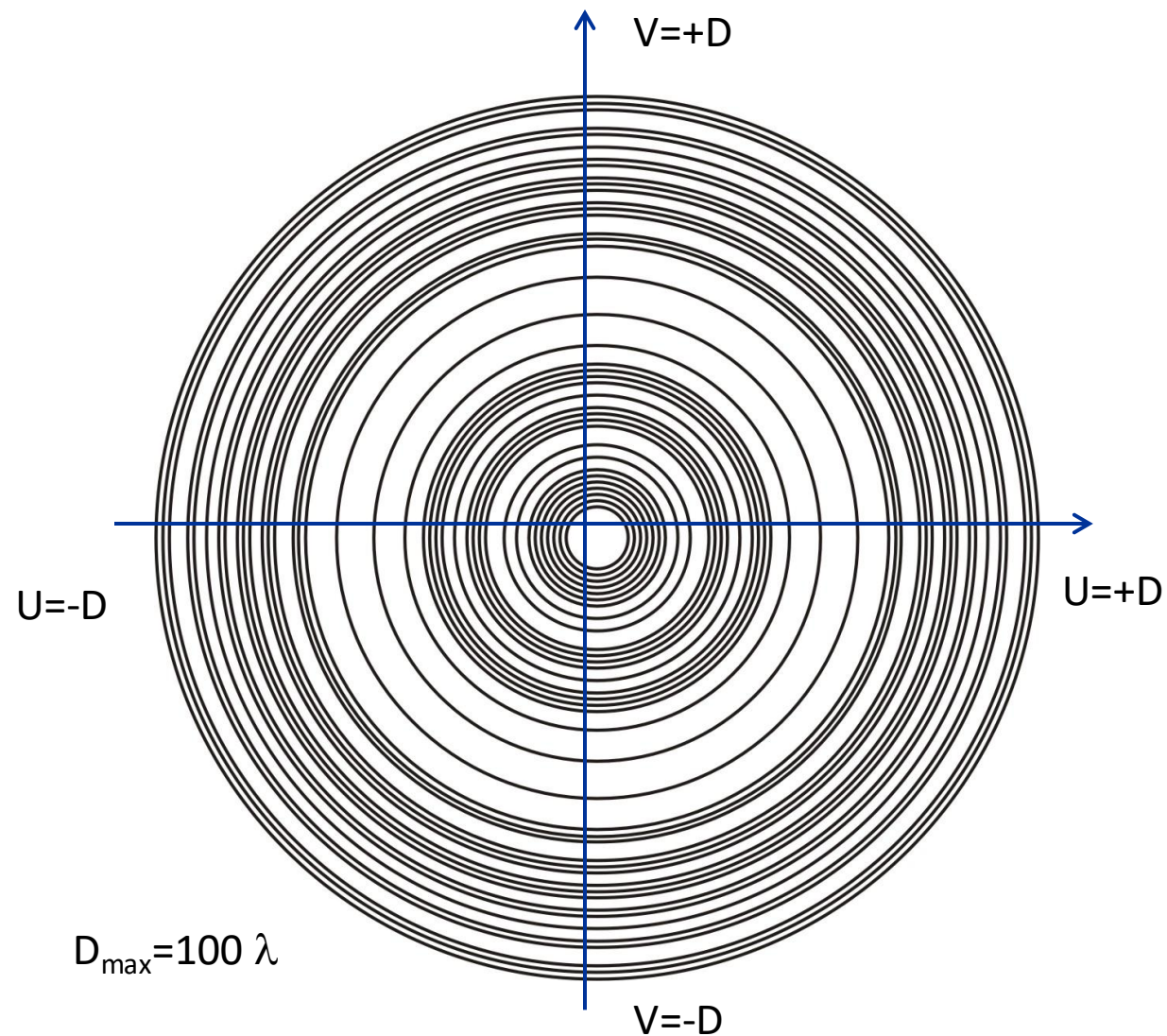
Bez impulsów minutowych

2



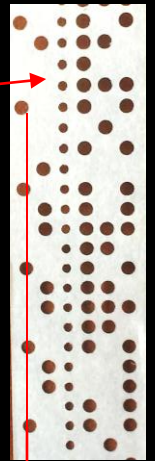
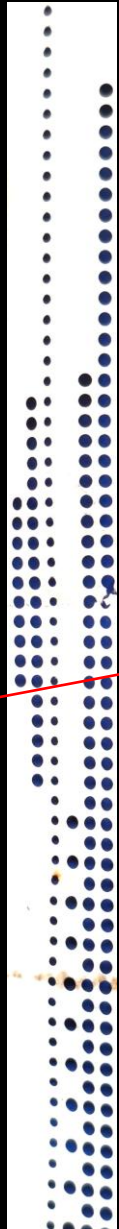
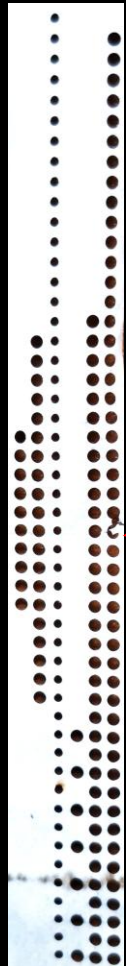
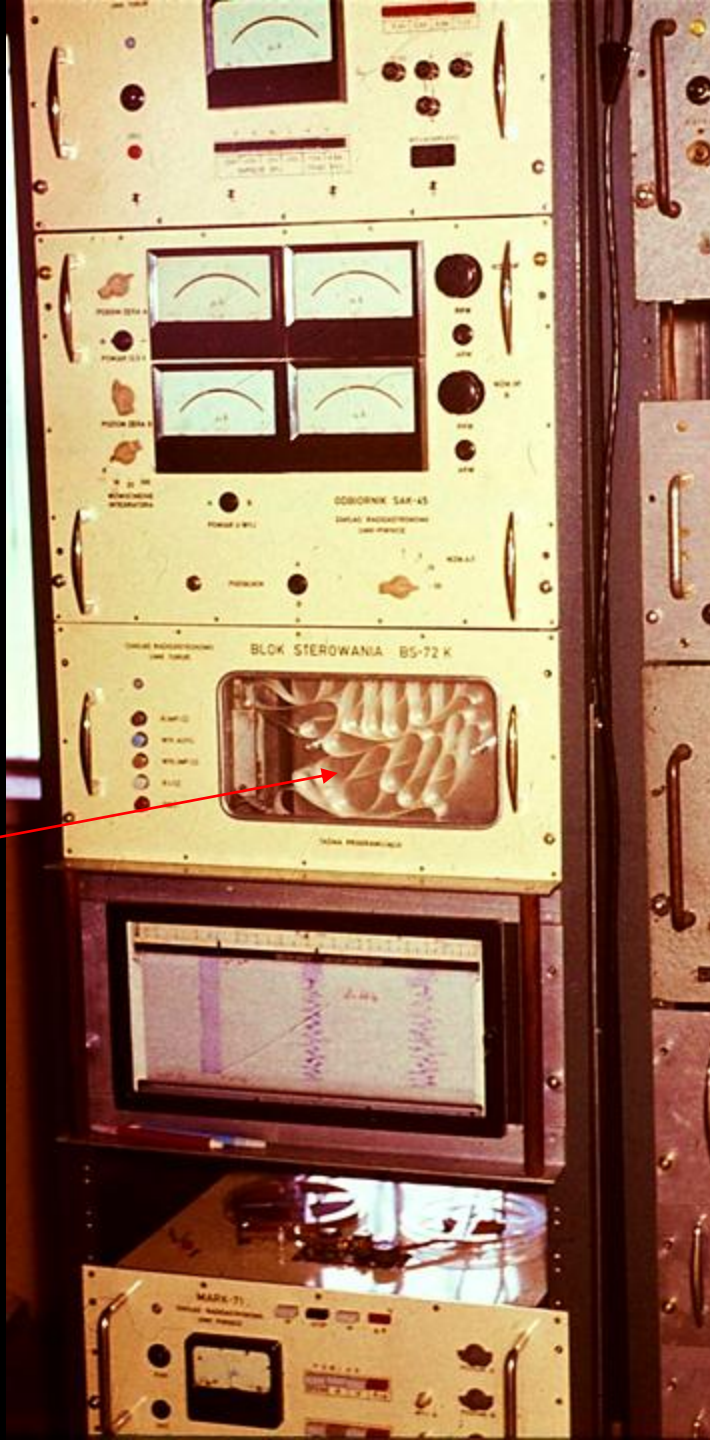
przełączanie co minutę
(tu co 6 sek bo odtwarzanie 6,5 cm/s)

Pokrycie płaszczyzny częstości przestrzennych U-V (zespolona funkcja widma obrazu)
odzyskane archiwalne dane z obserwacji wykonanych w 1973 r., ~40%



~60% taśm z danymi zaginęło (stan na 2024)

Kod sterowania
całą aparaturą



Początek słowa

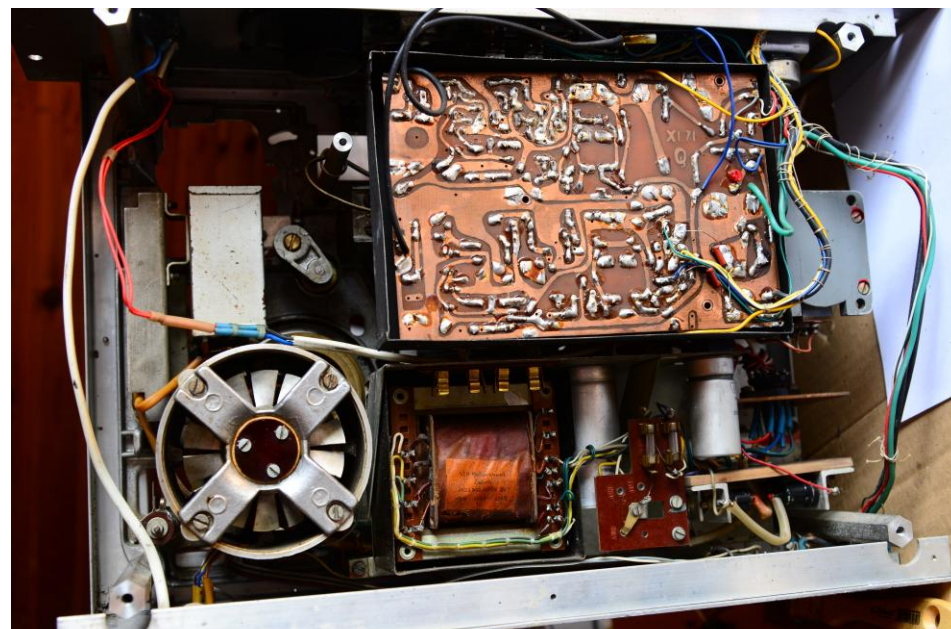
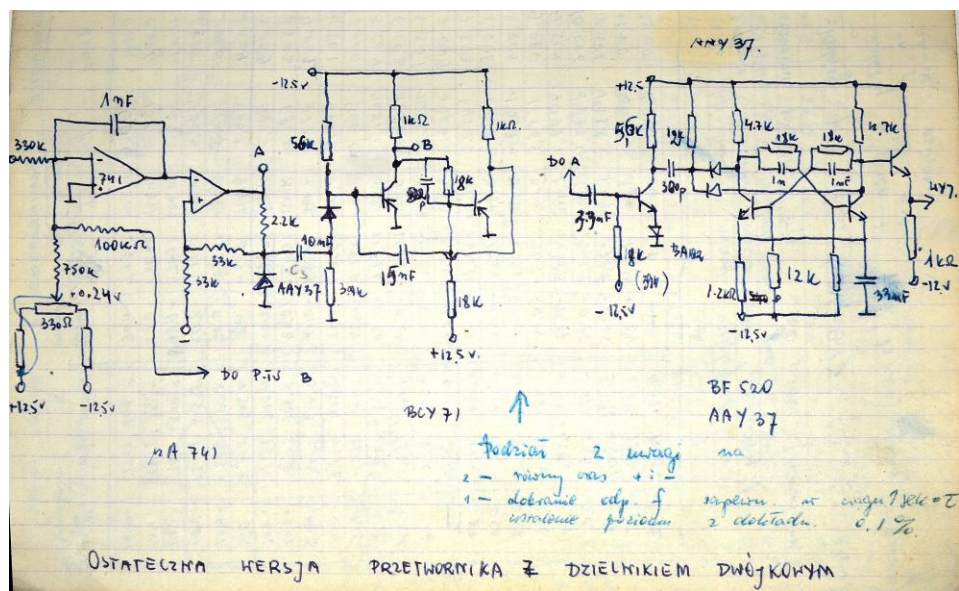
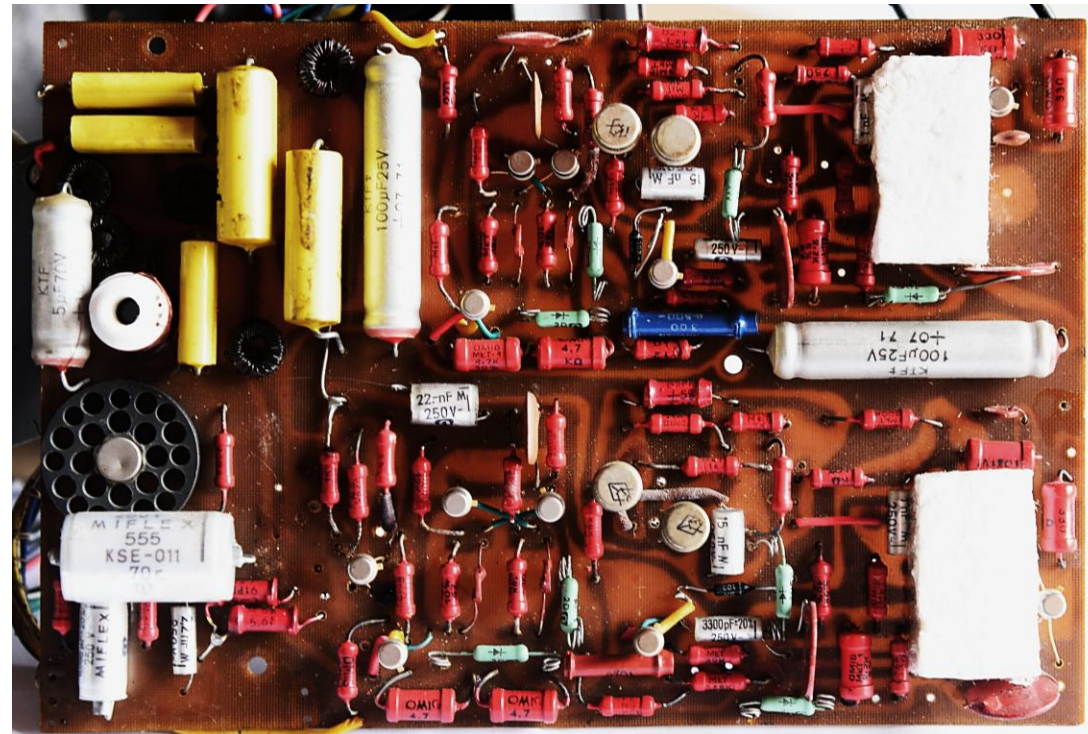
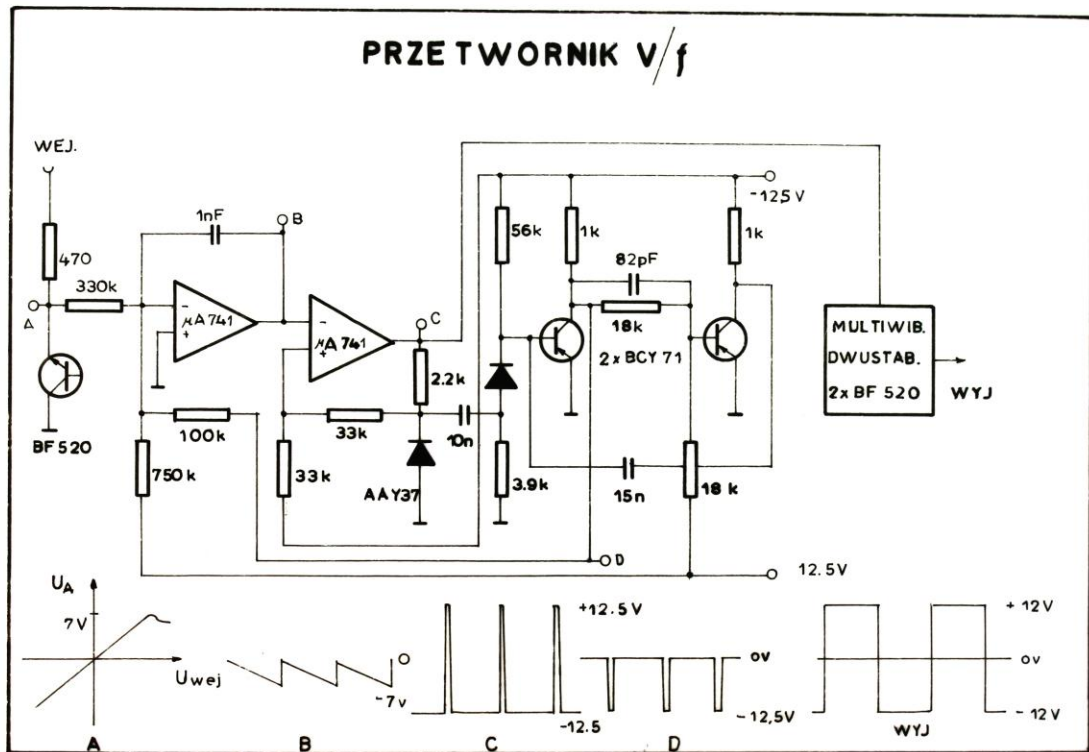
jednminutowa
integracja

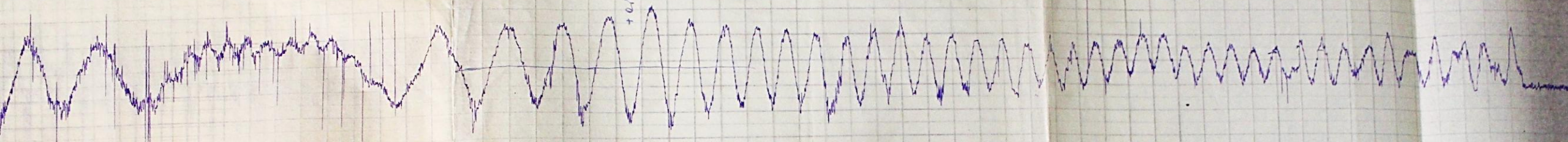
Zapis cyfrowy
16-bitów 4x4



Pierwsze w Polsce
rejestracje cyfrowe
danych
radioastronomicznych

1972/1973





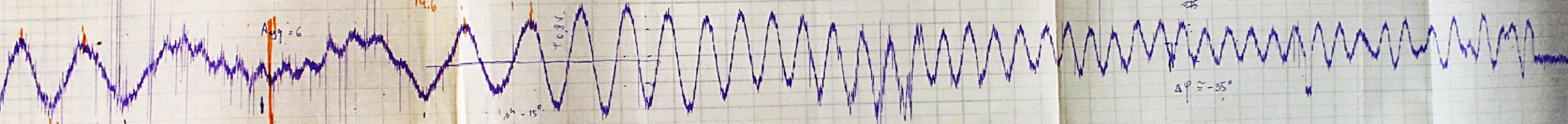
Widoczna linia bary

$A_{\text{os}} = 25 \text{ mm}$

$A_{\text{og}} = 6$

9.8
8.5 14.8

$A_{\text{os}} \sim 40 \text{ mm}$



$\alpha = -15^\circ$

-15° TiE

$A = 15 \text{ mm}$

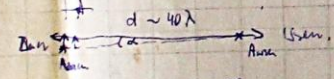
$\Delta \varphi \approx -35^\circ$

8.6
17.5: 2
11.5: 2
6.7
5.77 11.9
1.58 5.9
5.97

6 min.
5-10.
przejście 10 minut

$10 \text{ min} \times 15 \frac{\text{os}}{\text{min}} = 150 \text{ os}$
 $3 \times 15 = 45 \text{ max}$
 $3 \times 15 = 45 \text{ min}$

$(4 \times 15) = 60$
10



$\frac{0.03}{1.2} = 0.025$
dla

Widoczna linia bary

przejście Cas A
przez pod. zask.

$d \sim 100 \lambda$
 $\sim 3.5 \lambda = \sim 25 \mu\text{m}$
 $\sim 1.7 \lambda \sim 12 \text{ nm} \sim 10 \text{ nm}$

przejście przez pod. zask. Cyg A.

przejście Cas A

$\sim 15^\circ \text{ TiE}$
25'

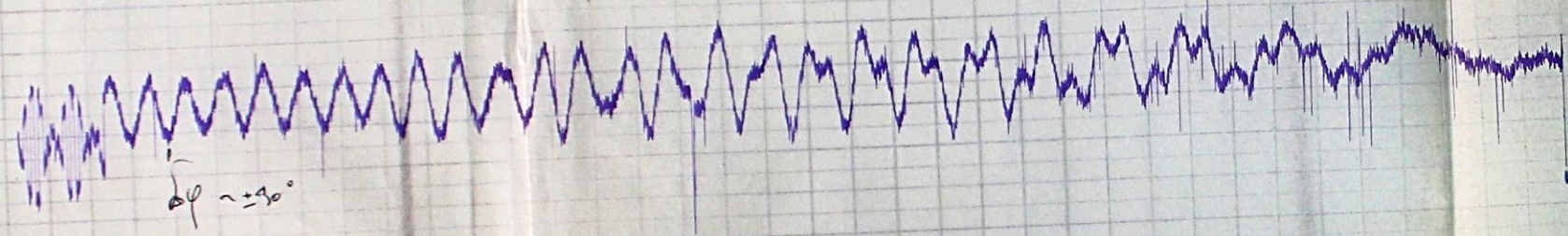
22' 15" T*

22'

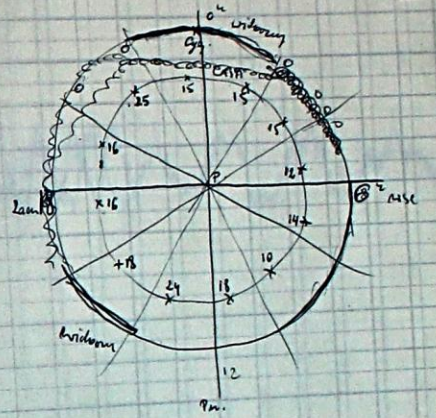
21'



ε prout. φ

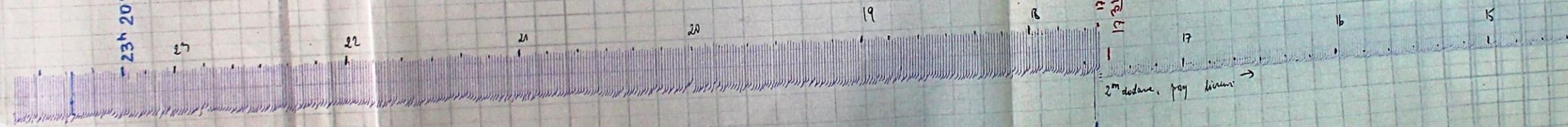


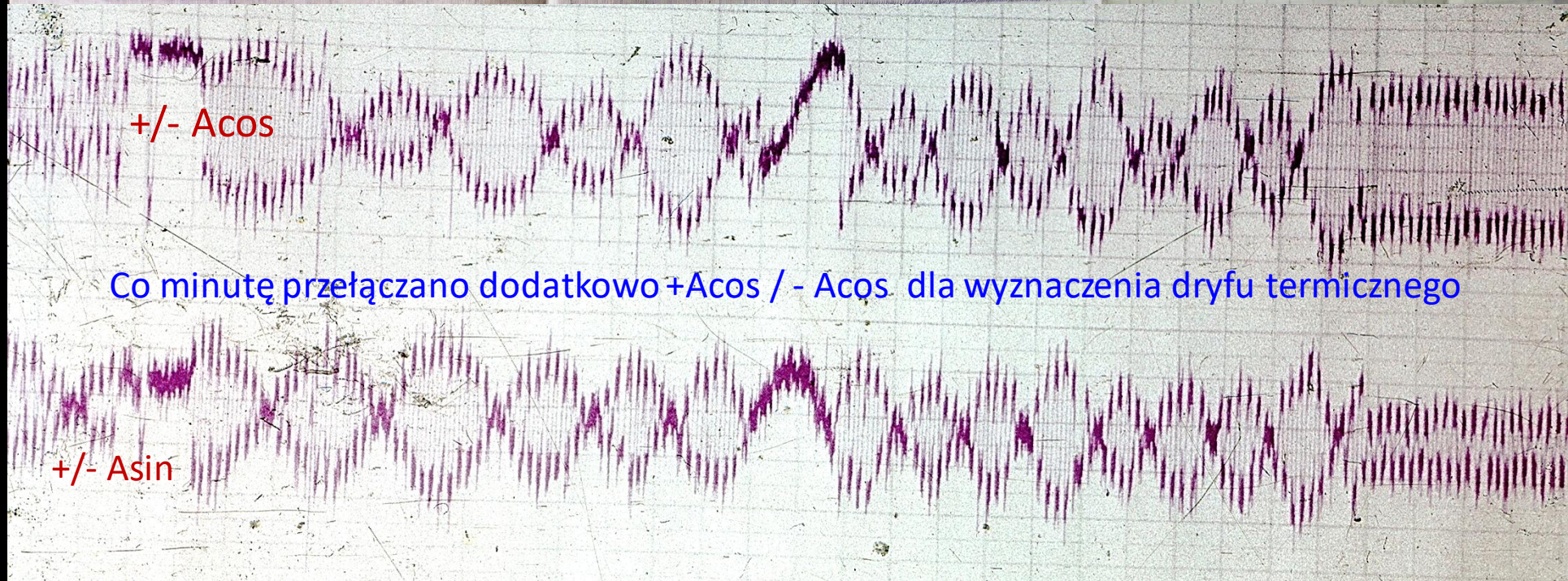
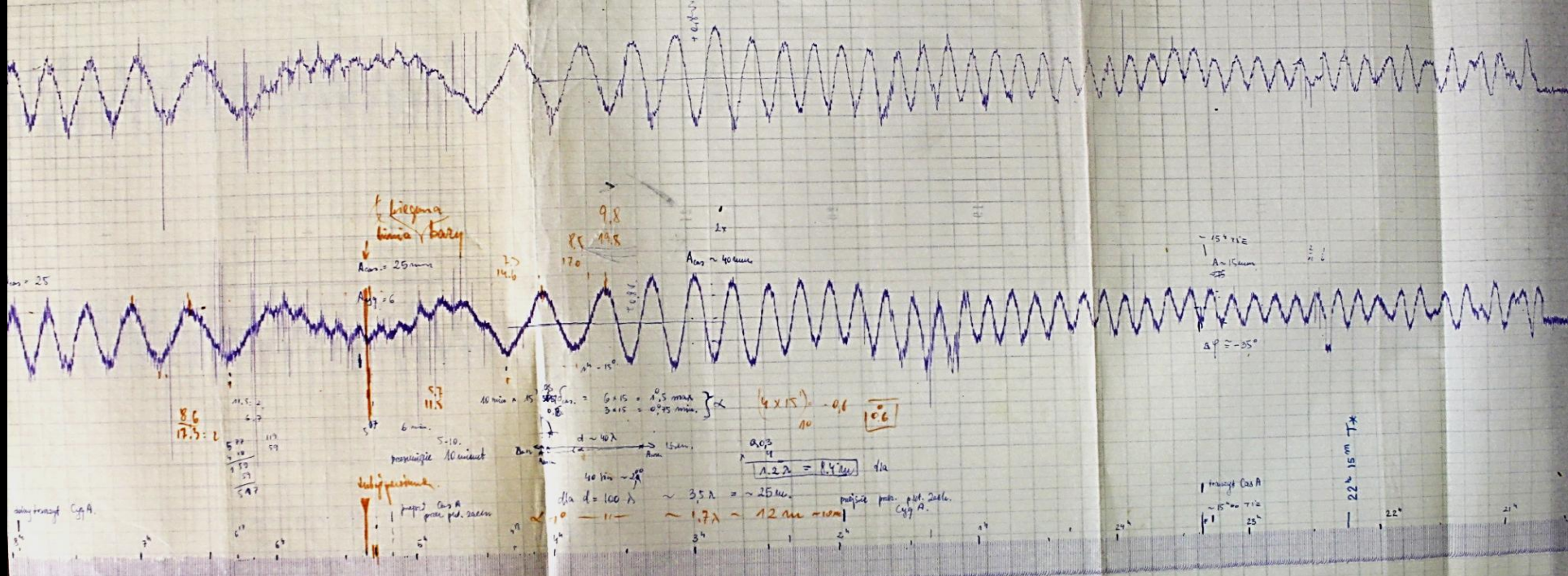
należy jeszcze zmierzyć A_{pr} obrot
ma różnicę



23.01.73

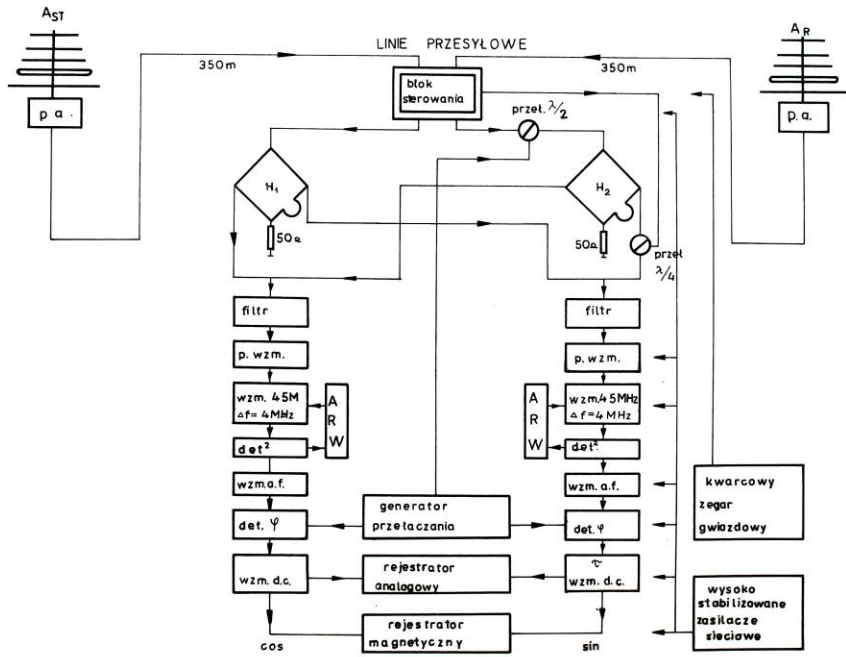
23h 20m



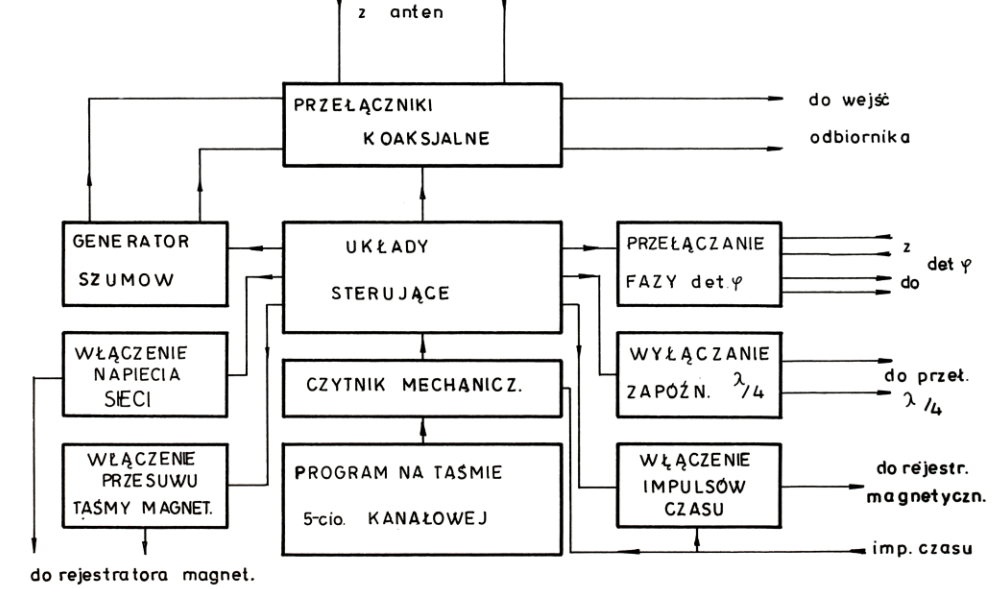


Co minutę przełączano dodatkowo +Acos / - Acos dla wyznaczenia dryfu termicznego

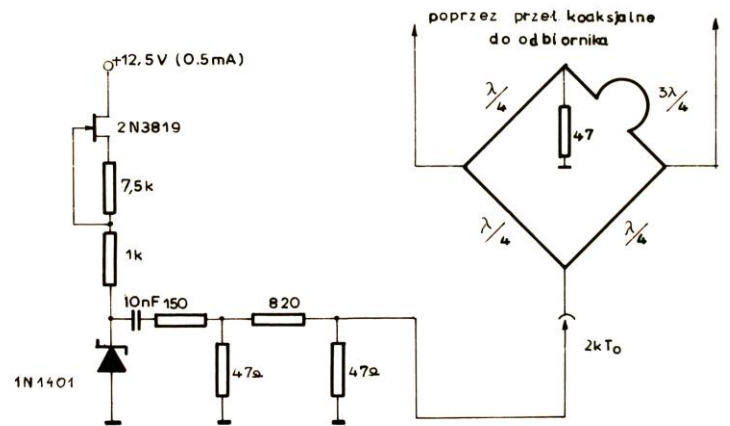
SCHEMAT BLOKOWY SYSTEMU ODBIORCZEGO



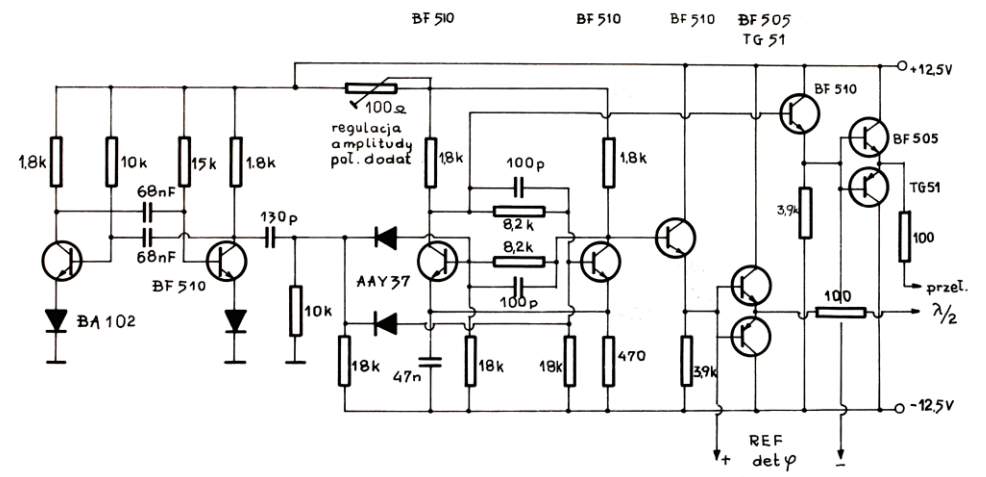
sygnat z anten



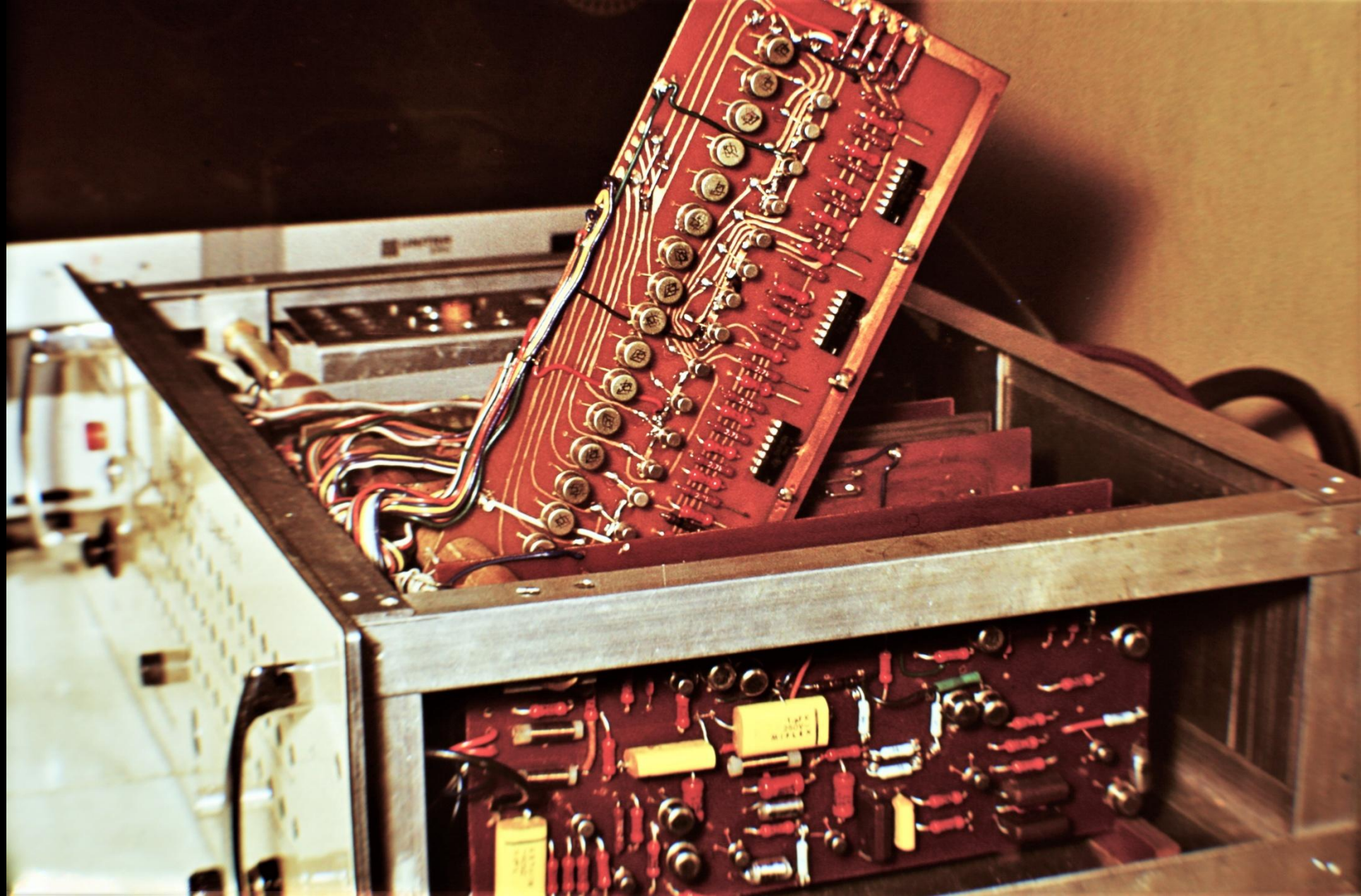
BLOK STEROWANIA

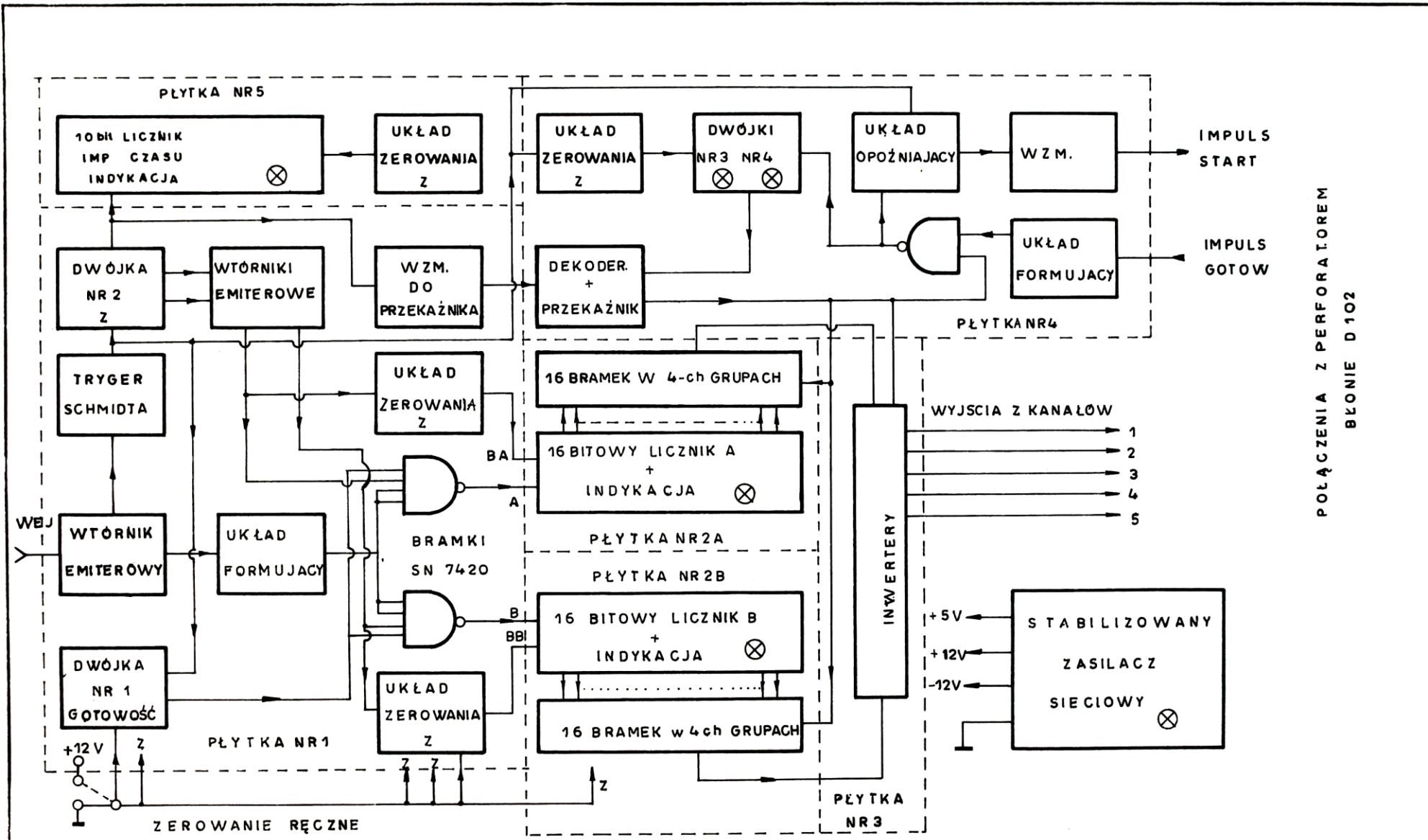


GENERATOR SZUMÓW



GENERATOR PRZEŁĄCZANIA

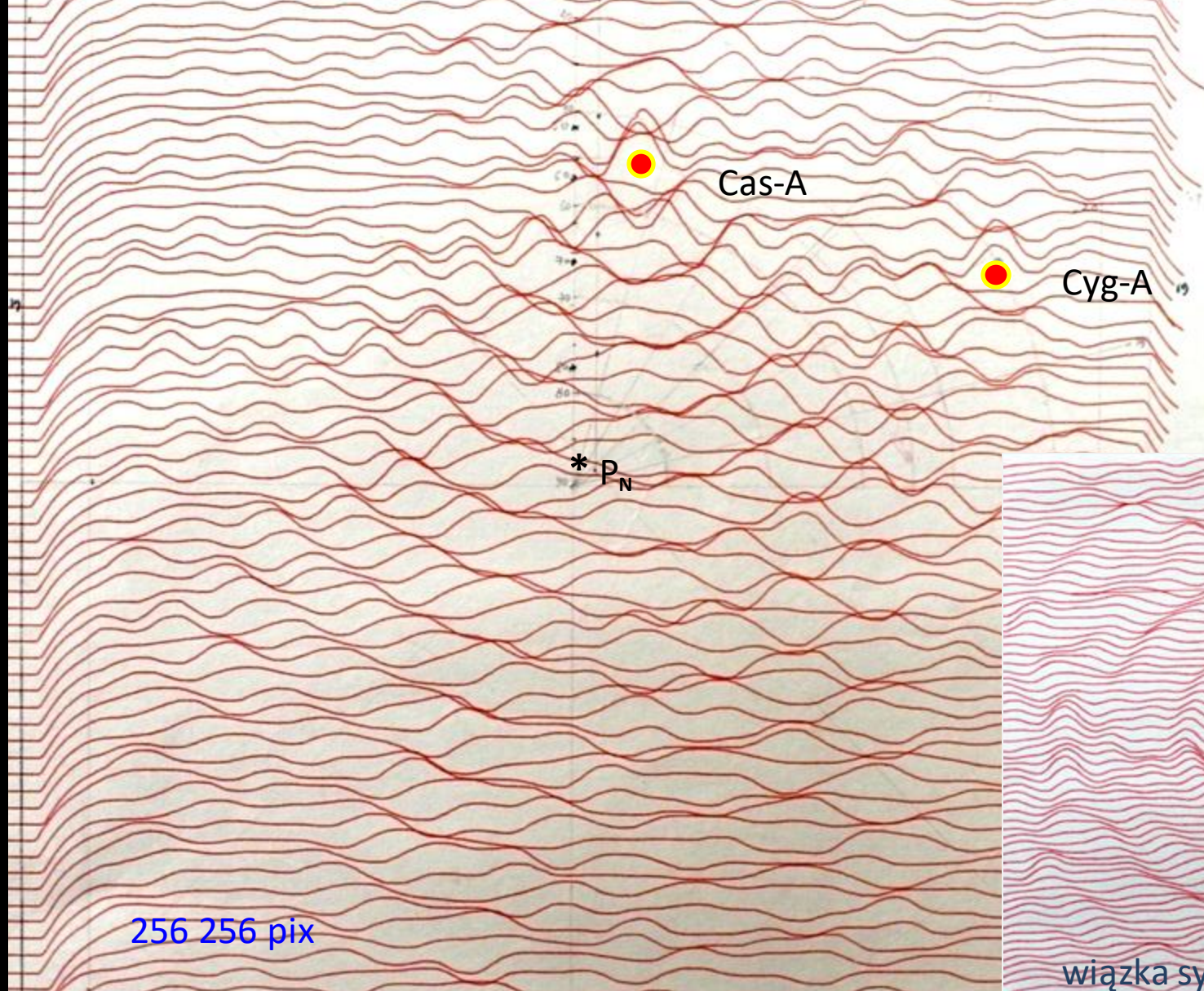




POŁĄCZENIA Z PERFORATOREM
 BLONIE D 102

SCHEMAT BLOKOWY PRZETWORNIKA ZAPIS MAGNETYCZNY-PERFORATOR ZAMP 72K

Mapa wykonana dla jednej bazy $D=10 \lambda$, 1972, symulowane dane

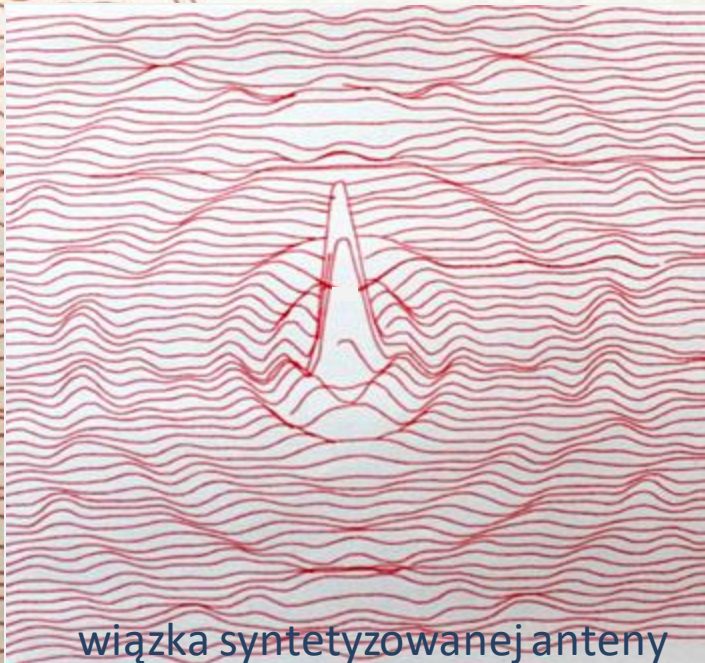


256 256 pix

Cas A, Cyg A
artificially generated.
 $N=1$; $\frac{D}{\lambda}=10$

Plotter:
speed: 4
size: 15
d.-a. conv.:
40 + 160 ms

	α	δ
Cas A	$23^{\text{h}} 21^{\text{m}} 11^{\text{s}}$	$+58^{\circ} 33'$
Cyg A	$19^{\text{h}} 57^{\text{m}} 45^{\text{s}}$	$+46^{\circ} 36'$



wiązka syntetyzowanej anteny

Nad oprogramowaniem pracowali A.Wolszczan (1971/1972) i L.Nowakowski (1974/1975)

Duża część (ok. 60%) danych zapisanych na perforowanych taśmach papierowych (pięciokanałowe) zaginęła, została zagubiona. Niewielka część danych, która jest aktualnie w posiadaniu AJK, została odczytana na mechanicznym czytniku (b. wolnym) sterowanym przez minikomputer Raspberry. Hardware i software do tego urządzenia napisał p. mgr Eugeniusz Pazderski. Odczyt jednego zapisu trwa ok. 15 minut, cały proces odczytania wszystkich posiadanych taśm papierowych zajął by kilka dni ciągłej pracy. Łącznie z innymi operacjami to zajęcie na miesiąc.

Część danych przetwarzanych w latach 1973-1976 przez mgr Leszka Nowakowskiego na komputerze Odra 1305 (Ośrodek Obliczeniowy UMK), zapisano na taśmie magnetycznej w systemie IBM. Taśma magnetyczna zawierała więc kopie danych obserwacyjnych, czyli ważnego materiału obserwacyjnego. W złożonym procesie odczytania tych danych cyfrowych pomogli mgr Rafał Maszkowski oraz pracownicy Katowickiego Muzeum Historii Komputerów i Informatyki. Szczególne podziękowanie należy się tu Dyrektorowi MHKiI, *p. Krzysztof Chwałowski* <k.chwalowski@muzeumkomputerow.edu.pl> który osobiście sprawił, że taśma została odczytana (czerwiec 2022) na jednym z działających komputerów Muzeum i pomógł w udostępnieniu cyfrowego obrazu całości zapisu (w postaci jednego pliku - zrzutu binarnego).

Rozkodowanie danych odczytanych z taśmy magnetycznej nie było proste. Wielka pomoc w rozwiązaniu problemu przyszła od mgr Romana Feilera. Poszukując podobnej sygnatury danych binarnych z taśmy magnetycznej do tych pochodzących z przykładowego pliku z taśmy papierowej, odczytanego na mechanicznym czytniku, RF wykrył te same obszary, co pozwoliło mu rozkodować cały zapis zrzutu binarnego z taśmy magnetycznej.

Była nadzieja, że na taśmie magnetycznej jest komplet danych obserwacyjnych, ale niestety są to te same dane, które zapisano na posiadanej obecnie perforowanej taśmie papierowej. Nie było więc wszystkich obserwacji.

Szybkość i łatwość czytania plików z taśmy magnetycznej sprawiły, że zaniechano odczytywanie wszystkich taśm papierowych.

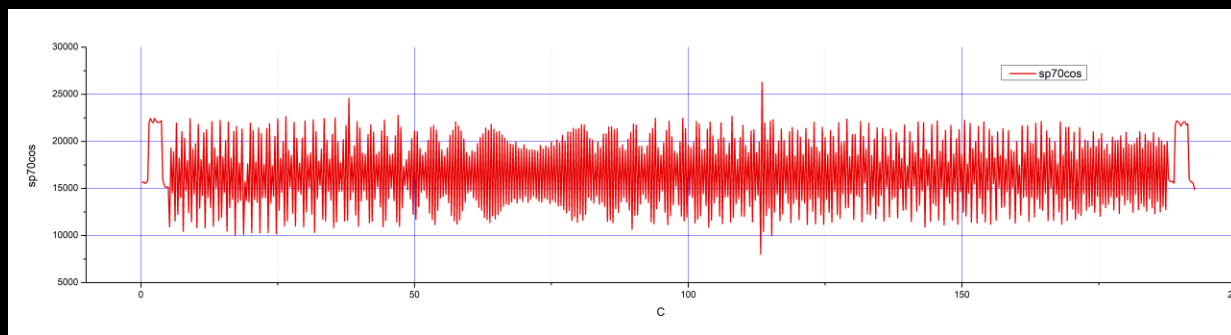
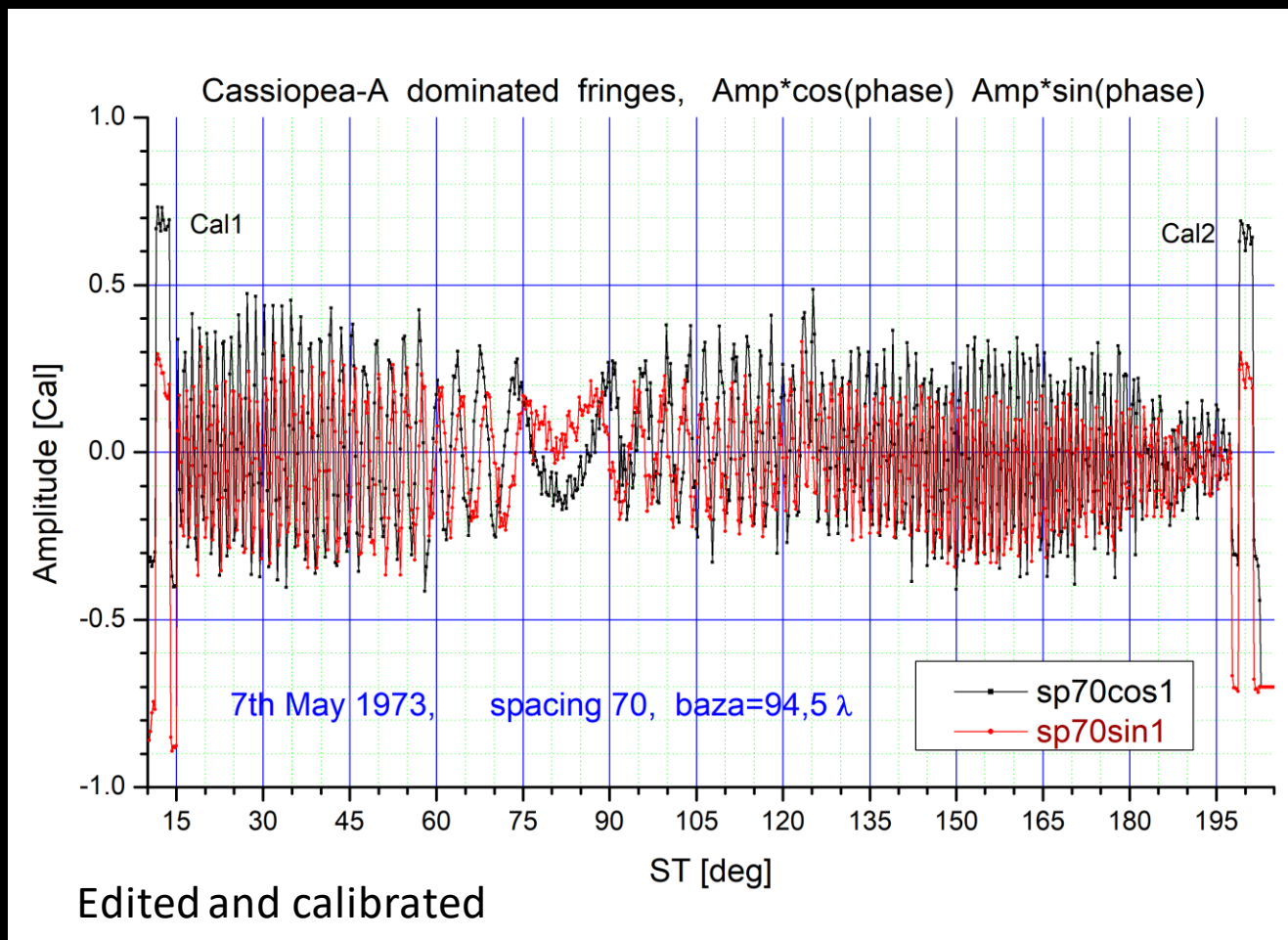
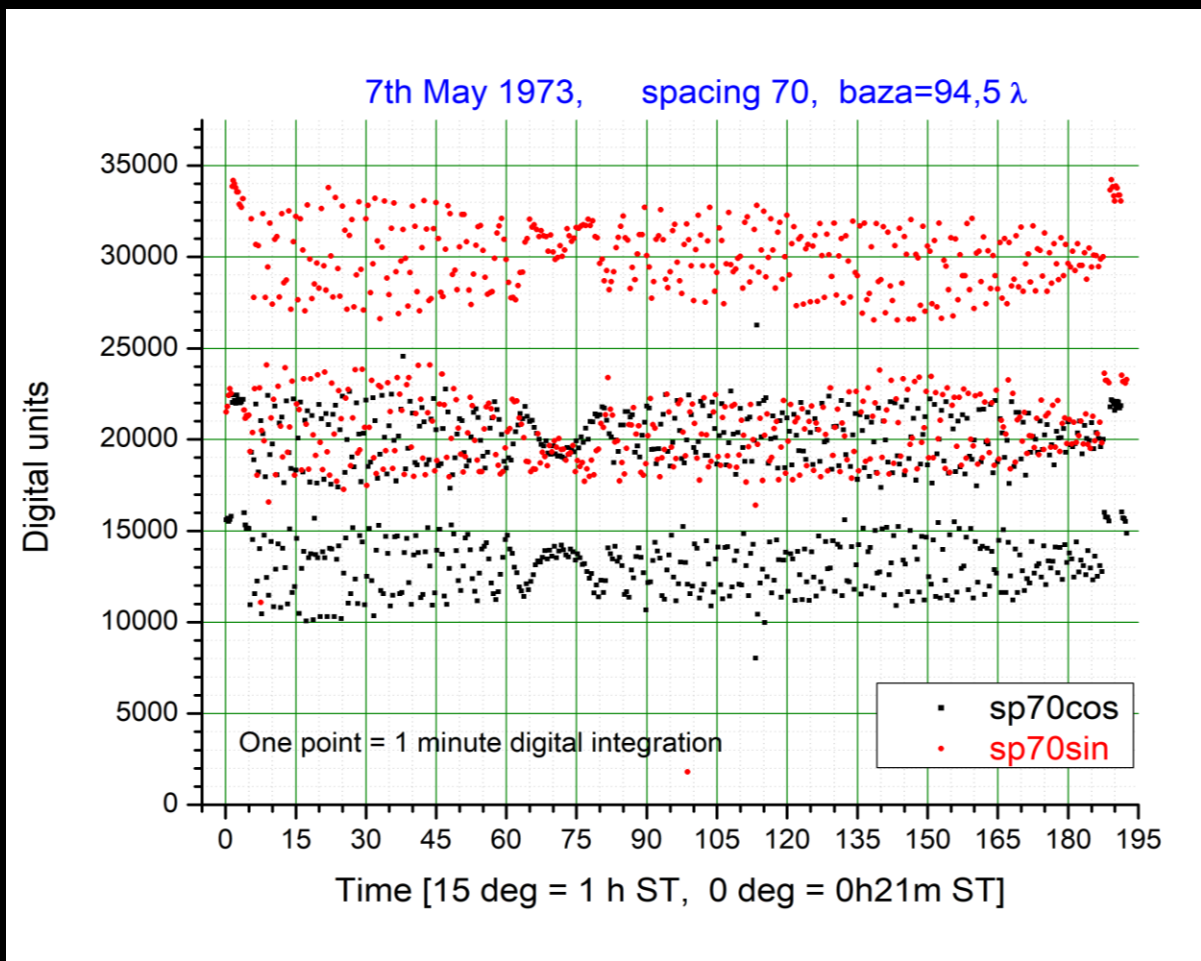
Software do obróbki danych obserwacyjnych 2024-2026

12h obserwacje z wstępną integracją 1 sek, $\text{Amplituda} \cdot \cos(\phi)$, $\text{Amplituda} \cdot \sin(\phi)$ po przetworzeniu V/f i zapisaniu na taśmie magnetycznej, po każdej dobie obserwacji były odczytane i zapisane na perforowanych taśmach papierowych. Ostatecznie jednogodzinowe integracje 730 punktów pomiarowych plus 40 kalibracyjnych, zostało poddane wstępnej obróbce programem EDIT. (Rozkodowanie obydwu kanałów zapisu $\pm A \cos$ i $\pm A \sin$, oraz kalibracja amplitudy względem sygnału porównawczego wytwarzanego podczas obserwacji przez generator szumów CAL).

Kolejny etap edycji odbywał się przy pomocy programu Origin8 (Origin Lab), dedykowanego do obróbki i prezentacji rezultatów pomiarów naukowych. Obejmował on edycję błędów zapisu, usunięcie dryfu, dopasowanie teoretycznych modeli listków interferencyjnych źródła Cas-A, co pozwoliło wyznaczyć skalibrowane amplitudy i parametry każdej bazy interferometru.

Poprawione w pakiecie Origin8 dane służyły do tworzenia map nieba programami napisanymi przez AJK (m.in. MAP, CLEAN, CONVolve).

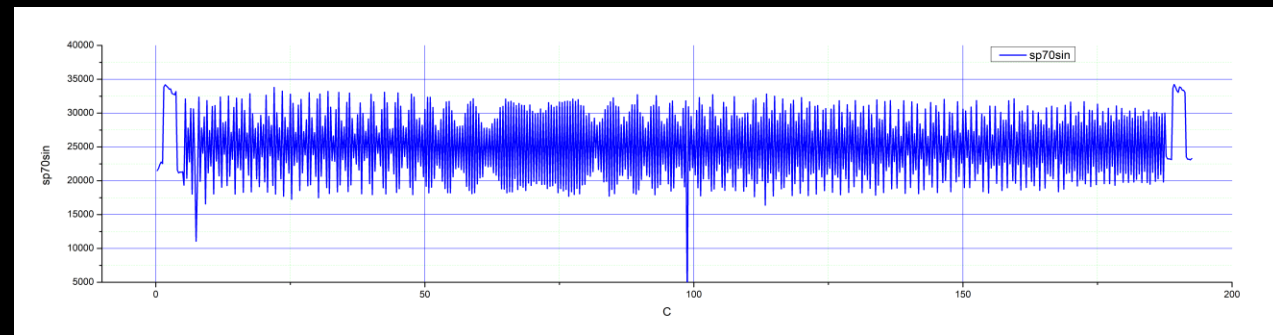
Mapy zapisywane w formacie ASCII lub FITS i są wyświetlane na ekranie komputera przy pomocy oprogramowania Surfer (Golden Software) lub w programie Fits View. Końcowa obróbka i prezentacja wyników wykonywana była w oparciu o programy własne AJK.



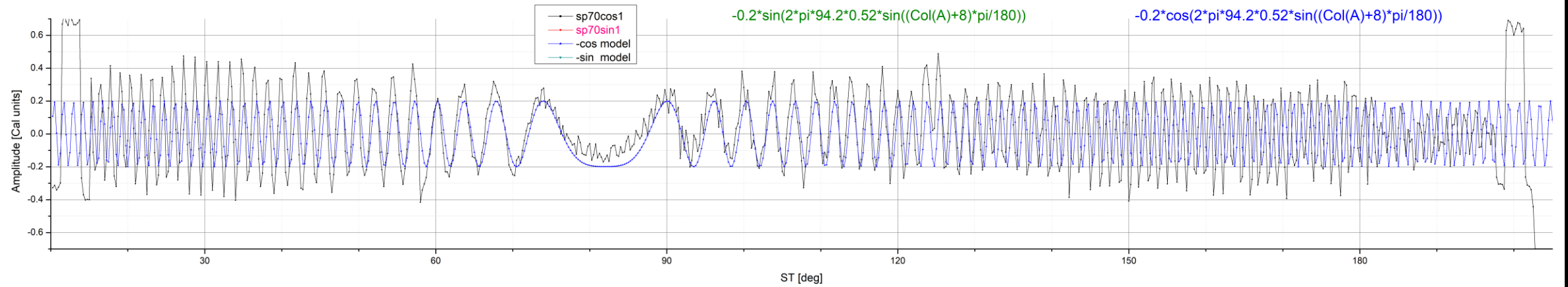
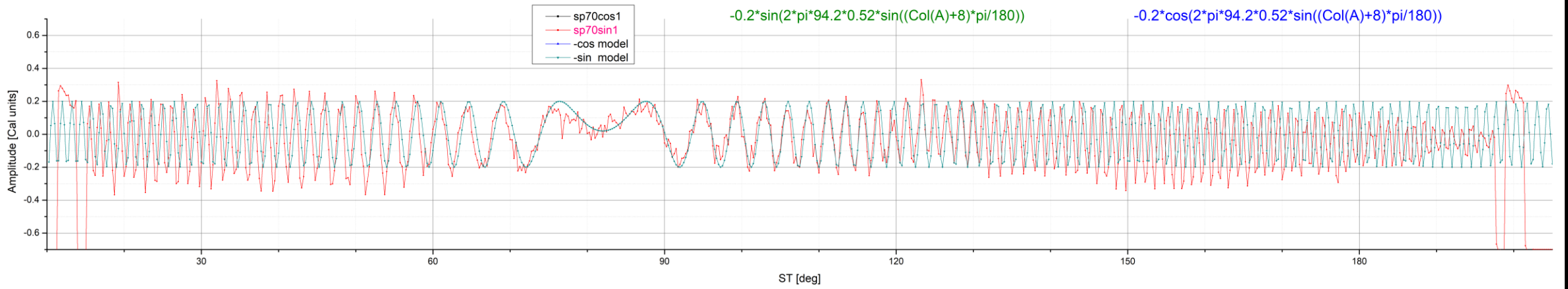
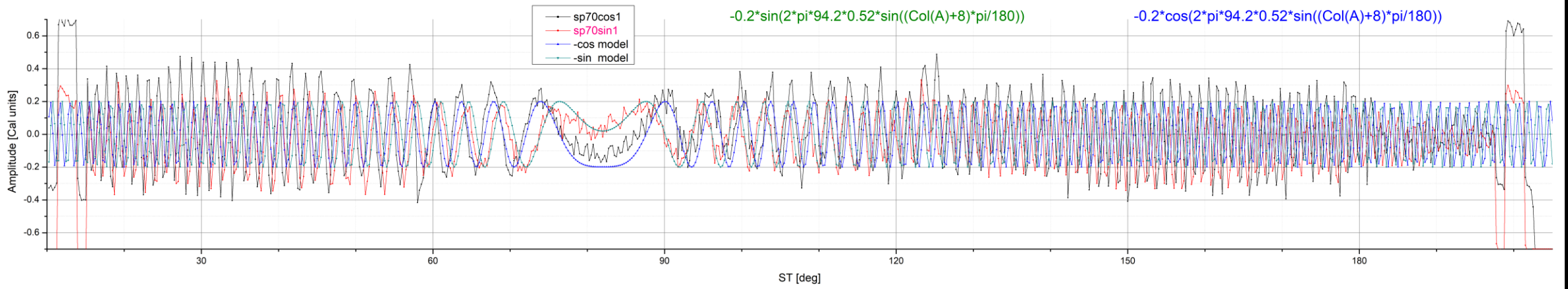
Original data set

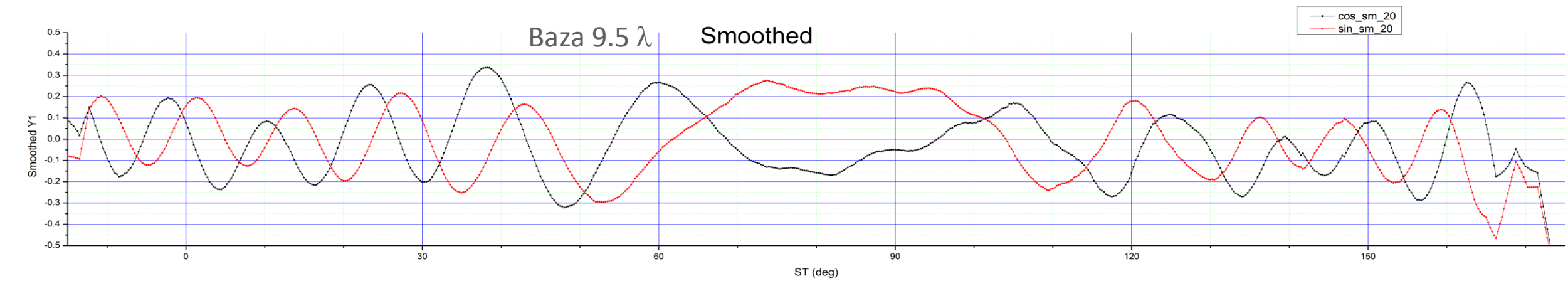
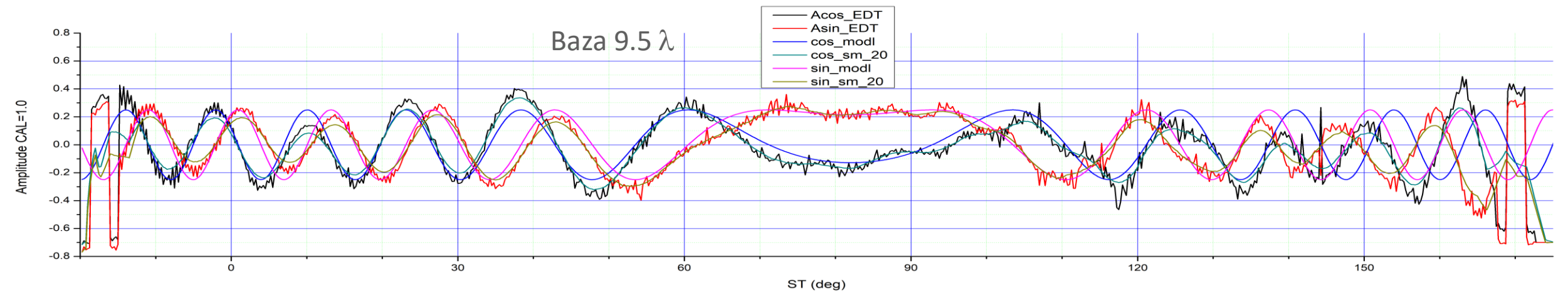
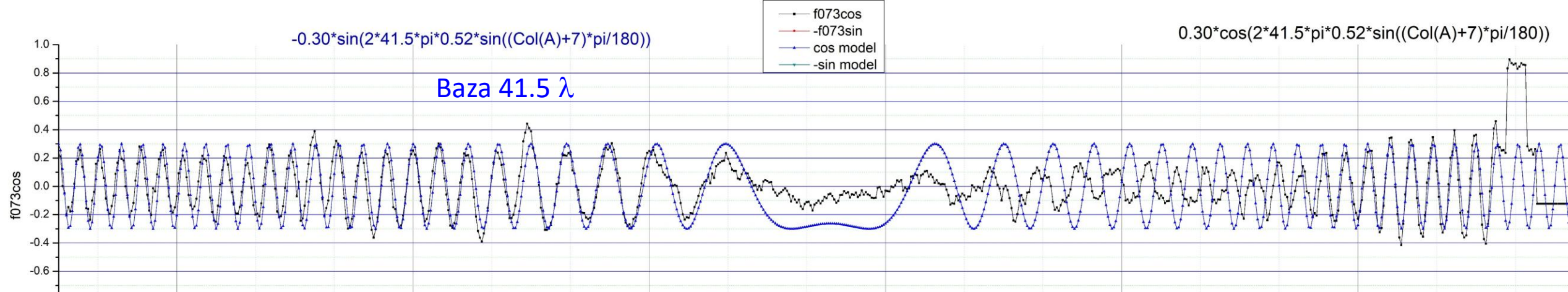
Acos

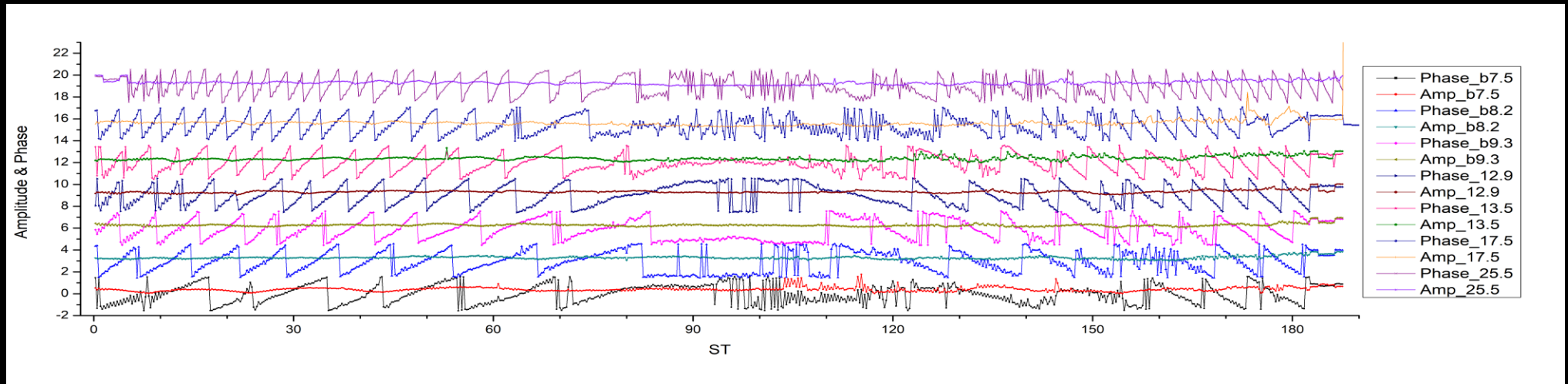
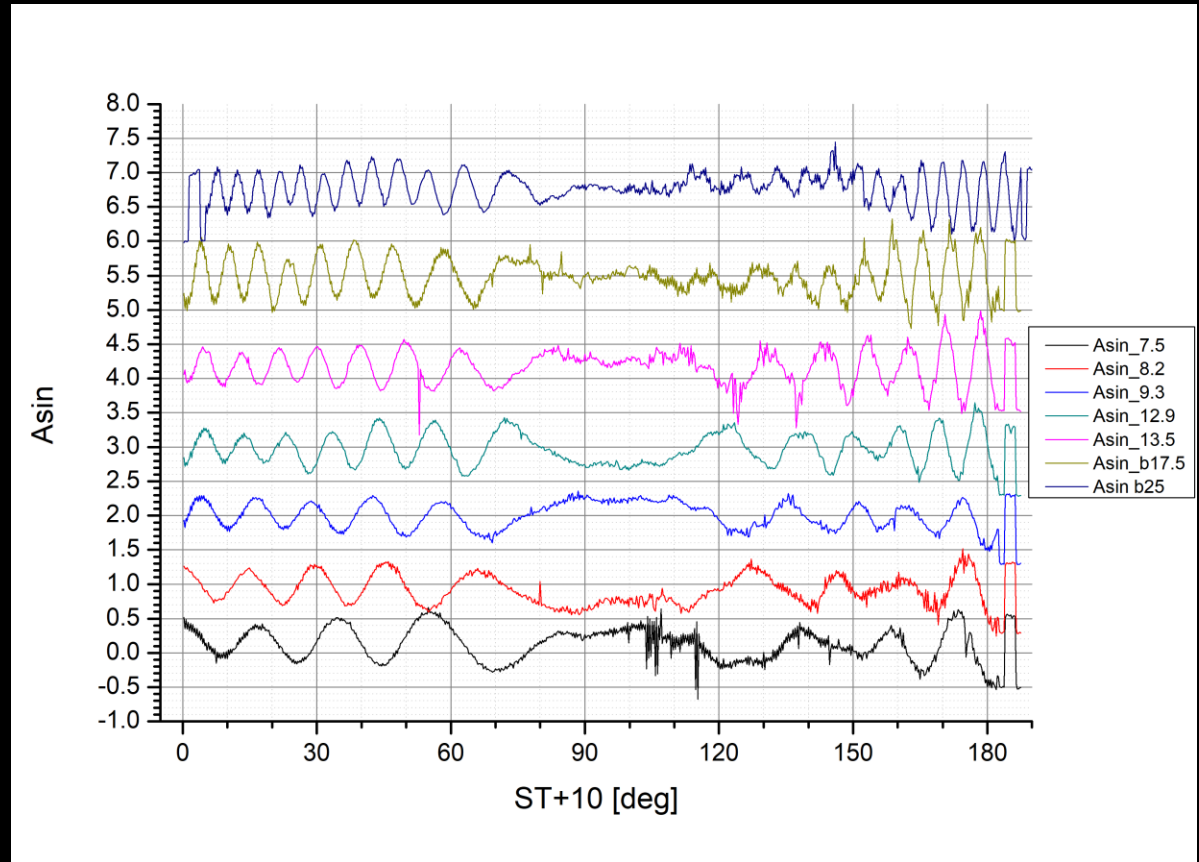
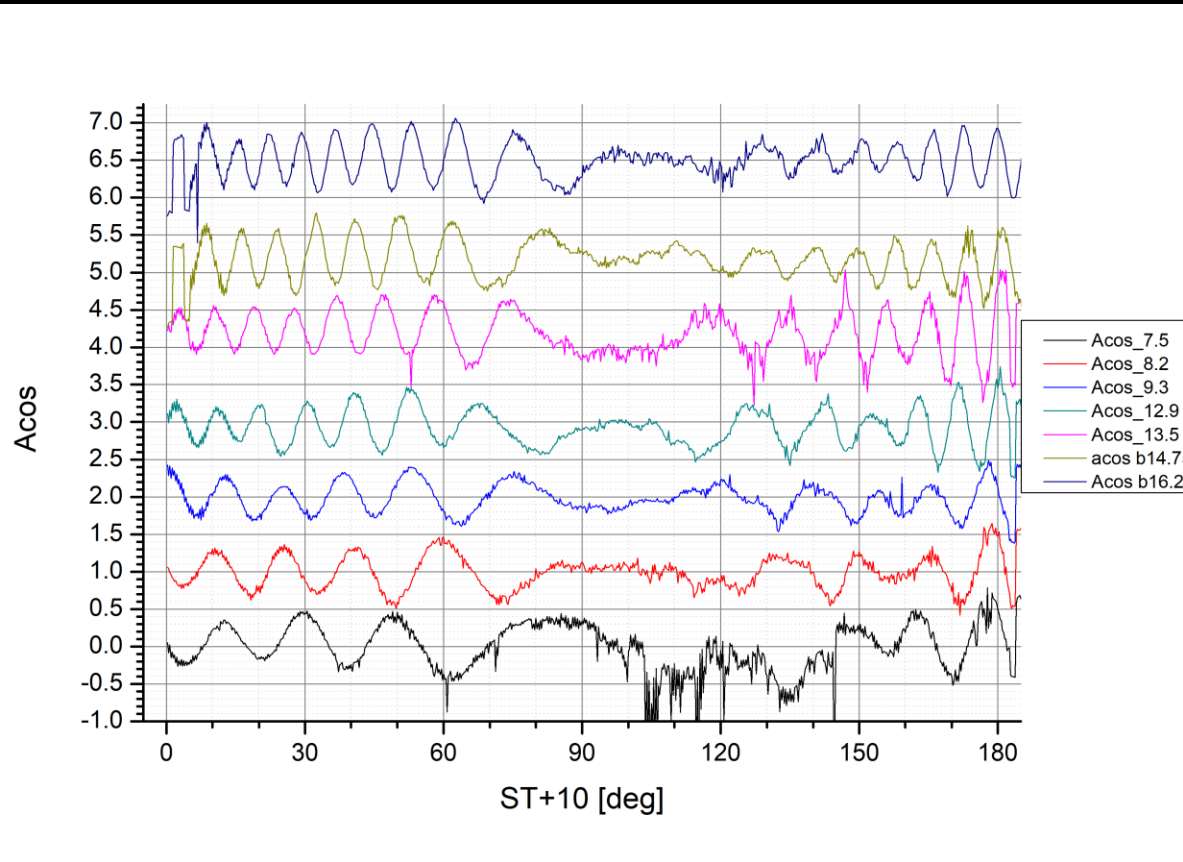
and

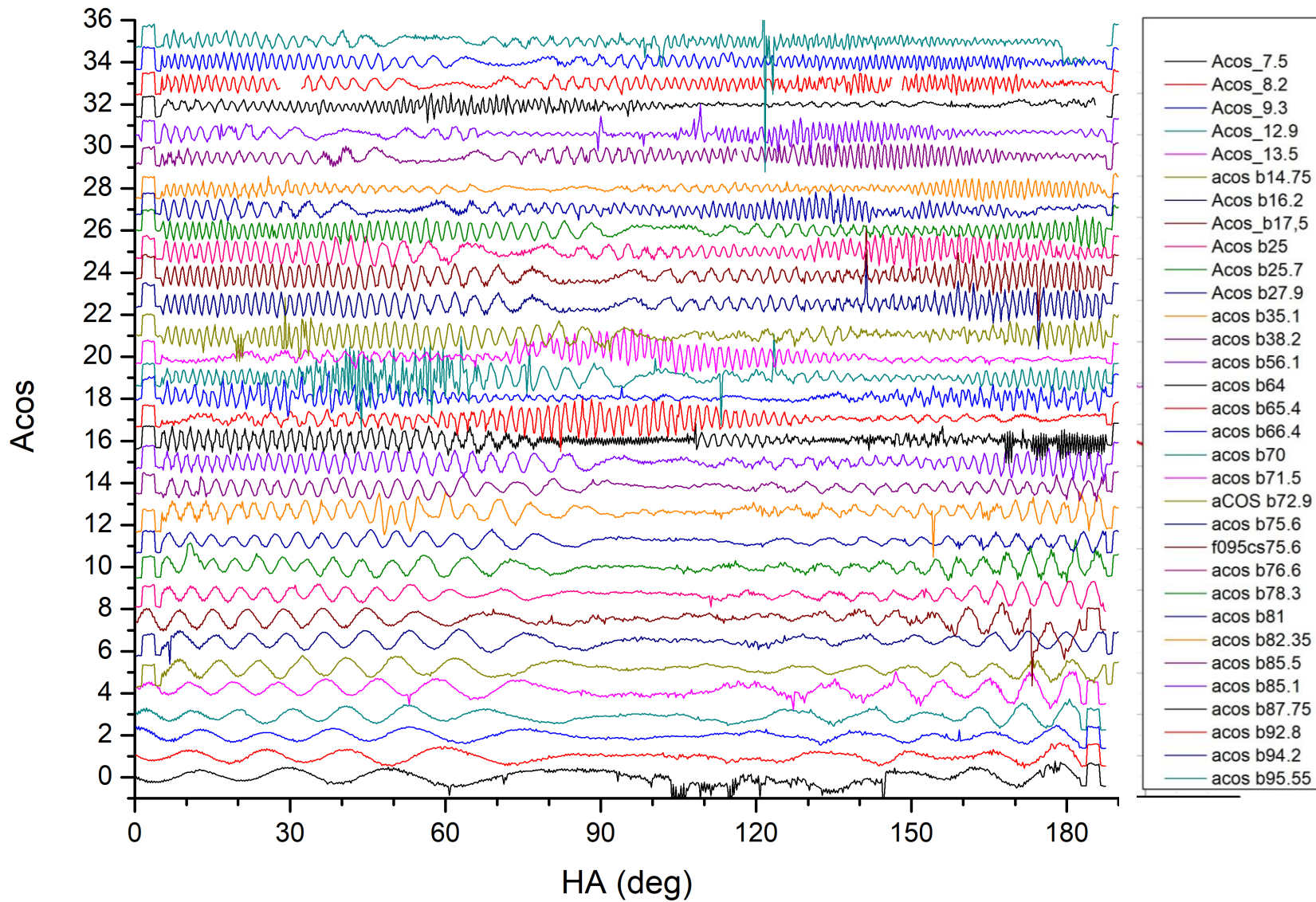


Asin



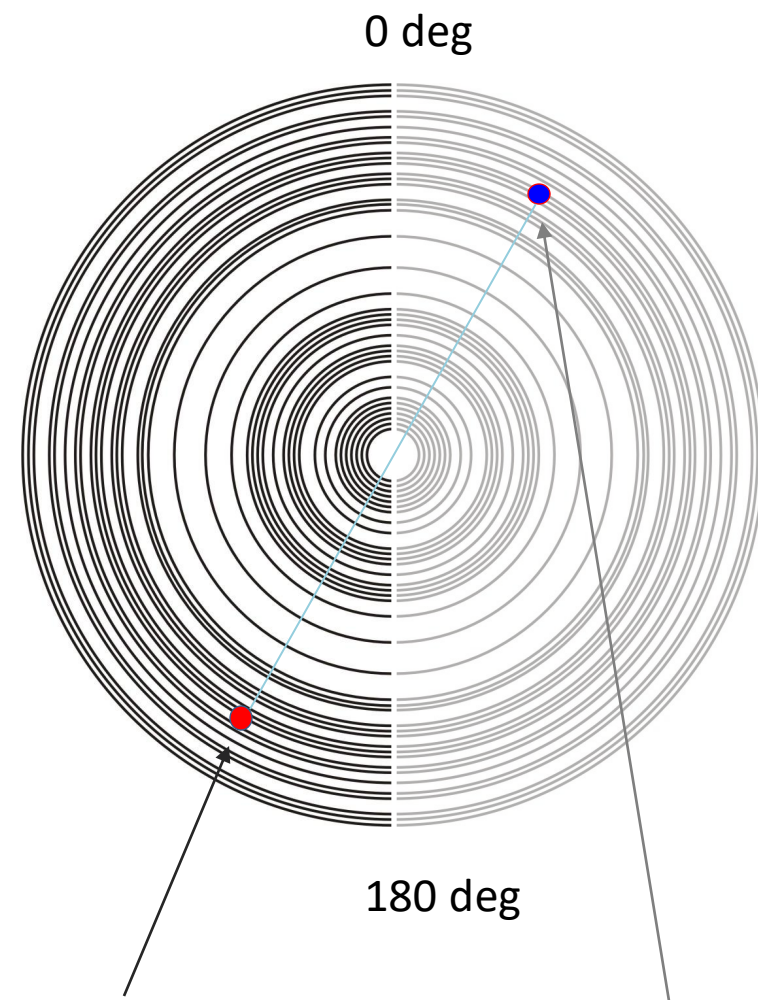




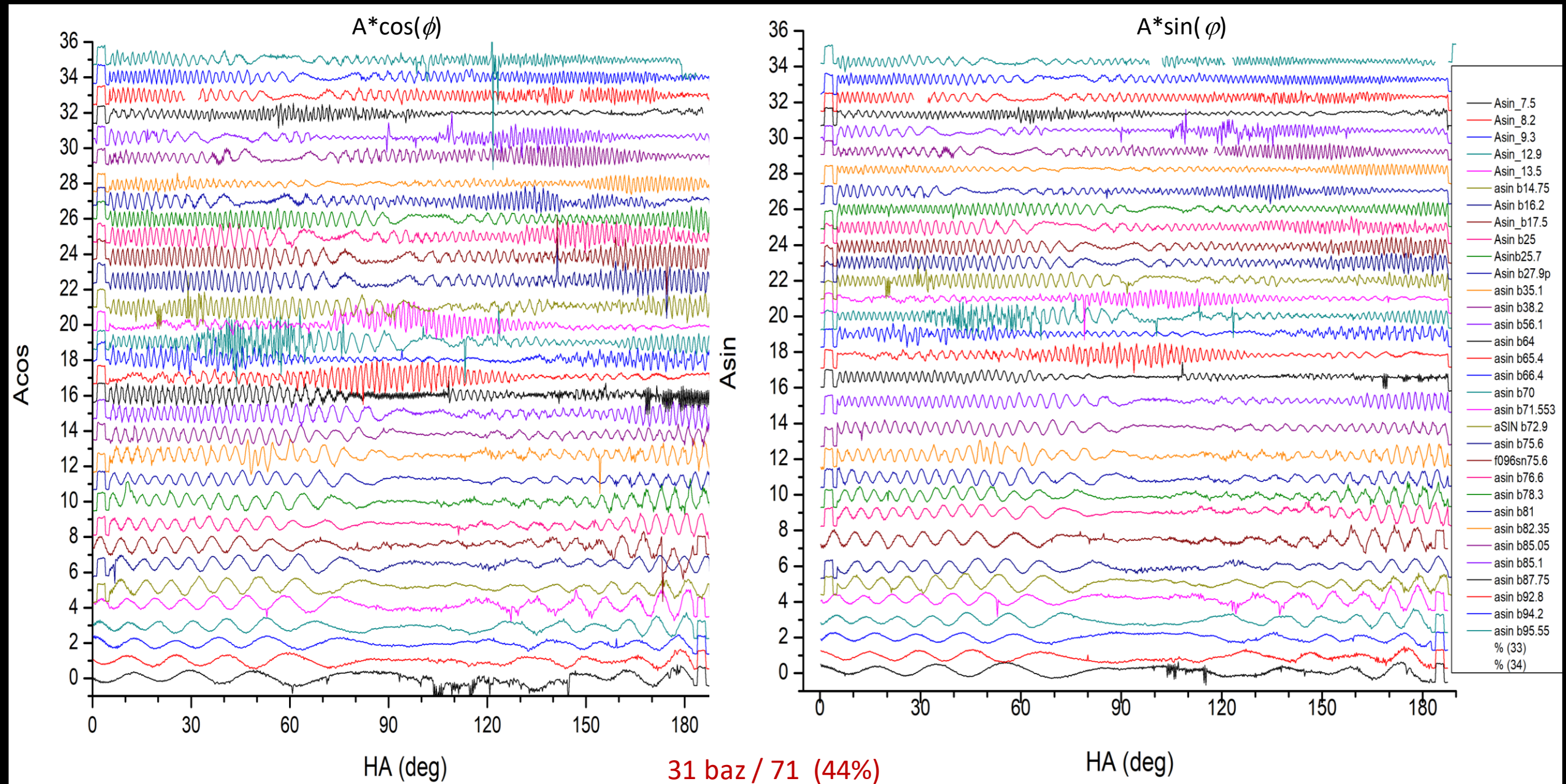


12 godzin obserwacji, ale dane te są kopiowane do obszaru 12h-24h dając efektywnie 24 godzinną rejestrację.

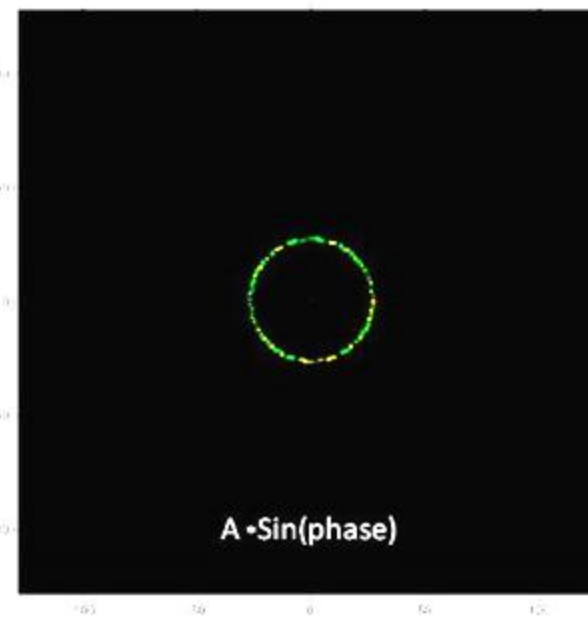
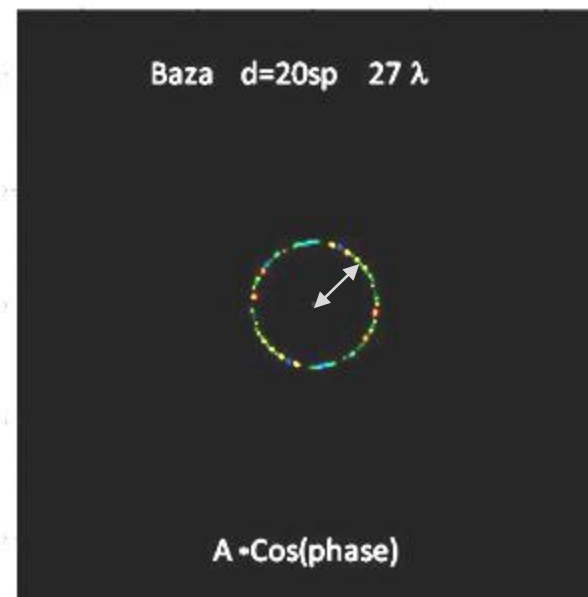
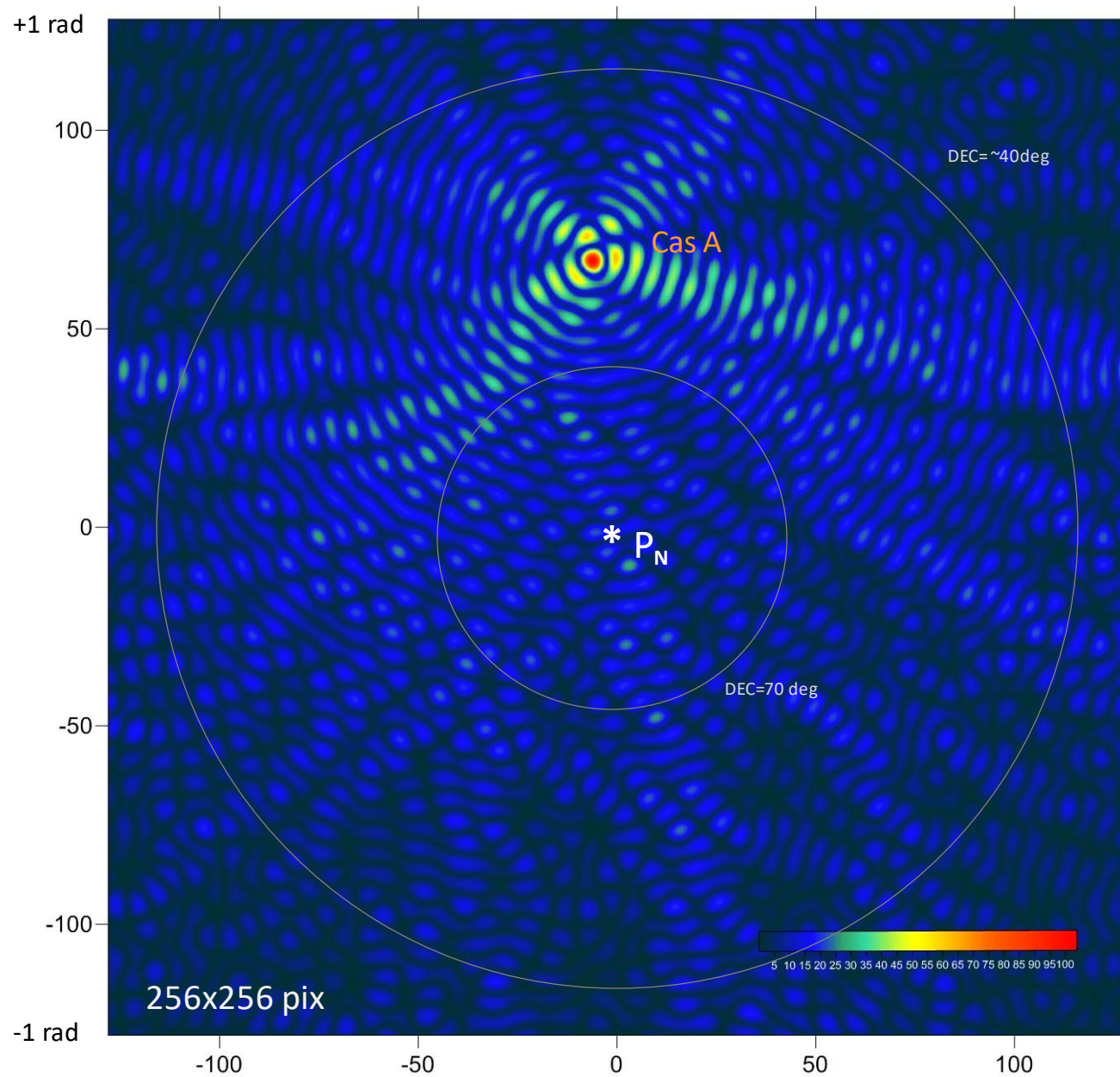
Pokrycie płaszczyzny częstości przestrzennych u-v
widmo obrazu - funkcja hermitowska

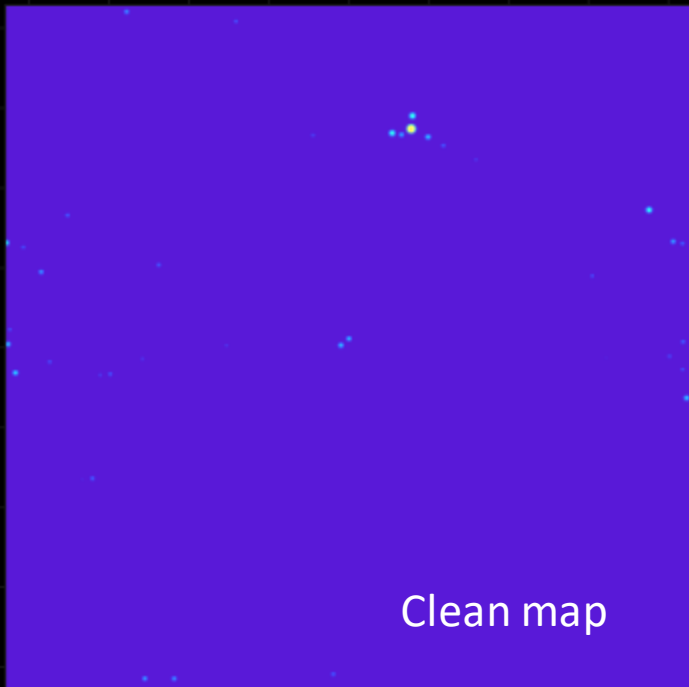
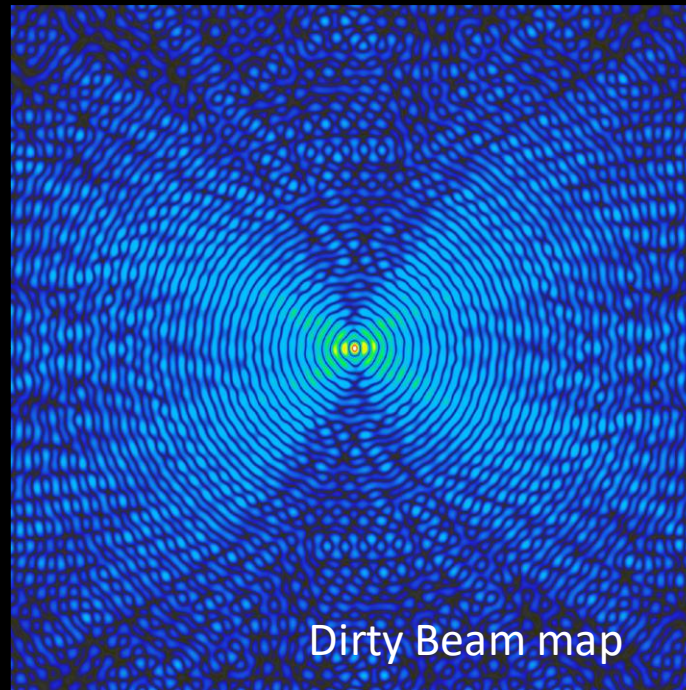
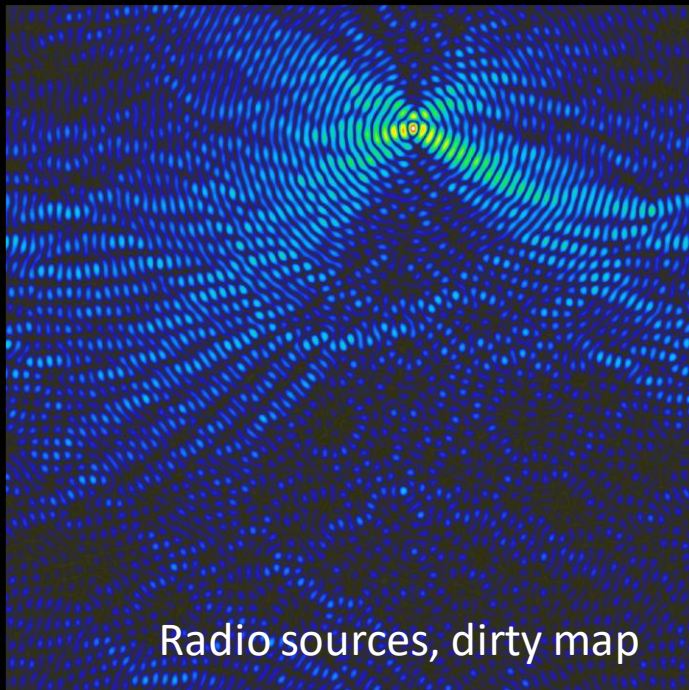


$\text{Acos}(u,v) = +\text{Acos}(-u,-v)$
 $\text{Asin}(u,v) = -\text{Asin}(-u,-v)$
 obserwacje kopia



2024-11-10 PIERWSZA MAPA z realnych danych, jedna baza, bez korekty osi czasu (HA).





Single baseline map

$D = 27 \lambda$

2048 x 2048 pix.

$\sim 90 \times 90$ deg.

Software
do edycji
przetwarzania
i prezentacji
danych
obserwacyjnych

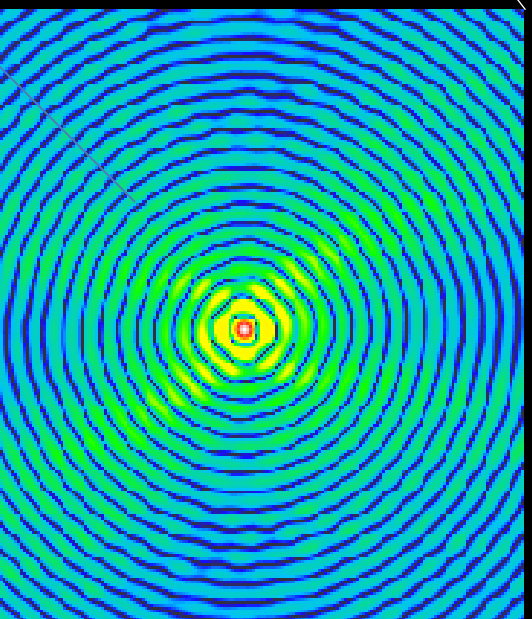
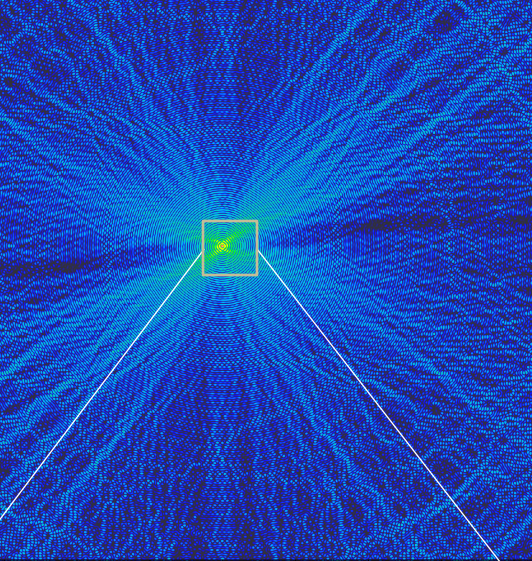
made by AJK

W11 + Debian
code f77

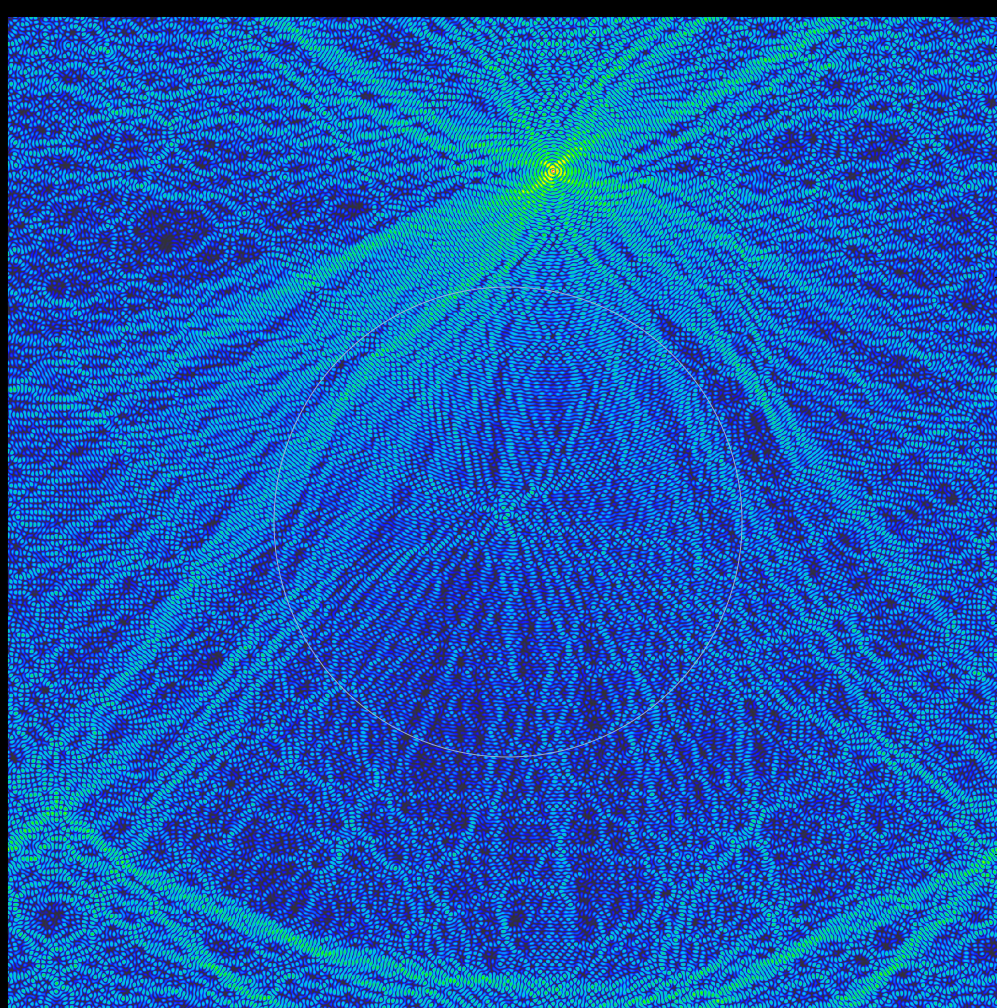
Wspomaganie

Origin 8, OriginLab
Surfer, Golden Software

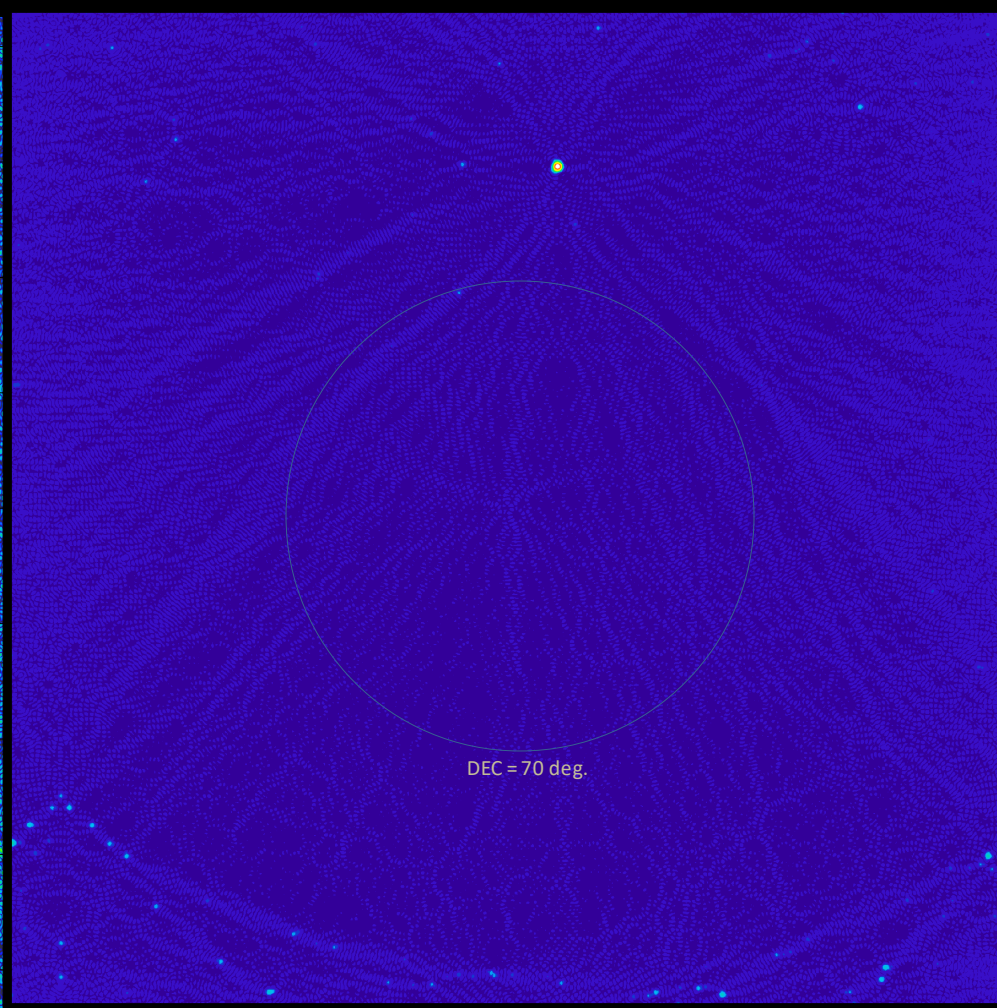
March 2026



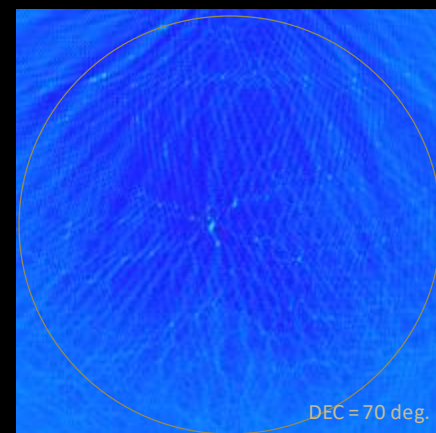
Dirty Beam



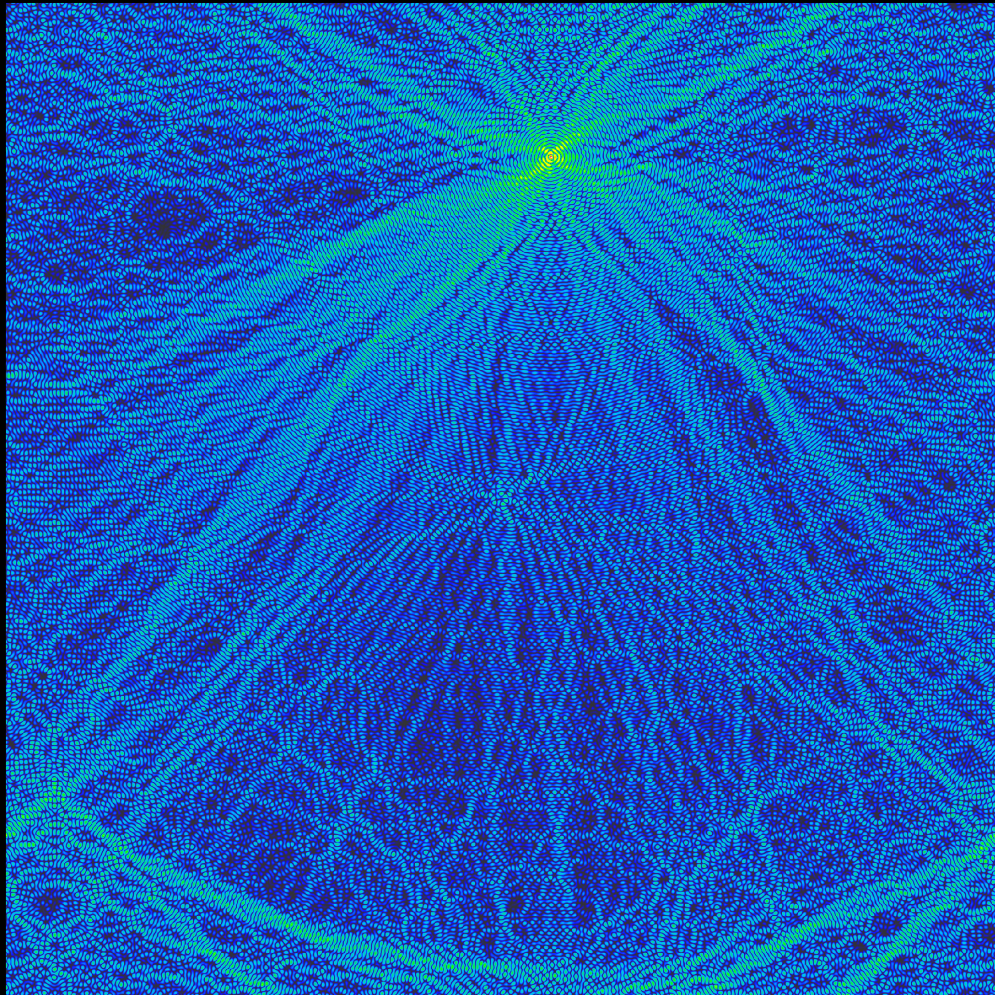
Dirty map of the sky



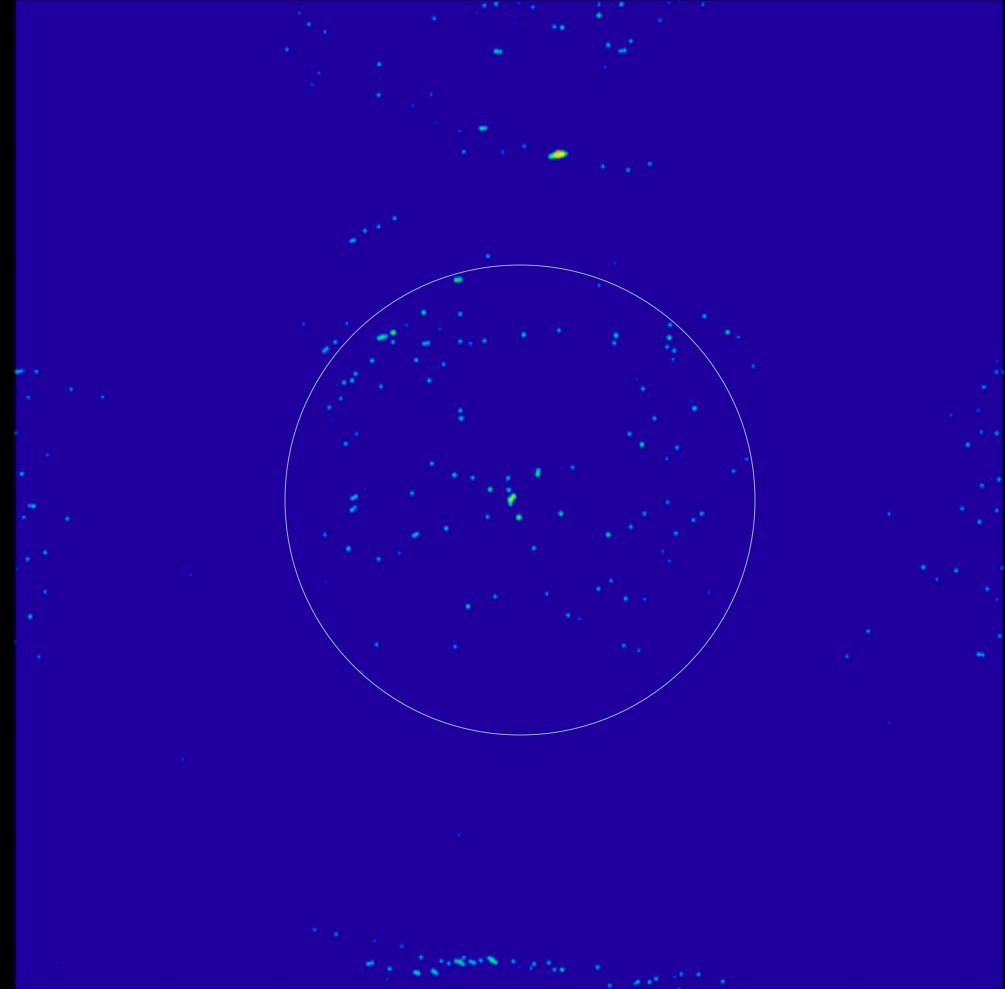
Clean map + residuals



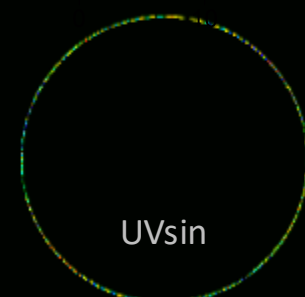
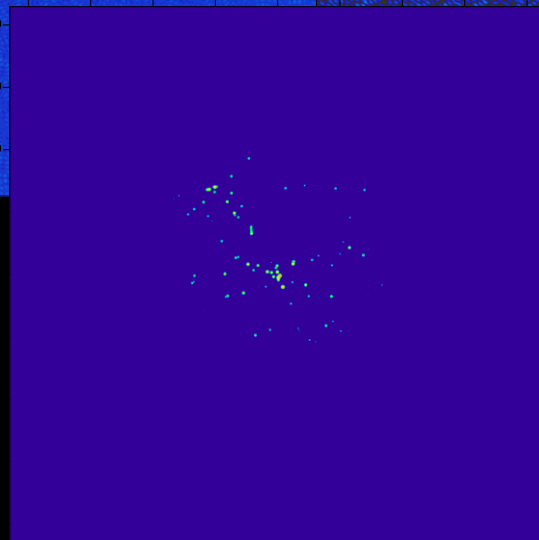
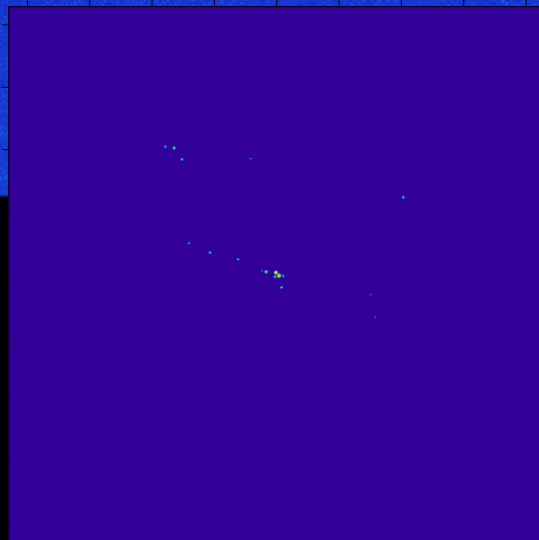
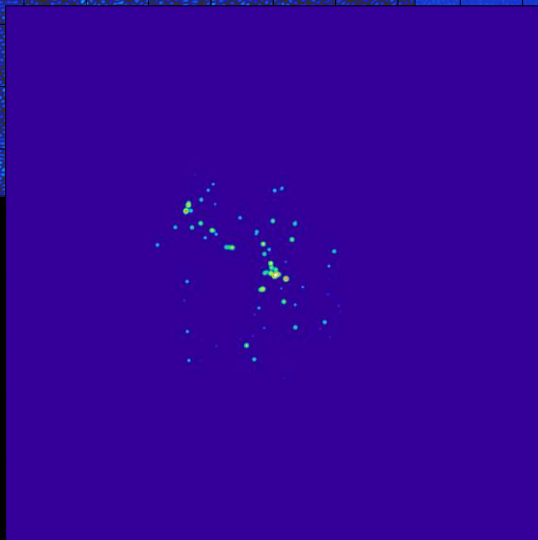
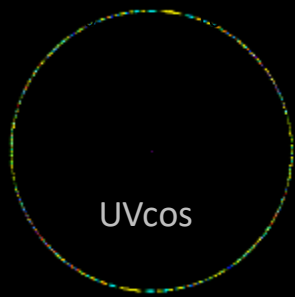
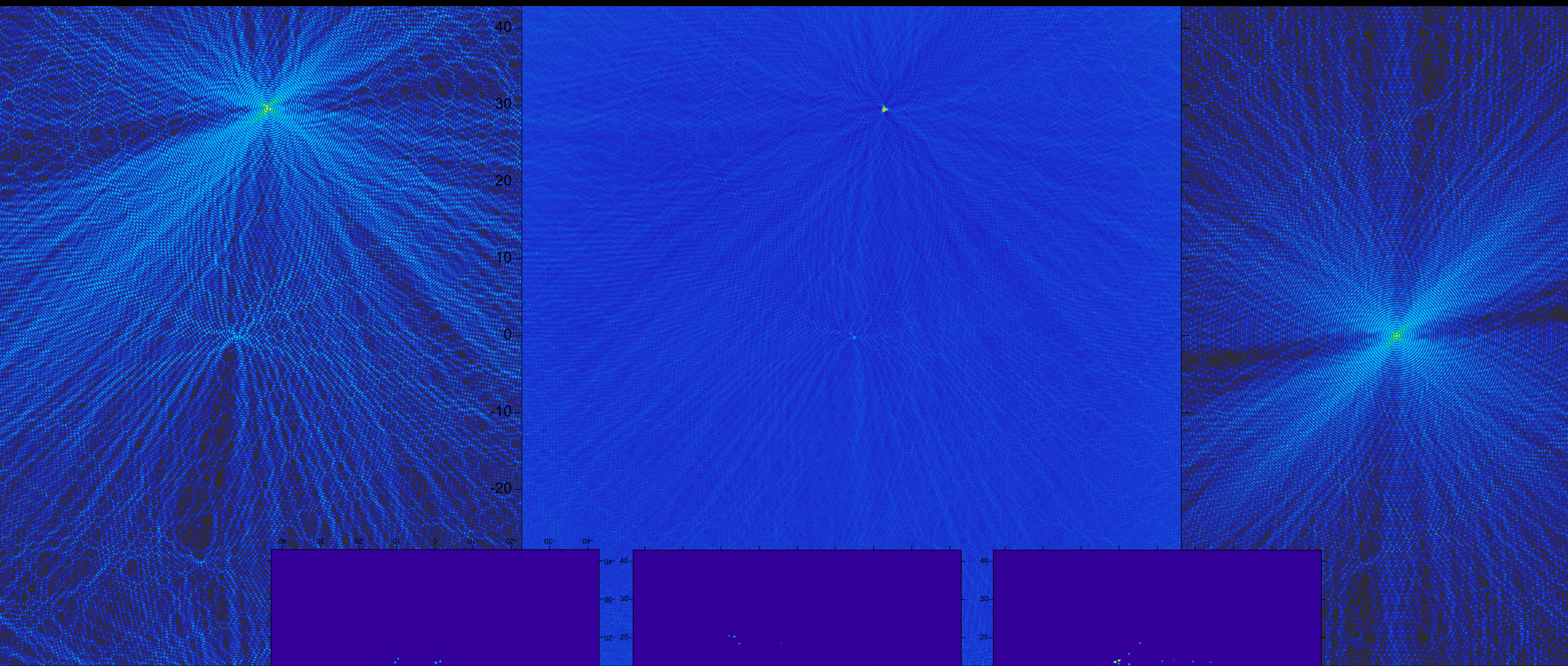
One baseline $D = 94 \lambda \Rightarrow 690\text{m}$

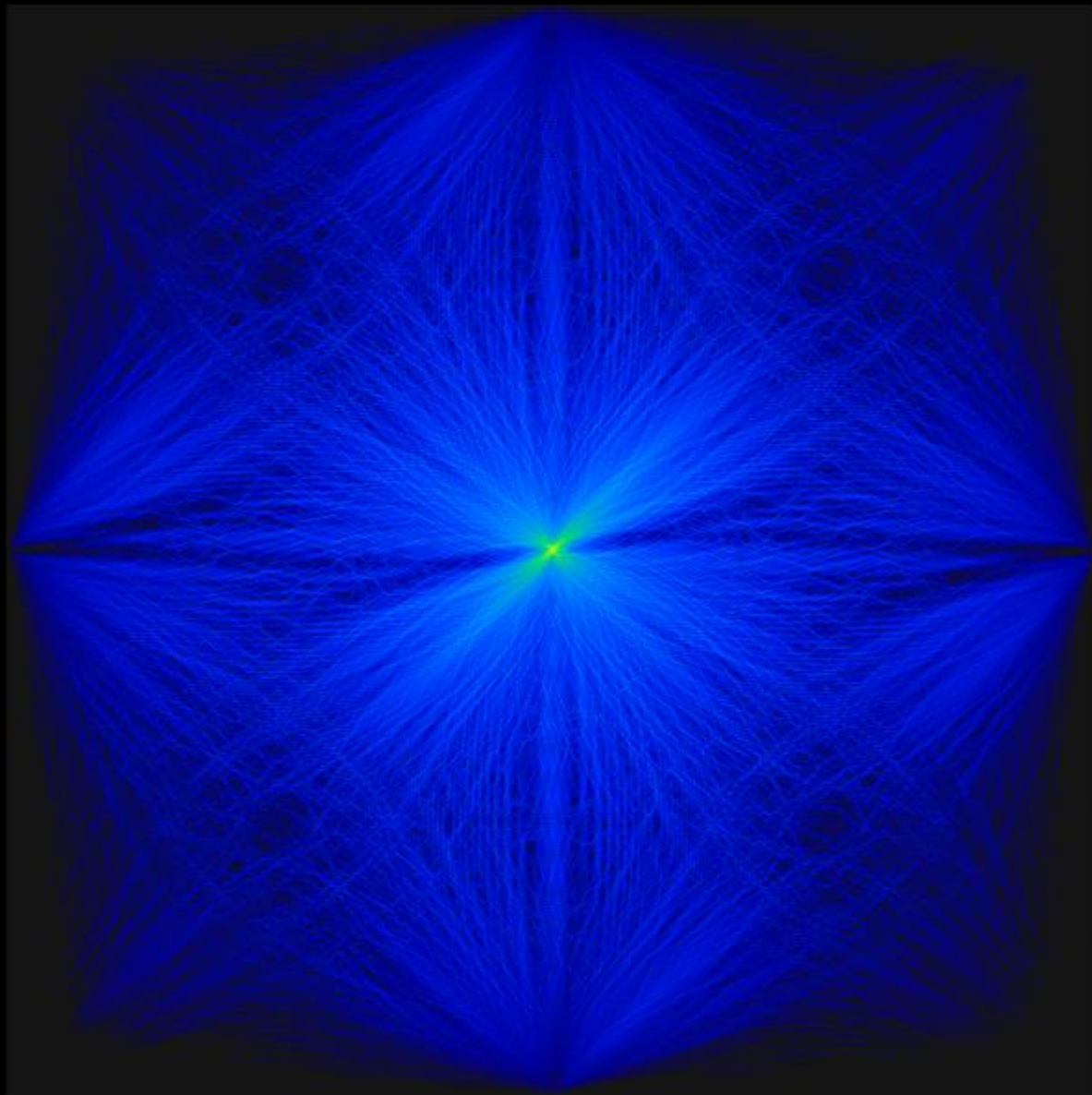


Dirty map single baseline



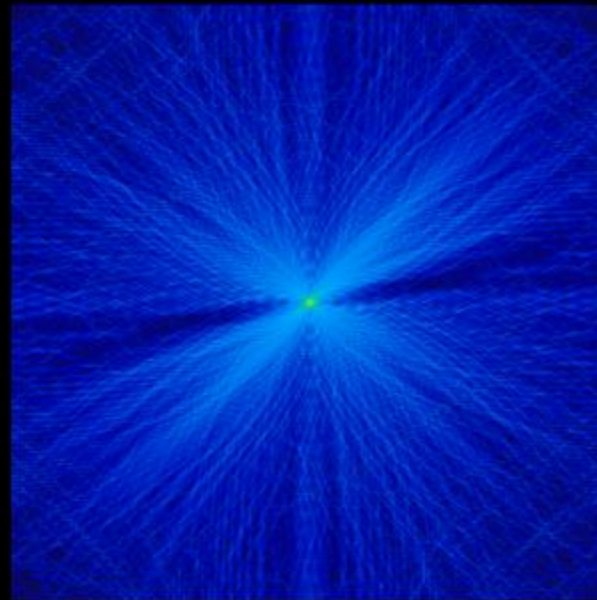
Map made of delta components obtained from CLEAN process



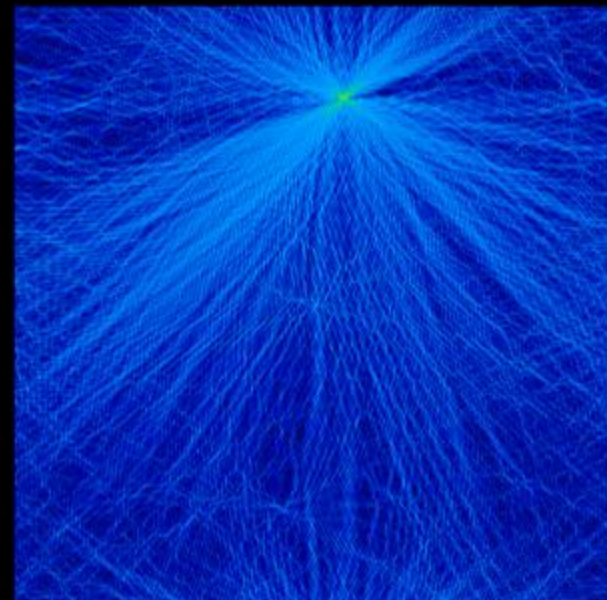


„Brudna” wiązka 4096 x 4096 pix

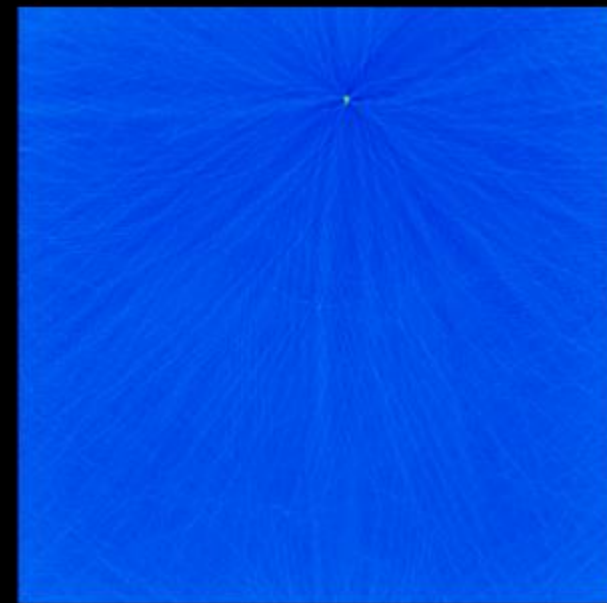
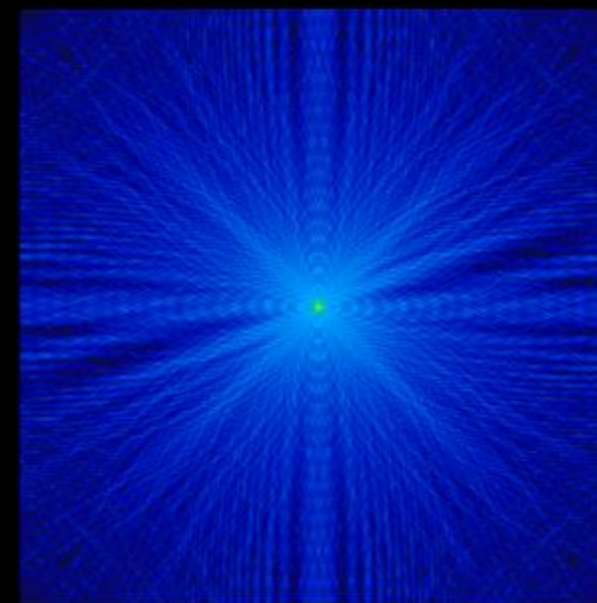
$D=94 \lambda$

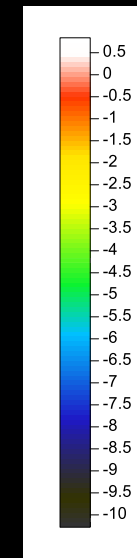
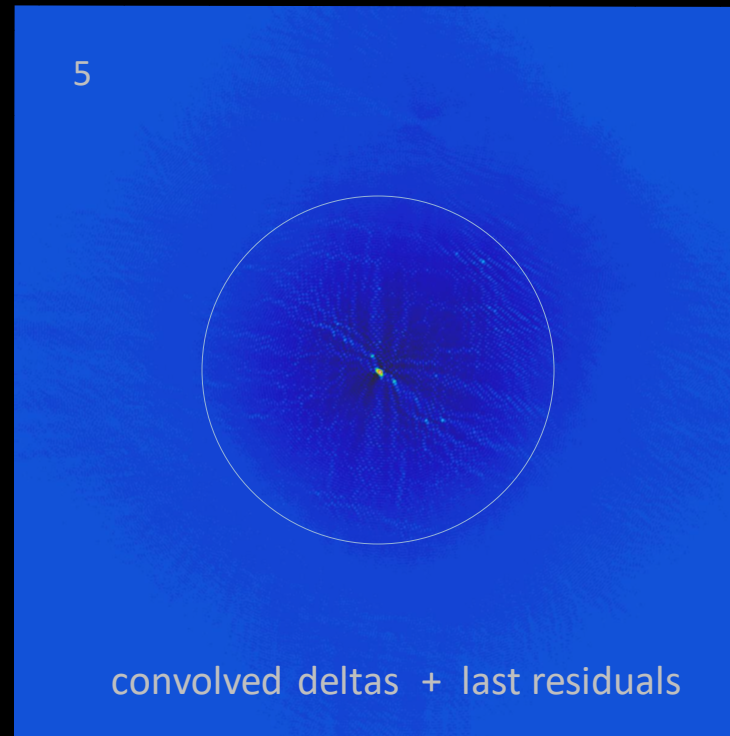
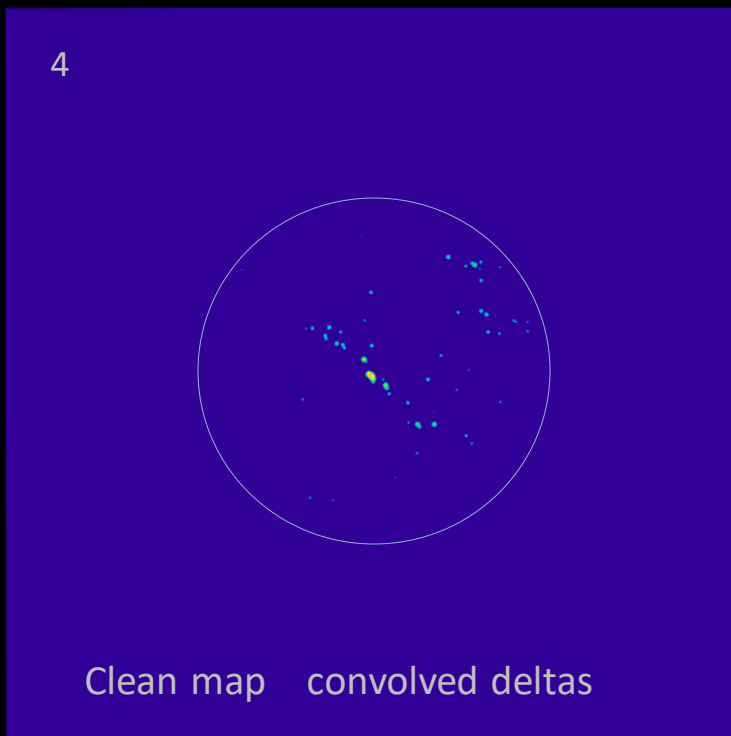
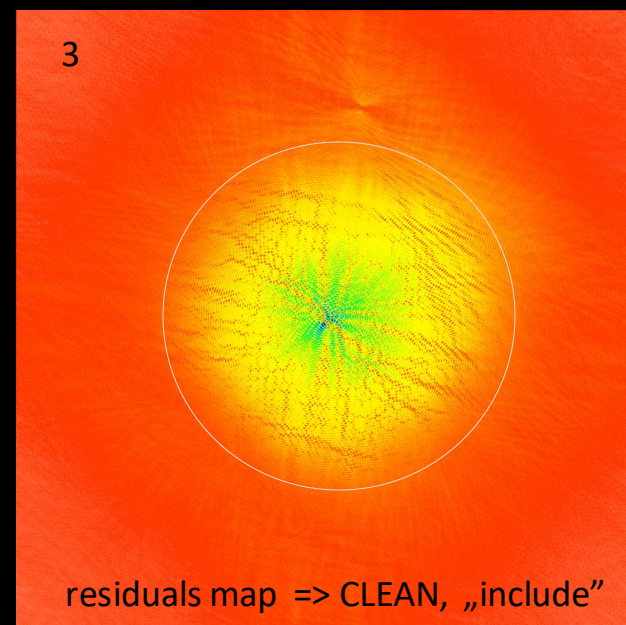
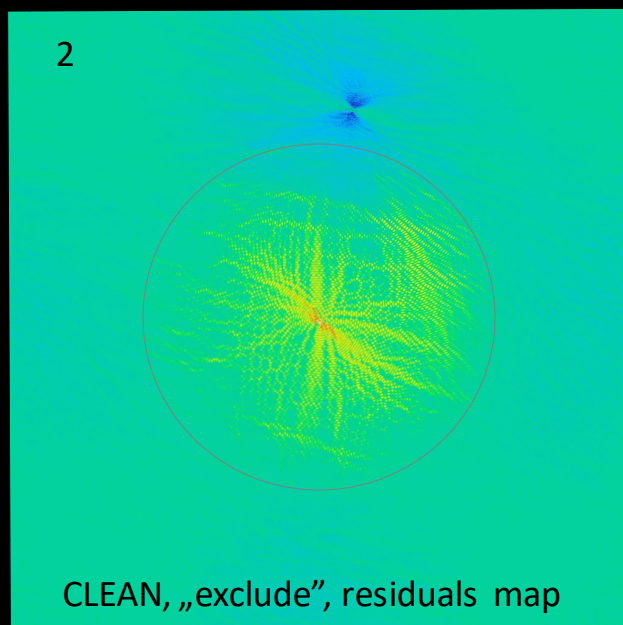
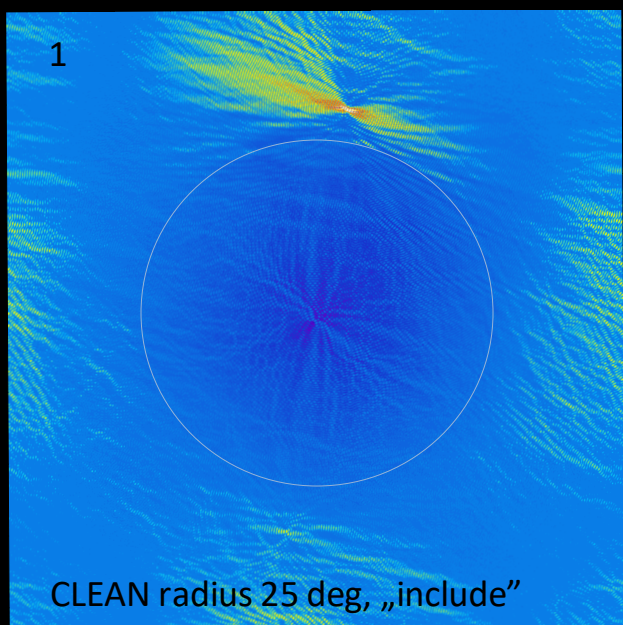
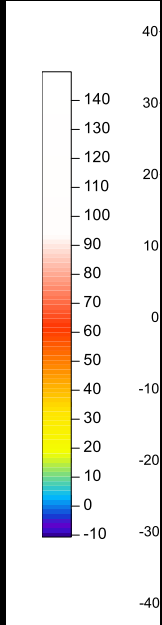


Brudna wiązka 2048 x 2048
Brudna wiązka (bez AM)



Brudna mapa nieba
Czysta mapa + residuals





Pole obszaru wybieranego do procesu CLEAN może być prostokątne w dowolnym miejscu mapy, lub kołowe względem bieguna .

Tu są przykłady użycia programu dla obszaru o średnicy 25 stopni

Baza $d=9.45 \lambda$ (66m)

Dane Acos i Asin wstępnie wygładzone

Po lewej

mapa CLEAN delta components

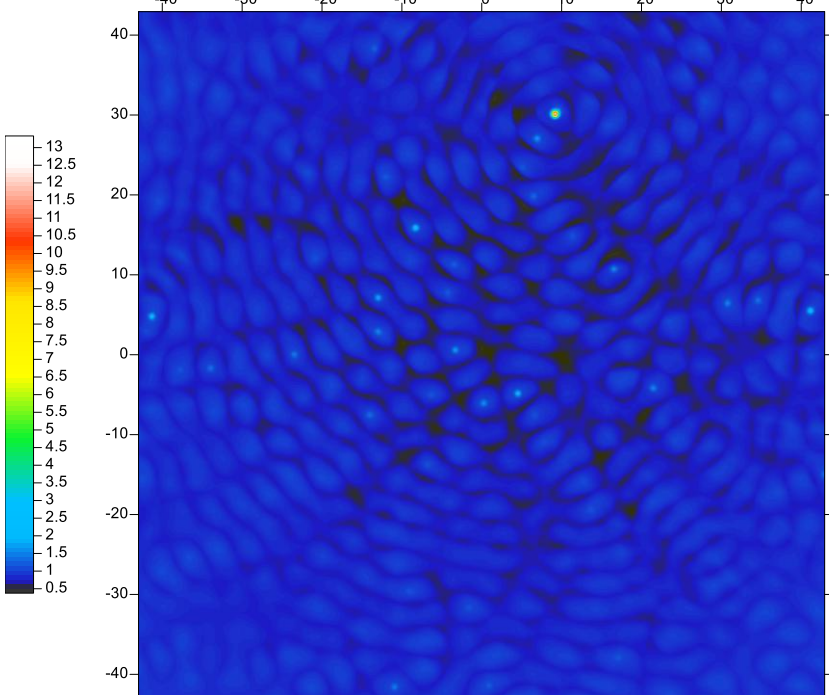
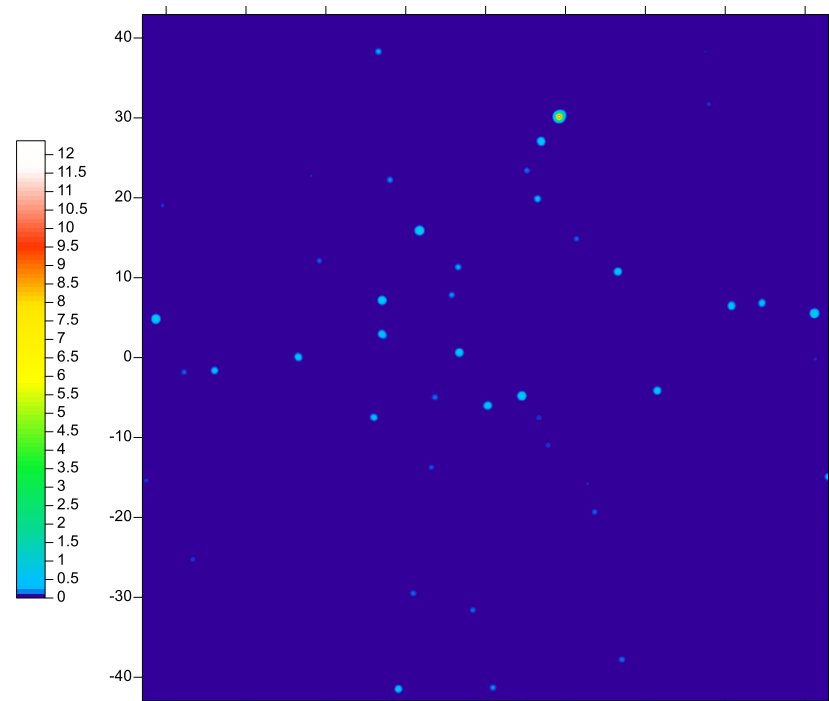
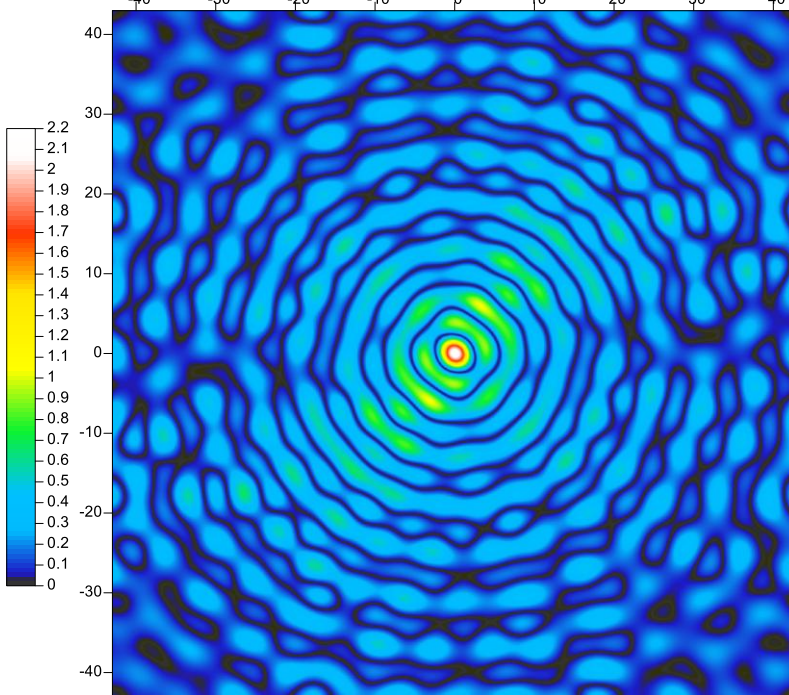
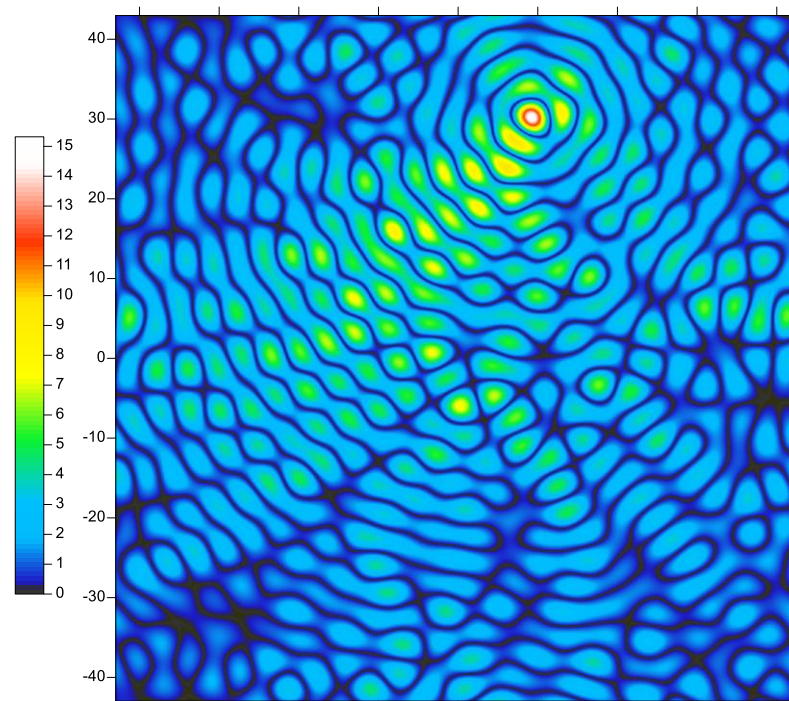
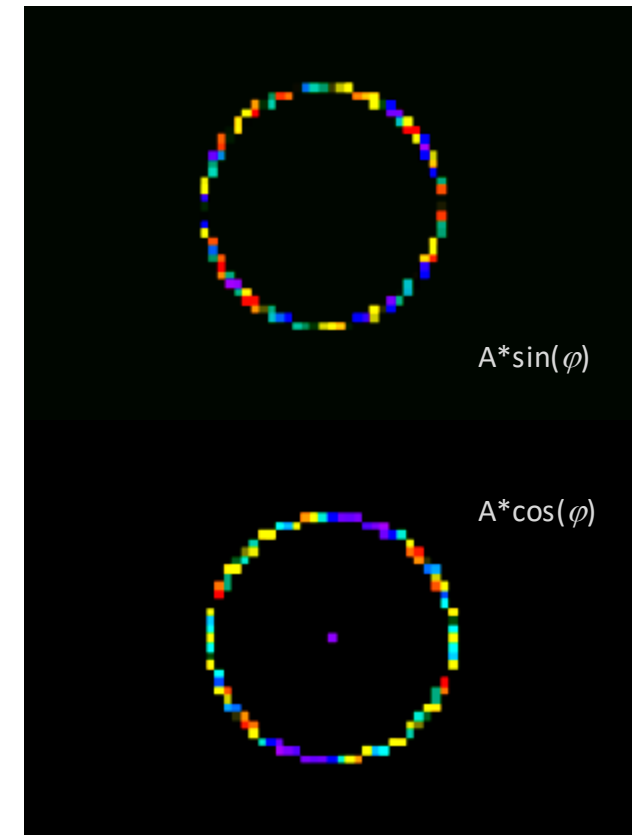
mapa CLEAN + residuals

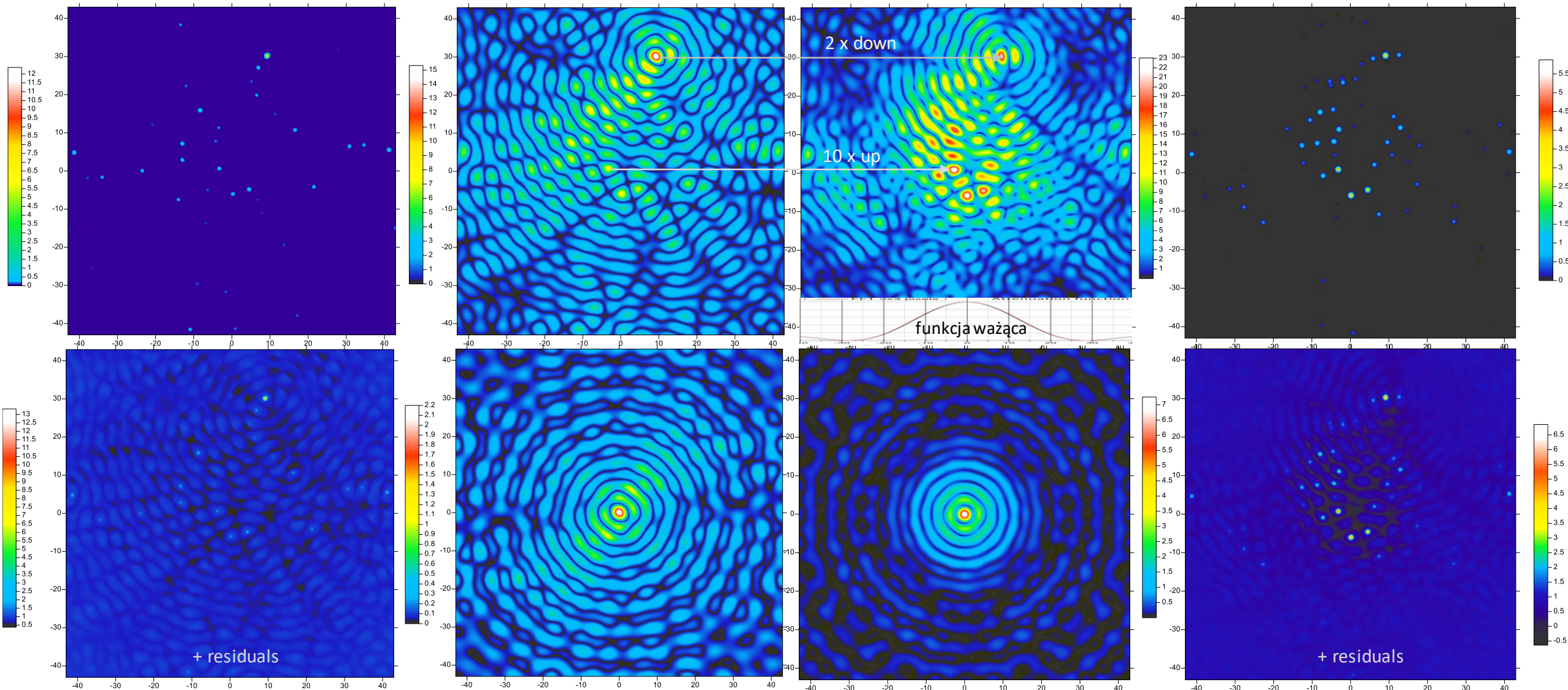
Po prawej

mapa brudna (Dirty Map) źródeł

mapa wiązki anteny (Dirty Beam)

Poniżej mapy U-V





CLEAN maps

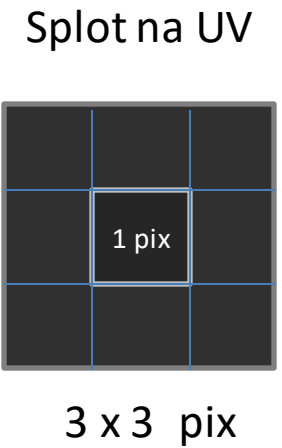
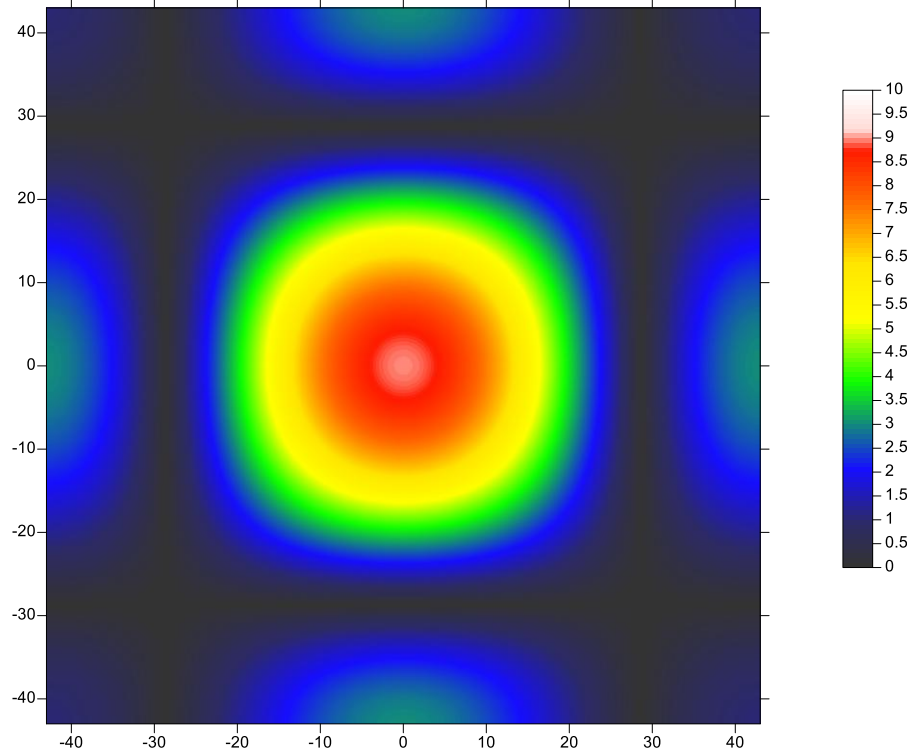
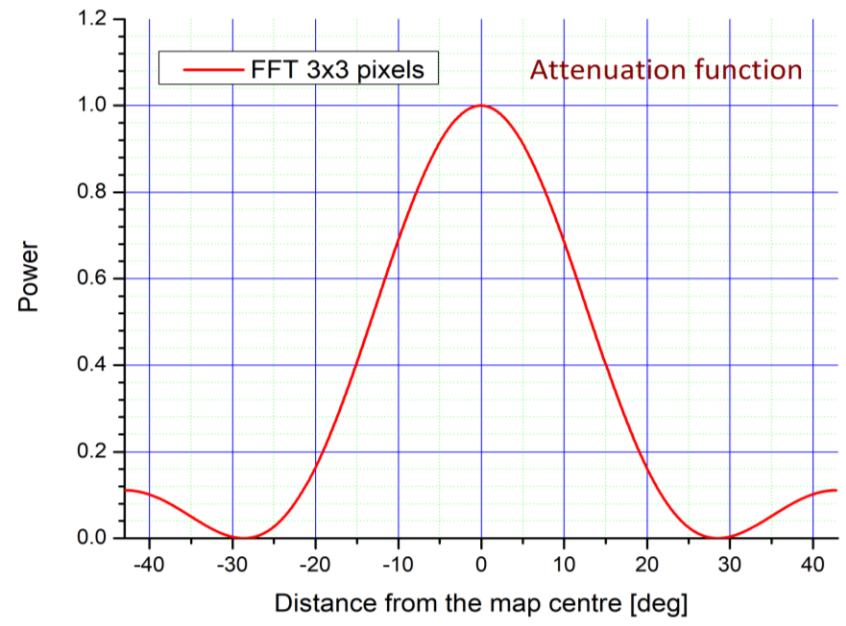
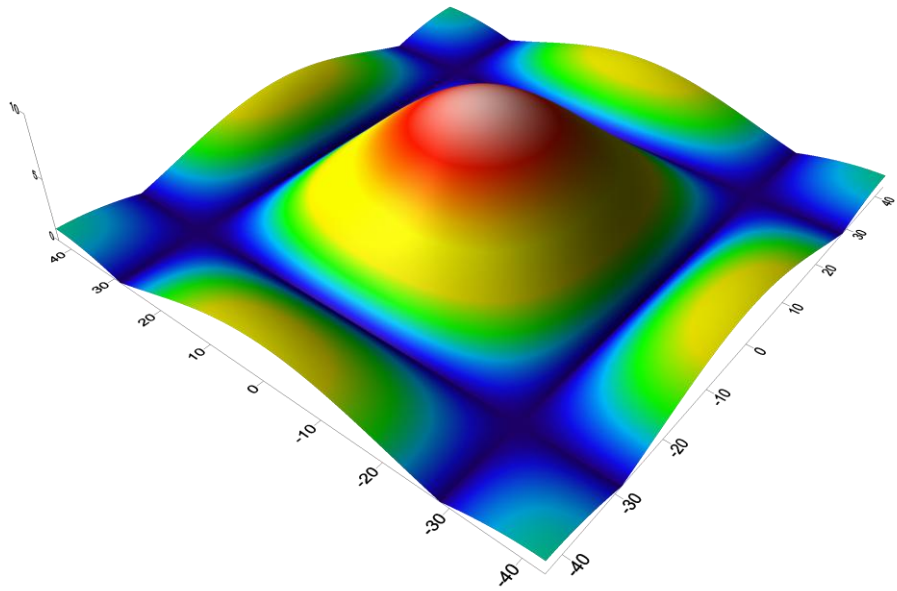
Dirty Maps sources (2048x2048) upper
Dirty Beam maps down

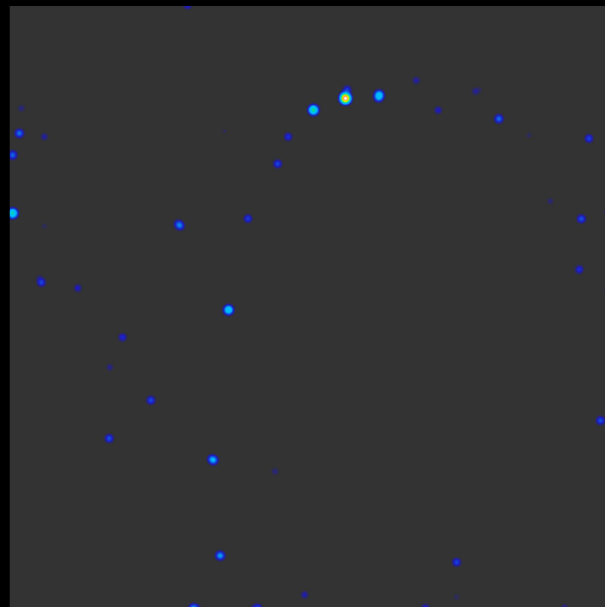
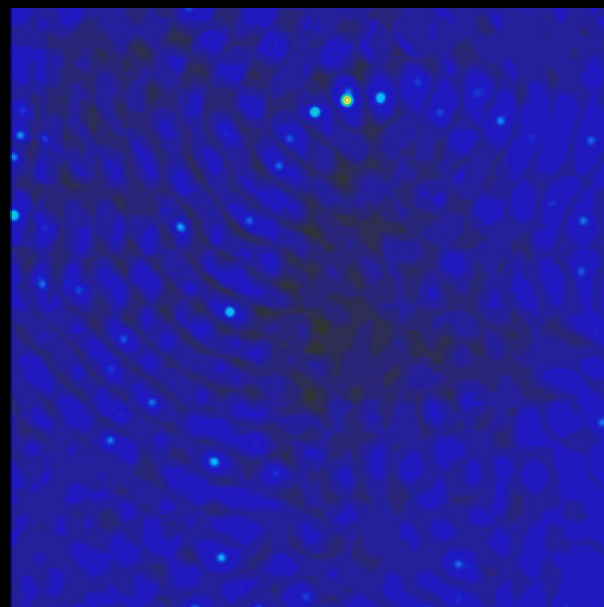
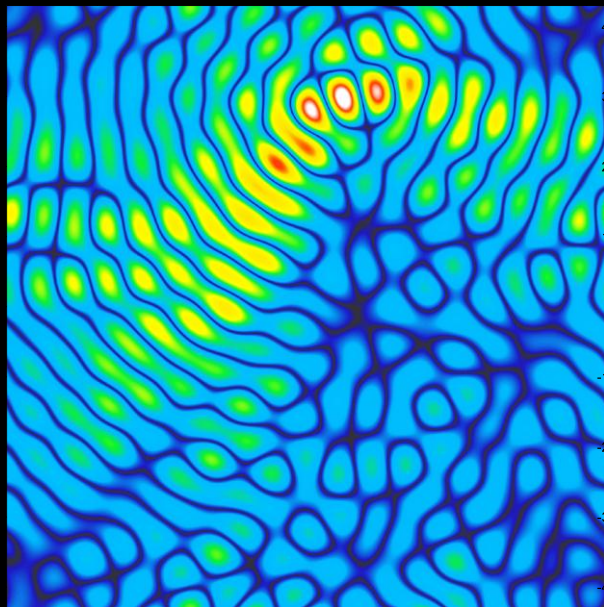
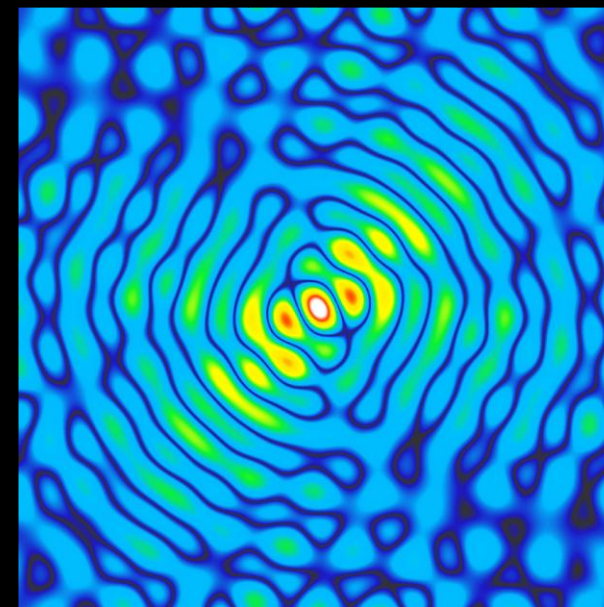
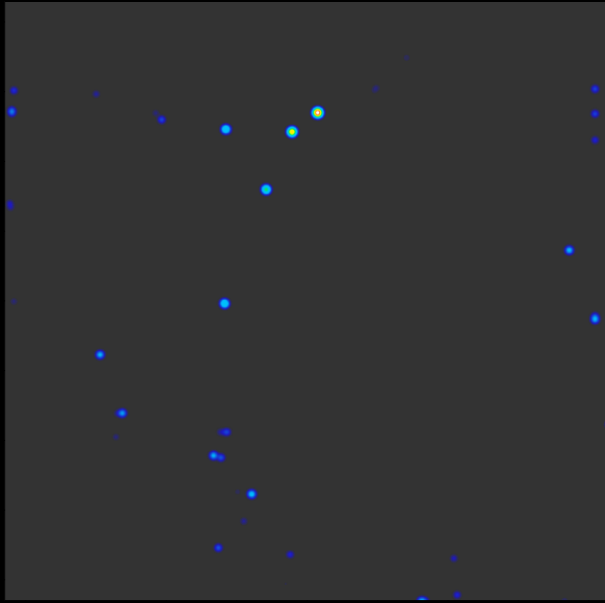
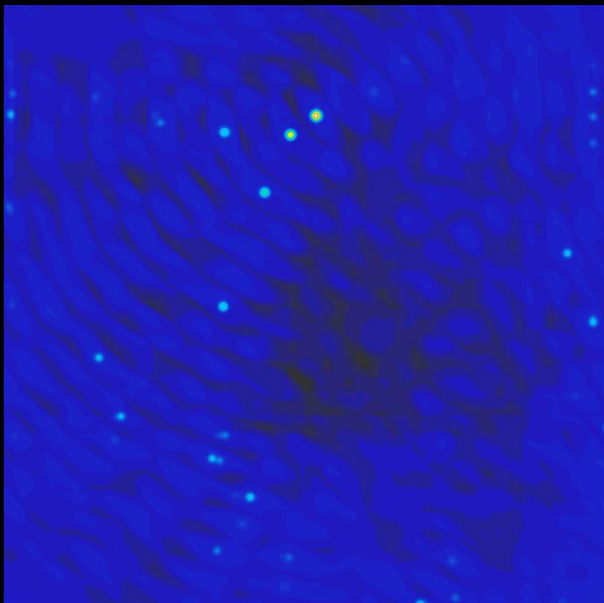
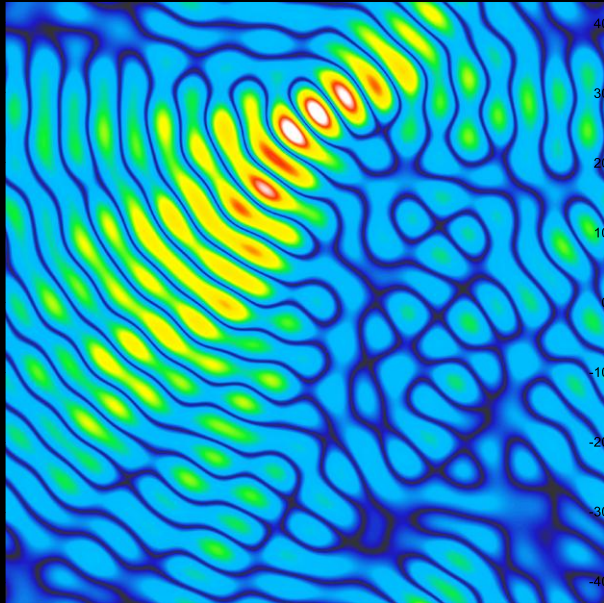
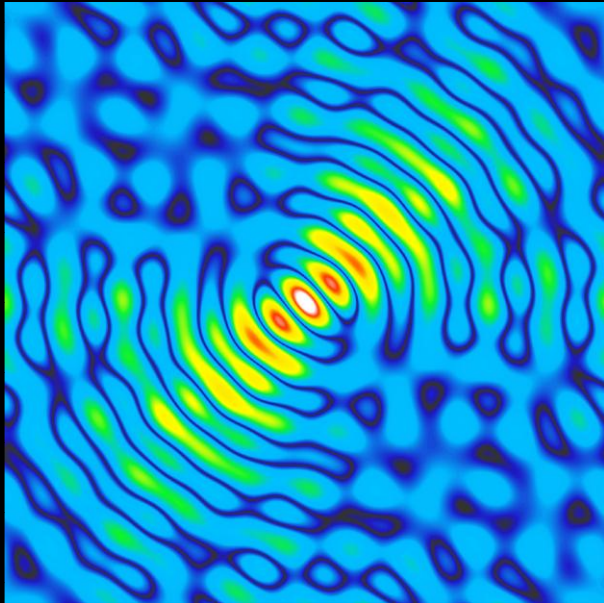
Baza=9.45 λ

CLEAN maps

----- mapy bez uśredniania pikseli na UV -----

----- uśrednione 3x3 piksele na UV -----





Brudna wiązka

górný rząd dane n4 412p/720 p

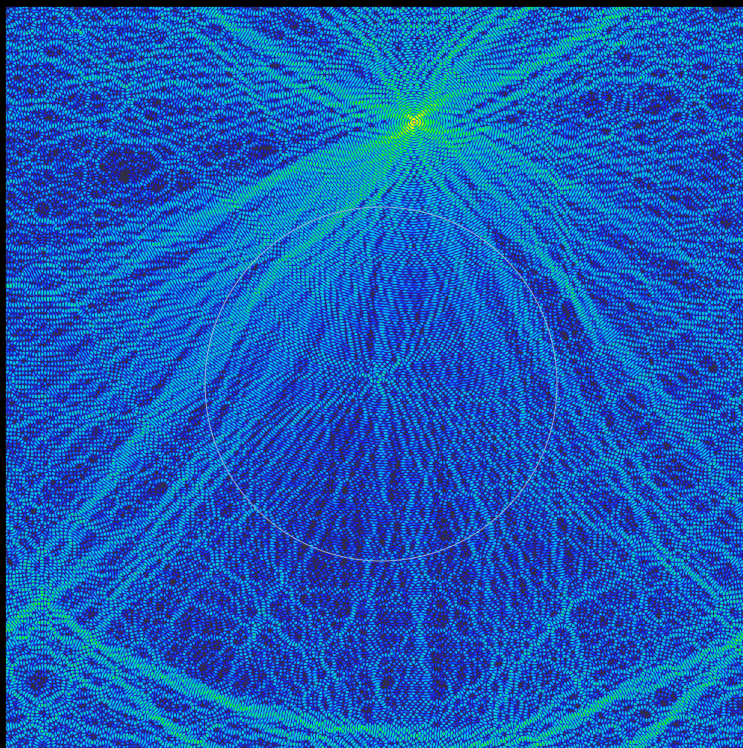
Mapa

dolny rząd dane n3 529p/720p

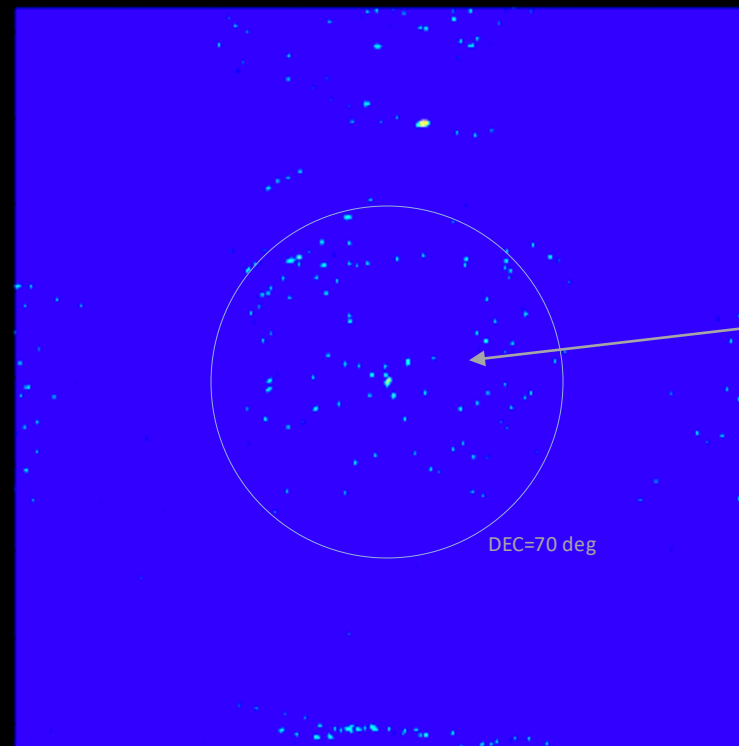
Baza 6.9 λ

delty +residuals

delty



Dirty map single baseline $d=94 \lambda$



„radioźródła”
w obszarze
okołobiegunowym
DEC>70 deg

single baseline
Baza 94λ

Map made of delta components obtained from CLEAN process

Projekt jest aktualnie w realizacji.

Końcowe mapy wykonane z danych wszystkich baz,
prawdopodobnie dostępne będą na początku lata 2026.

Obecny etap (marzec 2026) to wykonanie map z baz pojedynczych i
ich wspólna kalibracja. Korekta czasu obserwacji i rzeczywistych długości baz
możliwa będzie przez wzajemne porównanie map pojedynczych baz.