THE SPECTRAL POLARIMETER PROJECT OF THE POTSDAM - TREMSDORF SOLAR RADIO ASTRONOMY OBSERVATORY

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ABSTRACT. During the next activity cycle new meter-decimeter broad band receivers will be ready for solar observations at Potsdam - Tremsdorf. The 40 - 800 MHz spectral polarimeter project and the actual state of realization are shortly described. Some problems are summarized which can be tackled by the new instrument.

ПРОЕКТ СПЕКТРАЛЬНОГО ПОЛАРИМЕТРА ТРЕМСДОРФСКОЙ ОБСЕРВАТОРИИ СОЛНЕЧНОЙ РАДИОАСТРОНОМИИ: В Потсдам-Тремсдорфе во время ближайшего цикла солнечной активности начинает работа с новыми широко-полосными приемниками в дециметровом--метровом диапазоне. Кратко показан проект полариметра 40-800 МГц. Обсуждаются некоторые задачи, которые могут быть решены новым инструментом.

PROJEKT SPEKTRÁLNEHO POLARIMETRA, PRE ASTRONOMICKÉ, RÁDIOVO-SLNEČNÉ OBSERVATÓRIUM V POTSDAME-TREMSDORFE: V najbližšom budúcom cykle slnečnej aktivity v Potsdame-Tremsdorfe začnú pracovať nové široko-pásmové prijímače v oblasti decimetrových až metrových vĺn. Projekt spektrálneho polarimetra (pre oblasť od 40 do 800 MHz) a súčasný stav realizácie tohoto projektu sú krátko opísané. Uvedené sú problémy fyziky Slnka, ktoré by mohli byť riešené novým prístrojom.

1. INTRODUCTION

The regular solar radio observations have been taken up at Tremsdorf Observatory in 1954. Today, the single frequency flux and circular polarization patrol program embraces ten frequencies (Figs. 1 and 8b, left scale). In the years 1980 - 1985 we discussed basing on the experiences of three solar activity cycles and a stable KAPG cooperation with IZMIRAN Moscow and AO Ondřejov several concepts for improving the observatories technical facilities. We came up with the decision to built a sophisticated spectral polarimeter for the 40--800 MHz range. The present paper deals with the general features of the project. Some problems which can be studied with the new equipment (observations will begin in 1990) are listed.

2. DESCRIPTION OF THE PROJECT

The spectral polarimeter has to cover the 40-800 MHz range with the best possible time, intensity, and polarization resolution. Figure 1 (center) is a schematic of essential radio burst emission patterns observed in dm-m range. For achieving optimal parameters the spectral polarimeter is disigned to be a combination of several components (Fig. 1, right; Table 1):

1/ the quick-look spectrograph, consisting of five independent sweep spectrographs (S)

2/ seven single frequency polarimeters (P)

3/ two multichannel spectrographs (spectral magnifiers) which can be shifted in central frequency and spreaded in channel distance (MC).

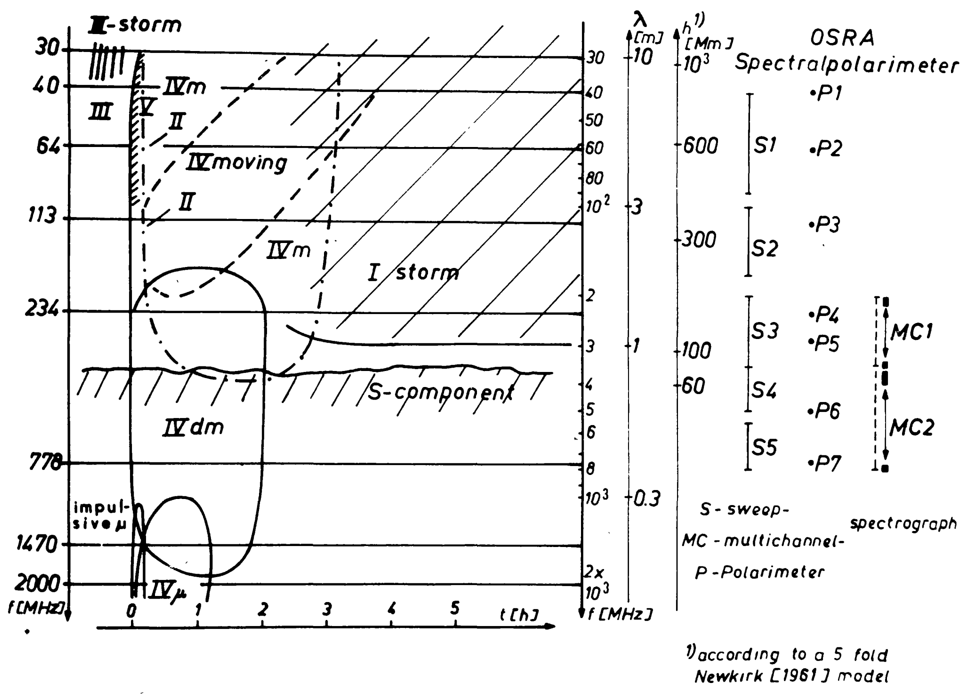

Fig. 1: Schematic drawing of the type IV spectral diagram and the spectral polarimeter components in the 40-800 MHz range.

Table 1
Parameters of the OSRA spectral polarimeter

Component	Bandwidth Range	Inst.or channel	Sampling rate (s)	$\frac{\Delta T}{T}$ (%)	Dynamic range (dB)	Remarks
Sweep spectrographs (S)	50-250	0,5 1,0	0,1	10	50	f < 200 MHz f ≥ 200 MHz
Polarimeters (P)	-	0,035 1,0	0,064	6,3 1,2	60	f < 500 MHz f ≥ 500 MHz
Multichannel spectrographs (MC) I	10	0,175	0,010	7,2	40	every fifth channel with polarization
Multichannel spectrographs (MC) II	40	1,0		3,0		

With lending us the lowest frequency sweep spectrograph (40-90 MHz) the IZMIRAN is partaking in the project.

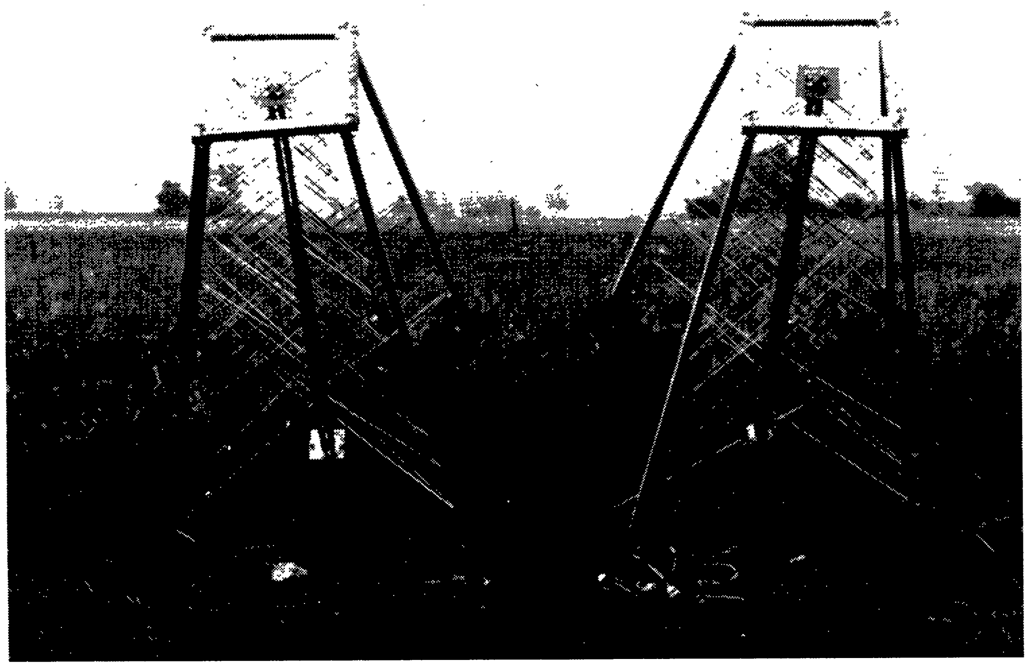

Fig. 2: A model of the 40 - 90 MHz circular polarized aerial.

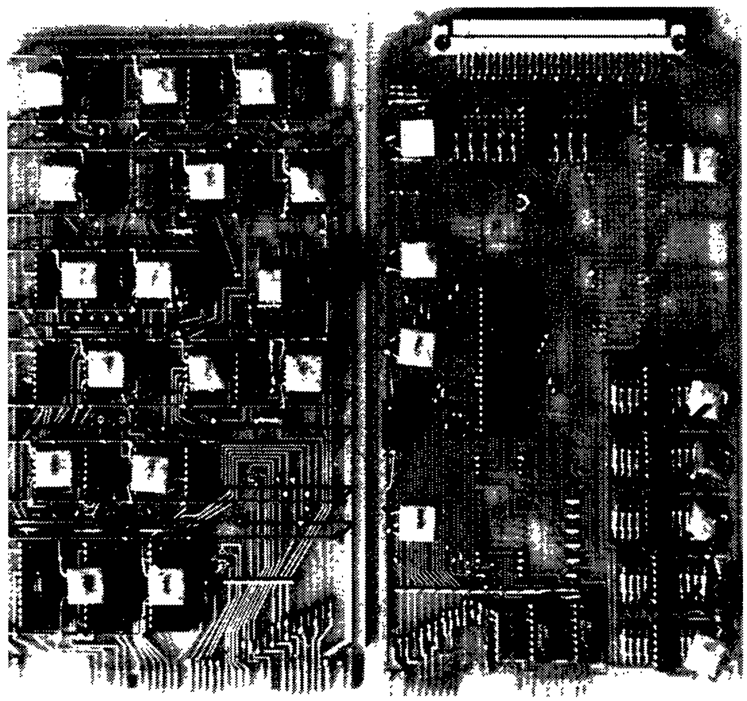

Fig. 3: The universal SM4 interface boards.

The different components of the instrument are fed by a set of four different aerials. In the 100-800 MHz range we shall use the already existing 10.5 m, 7.5 m, and 4.0 m diameter paraboloids with a newly developed crossed logarithmic-periodical feed system. In the 40-90 MHz range we built a circularly polarized structure, too (Fig. 2). Switching together the two orthogonal subsystems we eliminate the polarization bias introduced by the earth surface influence (Nowatzky, 1984). In the final state of the new instrument two such systems will be used as a short baseline interferometer.

Coming from the aerials the signal passes broad band, low noise (Si-FET's) preamplifiers and is distributed into the different components. The output data rate of roughly 6kwords s^{-1} (two 8 bit values per 16 bit computer word) is recorded on a logarithmic scale. The 60 dB dynamic range was easily attained (Fig. 3) using the field strength indicator signal of an analog integrated circuit A 225 (IF amplifier and demodulator).

Data acquisition and processing are managed by the SM4-10 computer of the observatory, which has been operating since 1982. For connecting the SM4 with the observatories hardware an universal interface board (Fig. 4) was constructed having a PIO-, SIO- and CTC operational mode. The interface can be applied for the SM4-2, too.

Together with the SM4 computer a microprocessor system MPS 4944 and an image processing system with colour display are used. The slow magnetic tape

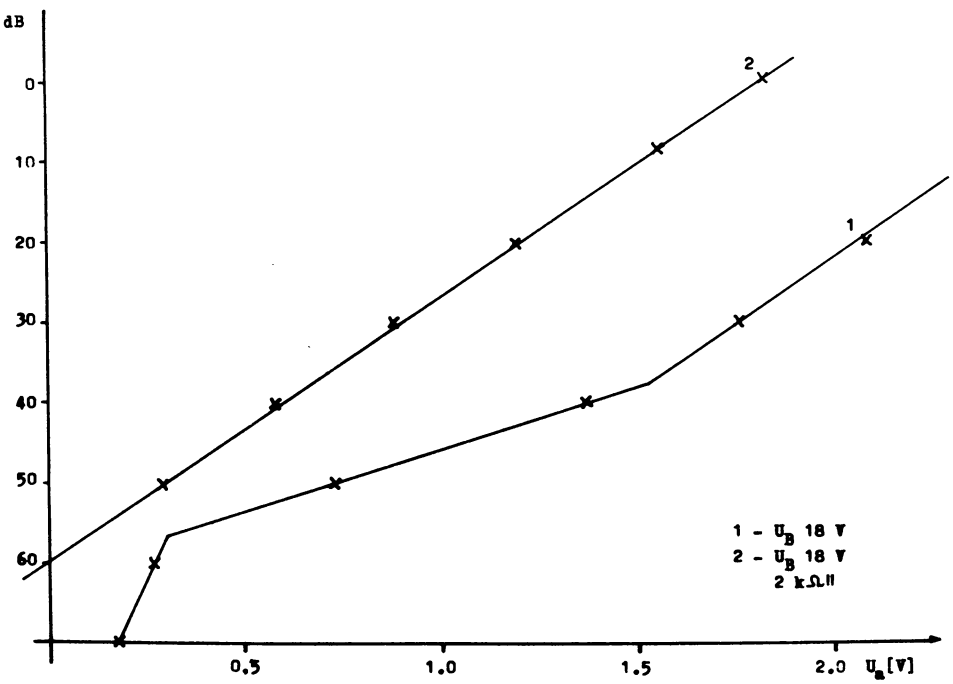

Fig. 4: The logarithmic characteristic of the IC 225 (W. Voigt, pers. comm.)

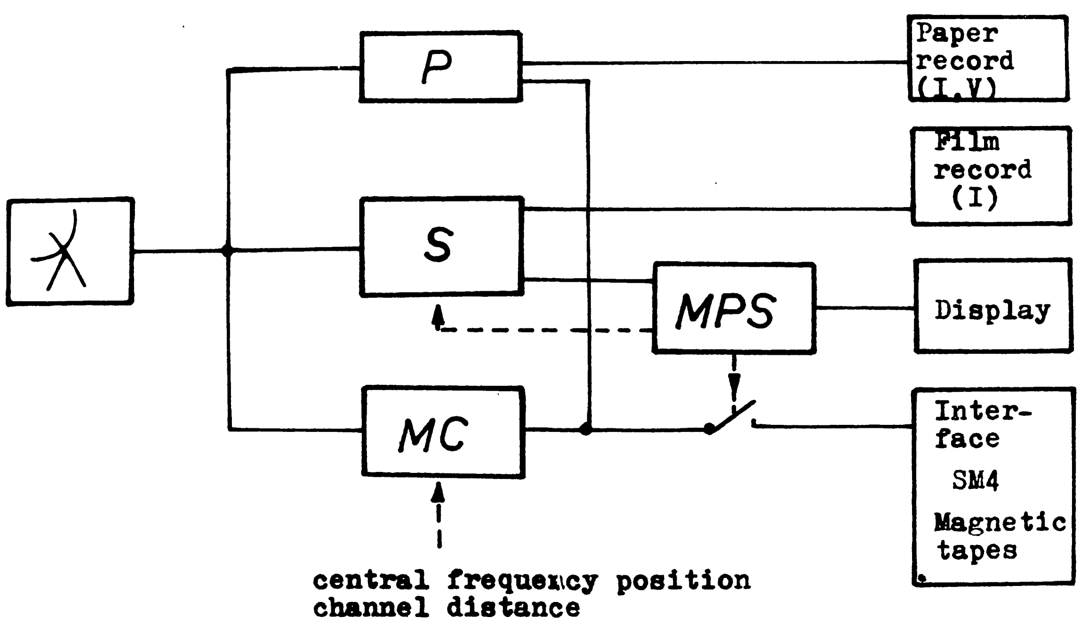

Fig. 5: Schematic of the spectral polarimeter components.

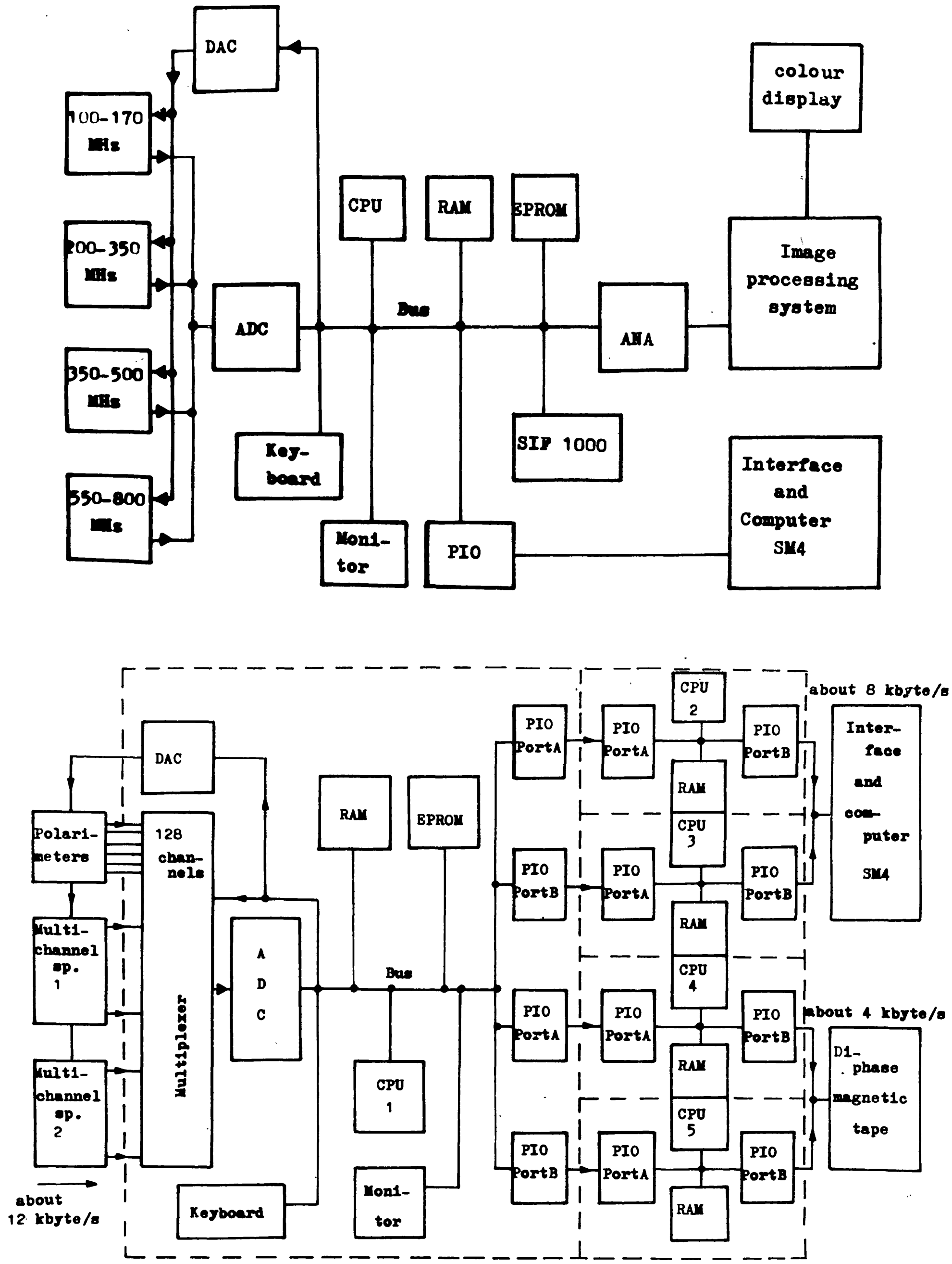

Fig. 6: The data acquisition microprocessor systems using MPS 4944 components (J. Paschke, pers. comm.)
a/ sweep spectrographs
b/ polarimeters and multichannel spectrographs.

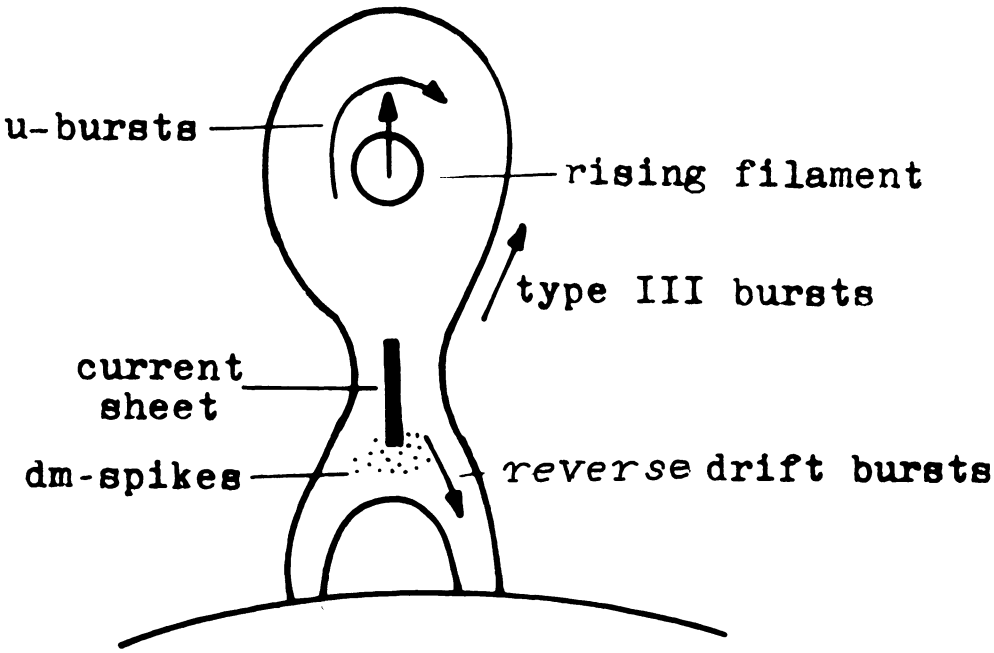

Fig. 7: Schematic of the double ribbon flare scenario and some type IV radio burst components (following Kaastra 1985).

unit of the SM4 is supported by additional computer-independent tape units. Further, a conventional 36 mm film camera belongs to the equipment.

Figure 5 gives a schematic bloc diagram of the spectral polarimeter.

During quiet observing conditions, only the S- and the P-data are recorded on film and on paper, respectively. The MPS controls the sweep spectrographs, thereby omitting strong transmitter signals. Further, the MPS recognizes burst onsets.

If there are events, digital data preprocessing and storage systems are switched on, additionally. The observer, looking on the colour display (which presents the two current sweep spectrograph data minutes), choses the position and spread of the two multichannel spectral magnifiers.

Figure 6a,b gives the internal MPS structure of the data acquisition system. The actual data processing of complex burst data will be done off-line.

3. HOW TO USE THE NEW INSTRUMENT

Two problems are of current interest:

- the fast and operative diagnosis of geoeffective solar phenomena from dm-m data

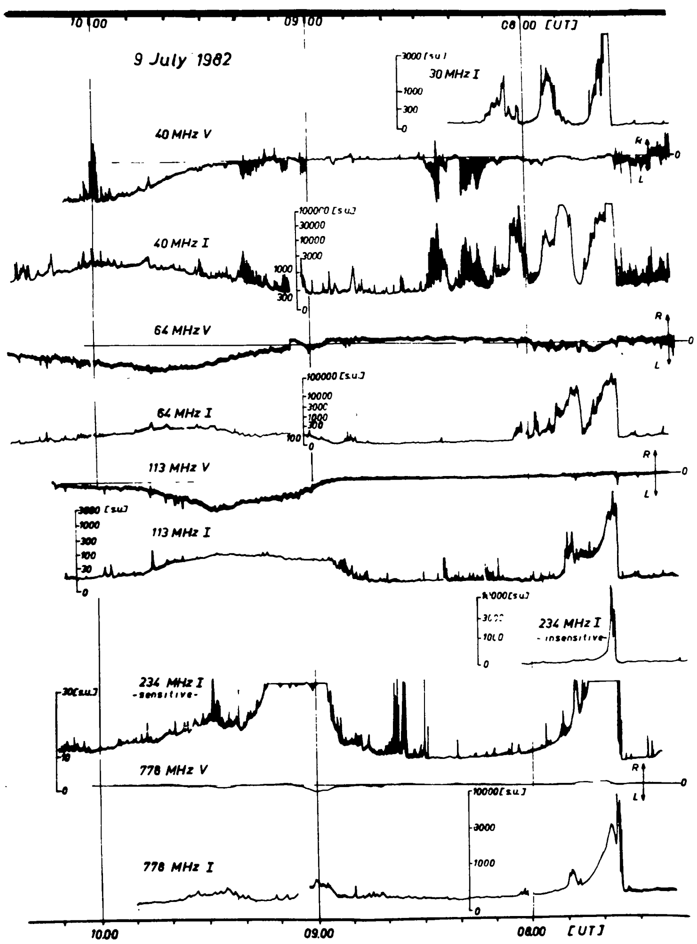

Fig. 8: The type IV burst on July 9, 1982 (Aurass et al. 1986)
a/ single frequency records

- contributions to a complex, dynamical picture of the flare burst complex in the lower corona.

Basing on the filament formation model of Kuperus and Raadu (1974), some close connections are evident between the dynamical processes during a double ribbon flare and some features of a corresponding complex type IV radio burst (e.g. Kaastra, 1985, and our Fig. 7). In the onset phase of the type IV burst, such features are, for instance:

- groups of drift bursts - both positive and negative frequency drift is possible - with slowly negatively drifting starting frequencies
- groups of U-bursts with slowly negatively drifting top frequencies
- dm spike bursts

This phase is normally followed by the impulsive and explosive μ burst

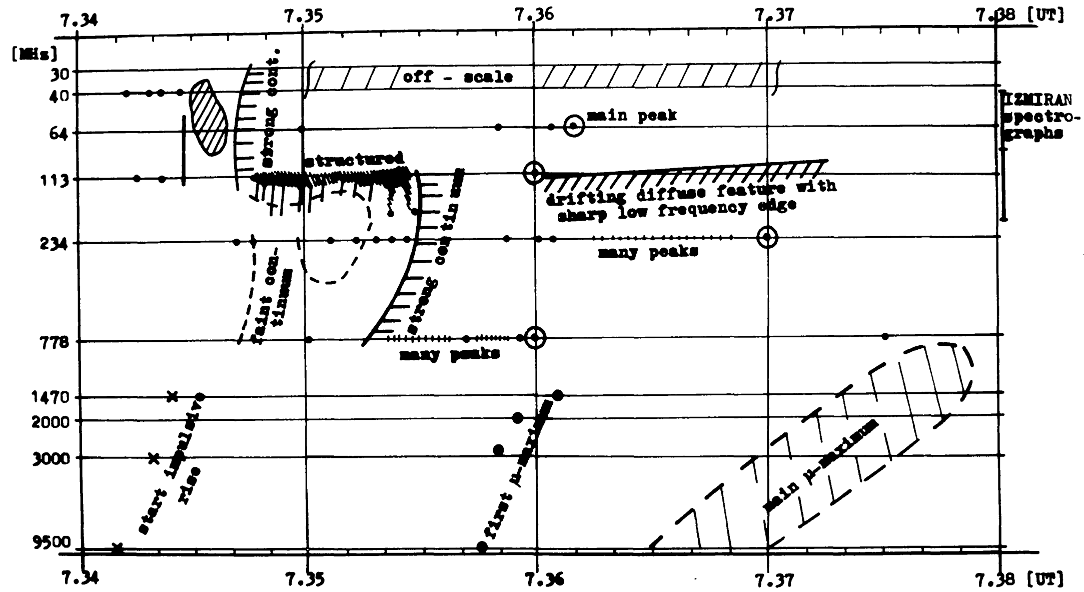

Fig. 8: b/ spectral diagram of the first four minutes of the event drawn using high time resolution single frequency records and IZMIRAN 40 - 180 MHz spectrograms (kindly supplied by V.V. Fomichev).

and by the onset of longer durating dm-m flare continua (e.g. Robinson, 1978). Included continuum fine structures like fiber bursts, zebra patterns and broad band pulsations (Slottje 1981, Kuijpers 1980) are favourable tools of coronal plasma diagnosis (e.g. Mann et al. 1986a, b) and reveal the structure of implied physical processes (for instance Kurths and Hertzel 1985).

In the late phase of complex type IV bursts we find long duration meter continua often modulated by minute scale fluctuations which are nearly unexplored until now. Sometimes, these fluctuations show a surprisingly clear structured period sequence (Aurass et al. 1976), thus challenging systematic studies with respect to coronal resonators (e.g. Stepanov et al. 1982). Further, often we see in the late type IV phase a recovery of a special dm-m component being again rich in spectral fine structures. Apparently, this phenomenon is typical for the early post flare loop formation stage (Karlický et al. 1985) and finishes the double ribbon flare picture in the radio spectrum.

Figure 8a, b gives an example of the onset behaviour of a type IV burst with a strong flare continuum (9 July 1982) as seen with high time and intensity resolution. This spectral diagram includes a lot of interesting details (note the onset in μ- and dm-waves, the drift bursts and the continuum structure in the m-dm gap, a slowly drifting type II burst like feature starting near the m-wave spectral maximum; the actual m-type II burst was much later observed).

To the aim of a better use of dm-m radio data for the diagnosis of the lower corona we intend, for instance, to continue systematically such studies basing on the homogeneous data obtained with the new spectral polarimeter.

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