An Atlas of 10-50 Kev Solar Flare X-Rays

Observed by the OGO Satellites

5 September 1964 to 31 December 1966

by

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I. INTRODUCTION:

The large ionization chambers carried by the OGO-I and OGO-III satellites have observed many radiation increases which can be identified as energetic x-rays produced during solar flare events. It is the purpose of this report to make available detailed ionization-rate profiles for about 70 events representing practically all cases detected by these ion chambers during the observing time of the OGO-I and OGO-III satellites up to the end of 1966. Our group has studied the relationship between these energetic x-rays, and the accompanying radio emission and the results have been given in several publications (Arnoldy, Kane and Winckler, 1967a; Arnoldy, Kane and Winckler, 1967b; Arnoldy, Kane and Winckler, 1967c). Further details of the instrumentation not contained herein are described in several documents (Kane, 1967; Kane, Pfitzer and Winckler, 1966). Copies of the above quoted papers are available on request.

The preliminary studies relating the x-ray phenomena to radio emission obviously leave many questions unanswered, and it is hoped that this atlas will stimulate further work in identifying the processes in various flare events and in finding some cases particularly on the solar limb which may give further essential information about the location of the sources. Since the Minnesota group is not at present engaged in a detailed study of the optical flares as seen in H_α or other emissions or of the magnetic character and development of the active centers, it is hoped that other groups will find interest in such a correlation to reach a better understanding of the flare energetics.

II. DESCRIPTION OF THE MEASURING INSTRUMENT:

The x-ray events tabulated in this report have been detected by a spherical aluminum walled ionization chamber containing argon gas. The general characteristics are given in Table 1.

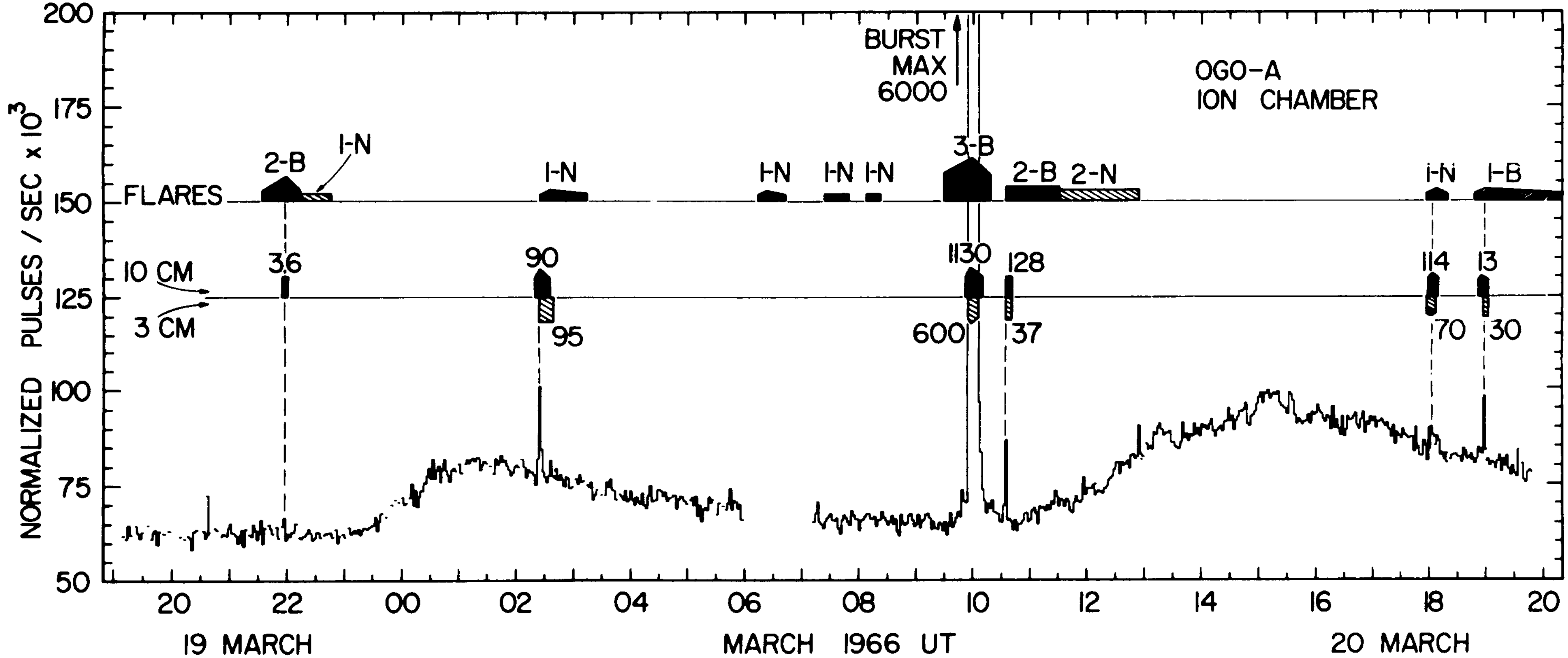
Table 1

OGO ION CHAMBER CHARACTERISTICS

Diameter	17.8 cms
Wall thickness	0.085 cms Aluminum
Argon pressure	
OGO-I	50 lbs./in.^{2} absolute
OGO-III	60 lbs,/in.^{2} absolute
Minimum energy for penetration by charged particles	
Protons	12 Mev
Electrons	0.6 Mev

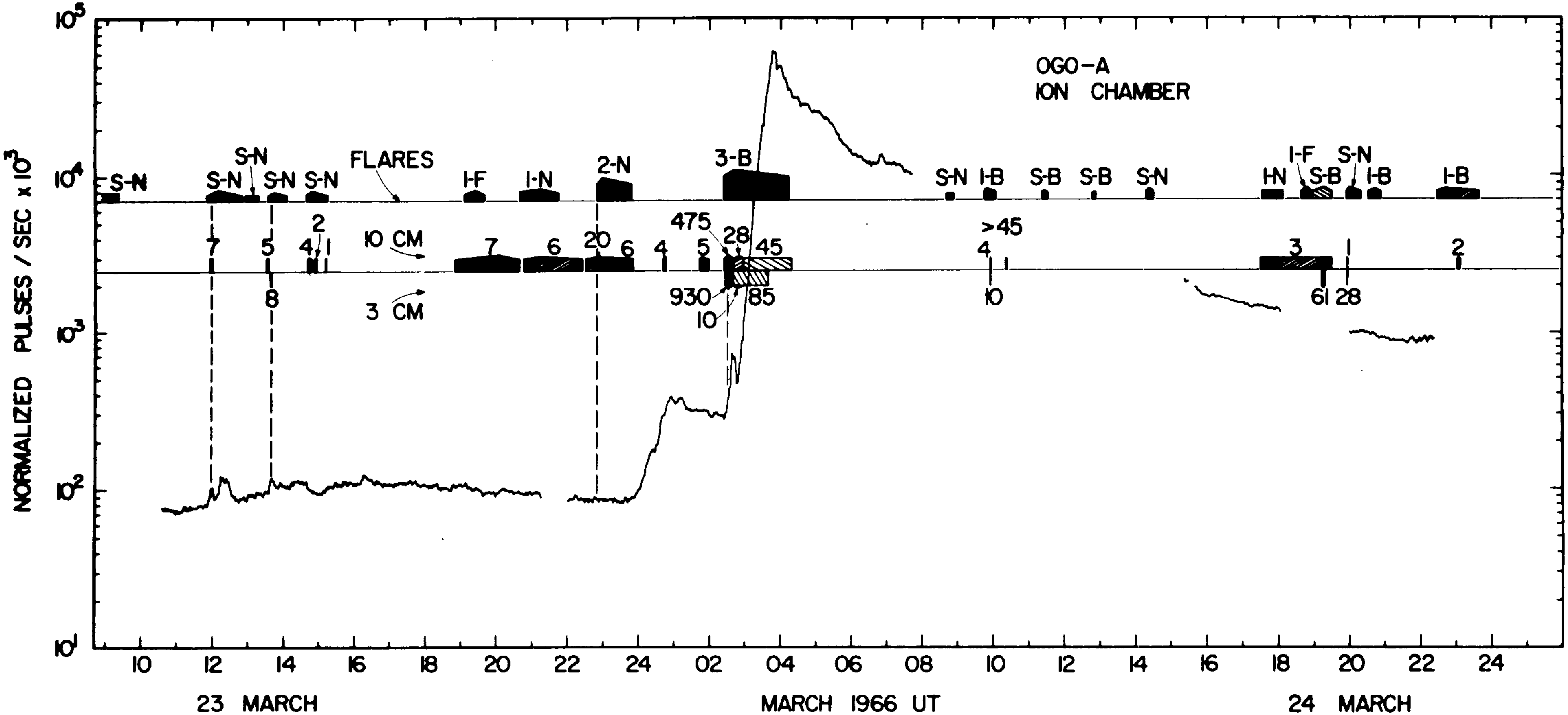
This ionization chamber is mounted at the end of a four foot boom which keeps it away from the main body of the OGO satellite. The ion chamber sphere is adjacent on the end of the boom to a rectangular box containing some electronics and is covered by a very thin blanket of aluminized mylar. It is sensitive over essentially 4π steradians of solid angle but occasionally, due to the rotation of the satellites, will be periodically eclipsed by the body of the satellite. In some of the events shown (for example 28 August 1966) one can clearly see the roll modulation of the solar x-ray beam produced by this effect. In some cases both the OGO satellites have simultaneously observed the same solar x-ray burst. (See, for example, 20 September 1966.) These features plus correlation with other electromagnetic radiations from the flare serve to identify the ionization increases as being due to x-rays. Usually these x-ray increases consist of isolated events detected when the satellites are outside the magnetosphere and the ionization chambers are responding only to the galactic cosmic ray background. In such cases the x-ray bursts are easily identified. Sometimes, however, the identification is more difficult especially in the transition region of the magnetosphere where electron "spikes" are often seen or during solar particle events in space to which the chambers are also sensitive. As an illustration of the response of these ionization chambers to various space radiations one may refer to Figures 1 and 2 which are "event plots" obtained during March 1966 with OGO-I when there was a complex series of x-ray and particle increases. These event plots are direct tracings of the automatic computer plot routine from the OGO data tapes but have, in addition, flare and radio burst data added above.

The graphs shown in the figures are expressed in an arbitrary rate of resetting of the ion chamber drifting electrometer in units called normalized pulses per second x 10^3 (NPPS x 10^3). These ionization production rates in the chamber can be converted from arbitrary units to energy fluxes in ergs cm^{-2} sec^{-1} by referring to the response characteristics of the chamber. Such response curves assuming exponential spectra for the x-rays are shown in Figure 3. The conversion factors for the different spectral constants shown in Figure 3 are summarized in Table 2.



Event plot obtained by an automatic data reduction which plots the ionization rate in two-minute averages. The galactic cosmic ray background outside the magnetosphere is about 62 NPPS x 10^3 as shown up to 2300 on 19 March. At this point a small solar particle event appears reaching a maximum at 0130 and then decaying away for a number of hours. This particle event was probably associated with the flare at 2200. Another particle event is associated with the large flare at 1000 on 20 March. X-ray bursts can be seen at 0220, 0950, 1035, 1800 and 1900.

FIGURE 1



Even't plot (continued) for March 1966. Note logarithmic scale due to large rates associated with the succession of proton events beginning at 2400 on 23 March. An x-ray event at 0230 occurs shortly before the beginning of the large proton event. A similar event was already in progress at this time. The gradual increase and decrease of the base line between 1100 and 2400 on 23 March is caused by a small particle event with possible superposed x-ray "noise".

FIGURE 2

The differential response of the ion chamber to photon spectra of exponential type. The curve labeled $E_0 = \infty$ corresponds to the ion chamber response to a ~~flame~~ flat spectrum. One expects that a characteristic energy of 50 Kev or less will characterize most spectra and thus the chamber response is concentrated between 10 and 50 Kev

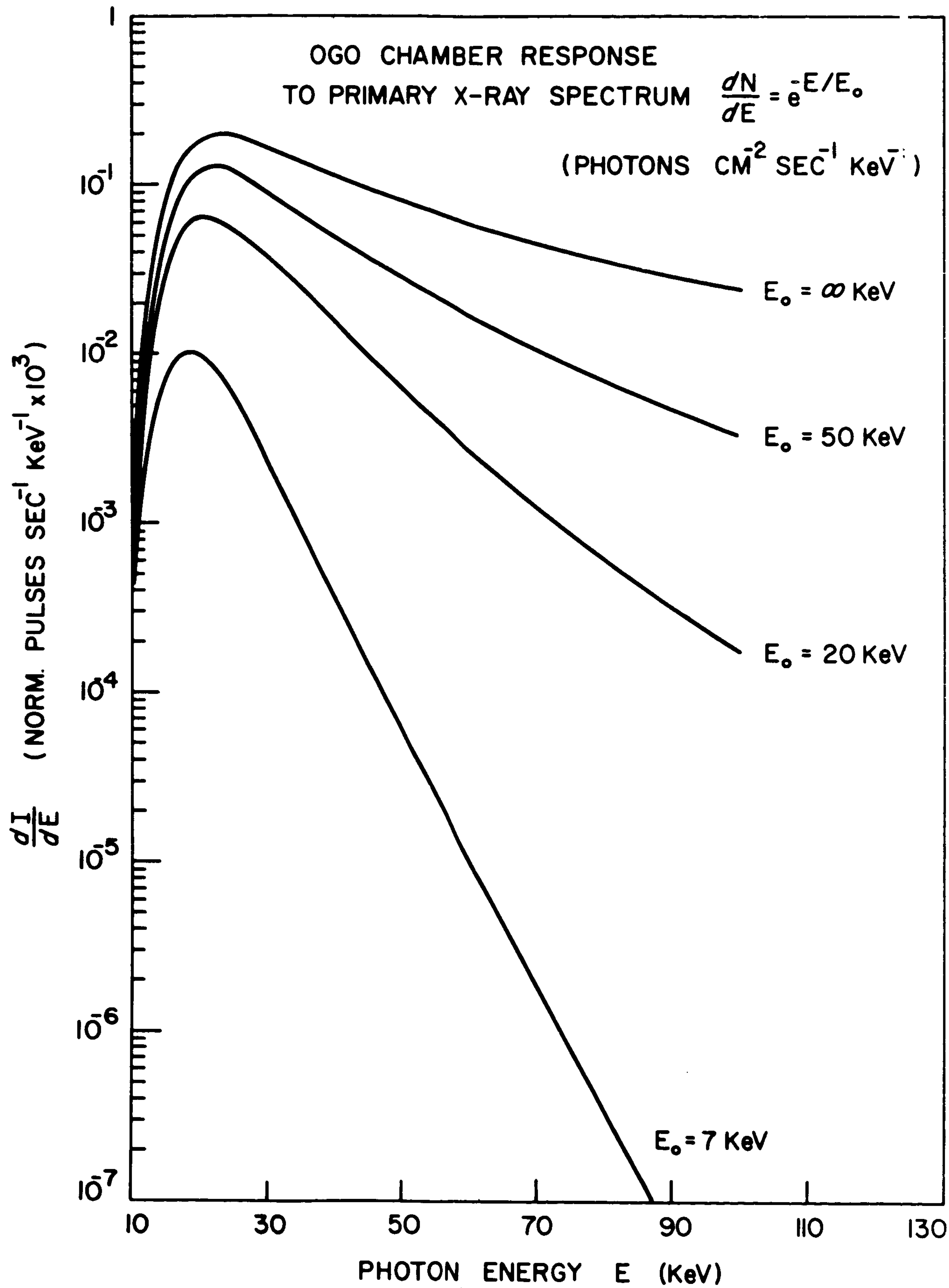


FIGURE 3

Table 2

ION CHAMBER RESPONSE

Primary X-ray Spectrum $dN/dE = e^{-E/E_0}$ photons cm^{-2} sec^{-1} Kev^{-1}

E_0 (Kev)	CHAMBER RATE (N. pulses sec^{-1} x 10^3)			TOTAL	INCIDENT ENERGY FLUX >~~10~~ 20 Kev ergs cm^{-2} sec^{-1}	CONVERSION FACTOR $\frac{\text{ergs } cm^{-2} \text{ } sec^{-1}}{\text{N. pulses } sec^{-1} \text{ x } 10^3}$
	10-16 Kev	16-106 Kev	106-150 Kev			
7	0.026	0.116	5.1×10^{-8}	0.142	1.7×10^{-8}	1.2×10^{-7}
20	0.106	1.16	1.8×10^{-3}	1.27	4.7×10^{-7}	3.7×10^{-7}
50	0.165	2.61	0.07	2.85	3.8×10^{-6}	1.3×10^{-6}

With the aid of this table and an assumption or other knowledge about the spectral shape one may convert the arbitrary ion chamber units to absolute fluxes expressed as ergs cm^{-2} sec^{-1} above ~~10~~ 20 Kev incident energy, but actually for a practical sense between ~~10~~ 20 Kev and 50 Kev. In the figures shown in this report the cosmic ray or particle background has been subtracted or in some cases the zero of the scale has been set on the cosmic ray baseline as shown in the figure.

The orbital characteristics of the two OGO satellites are tabulated in Table 3.

Table 3

	OGO-I	OGO-III
Launch date	5 Sept. 1964	7 June 1966
Height of perigee	280.5 km	295.3 km
Height of apogee	149,408.5 km	122,219.7 km
Inclination to equator	31.11 degrees	30.97 degrees
Local time at apogee	≈2100 hrs.	≈2300 hrs.
Orbital period	63.98 hrs.	48.63 hrs.
Spin period	11.85 sec	≈96 sec (variable)

III. PRESENTATION OF DATA IN GRAPHICAL FORM:

The data from which the figures are plotted was taken in one of three ways:

(a) ten second averages of the ionization rate calculated from the telemetered ramp as the ion chamber electrometer drifted between resets. The ten second average data is plotted as a smooth curve which frequently shows baseline noise.

(b) by computing the equivalent rate for one reset of the drifting electrometer by an accurate measurement of the time Δt of one reset. Since a rate point is obtained for each reset this means that higher rates give more points per unit time in the plot. The graphs using electrometer resets are plotted as histograms.

(c) the third method is to plot a point each minute but with the average taken over approximately 1.5 minutes of time. Data in this manner is plotted as a histogram.

The choice of the time interval in the plot depends on the data mode of the satellite, of the size of the event and several other factors. The ultimate time resolution available is <1 second.

We have also given on the plots the designation of which satellite has received the data and other relevant information such as accompanying shortwave fadeouts (SWF) shown as horizontal arrows starting from a vertical marker. This information was obtained from the Boulder reports of geophysical and solar data. We have also given some information about associated solar radio emission also obtained from the Boulder reports of geophysical and solar data. Beside the listing of the frequency and the observing station the presence of the radio emission is indicated by a horizontal line with a vertical arrow marking the reported time of maximum. Although radio information is quite complete, the absence of an indicated radio burst may in some cases be due to the unavailability of information and does not necessarily mean that a radio burst did not occur.

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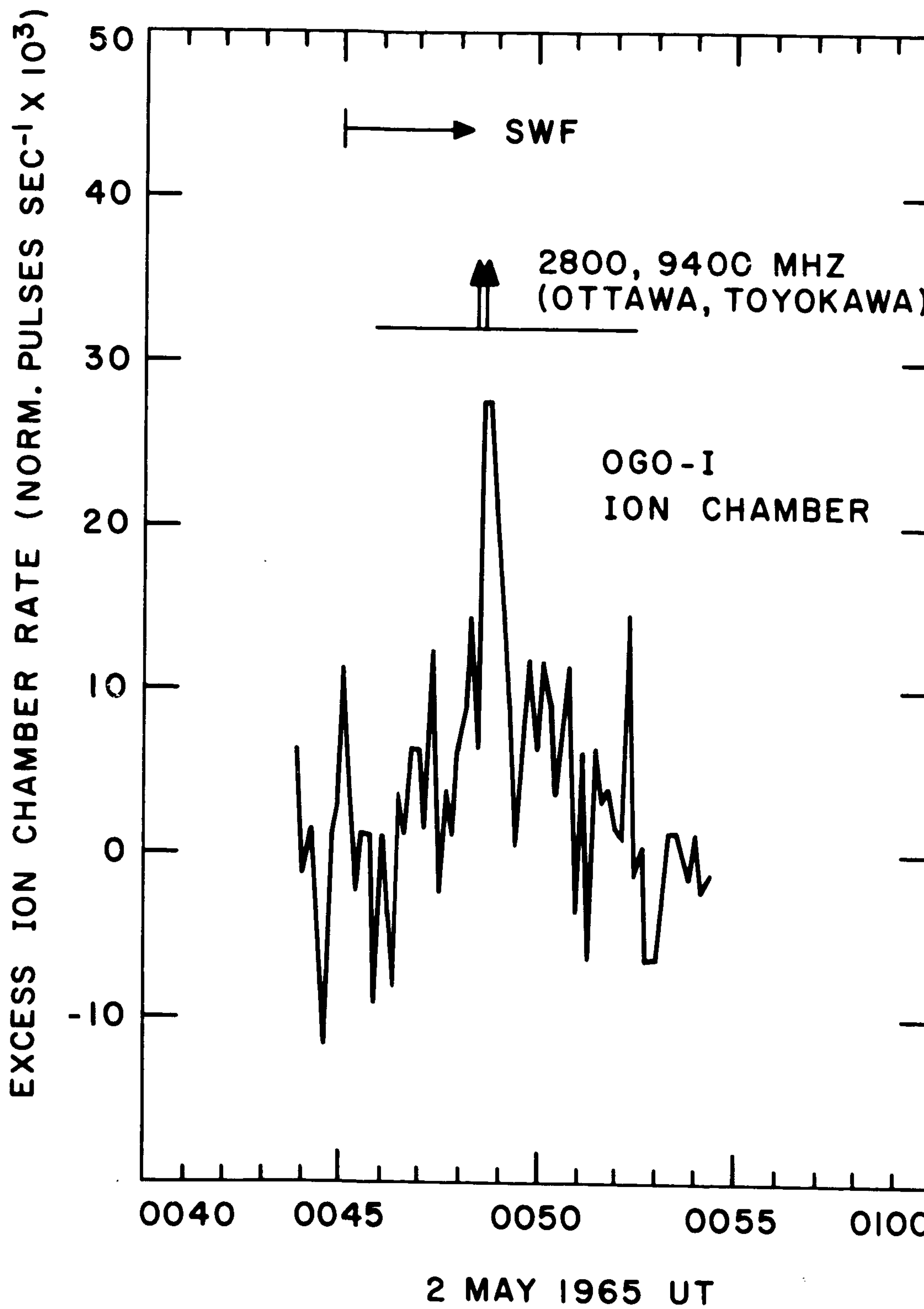
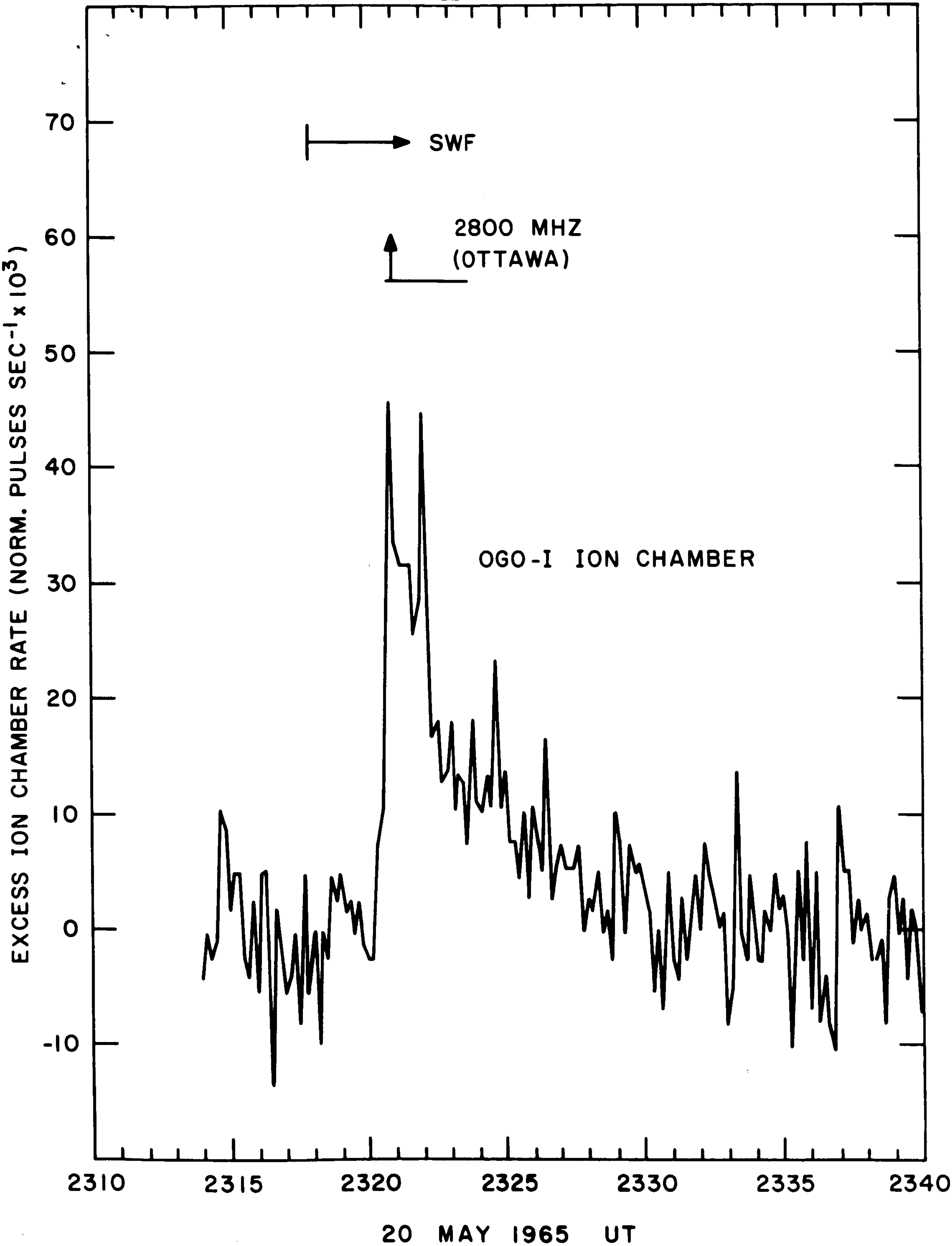
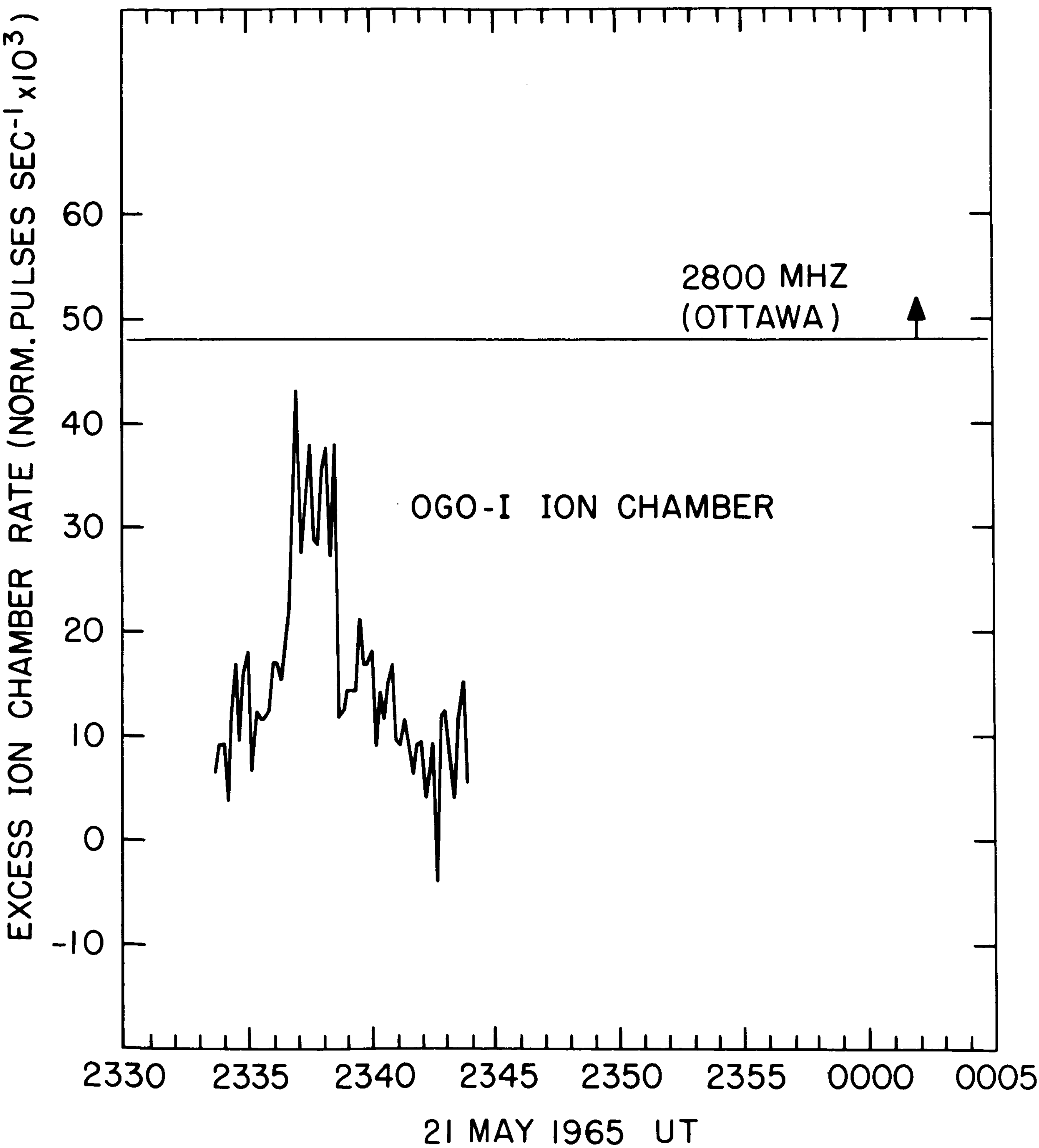
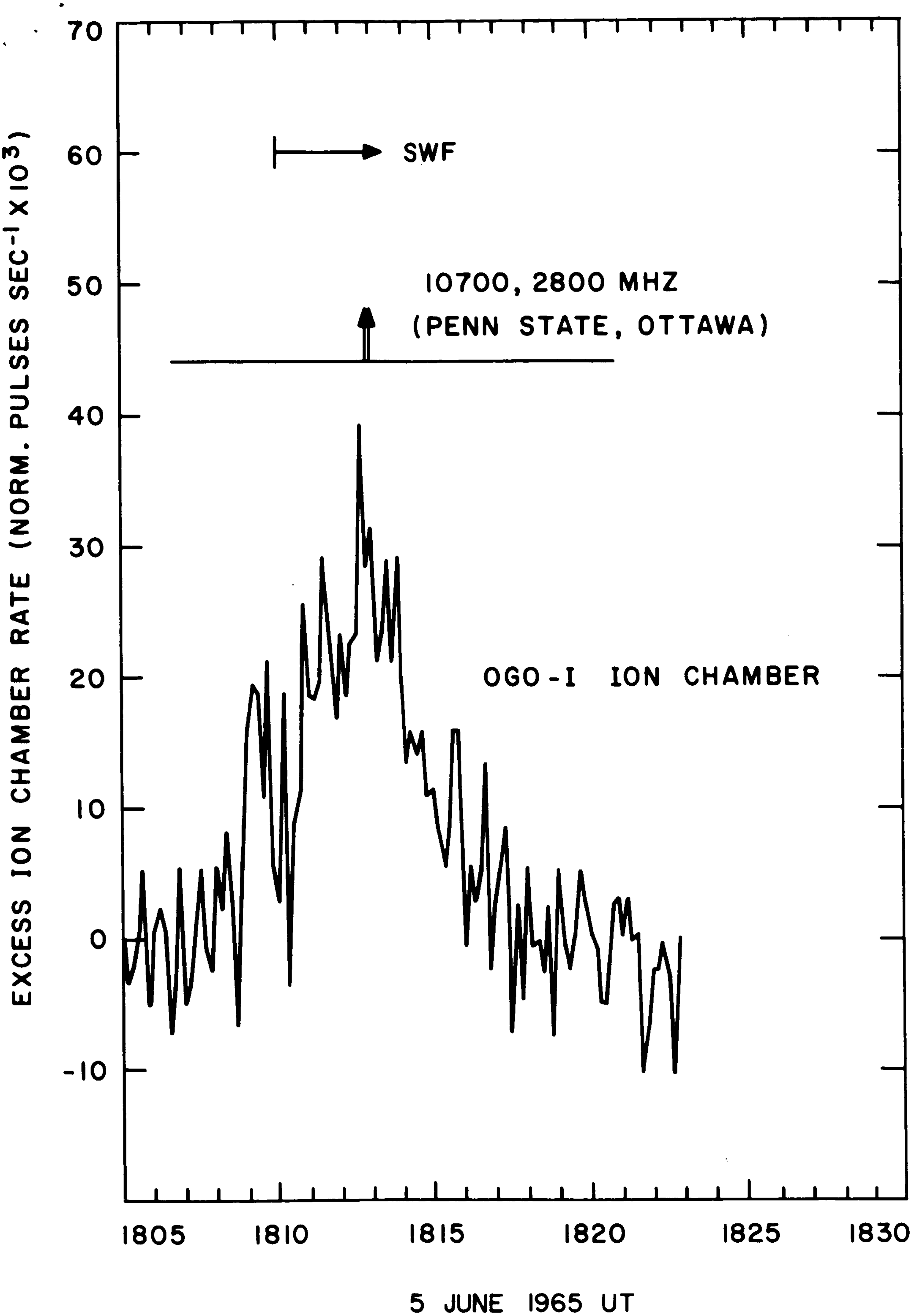


EXCESS ION CHAMBER RATE (NORM. PULSES SEC-1 X 10^3)
50
40
30
20
10
0
-10
SWF
2800, 9400 MHZ
(OTTAWA, TOYOKAWA)
OGO-I
ION CHAMBER
0040
0045
0050
0055
0100
2 MAY 1965 UT

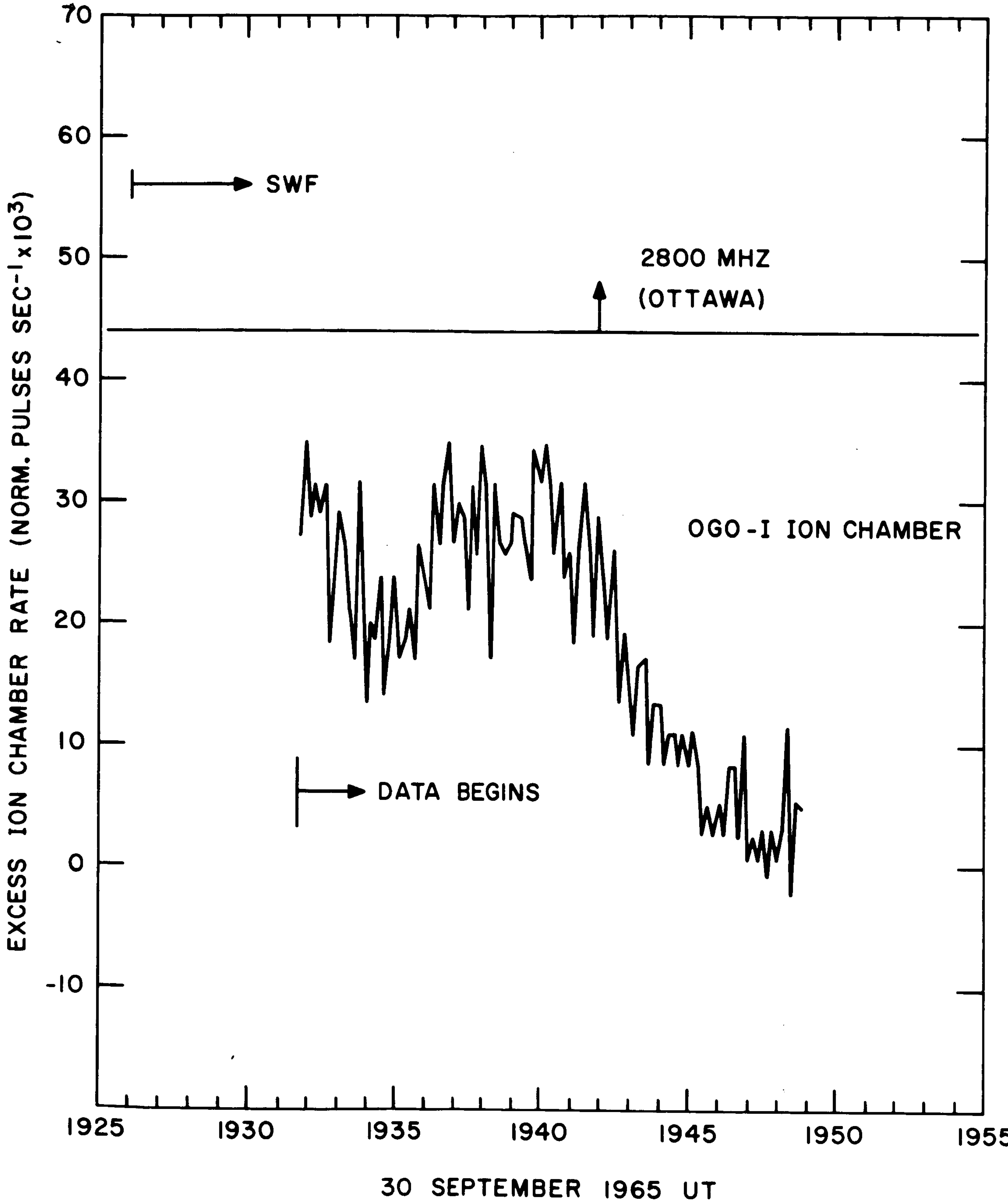


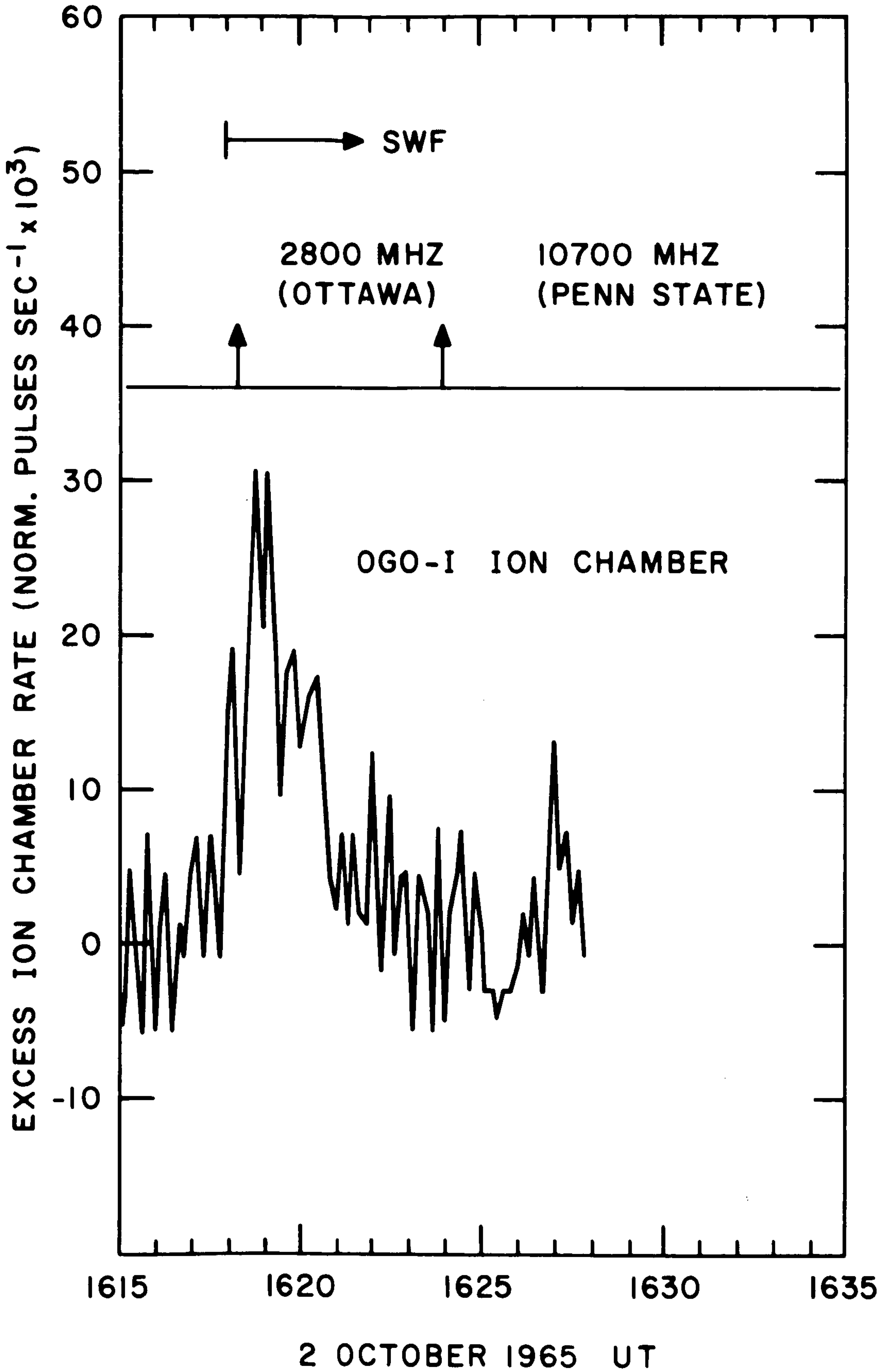
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^{3})
70
60
50
40
30
20
10
0
-10
SWF
2800 MHZ
(OTTAWA)
OGO-I ION CHAMBER
2310
2315
2320
2325
2330
2335
2340
20 MAY 1965 UT

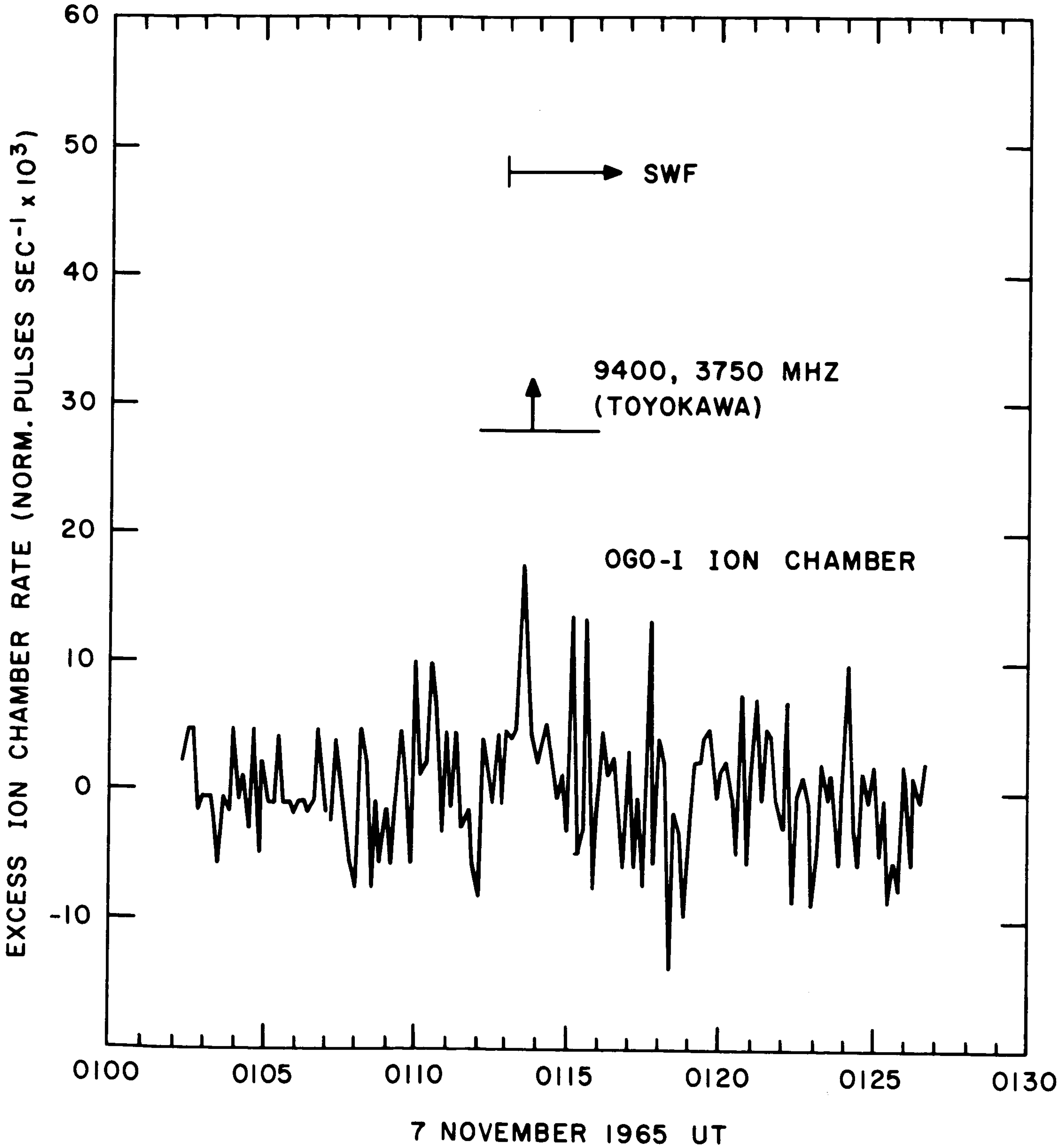

EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x10^3)
60
50
40
30
20
10
0
-10
2800 MHZ
(OTTAWA)
OGO-I ION CHAMBER
2330
2335
2340
2345
2350
2355
0000
0005
21 MAY 1965 UT

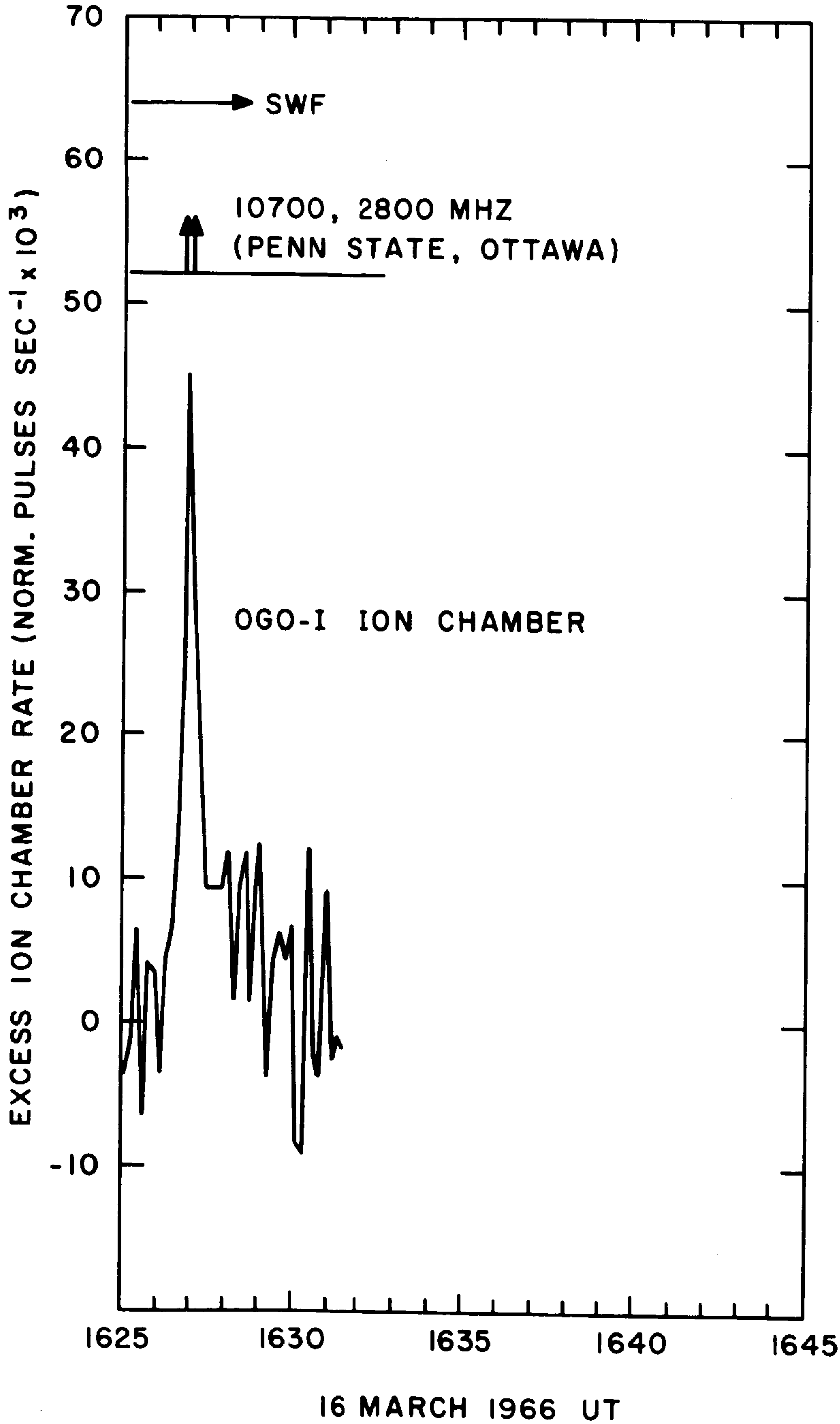


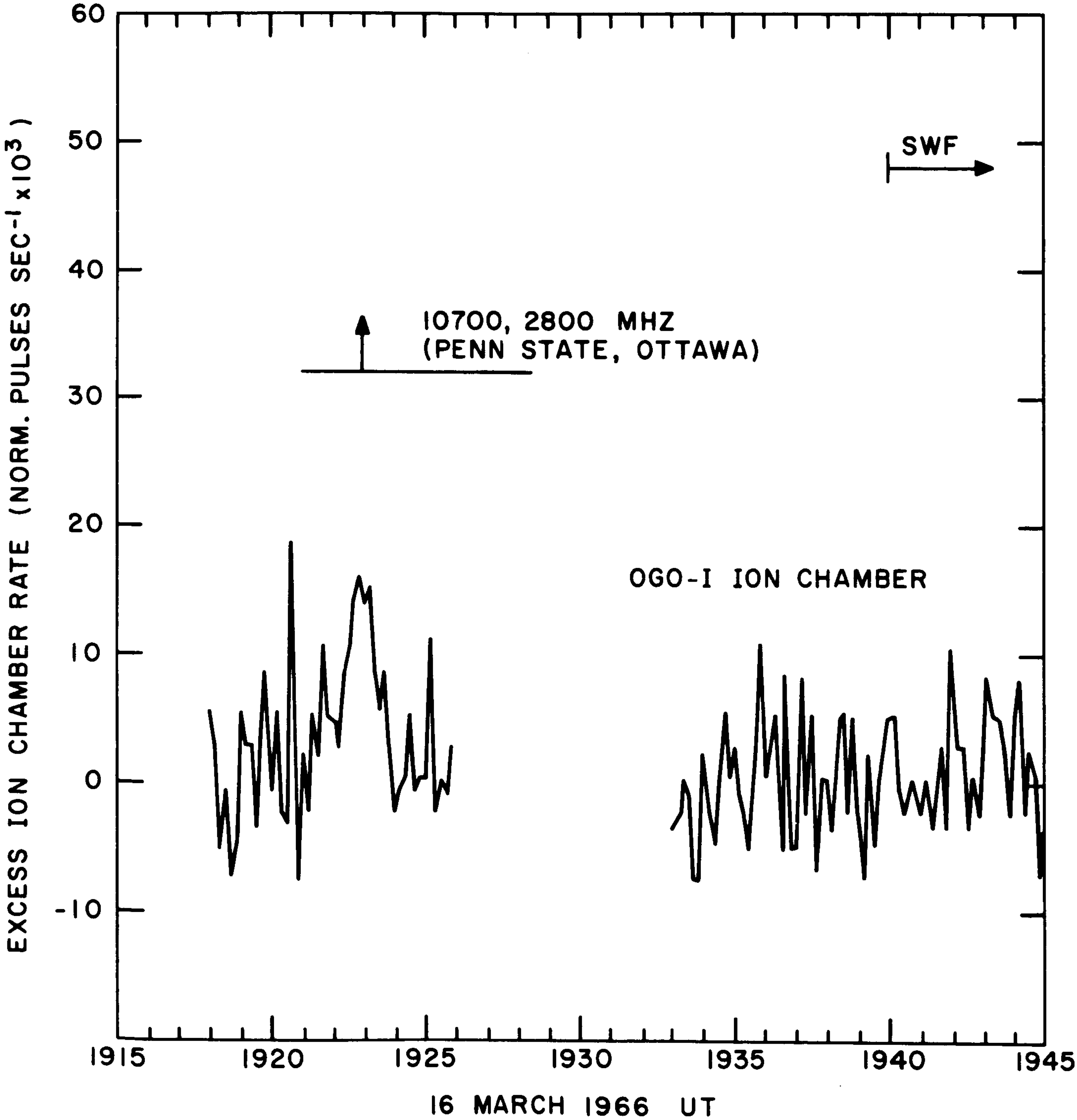
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} X 10^3)
70
60
50
40
30
20
10
0
-10
SWF
10700, 2800 MHZ
(PENN STATE, OTTAWA)
OGO-I ION CHAMBER
1805
1810
1815
1820
1825
1830
5 JUNE 1965 UT

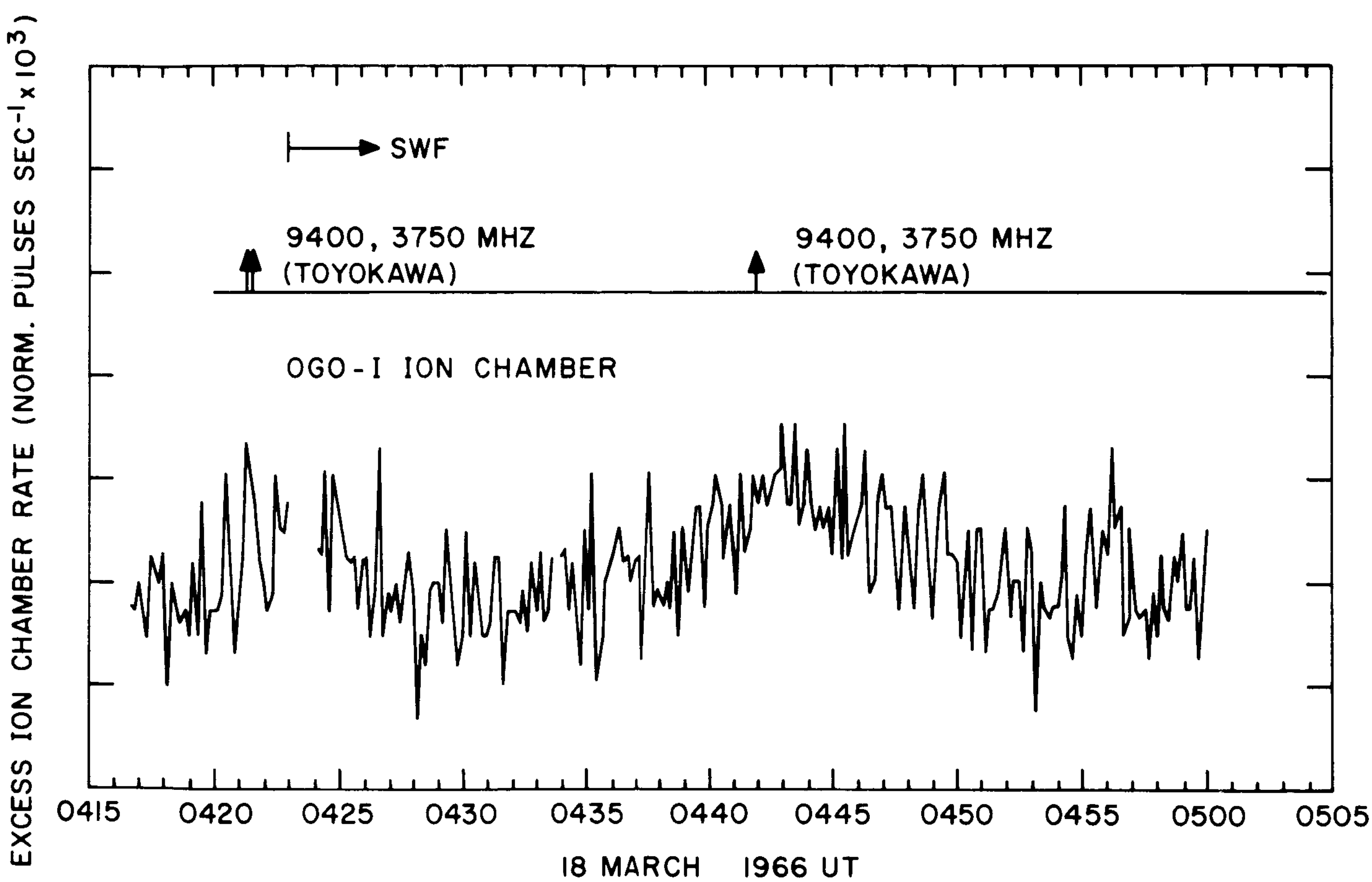

70
60
50
40
30
20
10
0
-10
EXCESS ION CHAMBER RATE (NORM. PULSES SEC⁻¹ x 10³)
SWF
2800 MHZ
(OTTAWA)
OGO-I ION CHAMBER
DATA BEGINS
1925
1930
1935
1940
1945
1950
1955
30 SEPTEMBER 1965 UT


60
50
40
30
20
10
0
-10
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
SWF
2800 MHZ
(OTTAWA)
10700 MHZ
(PENN STATE)
OGO-I ION CHAMBER
1615
1620
1625
1630
1635
2 OCTOBER 1965 UT

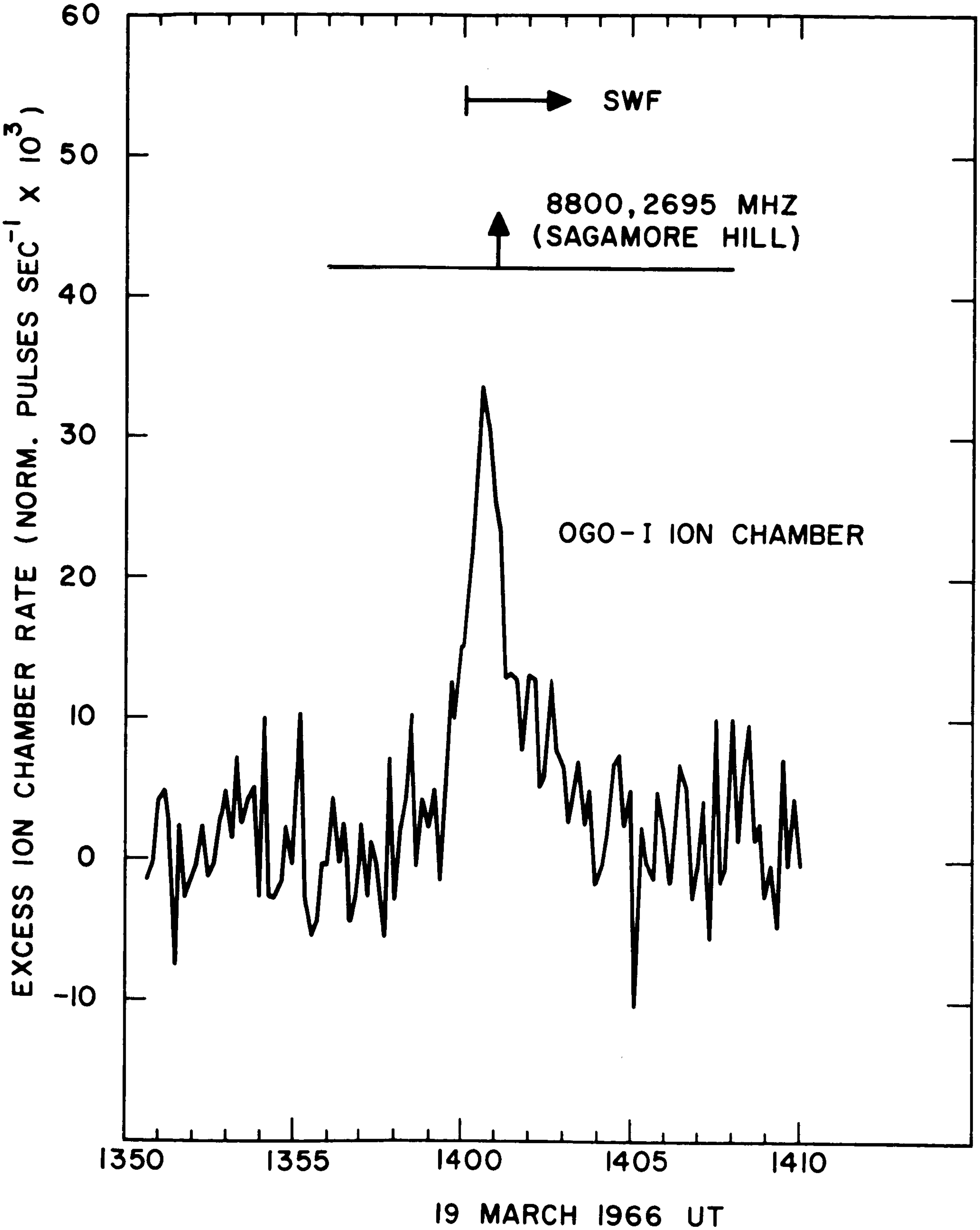

60
50
40
30
20
10
0
-10
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
SWF
9400, 3750 MHZ
(TOYOKAWA)
OGO-I ION CHAMBER
0100
0105
0110
0115
0120
0125
0130
7 NOVEMBER 1965 UT


70
60
50
40
30
20
10
0
-10
SWF
10700, 2800 MHZ
(PENN STATE, OTTAWA)
OGO-I ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^{3})
1625
1630
1635
1640
1645
16 MARCH 1966 UT

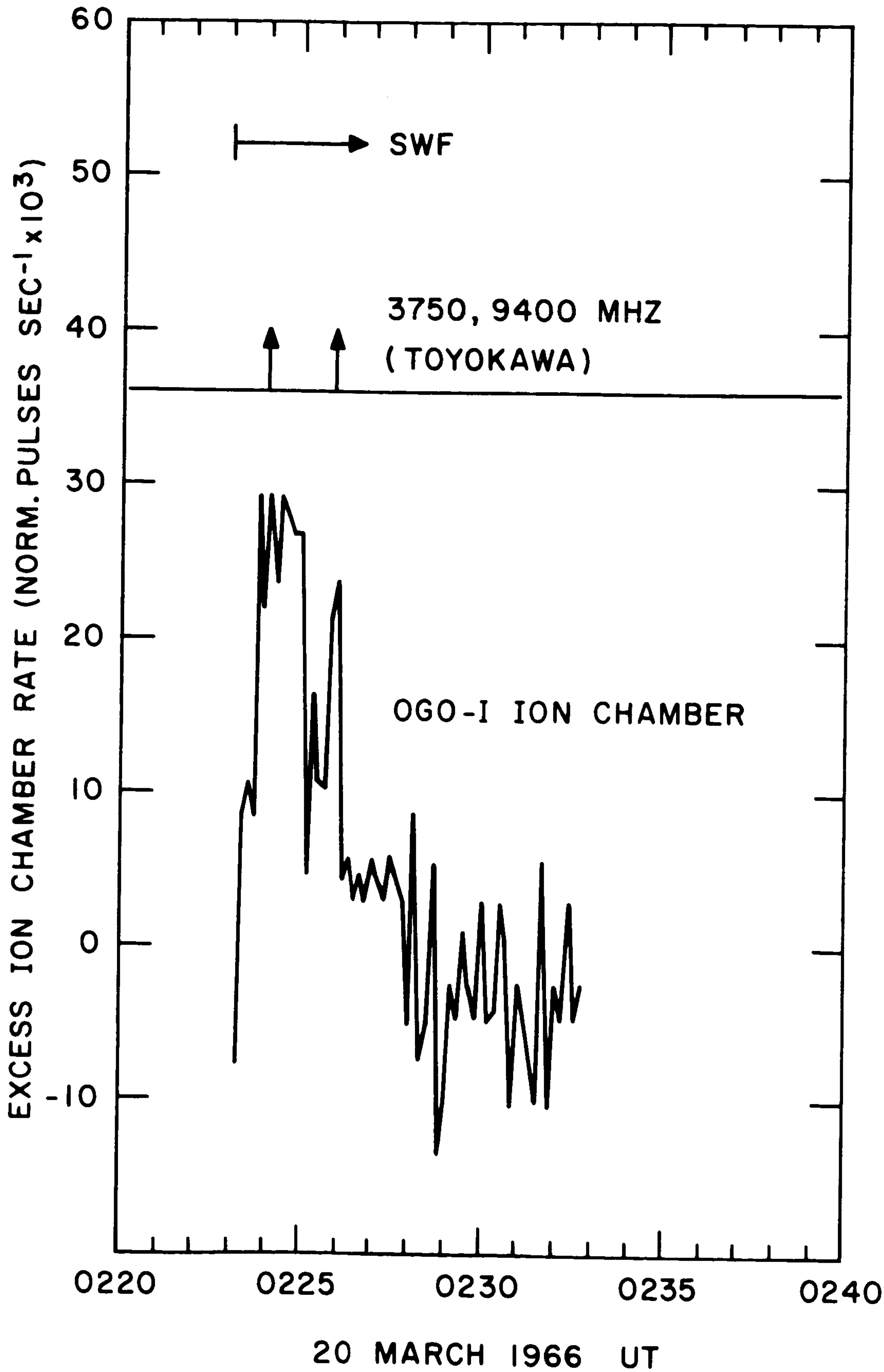

60
50
40
30
20
10
0
-10
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
SWF
10700, 2800 MHZ
(PENN STATE, OTTAWA)
OGO-I ION CHAMBER
1915
1920
1925
1930
1935
1940
1945
16 MARCH 1966 UT

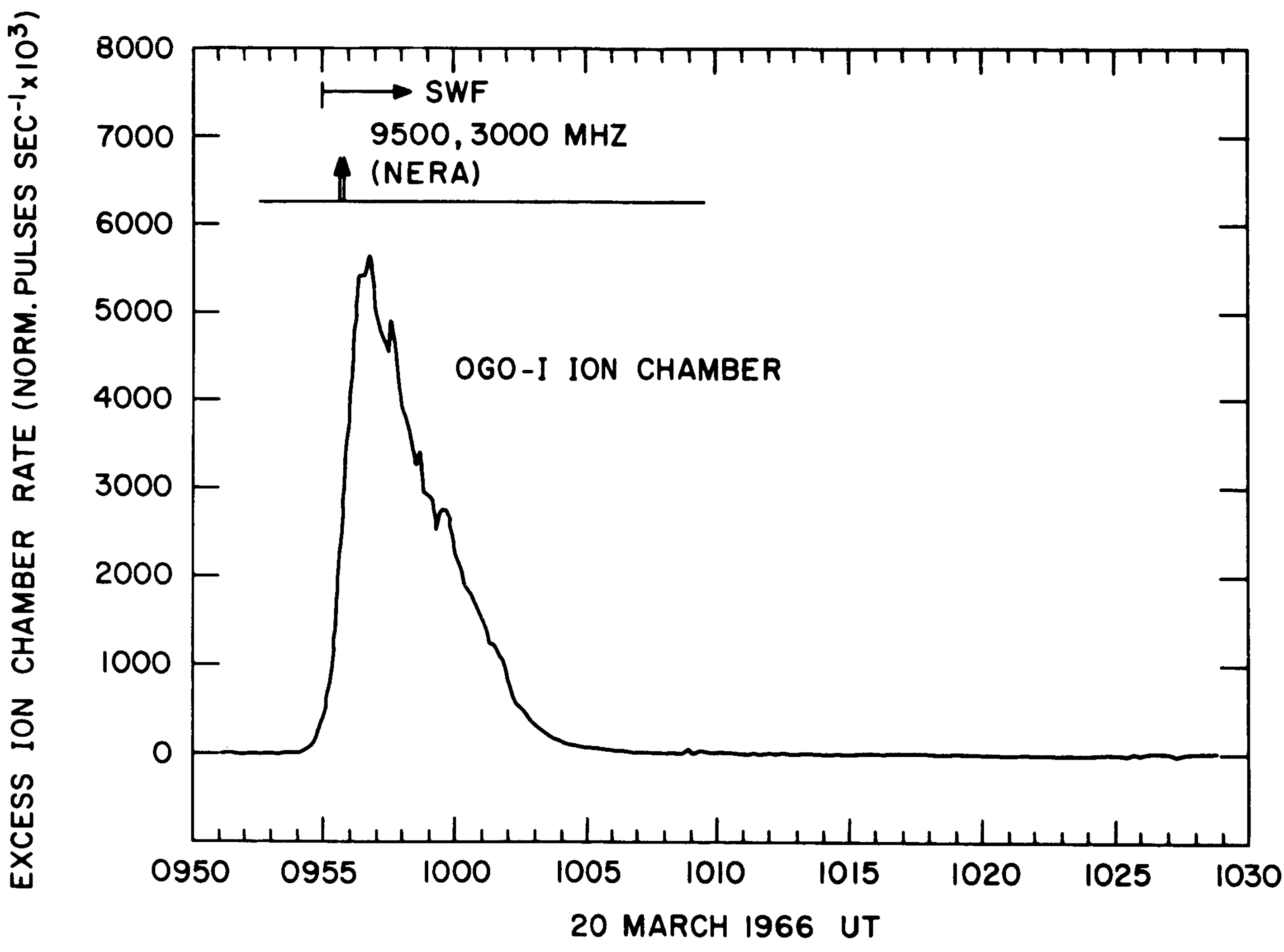


SWF
9400, 3750 MHZ
(TOYOKAWA)
9400, 3750 MHZ
(TOYOKAWA)
OGO-I ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
0415
0420
0425
0430
0435
0440
0445
0450
0455
0500
0505
18 MARCH 1966 UT

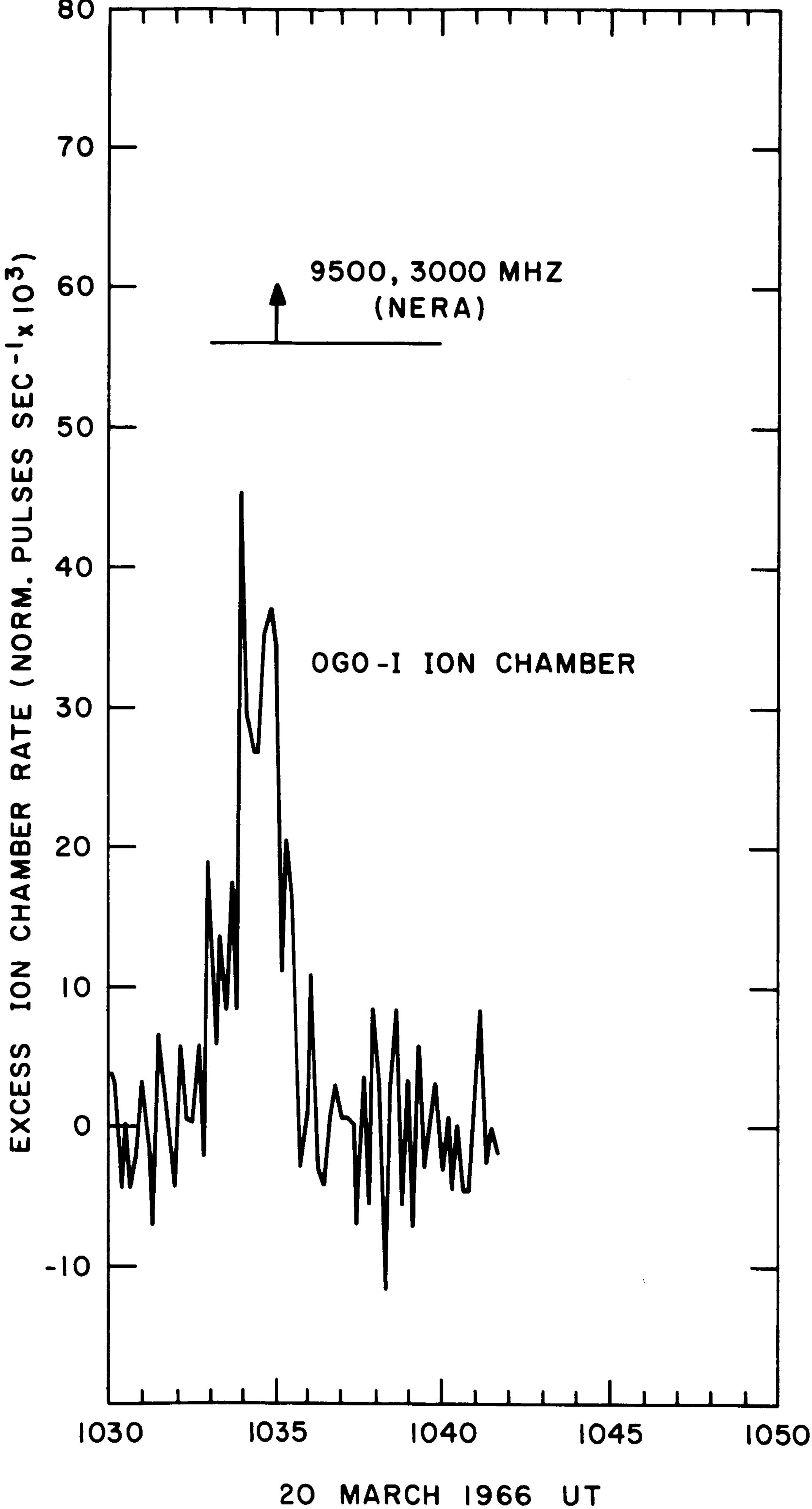


60
50
40
30
20
10
0
-10
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
SWF
8800, 2695 MHZ
(SAGAMORE HILL)
OGO-I ION CHAMBER
1350
1355
1400
1405
1410
19 MARCH 1966 UT

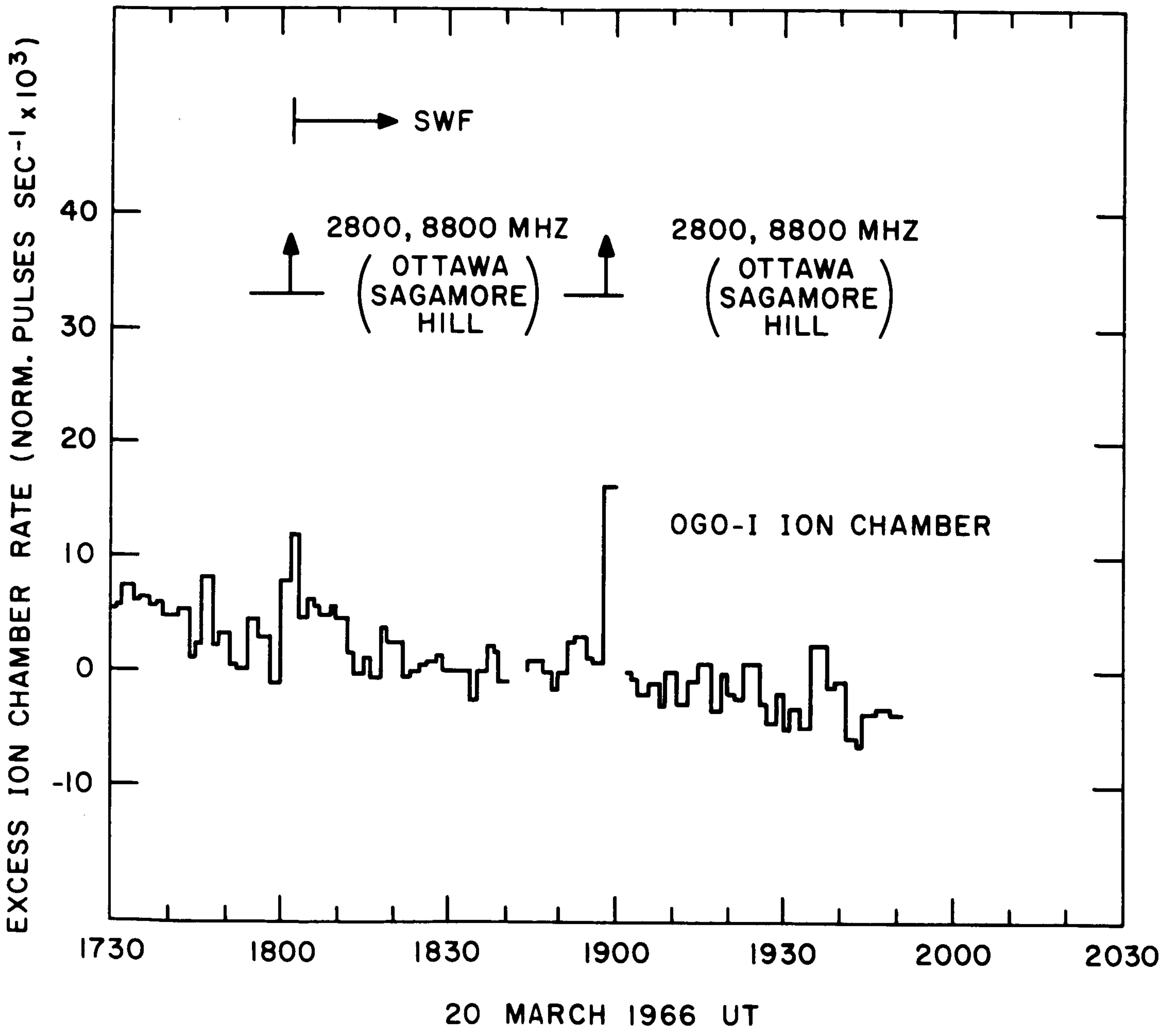

SWF
3750, 9400 MHZ
(TOYOKAWA)
OGO-I ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^{3})
60
50
40
30
20
10
0
-10
0220
0225
0230
0235
0240
20 MARCH 1966 UT

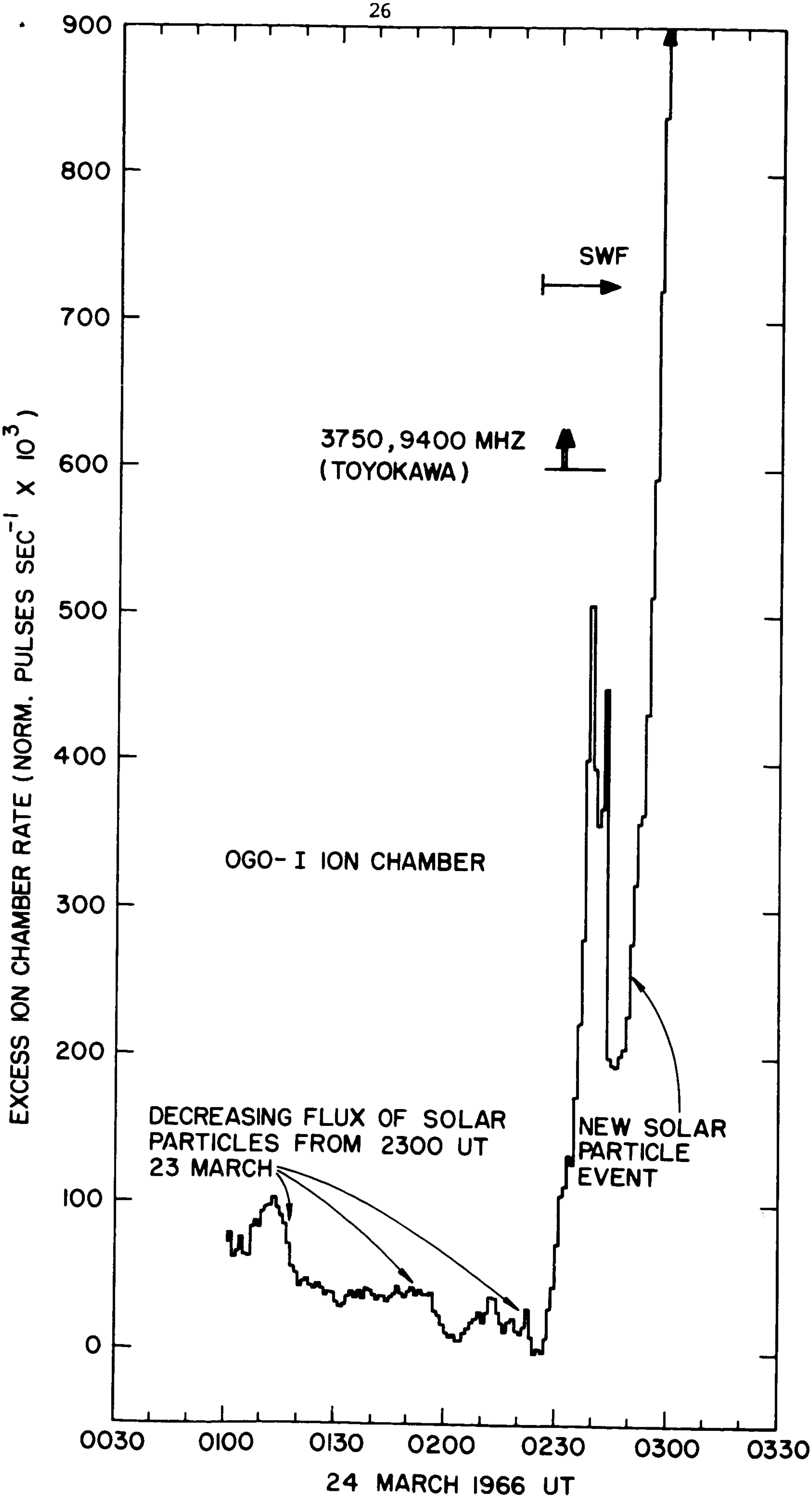


EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1}x 10^{3})
8000
7000
6000
5000
4000
3000
2000
1000
0
SWF
9500, 3000 MHZ
(NERA)
OGO-I ION CHAMBER
0950
0955
1000
1005
1010
1015
1020
1025
1030
20 MARCH 1966 UT

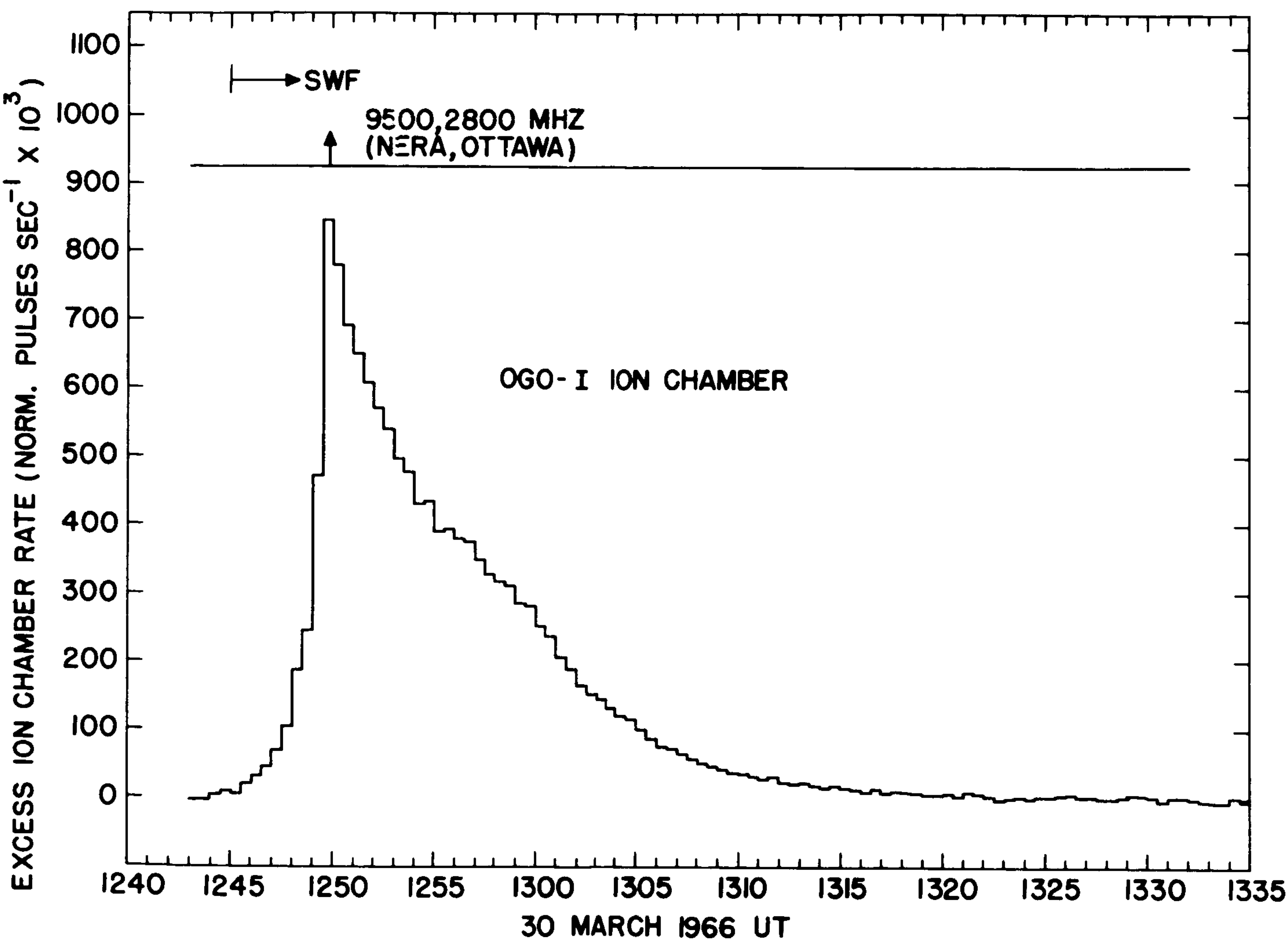


80
70
60
50
40
30
20
10
0
-10
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
9500, 3000 MHZ
(NERA)
OGO-I ION CHAMBER
1030
1035
1040
1045
1050
20 MARCH 1966 UT

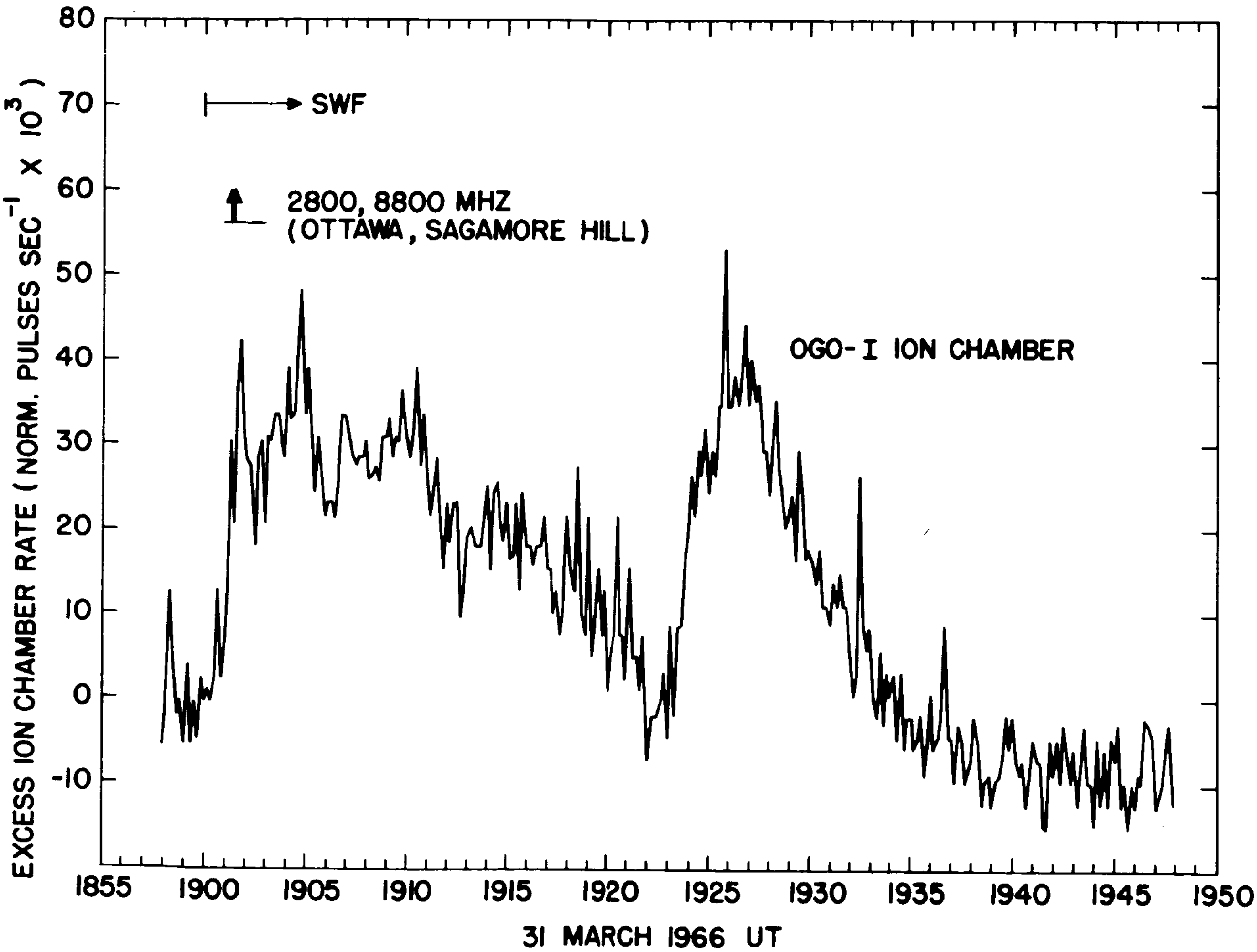

SWF
2800, 8800 MHZ
(OTTAWA SAGAMORE HILL)
2800, 8800 MHZ
(OTTAWA SAGAMORE HILL)
OGO-I ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
40
30
20
10
0
-10
1730
1800
1830
1900
1930
2000
2030
20 MARCH 1966 UT



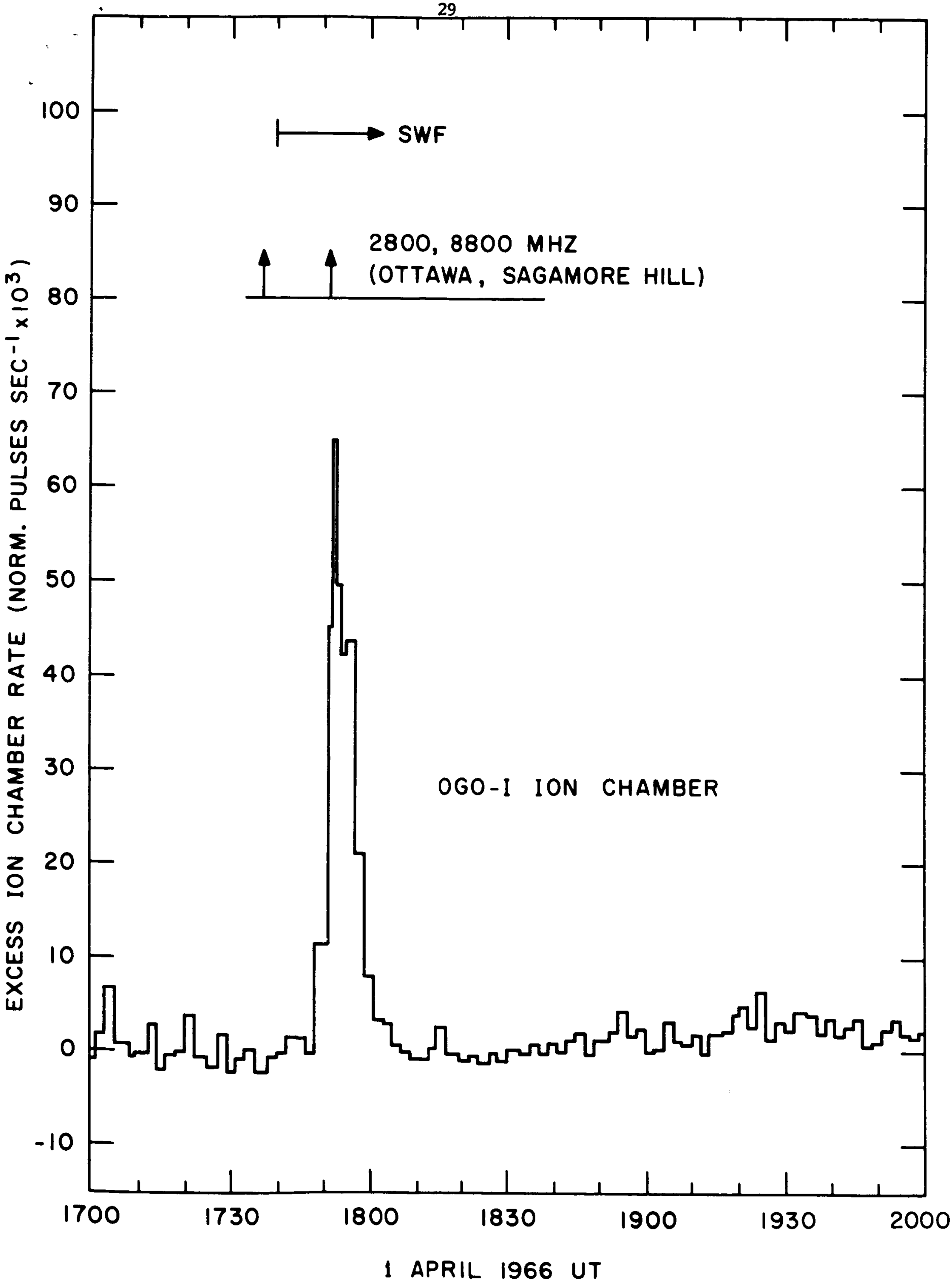
900
800
700
600
500
400
300
200
100
0
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} X 10^3)
SWF
3750, 9400 MHZ
(TOYOKAWA)
OGO- I ION CHAMBER
DECREASING FLUX OF SOLAR PARTICLES FROM 2300 UT 23 MARCH
NEW SOLAR PARTICLE EVENT
0030
0100
0130
0200
0230
0300
0330
24 MARCH 1966 UT

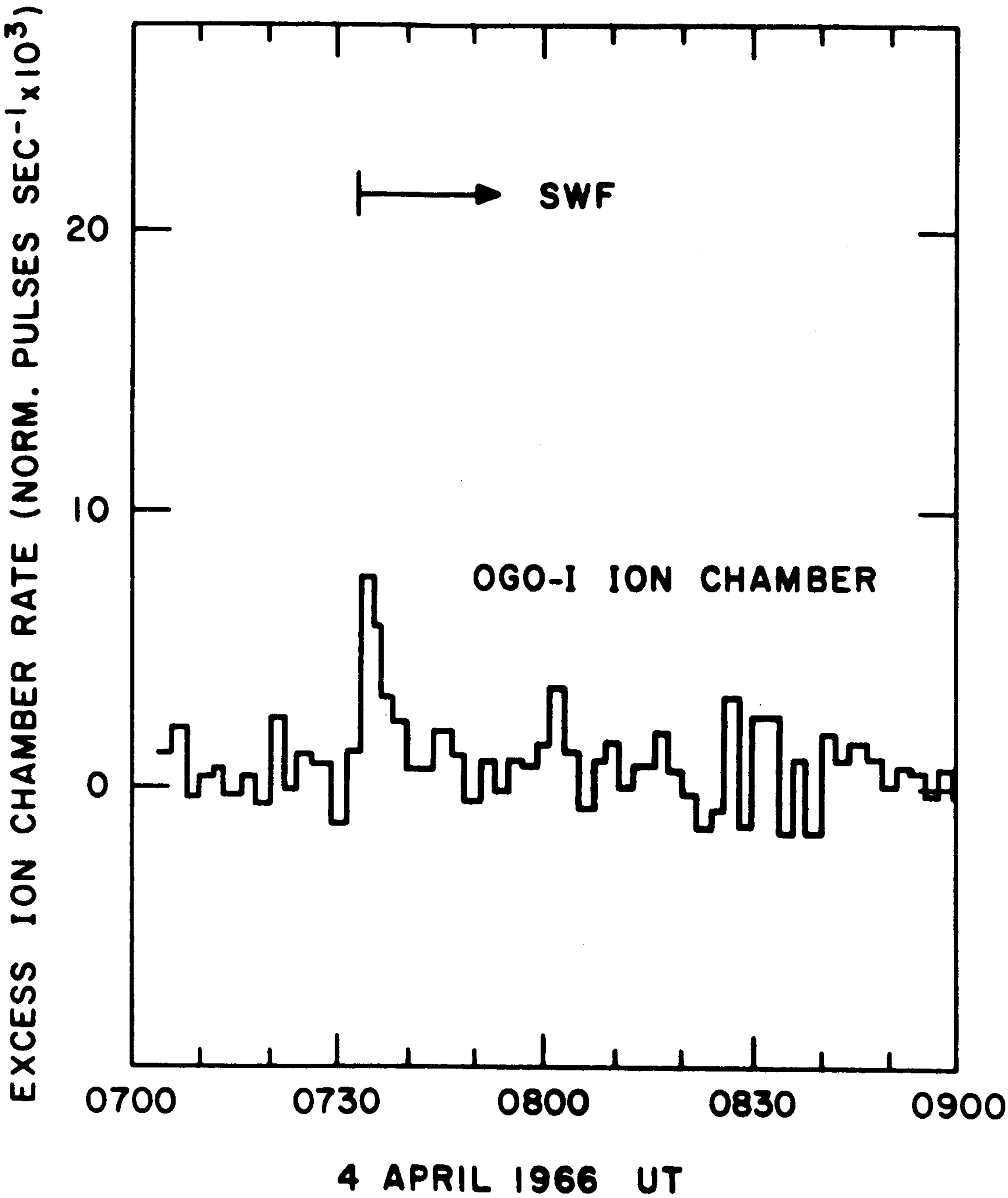


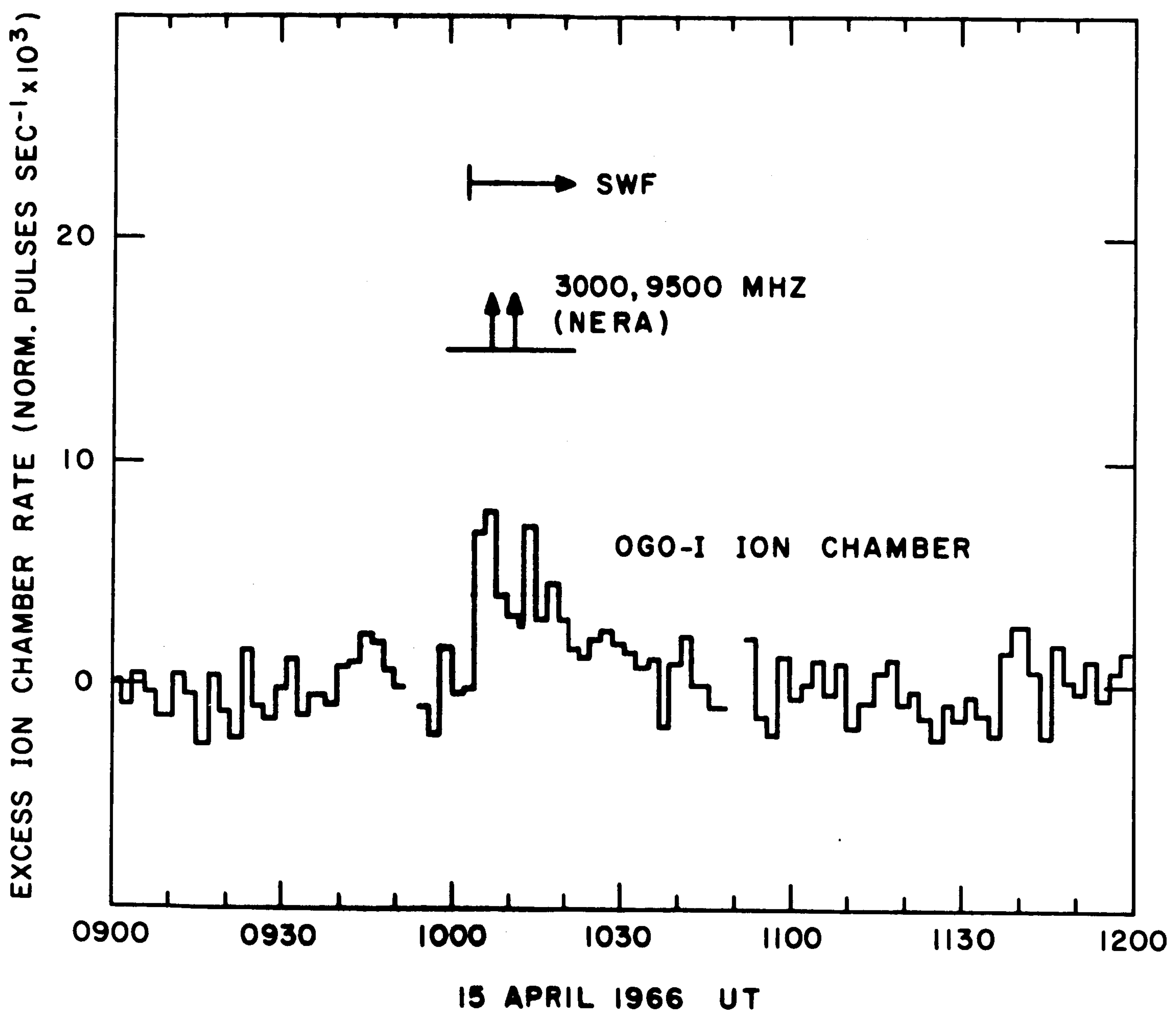
SWF
9500,2800 MHZ
(NERA, OTTAWA)
OGO-I ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} X 10^3)
1100
1000
900
800
700
600
500
400
300
200
100
0
1240
1245
1250
1255
1300
1305
1310
1315
1320
1325
1330
1335
30 MARCH 1966 UT



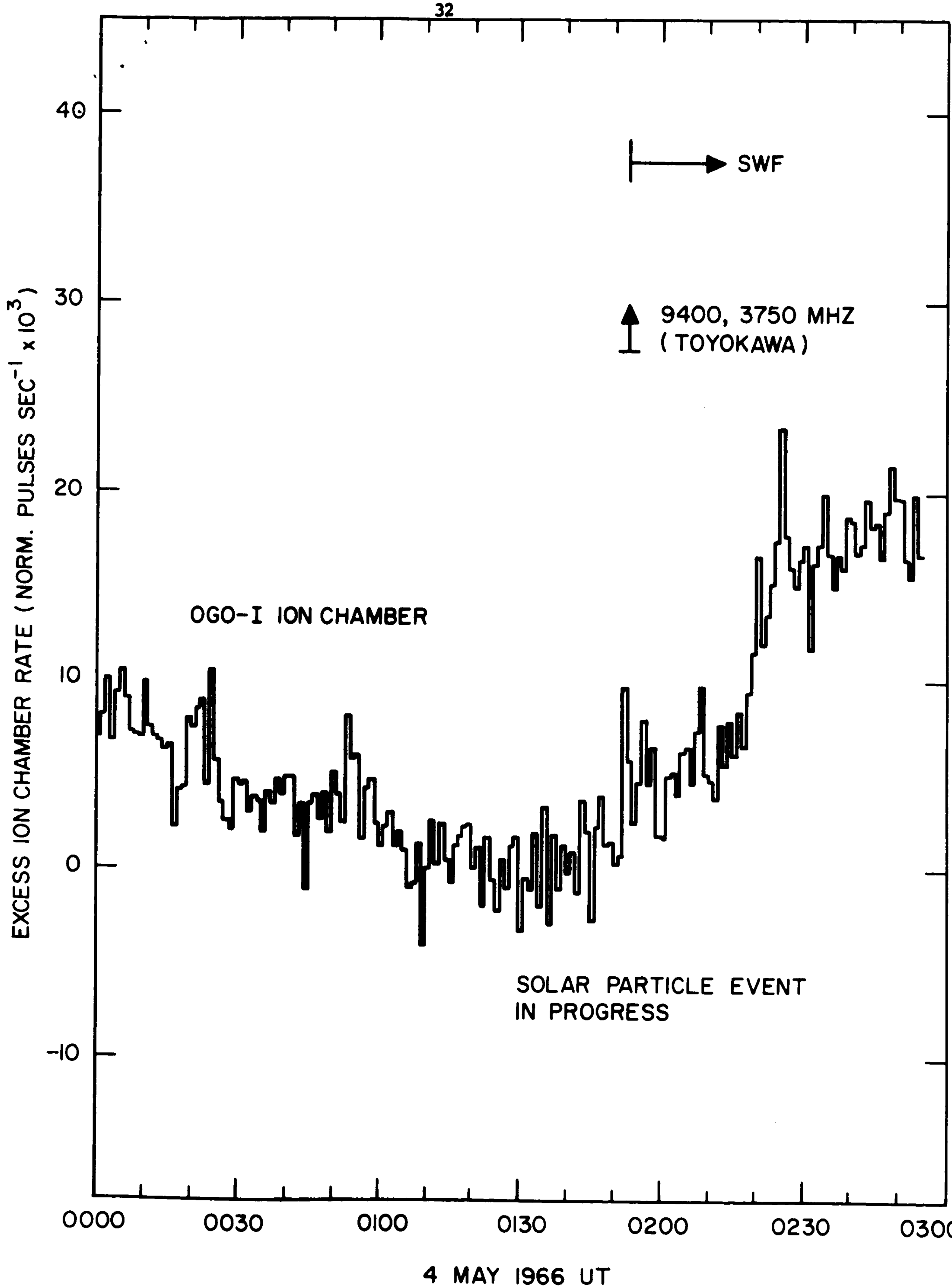
80
70
60
50
40
30
20
10
0
-10
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} X 10^3)
SWF
2800, 8800 MHZ
(OTTAWA, SAGAMORE HILL)
OGO-I ION CHAMBER
1855
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
31 MARCH 1966 UT


SWF
2800, 8800 MHZ
(OTTAWA, SAGAMORE HILL)
OGO-I ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
100
90
80
70
60
50
40
30
20
10
0
-10
1700
1730
1800
1830
1900
1930
2000
1 APRIL 1966 UT

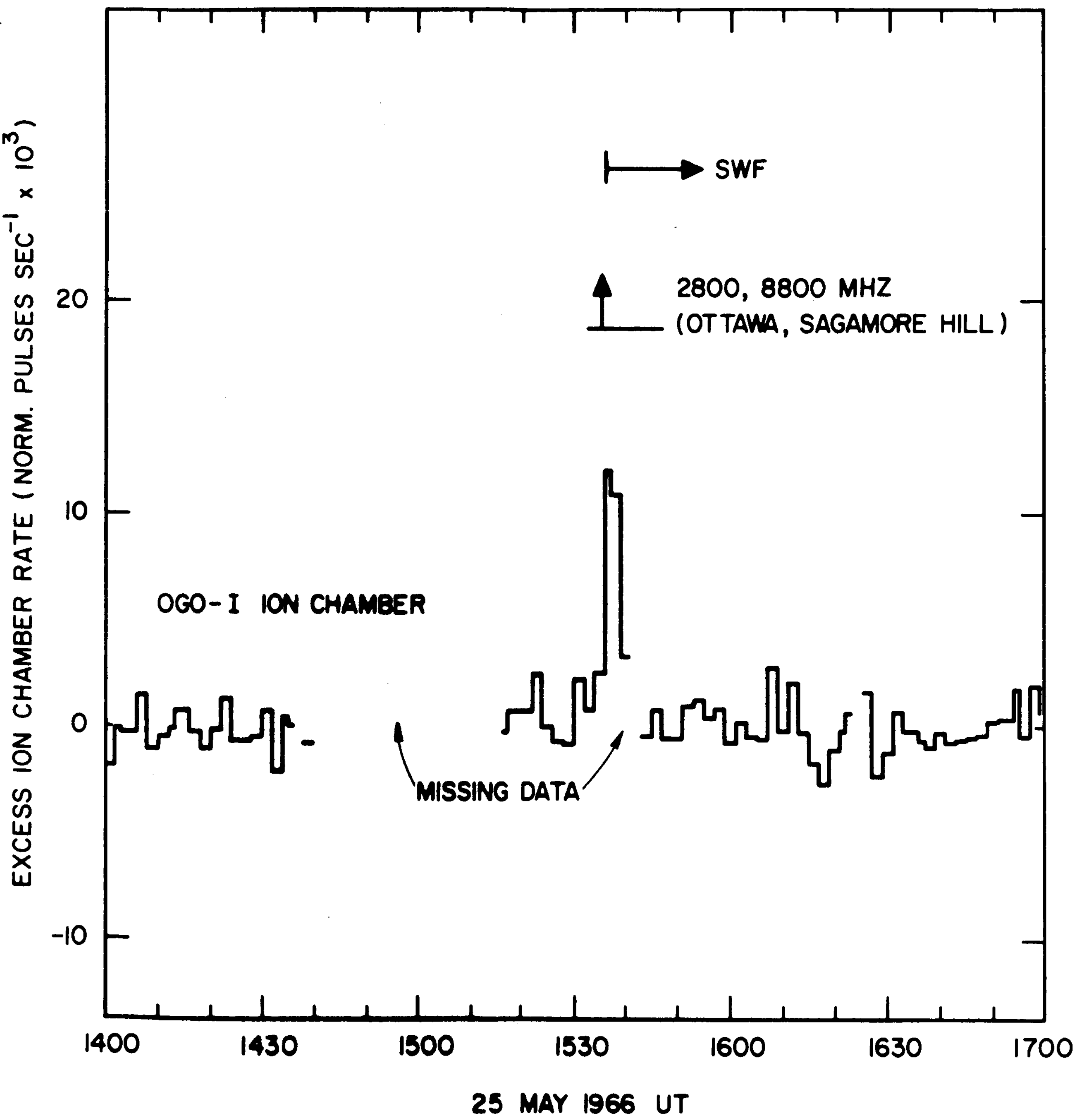

EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
20
10
0
SWF
OGO-I ION CHAMBER
0700
0730
0800
0830
0900
4 APRIL 1966 UT

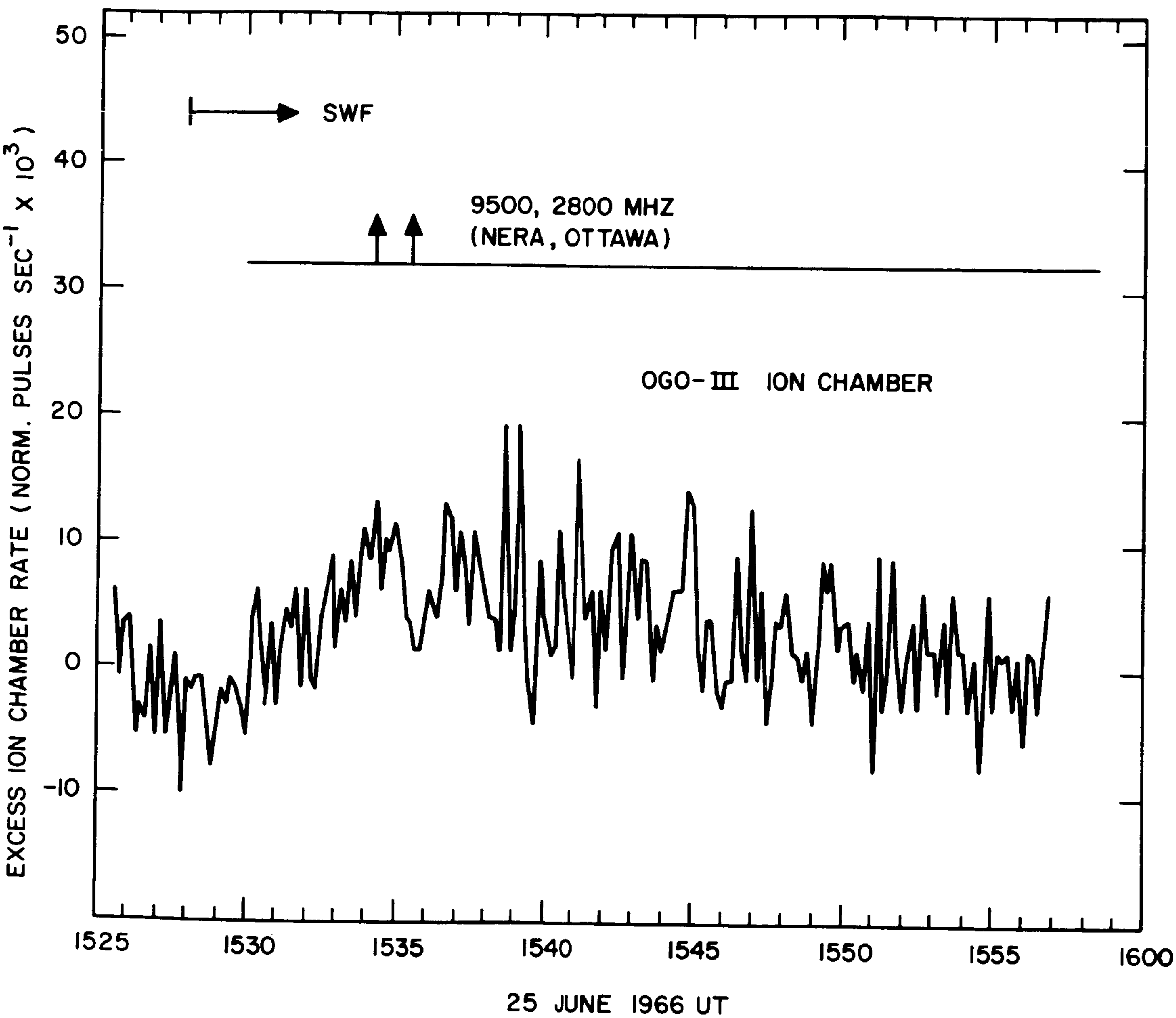


SWF
3000, 9500 MHZ
(NERA)
OGO-I ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
20
10
0
0900
0930
1000
1030
1100
1130
1200
15 APRIL 1966 UT

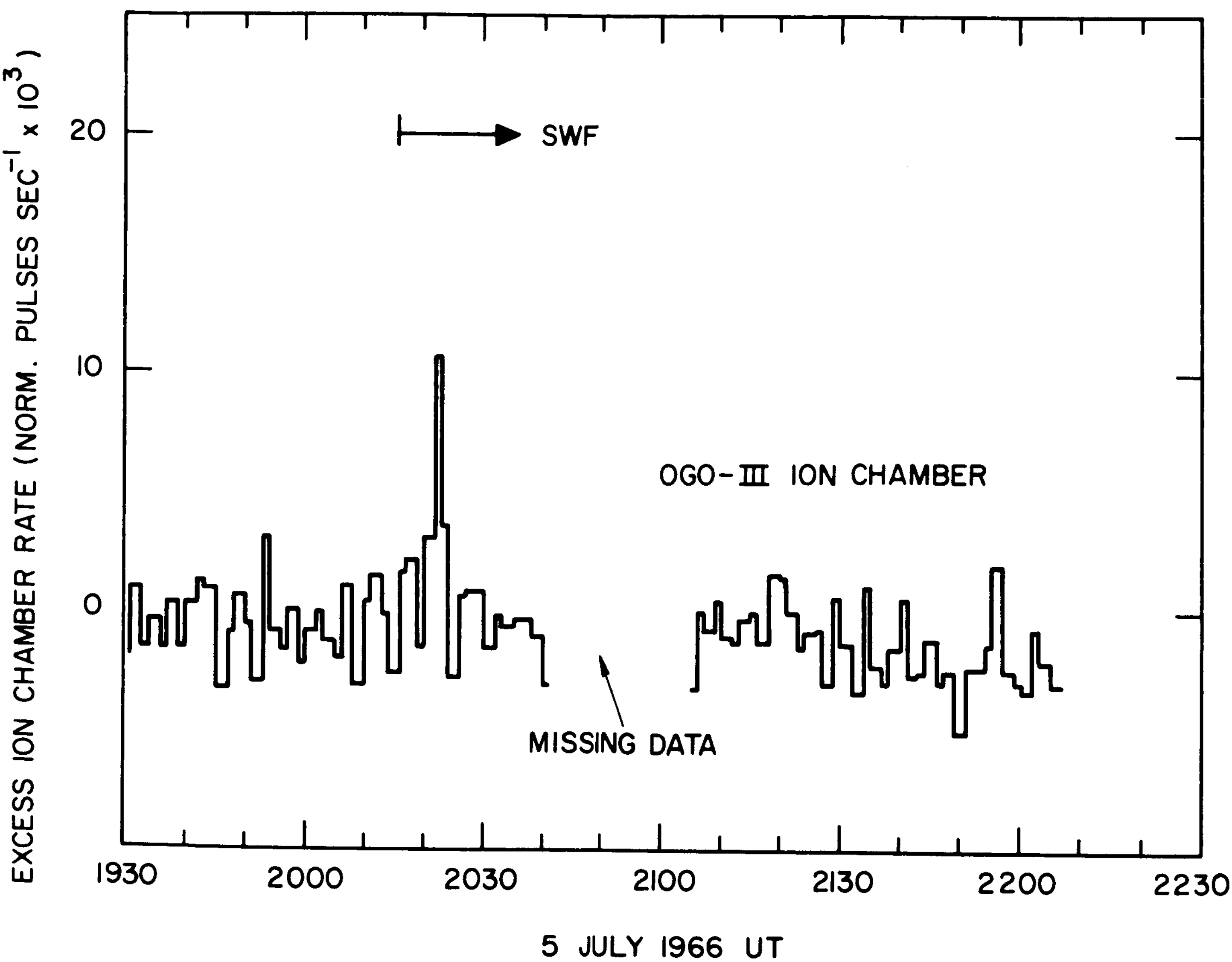


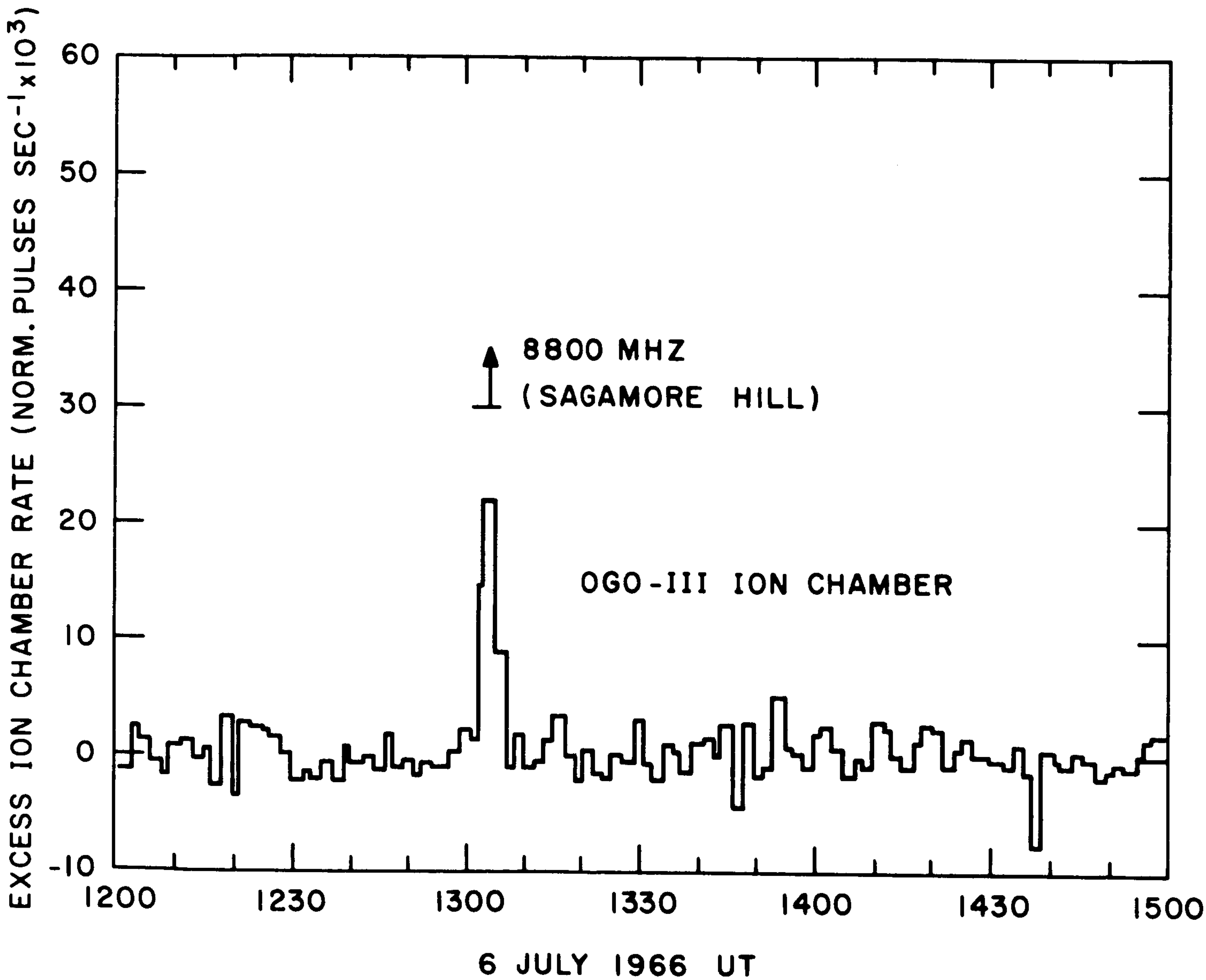
40
30
20
10
0
-10
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^{3})
SWF
9400, 3750 MHZ
(TOYOKAWA)
OGO-I ION CHAMBER
SOLAR PARTICLE EVENT
IN PROGRESS
0000
0030
0100
0130
0200
0230
0300
4 MAY 1966 UT

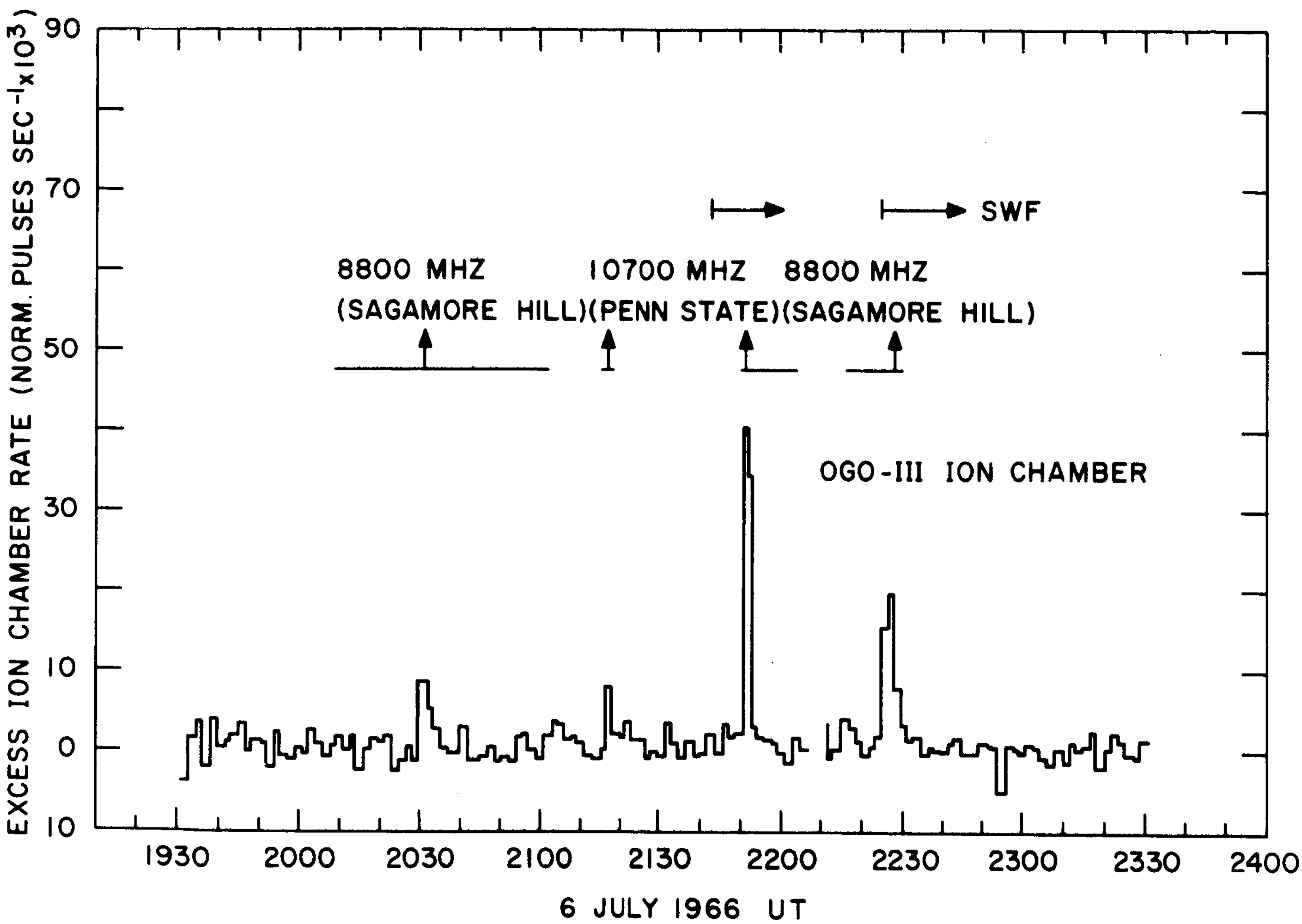

EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
20
10
0
-10
SWF
2800, 8800 MHZ
(OTTAWA, SAGAMORE HILL)
OGO-I ION CHAMBER
MISSING DATA
1400
1430
1500
1530
1600
1630
1700
25 MAY 1966 UT

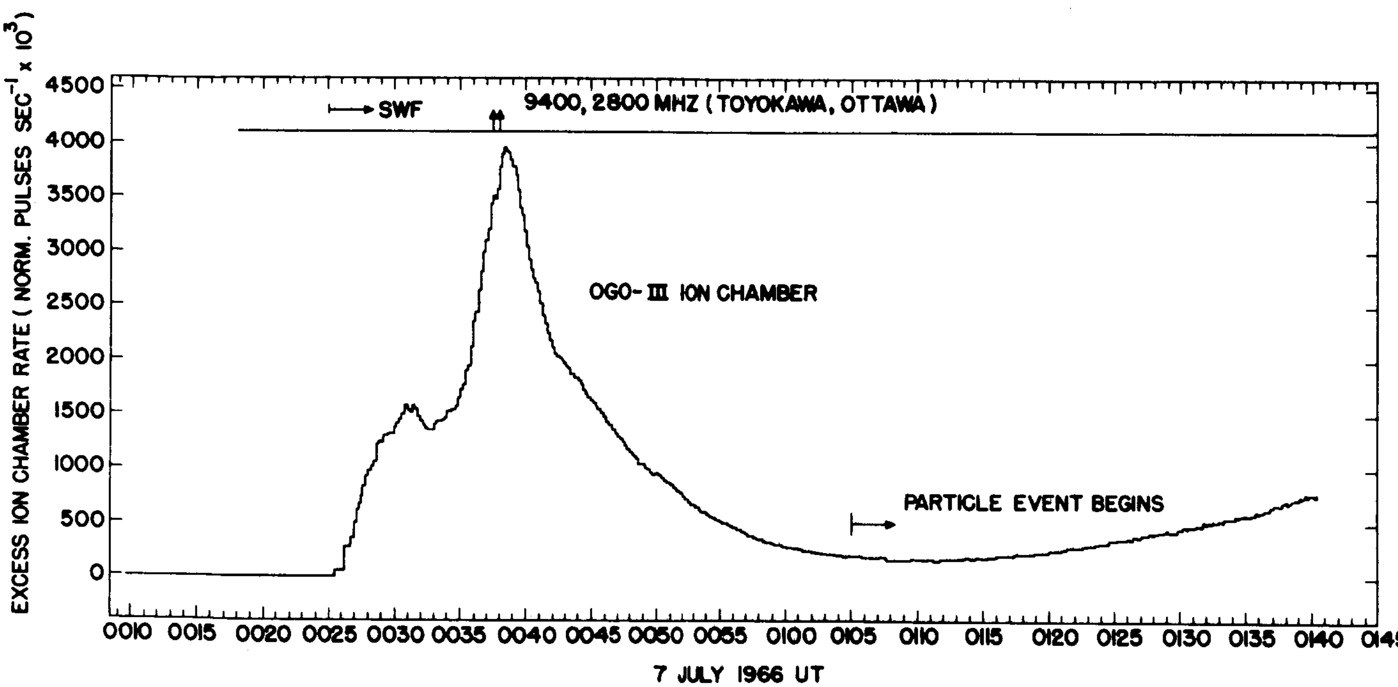


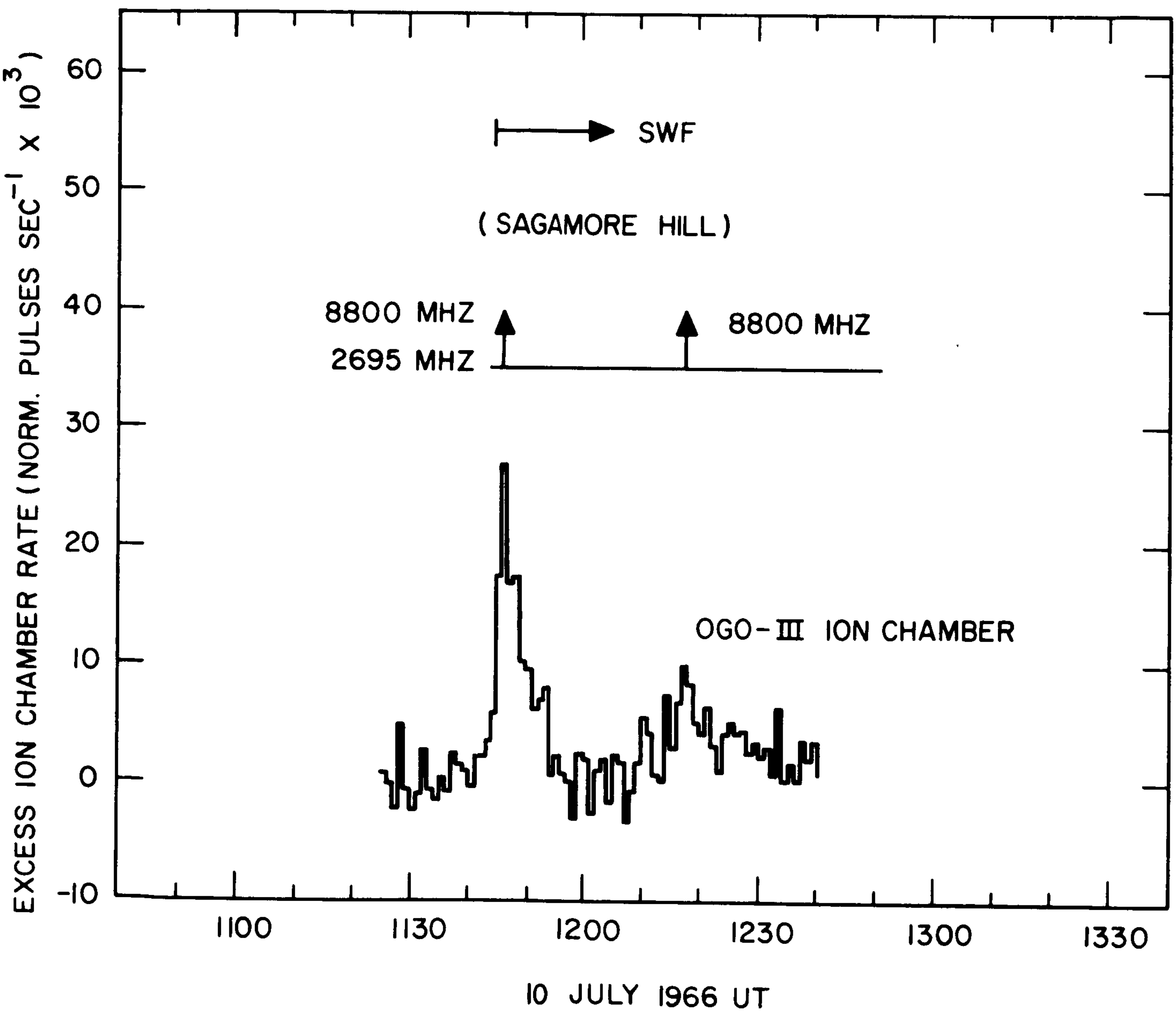
SWF
9500, 2800 MHZ
(NERA, OTTAWA)
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
50
40
30
20
10
0
-10
1525
1530
1535
1540
1545
1550
1555
1600
25 JUNE 1966 UT

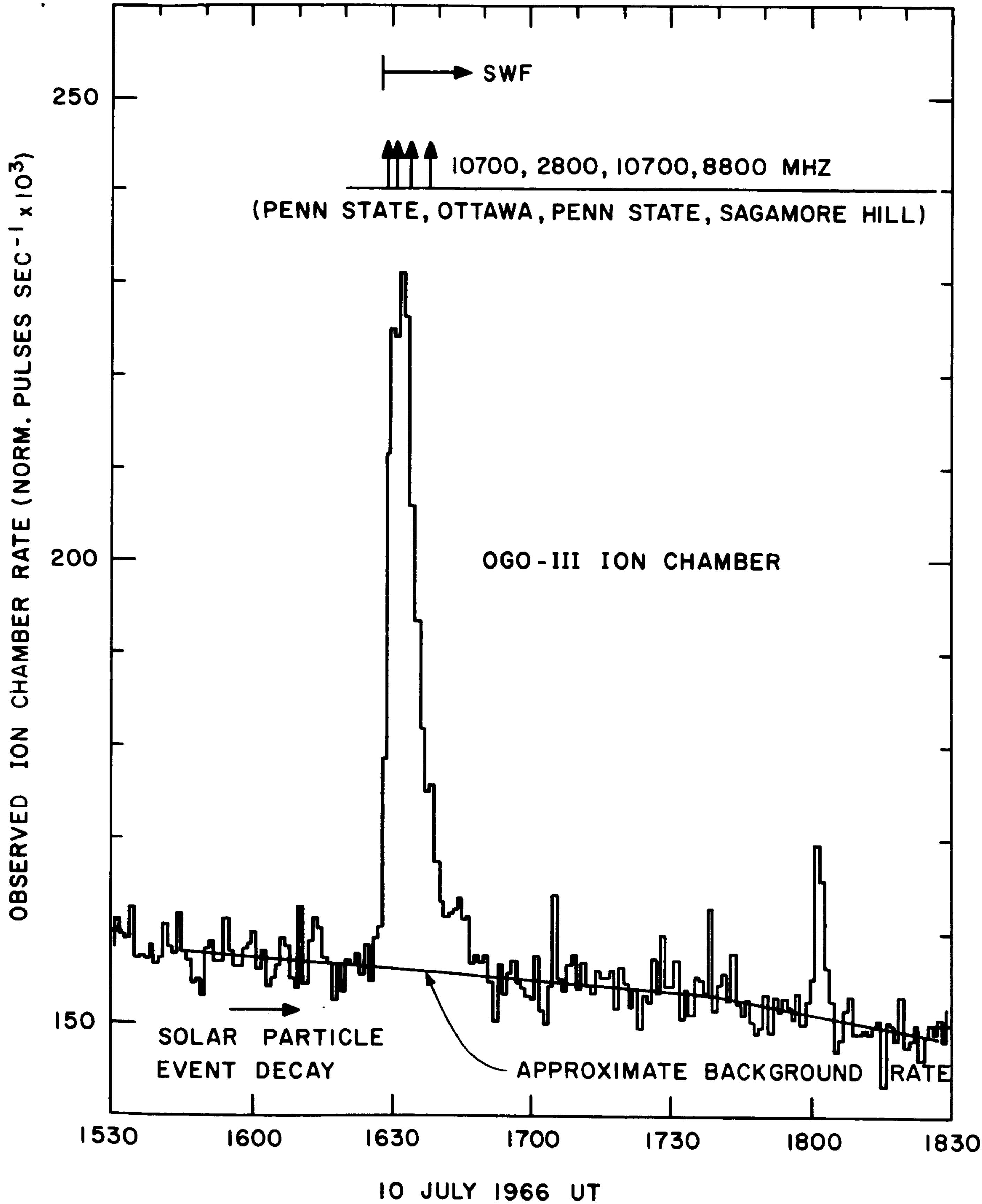

EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
20
10
0
SWF
OGO-III ION CHAMBER
MISSING DATA
1930
2000
2030
2100
2130
2200
2230
5 JULY 1966 UT


EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1}x10^{3})
60
50
40
30
20
10
0
-10
8800 MHZ
(SAGAMORE HILL)
OGO-III ION CHAMBER
1200
1230
1300
1330
1400
1430
1500
6 JULY 1966 UT

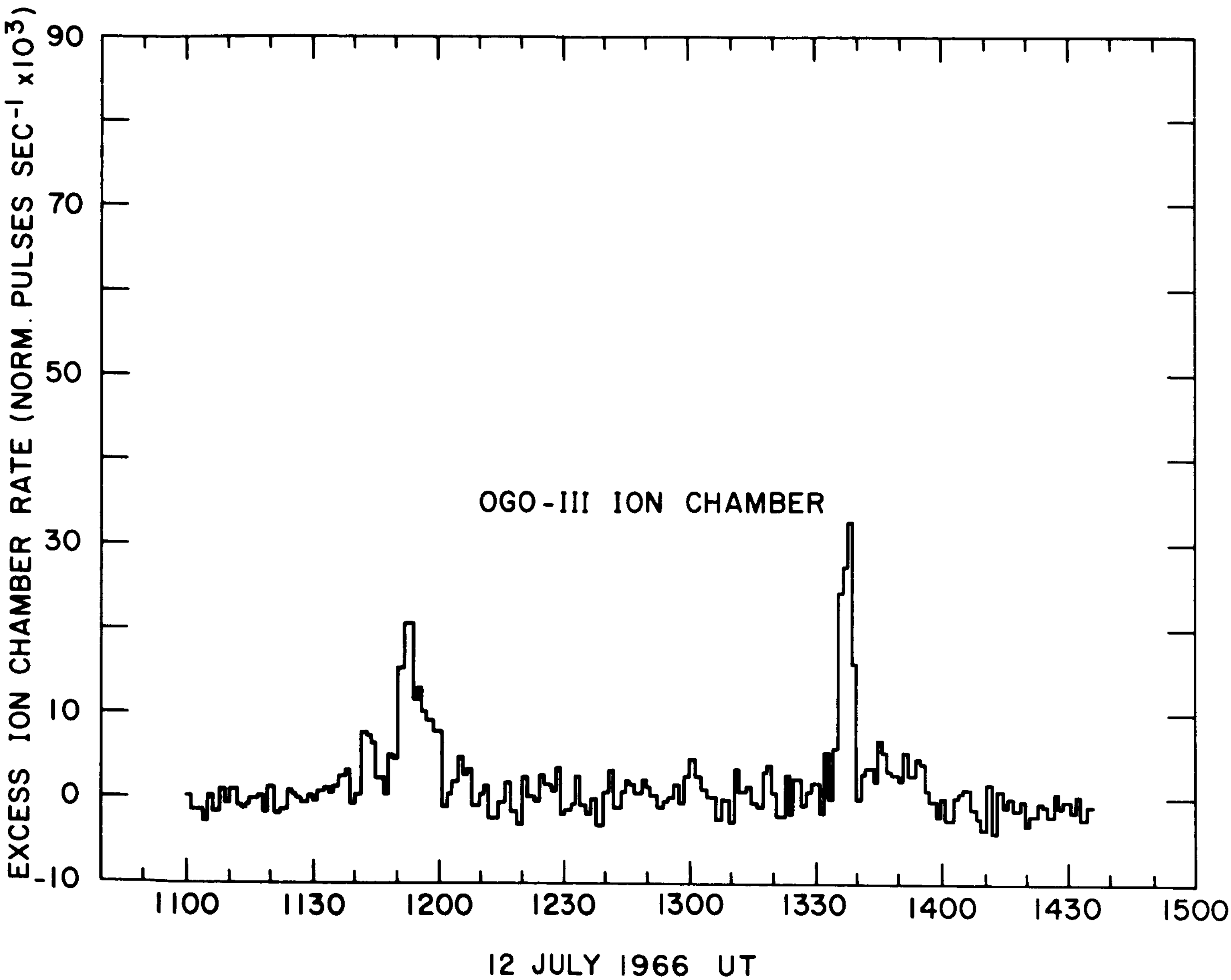

EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1}x10^3)
90
70
50
30
10
0
10
SWF
8800 MHZ
(SAGAMORE HILL)
10700 MHZ
(PENN STATE)
8800 MHZ
(SAGAMORE HILL)
OGO-III ION CHAMBER
1930
2000
2030
2100
2130
2200
2230
2300
2330
2400
6 JULY 1966 UT


EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
SWF
9400, 2800 MHZ (TOYOKAWA, OTTAWA)
OGO- III ION CHAMBER
PARTICLE EVENT BEGINS
0010 0015 0020 0025 0030 0035 0040 0045 0050 0055 0100 0105 0110 0115 0120 0125 0130 0135 0140 0145
7 JULY 1966 UT

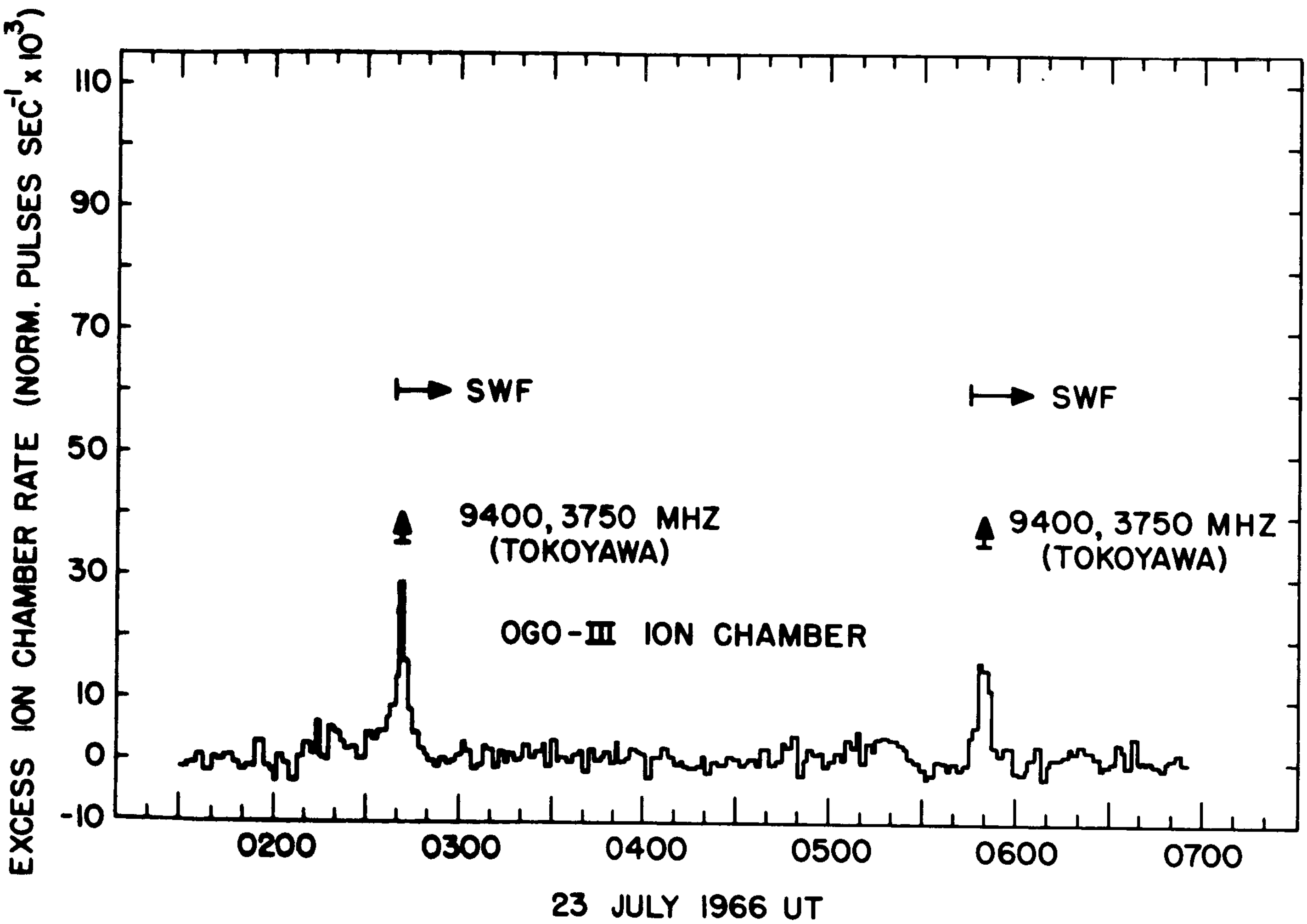

SWF
(SAGAMORE HILL)
8800 MHZ
2695 MHZ
8800 MHZ
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
60
50
40
30
20
10
0
-10
1100
1130
1200
1230
1300
1330
10 JULY 1966 UT



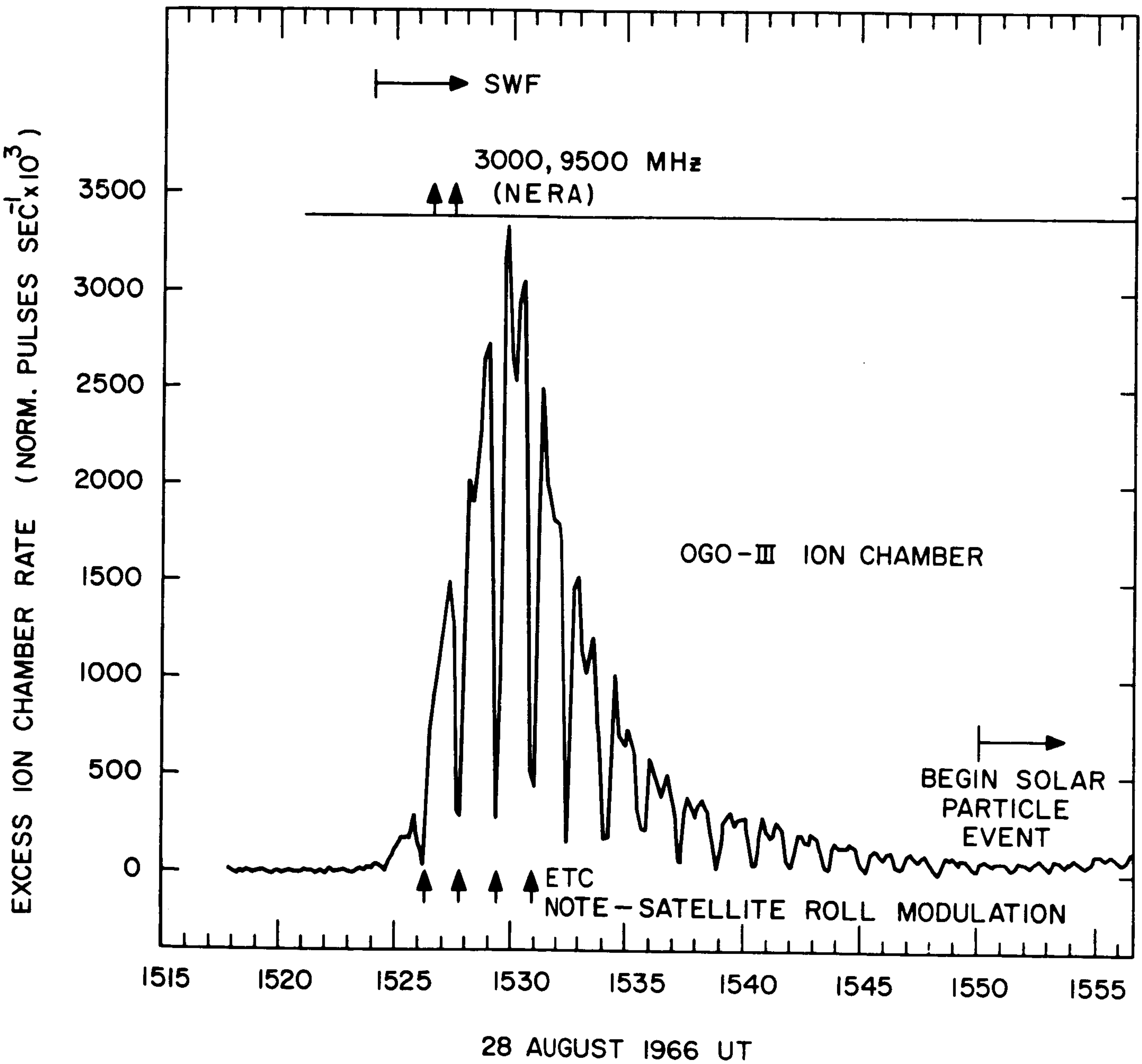
SWF
10700, 2800, 10700, 8800 MHZ
(PENN STATE, OTTAWA, PENN STATE, SAGAMORE HILL)
OGO-III ION CHAMBER
SOLAR PARTICLE EVENT DECAY
APPROXIMATE BACKGROUND RATE
250
200
150
1530
1600
1630
1700
1730
1800
1830
10 JULY 1966 UT
OBSERVED ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)



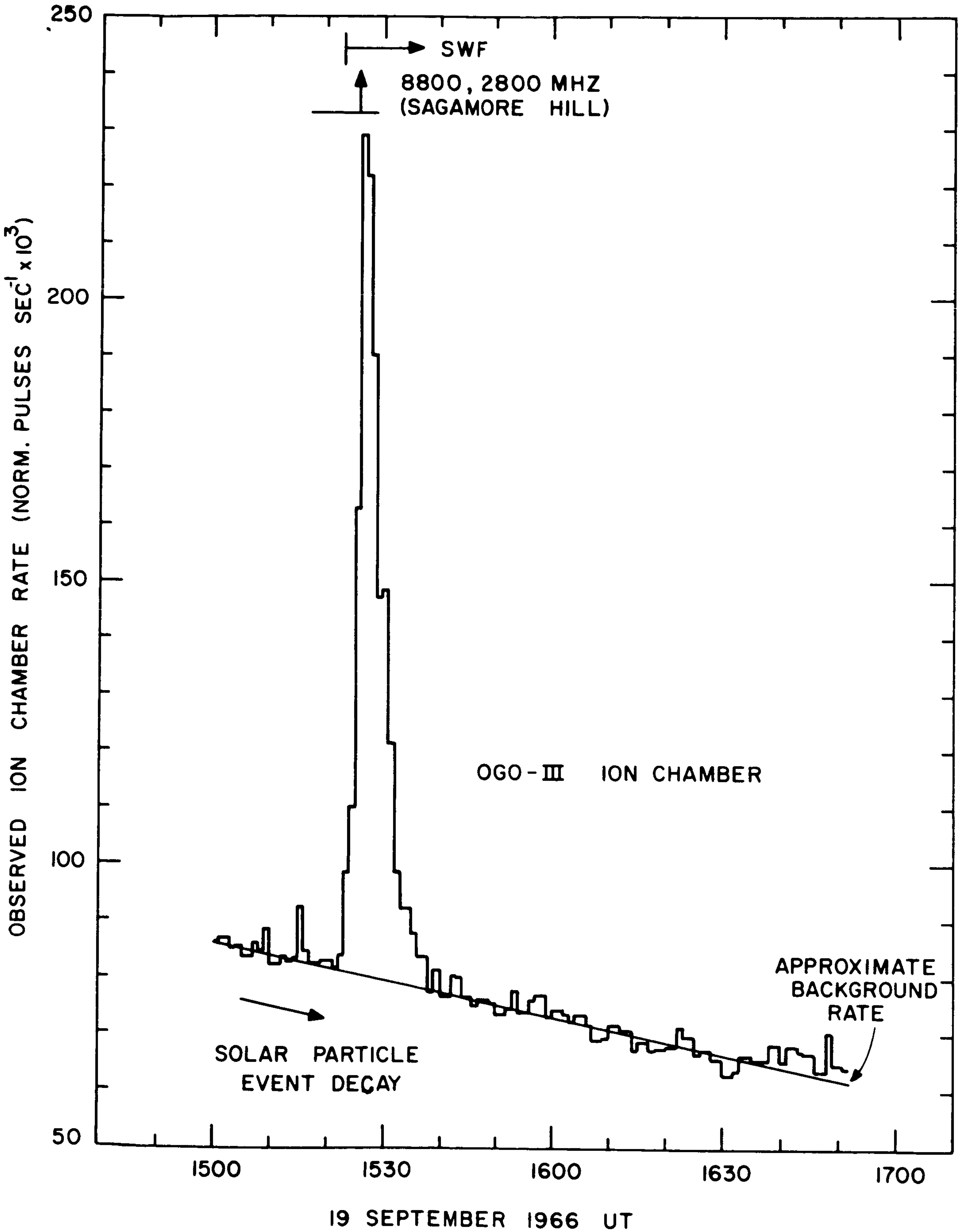
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x10^3)
90
70
50
30
10
0
-10
OGO-III ION CHAMBER
1100
1130
1200
1230
1300
1330
1400
1430
1500
12 JULY 1966 UT

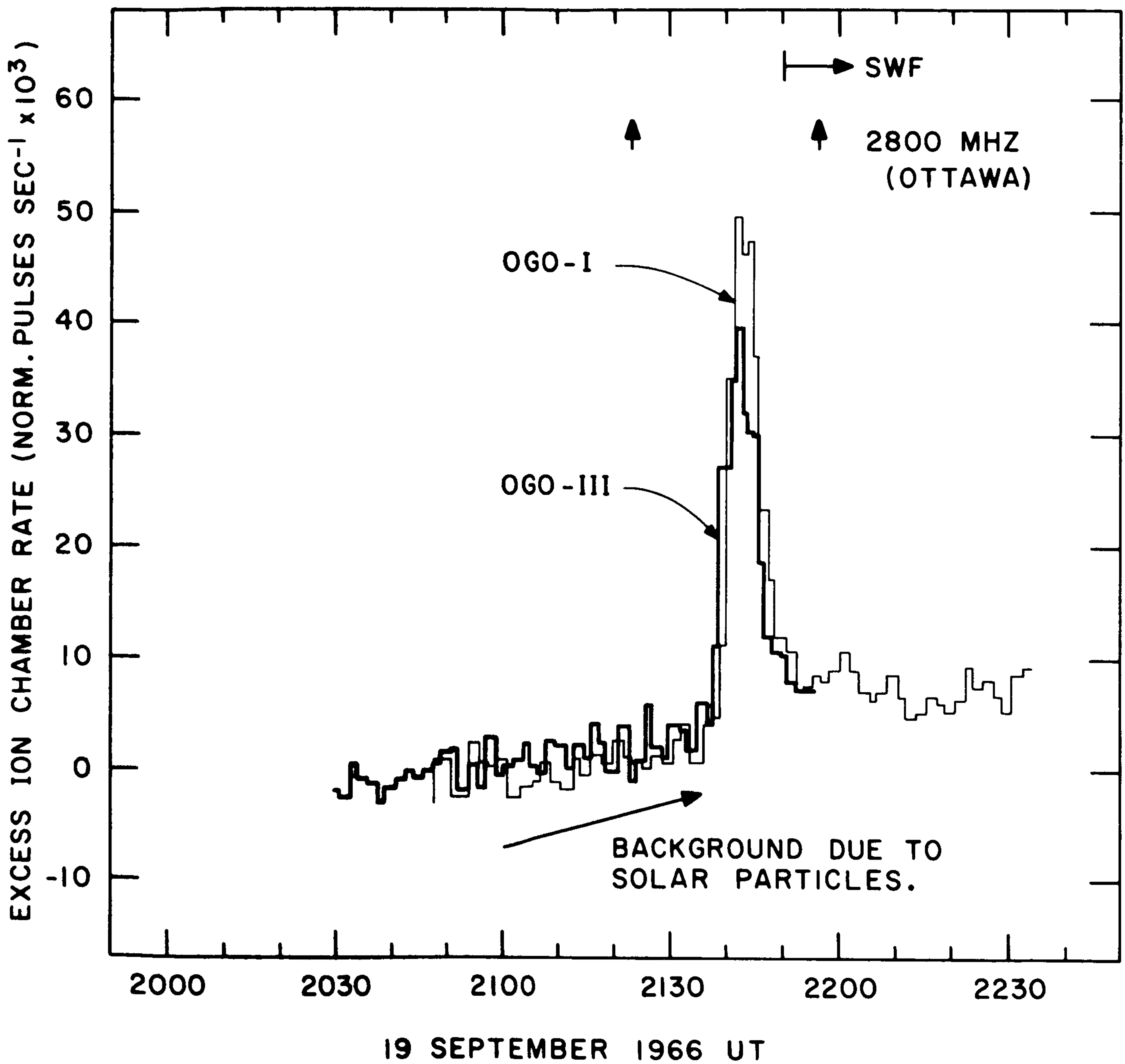


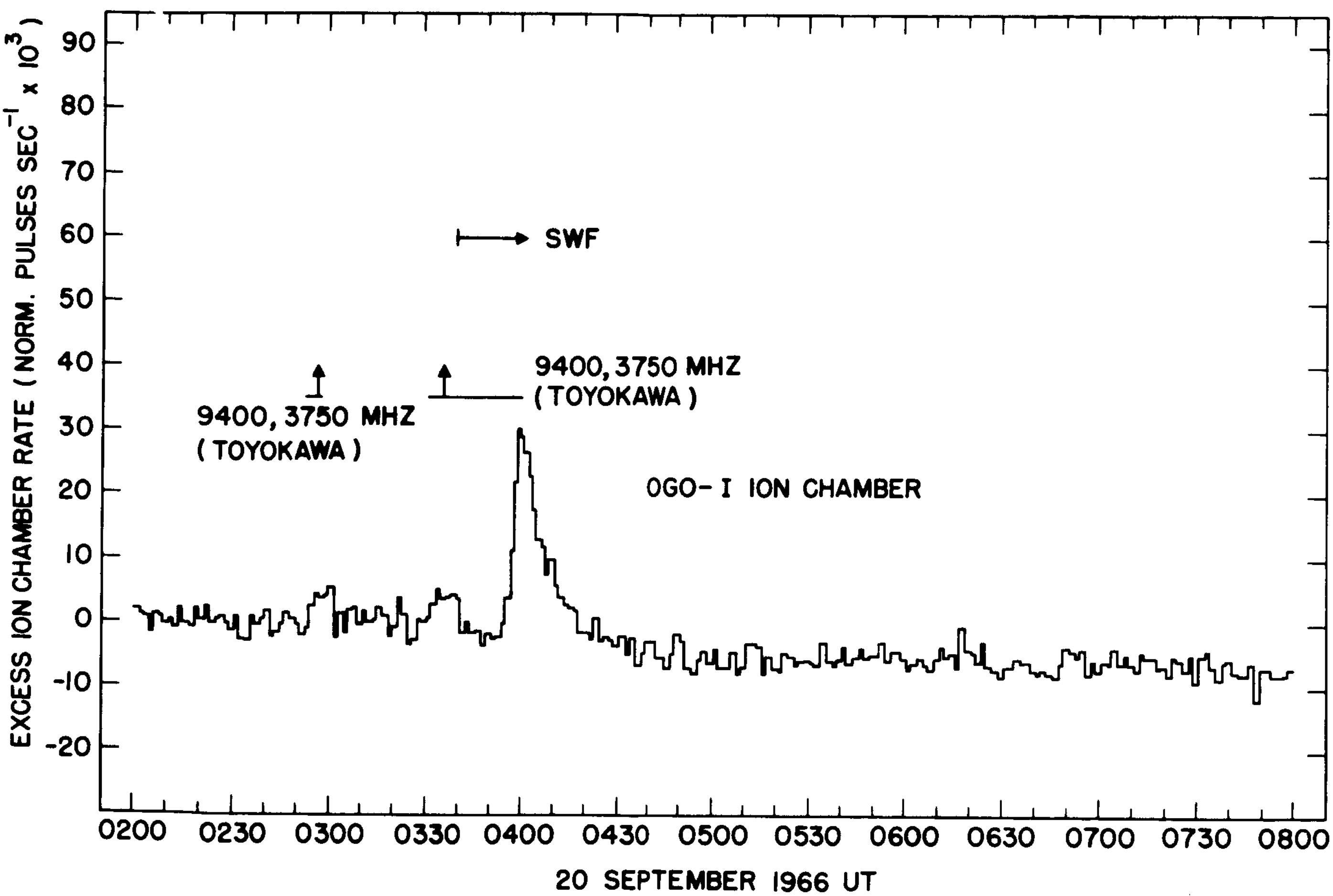
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
110
90
70
50
30
10
0
-10
0200
0300
0400
0500
0600
0700
23 JULY 1966 UT
SWF
9400, 3750 MHZ
(TOKOYAWA)
OGO-III ION CHAMBER
SWF
9400, 3750 MHZ
(TOKOYAWA)

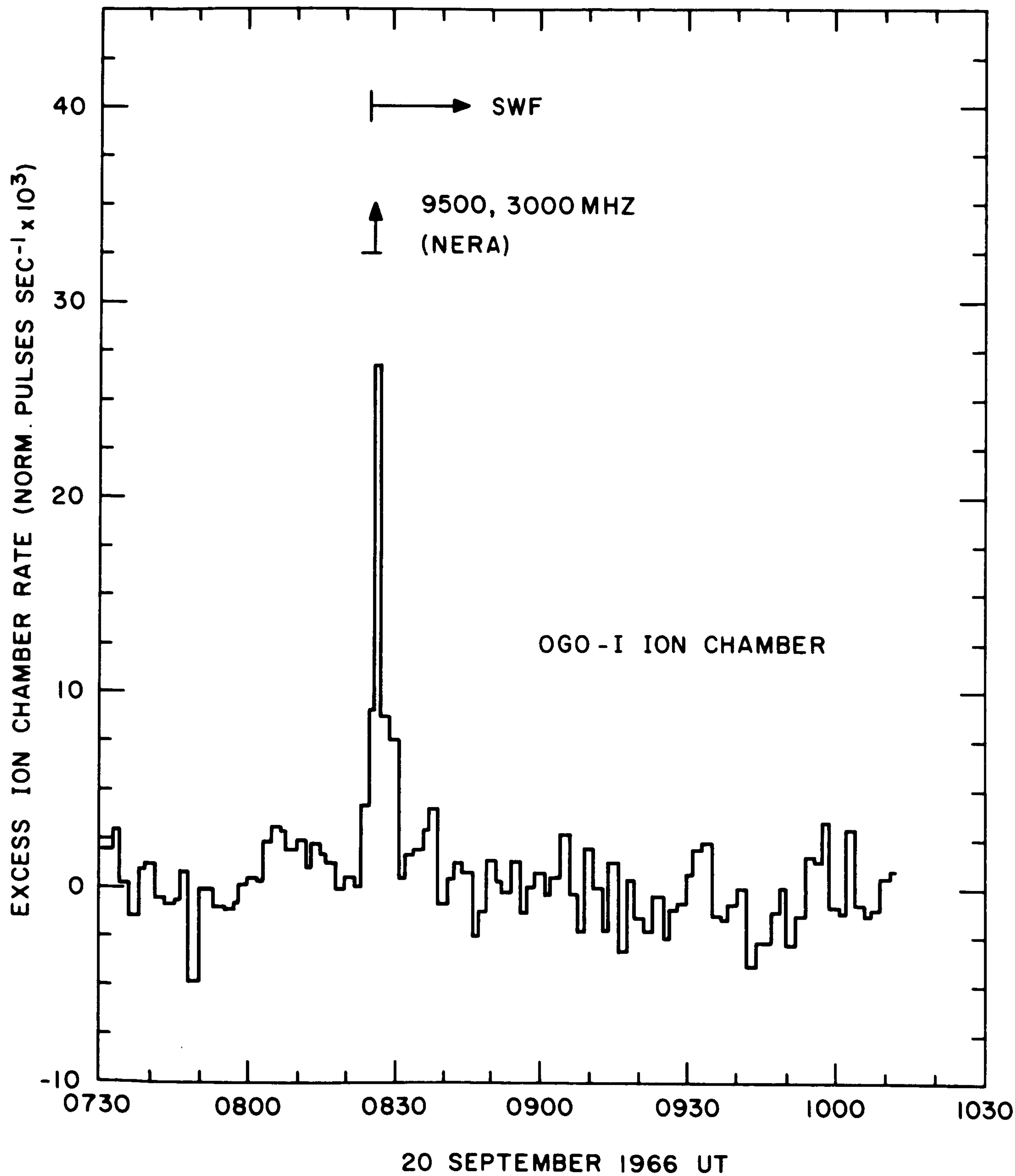


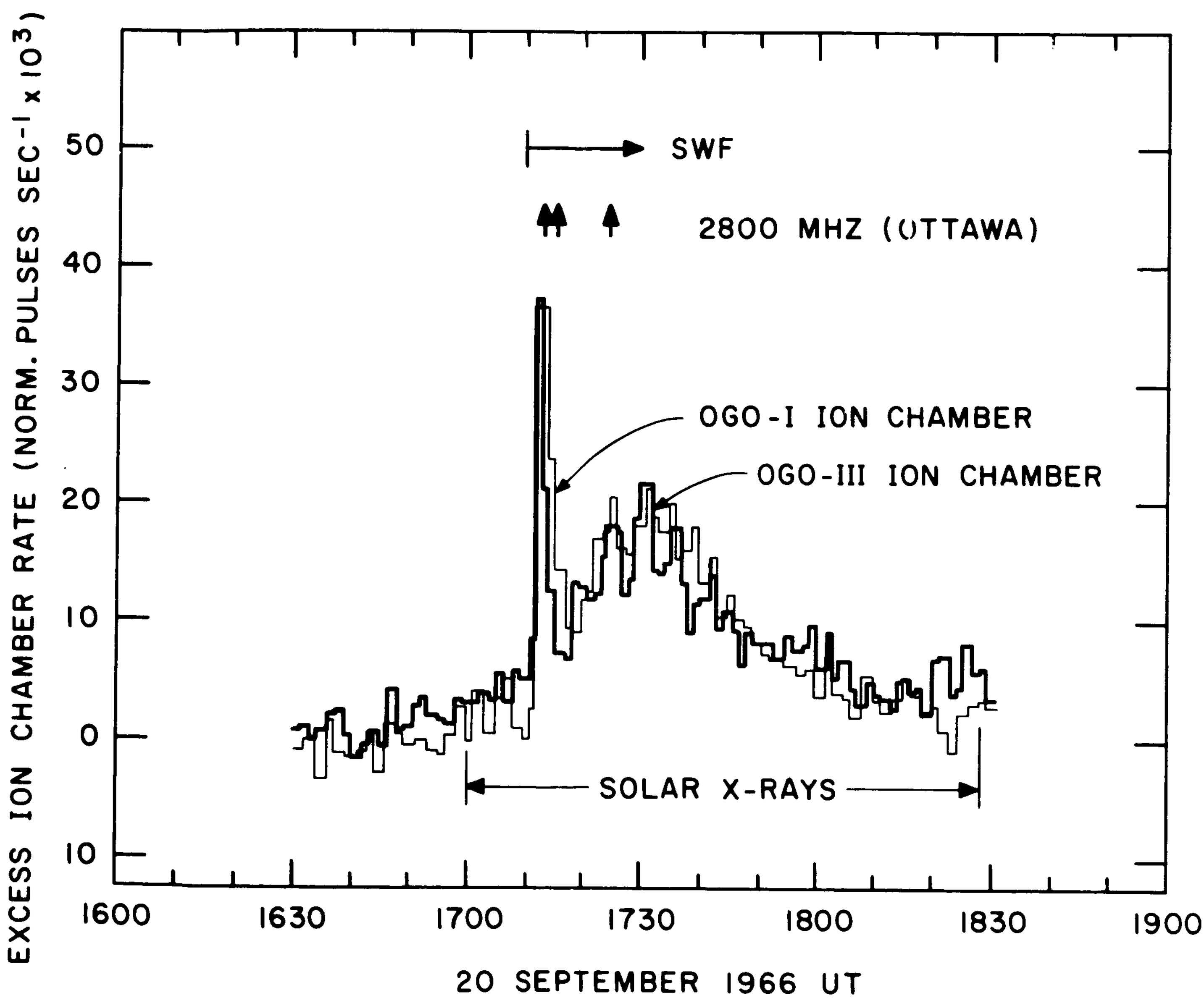
SWF
3000, 9500 MHz
(NERA)
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^{3})
3500
3000
2500
2000
1500
1000
500
0
OGO-III ION CHAMBER
BEGIN SOLAR PARTICLE EVENT
ETC
NOTE—SATELLITE ROLL MODULATION
1515
1520
1525
1530
1535
1540
1545
1550
1555
28 AUGUST 1966 UT


SWF
8800, 2800 MHZ
(SAGAMORE HILL)
OBSERVED ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
250
200
150
100
50
OGO-III ION CHAMBER
APPROXIMATE BACKGROUND RATE
SOLAR PARTICLE EVENT DECAY
1500
1530
1600
1630
1700
19 SEPTEMBER 1966 UT

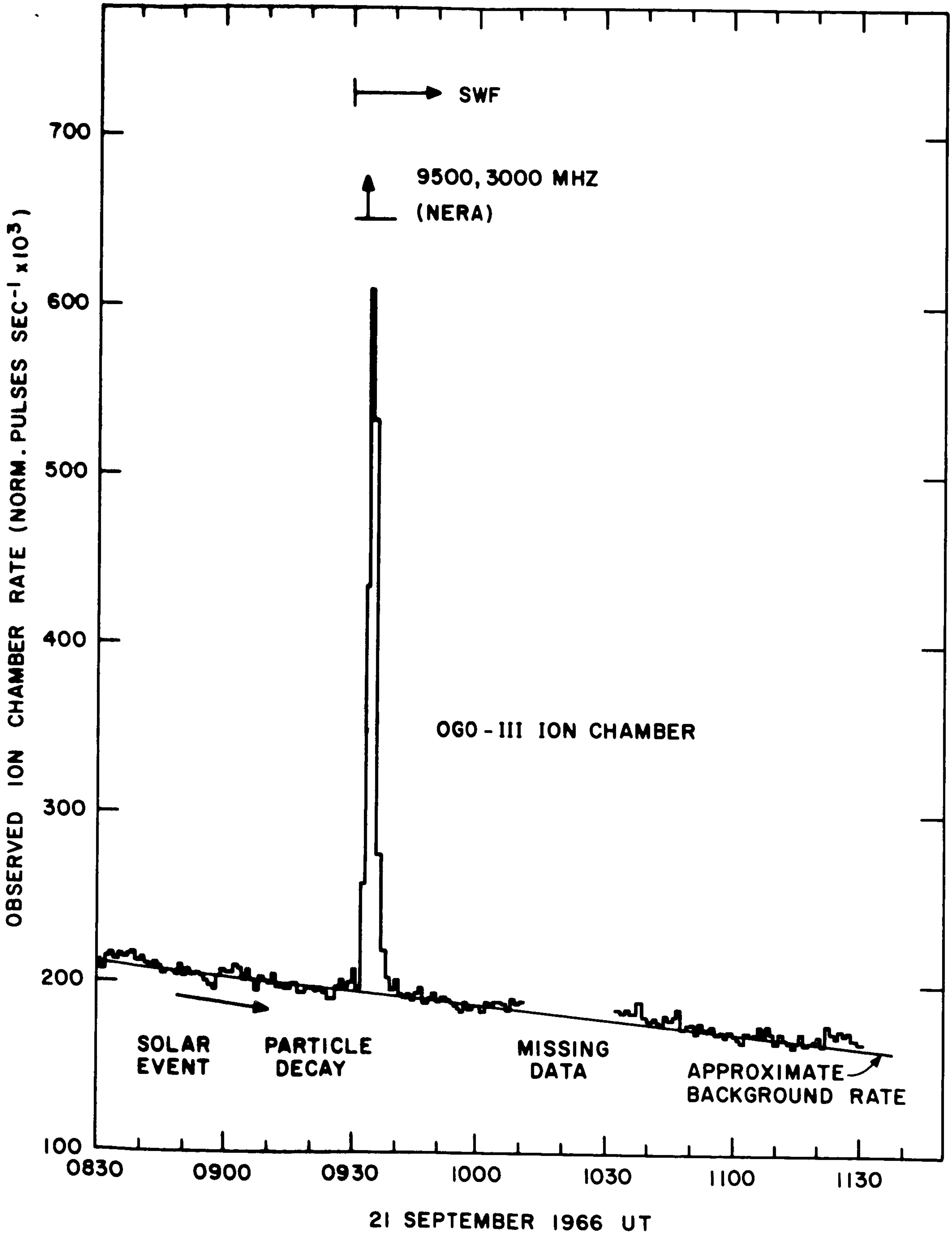

SWF
2800 MHZ
(OTTAWA)
OGO-I
OGO-III
BACKGROUND DUE TO
SOLAR PARTICLES.
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
60
50
40
30
20
10
0
-10
2000
2030
2100
2130
2200
2230
19 SEPTEMBER 1966 UT


EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
90
80
70
60
50
40
30
20
10
0
-10
-20
SWF
9400, 3750 MHZ
(TOYOKAWA)
9400, 3750 MHZ
(TOYOKAWA)
OGO- I ION CHAMBER
0200
0230
0300
0330
0400
0430
0500
0530
0600
0630
0700
0730
0800
20 SEPTEMBER 1966 UT

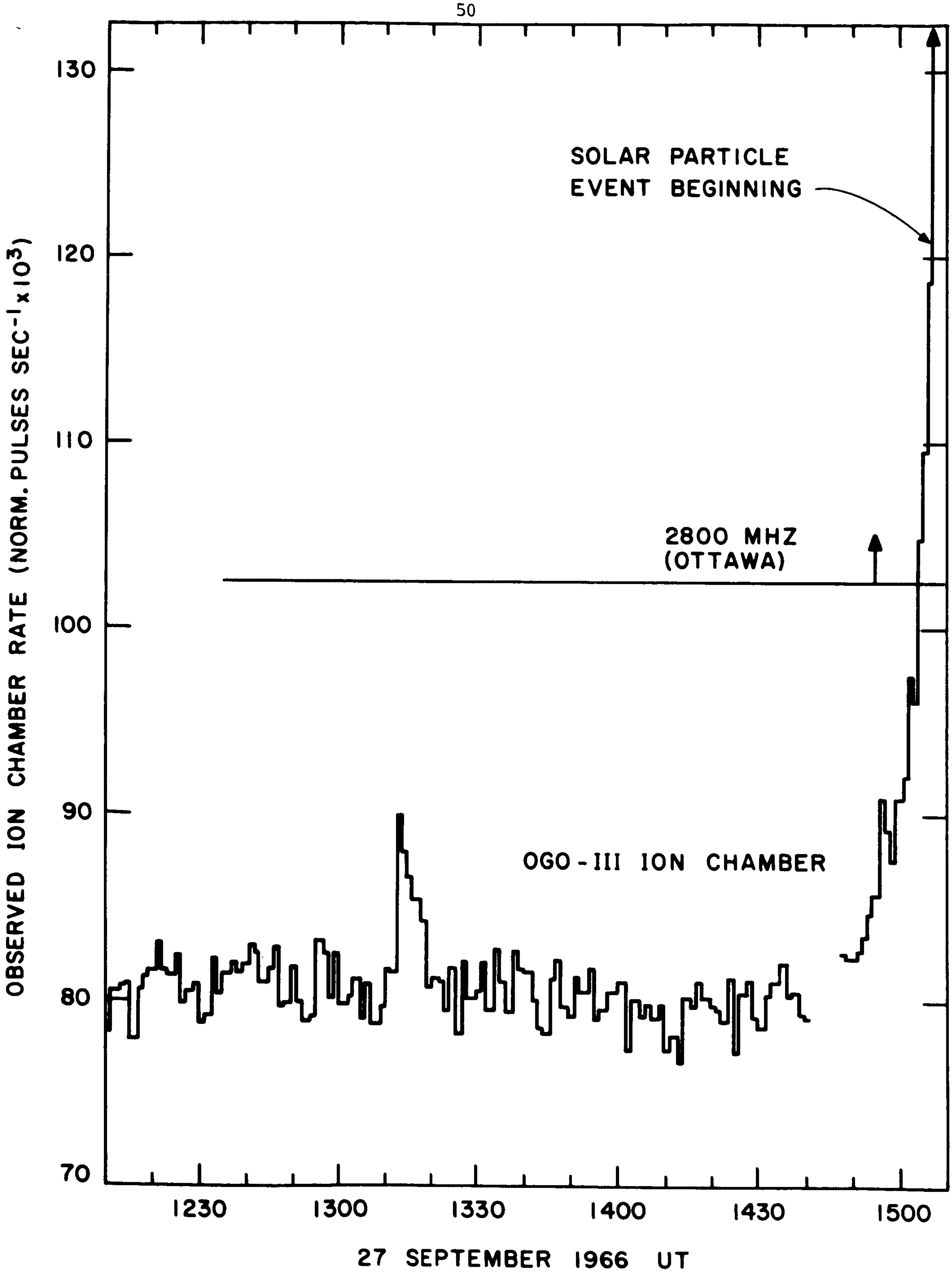

SWF
9500, 3000 MHZ
(NERA)
OGO-I ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
40
30
20
10
0
-10
0730
0800
0830
0900
0930
1000
1030
20 SEPTEMBER 1966 UT



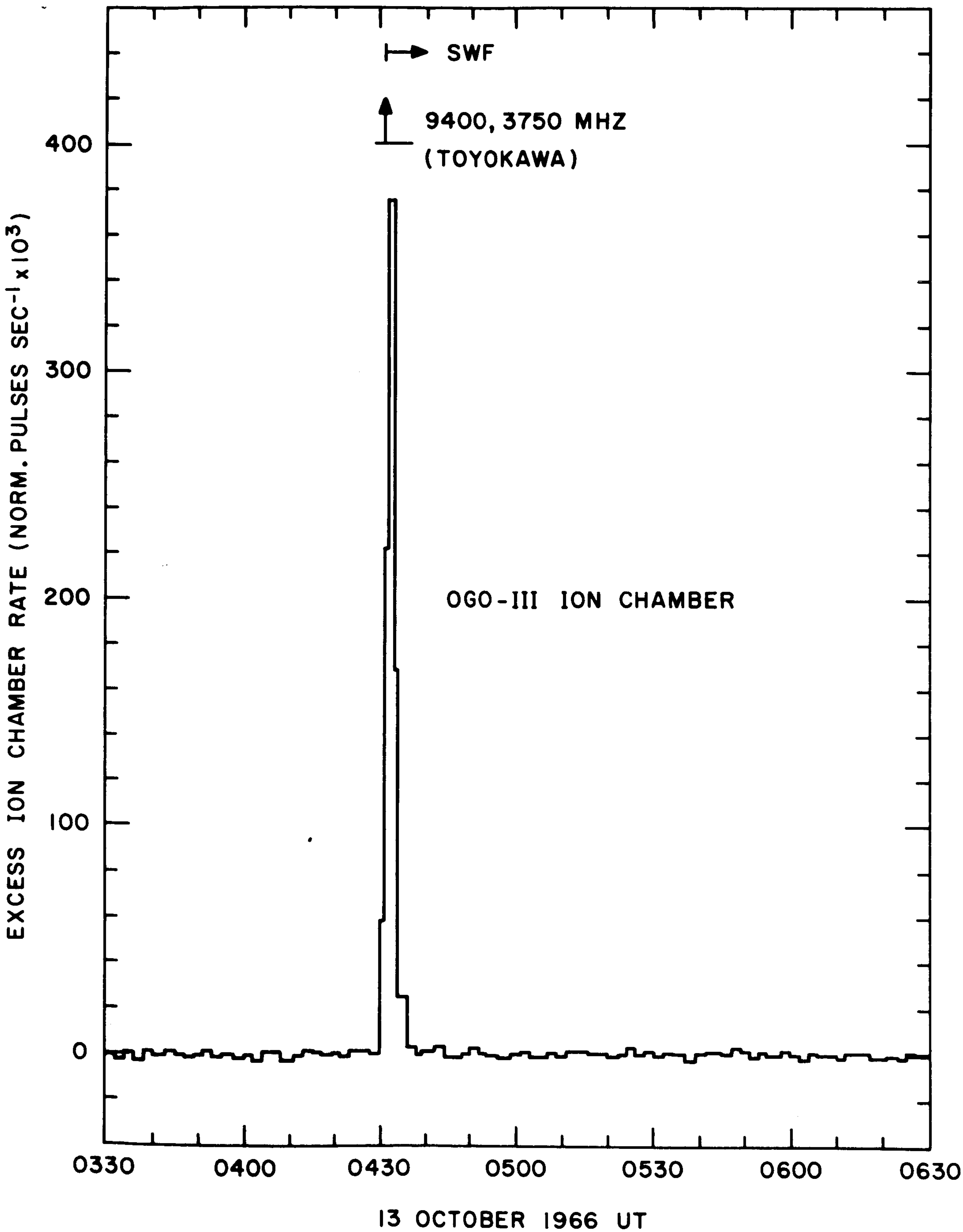
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
50
40
30
20
10
0
10
SWF
2800 MHZ (OTTAWA)
OGO-I ION CHAMBER
OGO-III ION CHAMBER
SOLAR X-RAYS
1600
1630
1700
1730
1800
1830
1900
20 SEPTEMBER 1966 UT

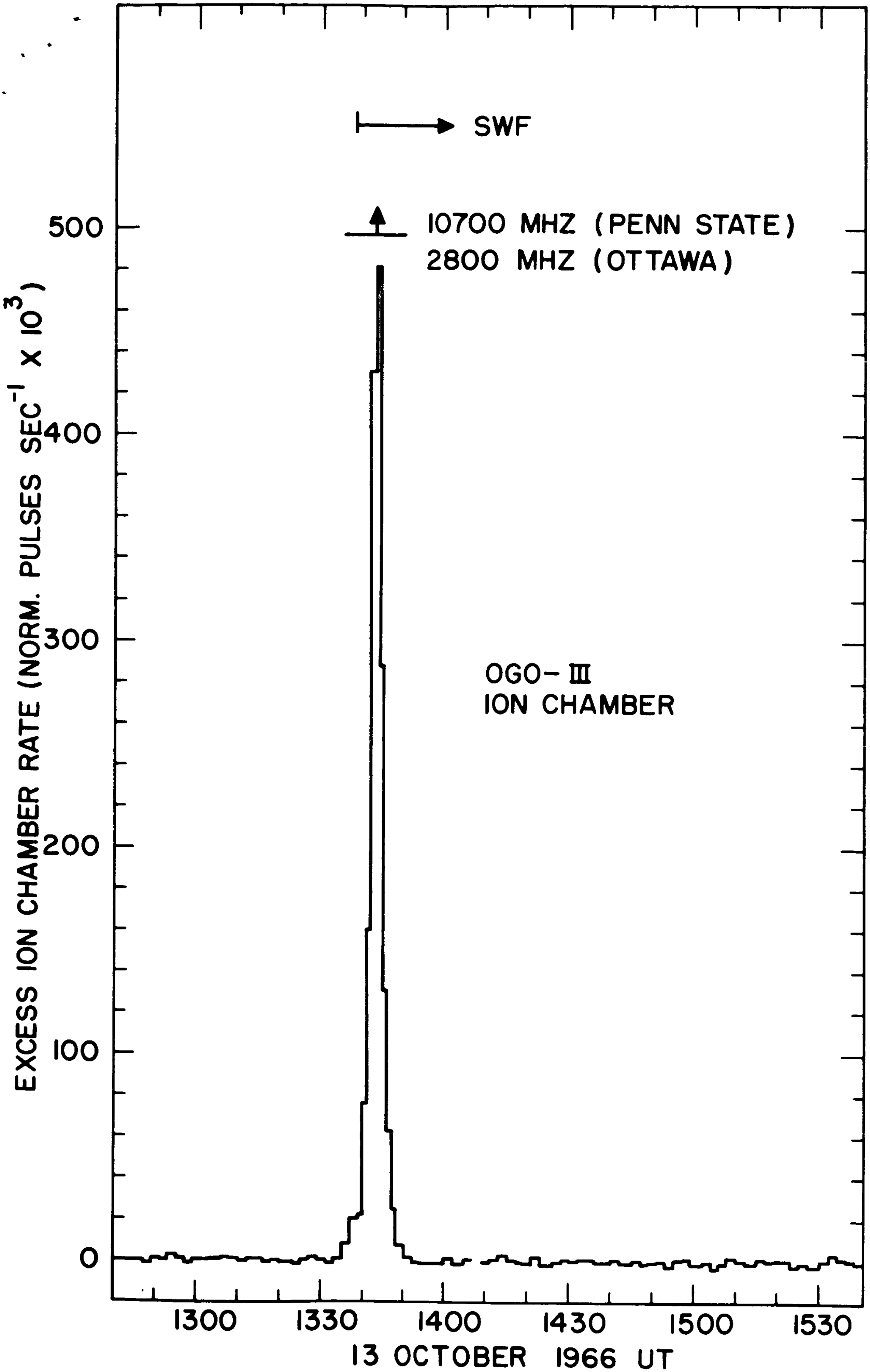


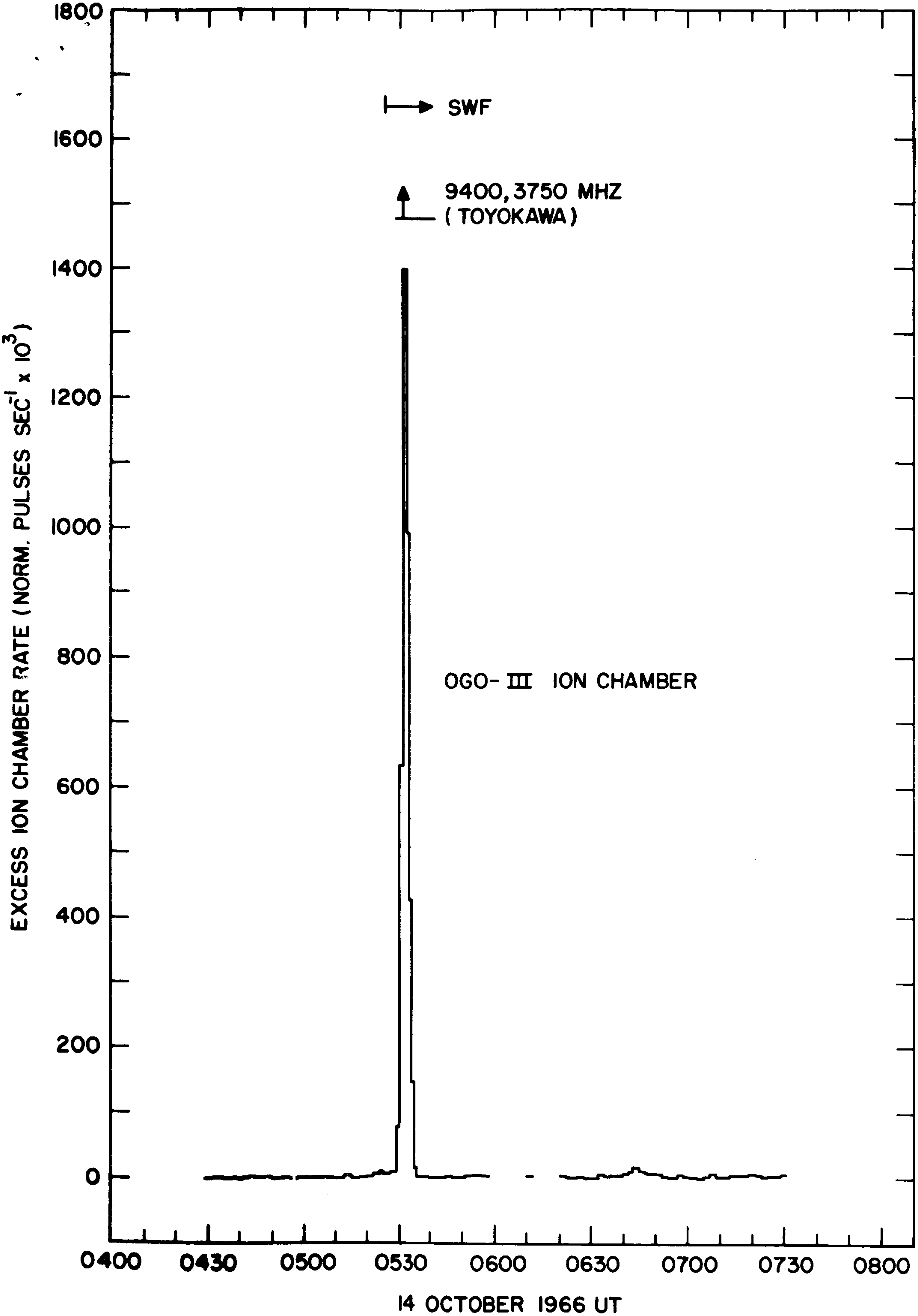
SWF
9500, 3000 MHZ
(NERA)
OGO - III ION CHAMBER
SOLAR EVENT
PARTICLE DECAY
MISSING DATA
APPROXIMATE BACKGROUND RATE
OBSERVED ION CHAMBER RATE (NORM. PULSES SEC^{-1} x10^{3})
100
200
300
400
500
600
700
0830
0900
0930
1000
1030
1100
1130
21 SEPTEMBER 1966 UT



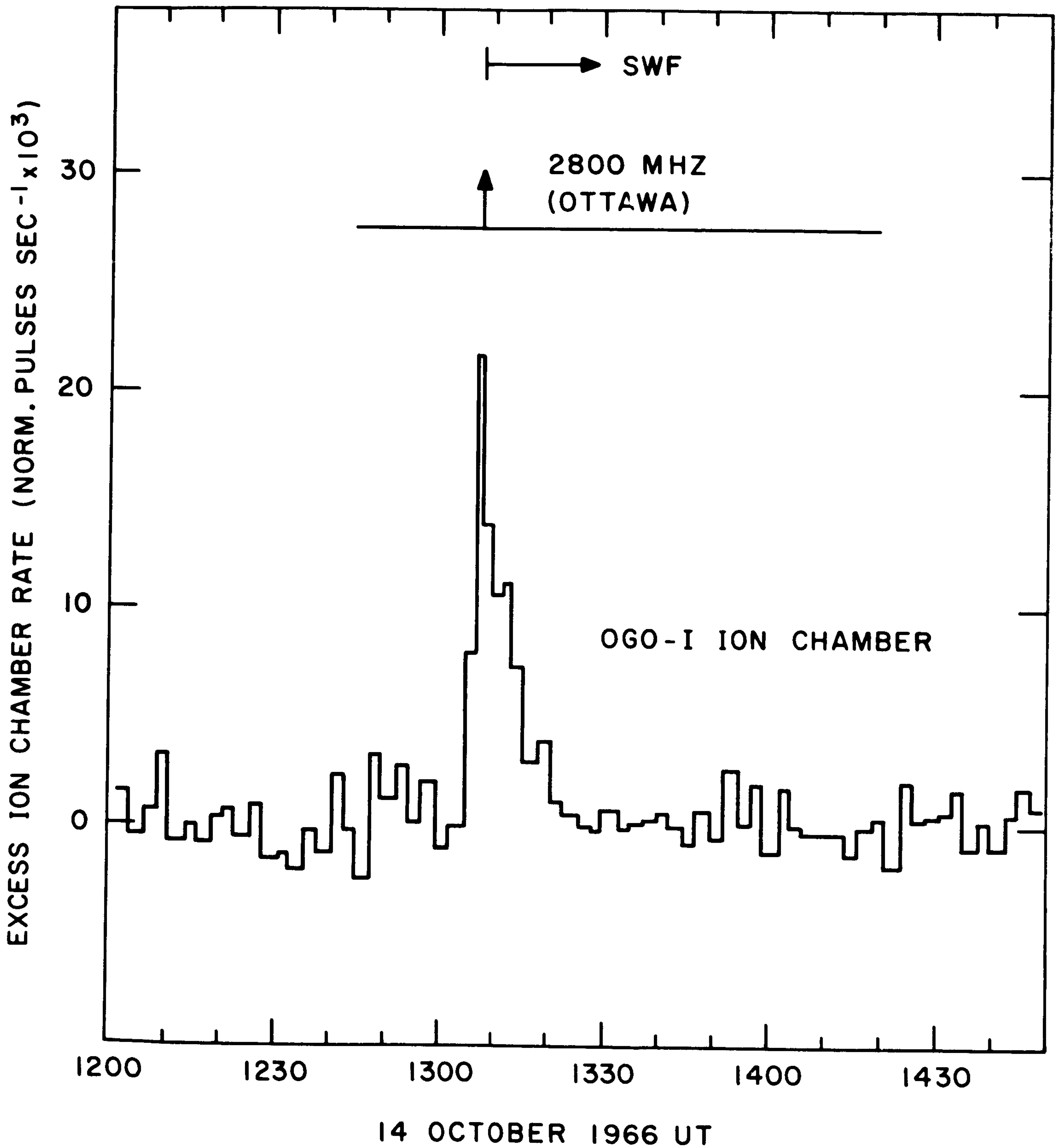
130
120
110
100
90
80
70
OBSERVED ION CHAMBER RATE (NORM. PULSES SEC-1 x 10^3)
SOLAR PARTICLE EVENT BEGINNING
2800 MHZ (OTTAWA)
OGO - III ION CHAMBER
1230
1300
1330
1400
1430
1500
27 SEPTEMBER 1966 UT

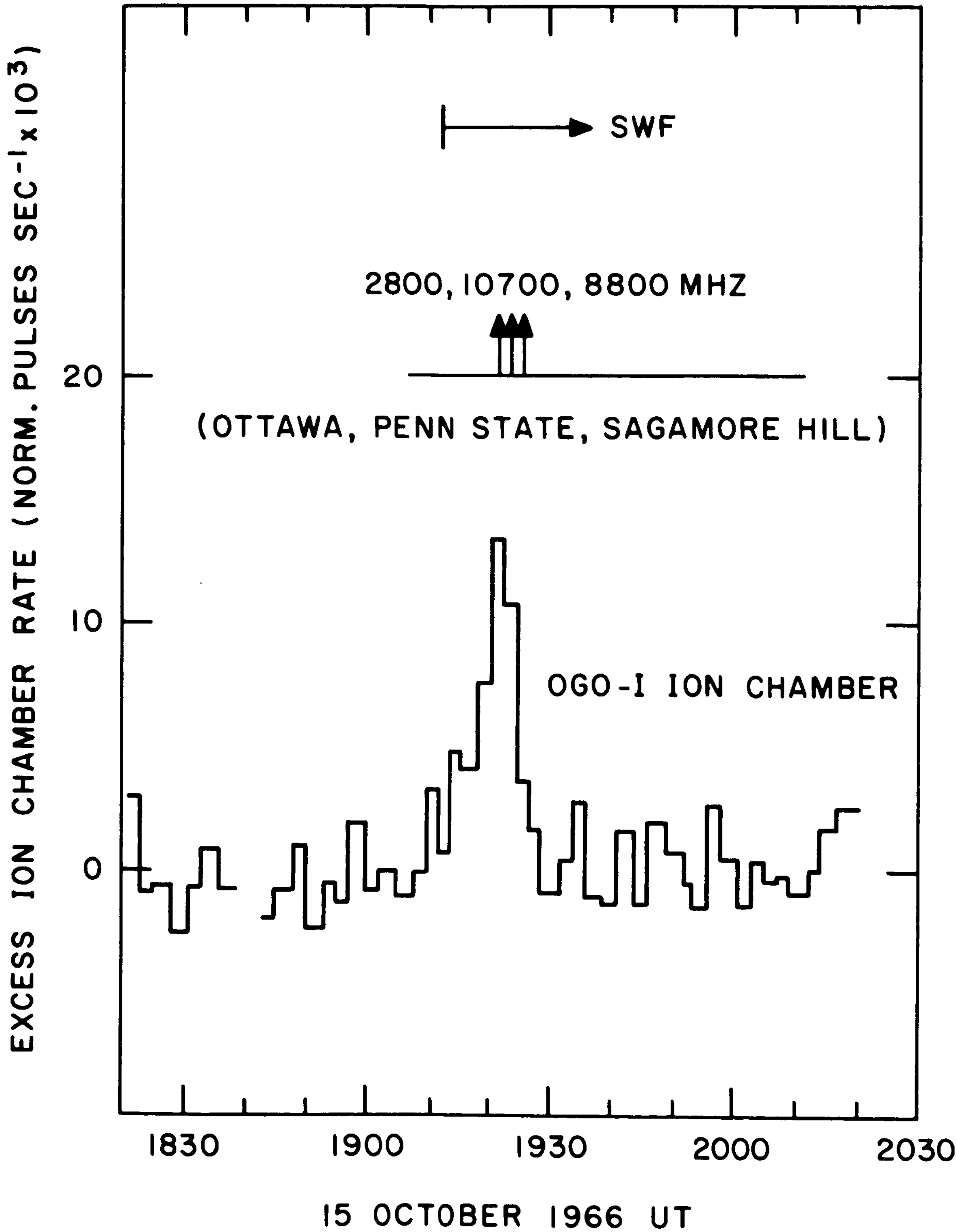

SWF
9400, 3750 MHZ
(TOYOKAWA)
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
400
300
200
100
0
0330
0400
0430
0500
0530
0600
0630
13 OCTOBER 1966 UT

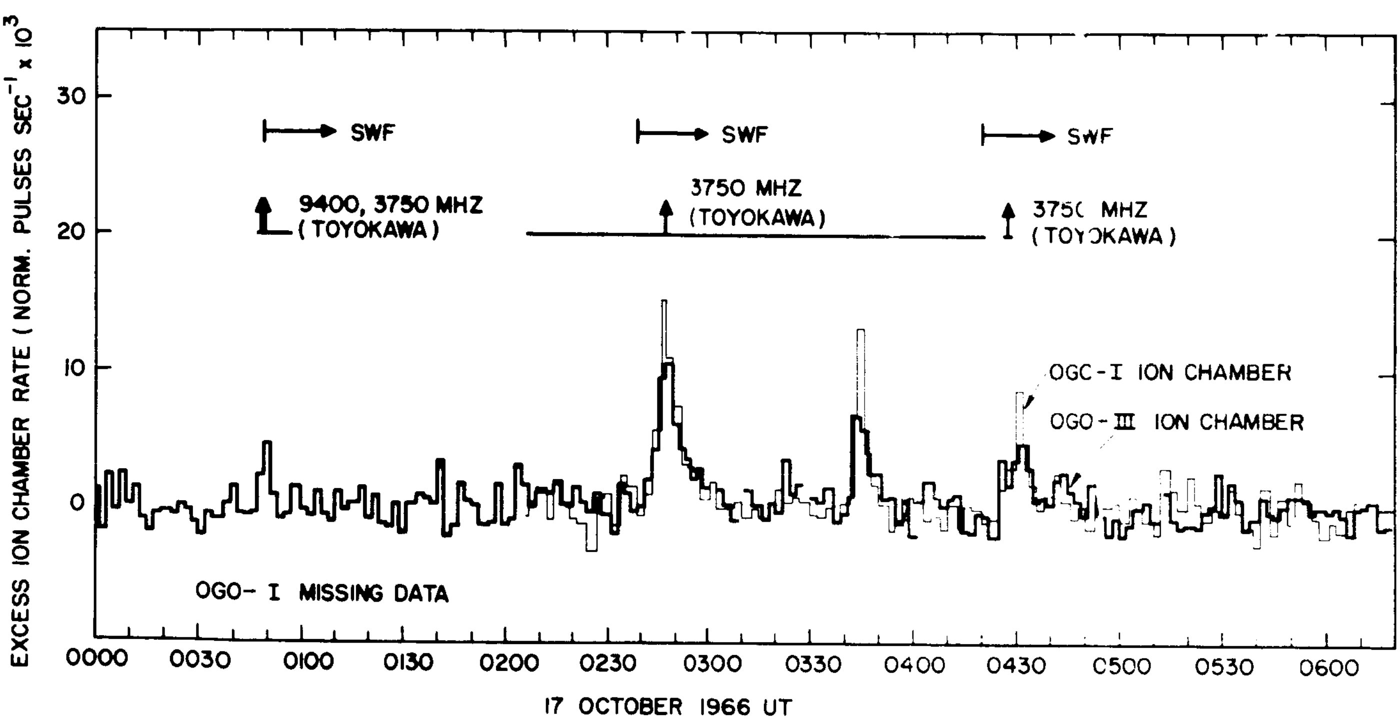

SWF
10700 MHZ (PENN STATE)
2800 MHZ (OTTAWA)
OGO-III
ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
500
400
300
200
100
0
1300
1330
1400
1430
1500
1530
13 OCTOBER 1966 UT



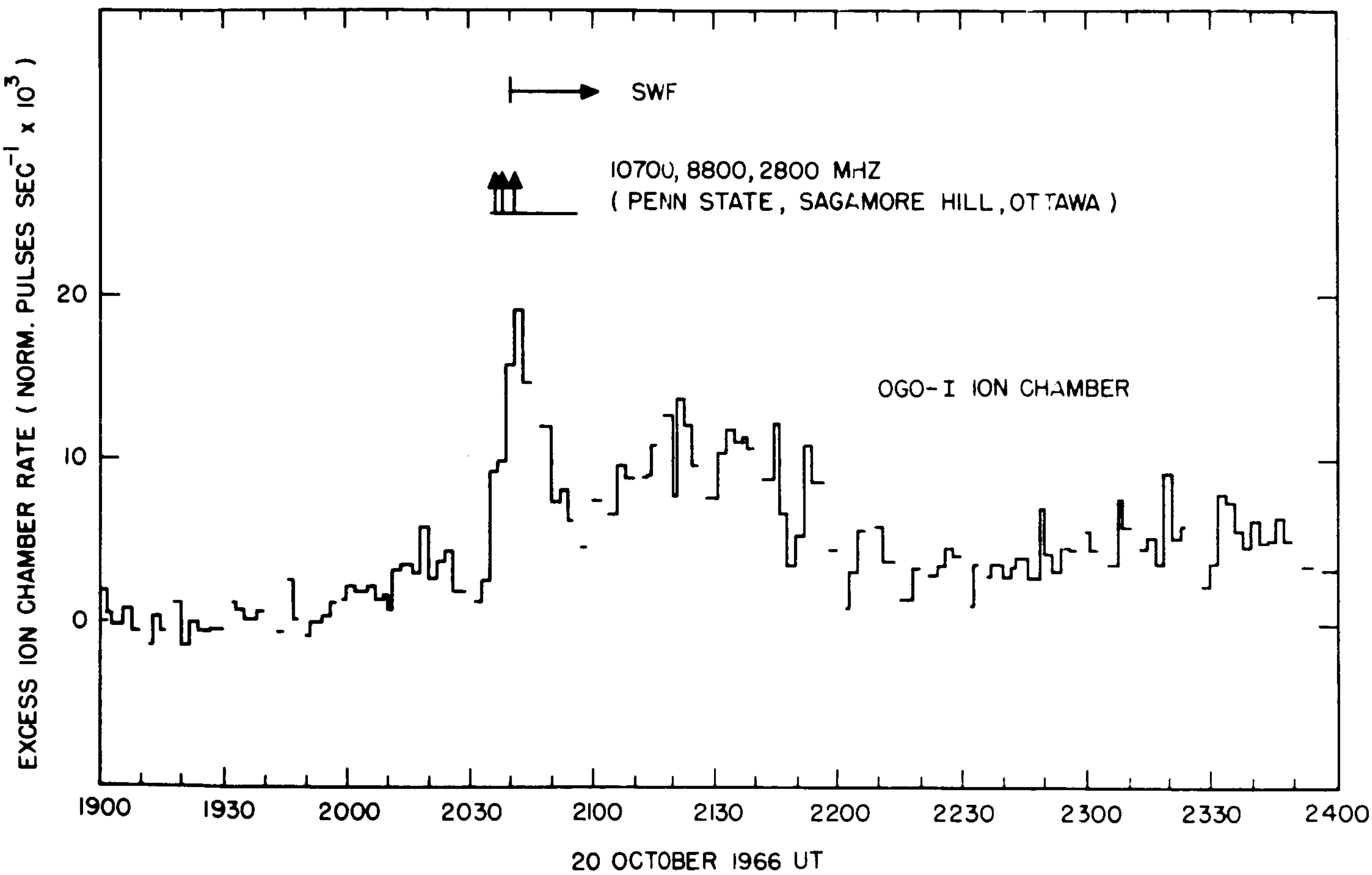
SWF
9400, 3750 MHZ
(TOYOKAWA)
OGO- III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
1800
1600
1400
1200
1000
800
600
400
200
0
0400
0430
0500
0530
0600
0630
0700
0730
0800
14 OCTOBER 1966 UT

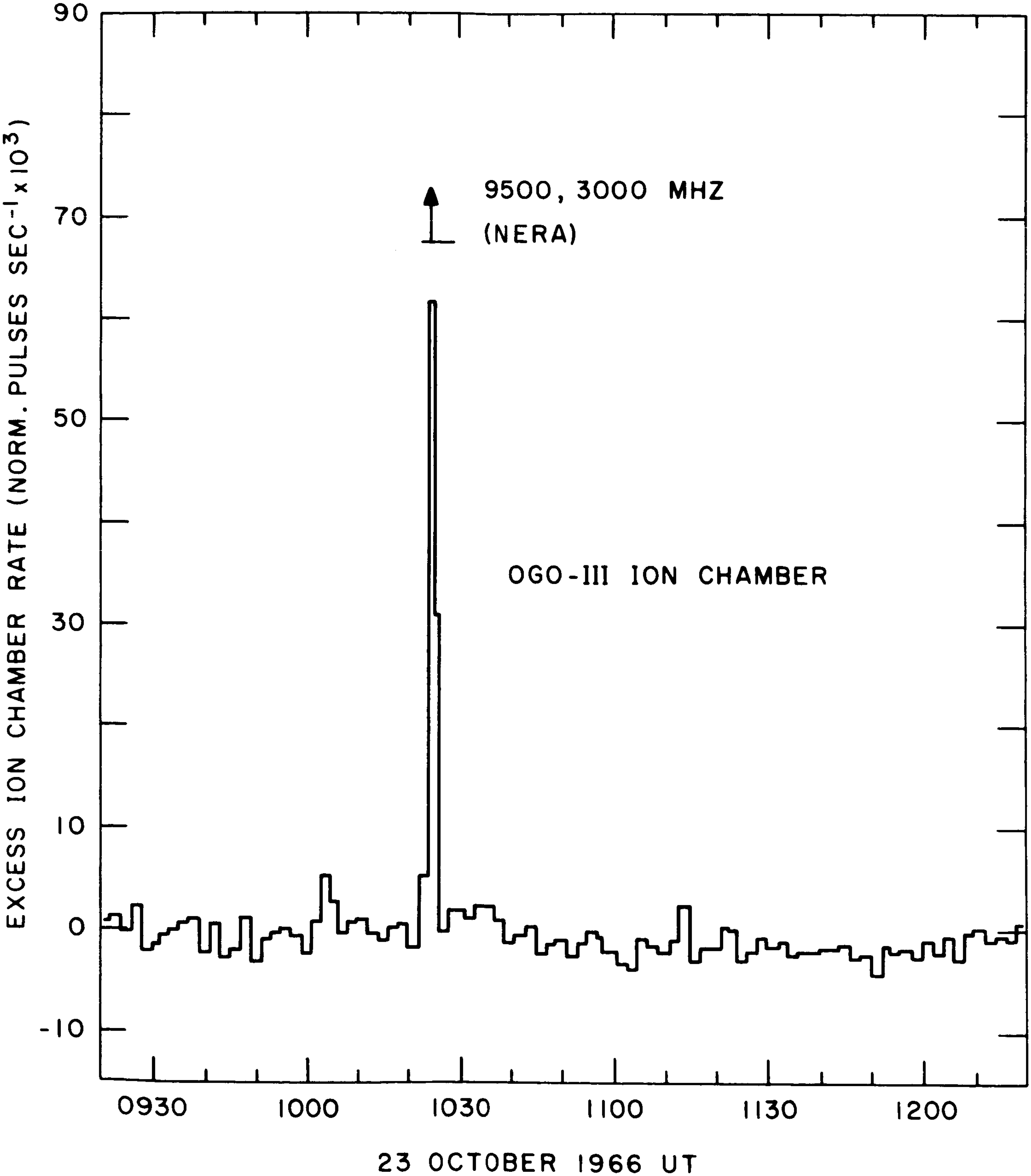

SWF
2800 MHZ
(OTTAWA)
OGO-I ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
30
20
10
0
1200
1230
1300
1330
1400
1430
14 OCTOBER 1966 UT

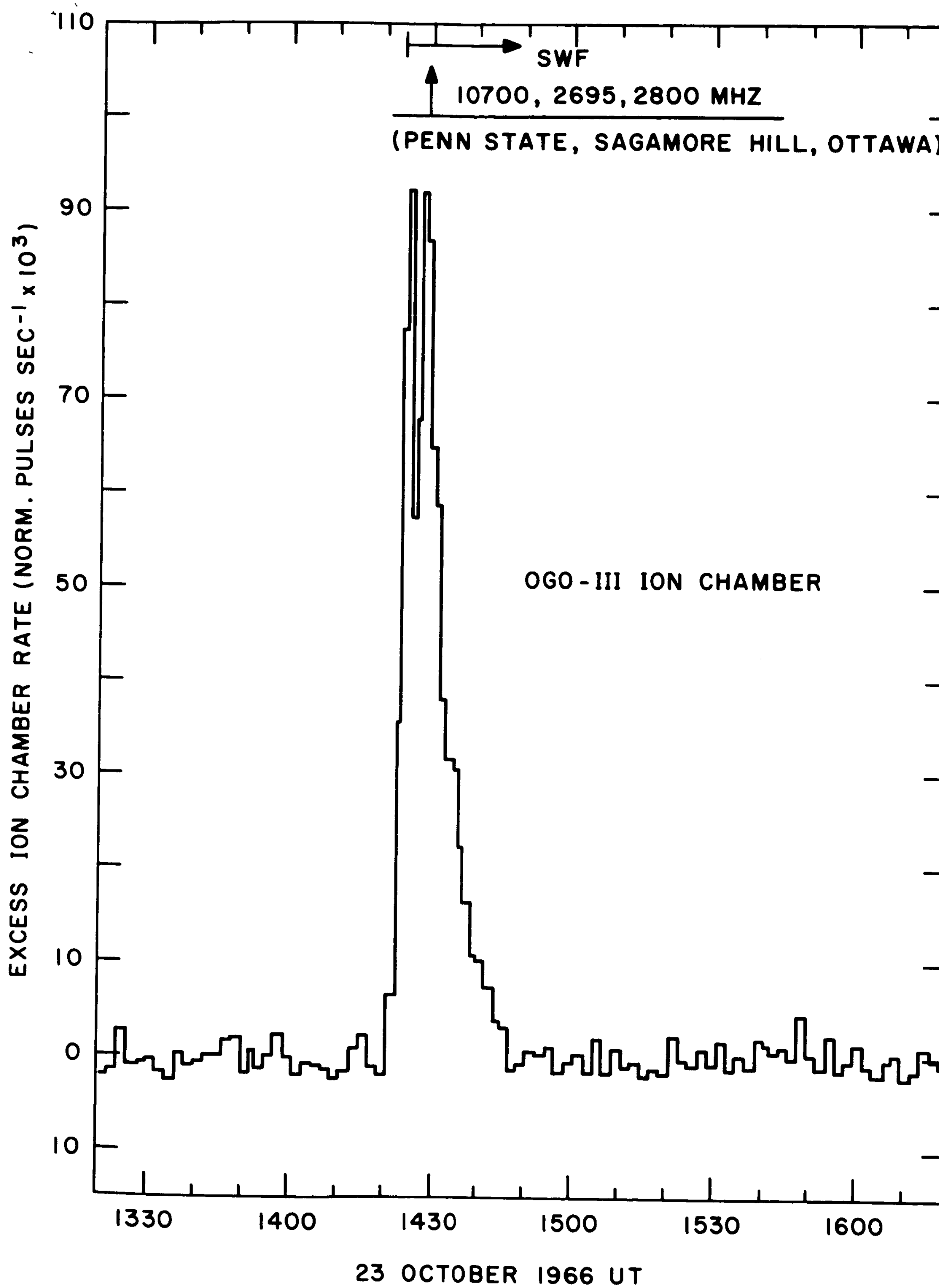

SWF
2800, 10700, 8800 MHZ
20
(OTTAWA, PENN STATE, SAGAMORE HILL)
10
OGO-I ION CHAMBER
0
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
1830
1900
1930
2000
2030
15 OCTOBER 1966 UT

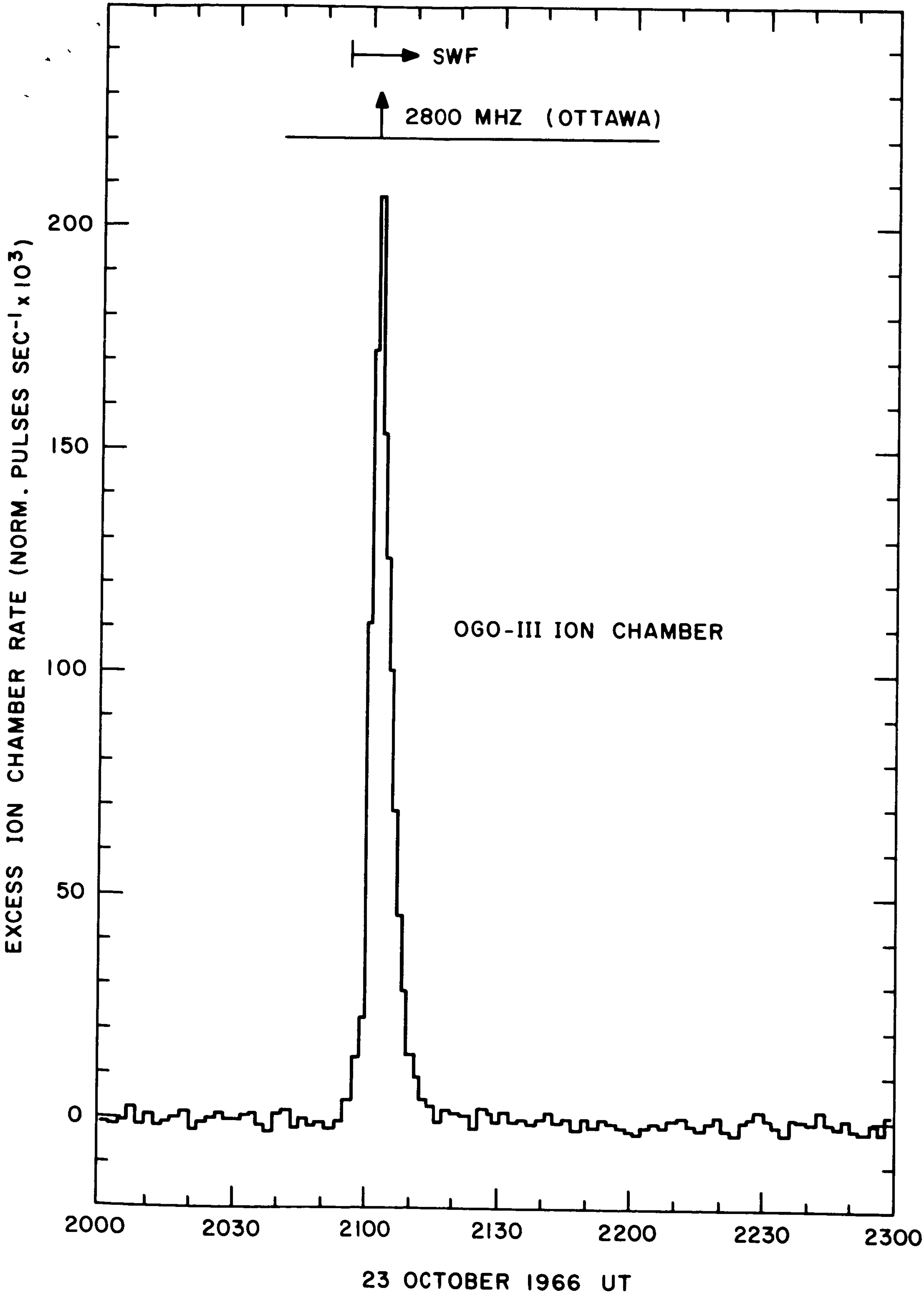


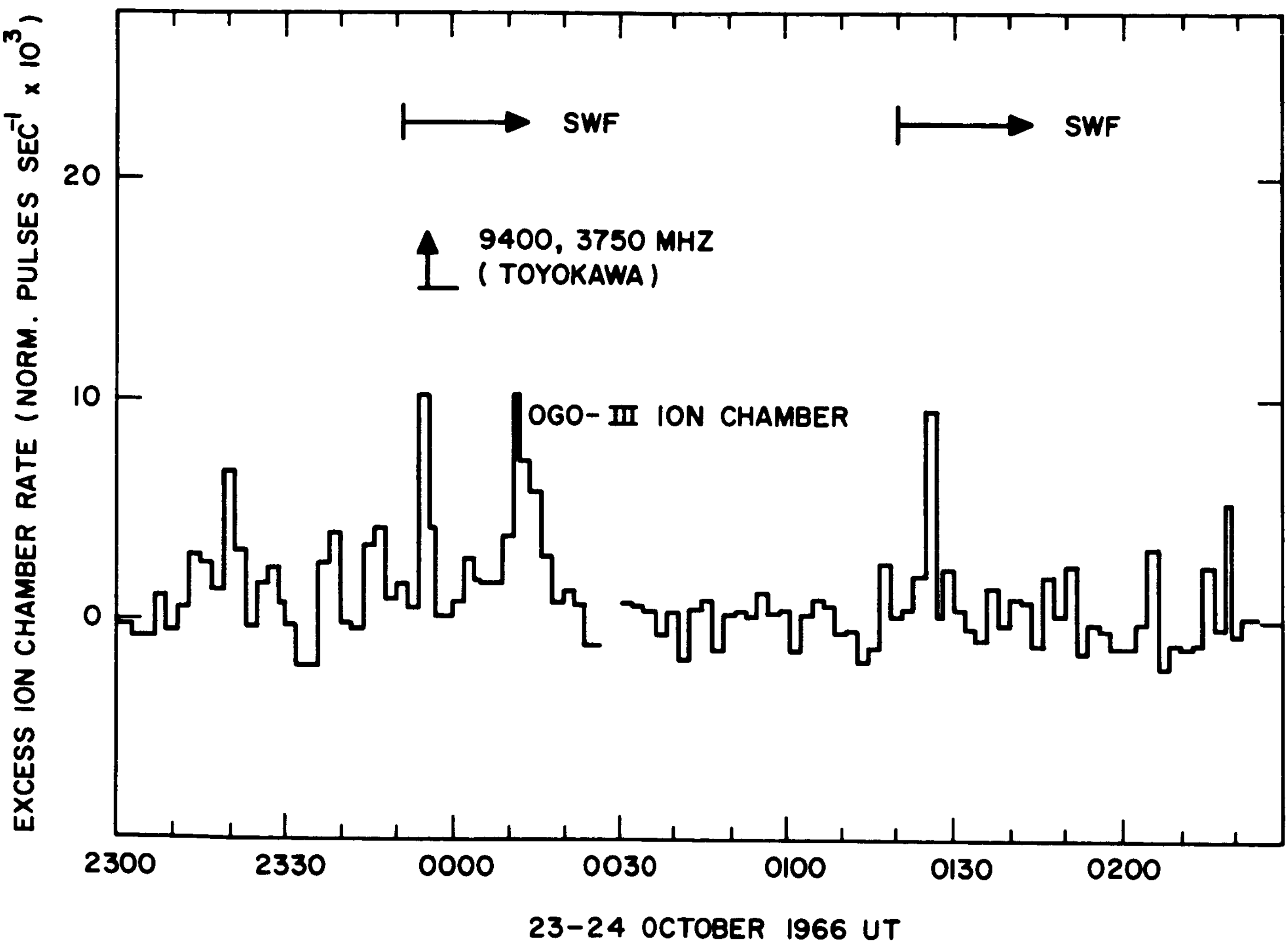
SWF
SWF
SWF
9400, 3750 MHZ
(TOYOKAWA)
3750 MHZ
(TOYOKAWA)
375(MHZ
(TOY)KAWA)
OGC-I ION CHAMBER
OGO-III ION CHAMBER
OGO- I MISSING DATA
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^{3}
30
20
10
0
0000
0030
0100
0130
0200
0230
0300
0330
0400
0430
0500
0530
0600
17 OCTOBER 1966 UT


SWF
10700, 8800, 2800 MHZ
(PENN STATE, SAGAMORE HILL, OTTAWA)
OGO-I ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^{3})
20
10
0
1900
1930
2000
2030
2100
2130
2200
2230
2300
2330
2400
20 OCTOBER 1966 UT

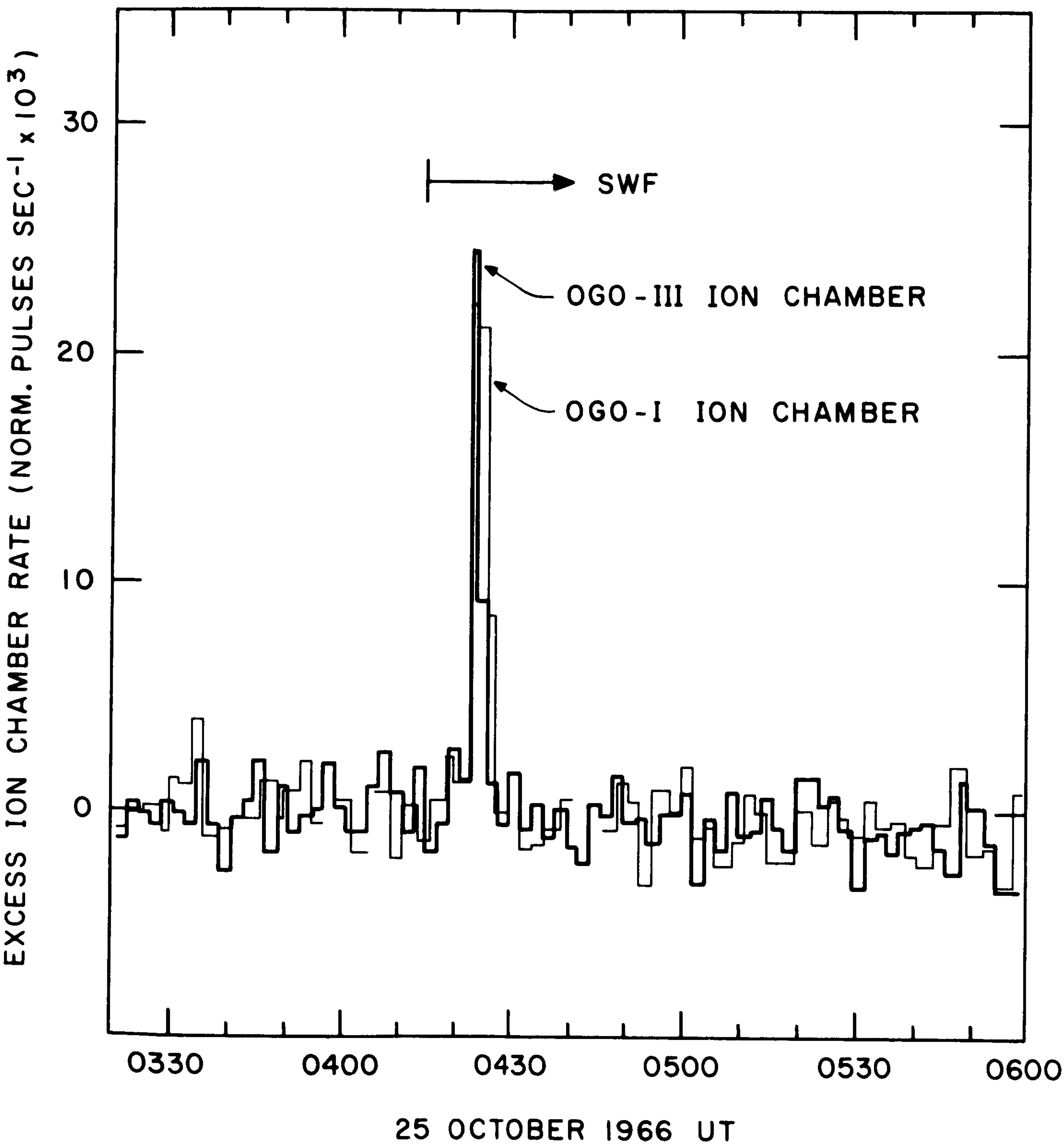

90
70
50
30
10
0
-10
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
9500, 3000 MHZ
(NERA)
OGO-III ION CHAMBER
0930
1000
1030
1100
1130
1200
23 OCTOBER 1966 UT


SWF
10700, 2695, 2800 MHZ
(PENN STATE, SAGAMORE HILL, OTTAWA)
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
110
90
70
50
30
10
0
10
1330
1400
1430
1500
1530
1600
23 OCTOBER 1966 UT

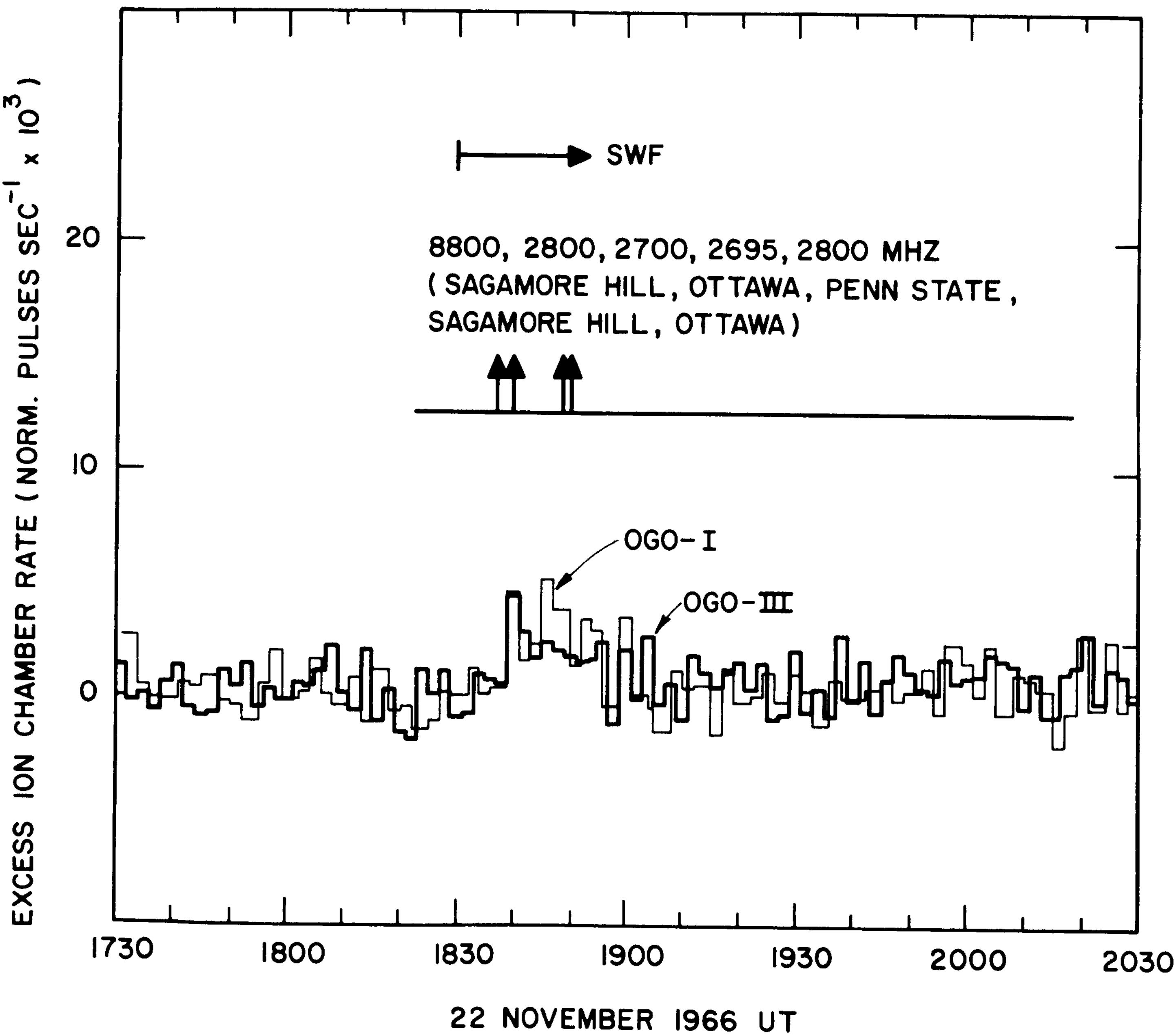

SWF
2800 MHZ (OTTAWA)
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC⁻¹ x 10³)
200
150
100
50
0
2000
2030
2100
2130
2200
2230
2300
23 OCTOBER 1966 UT

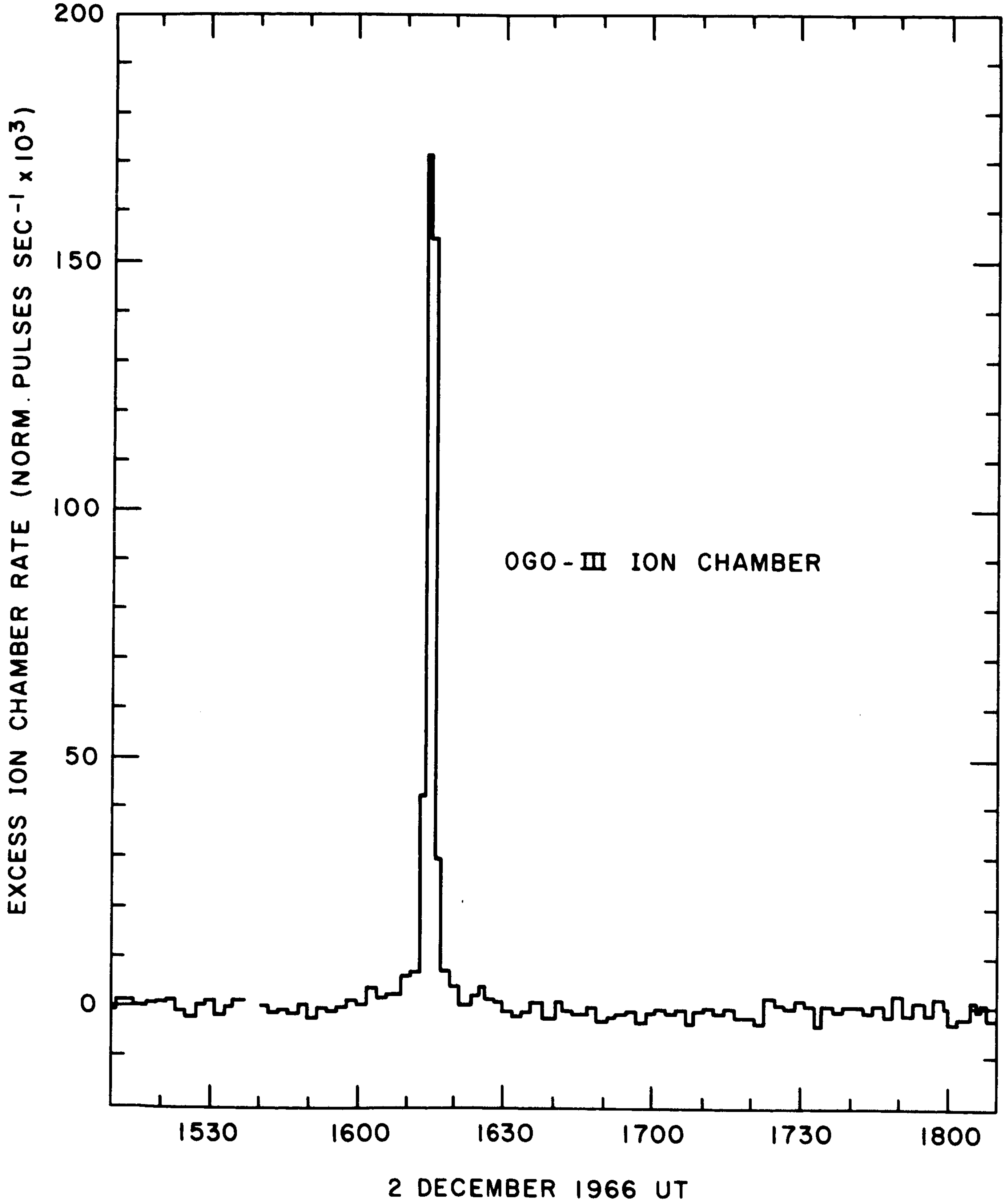


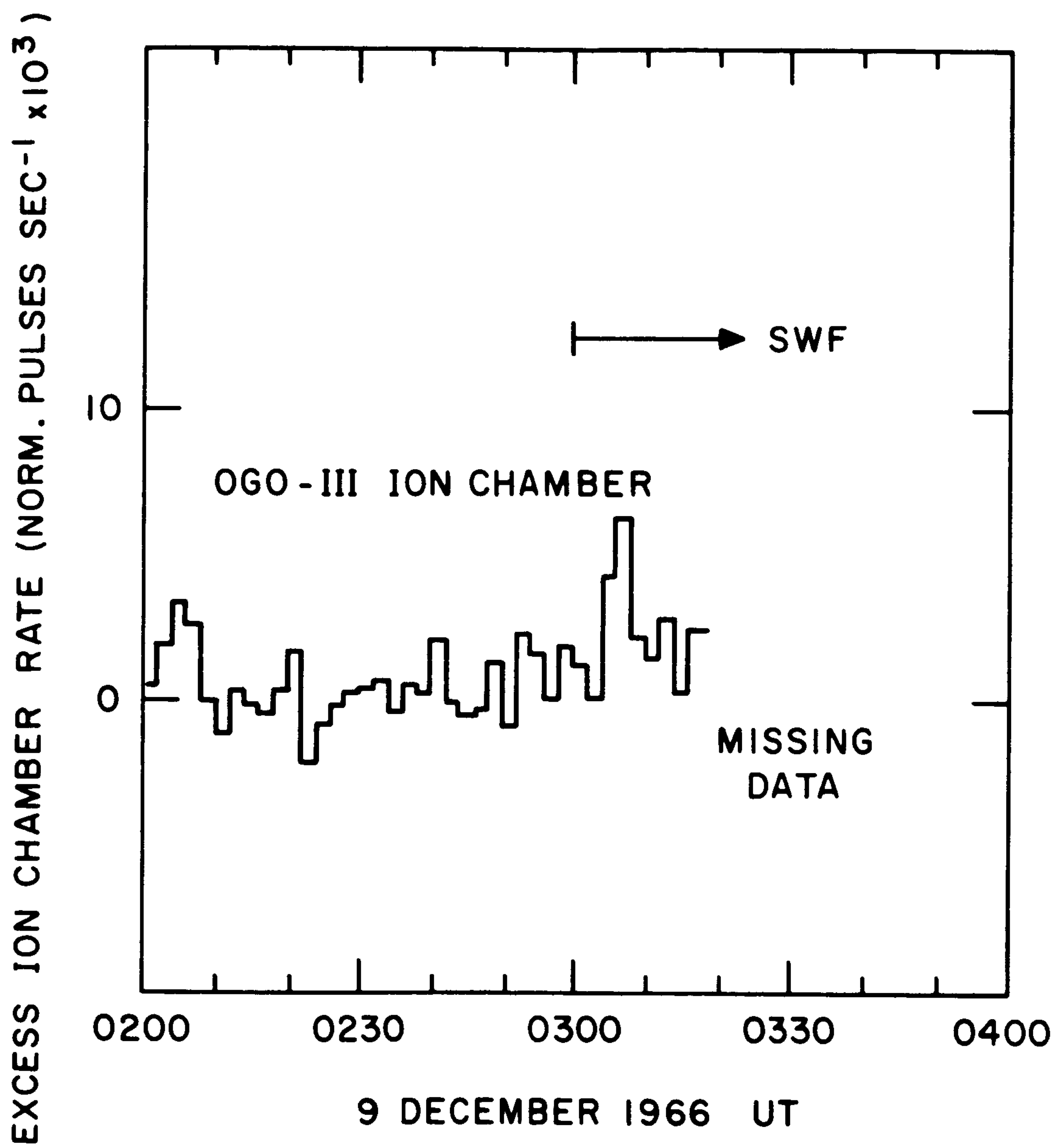
SWF
SWF
9400, 3750 MHZ
(TOYOKAWA)
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^{3})
20
10
0
2300
2330
0000
0030
0100
0130
0200
23-24 OCTOBER 1966 UT

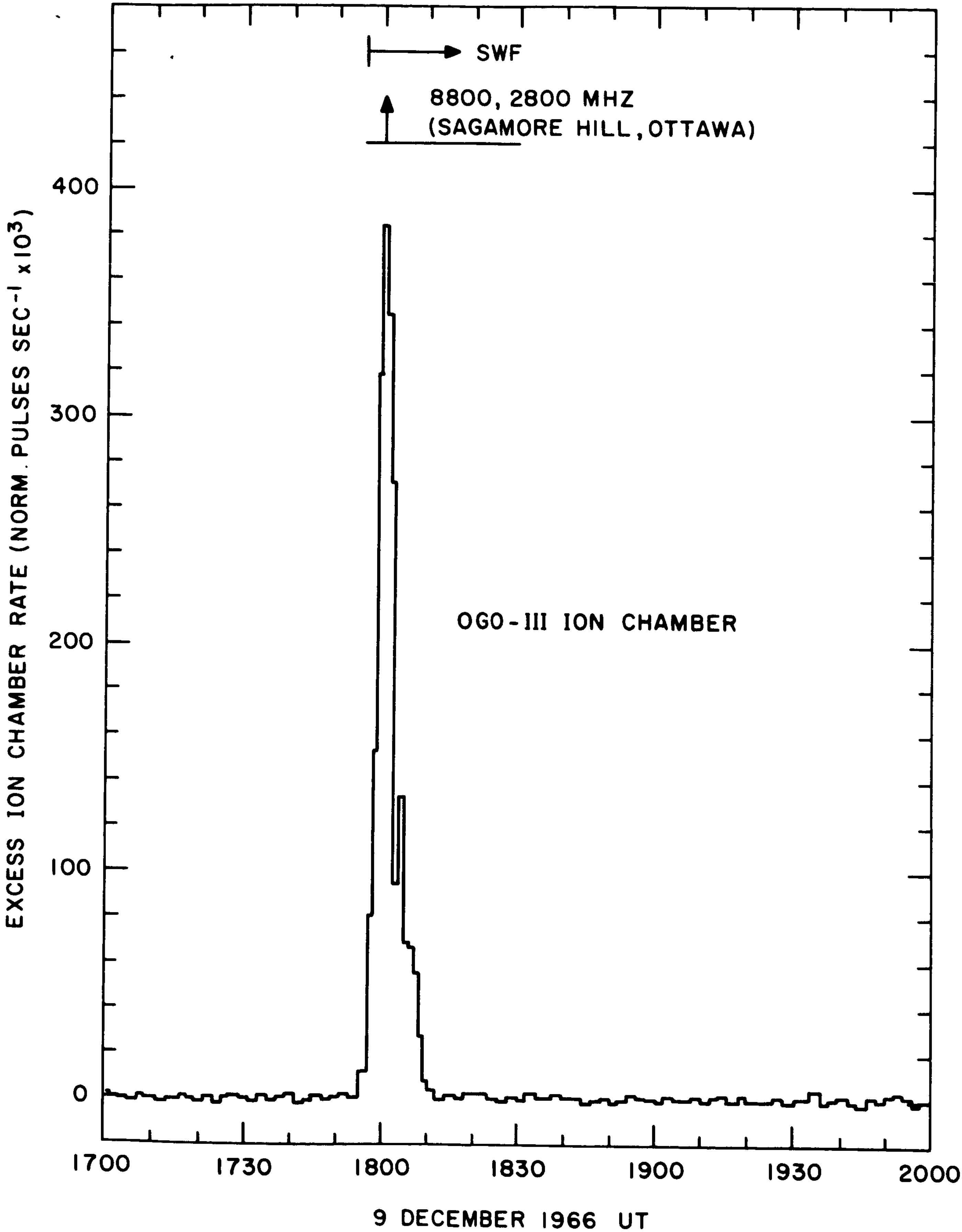


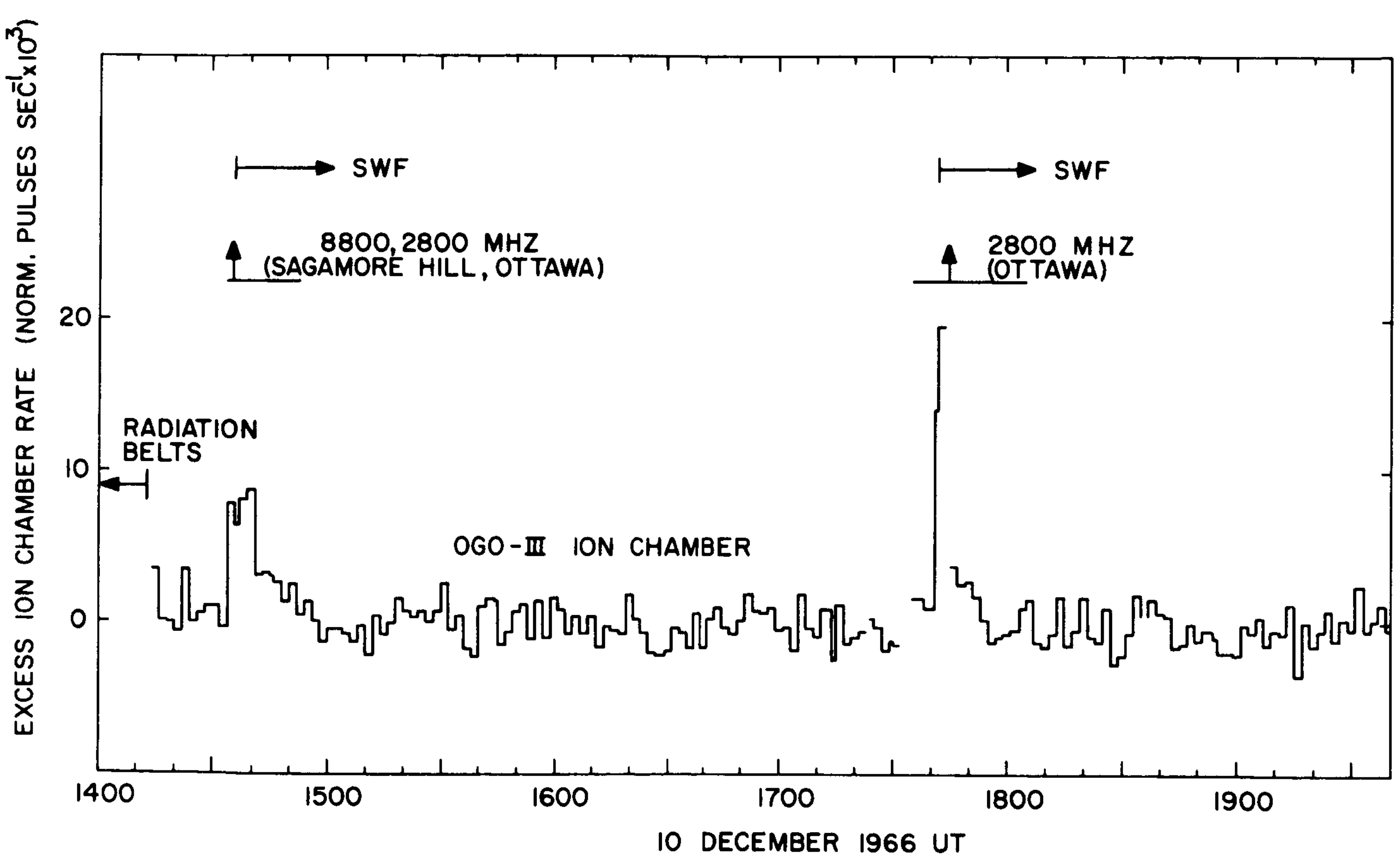
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^{3})
30
20
10
0
SWF
OGO-III ION CHAMBER
OGO-I ION CHAMBER
0330
0400
0430
0500
0530
0600
25 OCTOBER 1966 UT

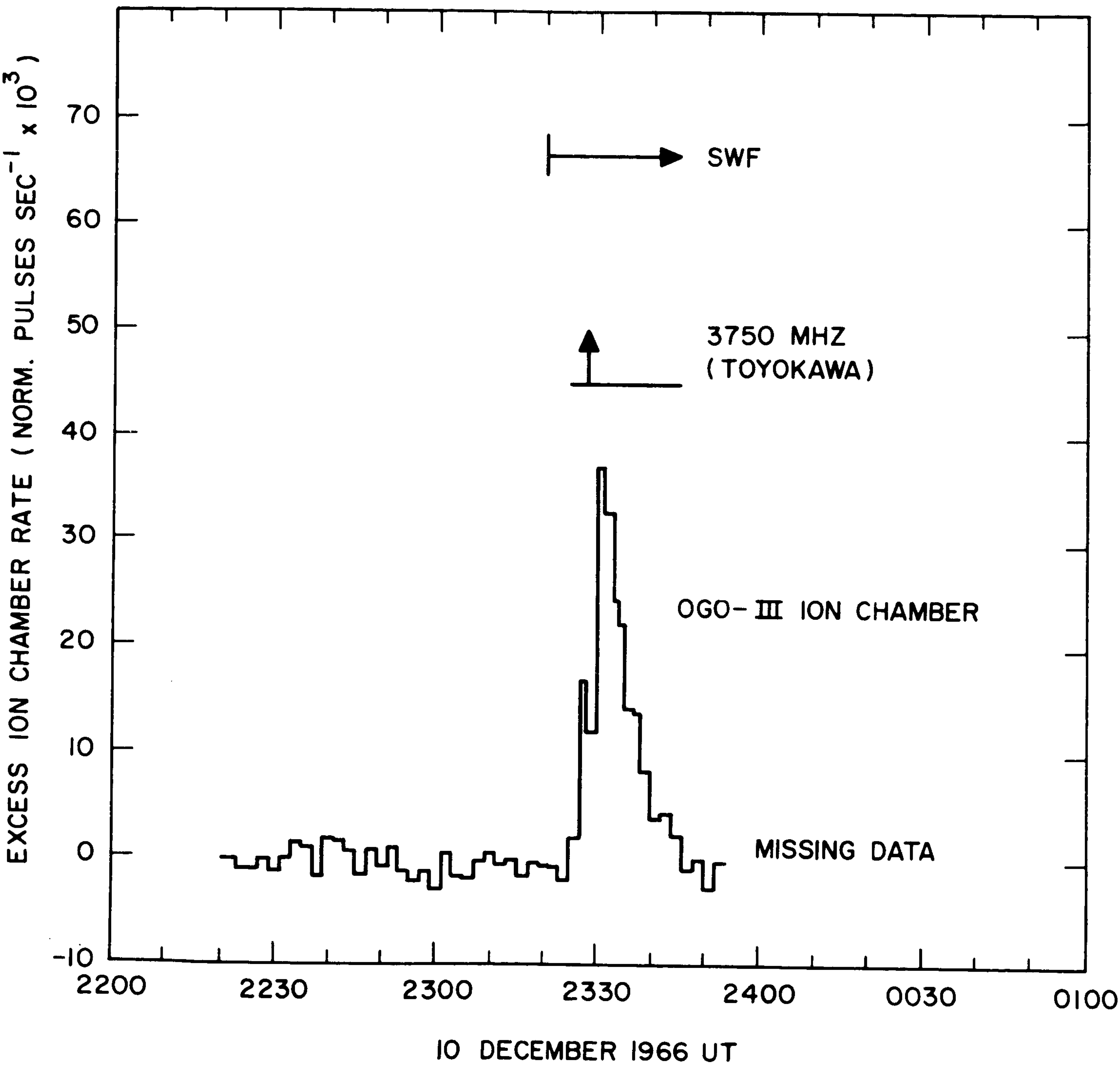

SWF
8800, 2800, 2700, 2695, 2800 MHZ
(SAGAMORE HILL, OTTAWA, PENN STATE, SAGAMORE HILL, OTTAWA)
OGO-I
OGO-III
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
20
10
0
1730
1800
1830
1900
1930
2000
2030
22 NOVEMBER 1966 UT

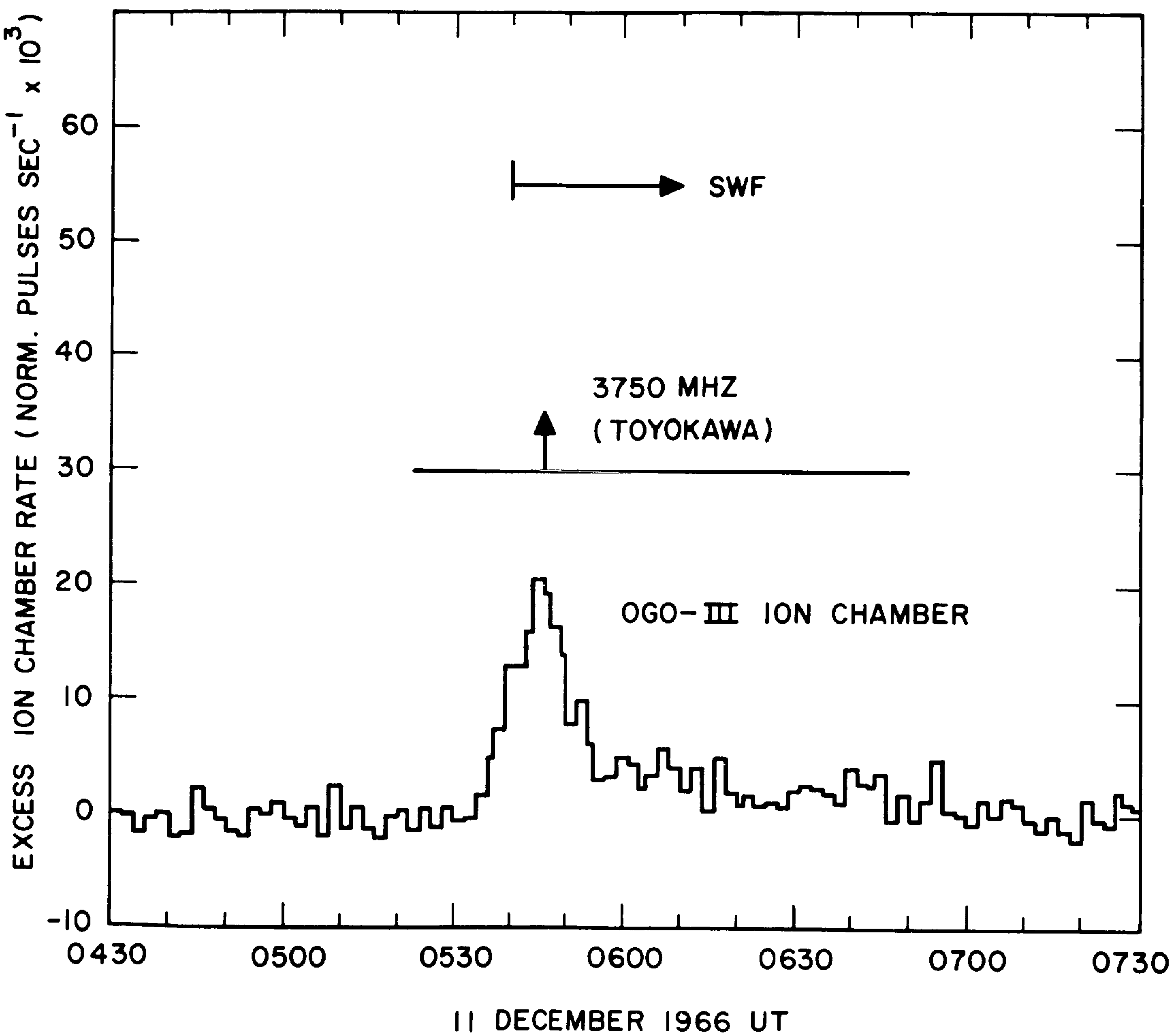

200
150
100
50
0
EXCESS ION CHAMBER RATE (NORM. PULSES SEC⁻¹ x 10³)
OGO-III ION CHAMBER
1530
1600
1630
1700
1730
1800
2 DECEMBER 1966 UT

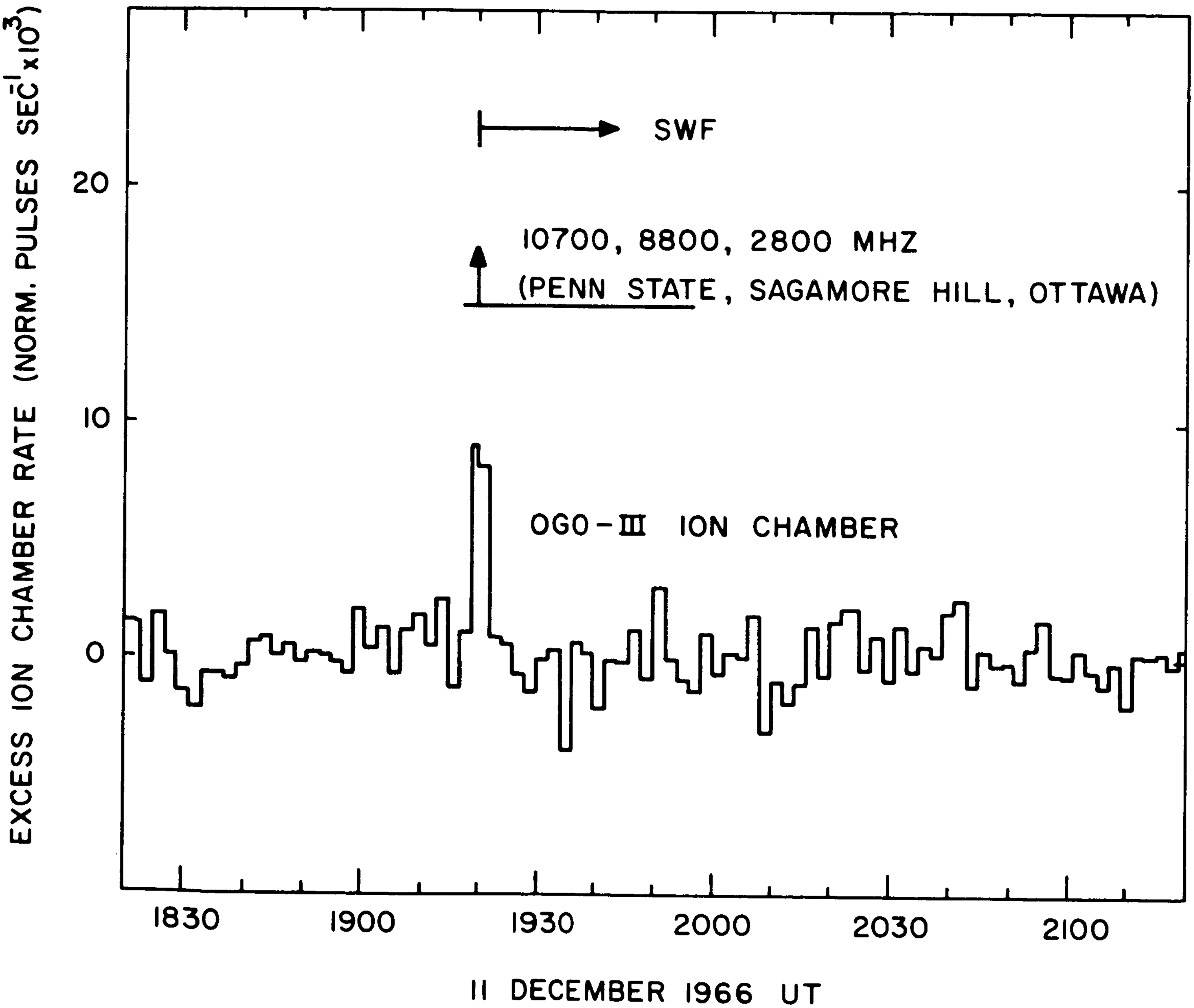

EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x10^{3})
10
0
SWF
OGO - III ION CHAMBER
MISSING
DATA
0200
0230
0300
0330
0400
9 DECEMBER 1966 UT

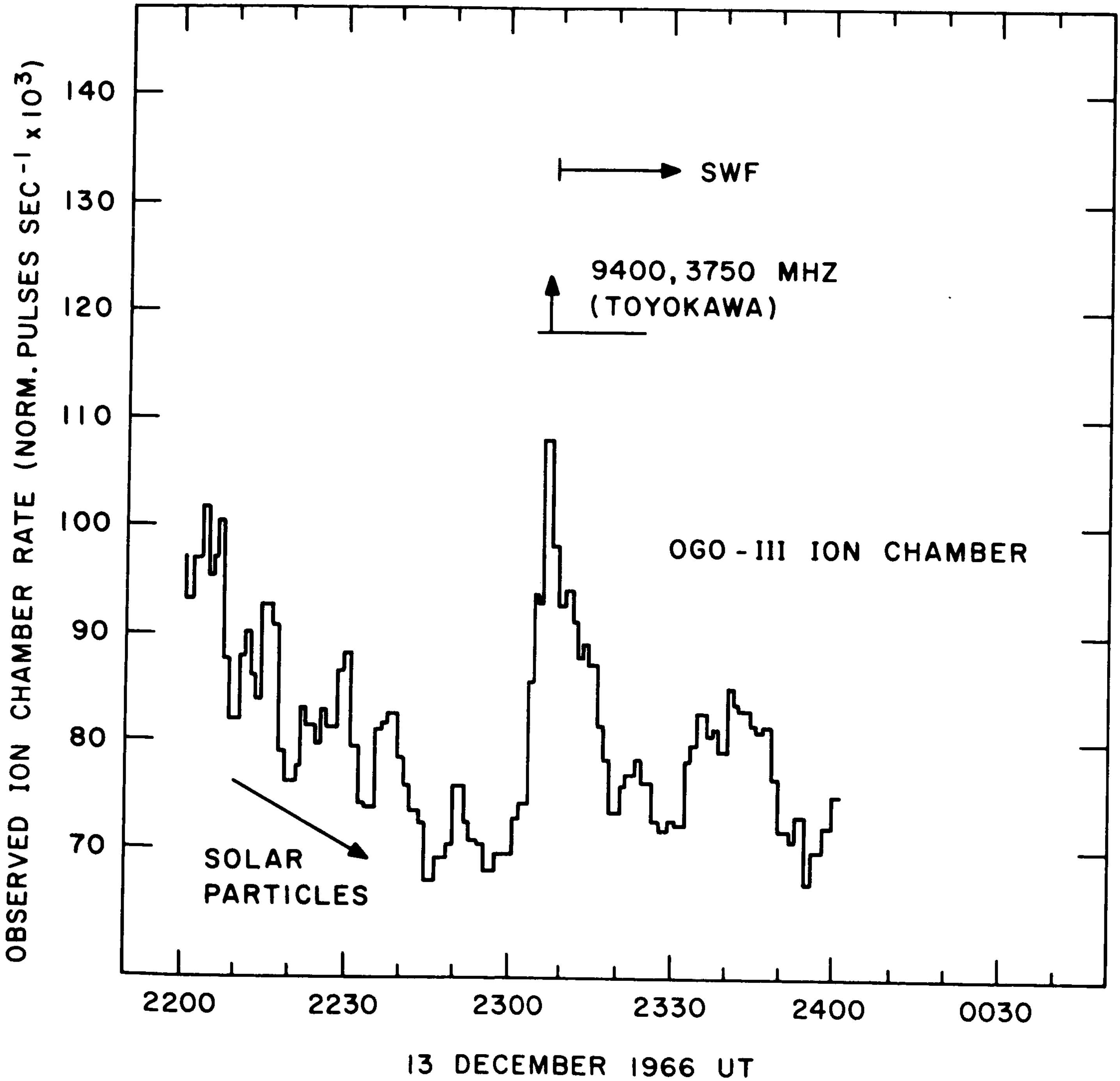

SWF
8800, 2800 MHZ
(SAGAMORE HILL, OTTAWA)
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x10^3)
400
300
200
100
0
1700
1730
1800
1830
1900
1930
2000
9 DECEMBER 1966 UT

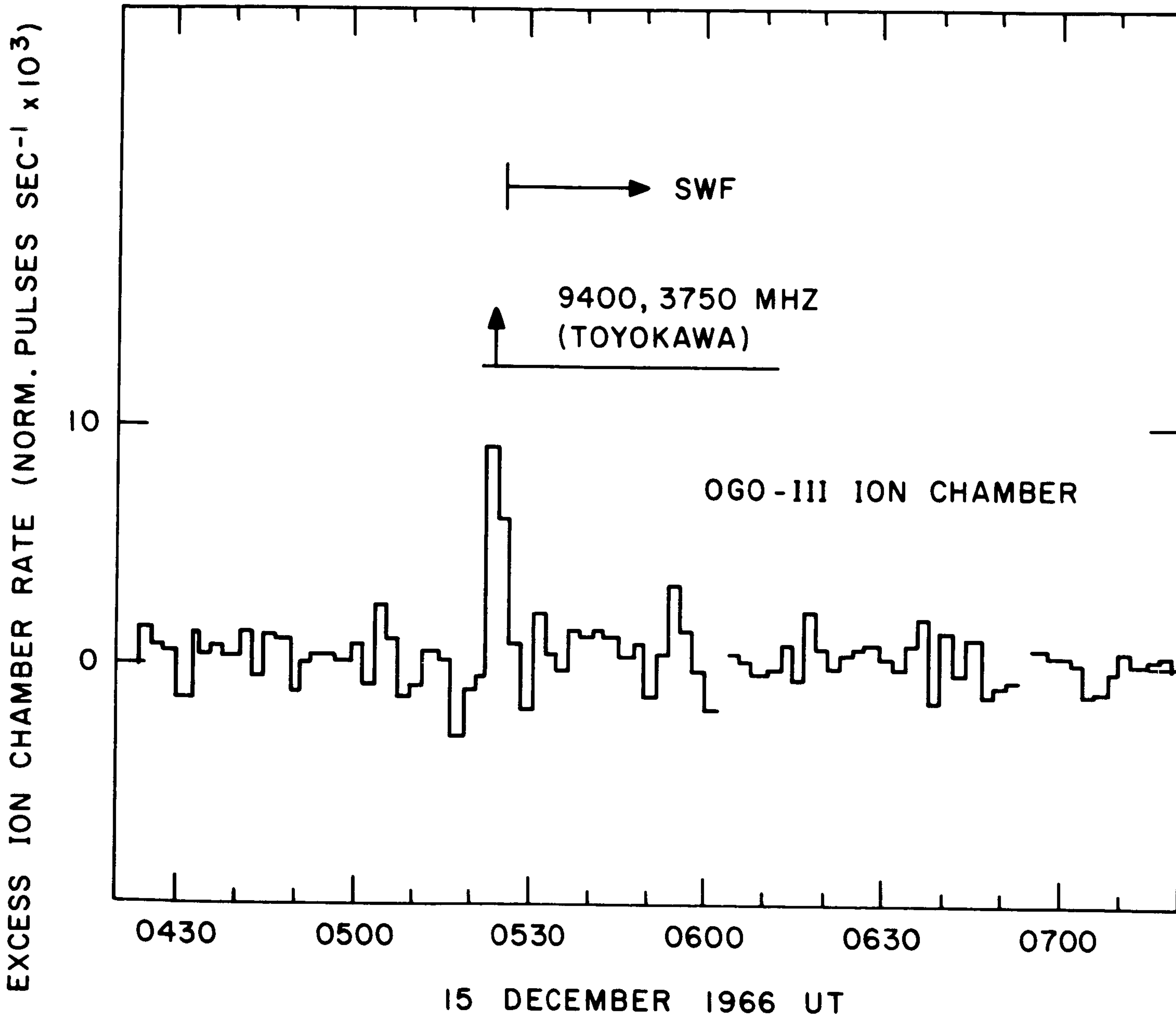

SWF
8800, 2800 MHZ
(SAGAMORE HILL, OTTAWA)
SWF
2800 MHZ
(OTTAWA)
RADIATION
BELTS
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES $SEC^{-1} \times 10^{-3}$)
20
10
0
1400
1500
1600
1700
1800
1900
10 DECEMBER 1966 UT


EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
70
60
50
40
30
20
10
0
-10
SWF
3750 MHZ
(TOYOKAWA)
OGO- III ION CHAMBER
MISSING DATA
2200
2230
2300
2330
2400
0030
0100
10 DECEMBER 1966 UT

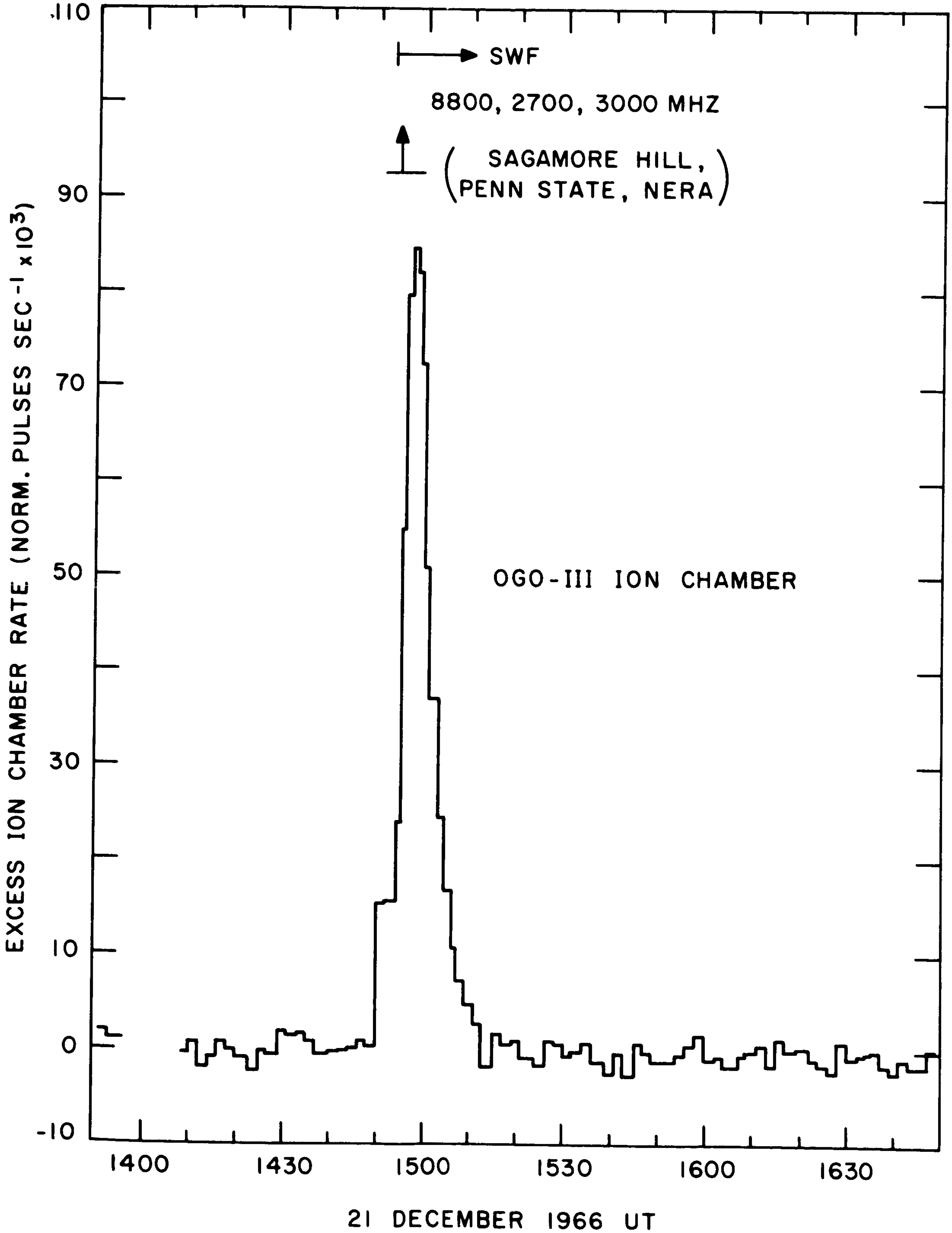

EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
60
50
40
30
20
10
0
-10
SWF
3750 MHZ
(TOYOKAWA)
OGO-III ION CHAMBER
0430
0500
0530
0600
0630
0700
0730
11 DECEMBER 1966 UT

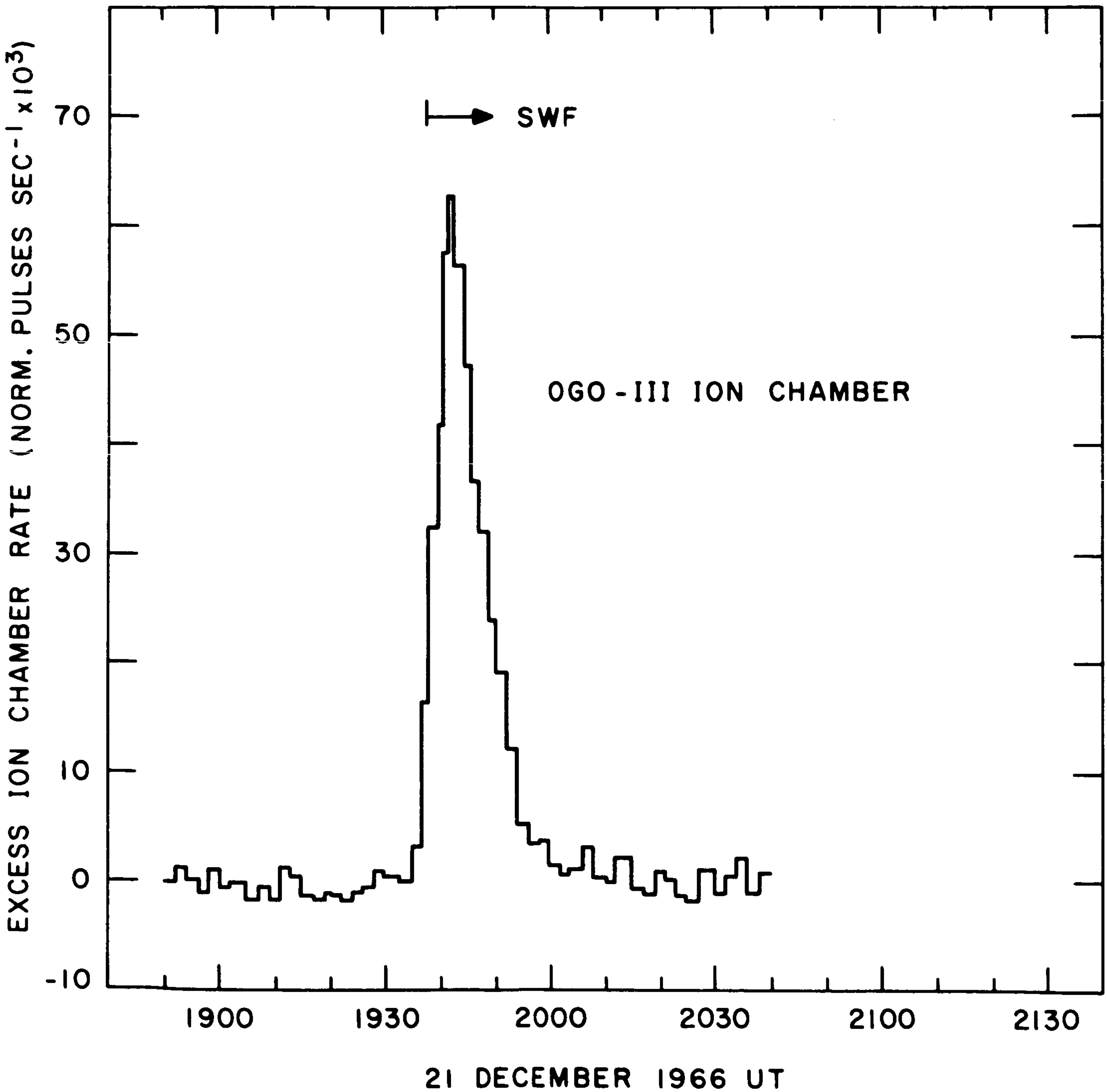

EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x10^3)
20
10
0
SWF
10700, 8800, 2800 MHZ
(PENN STATE, SAGAMORE HILL, OTTAWA)
OGO-III ION CHAMBER
1830
1900
1930
2000
2030
2100
11 DECEMBER 1966 UT


OBSERVED ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
140
130
120
110
100
90
80
70
SWF
9400, 3750 MHZ
(TOYOKAWA)
OGO - III ION CHAMBER
SOLAR
PARTICLES
2200
2230
2300
2330
2400
0030
13 DECEMBER 1966 UT

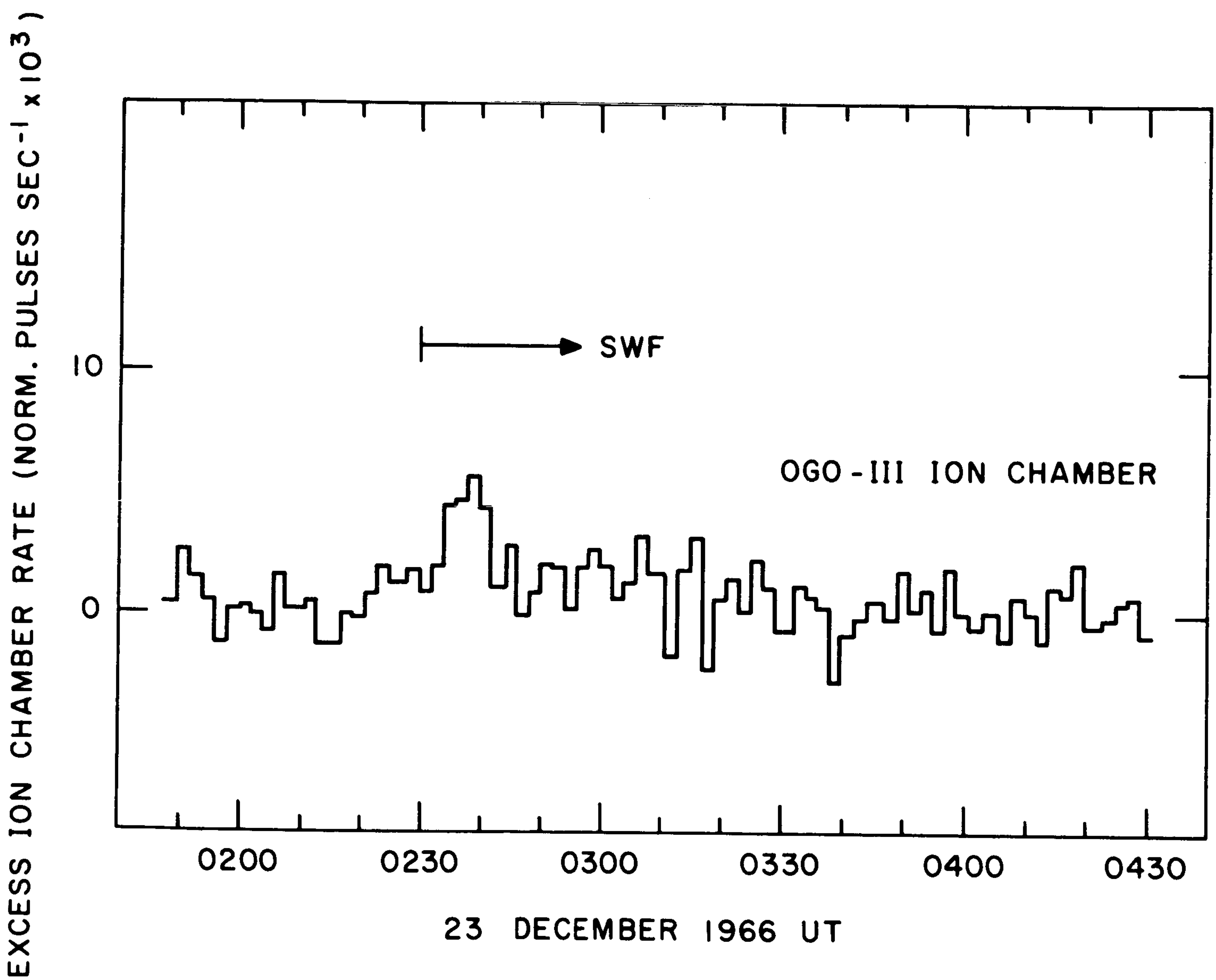


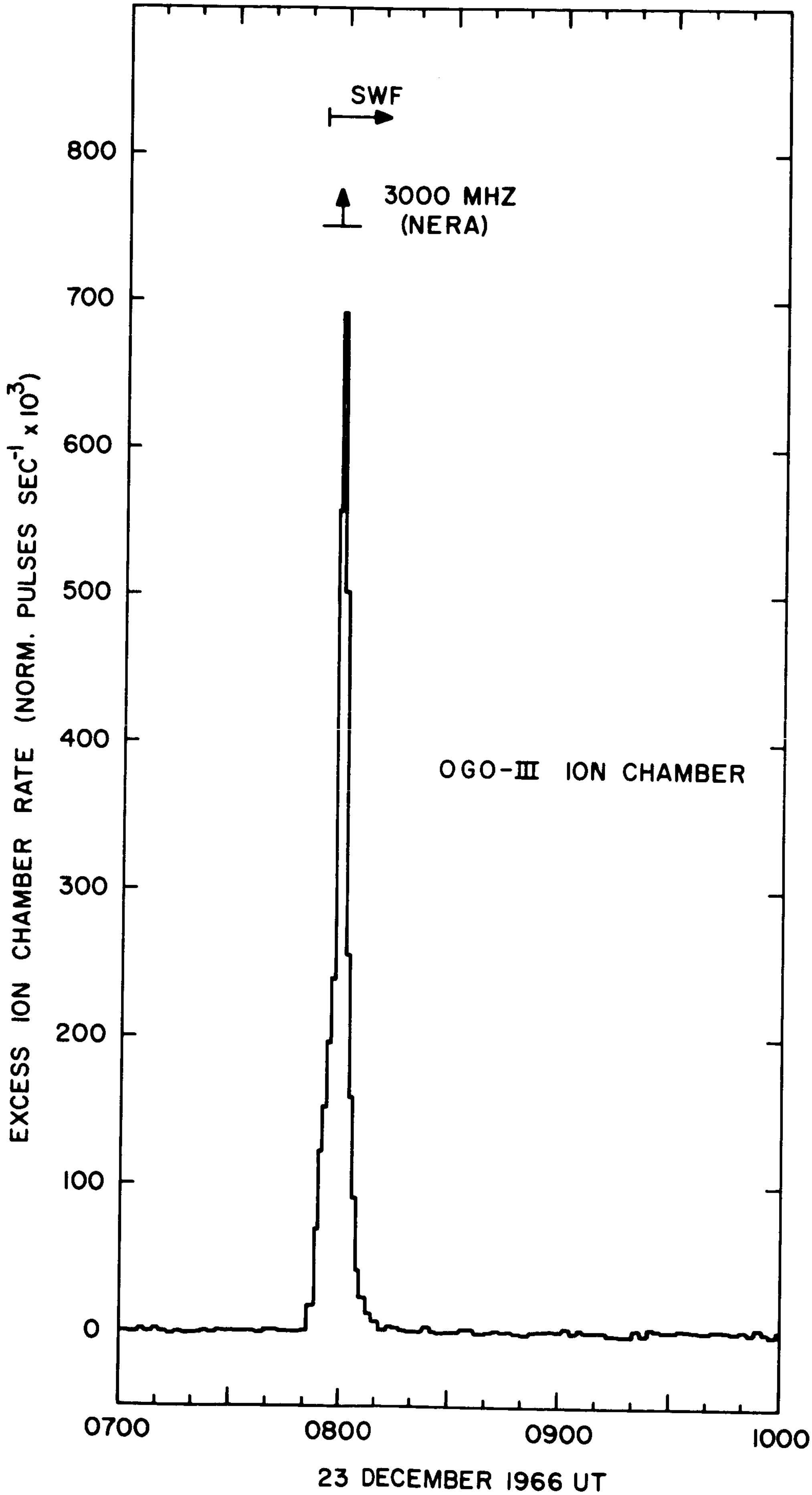
SWF
9400, 3750 MHZ
(TOYOKAWA)
OGO-III ION CHAMBER
10
0
0430
0500
0530
0600
0630
0700
15 DECEMBER 1966 UT
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)

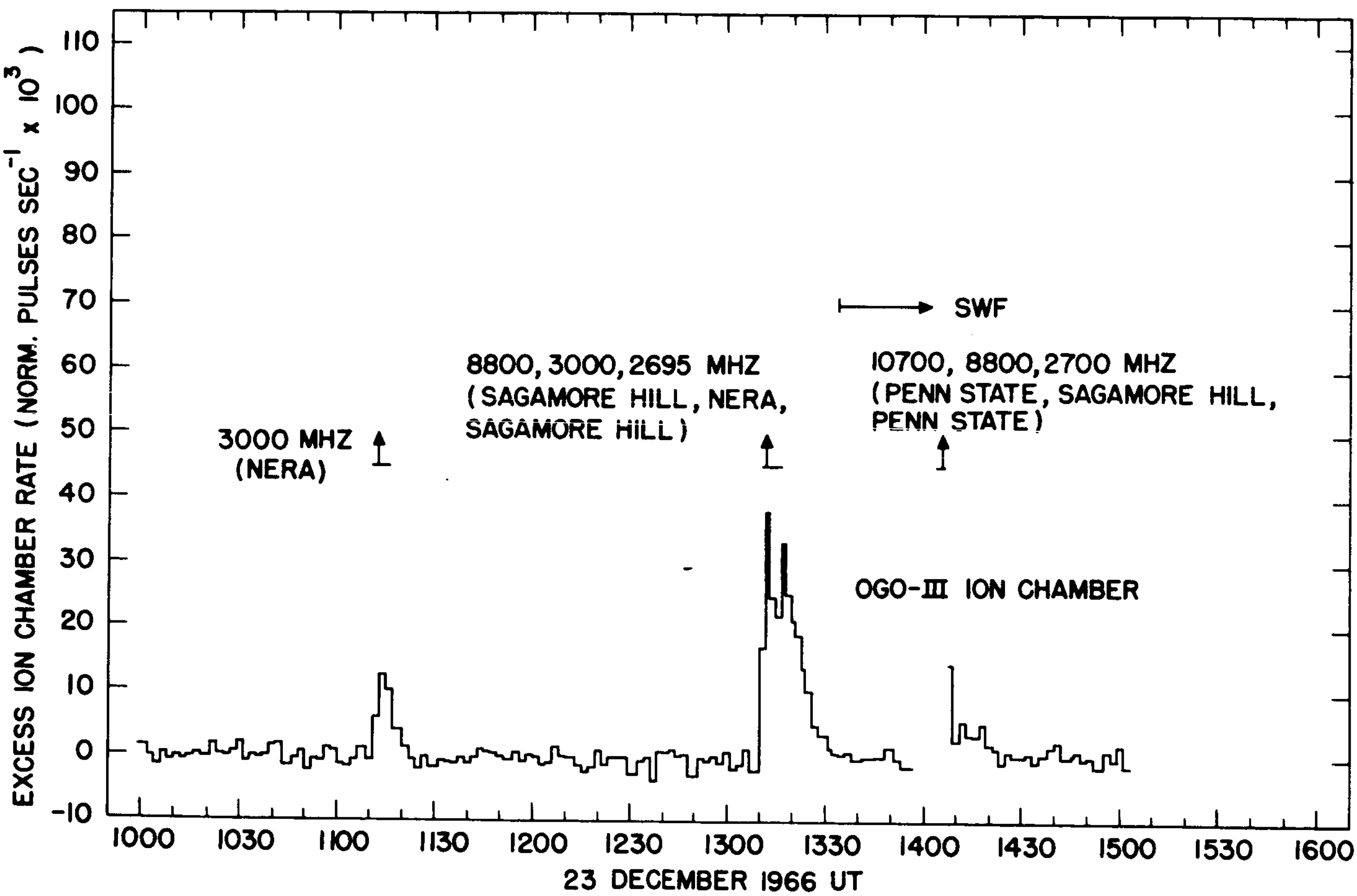

SWF
8800, 2700, 3000 MHZ
(SAGAMORE HILL, PENN STATE, NERA)
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
110
90
70
50
30
10
0
-10
1400
1430
1500
1530
1600
1630
21 DECEMBER 1966 UT



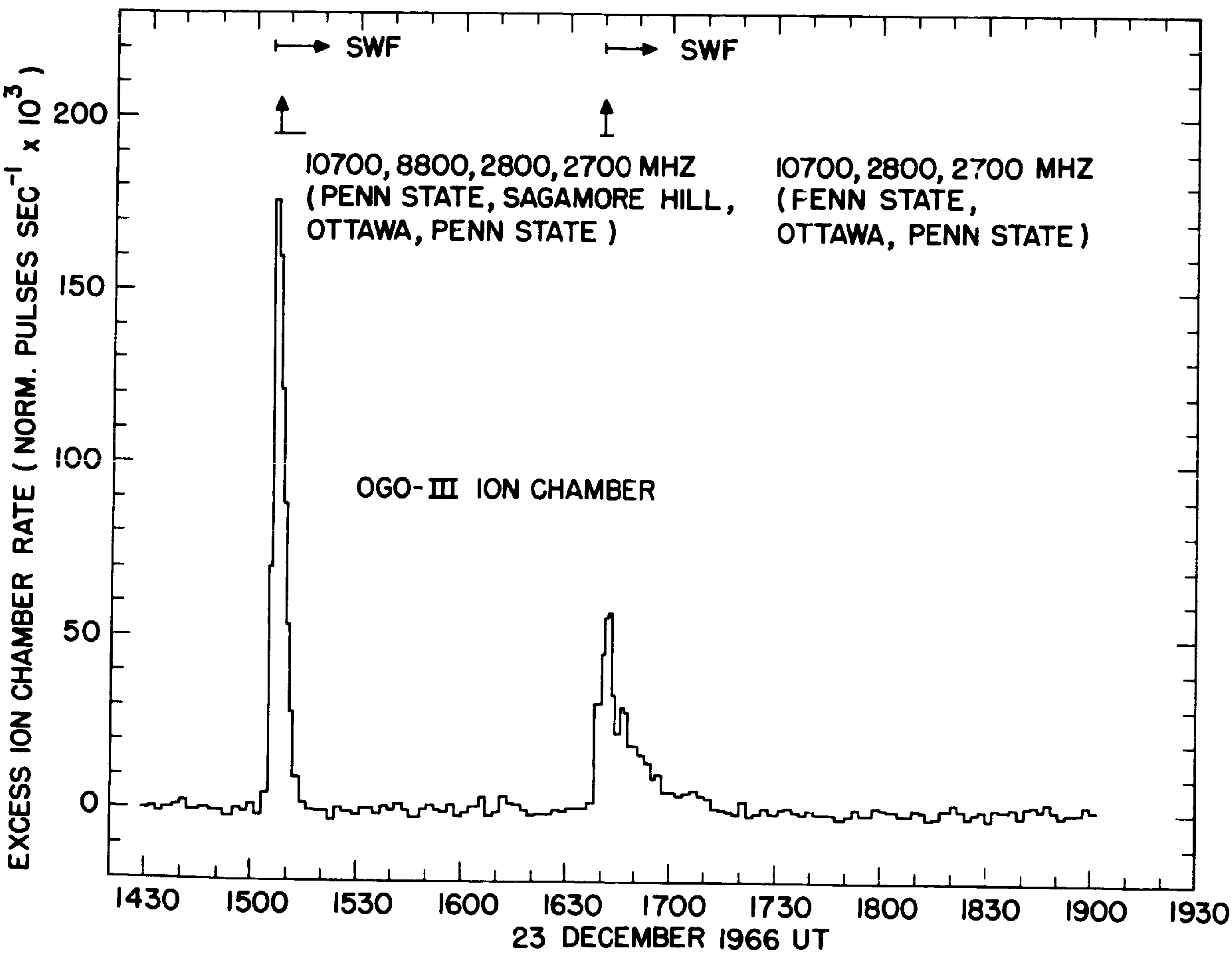
SWF
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x10^3)
70
50
30
10
0
-10
1900
1930
2000
2030
2100
2130
21 DECEMBER 1966 UT

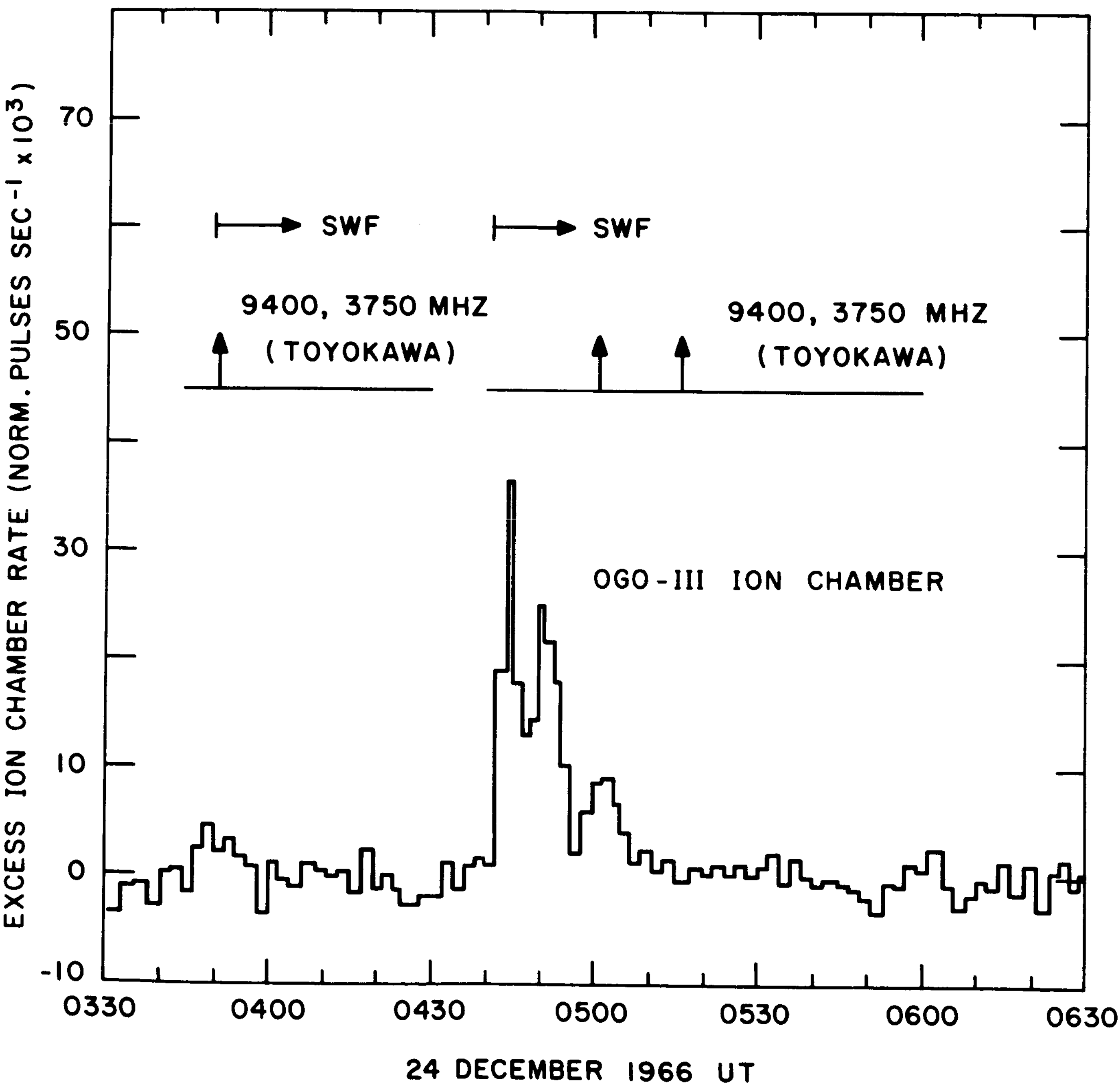

EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
10
0
SWF
OGO-III ION CHAMBER
0200
0230
0300
0330
0400
0430
23 DECEMBER 1966 UT

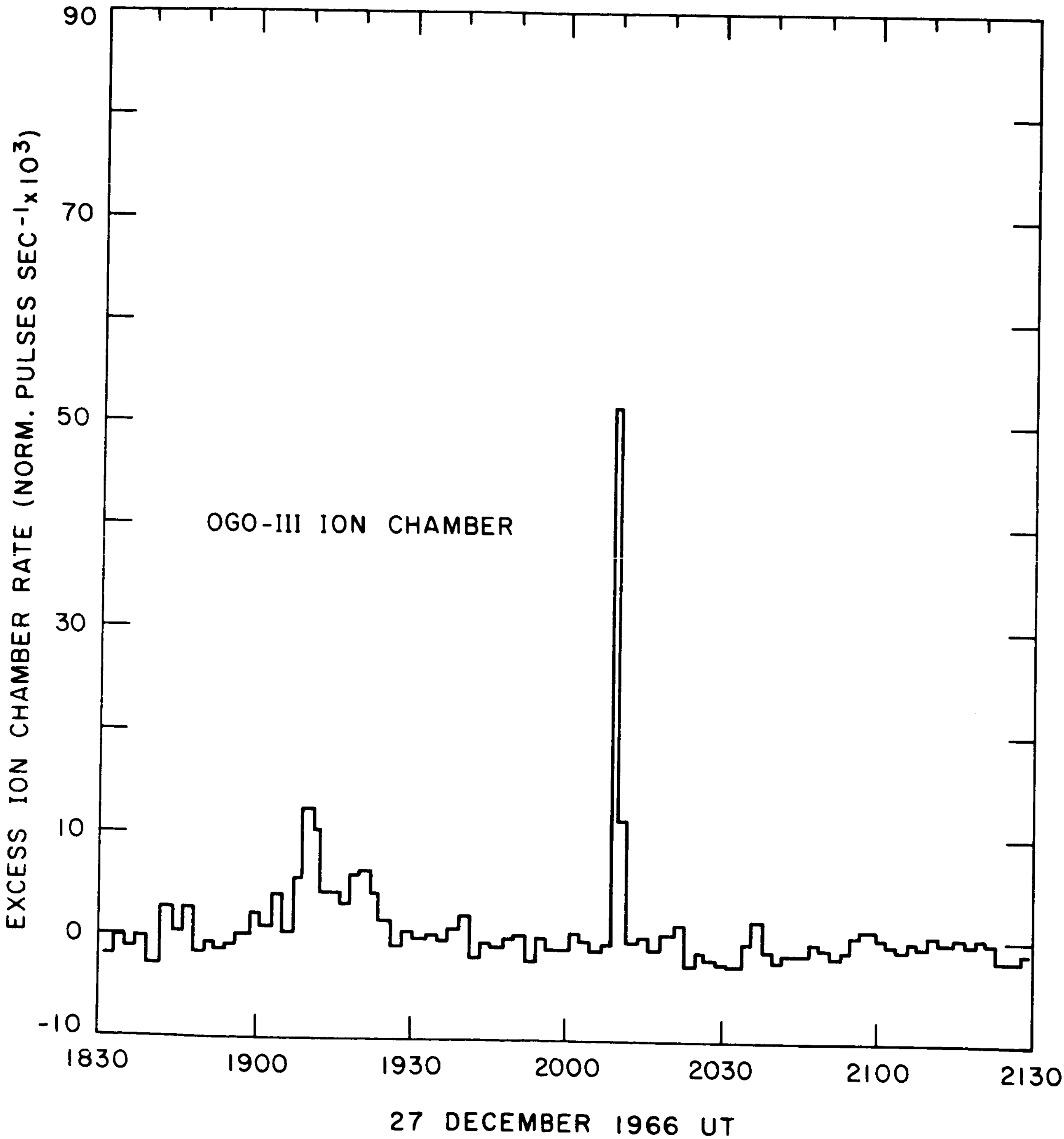

SWF
3000 MHZ
(NERA)
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
800
700
600
500
400
300
200
100
0
0700
0800
0900
1000
23 DECEMBER 1966 UT

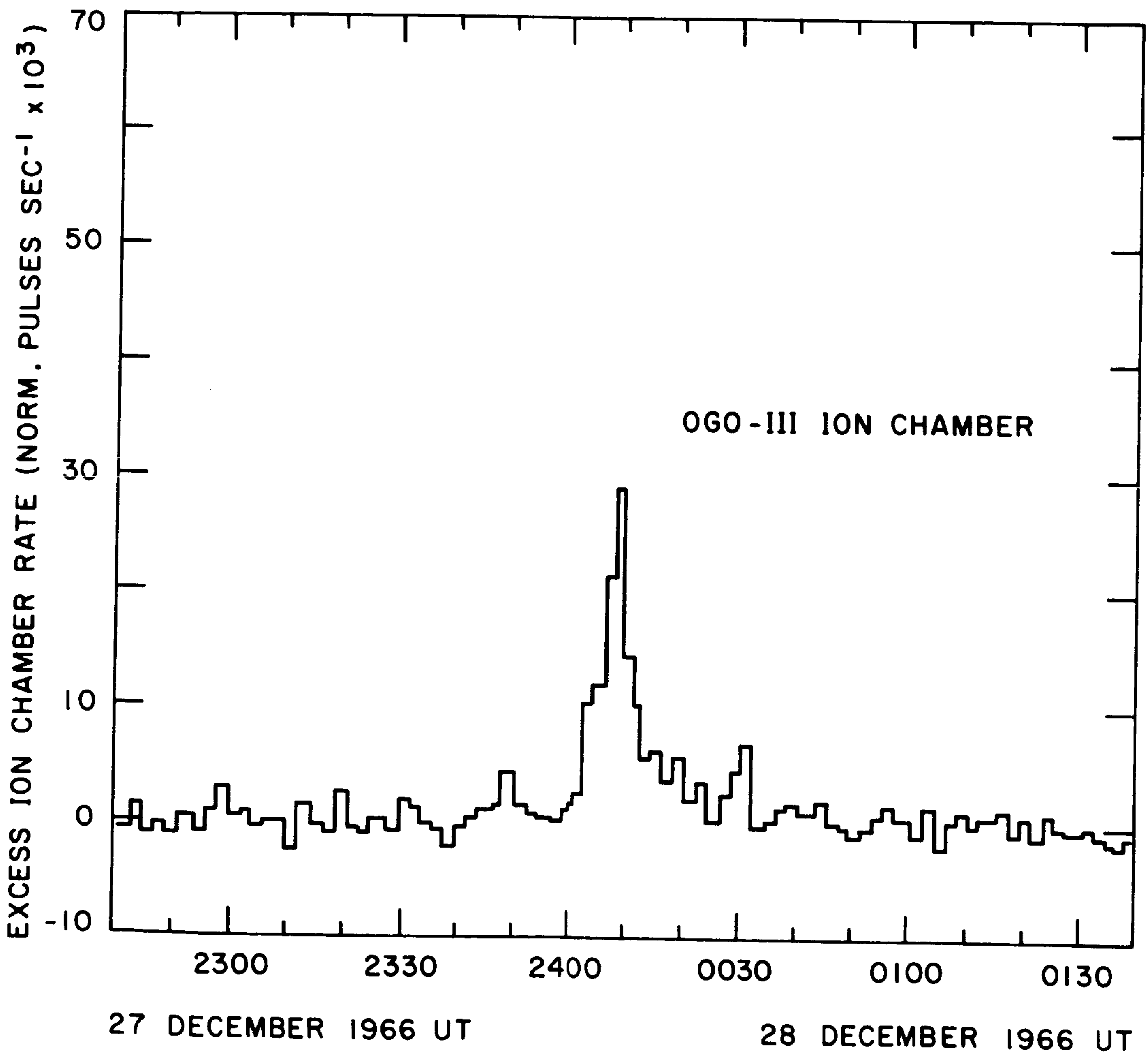


EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
110
100
90
80
70
60
50
40
30
20
10
0
-10
1000
1030
1100
1130
1200
1230
1300
1330
1400
1430
1500
1530
1600
23 DECEMBER 1966 UT
3000 MHZ
(NERA)
8800, 3000, 2695 MHZ
(SAGAMORE HILL, NERA,
SAGAMORE HILL)
SWF
10700, 8800, 2700 MHZ
(PENN STATE, SAGAMORE HILL,
PENN STATE)
OGO-III ION CHAMBER


SWF
SWF
10700, 8800, 2800, 2700 MHZ
(PENN STATE, SAGAMORE HILL, OTTAWA, PENN STATE)
10700, 2800, 2700 MHZ
(PENN STATE, OTTAWA, PENN STATE)
OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1} x 10^3)
200
150
100
50
0
1430
1500
1530
1600
1630
1700
1730
1800
1830
1900
1930
23 DECEMBER 1966 UT


EXCESS ION CHAMBER RATE (NORM. PULSES SEC-1 x 10^3)
70
50
30
10
0
-10
SWF
SWF
9400, 3750 MHZ
(TOYOKAWA)
9400, 3750 MHZ
(TOYOKAWA)
OGO-III ION CHAMBER
0330
0400
0430
0500
0530
0600
0630
24 DECEMBER 1966 UT


OGO-III ION CHAMBER
EXCESS ION CHAMBER RATE (NORM. PULSES SEC^{-1}x 10^{3})
90
70
50
30
10
0
-10
1830
1900
1930
2000
2030
2100
2130
27 DECEMBER 1966 UT



EXCESS ION CHAMBER RATE (NORM. PULSES SEC⁻¹ x 10³)
70
50
30
10
0
-10
OGO-III ION CHAMBER
2300
2330
2400
0030
0100
0130
27 DECEMBER 1966 UT
28 DECEMBER 1966 UT