Musical Information Research In Russia (History And The Present Time)

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History of musical sound investigations: Hermann Ludwig Ferdinand von Helmholtz

DIE LEHRE

VON DEN

TONEMPFINDUNGEN

ALS

PHYSIOLOGISCHE GRUNDLAGE

FÜR DIE

THEORIE DER MUSIK.

VON

H. HELMHOLTZ,

Professor der Physiologie an der Universität zu Heidelberg.

MIT IN DEN TEXT EINGEDRUCKTEN HOLZSTICHEN.

BRAUNSCHWEIG,

DRUCK UND VERLAG VON FRIEDRICH VIEWEG UND SOHN.

1 8 6 3.

INHALTSVERZEICHNISS.

History of musical sound investigations: 1920-th.
S. N. Rzhevkin & V. S. Kazansky

- **The investigations of singing voice.** S.-Petersburg, Russia, *Journal of Applied Physics*, 1928, v. 5, P. 87 (in Russian).

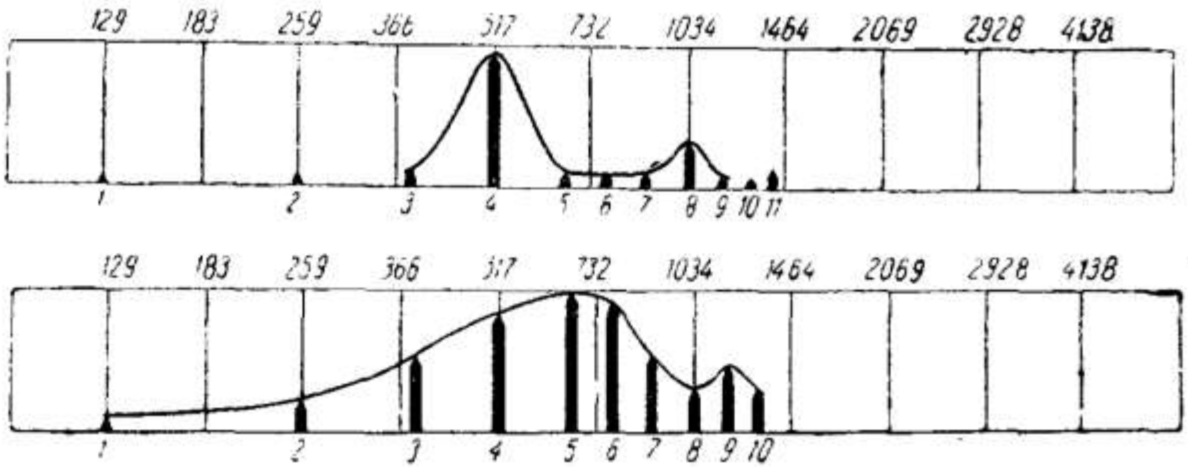


Fig 1. Lower formant measurement for a singer's voice (upper graph) and non-singer's voice (lower graph) -vowel "A", f_1 = 129 Hz

History of investigations: 1930-th. A.V.Rabinivich / V.S.Kazansky/ N. A. Garbusov

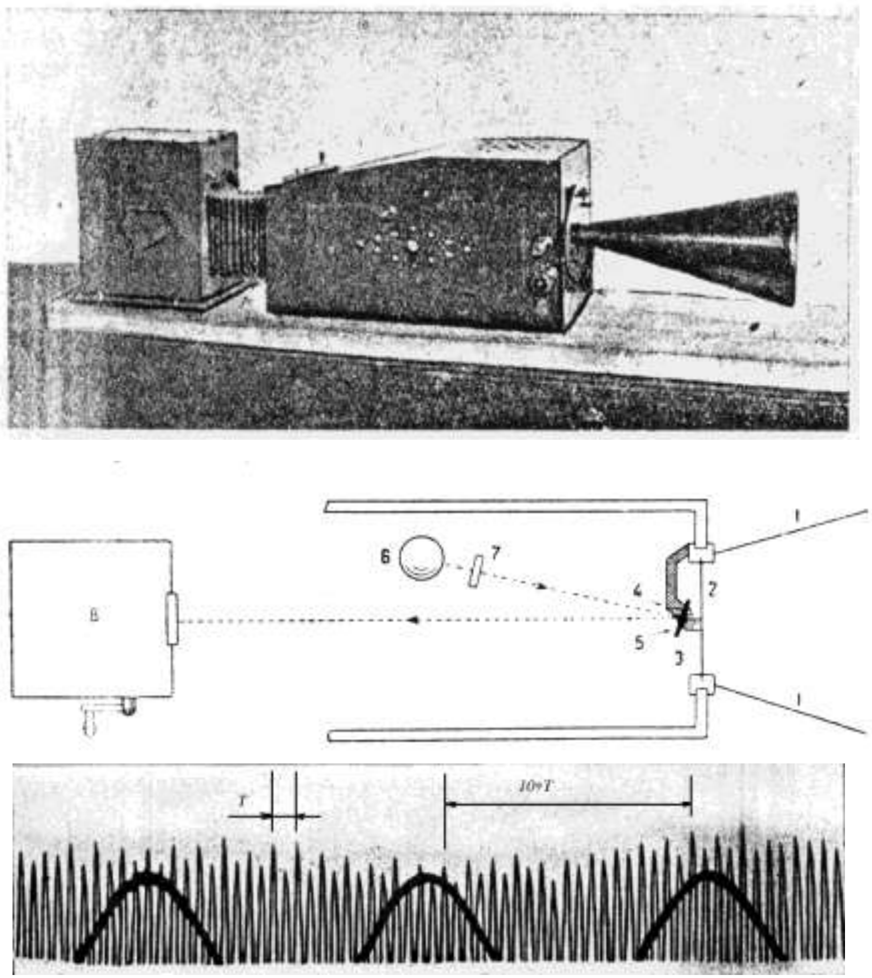


Fig 2. *Left:* Photo-recorder of sound oscillations created by **V. S. Kazansky** and a record example**.** Measurement of oscillation period.

Right: The Cover of the Book: **A.V.Rabinovitch.** Oscillographic method of melody analysis. Moscow, 1932.

History of investigations: 1930-th. A.V.Rabinivich / V.S.Kazansky/ N. A. Garbusov

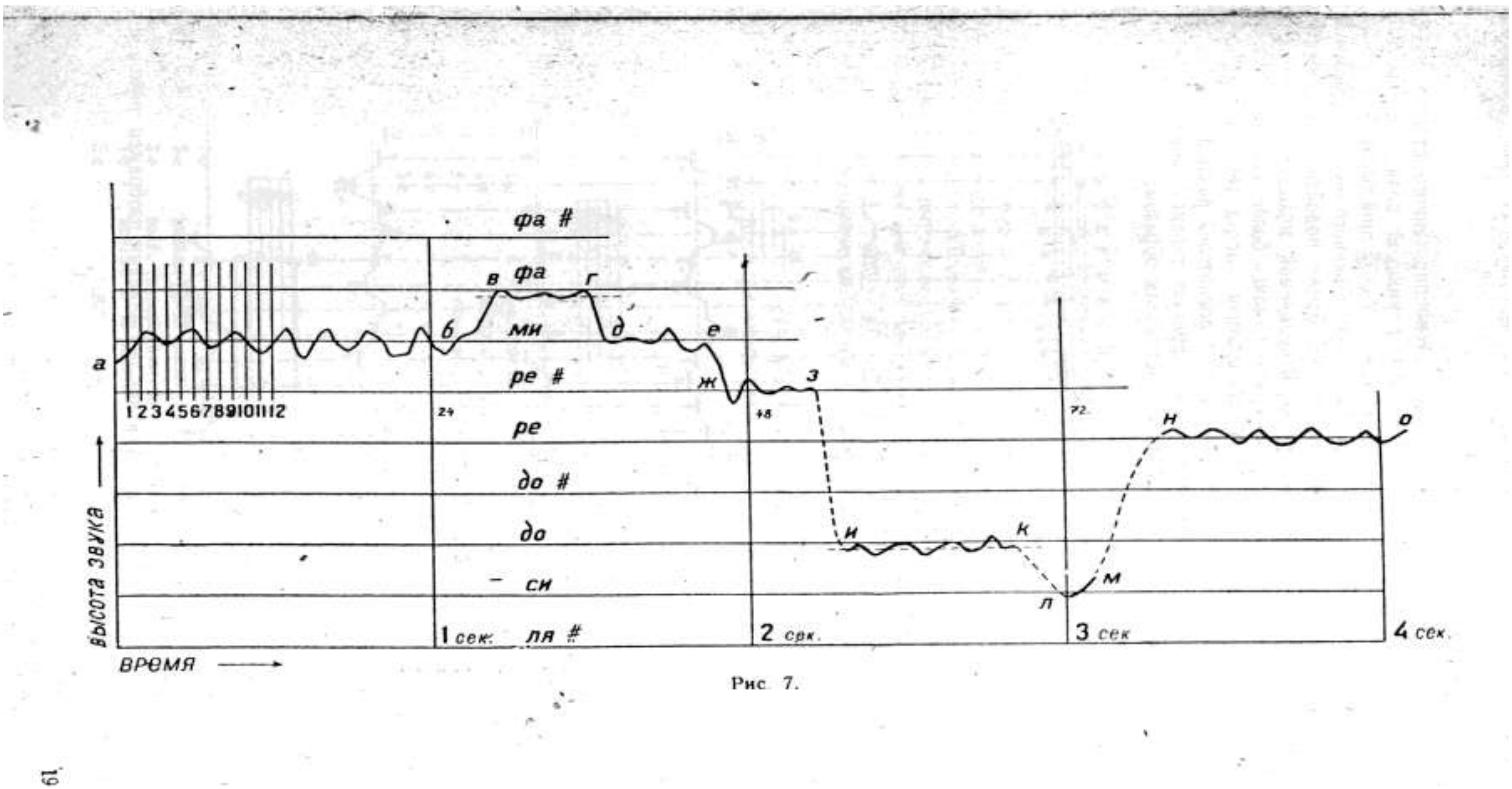


Fig. 3. Studying of exact performed melody with help of ‘photographic method’ by A.Rabinovitch: results in form of a melogram and measured deviations from standard tone pitches (horizontal lines).

History Of Investigations: 1930-th.
A. V. Rabinivich / N. A. Garbusov And His Pupils

- A. Rabinovich measured *deviation of every tone from the standard pitch value* pre-scribed in the score;
- he showed that *changing of sound pitch is a usual performer's method* for improving the harmony.
- A. Rabinovich prognosticated extend using of exact methods of melody study in musicologyst's investigations:
  — on the field of *classical music* (performance study),
  — in the study of *folk music and its non-European pitch rows.*
- In the 50th and 60th of the XX century pupils and colleagues of N. Garbuzov made several additional measurements of performer's strokes in *Acoustical Laboratory of Moscow P.I.Tchaikovsky Conservatory* — Sergey Screbkov, Eugeny Nazaikinsky, Youry Rags, Olga Sakhaltueva etc.

Beginning of Computer Investigations of Musical Sound: 1980-1990th

- **Zhenilo, V. R.** Analysis of parameters of main tone of human's voice for aims of person identification. Academy of Science of USSR, Computer Center, Series 'Computer Programming'. Moscow, 1988 (in Russian).
- **Zhenilo, V. R.** Computational Phonoscopy. Moscow, Academy of Ministry of Internal Affairs, 1995 (in Russian).

- **Bazhanov, N. S.** Dynamical intonation in the art of pianoforte performance — An investigation. Conservatory of Novosibirsk, 1994 (in Russian).
- **Morozov V. P., Kouznetsov Y. M., Kharuto A. V.** About specific properties of singer's voice in different genres. — Proc. of Conf. 'Informational approach and art science'. Moscow-Krasnodar, 1995, P. 147-156 (in Russian).

Tab. 1. Typical tasks of sound analysis in music science

The existence of written text (score)	**Aims of analysis**	**Examples of sound queue**
The text exists	*Deviation from the text as mistakes*	pupil or student performance
	Deviation from the text as interpretation	Master performance
The text exists but is not sufficient for fixing of sound	*Discovering and writing down of non-notable effects of sounding*	Electro-acoustic instruments, especially re-constructed acoustic instruments, unusual play technics
There is no text	*Creating of notation score, discovering of sound pitch row, fixing elements of performance style*	Traditional kinds of music: folklore, ritual music etc.

Tab. 2. Stages and Steps of sound analysis

Analysis of sound	**Detection of spectrum elements, measurement of its parameters**	**Statistical analysis**
Analysis of spectrum	Measurement of Characteristics for momentary spectrums and its elements: formants, overtone rows	Statistical parameters: average spectrum for given time interval, measurement of energy distribution
Analysis of sound pitch curve	Calculating of sound pitch curve (melogram); selecting of its elements: tones, glissando, vibrato and measurement of their parameters	Analysis of sound pitch row, measurement of statistical data for the elements of melogram (glissando, vibrato etc.)

Computer Investigations Of Musical Sound: ‘Sliding’ Analysis

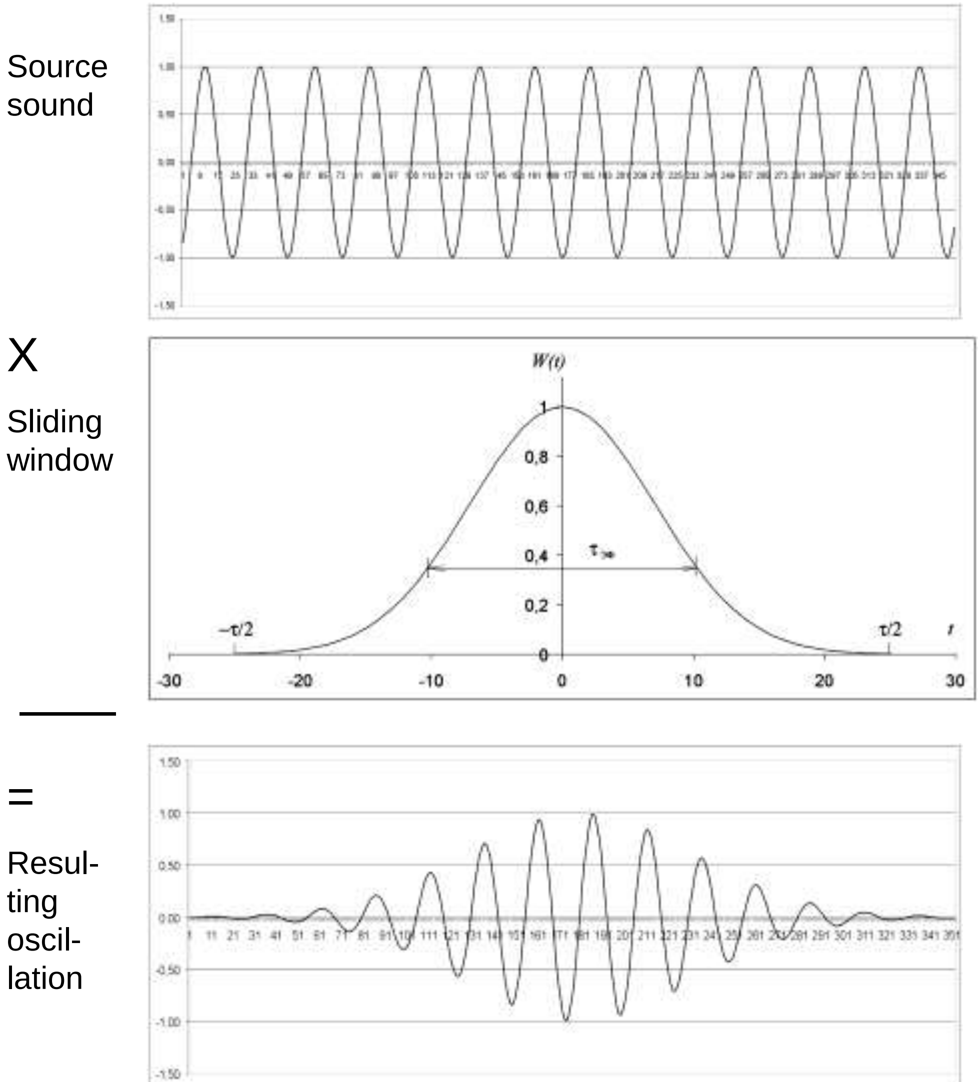


Fig. 4. Scheme of ‘sliding’ sound analysis

In order to follow the shortest elements of performance, the ‘sliding’ Fourier transformation will be used instead of usual ‘static’ spectrum calculation.

The sliding window width is about $\tau_{ЭФ}$ = 20..50 ms.

The ‘momentary’ spectrums can be calculated (according to the task) with different time steps (5..50 ms).

Fig. 6. *Upper:* sound oscillation; *middle:* sliding window form; *lower:* fragment of sound oscillation selected for analysis

Computer Investigations Of Musical Sound: Dynamical Spectrum As A Sonogram

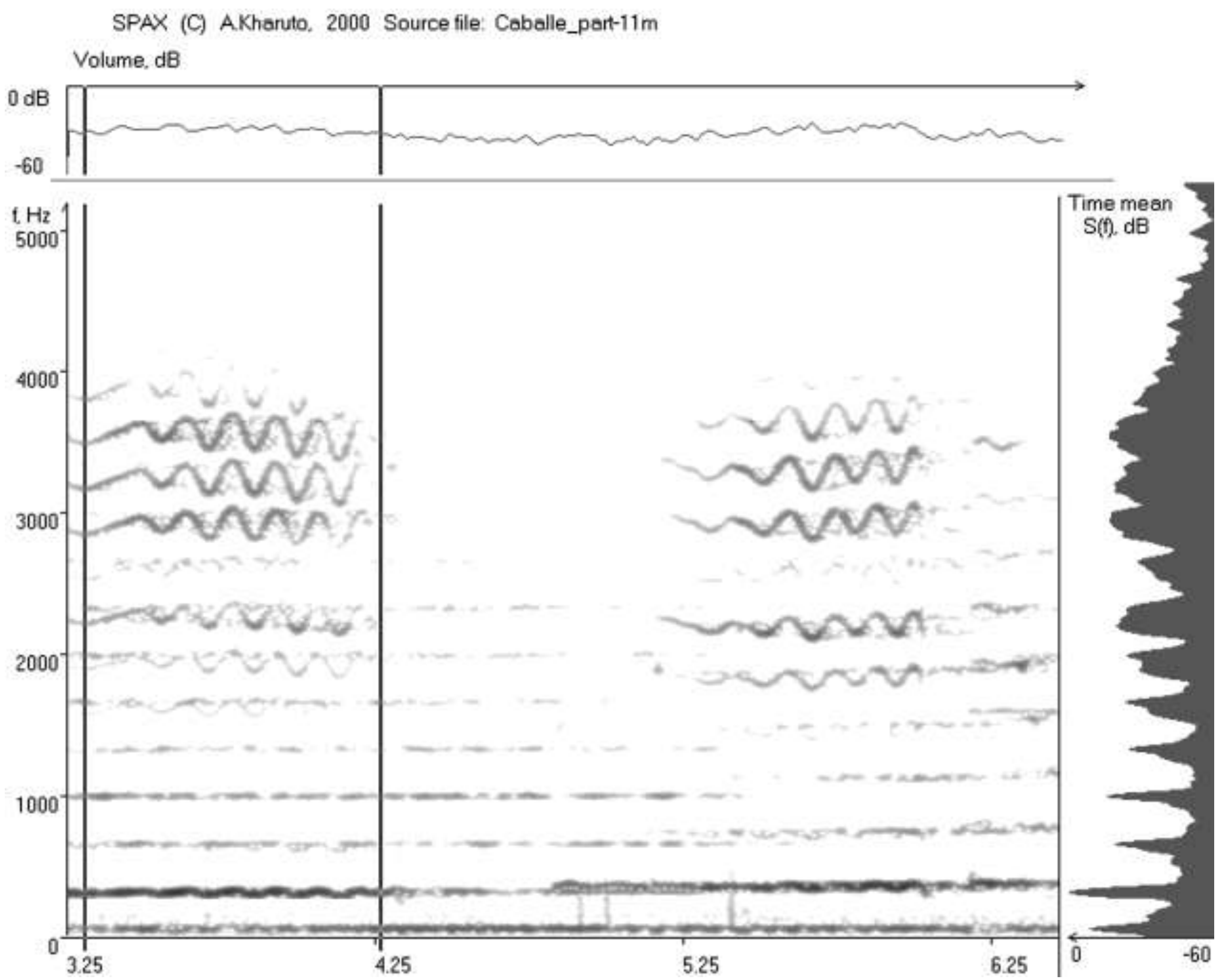
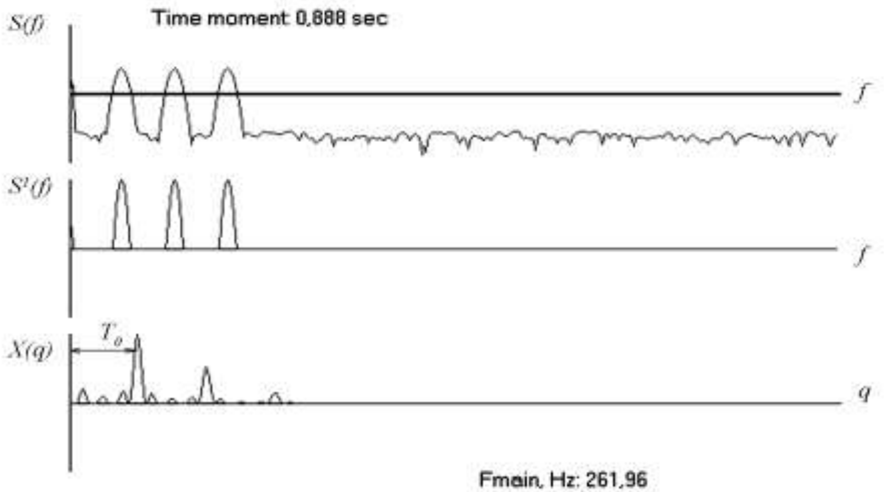
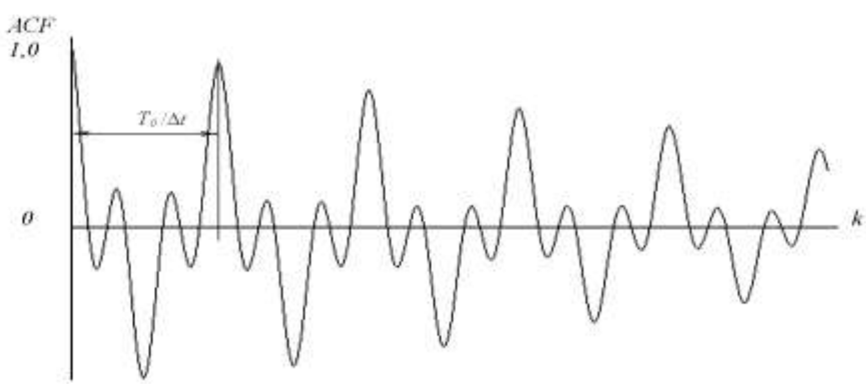


Fig. 5. Dynamical spectrum of M.Caballe singing. *Right:* the result of spectrum time averaging for measurement of high singer’s formant power

Computer Investigations Of Musical Sound: Sound Pitch Evaluation



General requirement: pitch estimation errors must be lower then 4..5 musical cents (1200 cents = 1 octave)



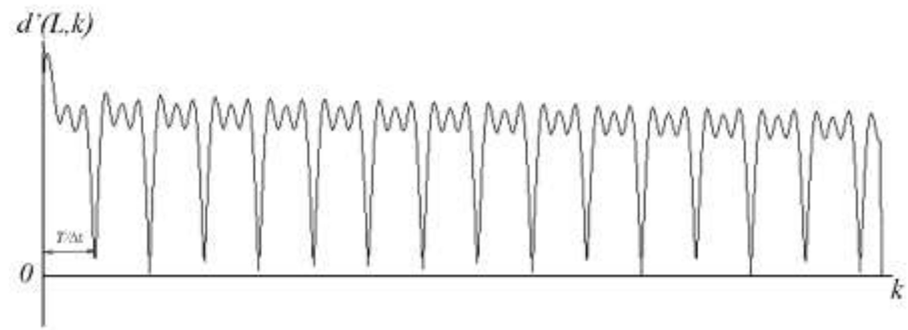


Fig. 6. ‘Popular’ methods of sound pitch estimation: *left, upper* — modified Cepstrum method; *left, lower :* autocorrelation method (ACF); *right:* — YIN-method, based on calculation of time-shift difference

Computer Investigations of Musical Sound: Graph Of The Sound Pitch — A Melogram

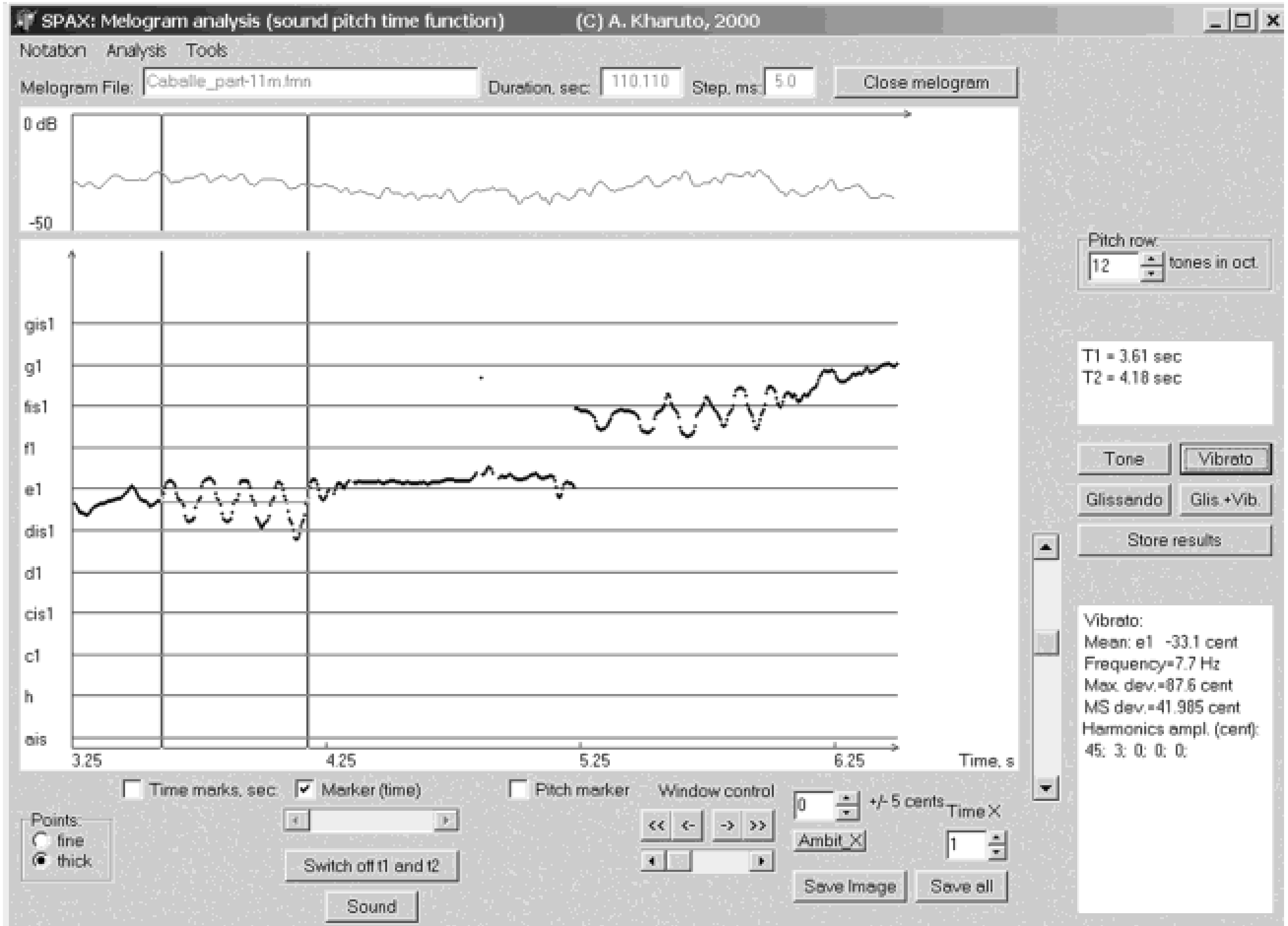


Fig. 7. Sound pitch curve for the fragment of M.Caballe singing (see Fig.5). Measurement of melogram elements: vibrato parameters. (Program SPAX — Author A.Kharuto, reg. #2005612875 of Federal Institute of Industrial Property of Russia, 2005)

Computer Investigations of Musical Sound: Sound Pitch Estimation For Folk Singing

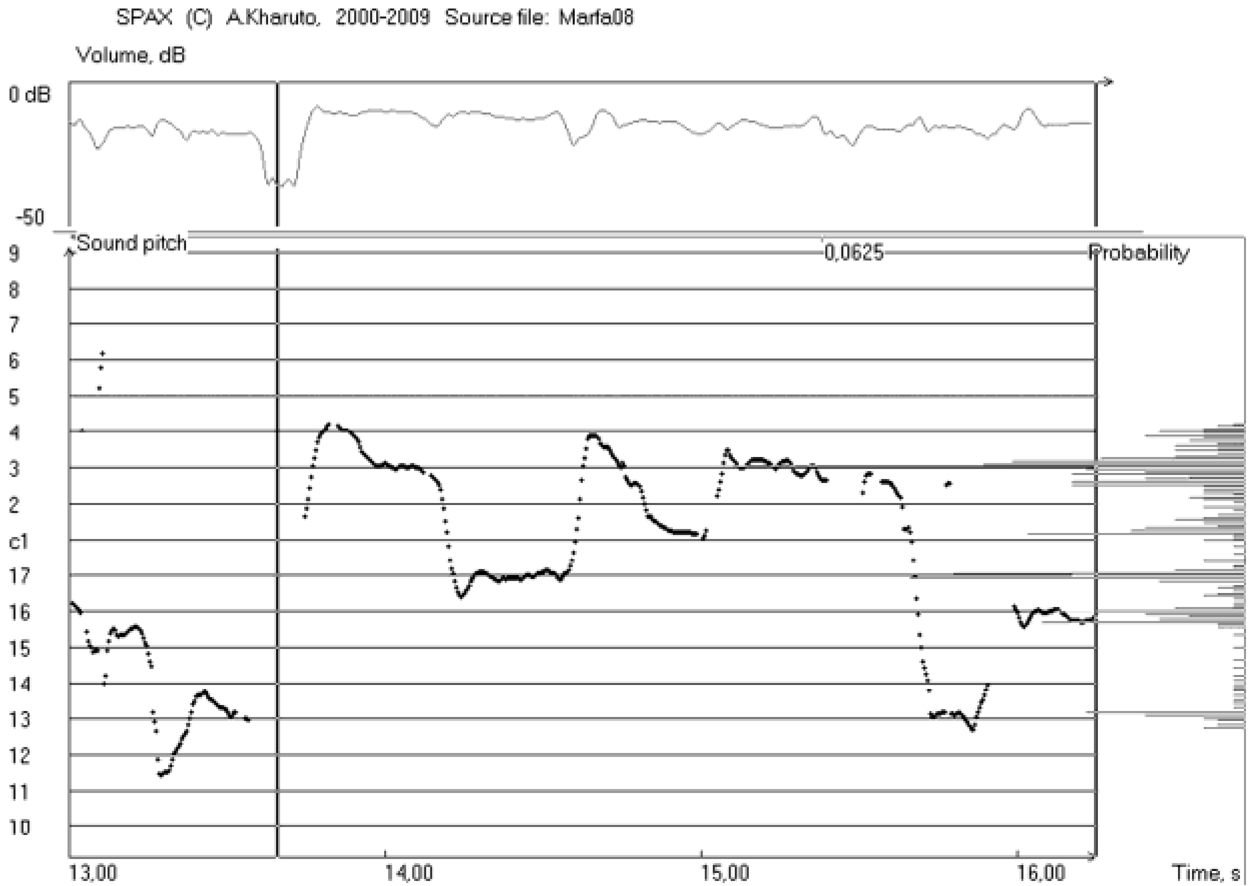


Fig. 8. The melogram of Russian folk song which sound pitch row, which differs from the 12-halftone row (***about 17 stages pro octave***)

Computer Investigations of Musical Sound: Sound Pitch Estimation For Folk Singing

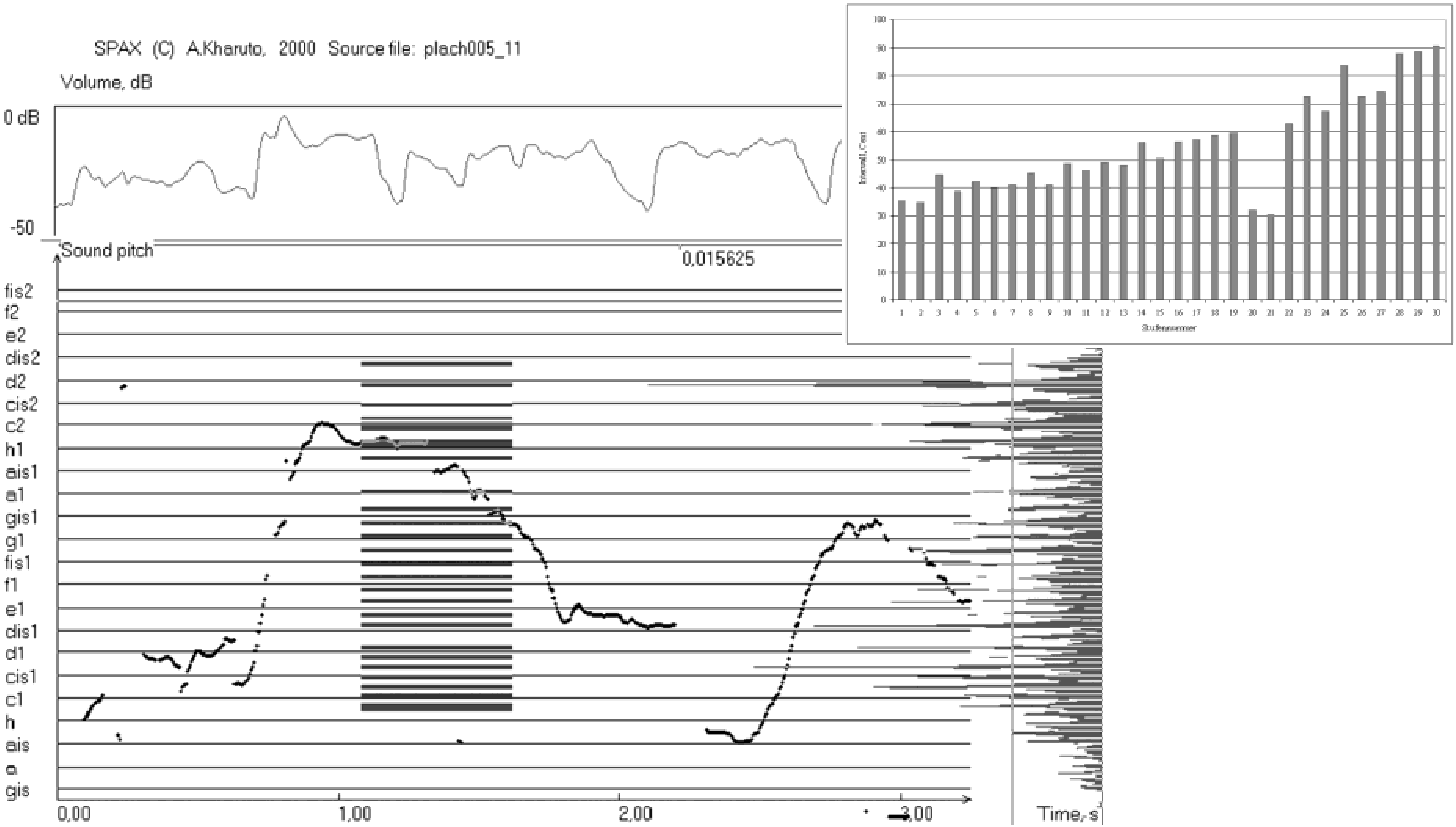


Fig. 9. Melogram of a north Russian lamentation song with a complex sound pitch row (***non-equal tempered pitch row with growing-up interval: 35..90 cents***)

Computer Investigations of Musical Sound: Tuva Traditional Throat Singing

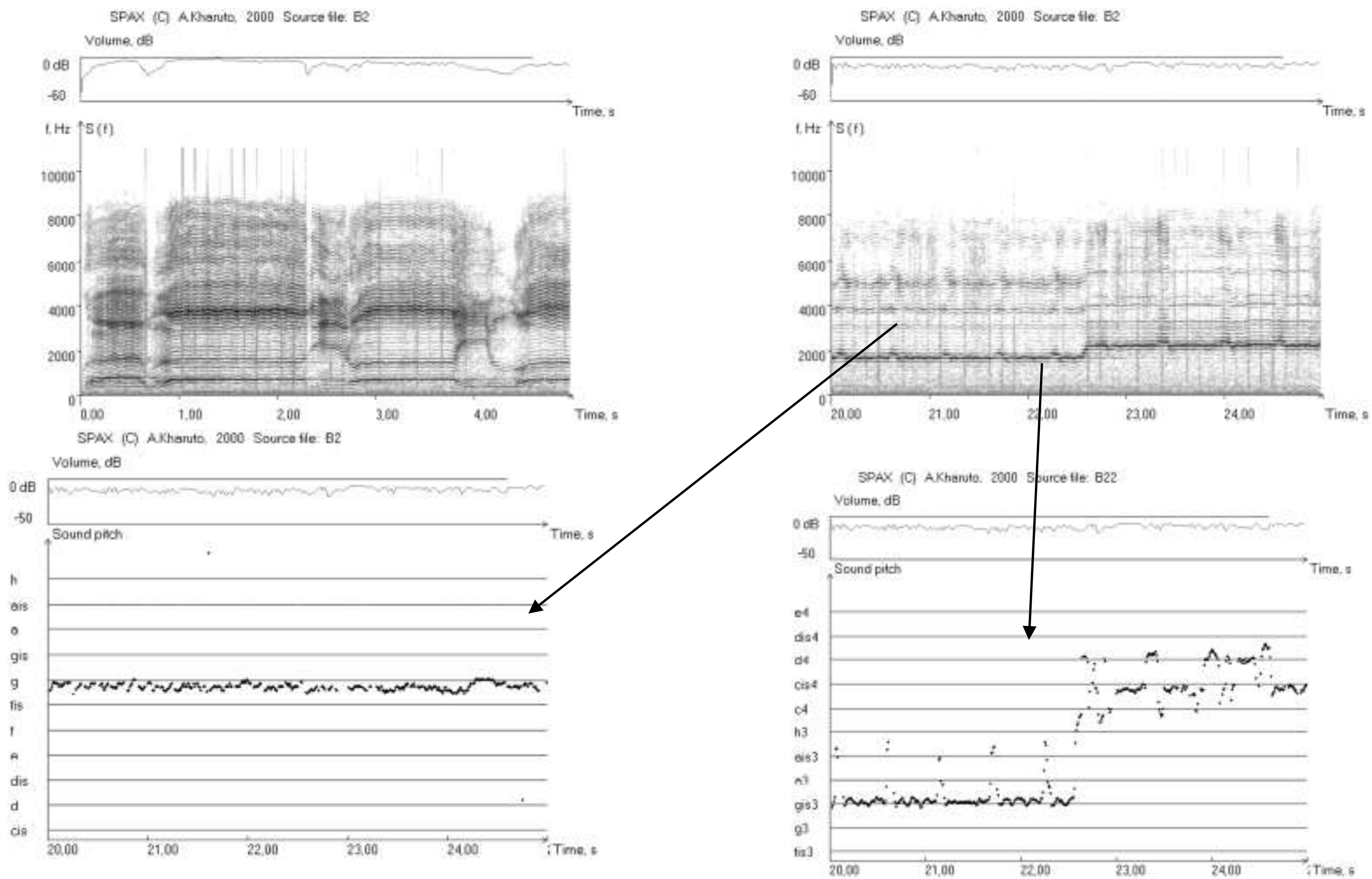


Fig. 11. Sonograms (*upper graphs*) and melograms (*lower graphs*) of Tuva throat singing: pitch estimation for 'vocalize' part — *left:* measurement based on all overtones; *right:* ~, based on most powerful overtones

Computer Investigations of Musical Sound: Tuva Traditional Throat Singing

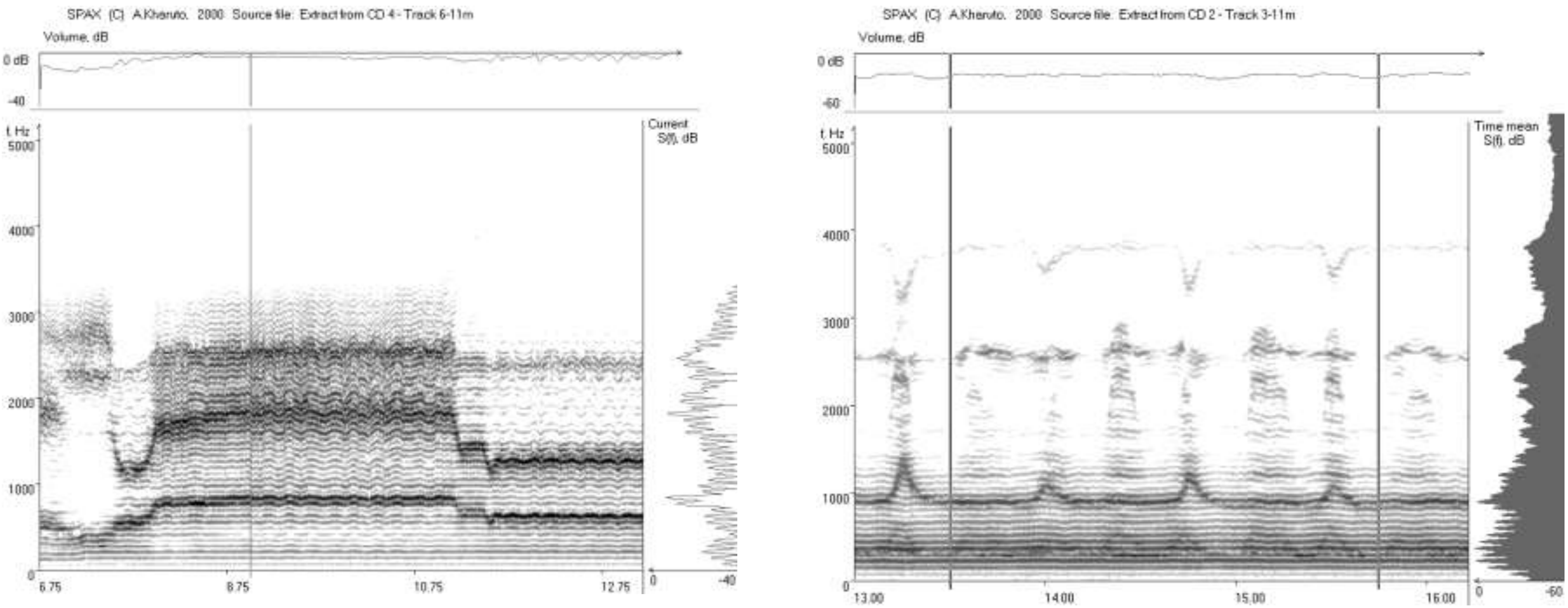


Fig. 12. Sonograms of two different kinds of Tuva throat singing: kargyraa (*left*) and borbannadyr (*right*)

Computer Investigations Of Musical Sound: Kazakhstan Traditional Instruments

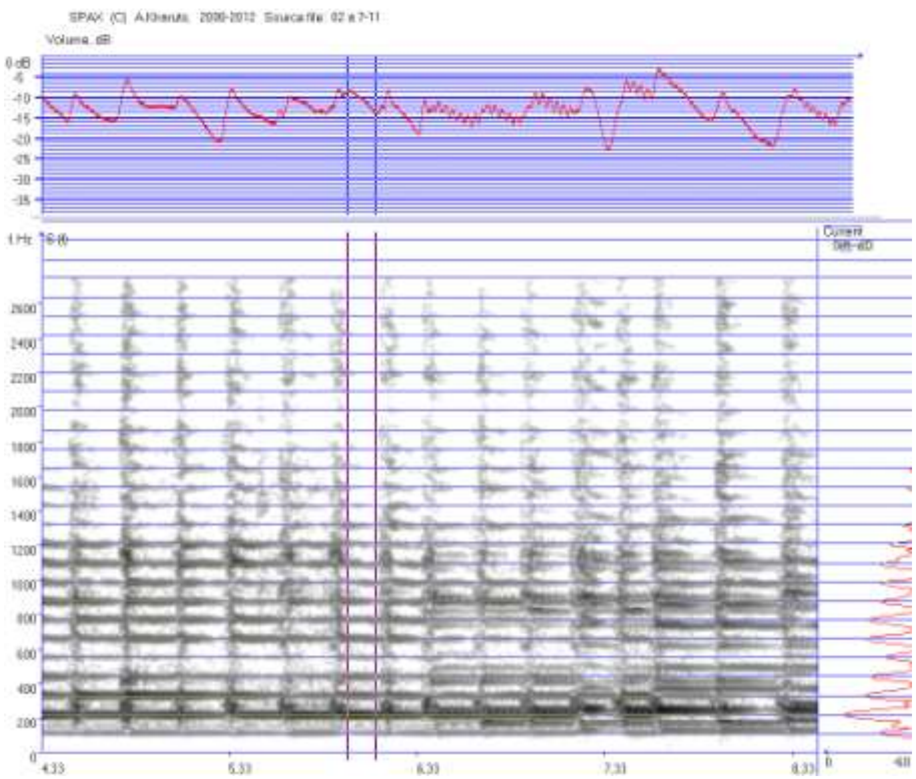


Fig. 13. Sonogram of kazakh dombra sound: pitch measurement on time interval. Measurement of main tone frequency based on overtone system.

Estimation for 40 sounds pitch measurement:

MSQ error = 5,5 cents. —> Accuracy of Interval measurement = 11 cents

Results of pitch row measurement: prevalence of traditional 'small' intervals

Interval, cent	Number of intervals	Number of intervals in %
25x	26	68.5
100x	11	29
150	1	2.6
Total	38	100

Computer Investigations Of Musical Sound: Traditional Performance On Azerbaijani *Tar* And Central-Asian *Tanbur*

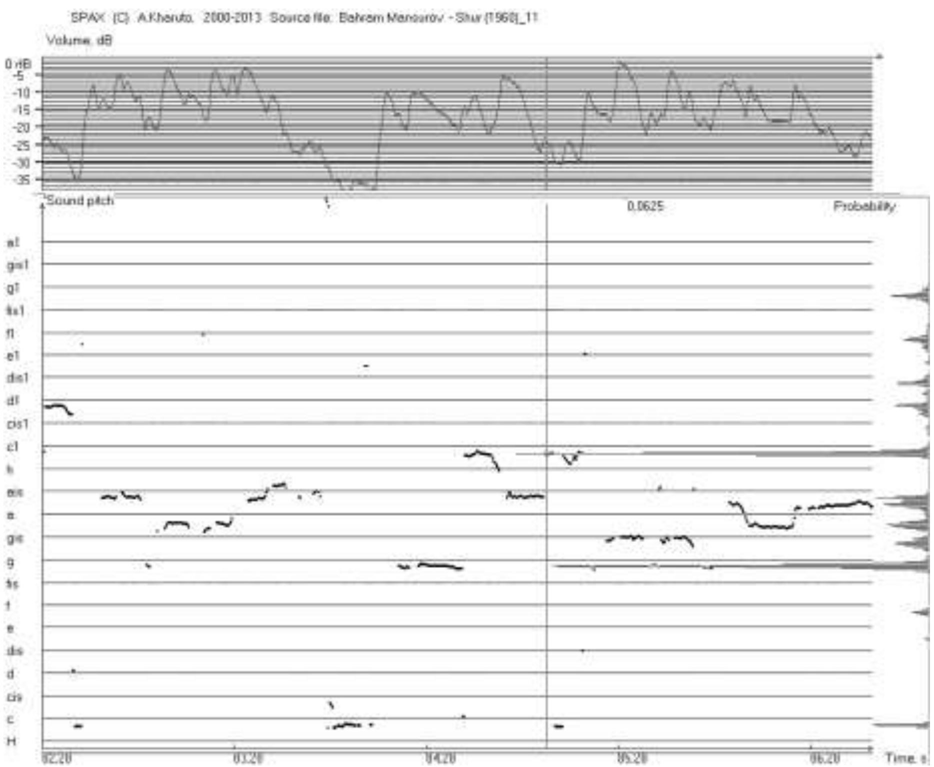


Fig. 14. Fragment of melogram (B. Mansurov, *tar* – duration: 220 sec.) and the hystogram of sound pitch (at the right side; probability rises from right to left)

Results of pitch row measurement for two performers generations (% of intervals multiple of 25 cents and of 100 cents)

Phonogram	25x cents	100x cents
B. Mansurov (1960th, tar)	54,5	45,5
V. Rahimov (1981, tar)	75	25
N. Aminov (1960th, tanbur)	76,9	23,1
M. Eshankoulov (2013, tanbur)	40	60
V. Rahimov (2012, tar)	35	65

Some additional publications for the theme

- **Kharuto A. V.** Using of Personal Computer as an Analyzing Device of Sound Spectrum in Musicological Investigation [Ispolzovanie personalnogo kompyutera kak sredstva analiza spektra zvuka v muzykovedcheskom issledovanii]. *Materialy mezhdunarodnogo nauchnogo simpoziuma «Empiricheskaya estetika: informatsionnyy podkhod»* (Materials of International scientific symposium “Empirical Aesthetics: informational approach). Mezhdunarodnaya akademiya informatizatsii, Mezhdunarodnaya assotsiatsiya empiricheskoy estetiki, Akademiya gumanitarnykh nauk, Taganrogskiy gosudarstvennyy radiotekhnicheskiy universitet. Taganrog, Izd. TRTU, 1997, P. 158–162 (in Russian).
- **Kharuto A. V.** Computer Transcription of Phonograms of Folk Singing [Kompyuternaya rasshifrovka fonogramm folklornogo peniya]. *Tvorchestvo v iskusstve — iskusstvo tvorchestva* (Creativity in Art — Art of Creativity). Nauchnye redaktory (Sci. Ed.): L. Dorfman, K. Martindale, V. Petrov, P. Mahotka, J. Kupchik. Moscow, Nauka; Smysl, 2000, P. 325–336 (in Russian).
- **Kharuto Alexander V., Smirnov Dmitry V.** Information approach in examining of evolution of Russian northern folk musical tradition. Proceedings of IAEA-2002 (17-th Congress of the International Association of Empirical Aesthetics, Takarazuka, Japan, 4-8 August 2002). — Takarazuka, 2002. — p.313–318.
- **Kharuto A. V.** Folk music sound: Methods and results of computer analysis. //Current Trends in Russian Approaches to Art and Culture: Bulletin of Psychology and the Arts, Vol. 3. . — Society for Psychology of Aesthetics, Creativity, and Culture, 2003. — p. 35–37.

Some additional publications for the theme

- **Kharuto A. V.** Computer Sound Analysis in Musicology: Its Goals, Methods, and Results. / In: L. Dorfman, C. Martindale, V. Petrov (Ed.). Aesthetics and Innovation — Cambridge Scholars Publishing, 2007, P. 305–322.
- **Kharuto A.V., Karelina E.K.** About Musical And Acoustical Properties Of Tuva Throat Singing (K voprosu o muzicalno-acusticheskih svoistvah tuvinskogo gorlovogo penia). *Muzicalnaya Akademia* (Musical Academy), 2008, Nr.4, P. 108–113 (in Russian).
- **Kharuto A. V.** Computer Sound Analysis in Musicology and Music Teaching [Kompyuternyy analiz zvuka v muzykovedenii i muzykalnoy pedagogike]. *Muzykalnaya akademiya* (Musical Academy), 2009, № 4, P. 77–83.
- **Kharuto A. V.** Computer Analysis of Sound Pitch Row made on Phonogram [Kompyuternyy analiz zvukoryada po fonogramme] *Muzykalnaya akademiya* (Musical Academy), 2010, № 3, P. 83–89.
- **Utegalieva S.I., Kharuto A.V.** Computer Analysis of Traditional Pitch Row of Kazakh Dombra made on a Fragment from D. Nurpeisova’s Kui ‘Enbek epi’ [Komputernoe issledovanie traditsionnogo stroya kazakhskoy dombry na primere fragmenta is kuia D. Nurpeisovoy ‘Enbek epi’]. *Musicovedenie* (Musicology), N 8, 2013, P. 28–39.
- **Yunusova V., Kharuto A.** Computer Analysis of Style Parameters in Traditional Culture Performance (on Material of Classical Eastern Music) [Kompyuternyy analiz parametrov stilya ispolneniya v traditsionnoy kulture (na materiale klassicheskoy muzyki Vostoka)]. *Muzykalnaya Akademiya* (Musical Academy), 2015, N.1, P. 143–147.