High speed cameras for evaluating vocal cord movements

Instruction course 1

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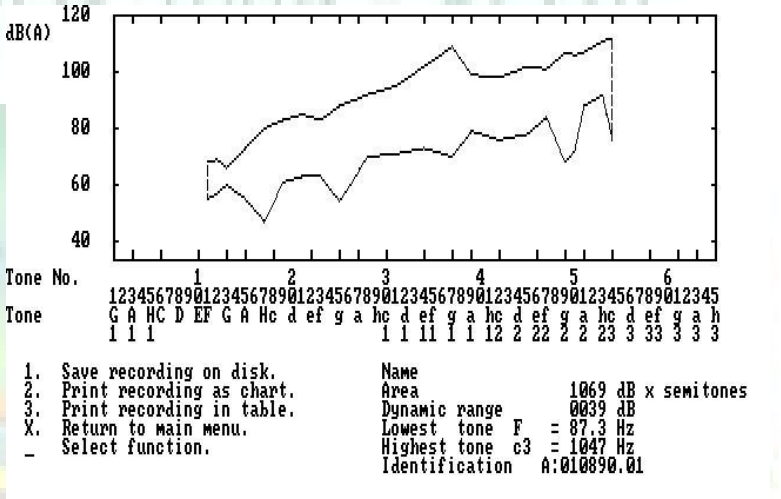
The presenter

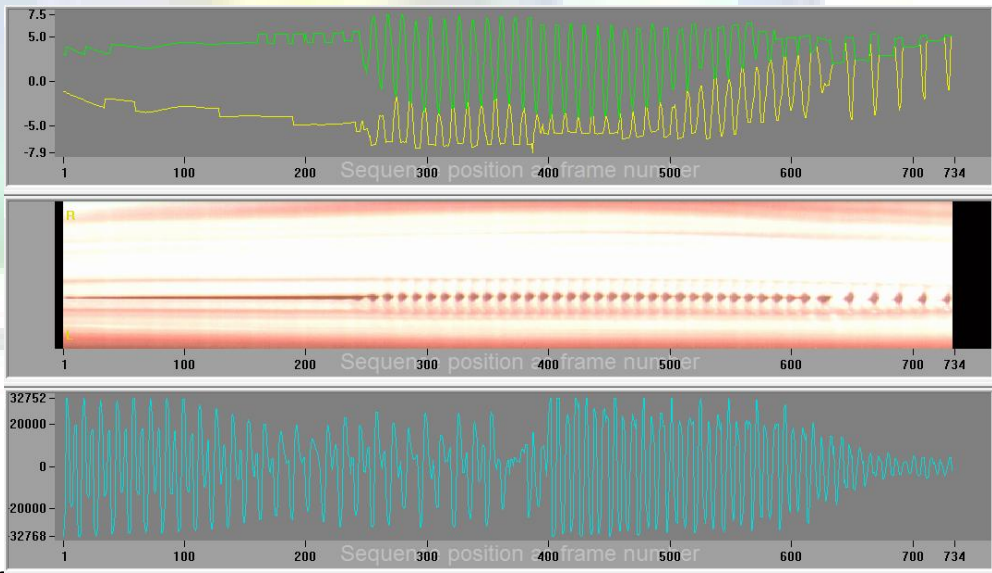
- Mette Pedersen

- FRSM Dr.med.Sci. et h.c. Ear-Nose-Throat specialist
- Delegate from the Danish Ministry of Science in the European Union.

Presenting the movements on the High Speed camera

- Watch movie
- One male
- one Female
- Child with nodules using false vocal cords
- Register shift in puberty 186 Hz (after40sec)
- Register shift in puberty 502 Hz (after40 sec) ex





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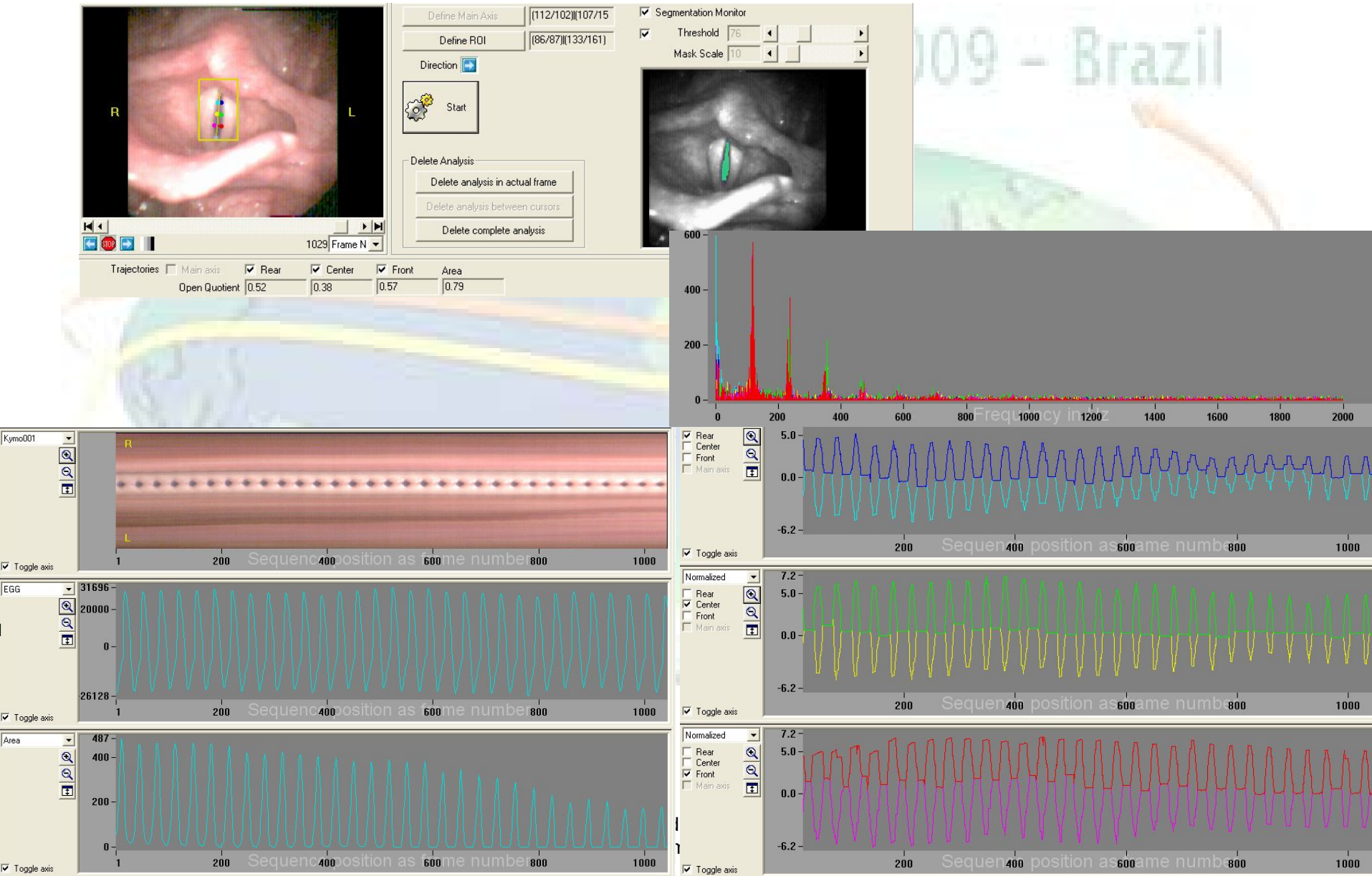
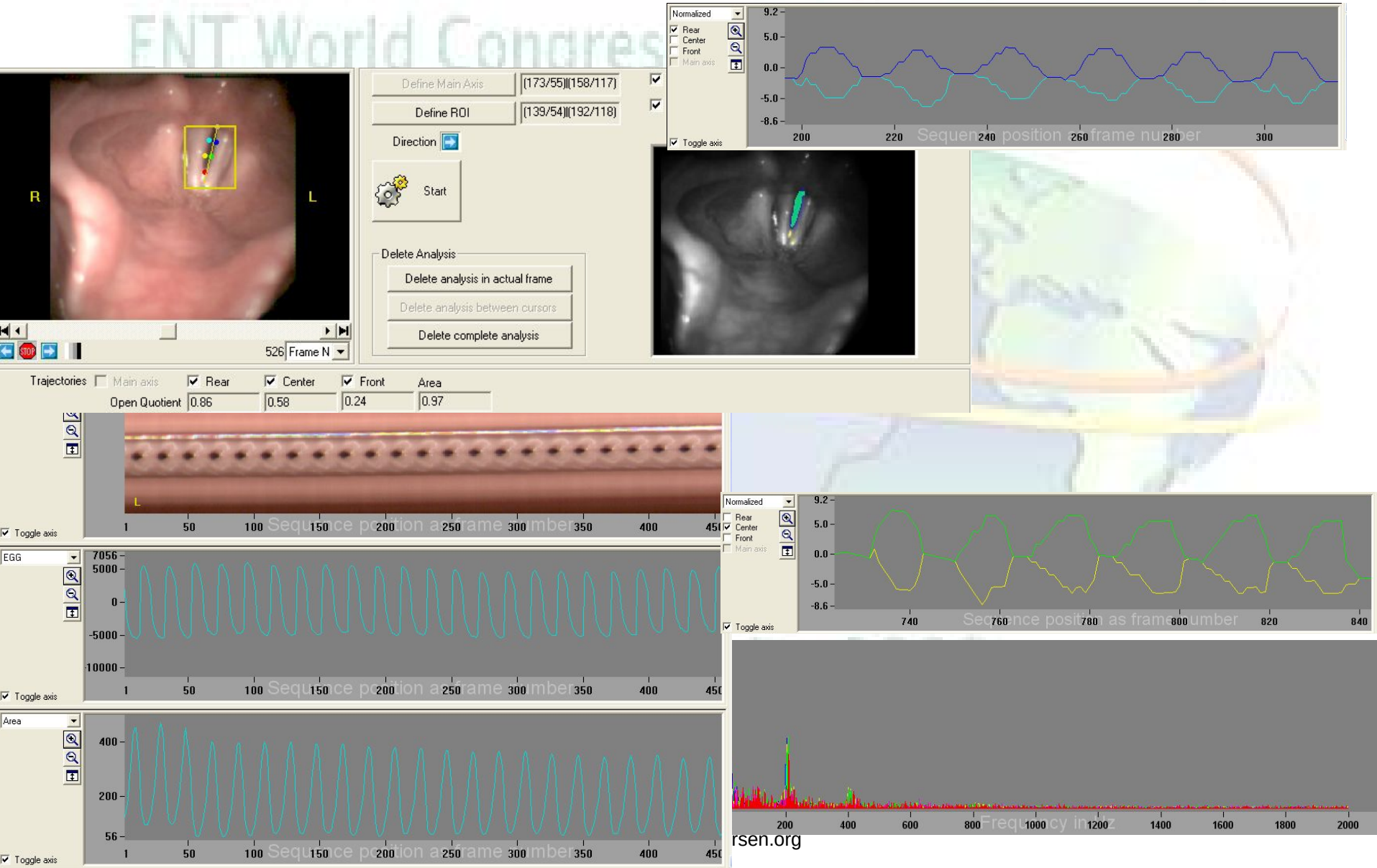
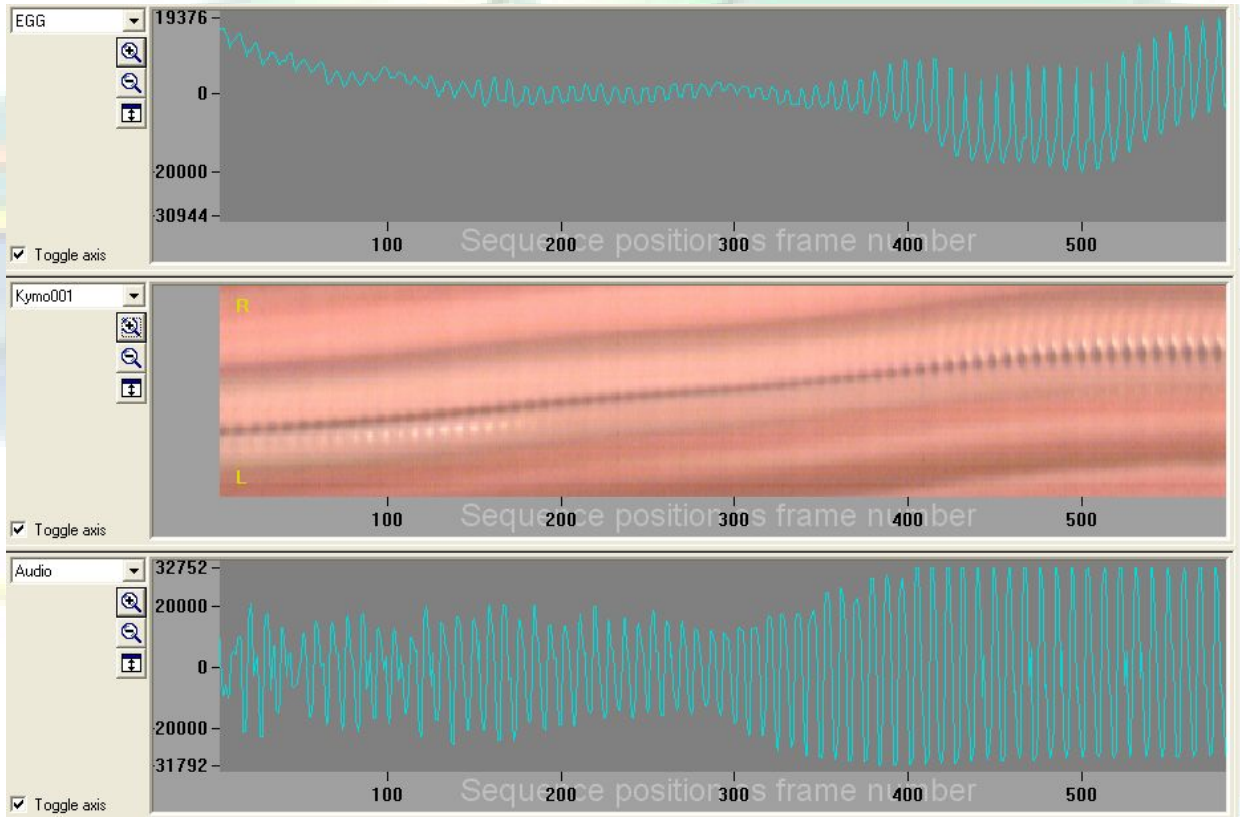
Normal Male


R
L
Define Main Axis
(112/102)|(107/15
Define ROI
(86/87)|(133/161)
Direction
Start
Delete Analysis
Delete analysis in actual frame
Delete analysis between cursors
Delete complete analysis
Segmentation Monitor
Threshold
Mask Scale
1029
Frame N
Trajectories
Main axis
Rear
Center
Front
Area
Open Quotient
0.52
0.38
0.57
0.79
Kymo001
Toggle axis
EGG
Area
Normalized
Sequence position as frame number

Normal Female



Pubertal boy register shift **186 Hz**



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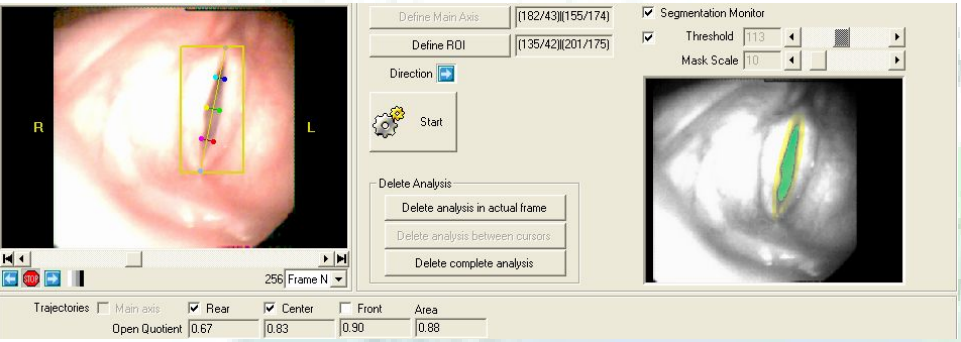
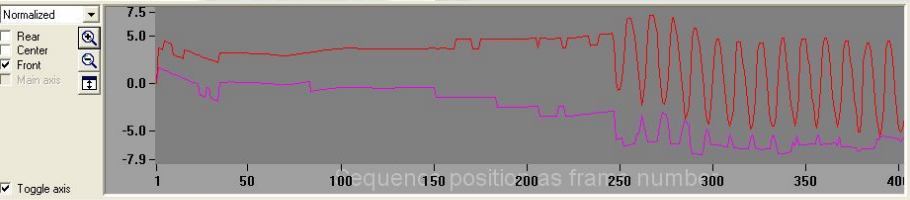
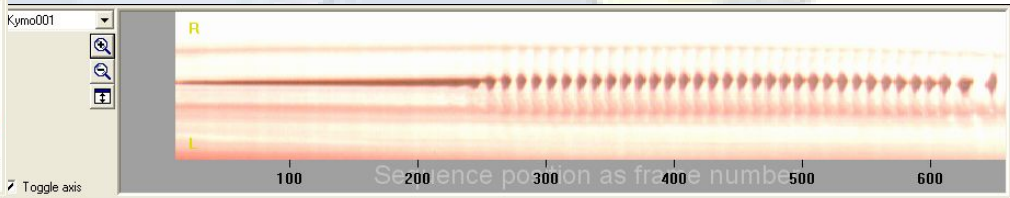
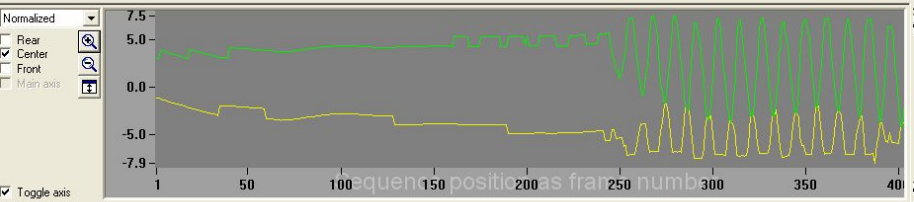
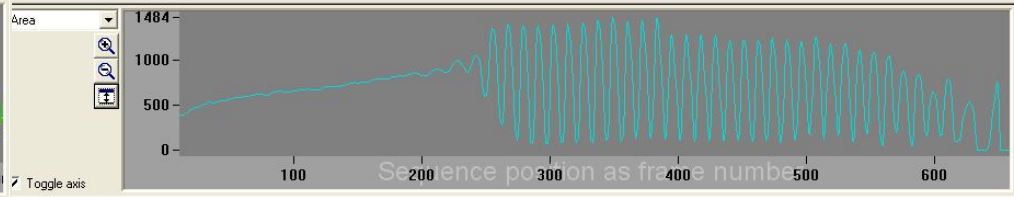
Pubertal boy intonation: **502 Hz**

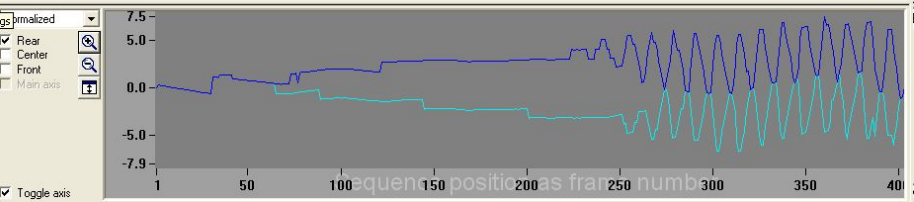


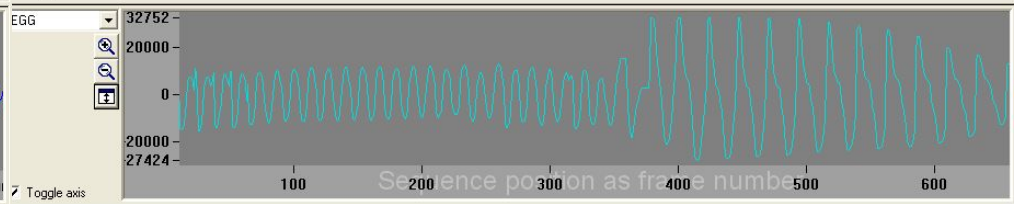












Segmentation

- Segmentation is demonstrated by the color variations seen in the figures below. The color variations show the differences of adduction and abduction of the vocal cords

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Examples of movements of the vocal cords

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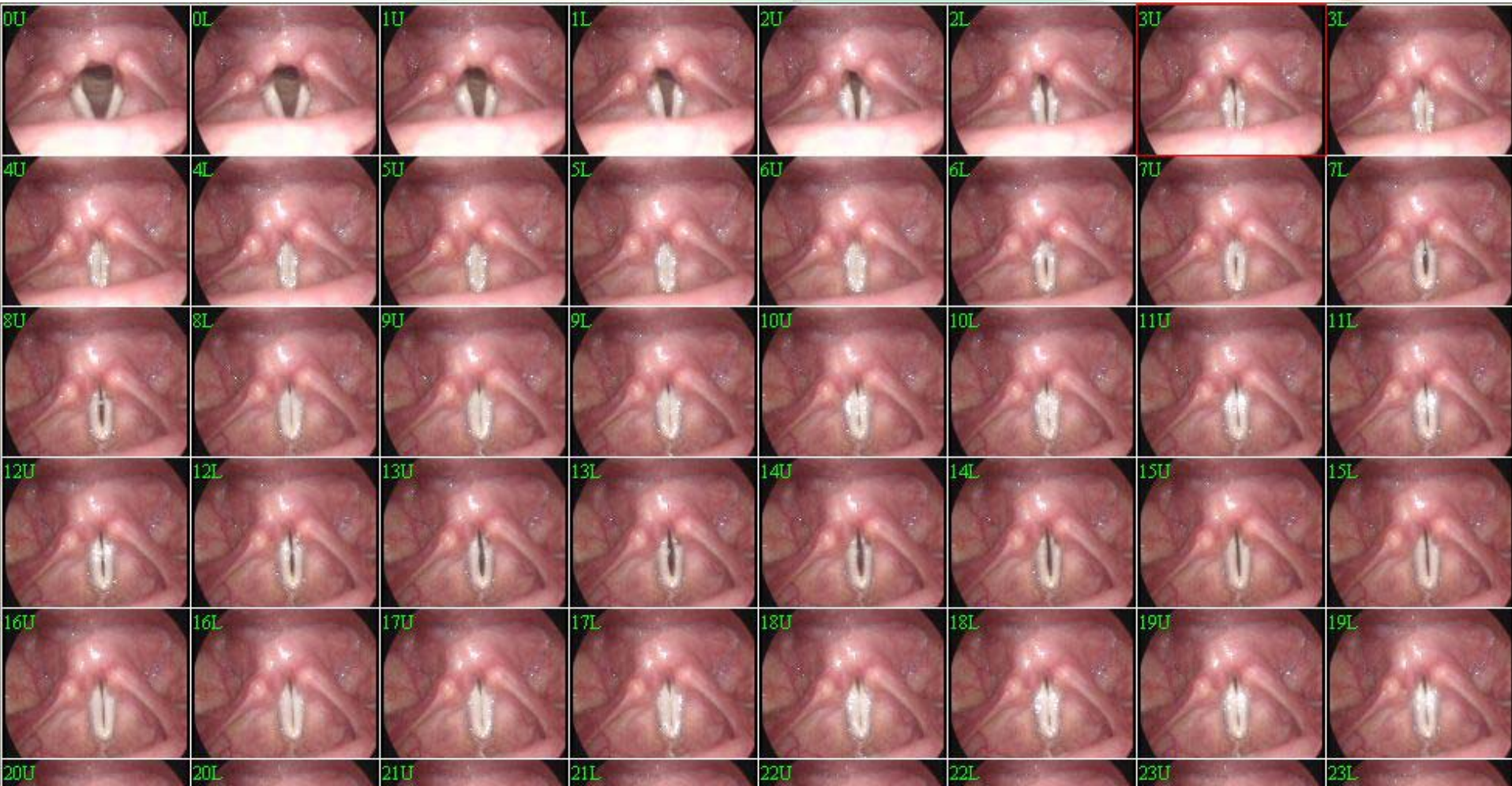
With stroboscopy, front, center and rear cannot be well defined

register shifts are presented in the movie

- Watch movie



High Speed film

Segmentation examples of a pubertal boy, a normal female and a normal male, at their speaking fundamental frequency

- Watch movie

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Quantitative calculations and segmentation on high speed films

	Range			
	Average	Lowest	Highest	S.D.
Open quotient front				
Male	0,45	0,14	0,92	0,32
Female	0,48	0,37	1,0	0,49
Open quotient center				
Male	0,51	0,09	1,0	0,27
Female	0,58	0,12	1,0	0,29
Open quotient rear				
Male	0,59	0,07	0,99	0,32
Female	0,48	0,00	1,0	0,31
Area between vocal cords				
Male	0,60	0,04	1,0	0,43
Female	0,68	0,13	1,0	0,30

- Normative values in our clinic, measured on 18 females and 12 males (aged 20-40 years) of high speed films, sustained tone (/a/) for two seconds (8000 pictures)
- Open quotient of the larynx between the vocal cords in:
  - Front
  - Middle
  - Rear
  - Area calculations

Using the high-speed film setup by WOLF Ltd.

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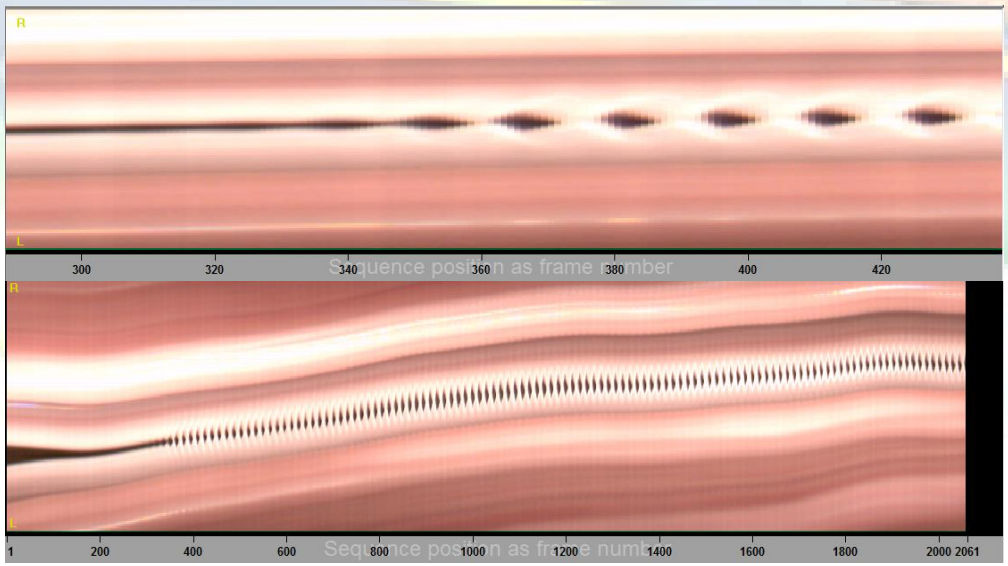
Kymography

- The kymogrophy on the High Speed setup by Wolf



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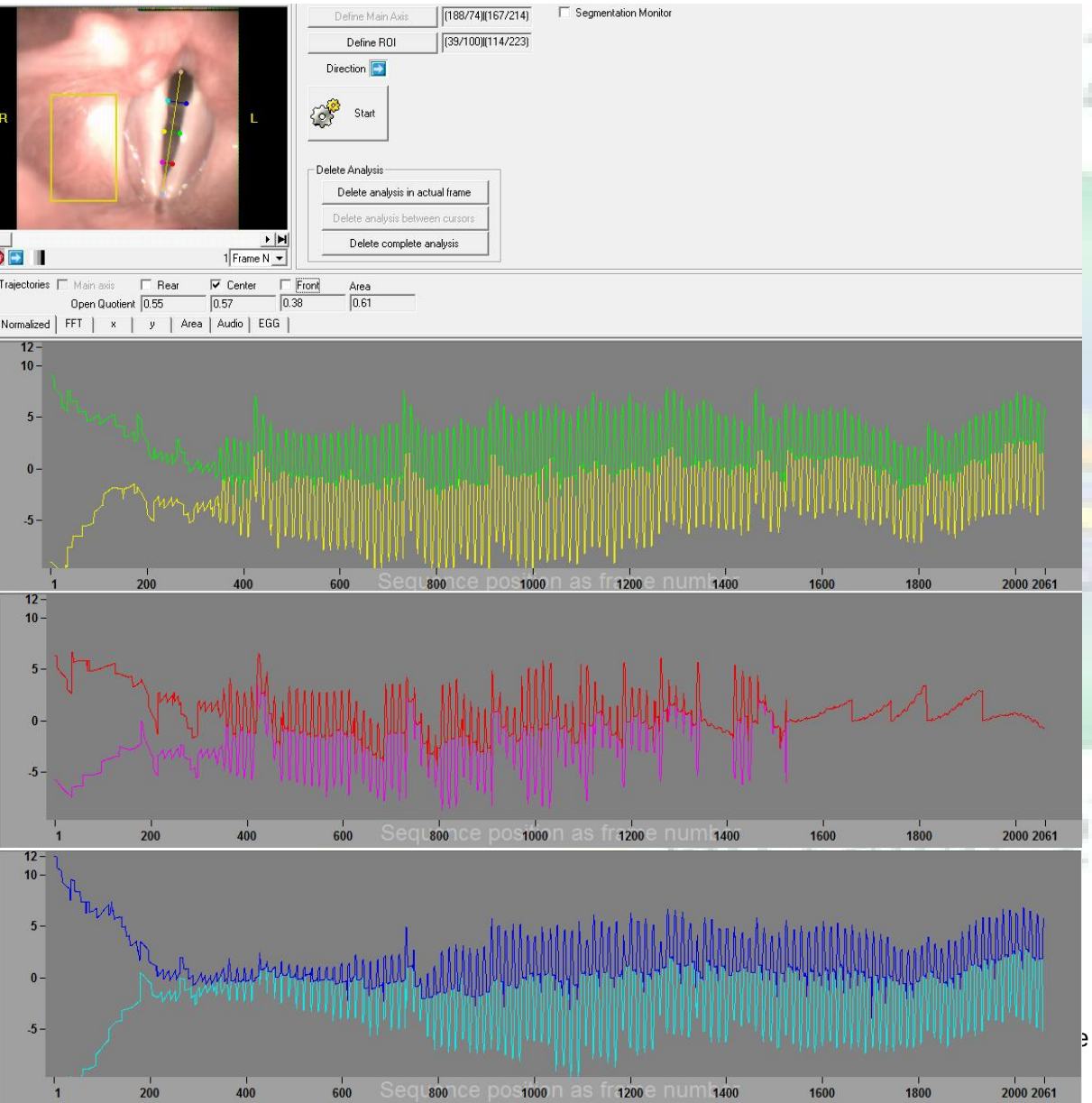
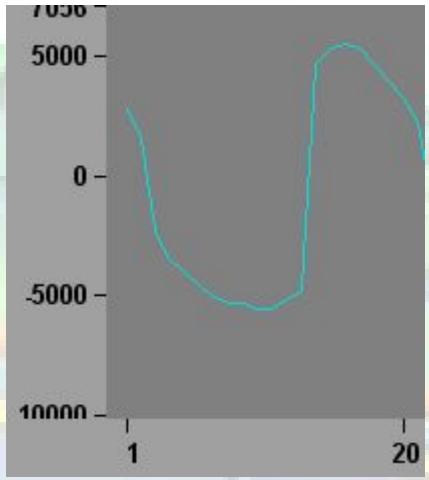
Presentation of the segmentation results

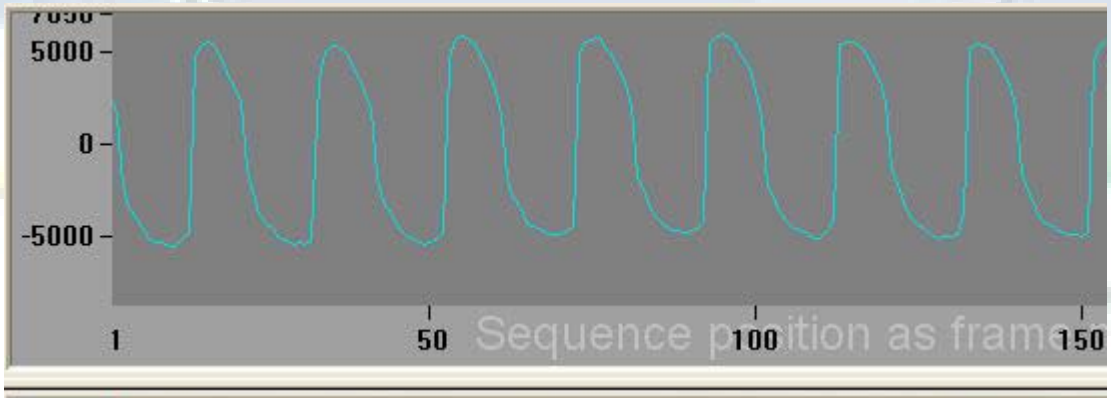


- Intonation pattern /a/: closing of the vocal cords, how the movements of the vocal cords begin.
- CENTER
- FRONT
- REAR

EGG (electroglottography)

- Overview picture
- Closeup





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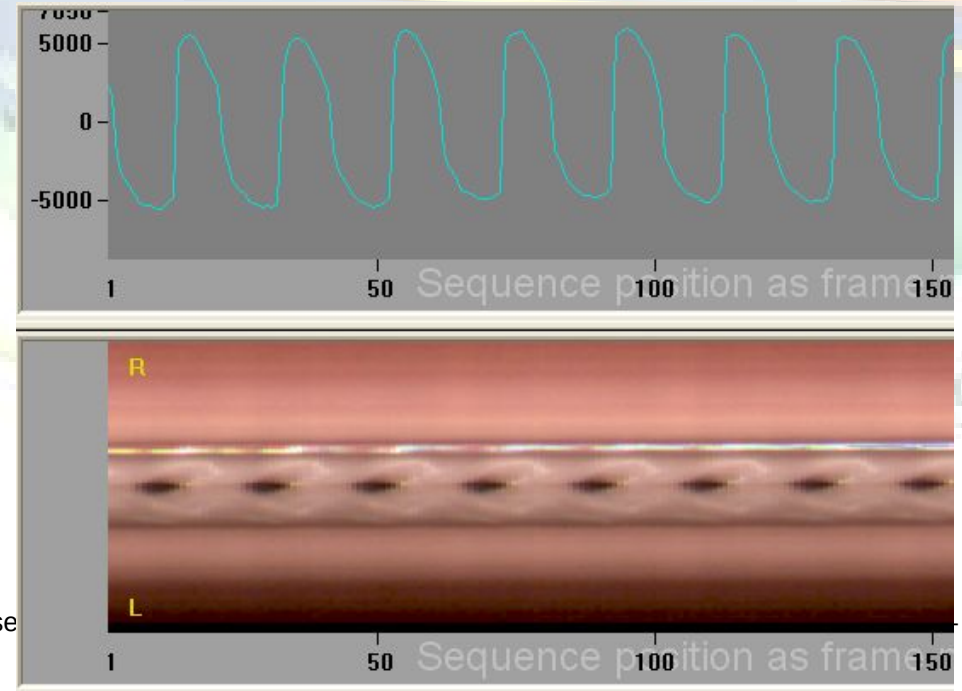
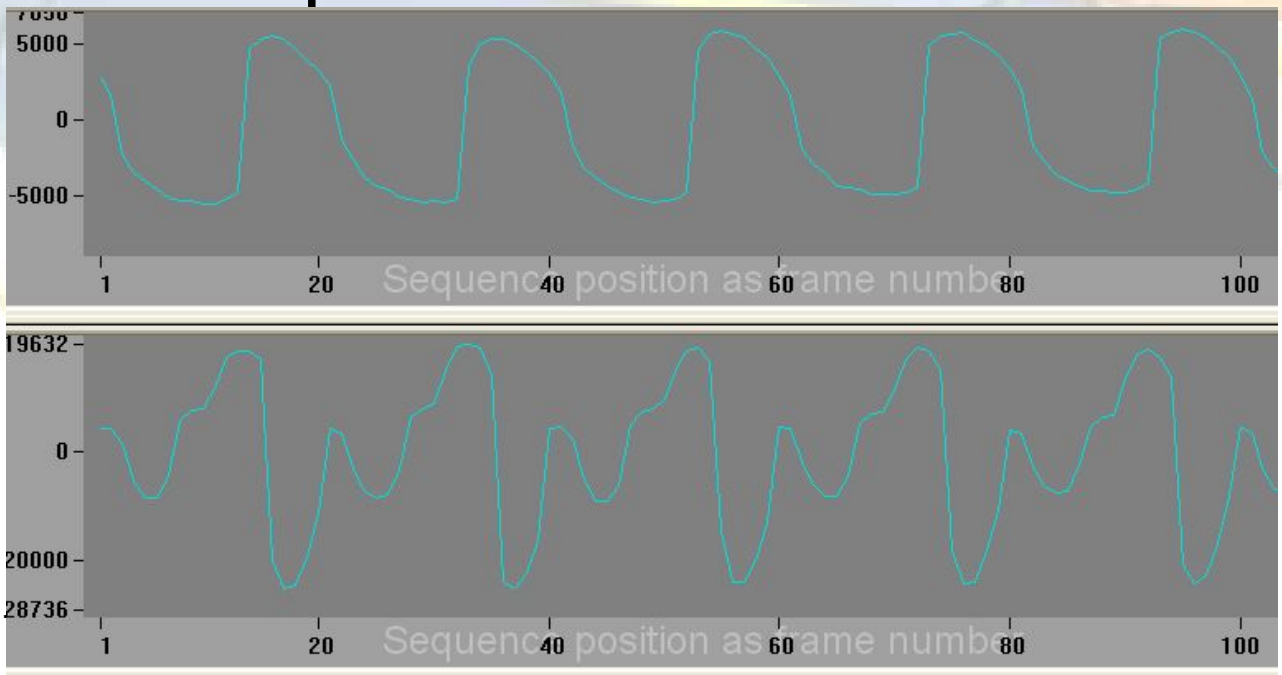
EGG (electroglottography) + Kymography

- The pictures compare
- the closed phase of the vocal cords with
- EGG and kymography



Acoustical measures with High Speed film software

- The picture shows the delay of the acoustical delay related to the EGG signal
- EGG shows the ”tone generator” and the acoustical picture shows the ”resonans”



Calculation in MDVP(EGG and acoustics)

- We are trying to to merge the two files of EGG and acoustical measure from Wolf GmBH to make use of the on line results in SPEAD by Laryngograph Ltd (=MDVP).
- We have been working together with Adrian Fourcin and Evelyn Abberton at University College London for many years, quantitative on line measures are possible.

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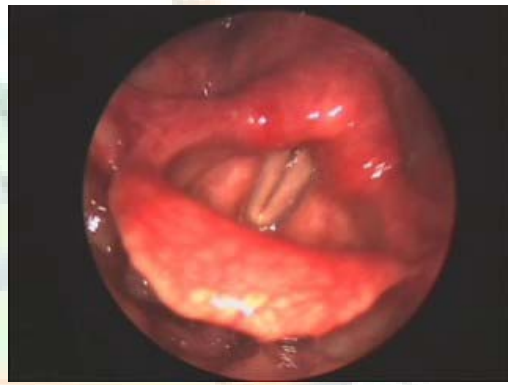
Laryngeal reflux and allergy oedema Visual score 1-5

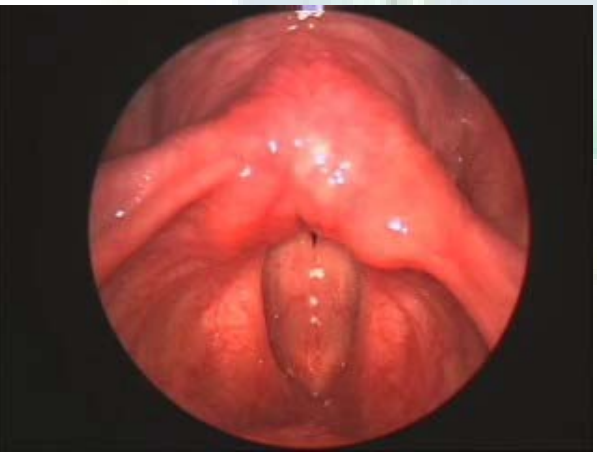
Group 1 a normal control group

Group 2 slight oedema

Group 3 moderate oedema



Group 4 extensive oedema



Group 5 oedema covering most of the vocal cords

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Parameters when stroboscopic picture of oedema is score 1 (normal larynx) *″The Nortern Wind and the Sun″ in Danish	**Normal values**
• Jitter% while reading of standard text	<9,0 %
• Shimmer% while reading of standard text*	<15,4 %
• Qx% while reading of standard text	50,0 %
• Jitter% on sustained tone /ah/	<1,0 %
• Shimmer% on sustained tone /ah/	<9,2 %
• Qx% on sustained tone /ah/	50 %

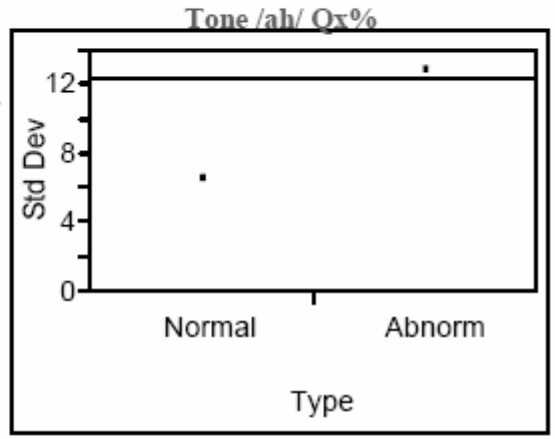
Normative values in our clinic of voice parameters. Acoustical measure of jitter and shimmer of intonation of a sustained tone, and reading of the standard text "The Northern Wind and the Sun". Electroglottographical measure of Qx closed phase of the vocal cords

Table 2

Groups of consecutive digitized videostroboscopies evaluated by 2-3 observers on the spot, and voice analysis at the same time of normal controls: arytenoids shape grade1, without laryngeal complaints versus: abnormal clients with laryngeal complaints, arytenoids shape grade 2-5, measured with SPEAD by the firm Laryngograph ltd. **A**: **sustained tone /ah/. B**: reading of a **standard text:** the North wind and the sun.

A:

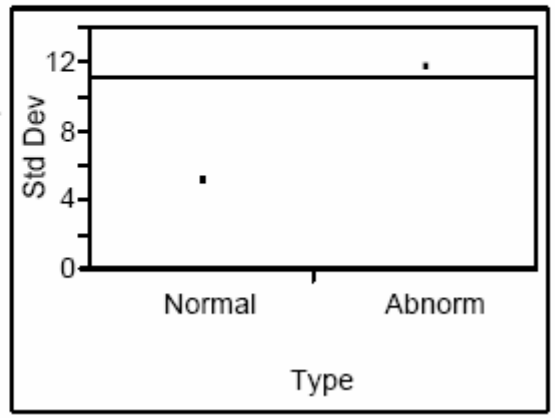
arytenoids shape 1	mean jitter% 1	Std Dev 1	mean shimmer% 9,2	Std Dev 6,5	mean Qx% 47,1	Std Dev 6,5	N 35	Comments
shape 2-5	4	10,5	8,2	6,6	45,3	12,7	338	
statistics	-	-	-	-	significant difference for Qx% and standard deviations between normal and abnormal measures, Welch ANOVA p<0,0001			



B:

arytenoids shape 1	frequency variation% 9	Std Dev 6,9	loudness variation% 15,4	Std Dev 5,1	Qx% 48,7	Std Dev 6,5	N 35	normals SD for frequency variation <6,9 abnormal> 11,1
shape 2-5	12,3	11,1	16,4	5,6	46,0	11,4	338	
statistics	p 0,03 *		-		p 0,011 *			normals SD for Qx% <6,5 abnormals >11.4

*p as given (Wilcoxon test)



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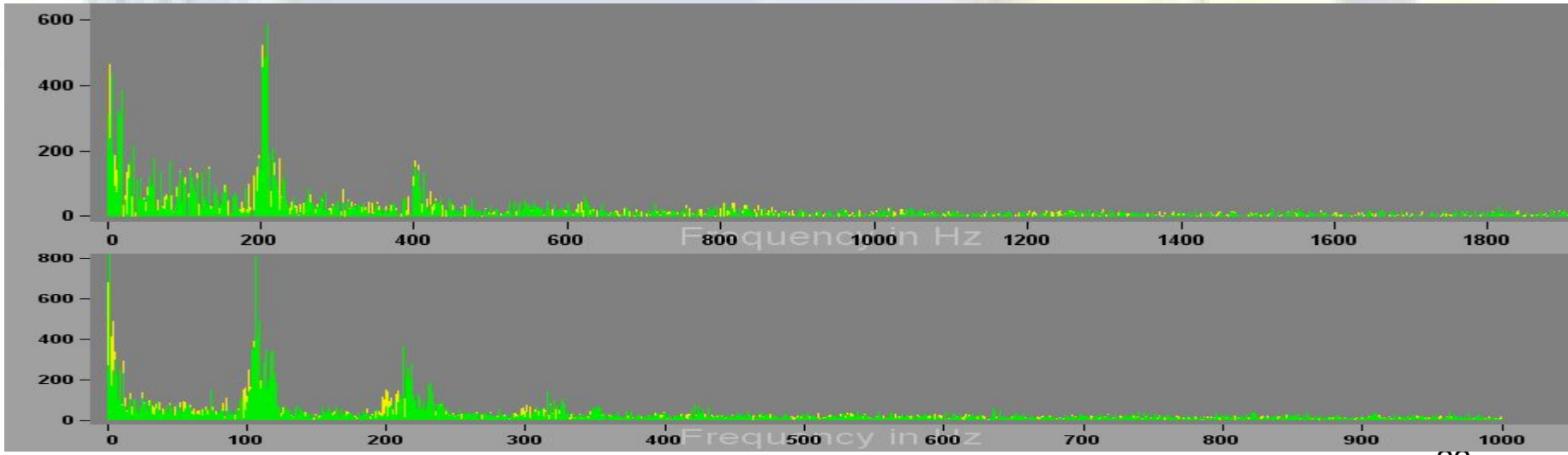
Fast Fourier Transformation (FFT)

- 1-2000Hz in the program
- Online on high speed films
- Is also defining the voice
- As shown in a normal female and male



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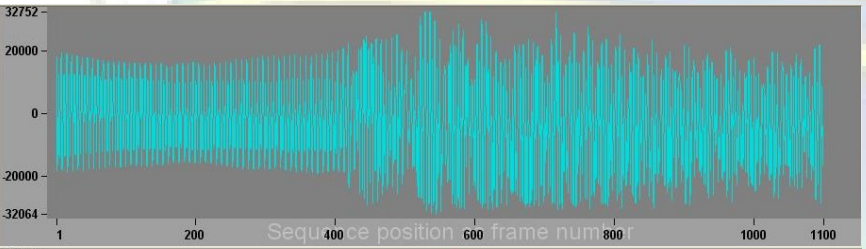
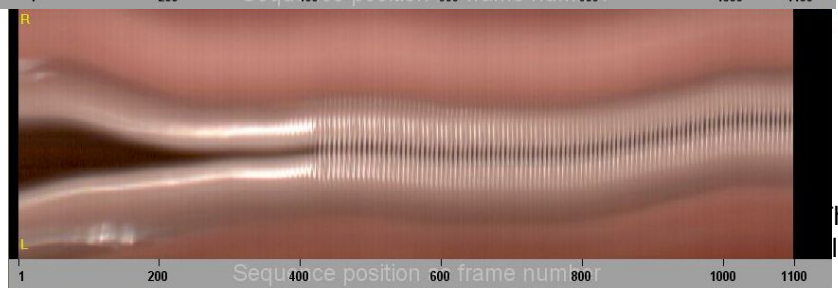
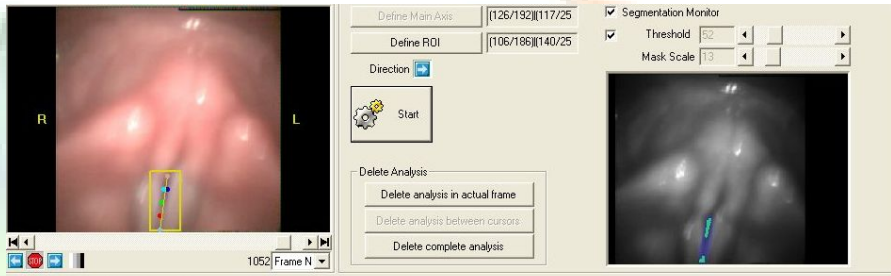
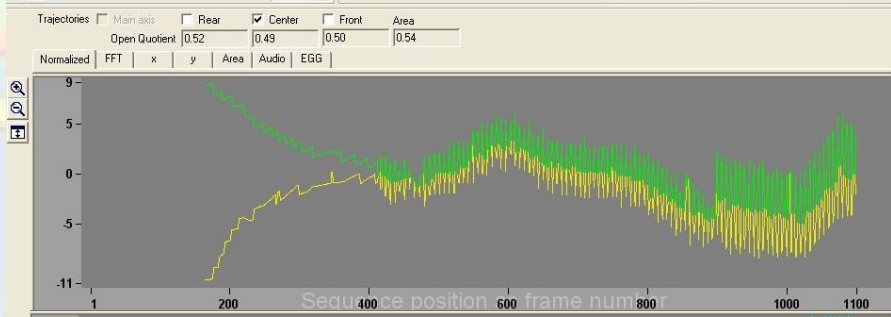
High speed data before dystonia treatment

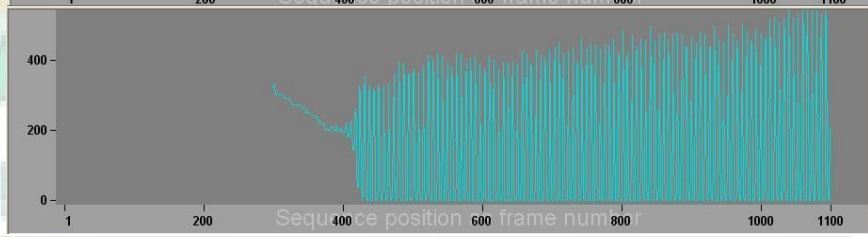
- Online with high speed film

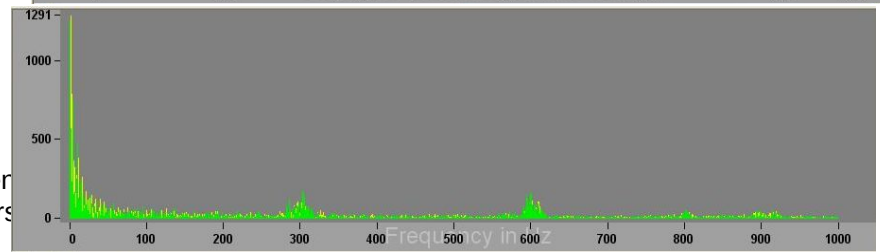






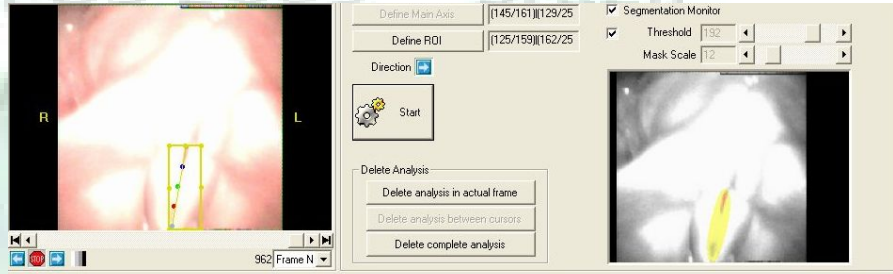


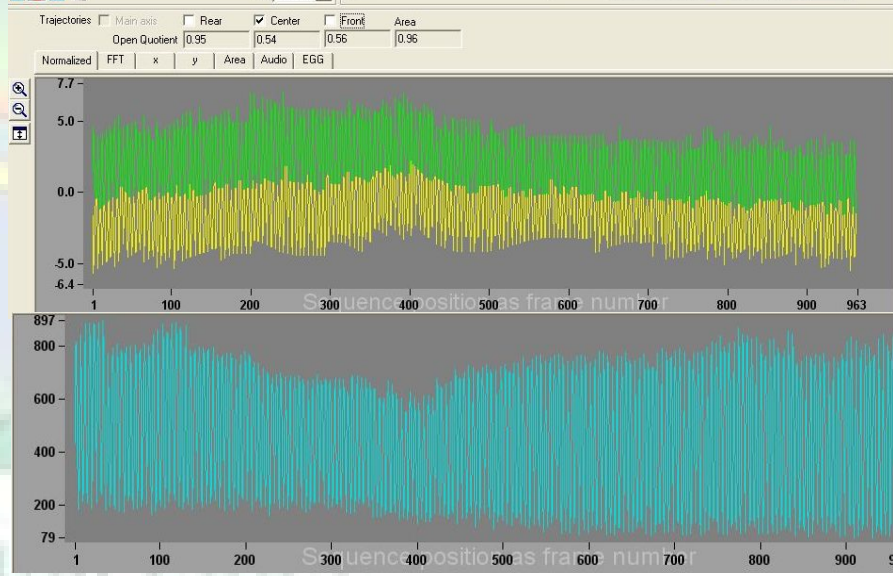


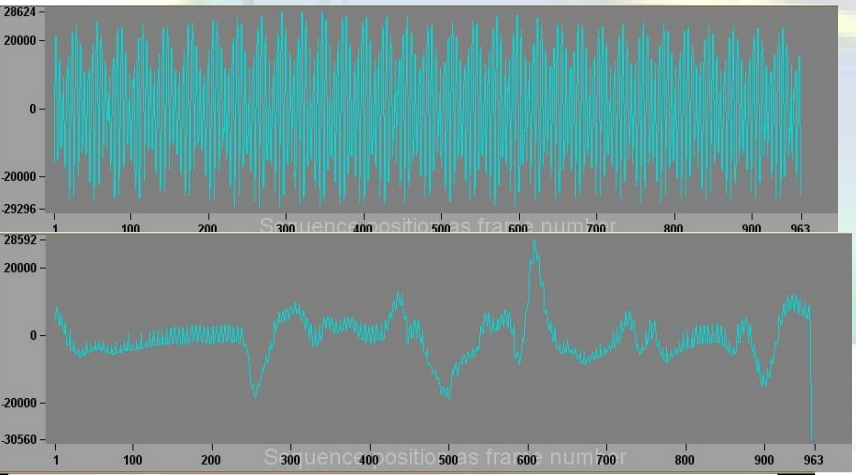


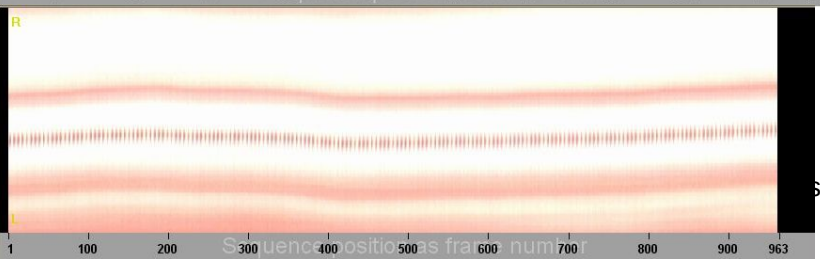
High speed data after dystonia treatment

- Online with high speed film

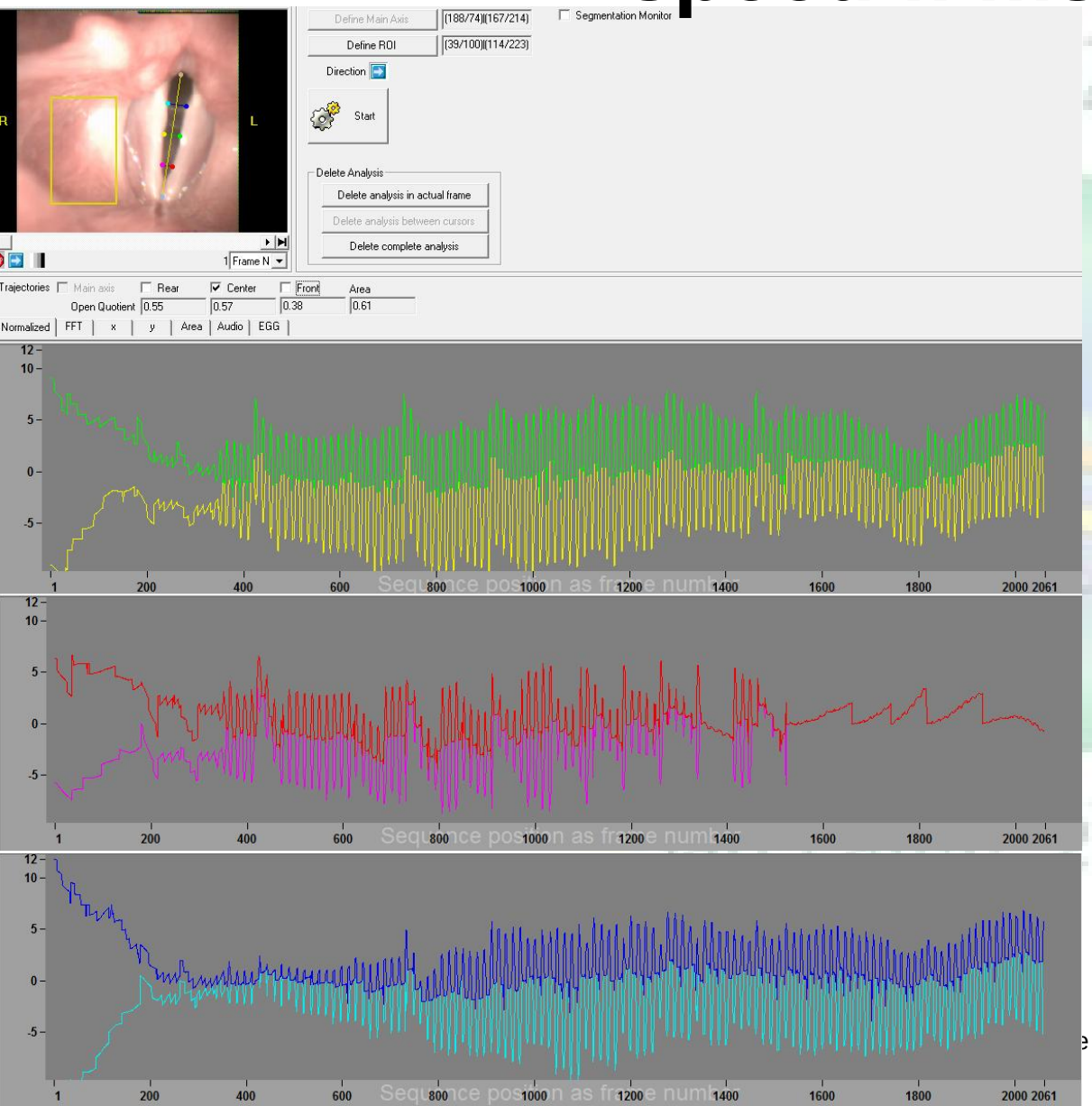






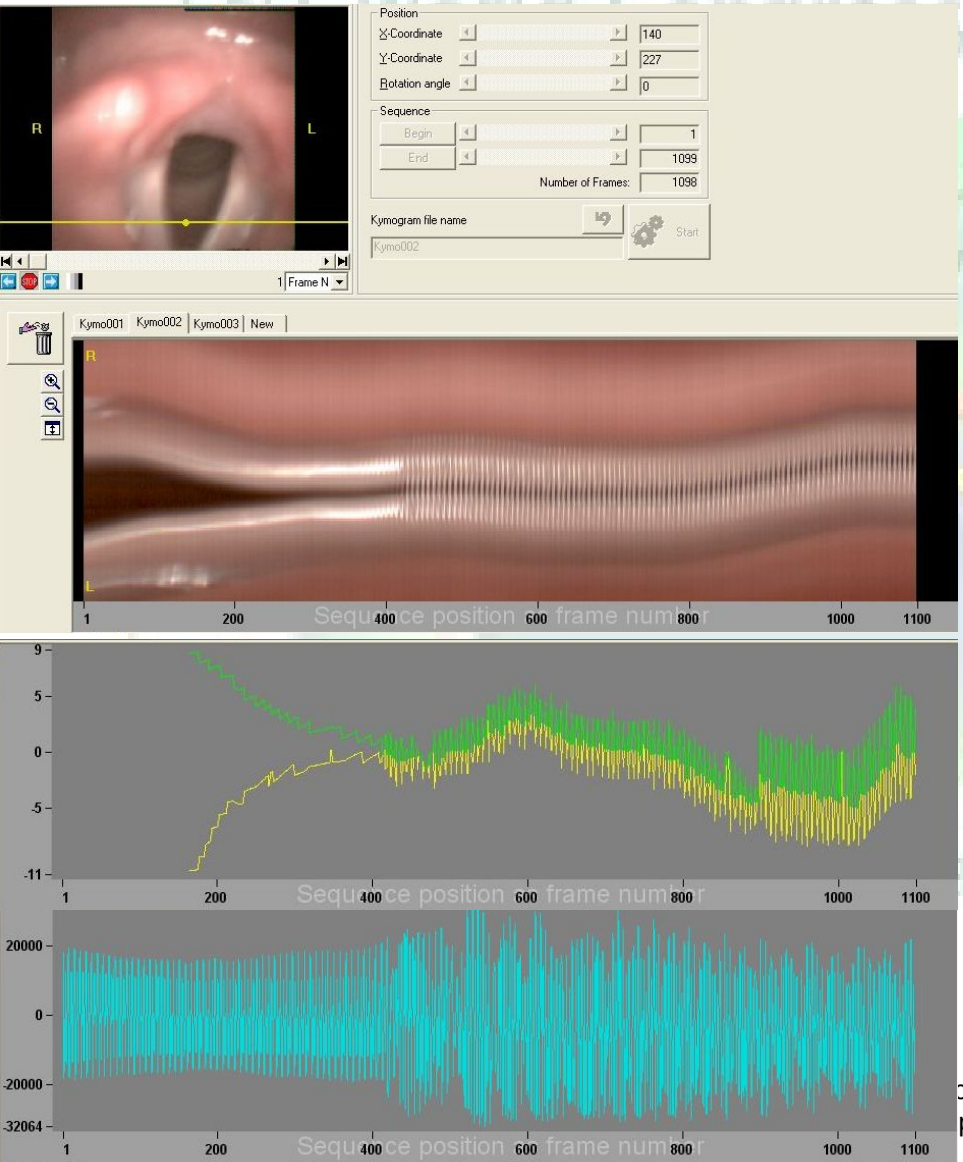


Front, center, rear intonation on high speed films



- Picture of normal intonation
- Center, front and rear of the vocal cords

Spastic voice intonation on High Speed films



- Kymogrophy on High Speed films
- Single movements in the center of the vocal ridge
- Acoustical curve

Summary

- Video segmentation,
- open quotient, in front, center and rear part of the vocal cords,
- kymography,
- area between the vocal cords,
- EGG,
- Acoustic measure,
- FFT

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  - Daniel Feddersen
  - Julie Pedersen
  - Anders Jønsson
  - Luca d'Alessandro