Institute of Agricultural Engineering

Christian-Albrechts-Universität zu Kiel

Eberhard Hartung and EIKO THIESSEN

Image Analysis in Fish Production

Project:

Fish in vivo online Monitoring (FIVOM) for Flatfish-Aquacultur

in Cooperaton with bbe Moldaenke, Kiel
Founded by ISH und EU

AquaLife 2008

1st – 3rd July

Kiel

Introduction

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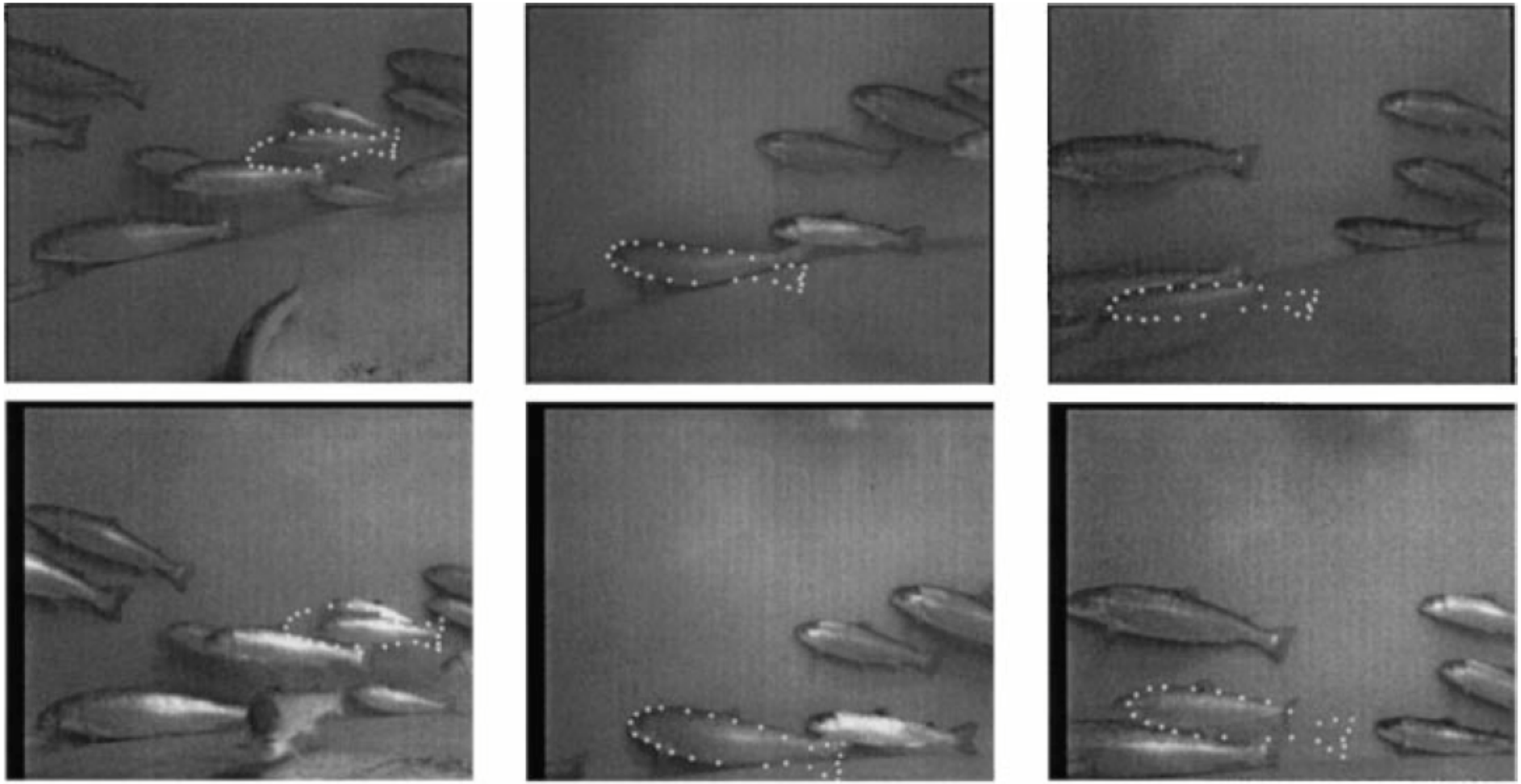
(Aquaculture, Fishery) ⊆ Agriculture
Livestock farming 1000 B.C. – Aquaculture today



Edges of other fish distorting model

Fish orientation too different

Model too large for fish

Tillet et al, 2000

Aquaculture

Definition

- Aquatic organism (fish, shellfish, shrimp, algea)
- Population is owned by the company

Versions

- Fish farming in pond or raceway (carp, trout) in Freshwater
- Nearshore net-contained (Salmon), ponds in mangrove (Shrimp) in saltwater
- **Onshore recirculating systems with filters** (sturgeon, turbot)

Food for the carnivorous species made out of fish meal

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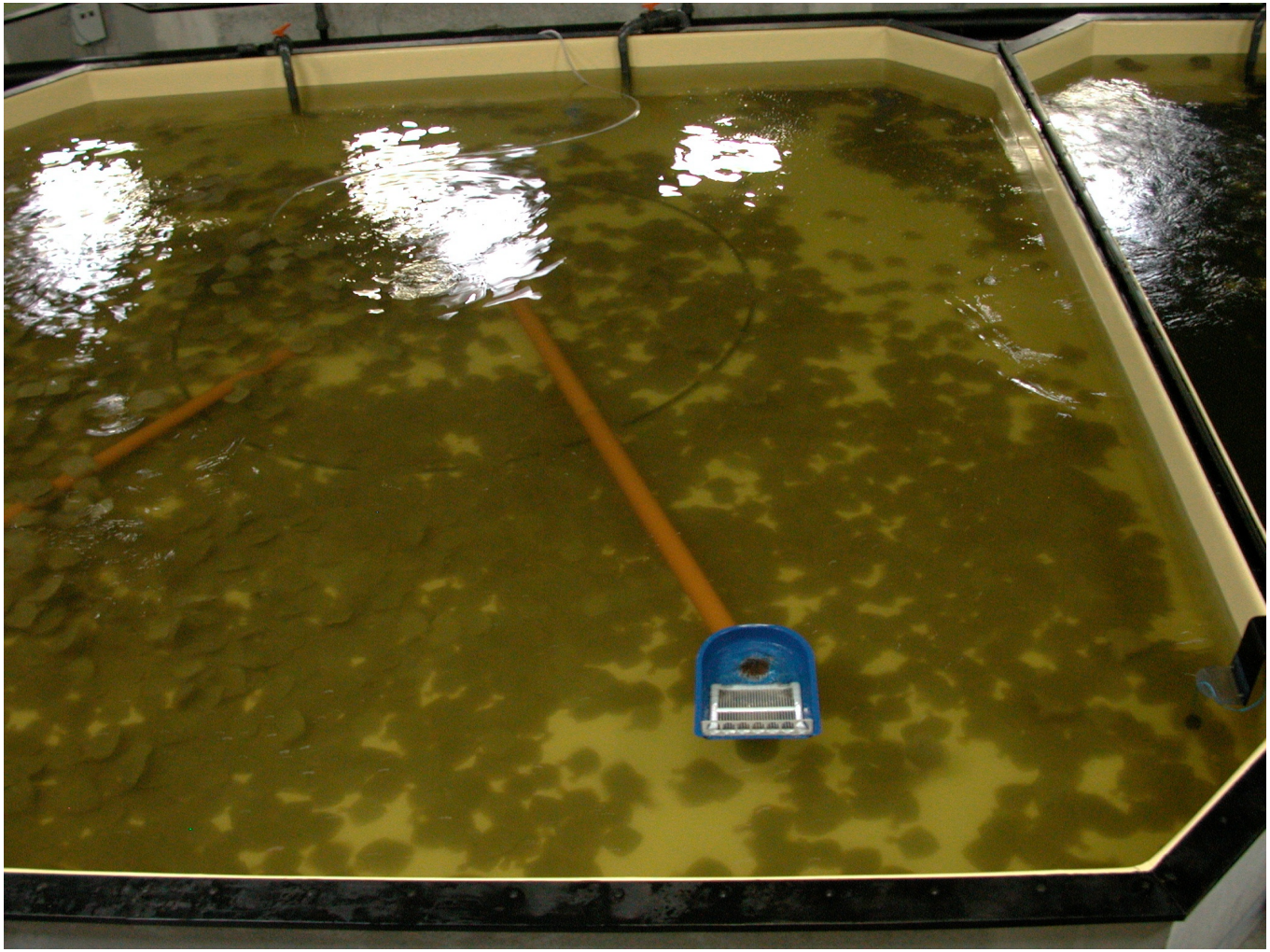
Turbotproduction



In 1-2 years

1-2 kg

40 kg/m²

10 % new water per day

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High manual effort in recirculations systems

Fishsorting every few weeks due to different growing of fish

Size-distribution is unknown before sorting, i.e. date can be too early
(homogenous distribution: needless stress and task)
or too late
(very heterogenous distribution: growth decrease of the smaller fish)

→ Monitoring the size distribution with a camera system

Image analysis in Aquaculture

- **Size-measuring for management-decision (sorting– and slaughter date, feedsize and –amount, growth, heterogeneity)**

- Automatic sorting (lock, picking belt)

- Behavior analysis (disease, feeding control)

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Automatic, continuous estimation of the fish size

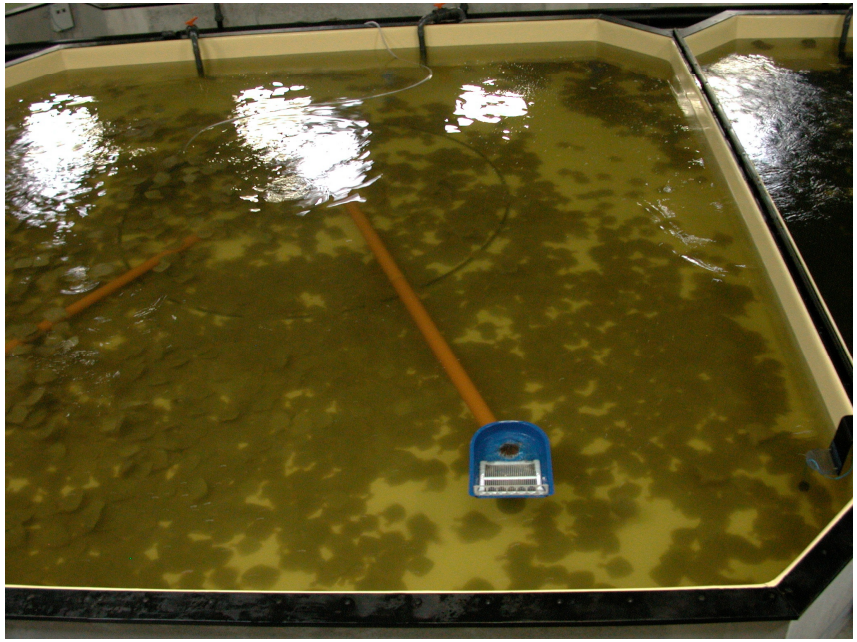
Development of a camerasystem for estimation the size (e.g. length, area, …) and derived parameter (weight) of flatfish in a well-defined distance

- Hardware:
  a) camerasystem optimised for recirculation systems

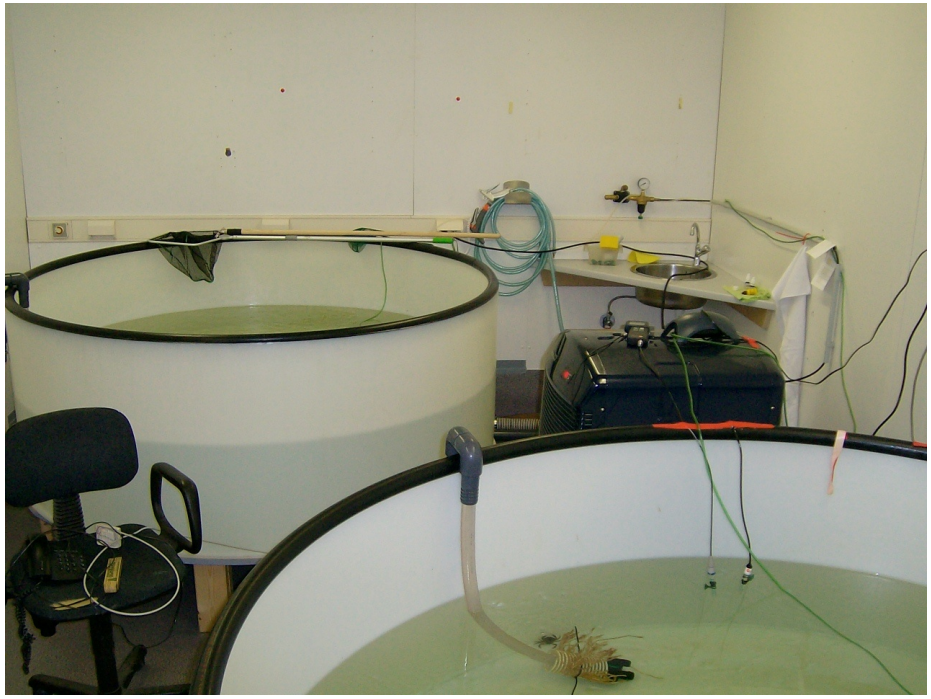
- Software:
  b) Database of the geometric parameters and weight
  c) Algorithm for fishdetection and measuring

Trials

Commercial plant: Ecomares, Büsum



Laboratory: ILV, Kiel



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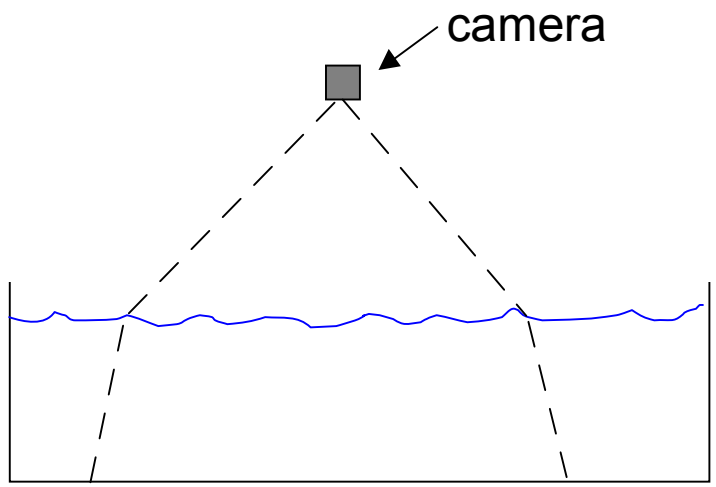
a) Camerasystems: Lab

Camera-Setups

- Camera above water
- Camera in glasbottombox
- Underwatercamera

1.



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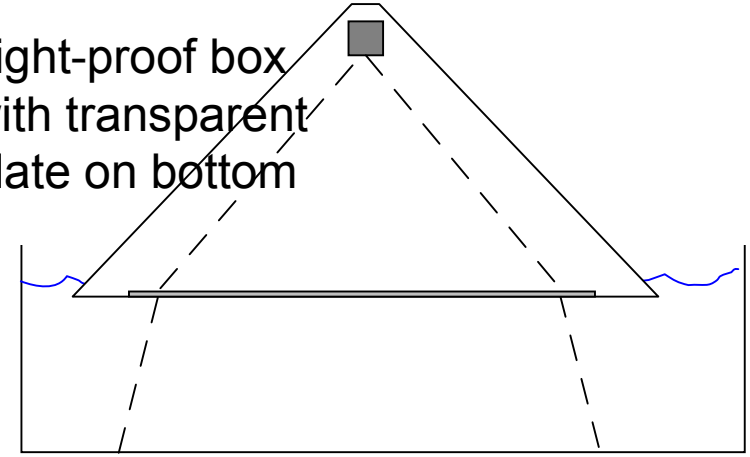

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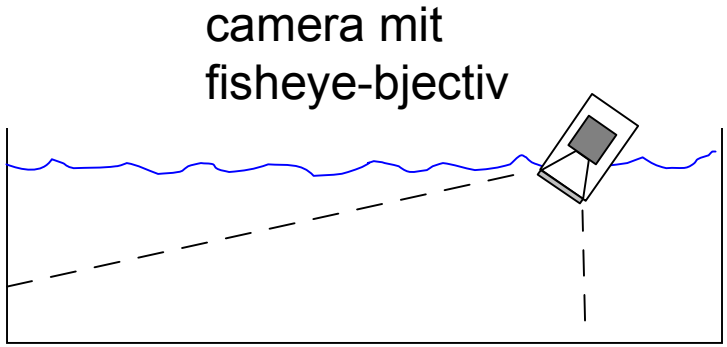

Validation in respect to accuracy, repeatability and suitability under changing environmental conditions

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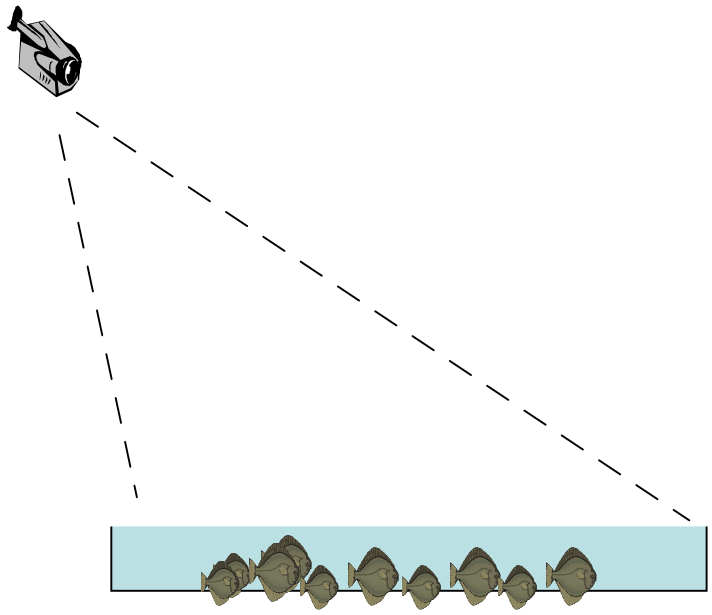
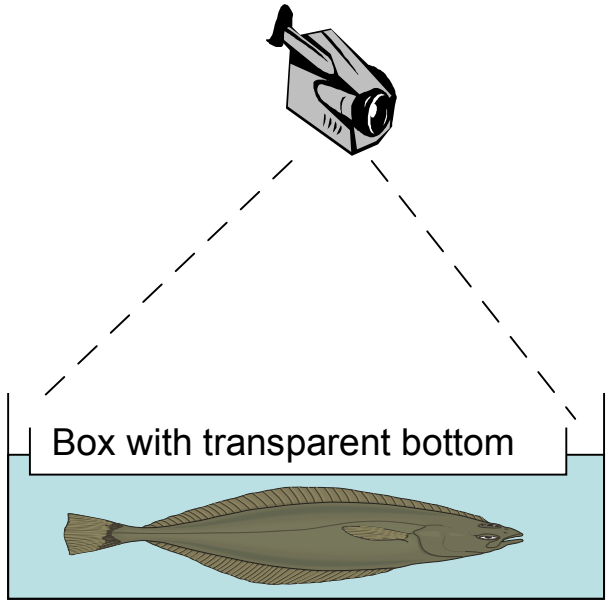
b) Database: Commercial production

Entire basin (8 m x 8 m)
Time lapse: some weeks, different production phase



Single fish
Weighing, measuring length and taking a picture



Expected results:
Fish-distribution in the bassin, „haunts“

Typical shape and weight-relation

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c) Algorithm sequence

Image Analysis should estimate the size (length, area) auf single unmoved turbot.

Therefor:

•Image acquisition optimised with lighting and placing

•Discarding of pictures with fish movement (Motiondetection with difference-images)
•Object-Extraction with imagefilters (edgedetection, thresholds)
•Calibration in Real World Coordinates (i.e. cm-unit)

•Selection of fish shapes by means of typical geometric parameters

•Measuring (length, weight, …)

•Post-Processing (statistical analysis, ignore repeated measurements of one fish)

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a) Validating the Setups

Well known referencefish was measured under different conditions

	camera above bassin	**glasbottombox**	**underwatercamera, sloped**
area [m²]	**1.45**	**1.35**	**1.15**
pro	Easy installation, big area	No reflexion	No reflexion
contra	Reflexion on the surface, image is disturbed due to waves	Difficult to handle (20 kg), partly shadow, air bubbles on the bottom	Small area, only increases with slope
Repeatibility Stdev of different positions **[cm]**	Without waves: **0.32** with waves: **1.2**	**0.12**	**0.25**
Accuracy mean quadr. deviation to reference **[cm]**	Without waves: **0.75** with waves: **1.4**	**0.57**	**0.41**

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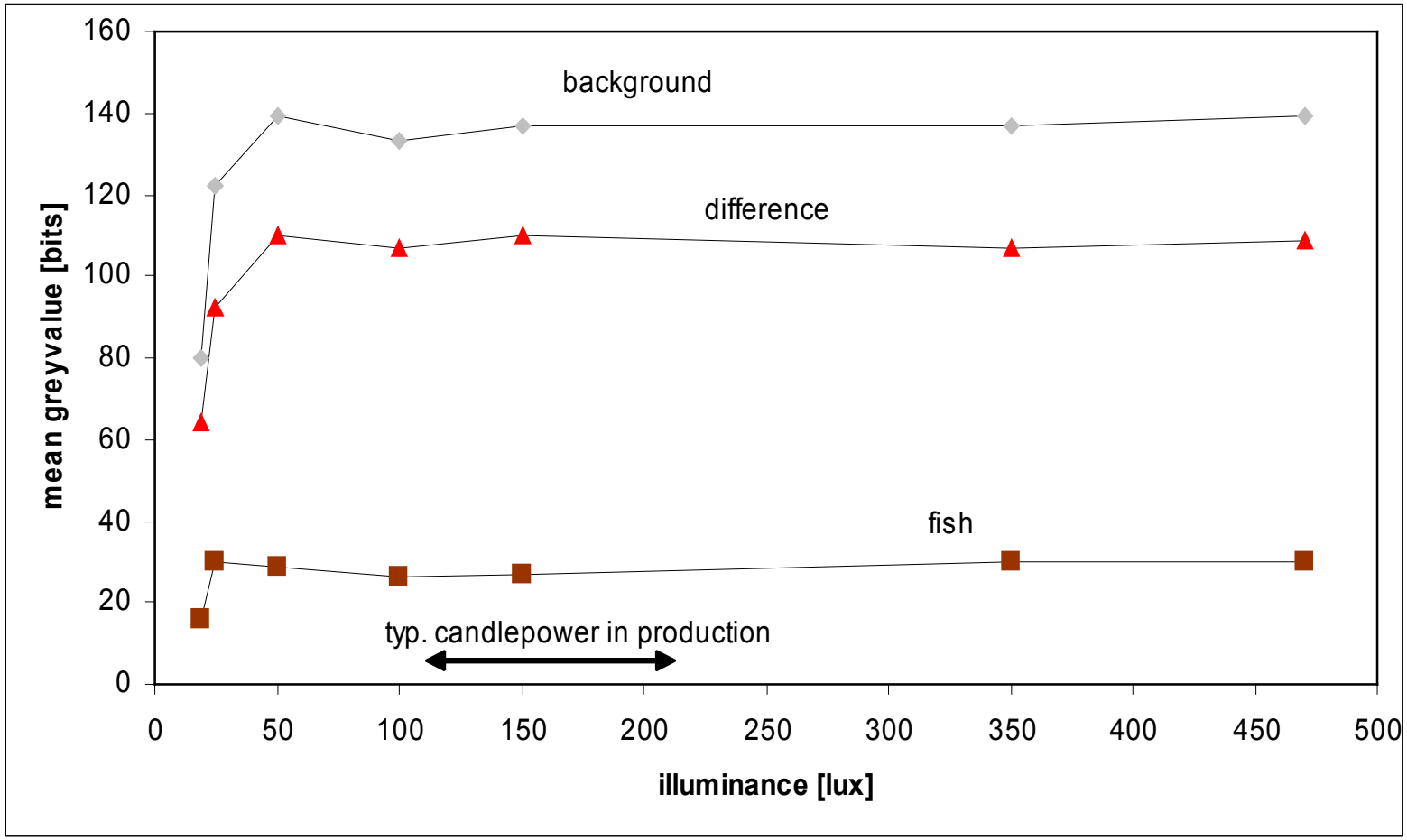
a) Light and camera

Automatic brightness-controll leads to constant contrast in the typical light conditions



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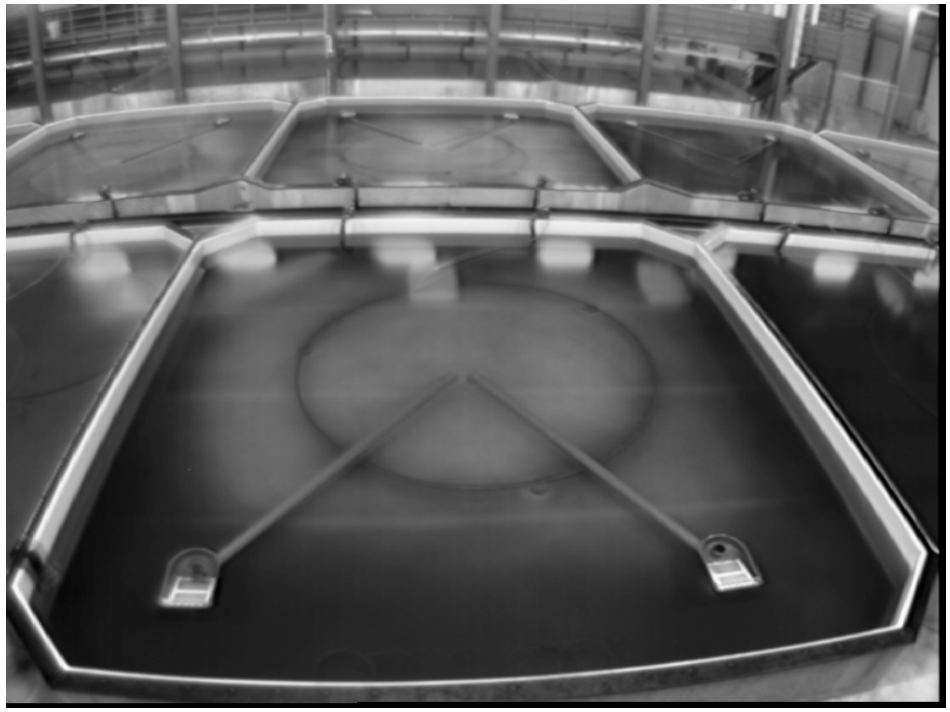
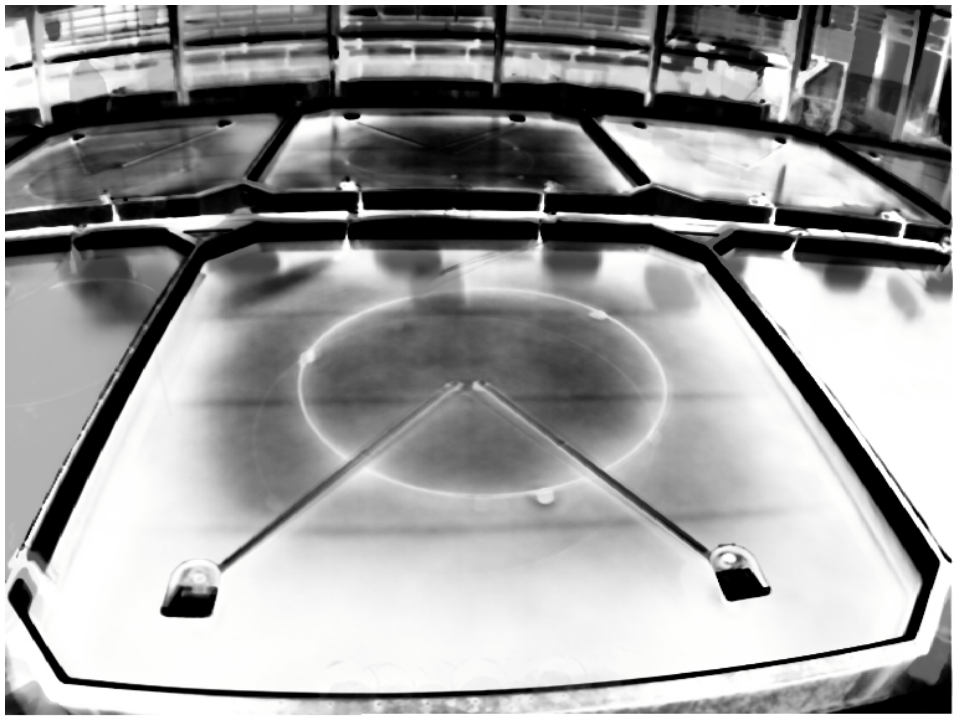
b) Distribution

Time lapse at Ecomares (every 5 min, 4 weeks)

Mean raw images



mean analysed images
(fish = white, background = black)



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b) distribution

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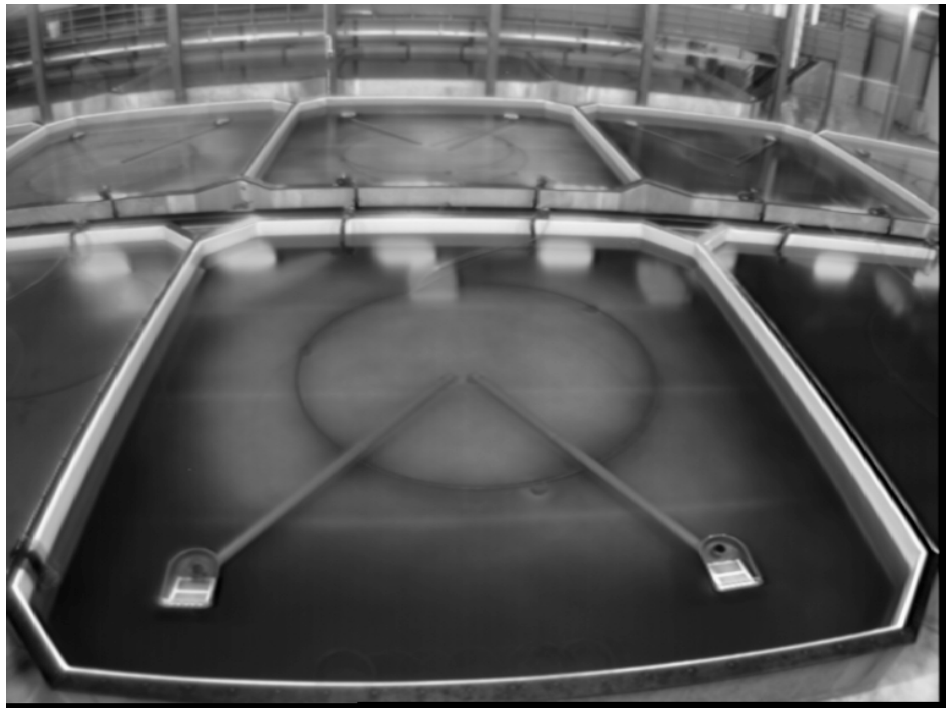
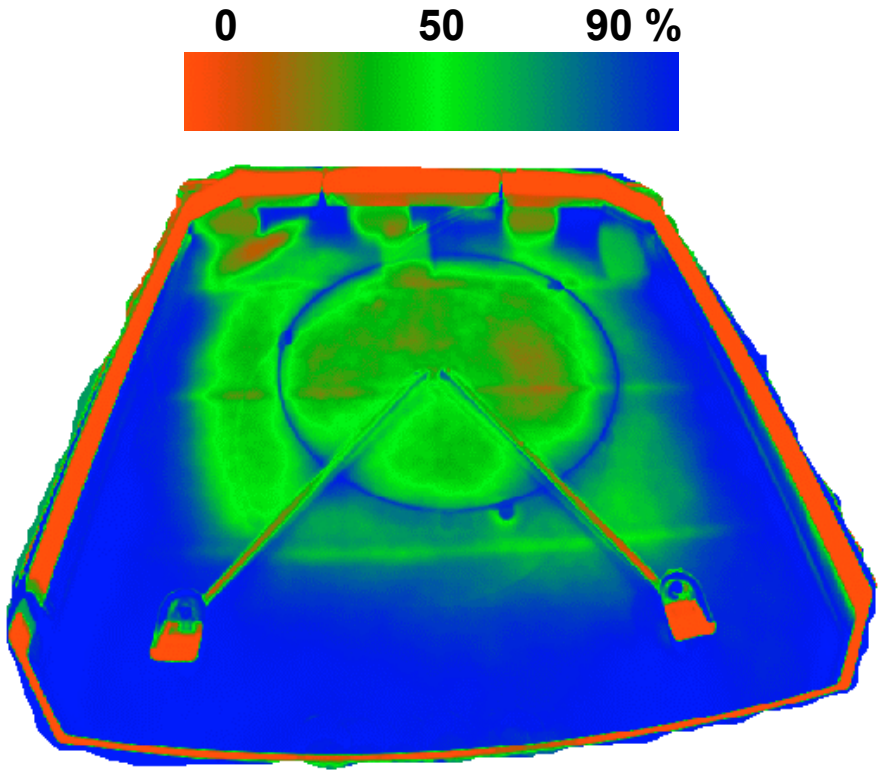


Spatial probability distribution



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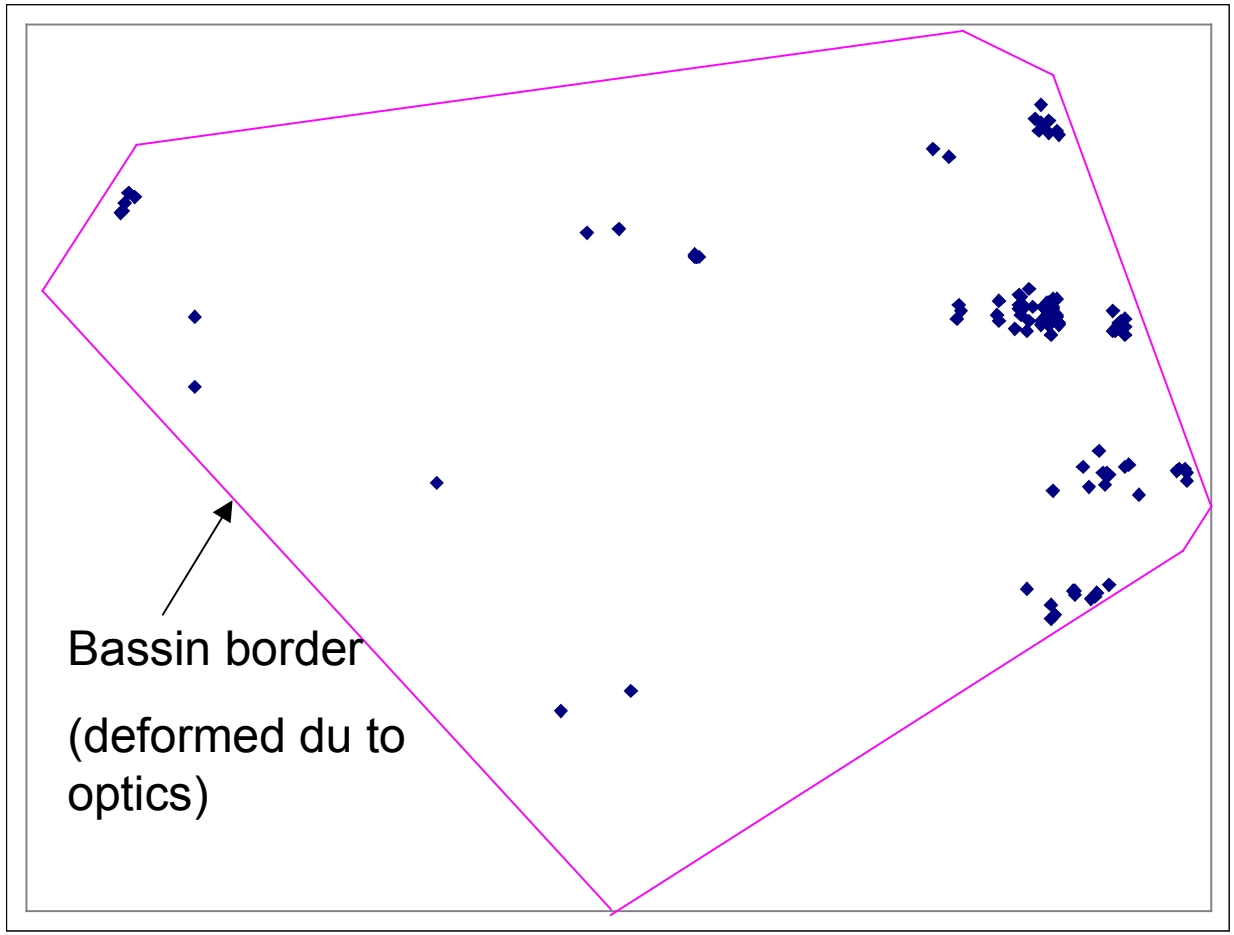
b) Distribution

A single fish marked with LED,
Points indicate stop of min. 30 s during 3 days



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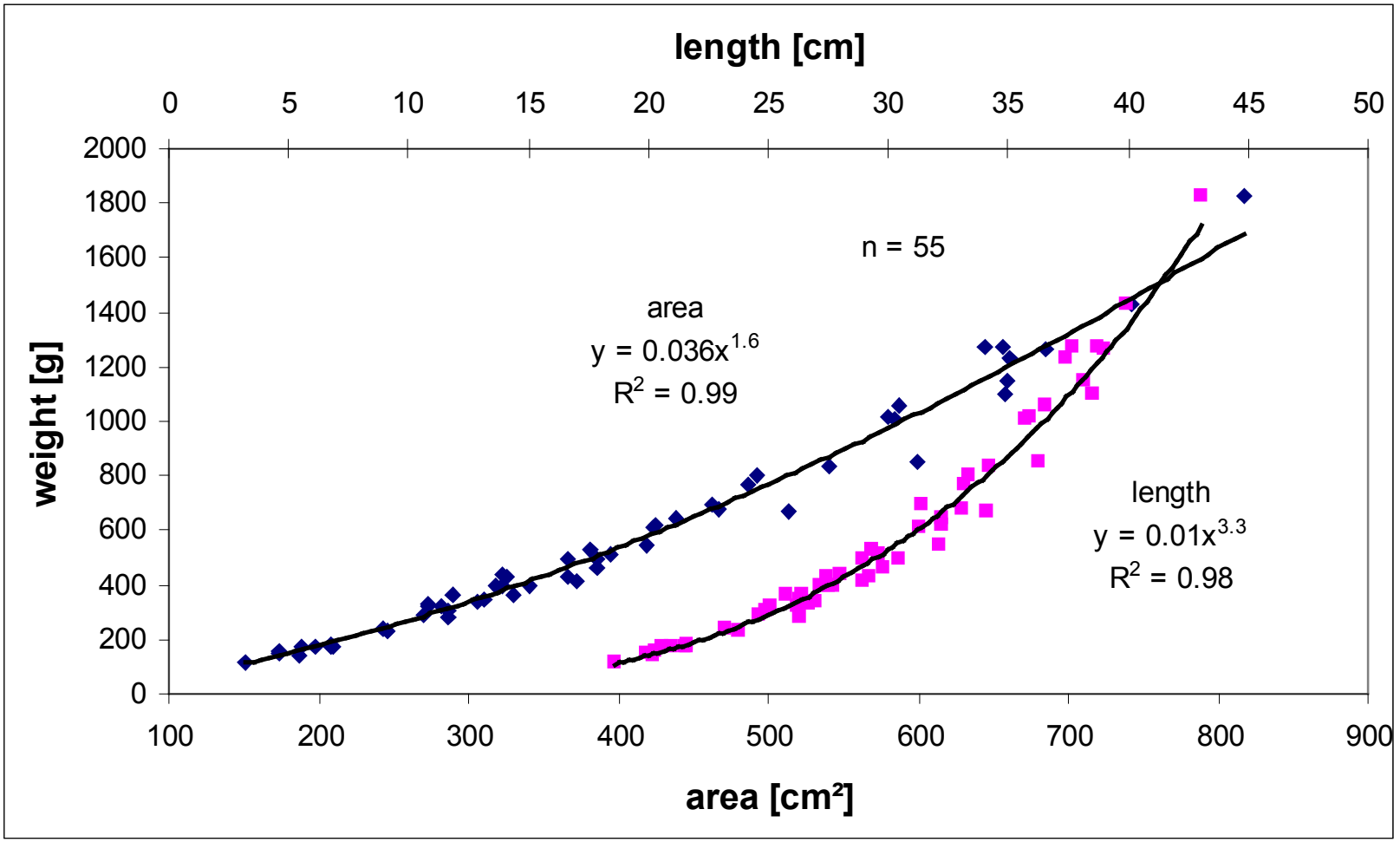
b) Shape-weight-relation

Single fish weighed, length measured and image aquired



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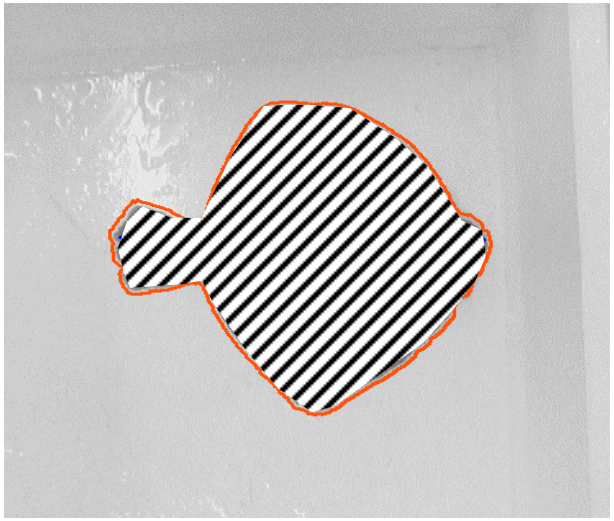
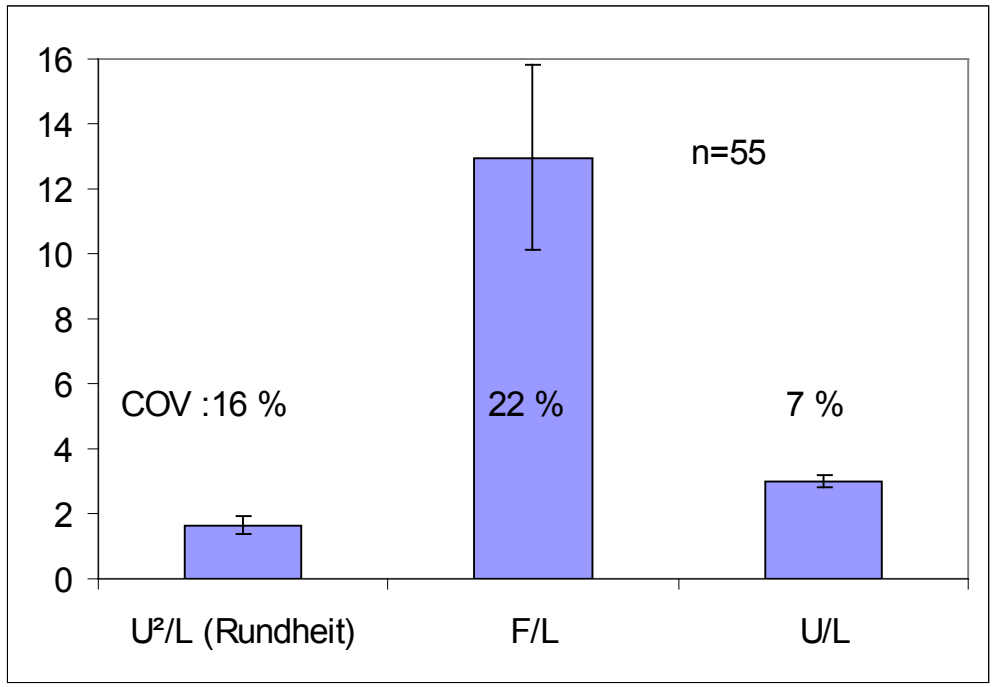
b) Shape-parameter

Single fish weighed, length measured and image aquired
Images analysed concerning shape parameters



L: length U: contour A: area

U²/F, F/L and U/L constant in the population?



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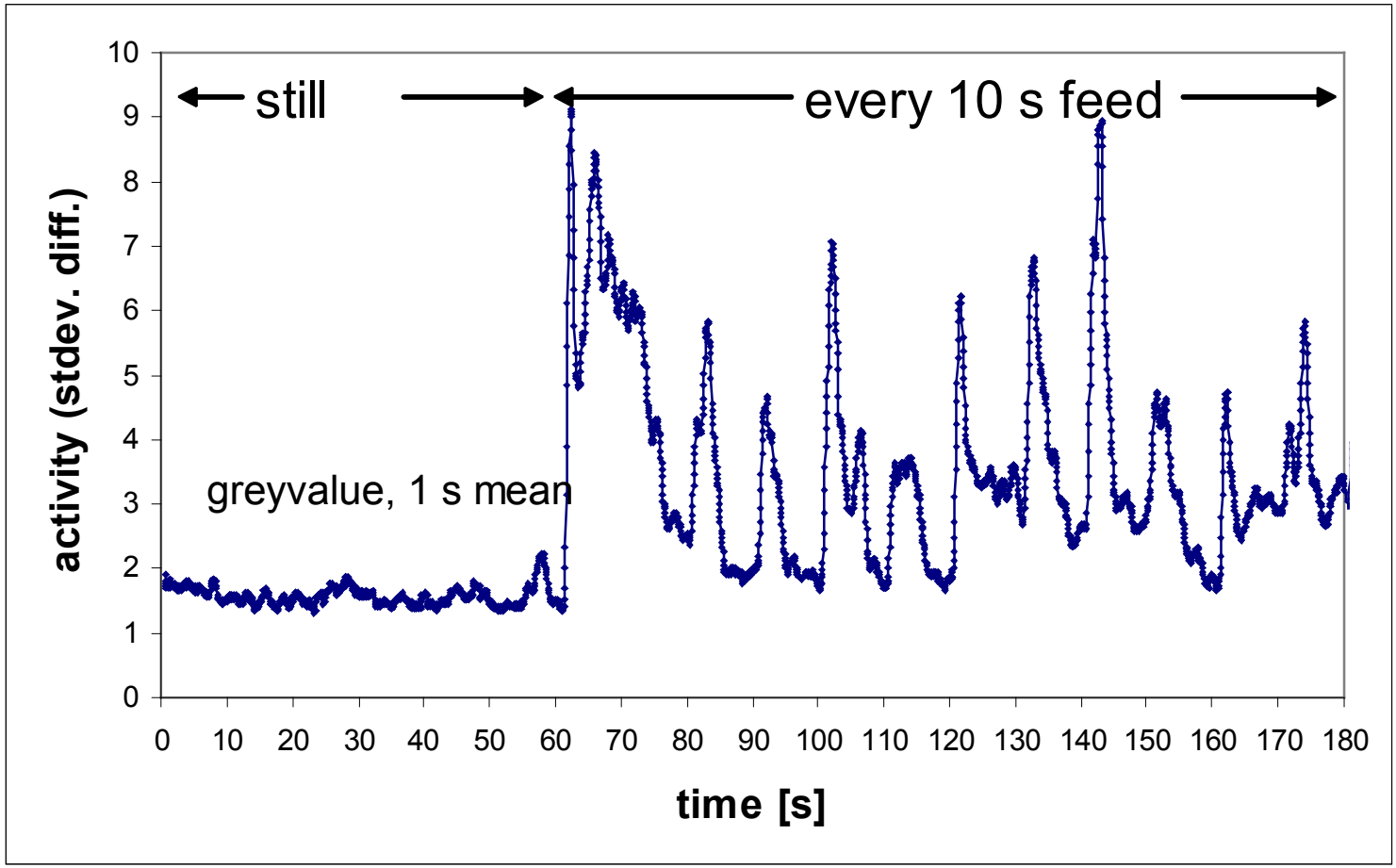
c) Motiondetection

Fishmovement was analysed with the stdev. in the difference from two frames during feeding



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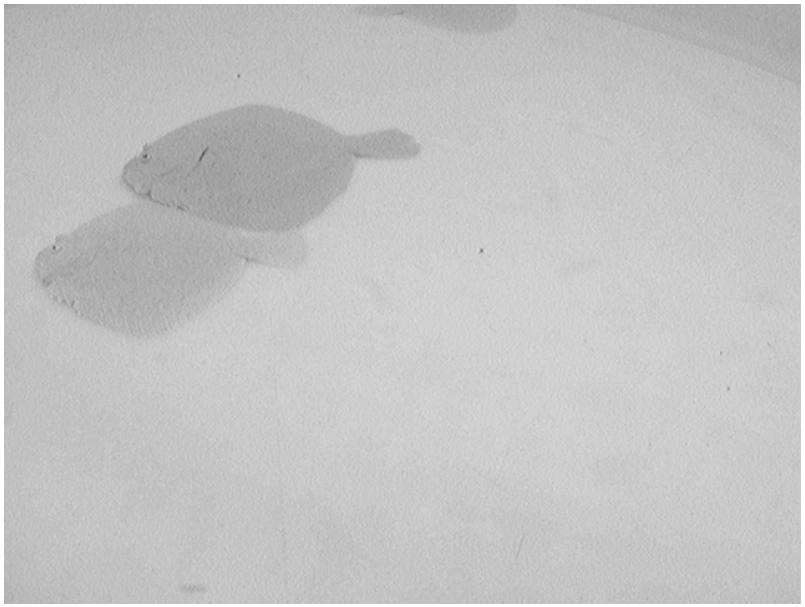
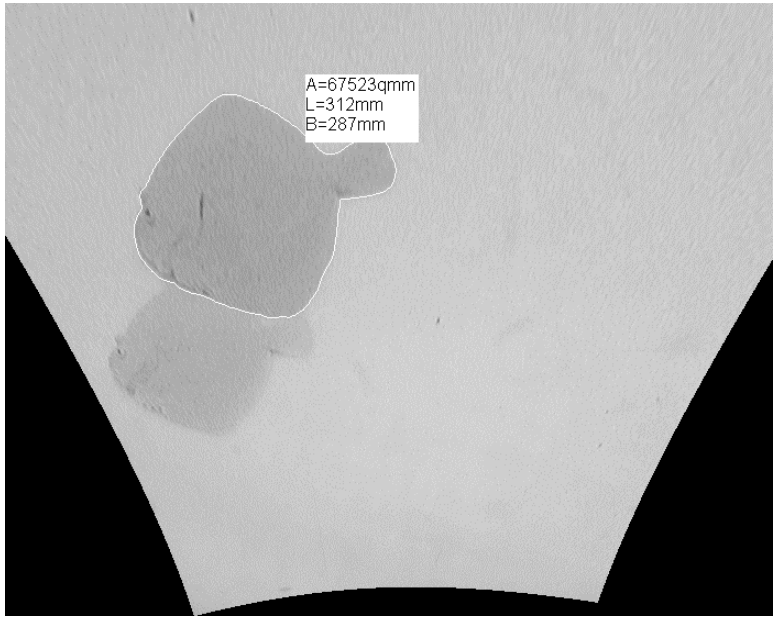
c) Calibration

Plate with points in defined distance is presentated to camera and calibrationparameters (objectiv focus and distortion, position of the camera in the real world coordinatesystem x, y, z, ß, ?) are calculated for transformation to cm-units



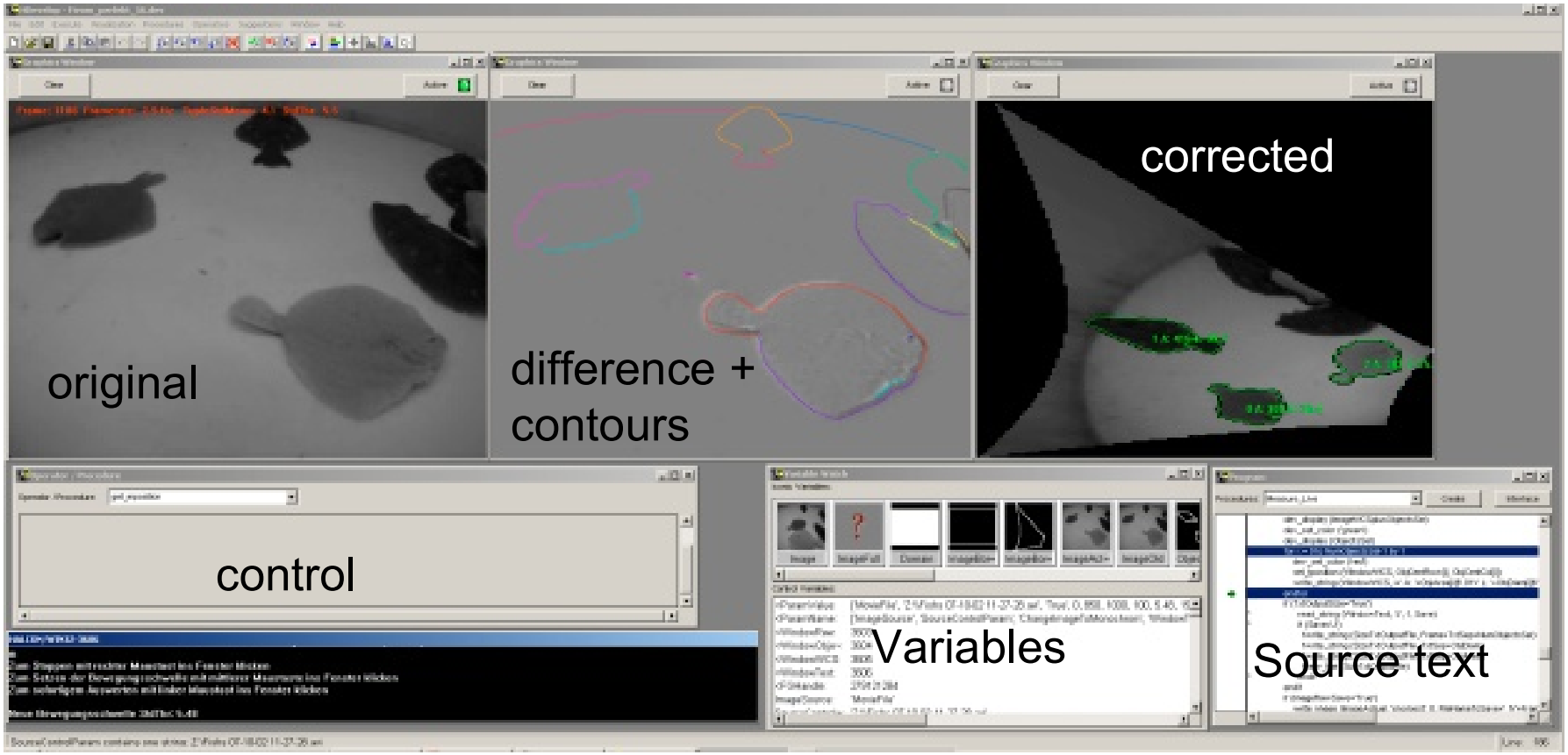
Raw image



corrected image
(projection in x-y-plane)

c) Screen-Shot

Software for calibration, objectdetection und –measuring and documentation programed in HDevelop



Summary and discussion

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Automatic Image Analysis can reduce manuel effort in fishproduction and serves important information directly related to fish for the producing management.

Underwatercamera minimises problems with watersurface and provides fishlength with an accuracy of better than 1 cm.

Turbots prefer the border of the bassin and changes position hourly over the whole bassin.

Fishdetection works well with edgefilter but problems if fish overlap with small contrast.

Statistic for calculating the mean and variation of fishsize is influenced by repeated measuremnet of the same fish

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Thank you for your Attention!

Dieses Projekt ist Teil von „e-region Schleswig-Holstein plus“,
ein Programm des Ministeriums für Wissenschaft, Wirtschaft und Verkehr und der Innovationsstiftung Schleswig-Holstein – gefördert von der ISH und der EU aus dem Europäischen Fonds für Regionale Entwicklung (EFRE)

Definition

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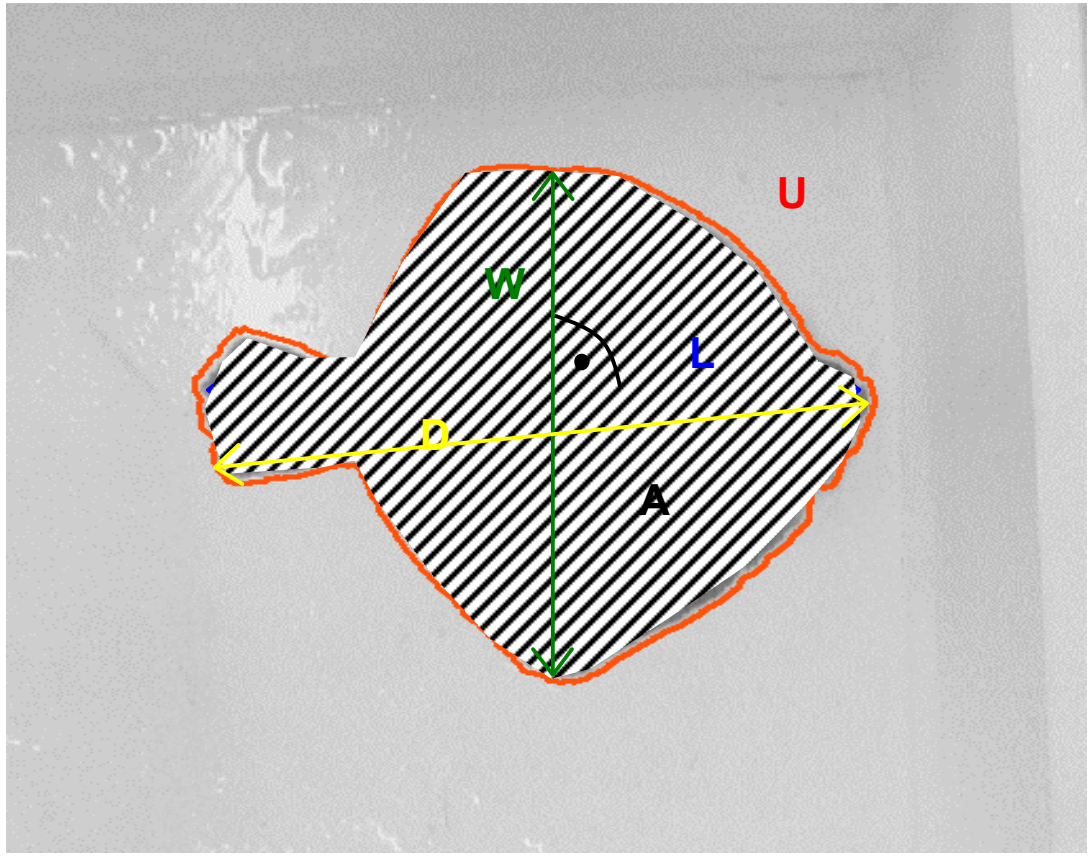
Fish „size“:

geometric parameters



Length L (longest distance along to fish axis)
Width W (longest distance perpendicular to Length)
Diameter D (longest distance in the area)
Area A
Contour U (Outline of the fish)

Bildanalyse (Datenaufnahme und –verarbeitung)

Kameras
digitale CMOS, Mono, 756x480 Pixel
digitale CCD, Farbe 640x480 und Mono 1280x960 Pixel
Sony Analog CCD + Framegrabber

Objektive
12 + 16 mm C Mount F1.4 (Pentax)
2.5 mm CS Mount F1.2
1.4 – 3.1 Vario CS Mount F1.4 (Fujinon)
5 mm C Mount (Compar)

Filter
Pol-, IR-Sperr- und Durchlassfilter

PC und Software
Intel Pentium 4 @ 1.6 GHz und 768 MB Ram, Intel Pentium Dual-Core und 2 x Intel Dual-Core Xeon @ 1.6 GHz und 2 GB RAM
Windows XP und Halcon 7.1 (unterstützt Parallelprozessoren)

HALCON
the Power of Machine Vision

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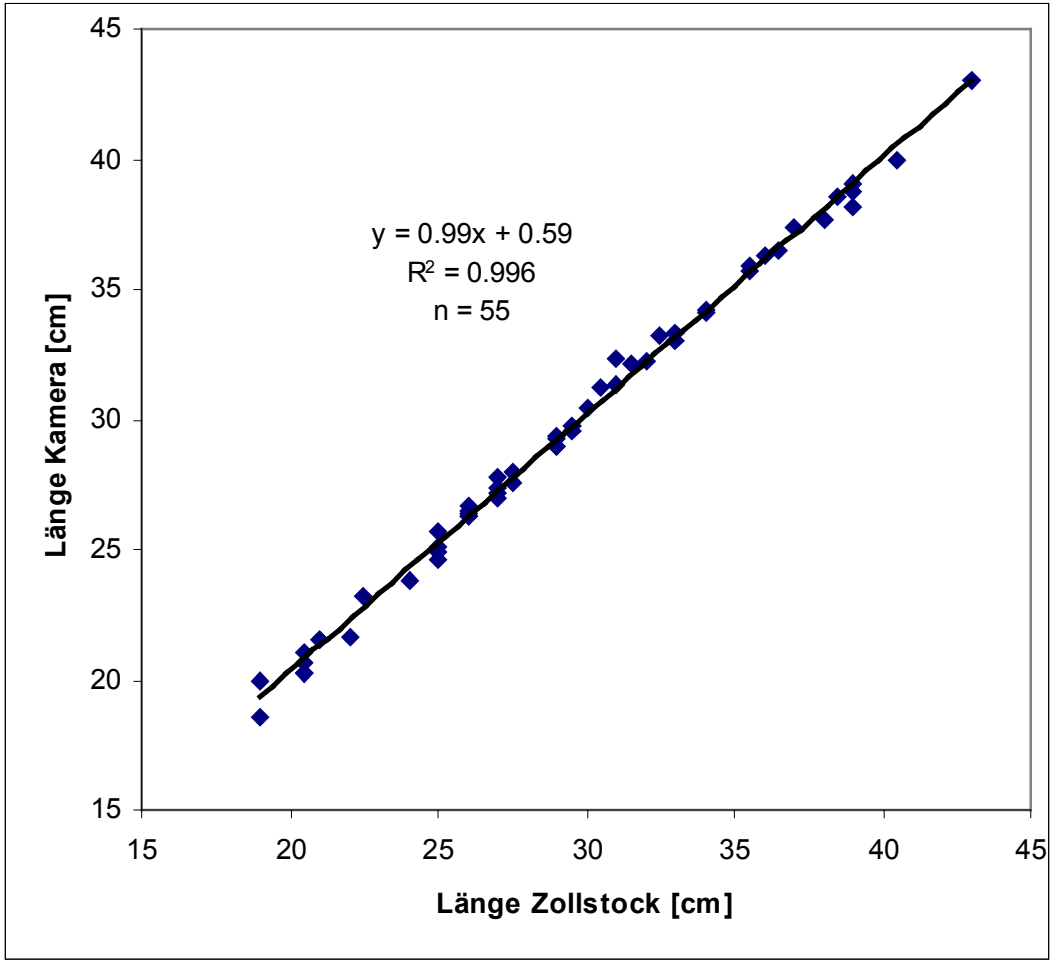
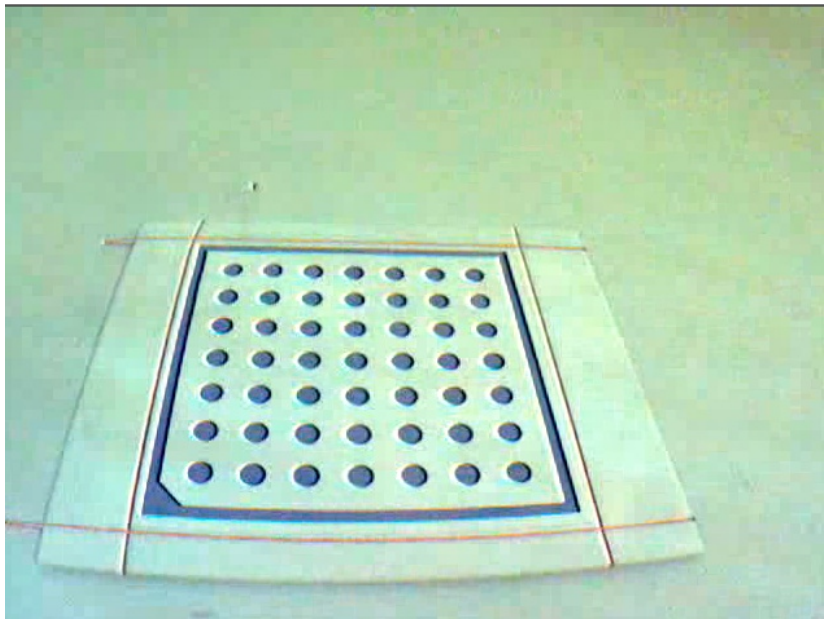
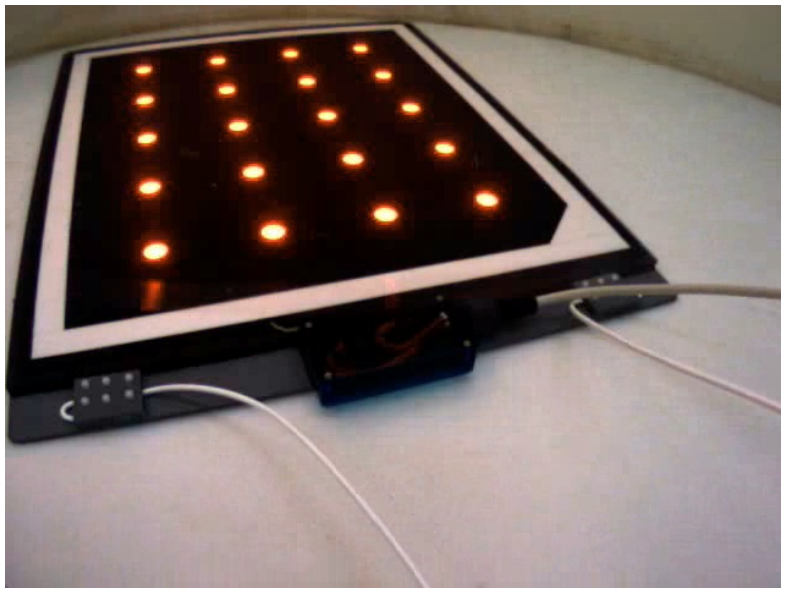
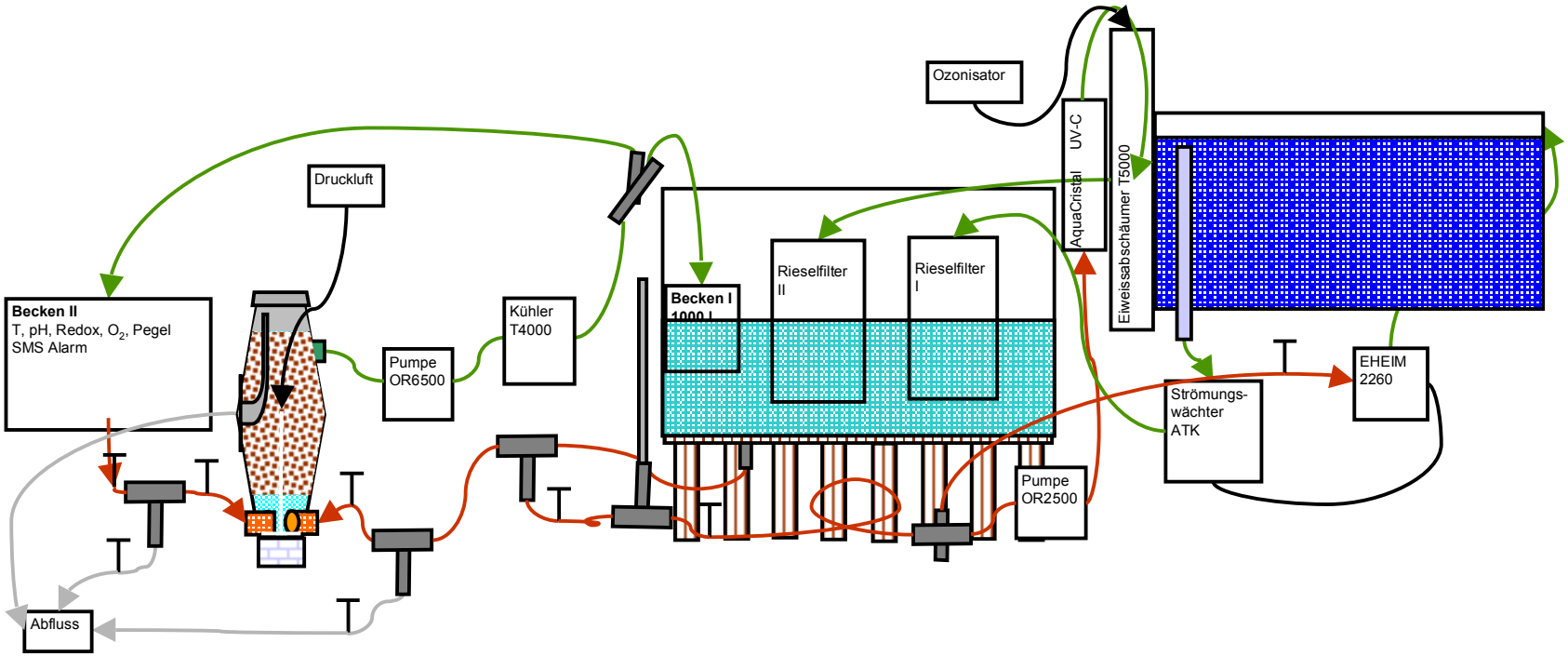
b) Genauigkeit Kamera

Kamera (55 Bilder) gegen Zollstock








Ozonisator
UV-C
AquaCristal
Eiweissabschäumer T5000
Druckluft
Becken II
T, pH, Redox, O_2, Pegel
SMS Alarm
Pumpe
OR6500
Kühler
T4000
Becken I
1000 l
Rieselfilter
II
Rieselfilter
I
Strömungs-
wächter
ATK
EHEIM
2260
Pumpe
OR2500
Abfluss