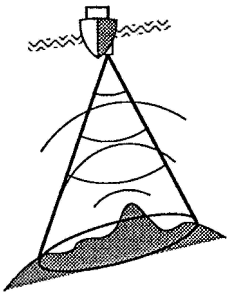
TuAMK Väyläsuunnittelu

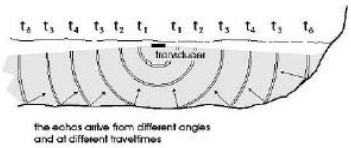
Syvyysmittaus
3.2.2015

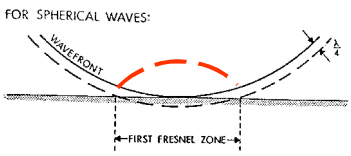
# AKUSTISET ÄÄNIAALLOT

- Acoustic signals propagate through the water media as longitudinal pressure wave type (P-wave);
- Acoustic waves propagate best through solids and liquids;

- Spreding is estimated as cylindral, although it is spherical;
- Acoustic sound level is expressed as decibels [dB] ($L=\log_{10} \cdot I / I_{ref}$)





# THE SONAR EQUATION

$$EN = SL - 2TL - NL + BS + DI_R$$

Acoustic power budget terms (dB)

- EN = Echo-to-Noise level ← Measured
- SL = Source Level ← Sonar parameter
- TL = Transmission Loss ← f(sonar frequency, range)
- NL = Noise Level ← f(frequency, receiver bandwidth)
- BS = Backscatter Strength ← f(frequency, angle, bottom type)
- $DI_R$ = Directivity Index (receive) ← Sonar parameter



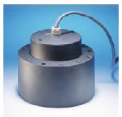
# AKUSTISET ÄÄNIAALLOT

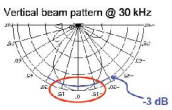
- KUINKA ÄÄNISIGNAALI MUODOSTETAAN?
  - Lähetys: sähköenergia muutetaan liike-energiaksi
  - Vastaanotto: liike-energia muutetaan sähköenergiaksi

Piezo-electric material
- PZT Ceramics
- 1-3 composite
- PVDF

- KAIKULUOTAINANTURIN OMINAISUUKSIA (PROJECTOR – SIGNAALIN LÄHETIN)
  - Signaalin taajuus
  - Signaalin harmonisuus
  - Signaalin pituus
  - Signaalin avauskulma (directivity, beam pattern)
  - Teho, herkkyys (transmit volt. resp.)
  - ”Tarkkuus” (range resolution)

Directional Transducer: RESON TC2137

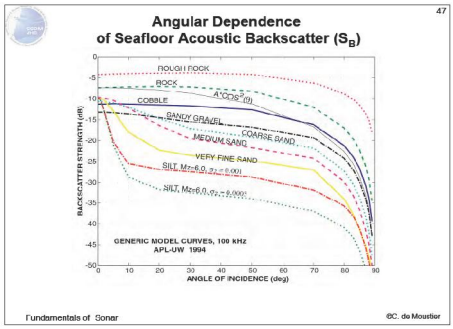


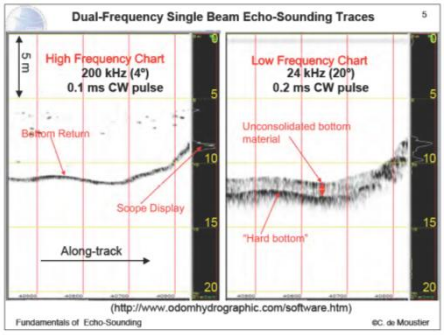



**Resonant Frequency:** 30 ± 2kHz
**Transmitting Sensitivity:** 164 ± 3dB re 1µPa/V @ 1m
**Receiving Sensitivity:** -182 ± 3dB re 1V/µPa
**Impedance:** 80 ohm ± 24% at 30 kHz
**Beam Width:** 29° at 30 kHz
**Beam Shape:** Conical
**Max input power:** 300 W (at 1% duty cycle)

© RESON (WWW.RESON.COM)

# AKUSTISET ÄÄNIAALLOT

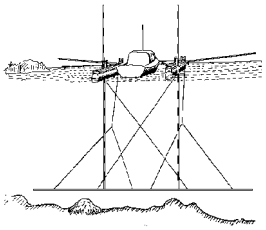




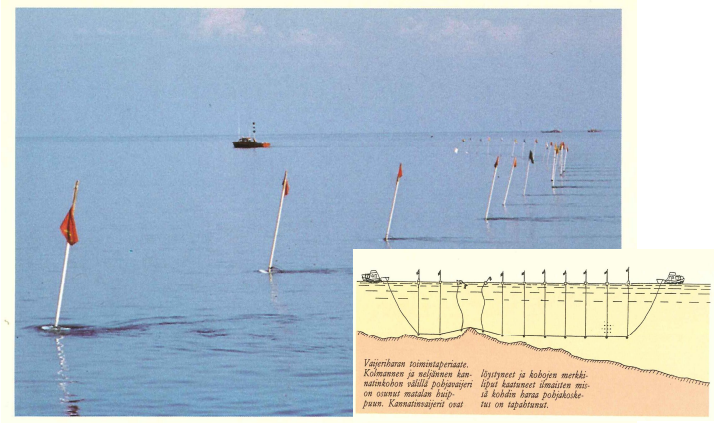

## Mekaaninen merenmittaus

- Tankoharaus
  - Harauskalusto on kehittynyt ajan saatossa
  - Nykyiset tankoharat:
    - 1. Veneiden työntämiä
    - 2. Koneellistettuja lauttoja
- Ruoppaustöiden vastaanotto



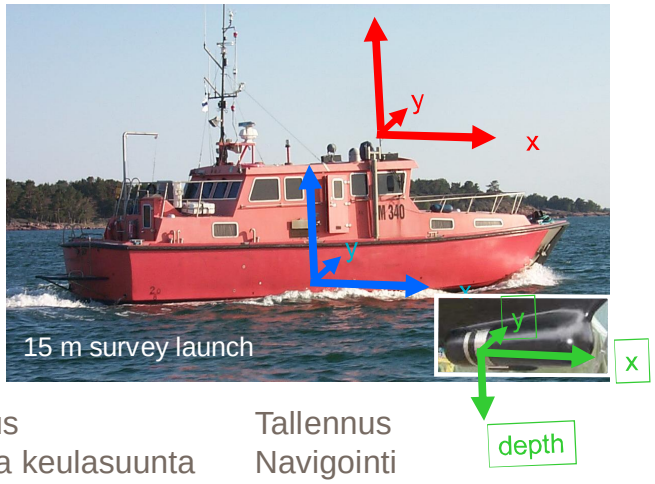
## Mekaaninen merenmittaus

- Vaijeriharaus





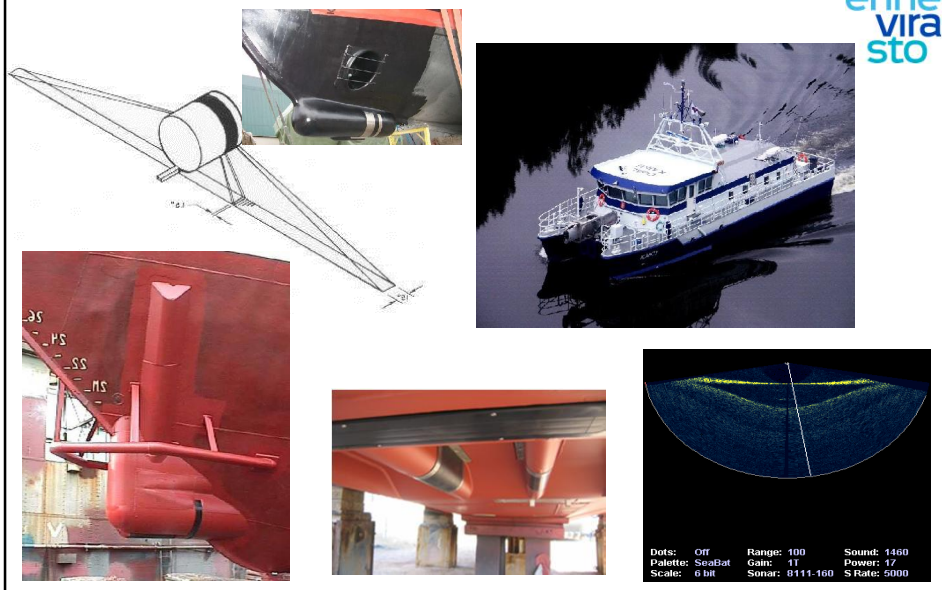

## MONIKEILAINLAITTEISTO ON KOKONAISUUS




Paikannus
Nopeus ja keulasuunta
Äänennopeus
Monikeilain ja sivukeilain

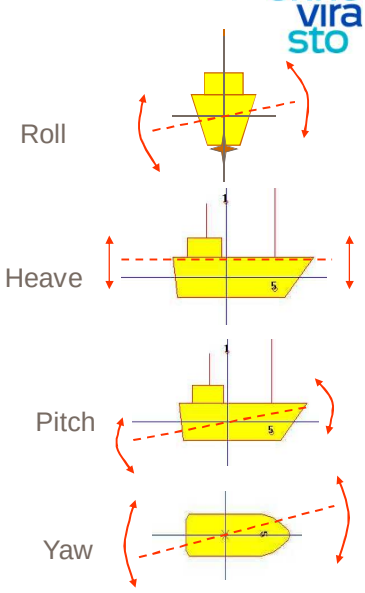
Tallennus
Navigointi
Kuljettajan näyttö
Laatu ja eheys

## ANTURIEN ASENNUS ON TARKKAA PUUHAA




## ALUKSEN LIIKKEEN SEURANTA

- Motion sensor, motion reference unit requires GPS position, and vessel speed as guidance
- Also an optical gyro compass: heading

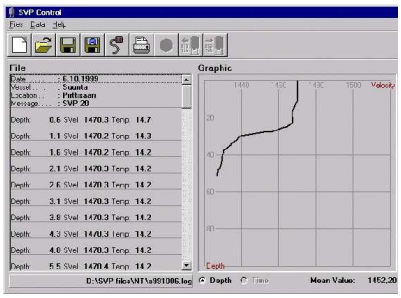


## ÄÄNIAALLON ETENEMINEN VEDESSÄ VÄLIAINEENA

**Vesi väliaineena käsittää useita ominaisuuksia:**
- **lämpötila - temperature (T)**
- **paine - pressure (P), riippuen veden syvyydestä (z)**
- **suolaisuus - salinity (S), mitataan usein sähkön johtavuudella**

**Äänen etenemisnopeuden empiirinen kaava (Wilson):**

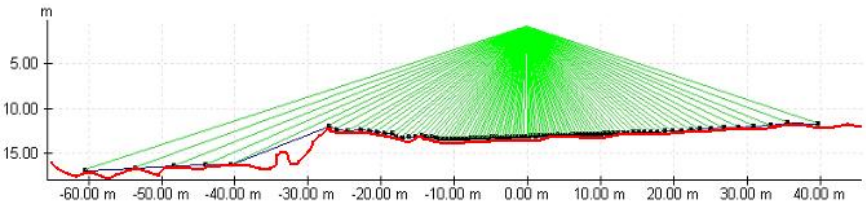
$$c = 1449{,}2 + 4{,}6T - 0{,}055T^2 + 0{,}00029T^3 + (1{,}34 - 0{,}010T) \cdot (S-35) + 0{,}016z$$



**Ilmatieteen laitos**
**(www.fmi.fi)**

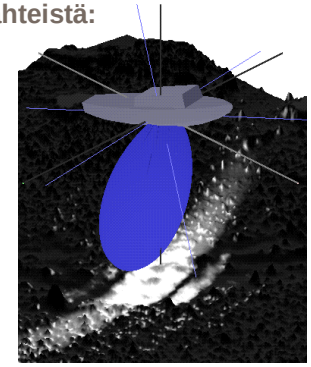
- **Vedenkorkeustiedot (mareografit) suljettu allas, vallitsevat tuulet**
- **Aallon korkeustiedot**
- **Jäätiedot**



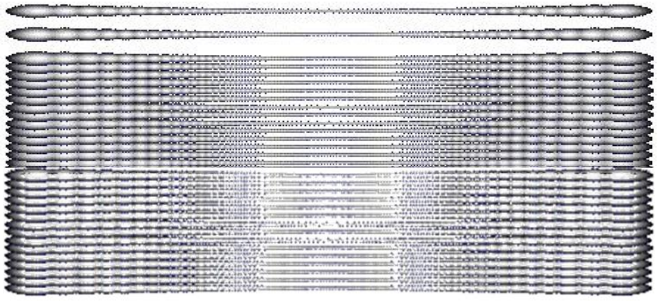


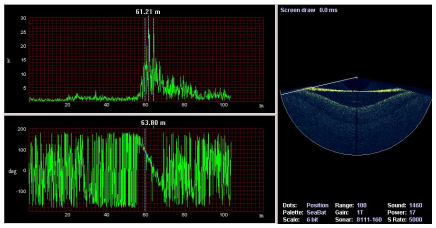

**Syvyysarvon epätarkkuus koostuu virhelähteistä:**
- **GPS antennin paikka;**
- **veneen / aluksen syväys;**
- **kulkusuunta ja liike;**
- **sensorien keskinäinen sijainti;**
- **kunnollinen syvyyshavainto;**
- **äänennopeus väliaineessa;**

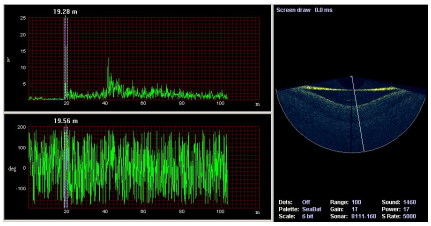
**Tyypillisesti näitä virhelähteitä käsitellään pienimmän neliösumman menetelmällä. Tämän pohjalta voidaan arvioida havainnon laatua;**



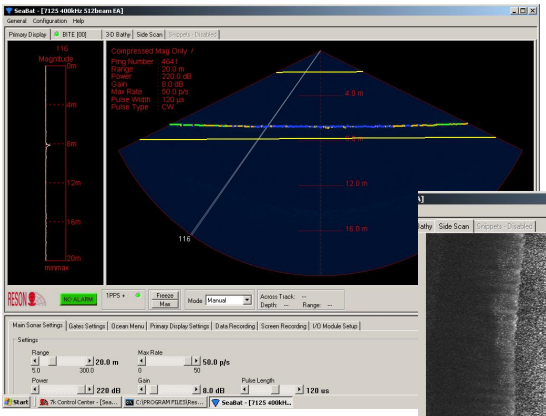
## HAVAINNOT: AMPLITUDI TAI VAIHE





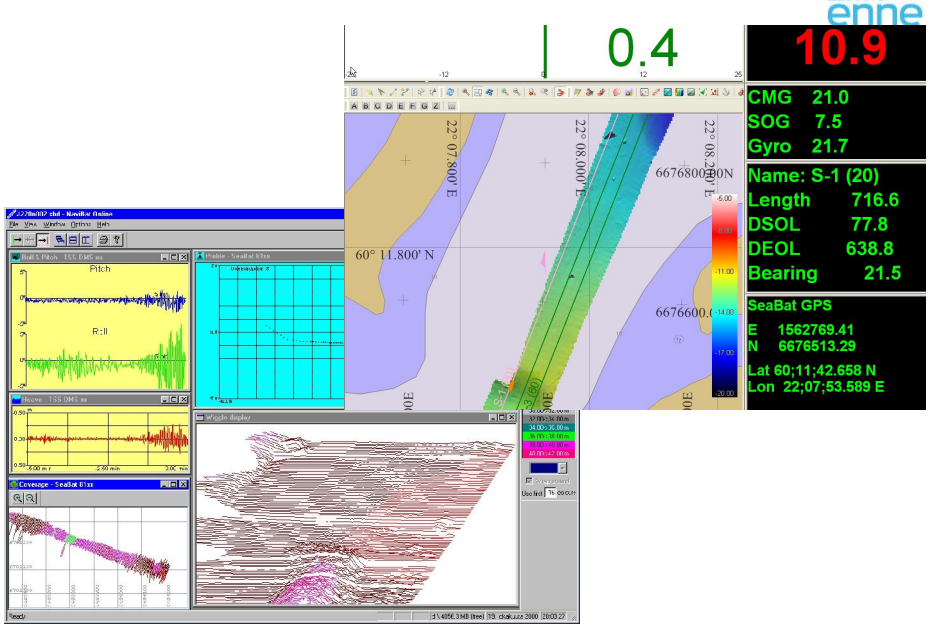


## MBES – MONIKEILAIN SSS - SIVUKEILAIN



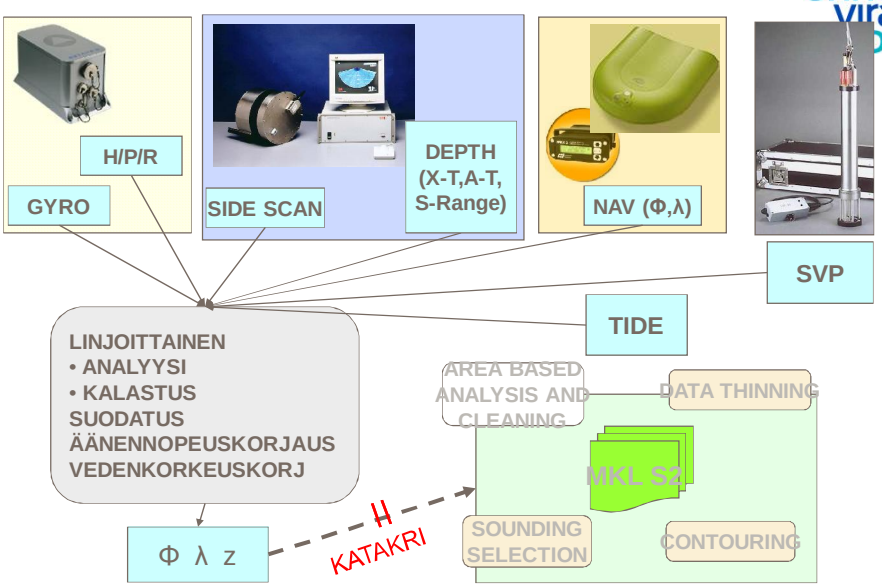
SOund NAvigation and Ranging - SONAR

## OPERAATTORIN NÄYTÖT

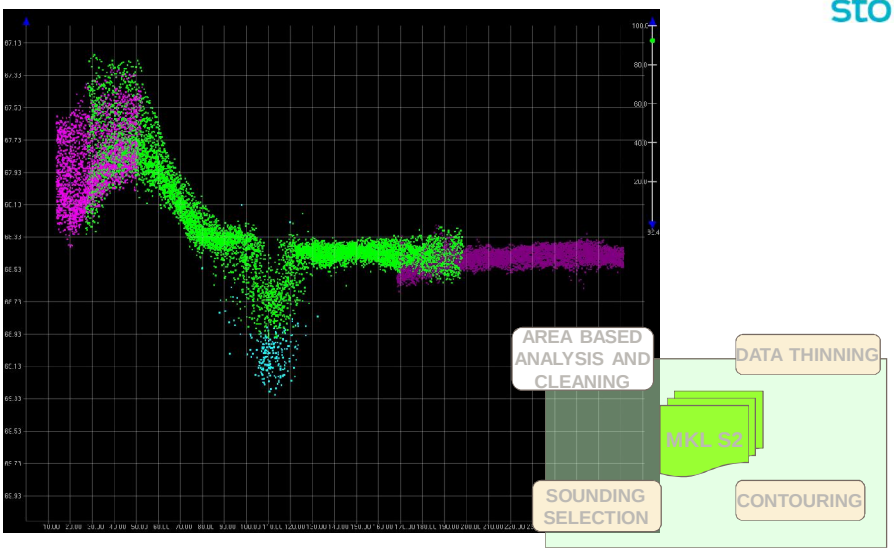



## OPERAATTORIN NÄYTÖT

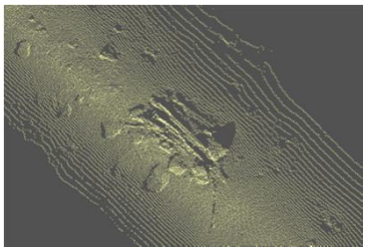
# TIETOJEN YHDISTELY

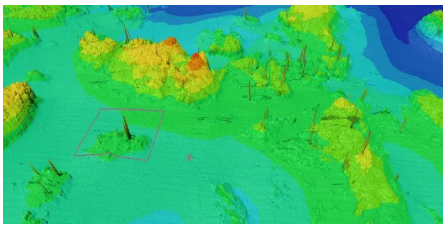


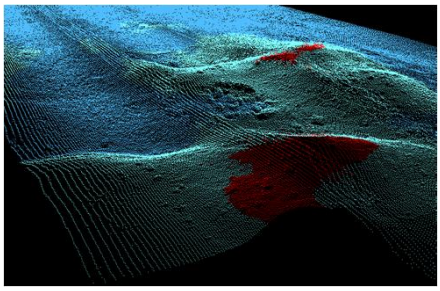

# AINEISTON TARKASTELU

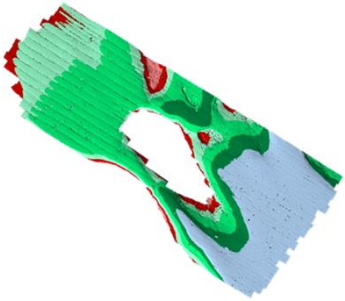


## AINEISTON TARKASTELU JA KÄSITTELY

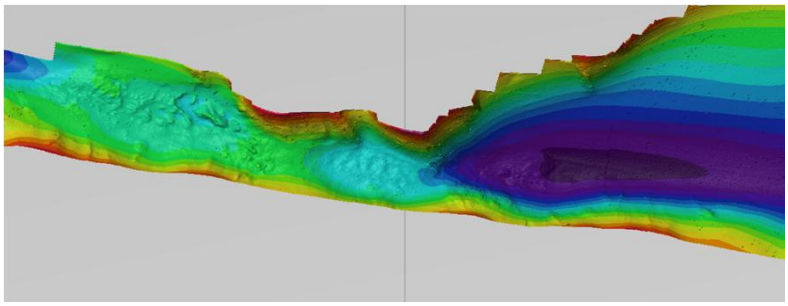


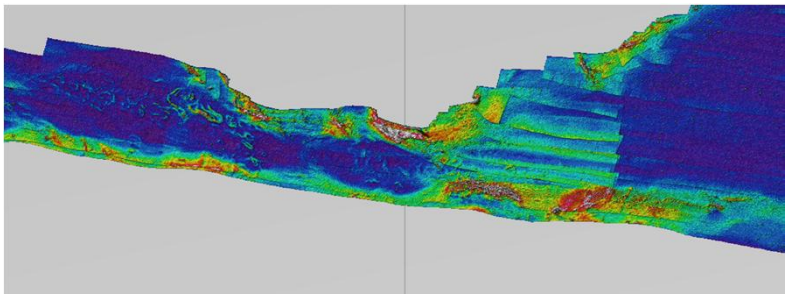






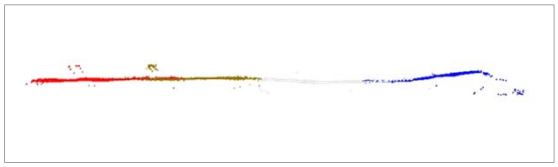
## AINEISTON TARKASTELU JA KÄSITTELY





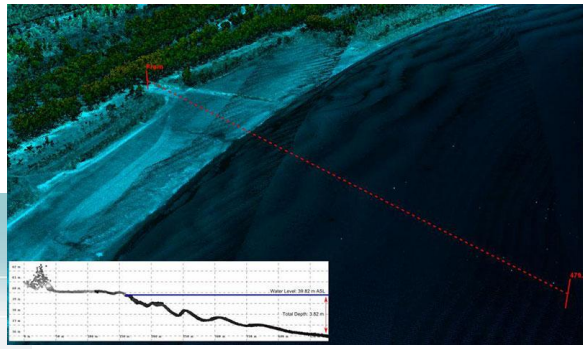
## AINEISTOSSA ESIINTYVIÄ VIRHEITÄ / ONGELMIA

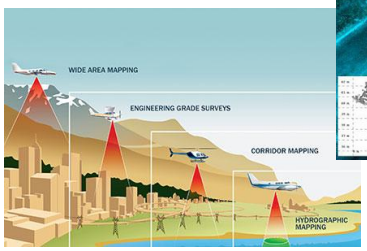
- KALAPARVET
- VESIKASVILLISUUS
- KELLUVAT (VESIKERROKSESSA) ESINEET
- POHJAN LAADUN MUUTOKSET



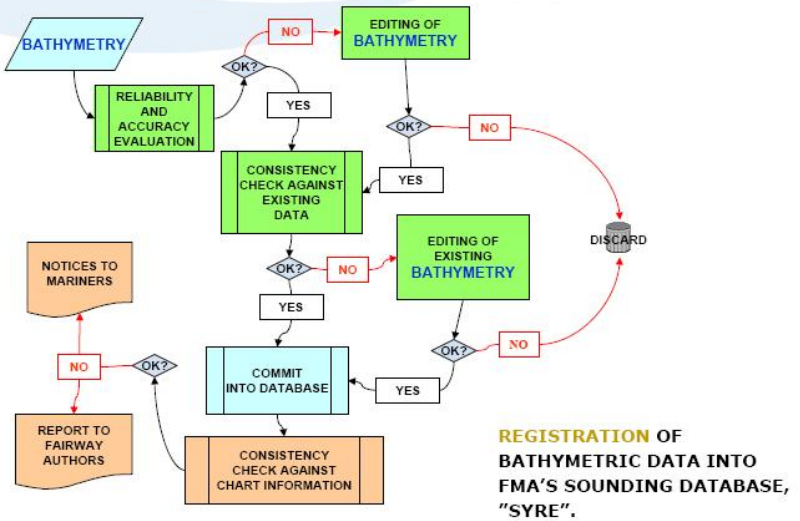
## Merenmittaus laservalolla

- Monitaajuuslaserlaitteistot
  - pulssin tiheys 10.000 Hz
  - taajuudet
    - Veden läpäisy
    - Rantaviiva
- ilma-alus lupa
- Lennokki





## HYDROGRAPHIC DATA PROCESSING, PROCESS DIAGRAM – FMA CASE




**REGISTRATION OF BATHYMETRIC DATA INTO FMA'S SOUNDING DATABASE, "SYRE".**