One step towards True Along Hole logging depths: proper WLL corrections

Amsterdam ICSWSA meeting

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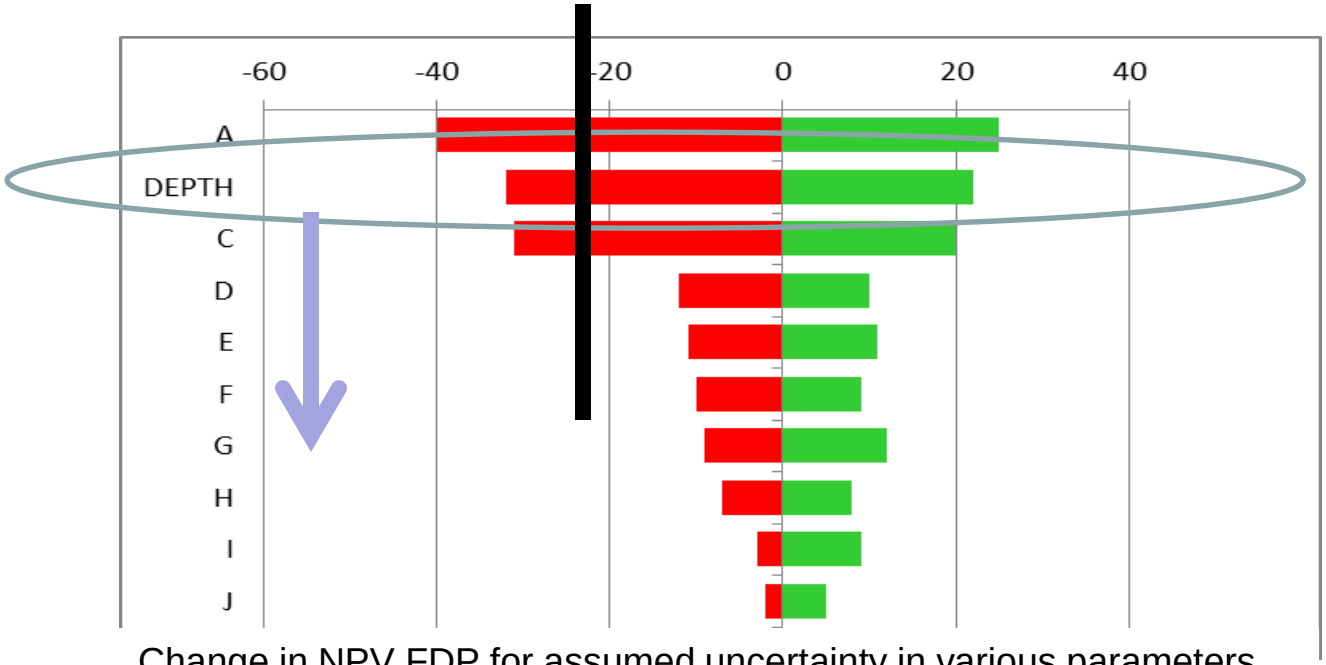
Why work on depth QC??

- ***Depth one of the top uncertainty factors FDP's***
- ***Sensitivity analysis Net Present Value typical FDP***

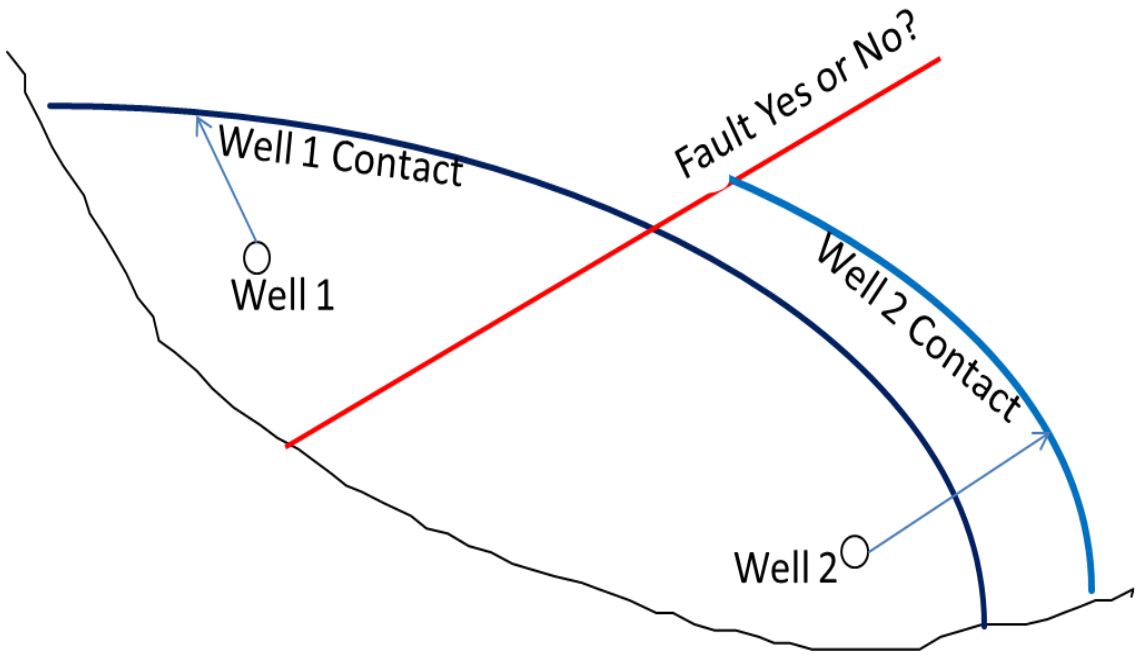


Change in NPV FDP for assumed uncertainty in various parameters

- ***Direct impact fluid contacts on HC vol.***
  - *Extreme case: >>> 1 million bbl per 1 ft change in GOC*

Accuracy & precision needed

- ***Fluid contacts***
  - *A few feet difference has major impact*



- Not many examples (...yet ...)
about lateral error mishaps.

AH-depth and 3D position

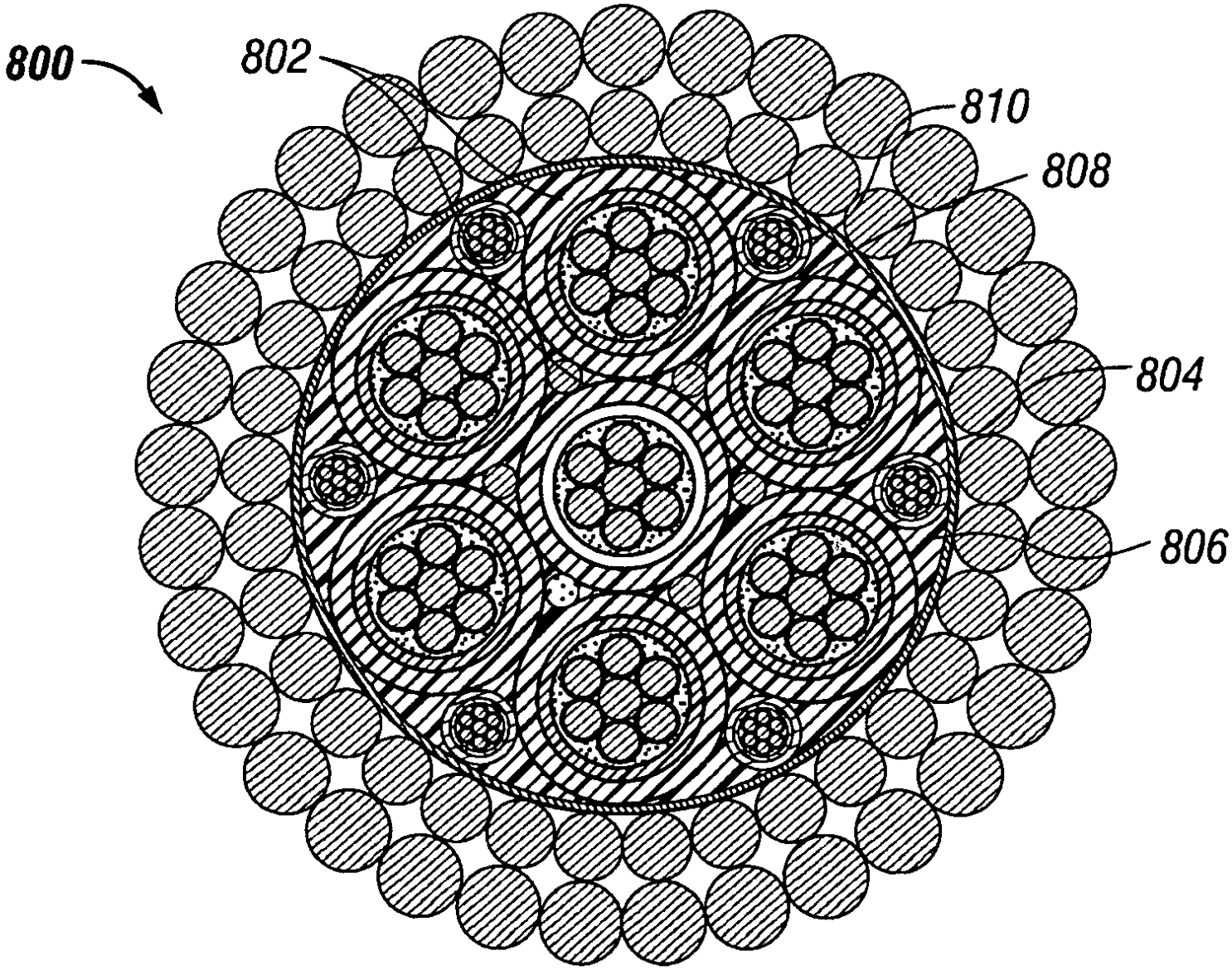
- ***Limit to AH depth***

- ***Surveying needed for 3D position***
  - *AH depth (often) important input*
    - *Plenty of ~~problems~~ challenges already*

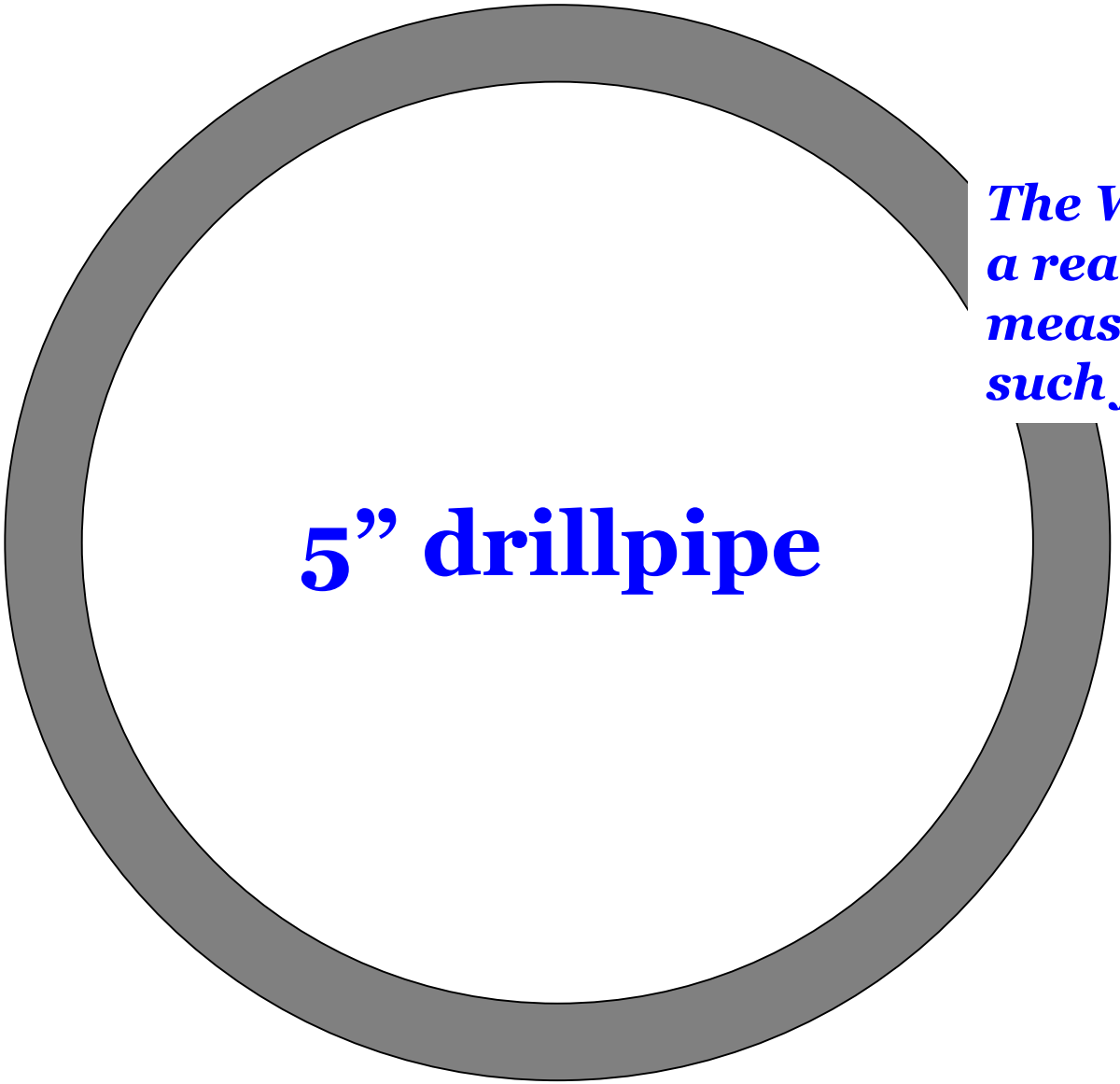
Current practice

- ***Wireline – loggers depth***
  - *Normally (some) stretch corrections applied*
- ***LWD logs – drillers depth***
  - *Surface measured lengths*
  - *No stretch corrections applies*
    - *Hence grossly in error; errors not consistent*
- ***WLL depths (used to be) believed as being better than drillers depth***
  - *But LWD/drillers depth taken for lack of WL in horizontals*

Drillpipe and logging cable

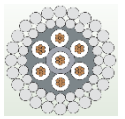


Drillpipe and logging cable



The WLL challenge: get a really good (accurate) measurement even with such flimsy cable..!!)

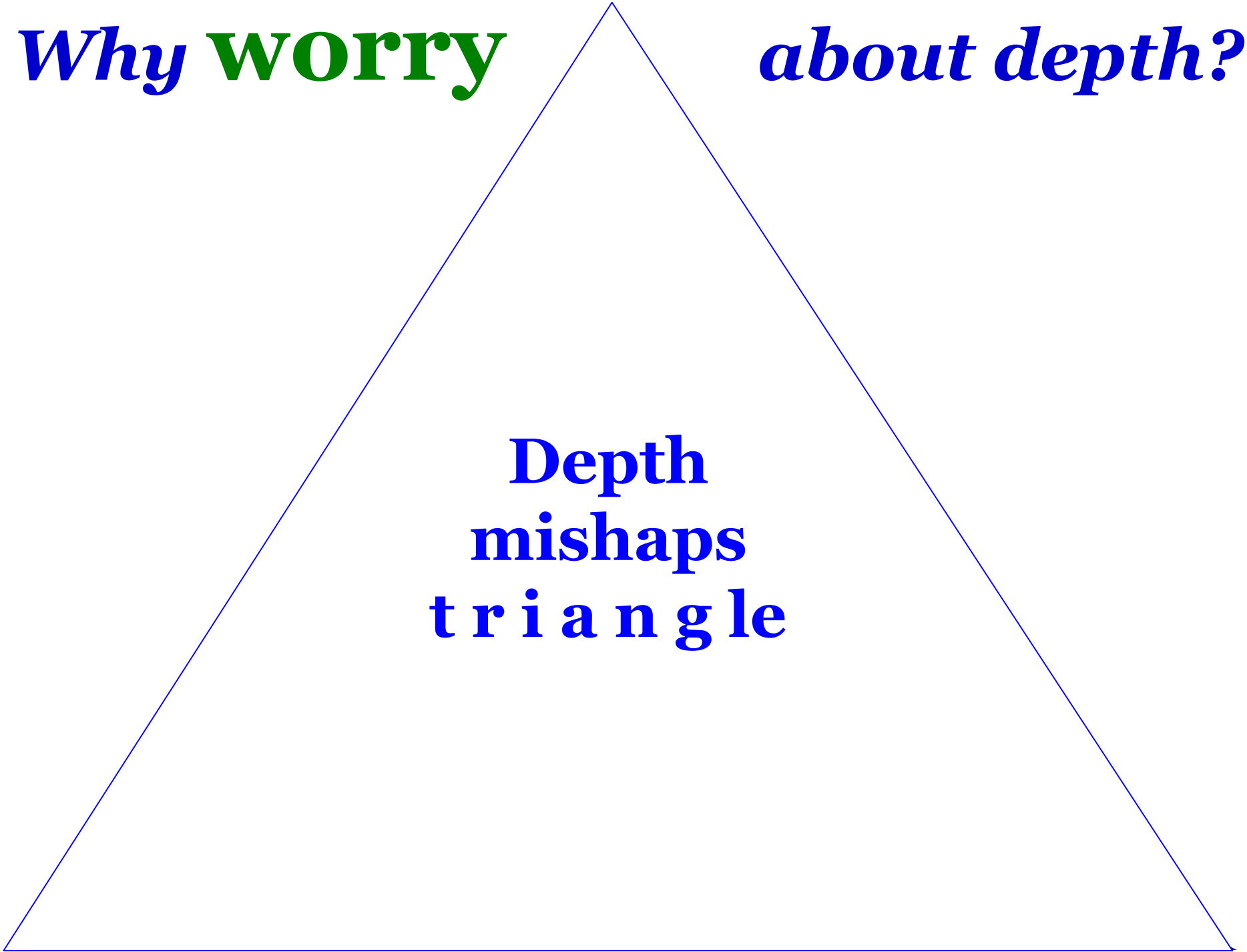
heptacable



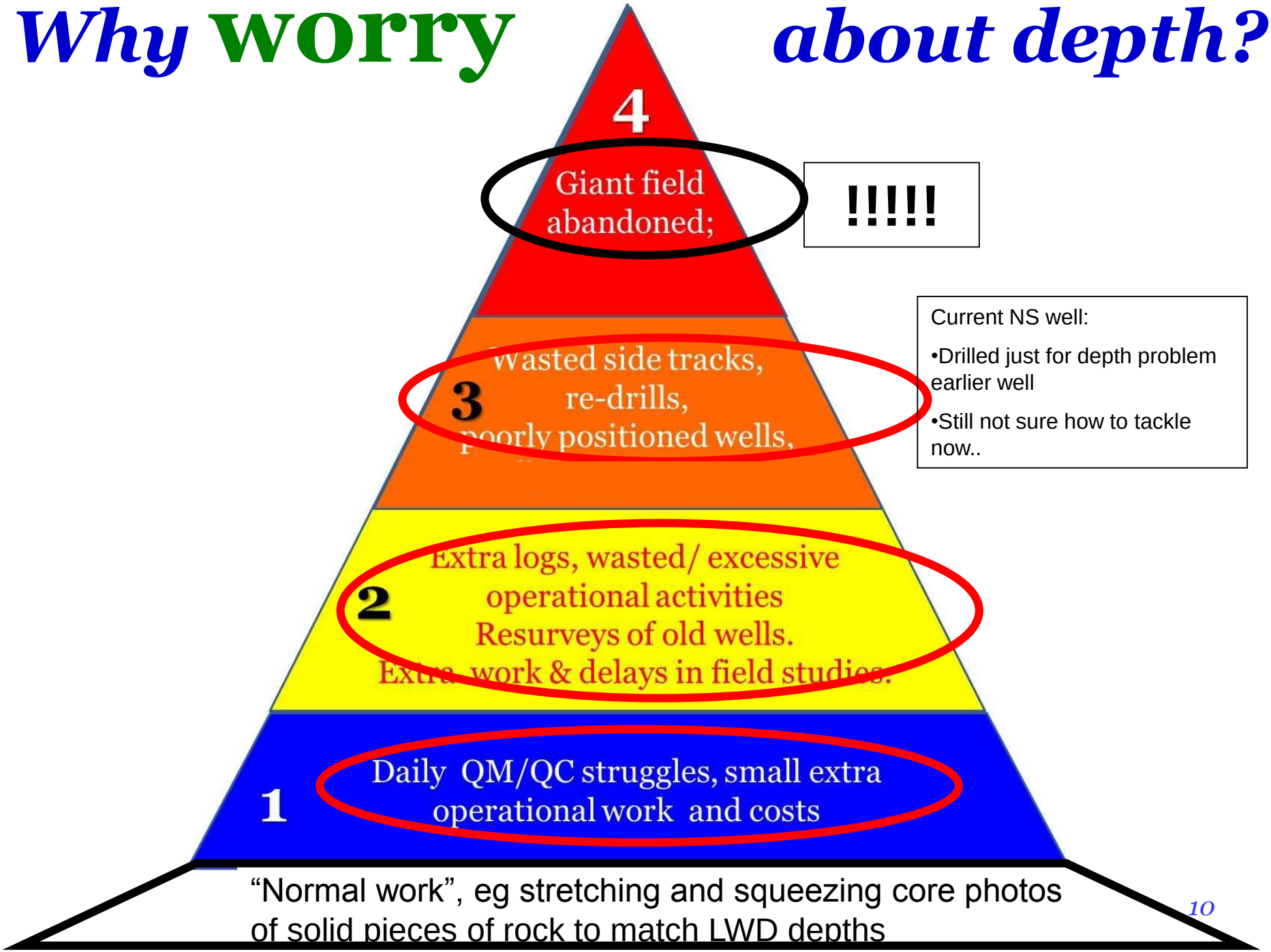
Depth problems common

- ***Random field example***
  - *25 well field*
  - *7 wells with serious depth problems suspected*
  - *4 wells resurveyed → confirmed significant problems original depths*
    - *errors from -12 to +28 ft (< 10000 ft wells)*
- ***(suspected) errors & mismatches jumping up & down***
  - *one well, WLL only: 19, 29, 10, 21, 10, 30, 2 ft*
  - *WLL/LWD mix: similar problems*
- ***25 % of wells have reason to worry, / too large depth discrepancy (Saudi Aramco 2013)***

Why worry *about depth?*



Why **worry** *about depth?*



Current NS well:

- Drilled just for depth problem earlier well
- Still not sure how to tackle now..

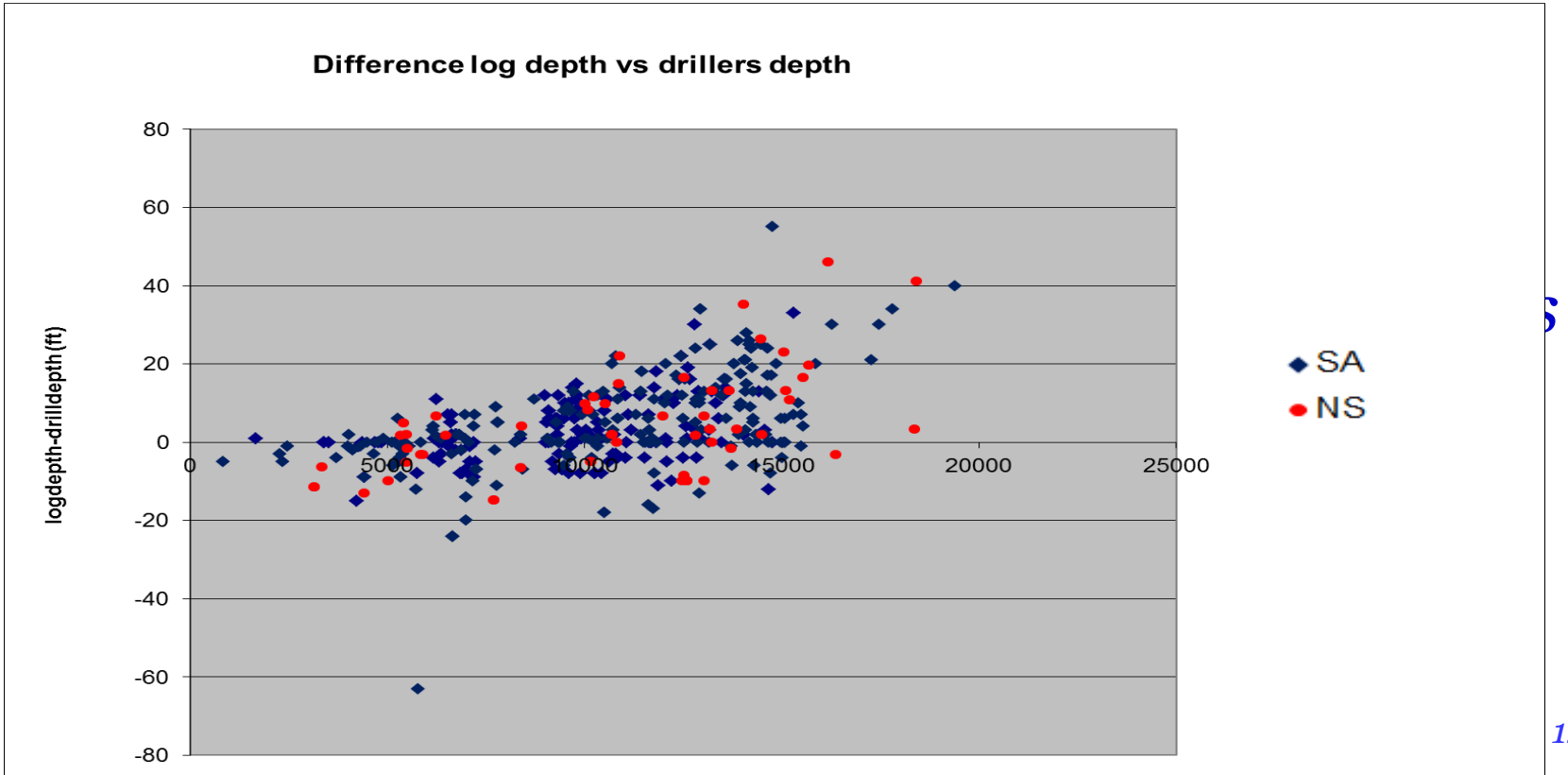
"Normal work", eg stretching and squeezing core photos of solid pieces of rock to match LWD depths

Cause of problems??

- ***Inadequate QC service companies??***
  - *"type 1 errors" logging depths are simply wrong, so logs have to be shifted*
- ***Lack of audit trail/documentation leading to "type 2" error***
  - *Operator shifts logs, assuming they're wrong, to match existing model*
- ***"Quest for depth" (started mid 1990's) focussed on improvements QM/QC/audit trail***

QC not main problem; methods fall short

- **Problems (often/mostly?) not from operational errors**
  - *Not much difference various regions/countries*



QC not main problem; methods fall short

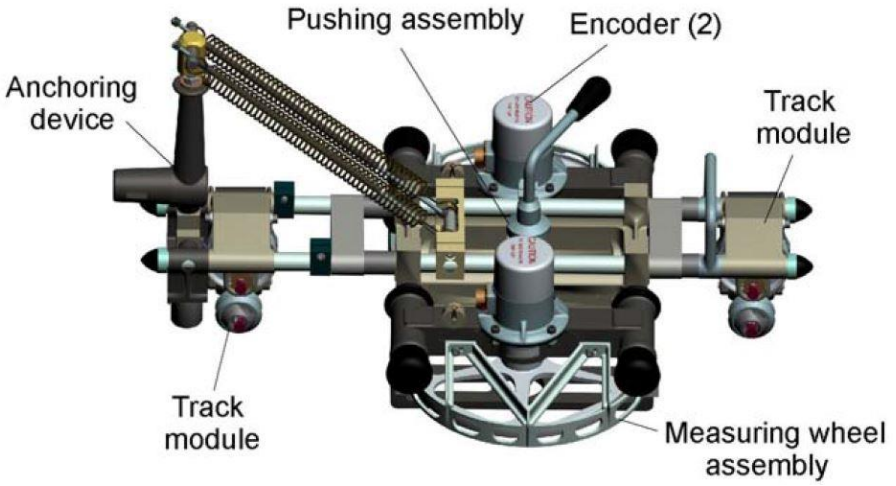
- ***Problems (often/mostly?) not from operational errors***
  - *Not much difference various regions/countries*
  - *Not much difference after QC improvement campaign*
  - *Stretch profile more complicated than traditionally assumed for smooth vertical wells*

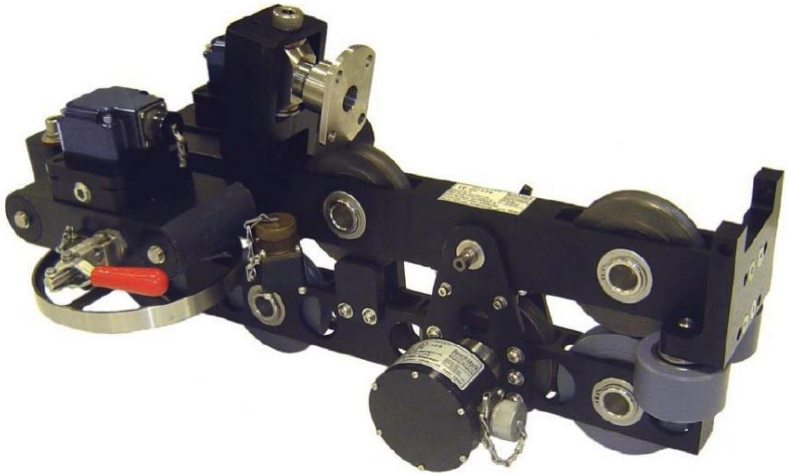
Improve stretch corrections

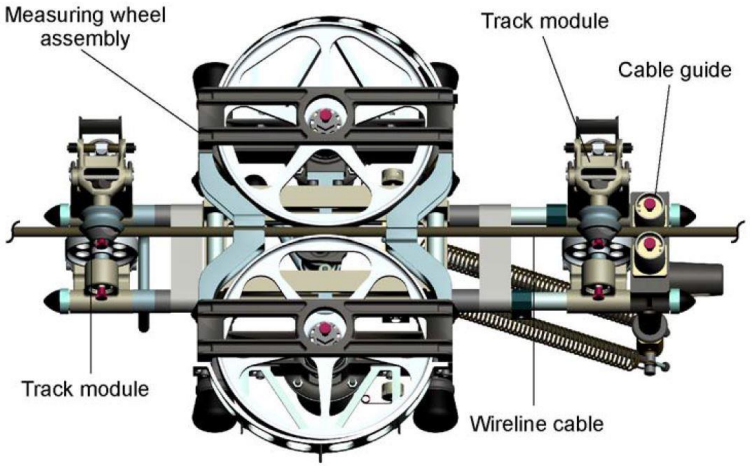
- ***Current stretch corrections developed for simple, smooth, vertical wells***
  - *Two point correction OK*
- ***Need improved corrections (for both WLL and LWD)***
  - *Newly development routines for (marked cable) WLL routines seem a major step forward*

Harald Bolt (ICT Europe)

Measurehead systems







courtesy of MPA and BenchMark

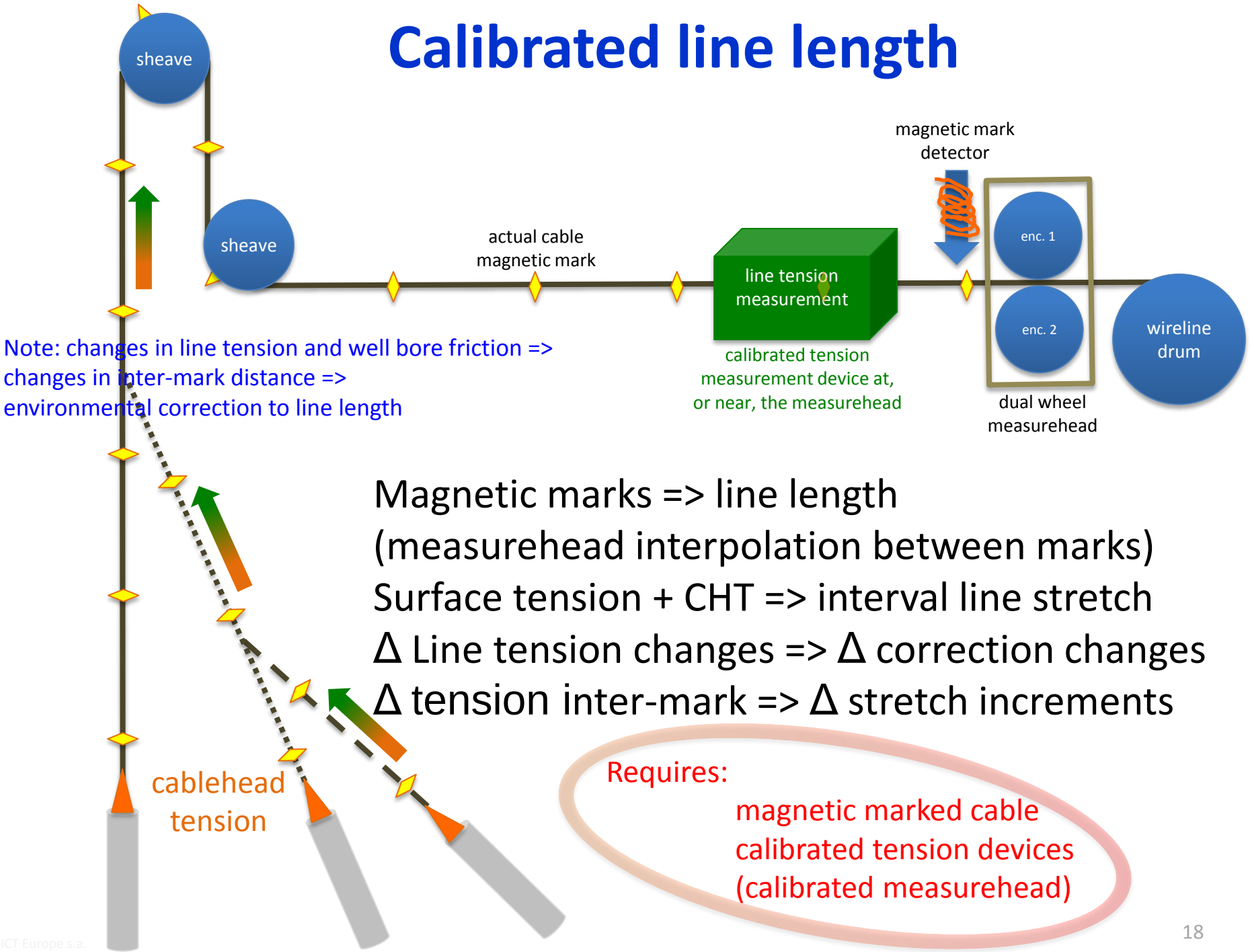
courtesy of Schlumberger

Calibrate, verify and correct

- Calibrate the cable length
- Verify cable length measurements
- Environmental corrections

- Uncertainty statements
- Audit trail

Calibrated line length

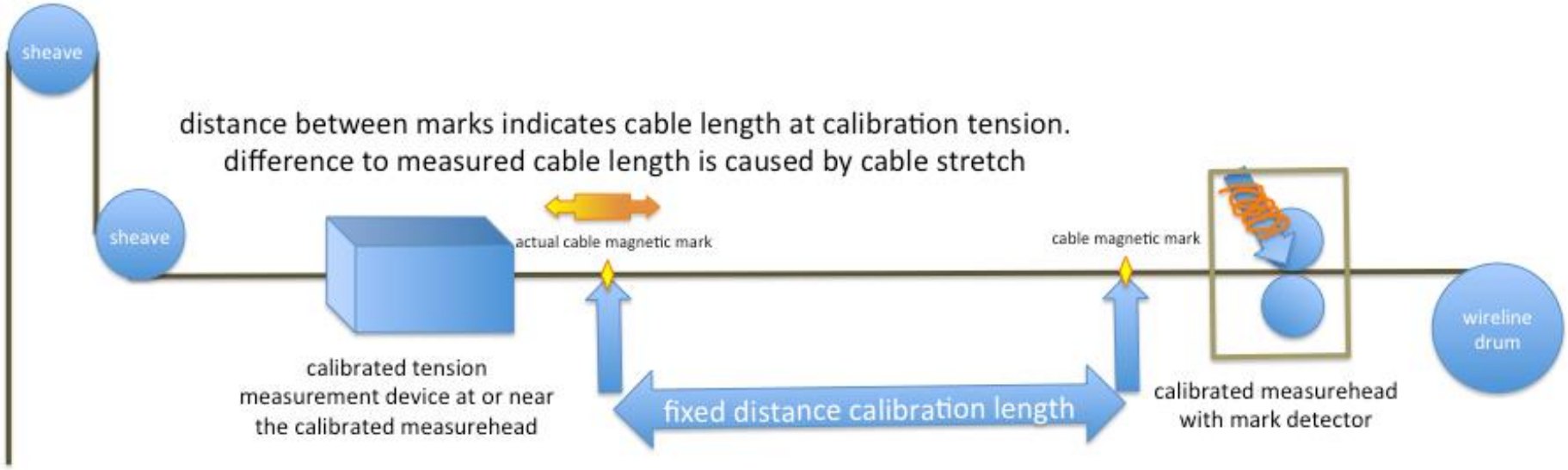


Magnetic marks => line length
(measurehead interpolation between marks)
Surface tension + CHT => interval line stretch
Δ Line tension changes => Δ correction changes
Δ tension inter-mark => Δ stretch increments

Requires:
magnetic marked cable
calibrated tension devices
(calibrated measurehead)

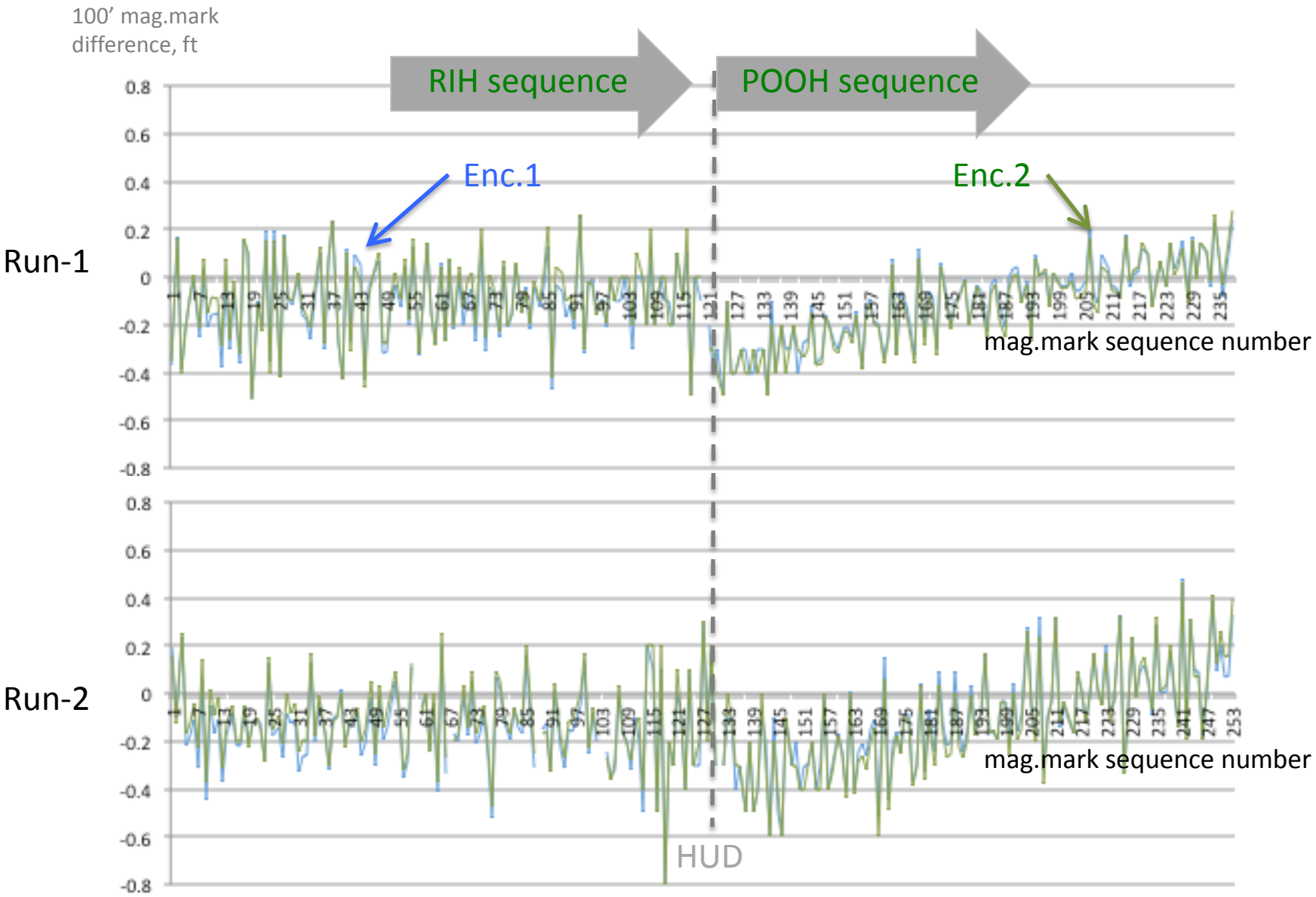
Verification of depth

The difference between individual measurewheel encoder responses (per mark) are logged and compared.

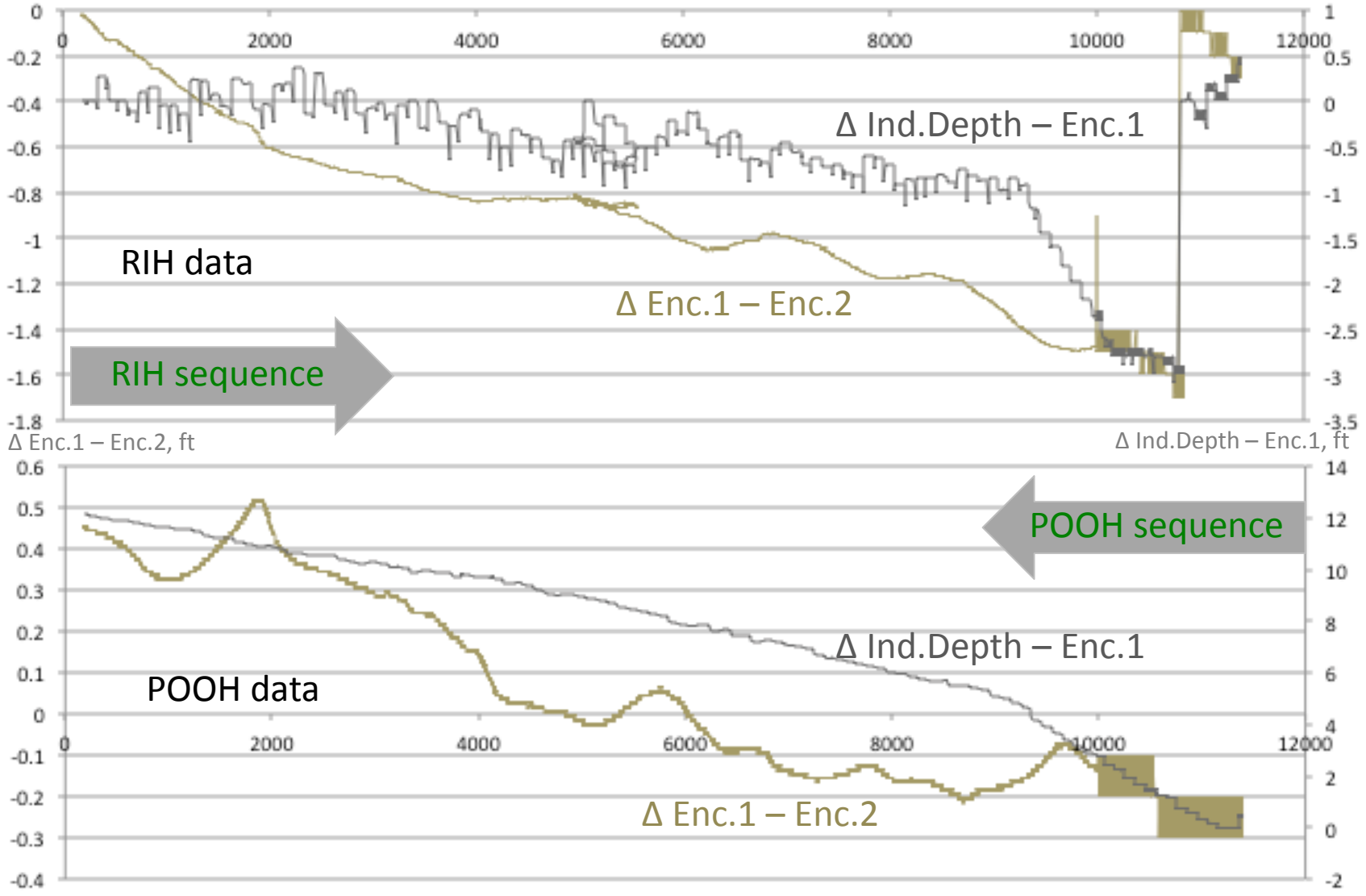


Use high resolution encoders (typ. 600 ppf).
Inter-mark distance will depend on tension and st. coeff.
Cable IPD will be seen as a change in gain on both encoder responses.

Measurewheel verification

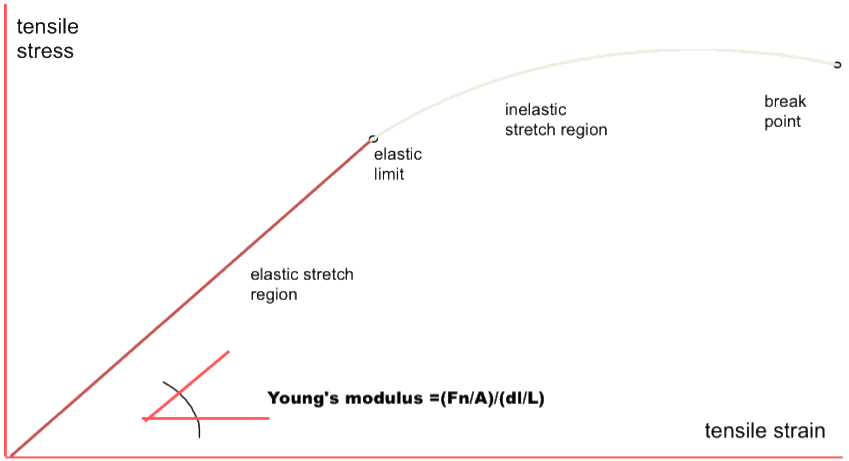


Measurewheel problem example



Correction basics – elastic stretch

- Hooke's Law



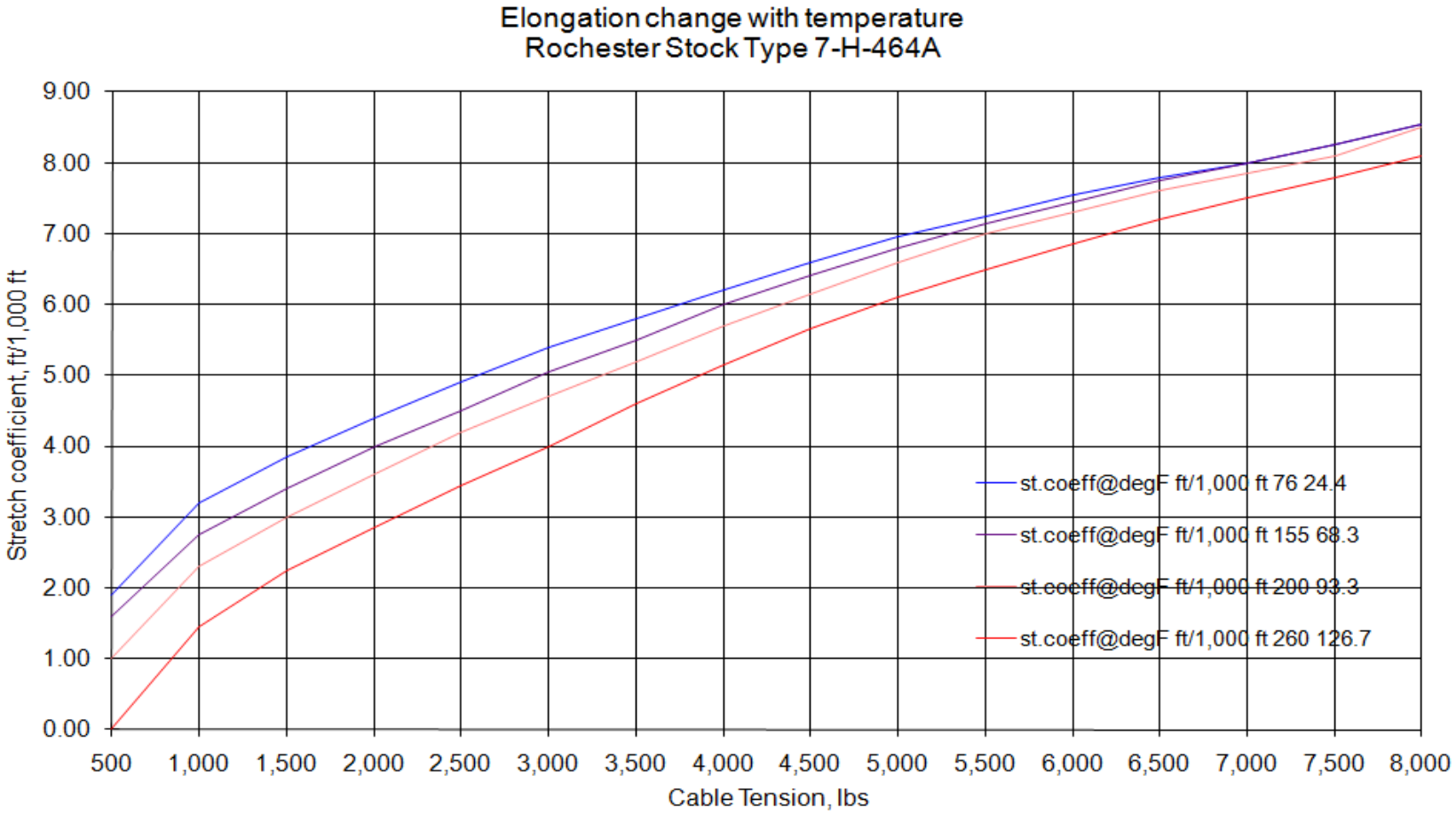
- General stretch equation

$$cable\ elastic\ stretch = \int_{surface}^{measured\ depth} \left(\left(\frac{surface\ tension + cablehead\ tension}{2} \right) \times stretch\ coefficent \right)$$

- Total stretch applicable to WL correction

$$total\ elastic\ stretch = \sum_{surface}^{measured\ depth} \left(\left(\frac{tension\ to\ top\ of\ segment + tension\ at\ bottom\ of\ segment}{2} \times segment\ length \times stretch\ coefficent \right) \right)$$

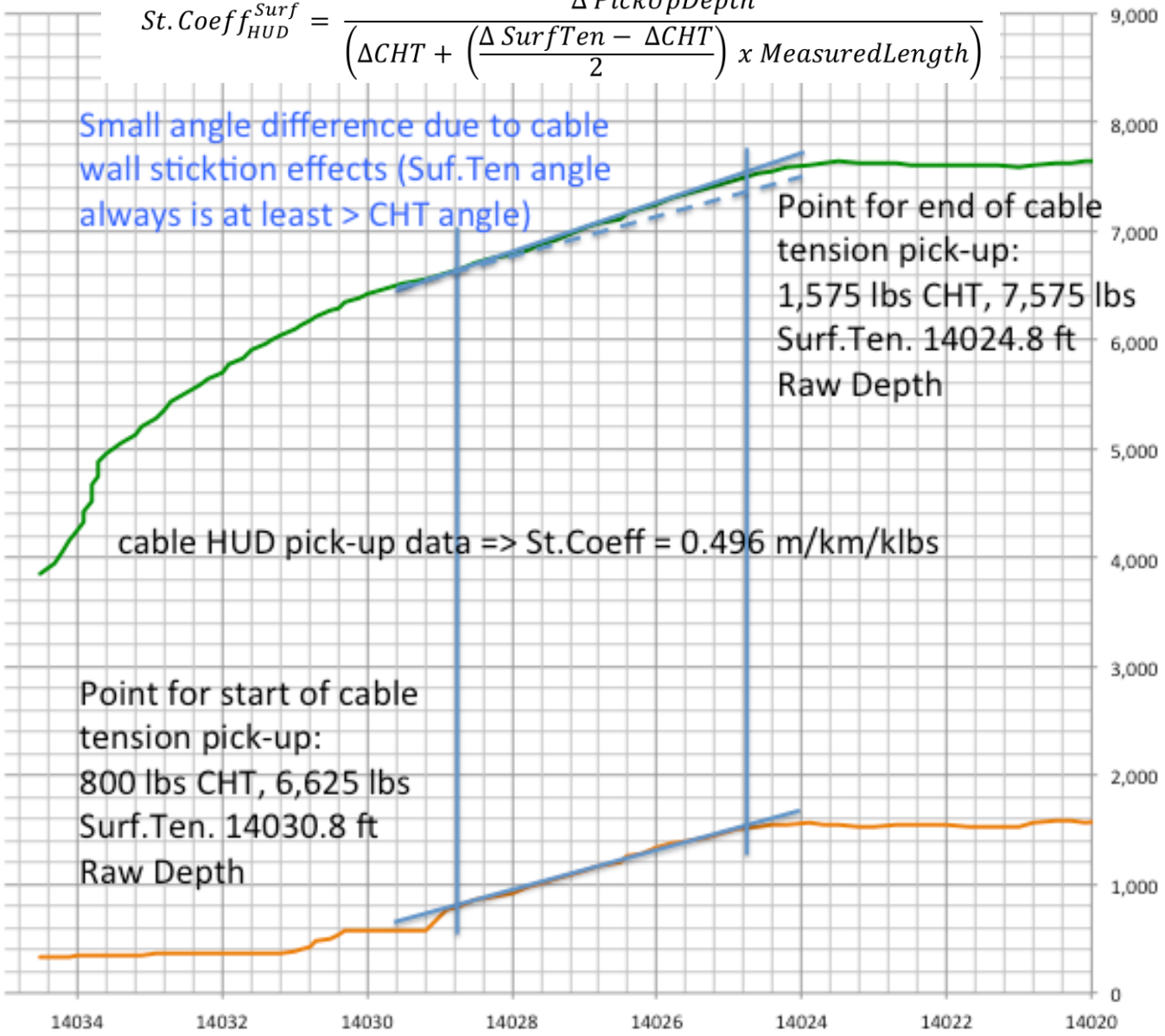
Stretch coefficient behaviour



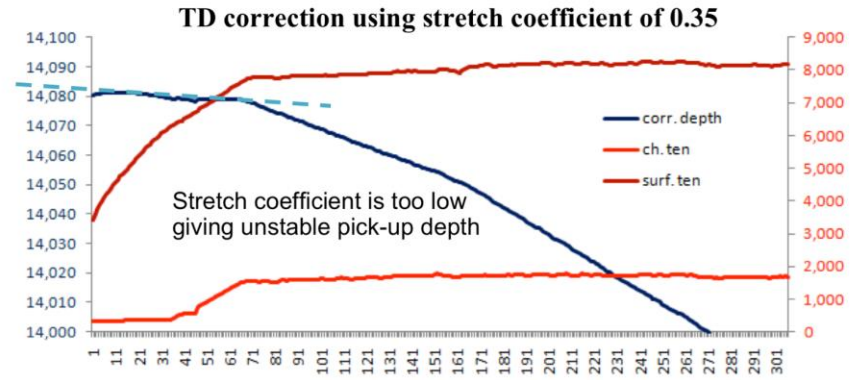
As wireline design complexity increases, the complexity of the stretch coefficient increases

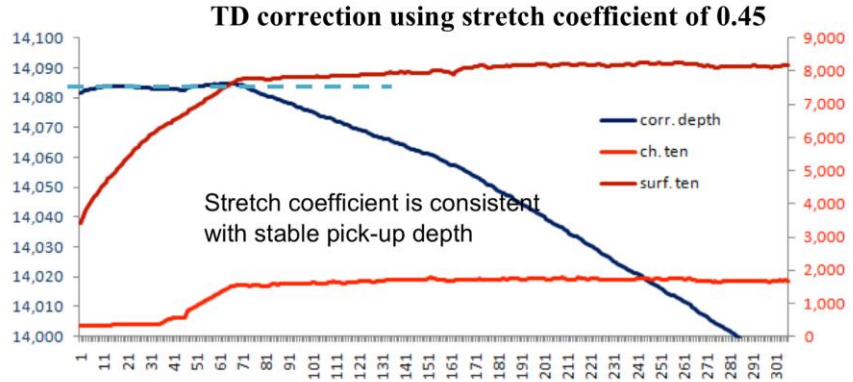
HUD st.coeff - example

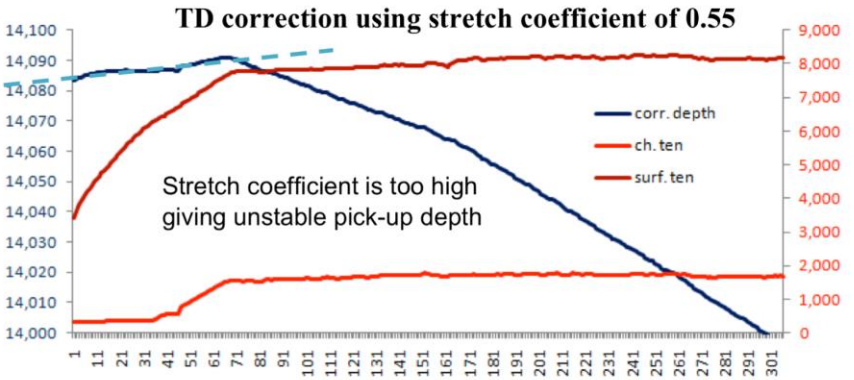
$$St.Coeff_{HUD}^{Surf} = \frac{\Delta\, PickUpDepth}{\left(\Delta CHT + \left(\frac{\Delta\, SurfTen - \Delta CHT}{2}\right) x\ MeasuredLength\right)}$$



HUD st.coeff testing

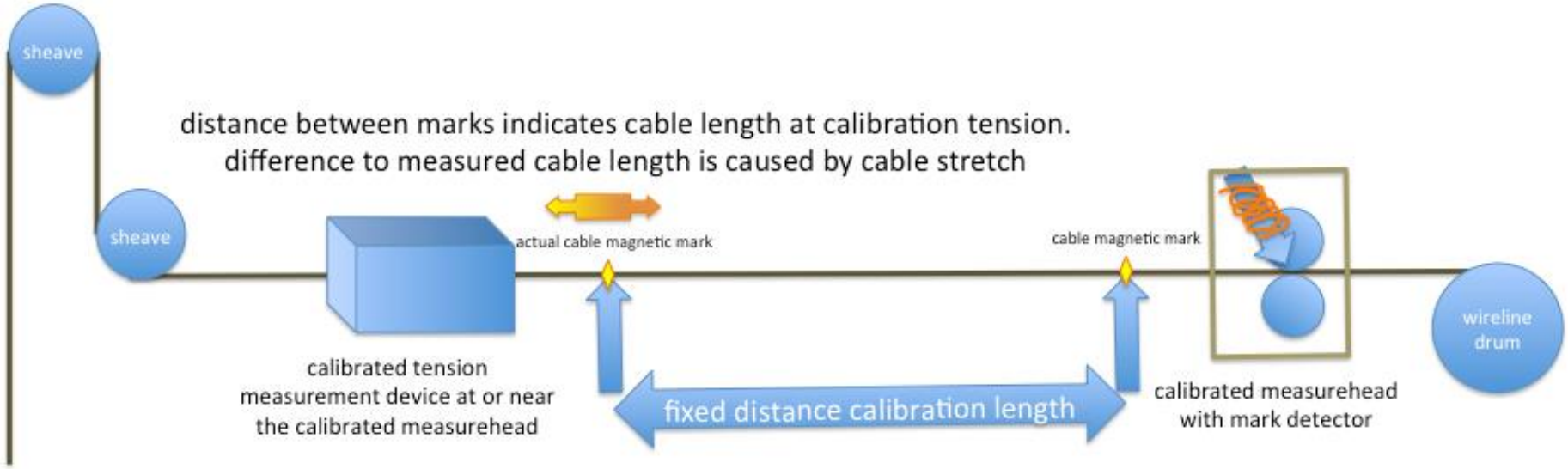






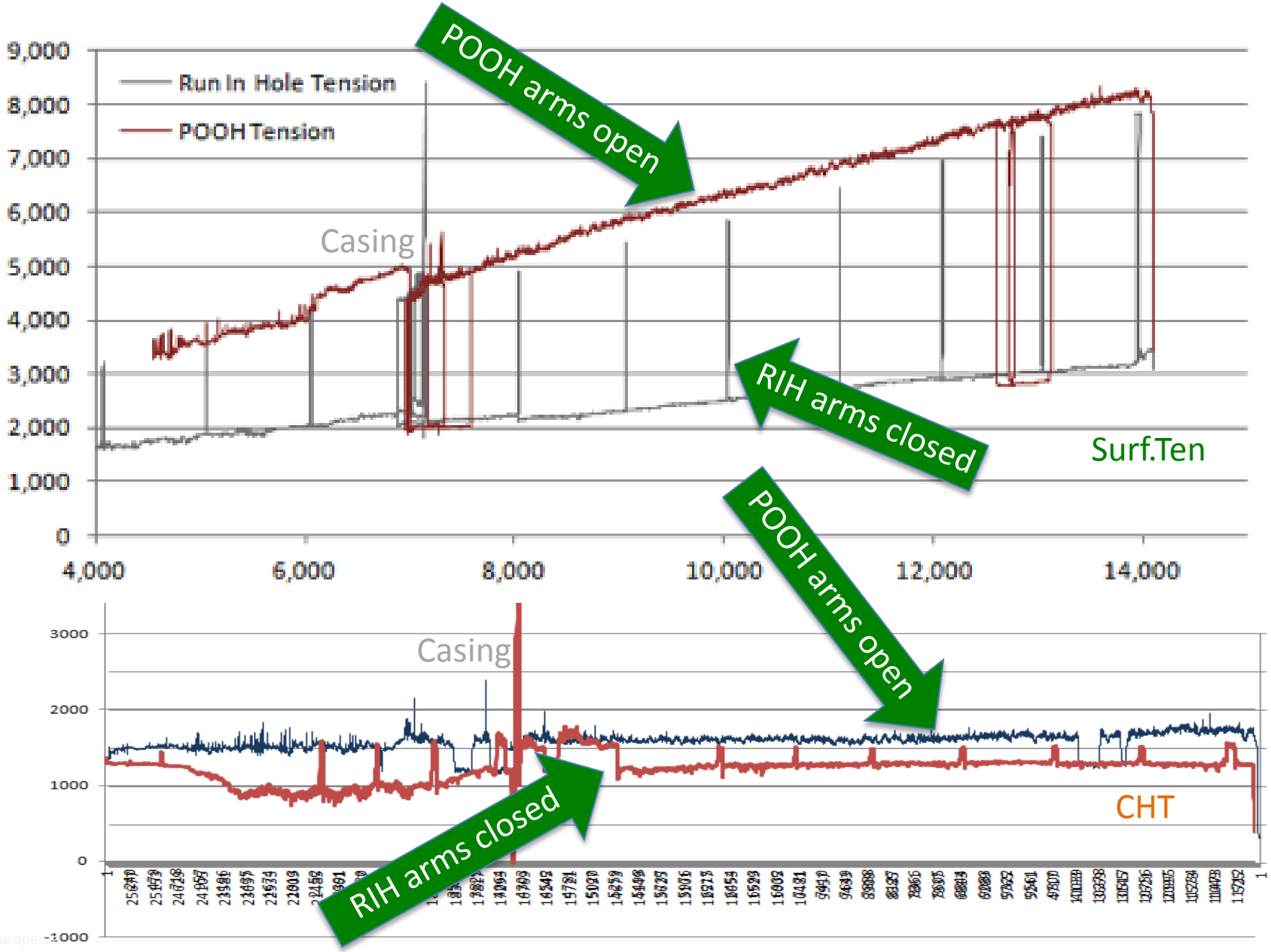
Magnetic mark defined st.coeff

Using a marked cable and a calibrated measurehead, St.Coeff and tension determines the inter-mark distance



This assumes that cable IPD has been worked out.

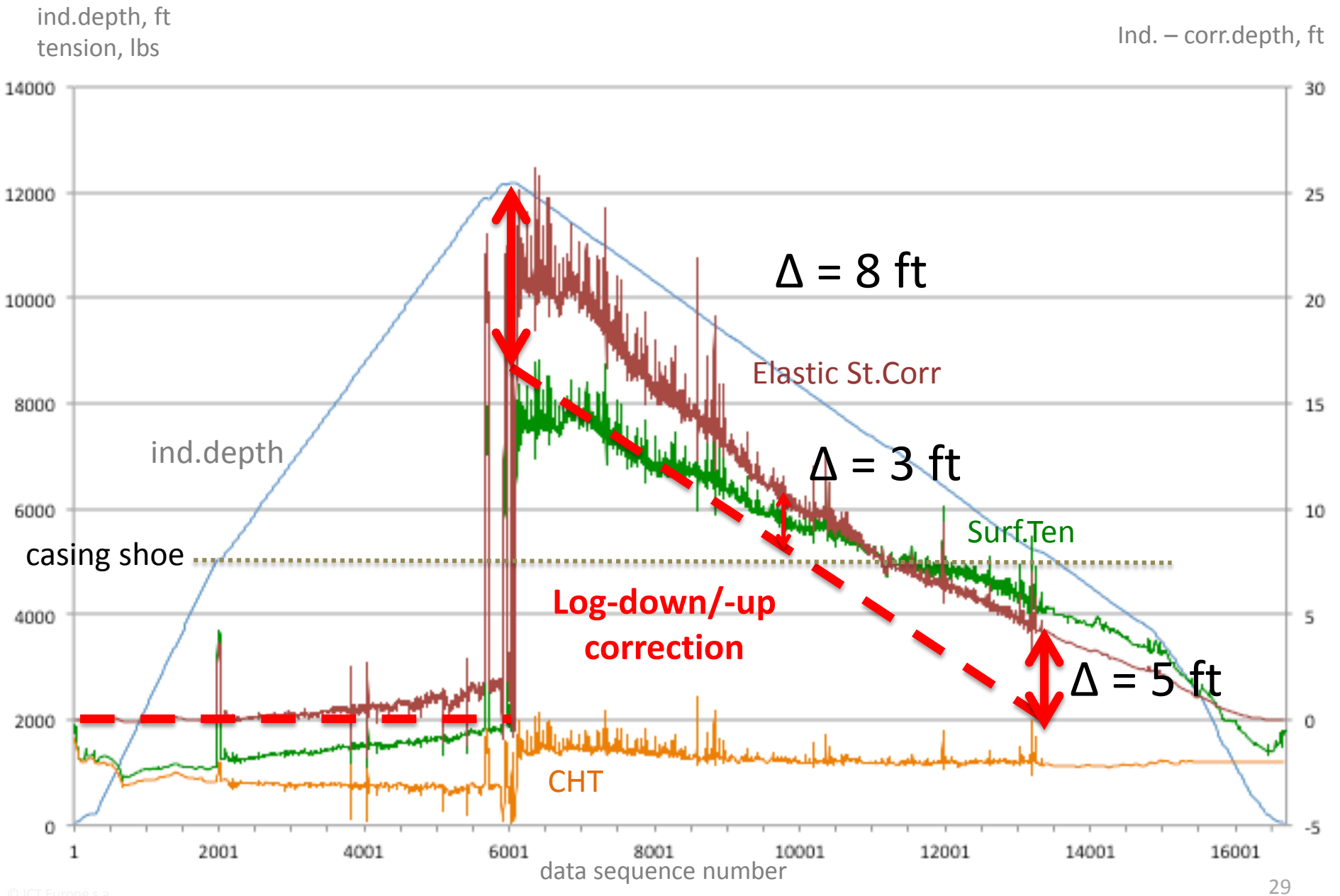
Way-point measurement method



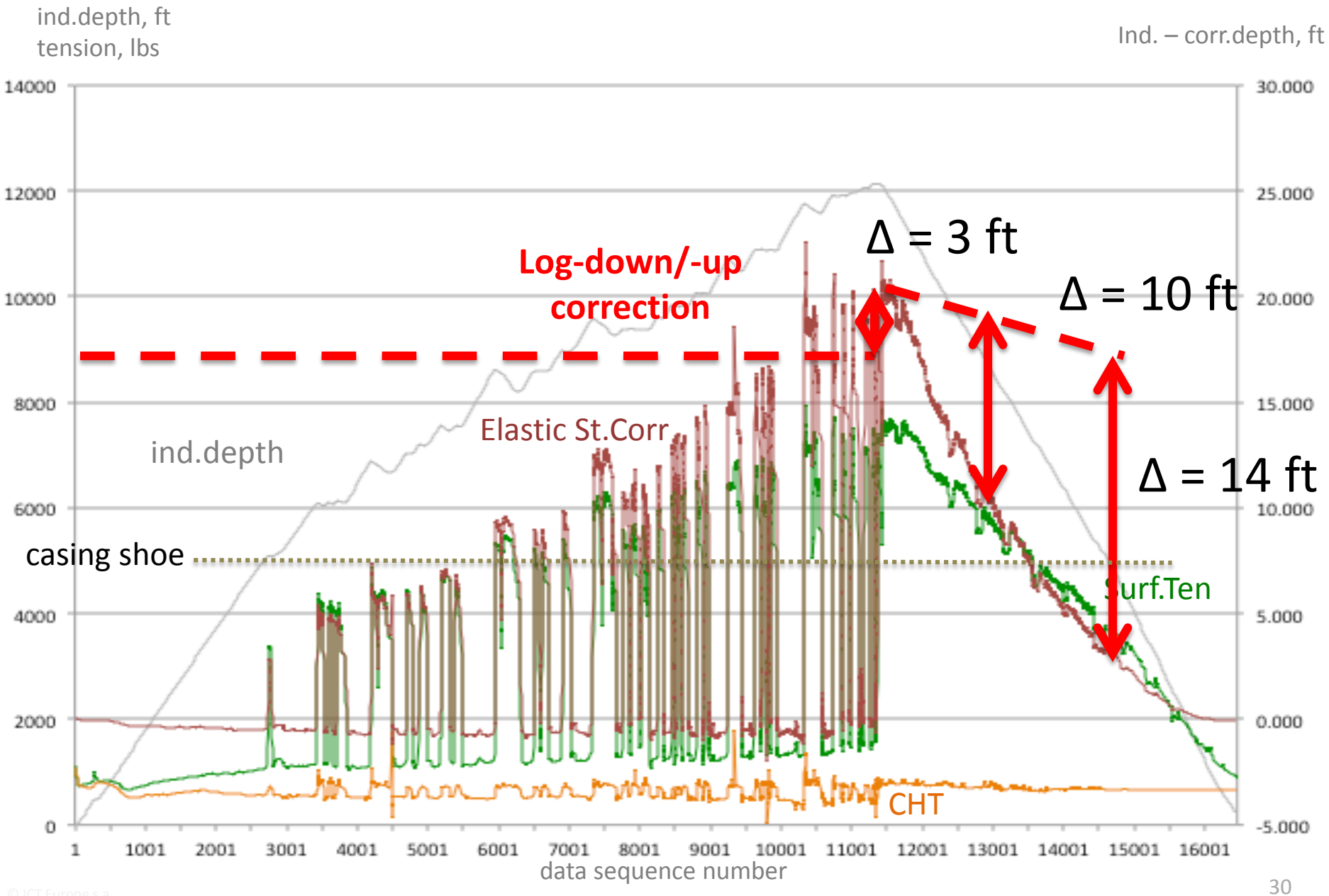
Available technologies and processes

- ✓ Calibrated Cable Length
- ✓ Cable calibration verification
- Thermal expansion
- Stretch Coefficient Calibration
- Stretch Coefficient Profiling
- ✓ HUD Stretch Coefficient
- ✓ Real Time Stretch Coefficient
- Straight Line Stretch Correction
- ✓ Way-Point Depth with Correction
- Way-Point Depth with Real-Time Stretch Coefficient

Simple case correction comparisons ??



Complex comparisons ??



Wrap up

TAH depth consortium (isn)

Joint activity service companies, operators

- *Main objectives: provide standards and recommended practices for TAH depth determination WLL and LWD*
- *Expand and hone this new WLL corrections method*
  - *Consider "wheels only" WLL*
  - *Further quantification uncertainties/errors needed*
- *Agree on methods for LWD stretch corrections*
  - *Obvious ISCWSA collaboration potential*

Conclusions

1. ***WLL and LWD need better along hole depths***
2. ***Proper corrections to get to real TAH (True Along Hole) depth for both LWD & WLL possible***
   - *New method shown for marked cable WLL*
   - *Better than 2 / 10000 achievable*
   - *TAH depth consortium can deliver all what is needed*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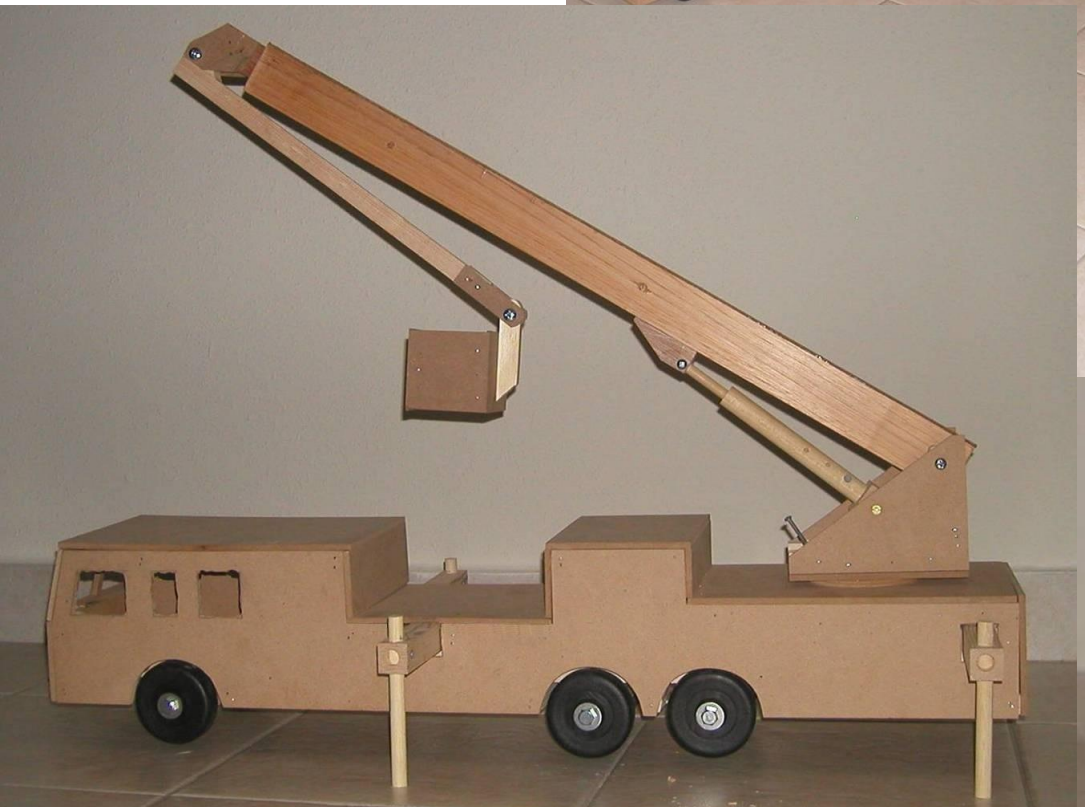
Bouwpakket houten brandweerauto

DIY fire truck model building kit



Section/LWD Run#:	8 ½”	Run#4
Depth difference:		
before correction:	12.3m	
after correction:	0.5m	
LWD log shift:	6.1m	
Wireline log shift:	-6.7m	
Improvement:	96%	

Taken from Chia, 2006