High-sensitivity cavitation monitoring

In most cases where a hard body passing through the trash rack or a similar occurrence causes a small amount of initial damage to a runner blade, the detrimental effects are cumulative: the initial damage causes cavitation, the cavitation causes erosion, the erosion intensifies the cavitation...

This makes early detection of any damage important.

Monitoring

A simple cavitation monitor yields only a (rather inaccurate) estimate of the total intensity of cavitation in the turbine.

In the initial phase of the damage development, the change in the mean total cavitation intensity is usually too small to be detected. Thus, a simple cavitation monitor will typically fail to detect the initial small damage.

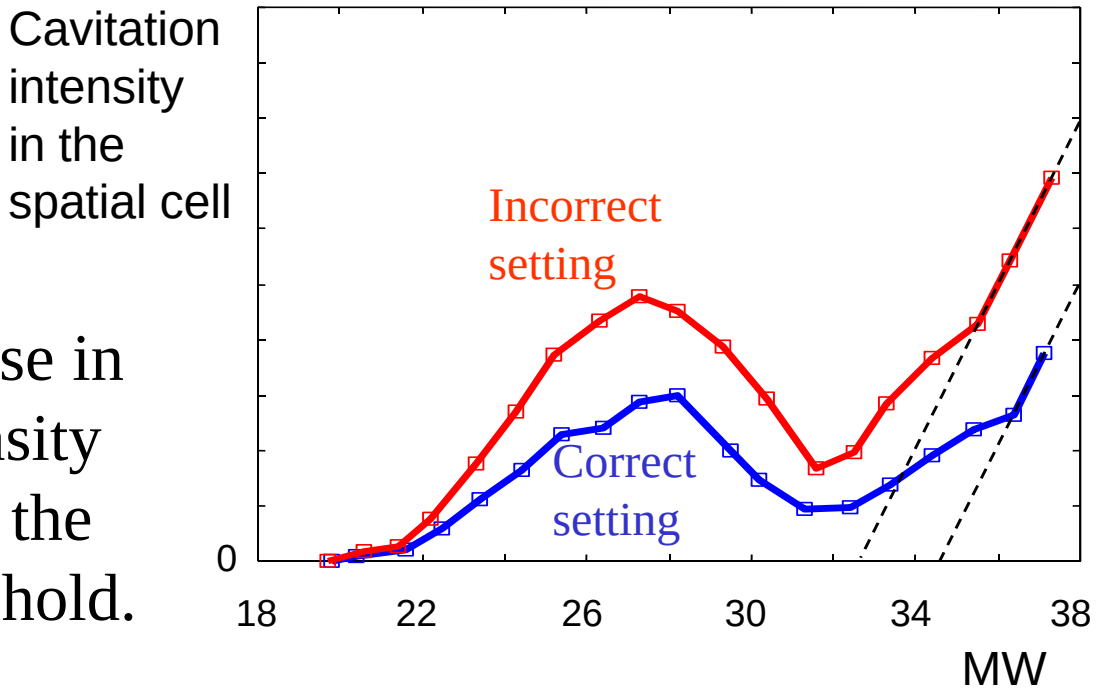
Monitoring

The ability of the multidimensional monitor to distinguish between cavitation developed in separate water volumes, makes it more sensitive. An experiment showing this was made on a bulb unit (see next figure).

One guide vane was shifted slightly from its optimal setting. The resulting change of cavitation is looked for in the total intensity and in the intensity in the related spatial cell.

Monitoring

There was no observable change in the total intensity, but the change in the cell was clear:



Note the increase in cavitation intensity and the shift of the cavitation threshold.

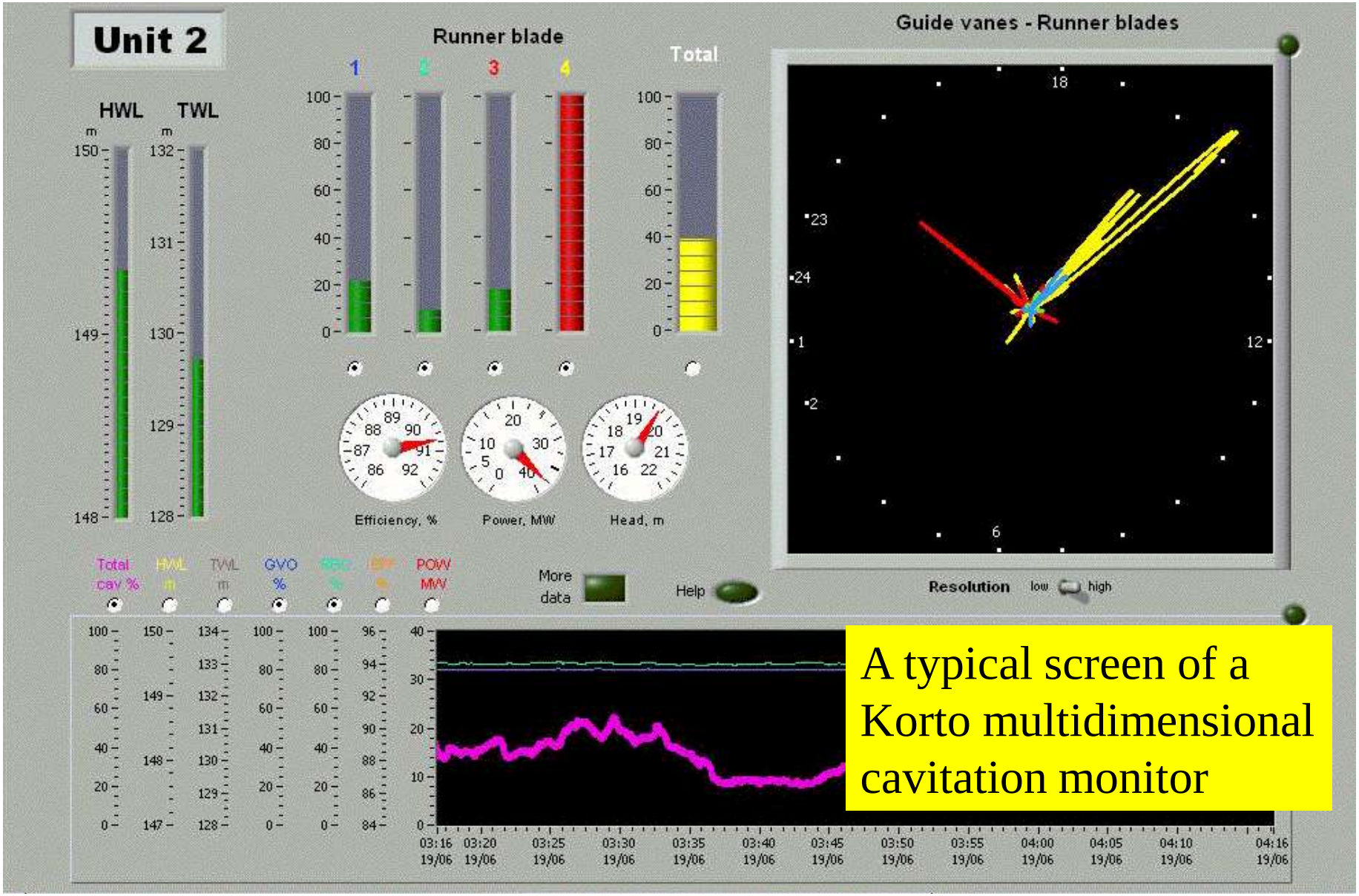
Monitoring

The multidimensional cavitation monitor distinguishes between turbine parts. It delivers independent estimates of the intensity of cavitation close to each runner blade. Thus, the small initial change is not compared to the total intensity of all the blades but, instead, to the intensity of the damaged blade only. This makes the monitoring sensitivity higher by a factor equal to the number of runner blades.

Monitoring

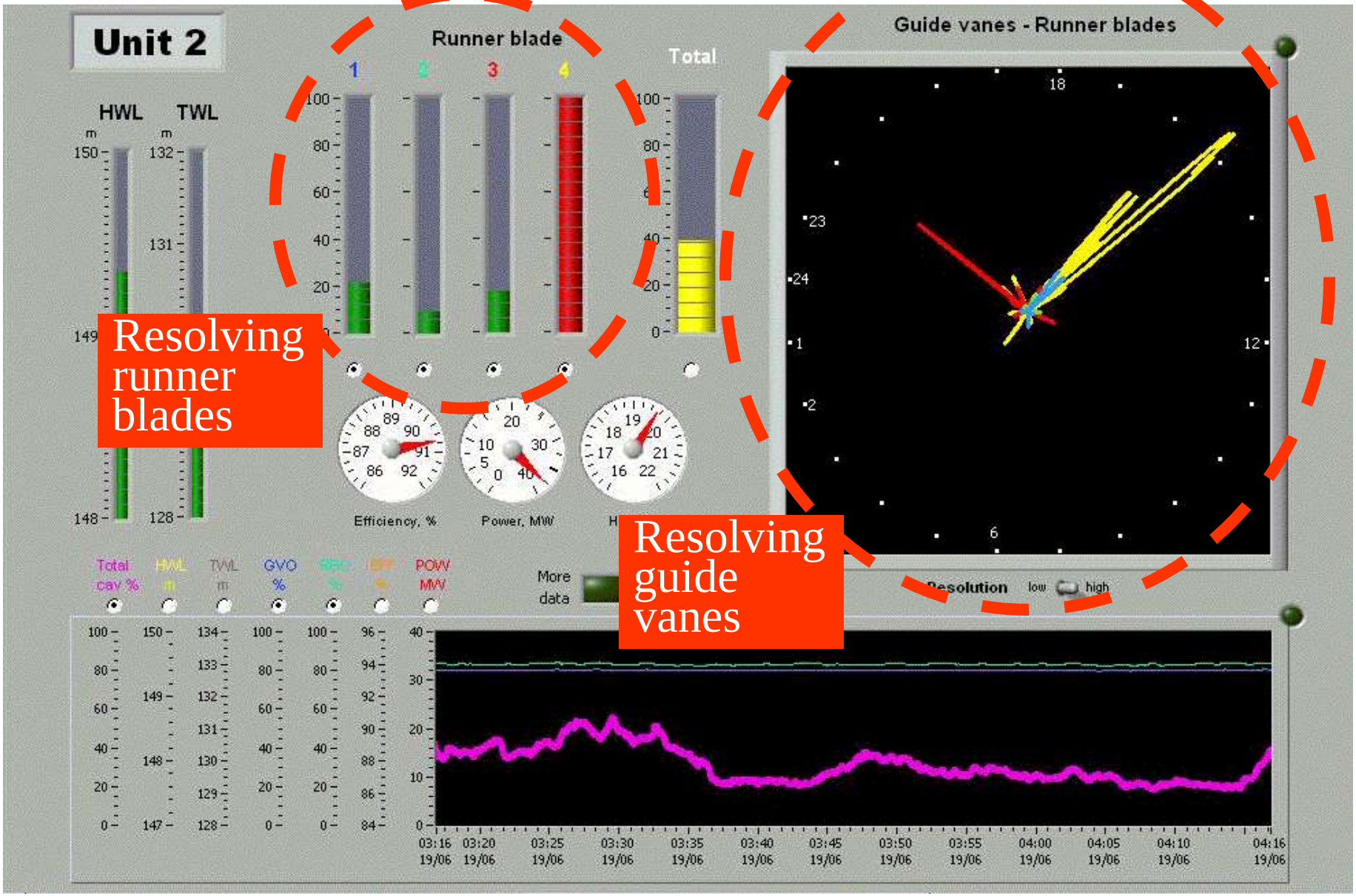
The multidimensional cavitation monitor also distinguishes between the contributions to the cavitation on one runner blade that result from the flow disturbance provoked by each guide vane. If the cause of the cavitation change has to do with the degradation of a guide vane, the sensitivity will be higher by a factor equal to the number of runner blades times the number of guide vanes.

Monitoring

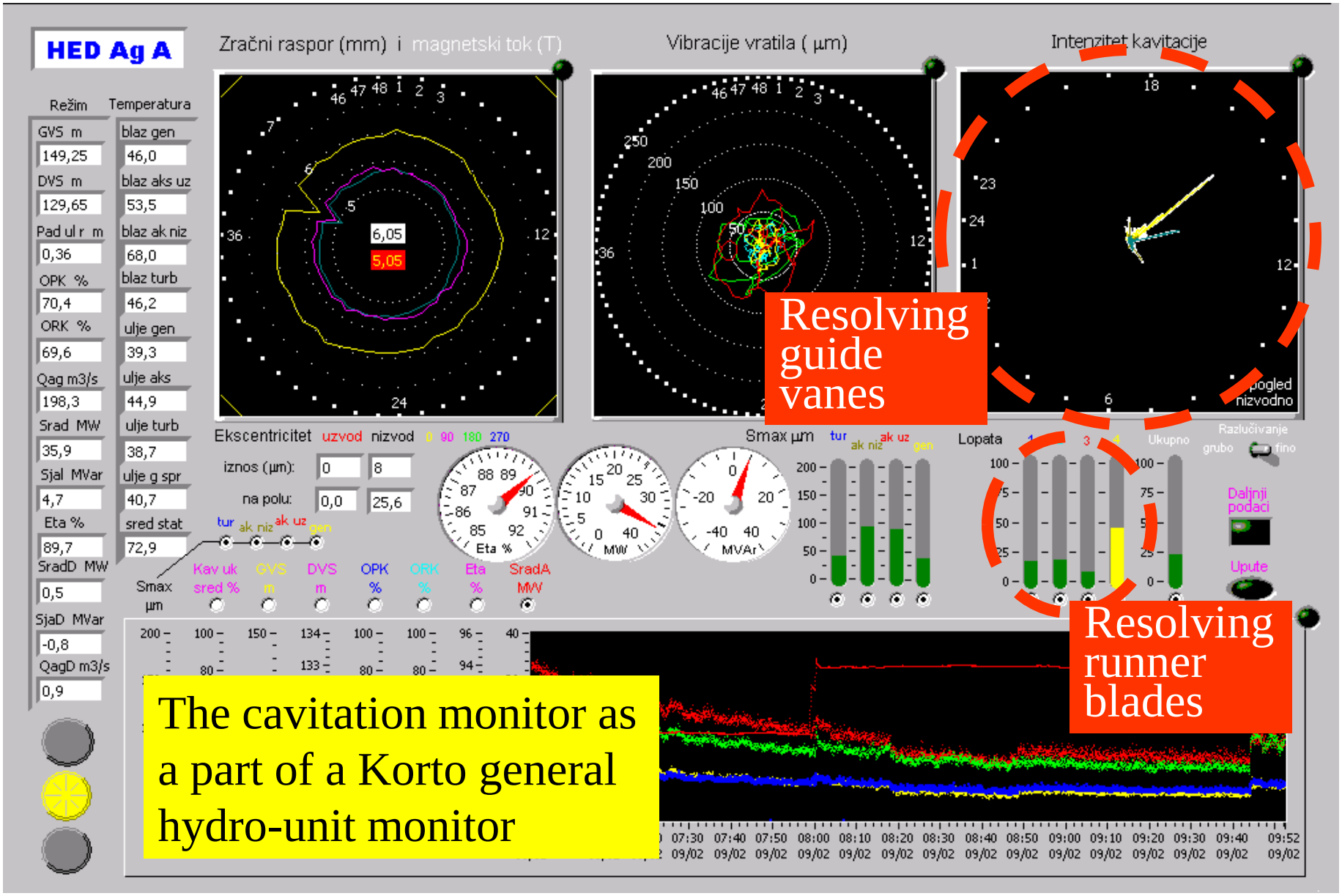


A typical screen of a Korto multidimensional cavitation monitor

Monitoring


Unit 2
Runner blade
Total
HWL
TWL
Guide vanes - Runner blades
Resolving runner blades
Resolving guide vanes
Efficiency, %
Power, MW
More data
Resolution
low
high

Monitoring


HED Ag A
Zračni raspor (mm) i magnetski tok (T)
Vibracije vratila (µm)
Intenzitet kavitacije
Režim
Temperatura
GVS m
149,25
DVS m
129,65
Pad ul r m
0,36
OPK %
70,4
ORK %
69,6
Qag m3/s
198,3
Srad MW
35,9
Sjal MVar
4,7
Eta %
89,7
SradD MW
0,5
SjaD MVar
-0,8
QagD m3/s
0,9
blaz gen
46,0
blaz aks uz
53,5
blaz ak niz
68,0
blaz turb
46,2
ulje gen
39,3
ulje aks
44,9
ulje turb
38,7
ulje g spr
40,7
sred stat
72,9
6,05
5,05
Ekscentricitet uzvod nizvod
iznos (µm):
na polu:
tur ak niz ak uz gen
Smax µm
Kav uk sred %
GVS m
DVS m
OPK %
ORK %
Eta %
SradA MW
Eta %
MW
MVAr
Smax µm
Lopata
Ukupno
Razlučivanje
grubo
fino
Daljnji podaci
Upute
Resolving guide vanes
Resolving runner blades
The cavitation monitor as a part of a Korto general hydro-unit monitor

Applications of the cavitation monitor

- Acceptance test
  - check of the cavitation threshold height
  - check of the true cavitation quality of a prototype turbine
  - check of the cavitation predictions based on model tests
- Assessment of the results of refurbishment, uprating and other changes on a turbine
- Comparison of turbines

- Diagnosis of the causes of non-optimal turbine cavitation characteristics, check of repair results
- Monitoring cavitation in a turbine, early detection of detrimental effects
- Optimisation of the turbine and plant operation for minimal cavitation erosion
- Optimisation of the overhaul schedule
- Diagnosis of other dynamic processes by means of cavitation