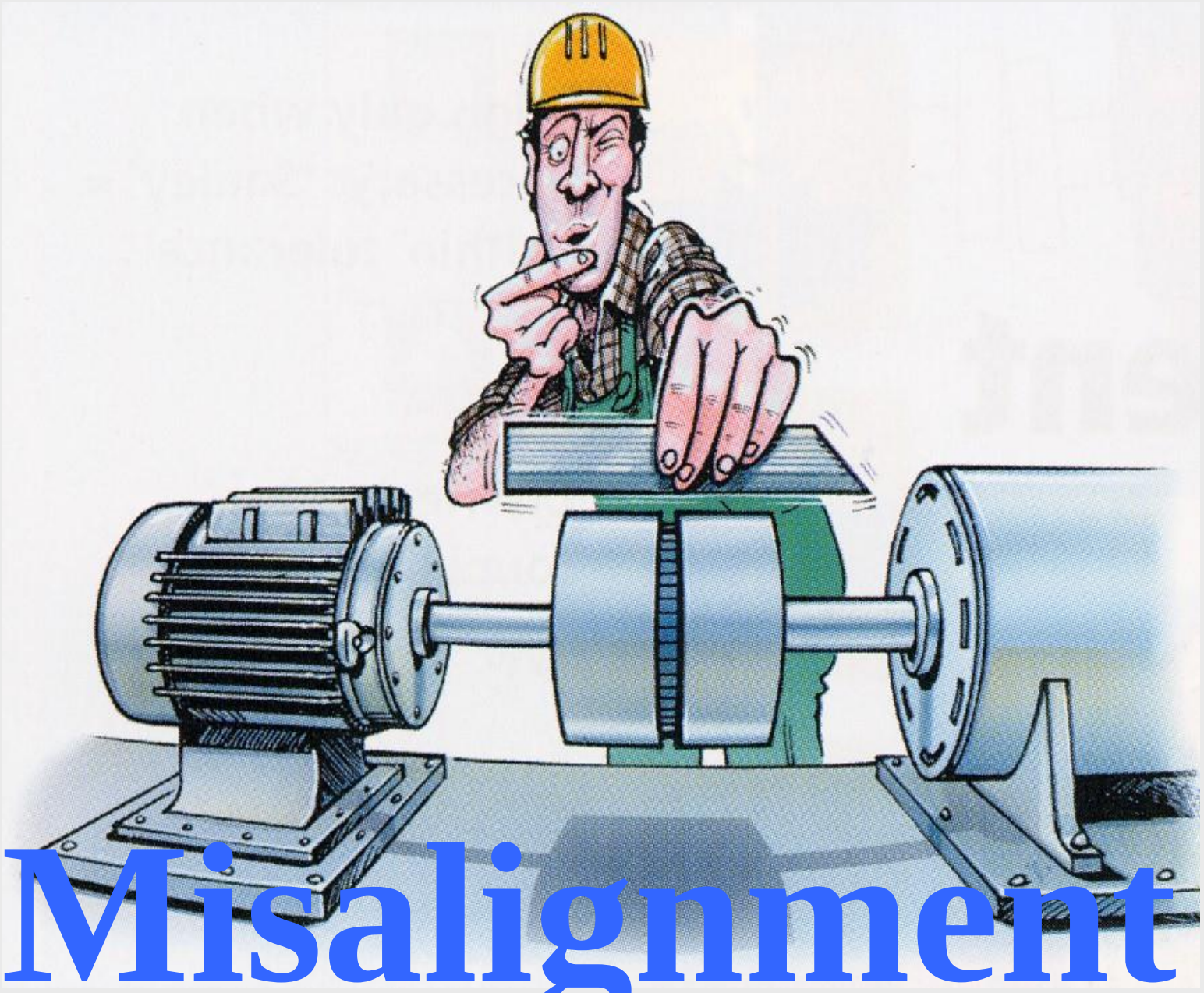
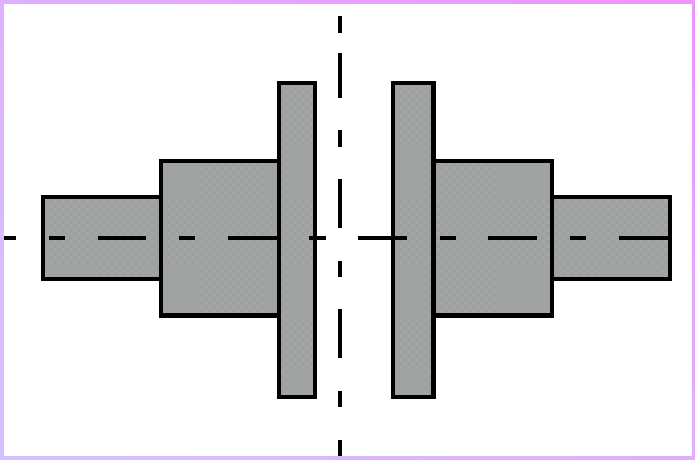
TRAINING PROGRAM ON ALIGNMENT



Misalignment

What is Alignment?

It is the process of positioning two (or more) machines that are coupled, so that Center lines of rotating shafts form a single line, when the machines are working at normal operating temperature.



Causes Of Misalignment

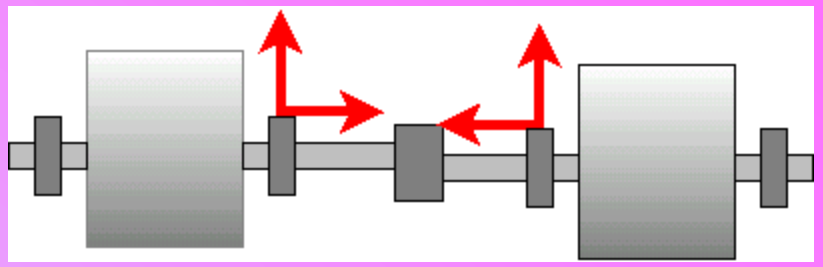
- Thermal expansion - Most machines align cold.
- Machine vibrations.
- Forces transmitted to the machine by pipe or
- support structure.
- Soft foot.
- Direct coupled machined are not properly aligned.
- Poor workmanship.

Effects Of Misalignment

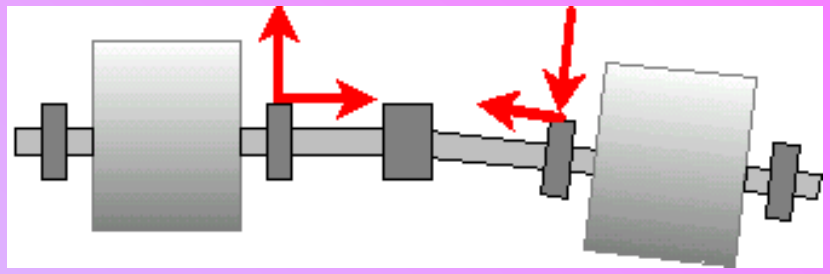
- More than 50% problems are due to misalignment.
- Causes vibration on the machine
- Vibration destroys critical parts of machines like bearings, gears, seals, coupling etc.
- Breaks lubricant film inside the bearing and increase friction.
- Increases load on the bearing.
- Increase 2 - 17% power consumption.
- Generates heat inside the coupling.

Types Of Misalignment

1. Off set

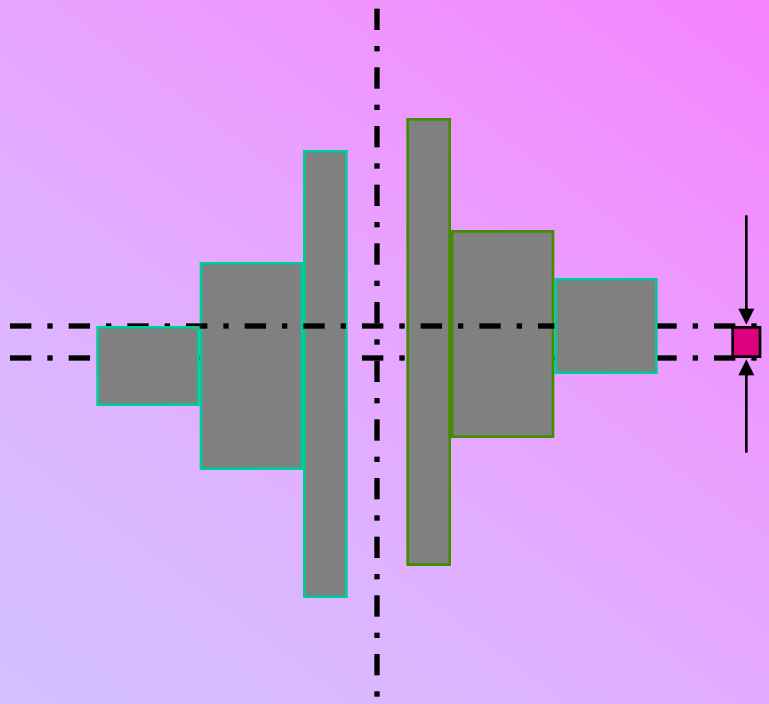


2. Angular



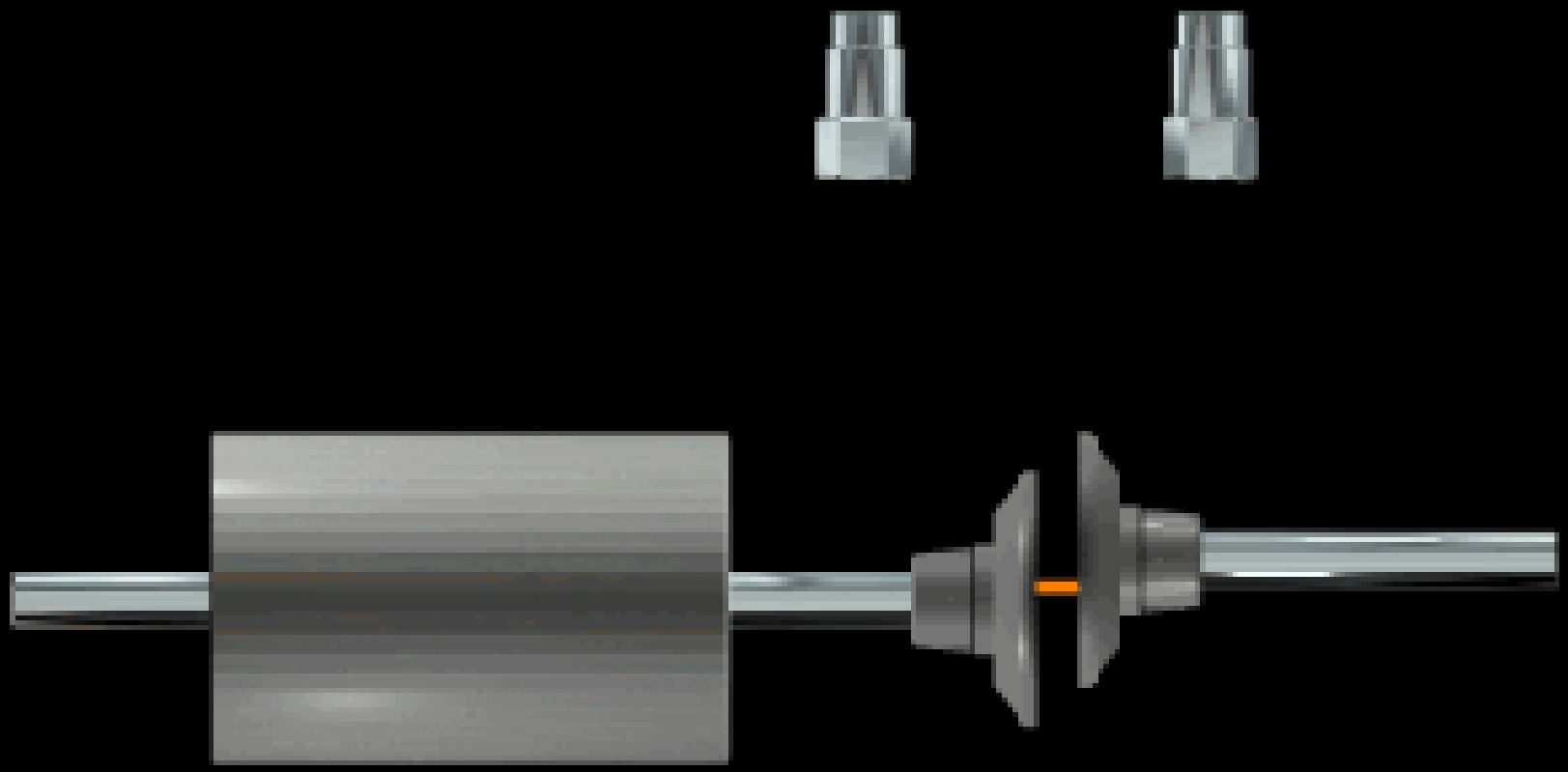
3. Skew - Combination of offset & angular

Offset Misalignment



Offset Misalignment

If the misaligned shafts centerlines are parallel but not coincident, then the misalignment is said to be parallel (or offset) misalignment.

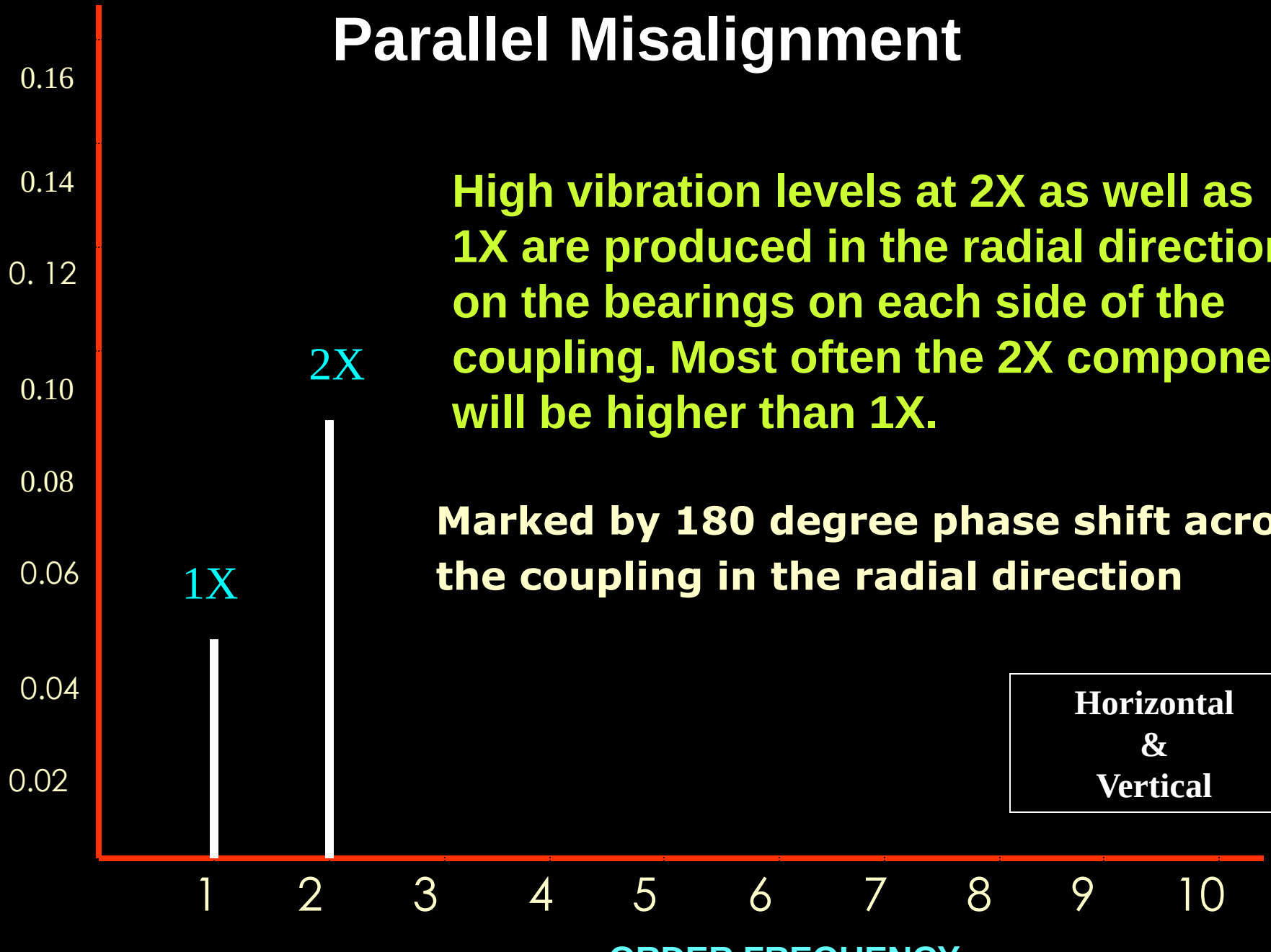


Offset (Parallel) Misalignment

Offset Misalignment

Offset (Parallel) misalignment produces both a shear force and bending moment on the coupled end of each shaft.

Parallel Misalignment

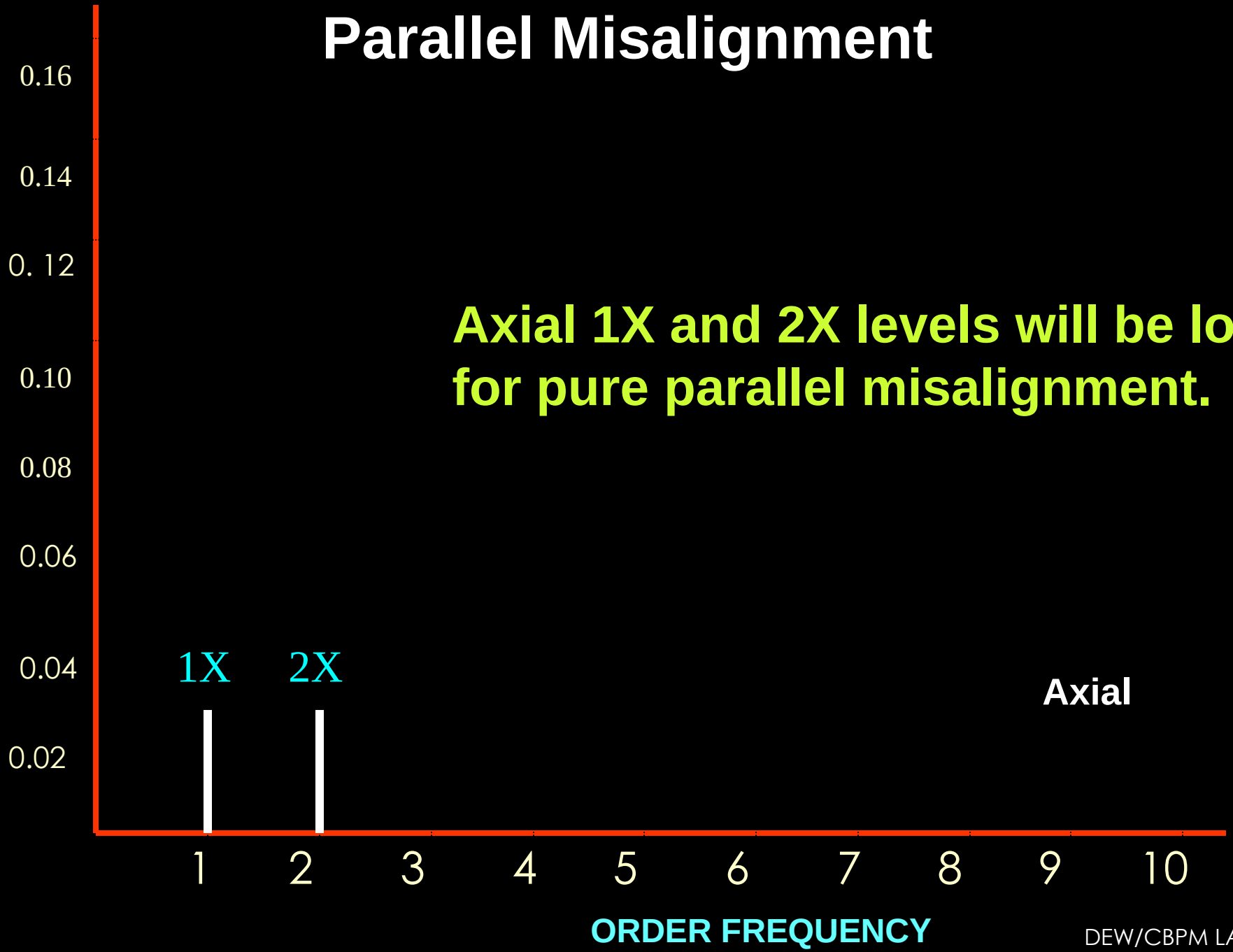


High vibration levels at 2X as well as 1X are produced in the radial directions on the bearings on each side of the coupling. Most often the 2X component will be higher than 1X.

Marked by 180 degree phase shift across the coupling in the radial direction

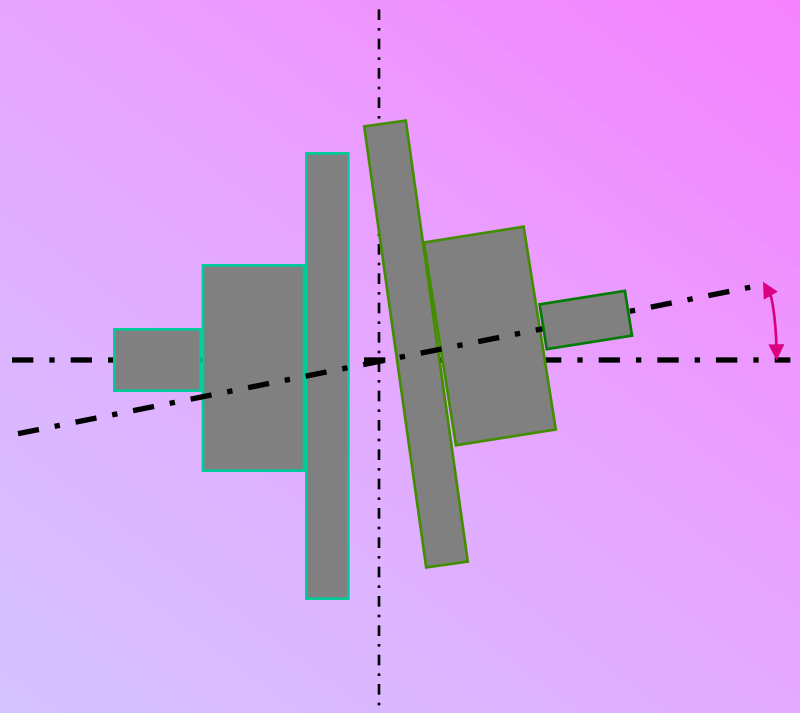
Horizontal & Vertical

Parallel Misalignment



Axial 1X and 2X levels will be low for pure parallel misalignment.

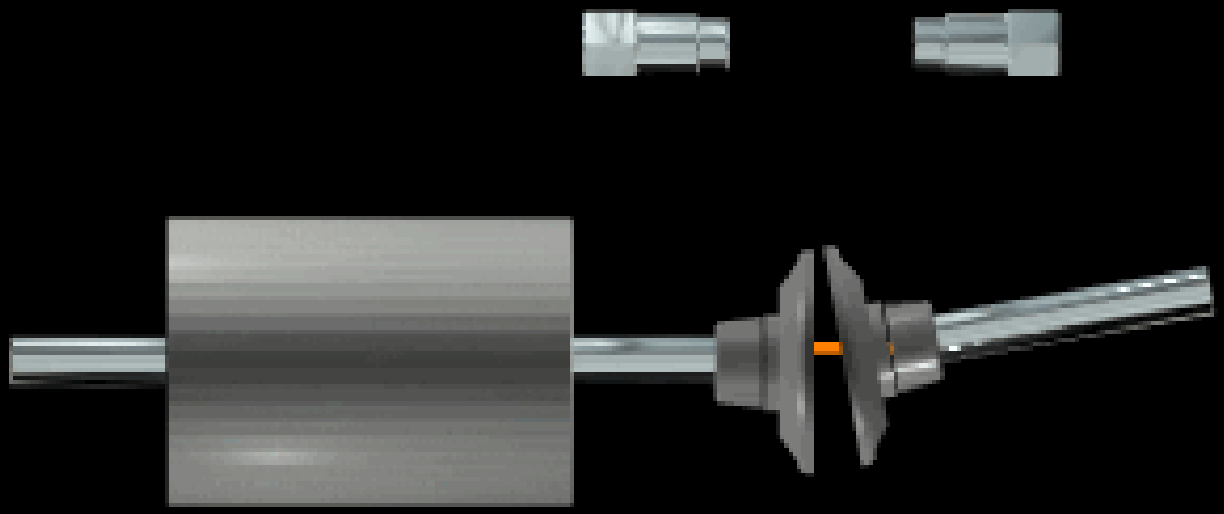
Angular Misalignment



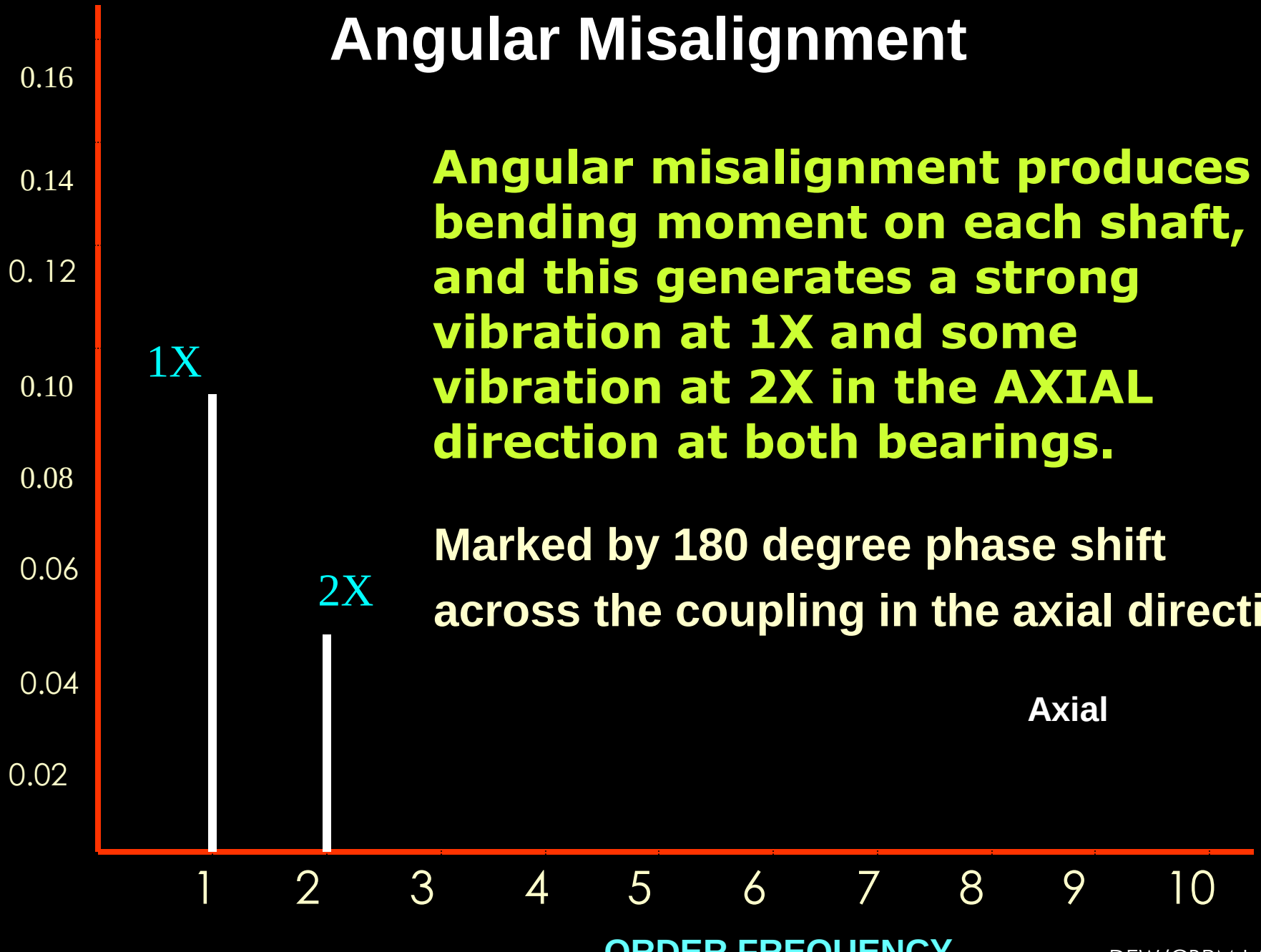
Angular Misalignment

If the misaligned shafts meet at a point but are not parallel, then the misalignment is called angular misalignment.

Angular Misalignment



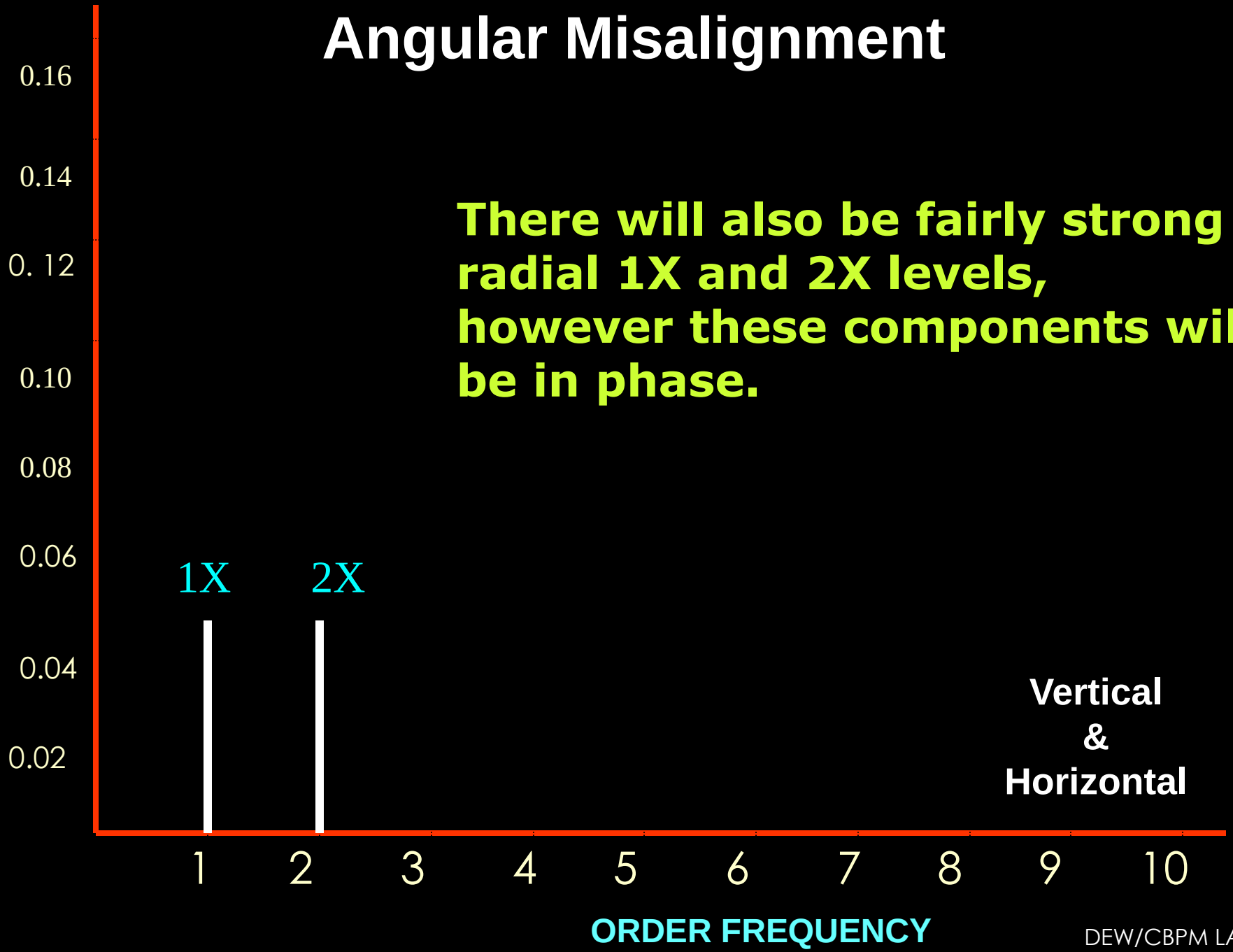
Angular Misalignment



Angular misalignment produces a bending moment on each shaft, and this generates a strong vibration at 1X and some vibration at 2X in the AXIAL direction at both bearings.

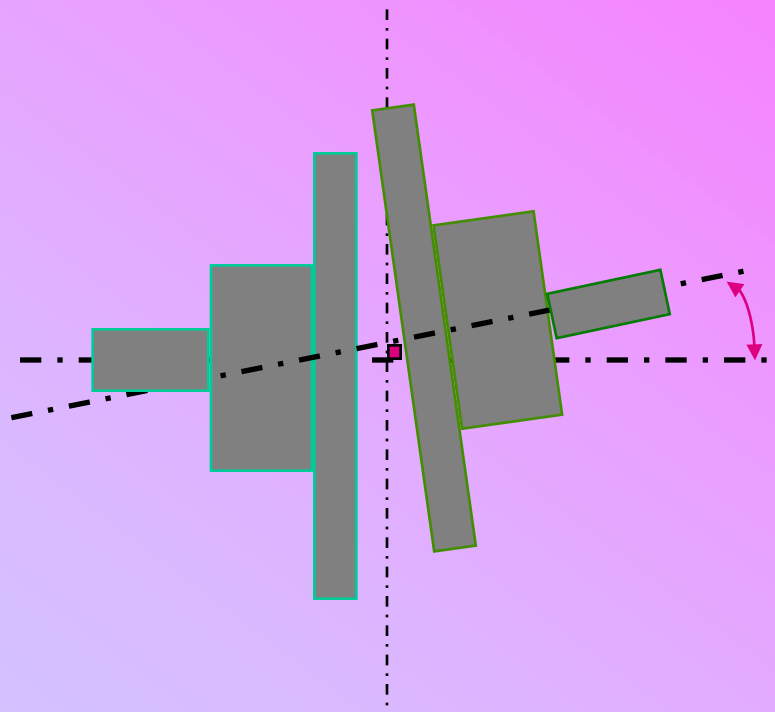
Marked by 180 degree phase shift across the coupling in the axial direction

Angular Misalignment



There will also be fairly strong radial 1X and 2X levels, however these components will be in phase.

Skewed Misalignment



Scientific

Diagnosis Of Misalignment

1. Vibration Spectrum Analysis
2. Vibration Phase Analysis
3. Wear Particle Analysis

1. Vibration Spectrum Analysis

Angular - Axial vibration at 1X RPM

Offset - Radial vibration at 2X or 3X RPM

Harmonics (3X-10X) generates as severity increases.

- If the 2X amplitude more than 50% of 1X then coupling damage starts.

- If the 2X amplitude more than 150% of 1X then machine should be stopped for correction.

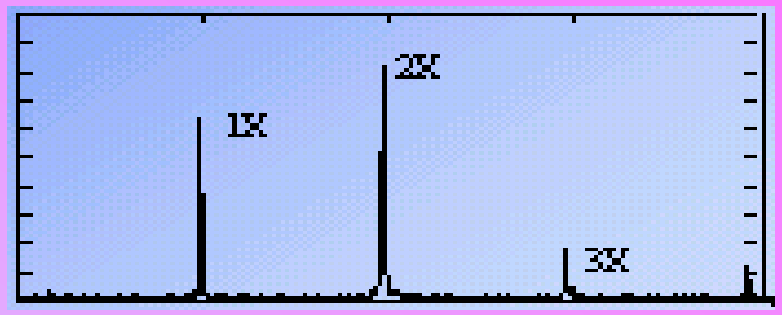
2. Vibration Phase Analysis

Angular - 180^0 phase shift in the axial direction across the coupling.

Offset - 180^0 phase shift in the radial direction across the coupling. 0^0 to 180^0 phase shift occur as the sensor moves from horizontal to the vertical direction of the same machine.

Skew - 180^0 phase shift in the axial or radial direction across the coupling.

Vibration Spectrum Analysis..Recap..



Angular - Axial vibration at 1X RPM

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Harmonics (3X-10X) generates as severity increases.

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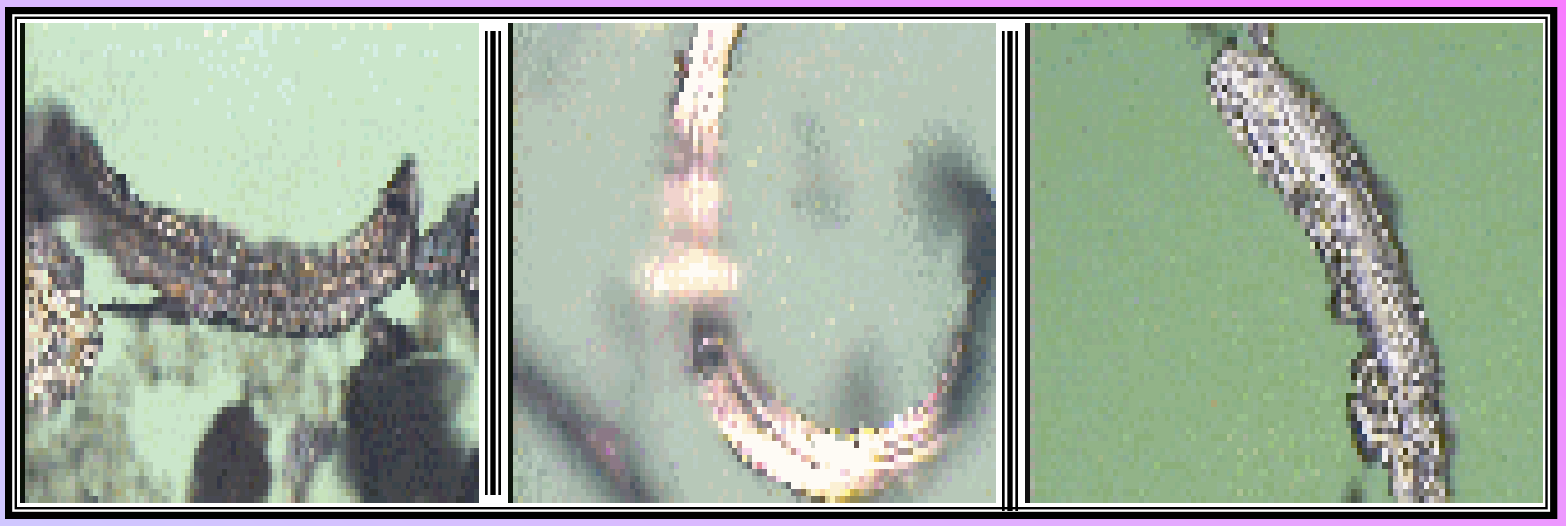
If the 2X amplitude more than 150% of 1X then machine should be stopped for correction.

3. Wear Particle Analysis

Curly cutting wear particle of 5:1 to 50:1 aspect ratio.



Types Of Couplings

Flexible : Pin bush, Tyre, Love joy,
ESBI Valkan tyre

Semi Flexible : Fluid

Rigid : Geared, Resilient

Flexible Coupling

Can flexible coupling take misalignment?

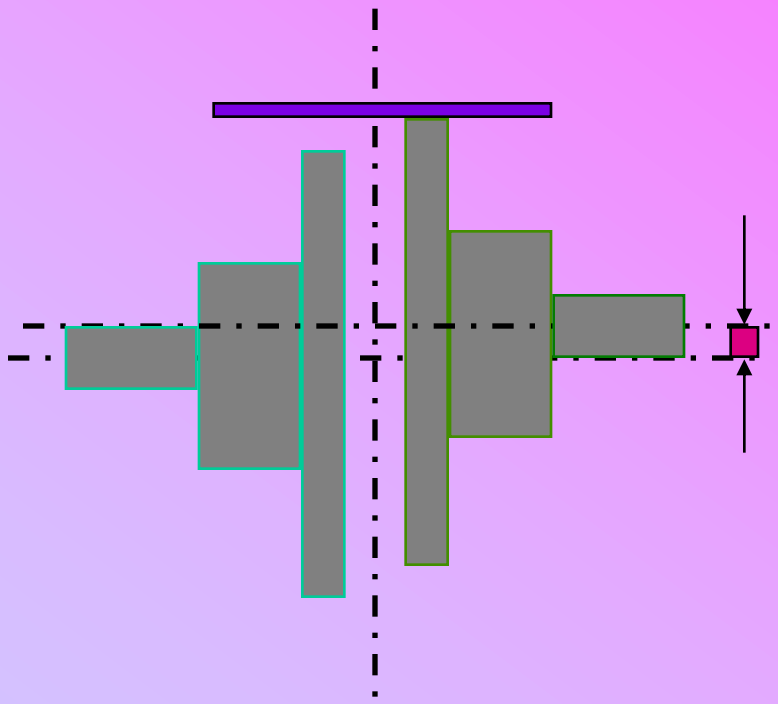
Flexible coupling can be used to take minor misalignment but it will generate heat and flexible members will fail prematurely.

Alignment Methods

1. Rough Alignment
   - (a) Using straight edge
   - (b) Twin wire method
2. Precision Alignment
   - (a) Face & Rim
   - (b) Reverse indicator

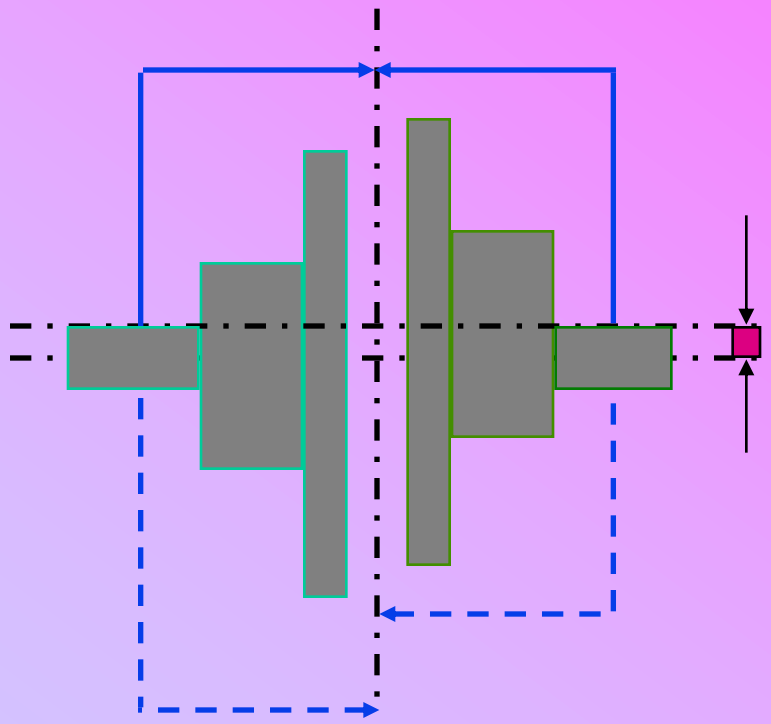
Rough Alignment

Using straight edge



Rough Alignment

Using twin wire



Face & Rim Method

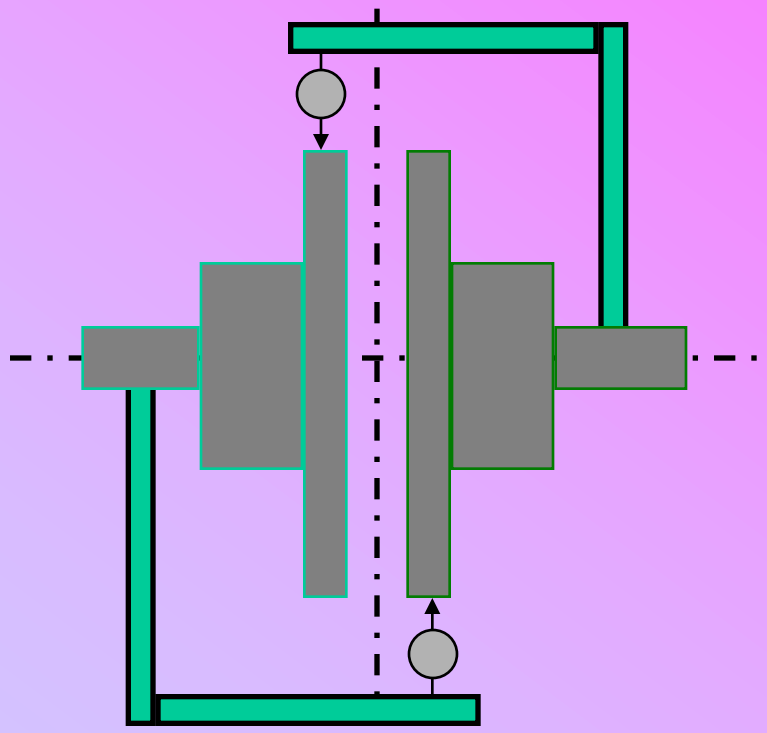
Advantages:

1. Good for large dia. coupling hubs where the shafts are close together.
2. To be used where one of the shafts can not rotate during alignment.
3. Easy to use.

Disadvantages:

1. Difficult to take face readings, if there is axial float in the shaft.
2. Requires removal of coupling spool.
3. More complex alignment calculation.

Reverse Indicator Method



Reverse Indicator Method

Advantages:

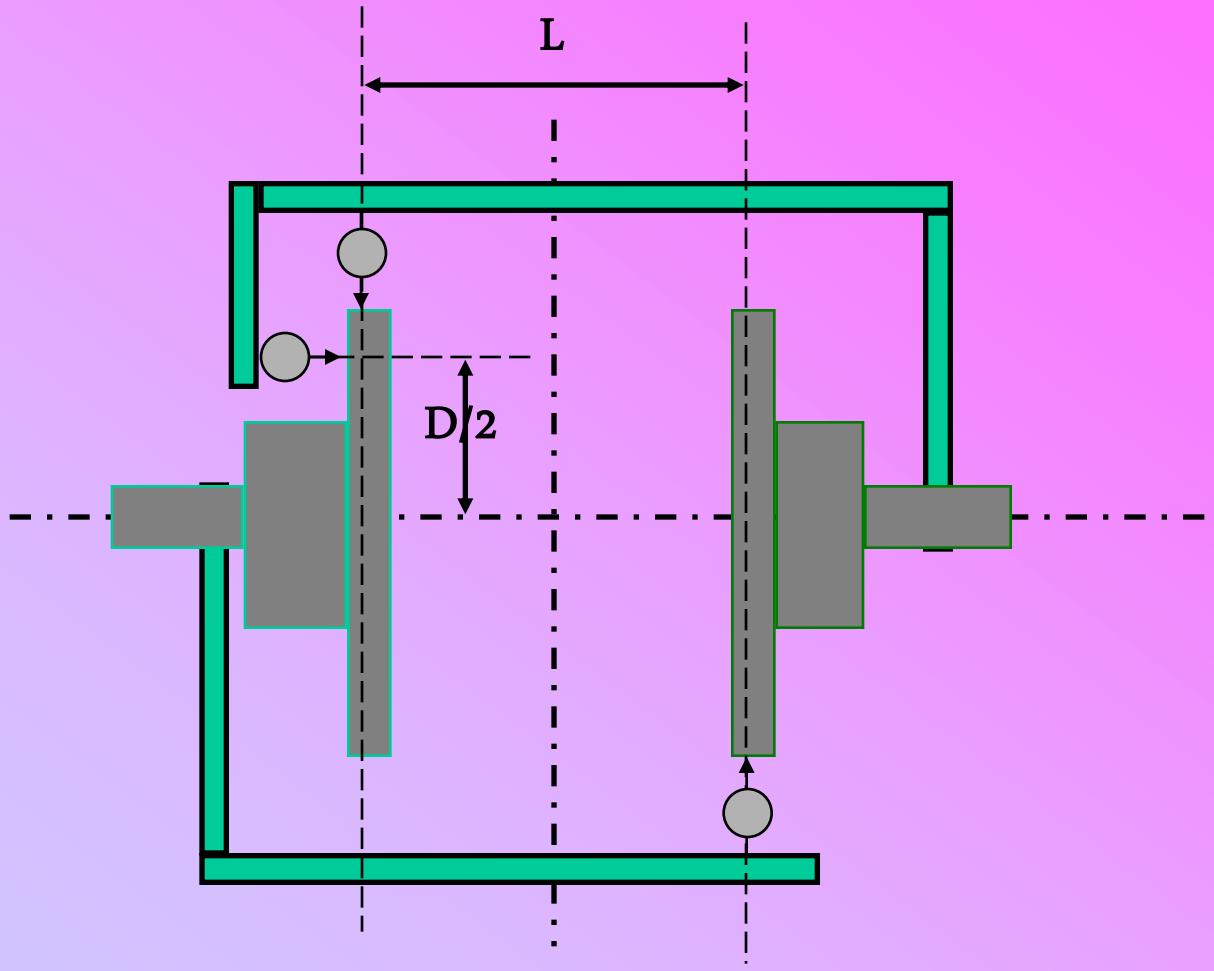
1. More accurate than face & rim method.
2. Readings are not affected by axial float.
3. Possible to keep the coupling spool.

Disadvantages:

1. Both shafts have to be rotated.
2. Should not be used on close coupled shafts.
3. Difficult to take readings on long shaft.

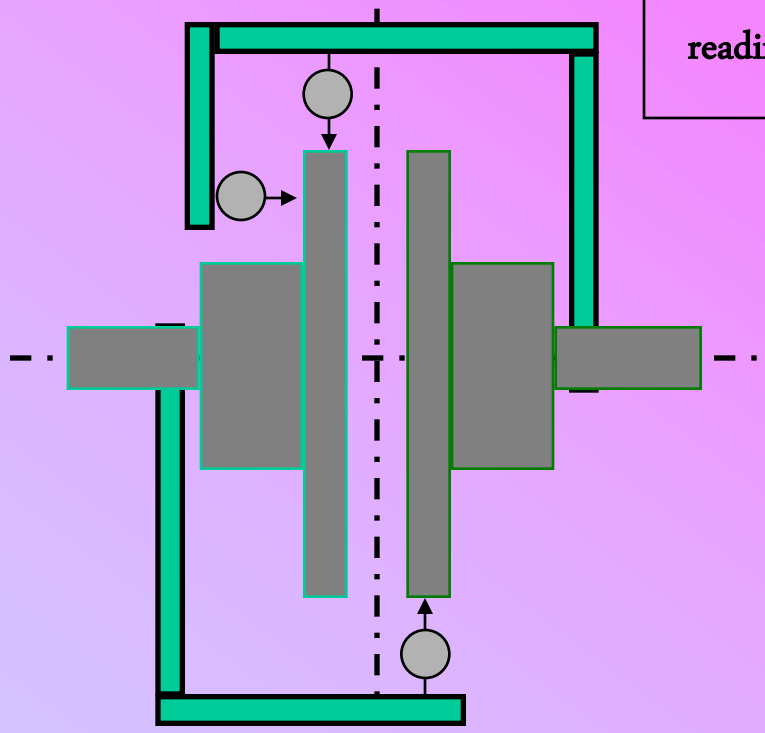
Which Method To Be Used?

If L > D Reverse Indicator



Combination Method

Calculation can be made for each of the method to verify the readings.



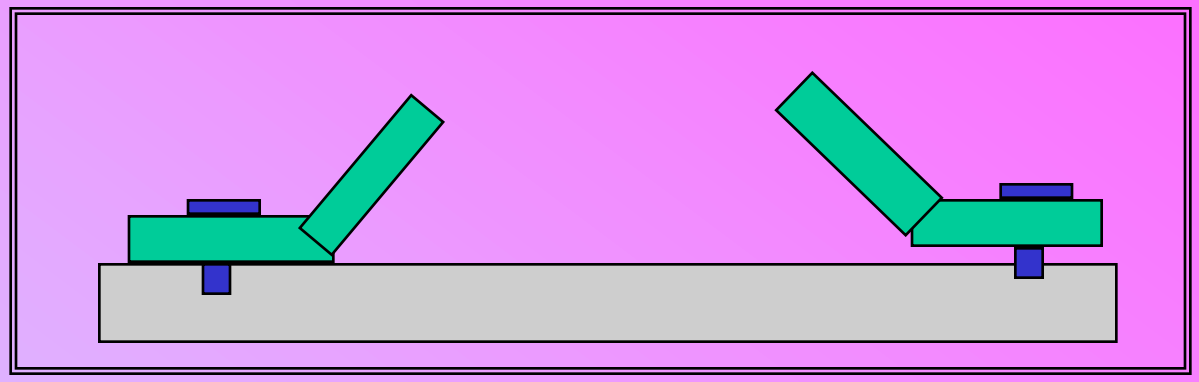
Alignment Tolerance

	Off Set	Angular
RPM	mm	mm / 100 mm
0000 - 1000	0.13	0.10
1000 - 2000	0.10	0.08
2000 - 3000	0.07	0.07
3000 - 4000	0.05	0.06
4000 - 5000	0.03	0.05

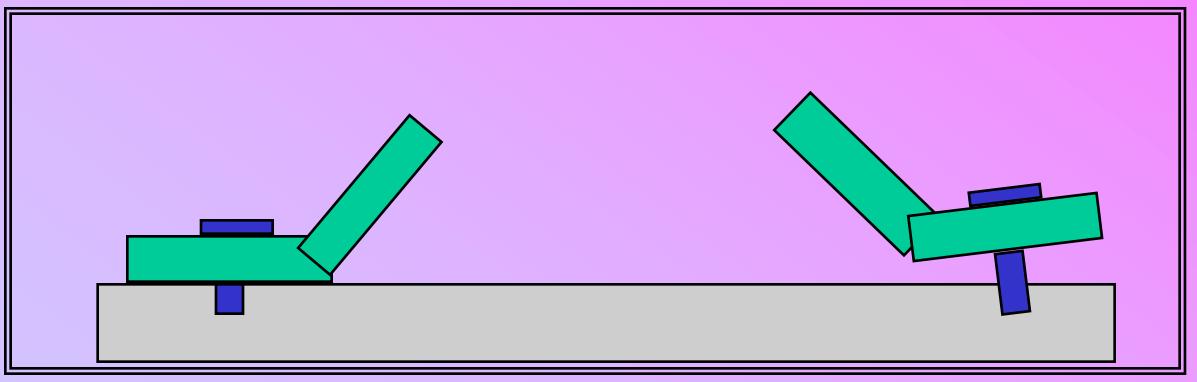
Disadvantages Of Dial Indicator Method

- More time consuming.
- Too much manual work.
- Indicator sag.
- Difficult to perform on long shaft.
- Difficult to determine soft foot.
- Difficult to perform vertical shaft alignment.

Soft Foot

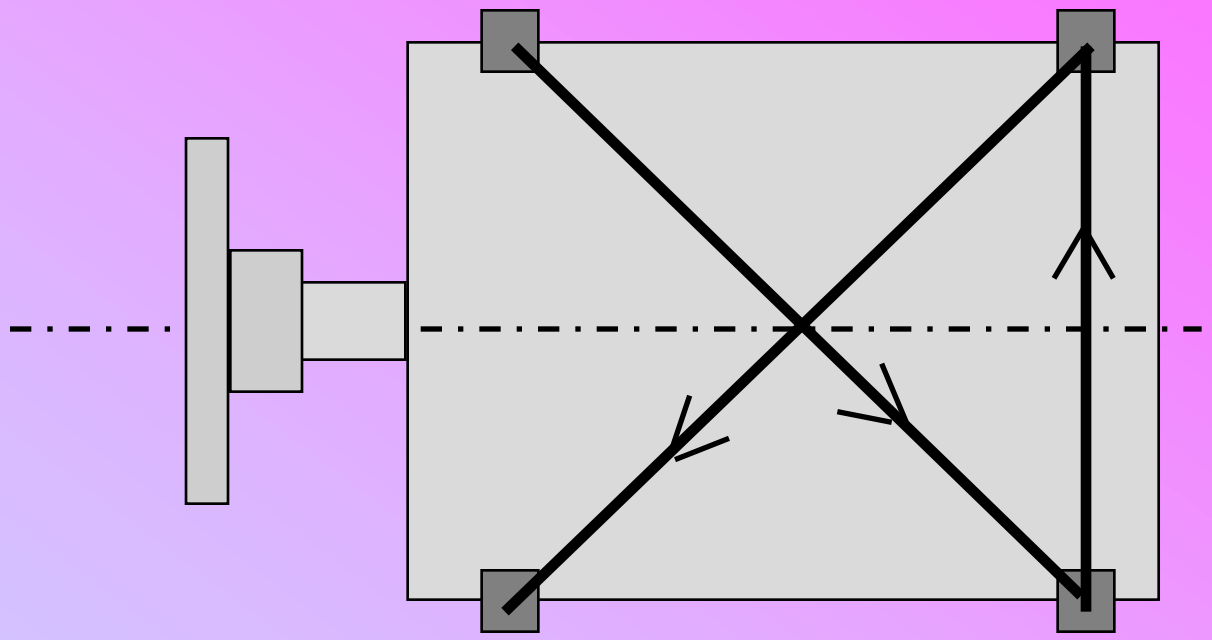


Short Foot



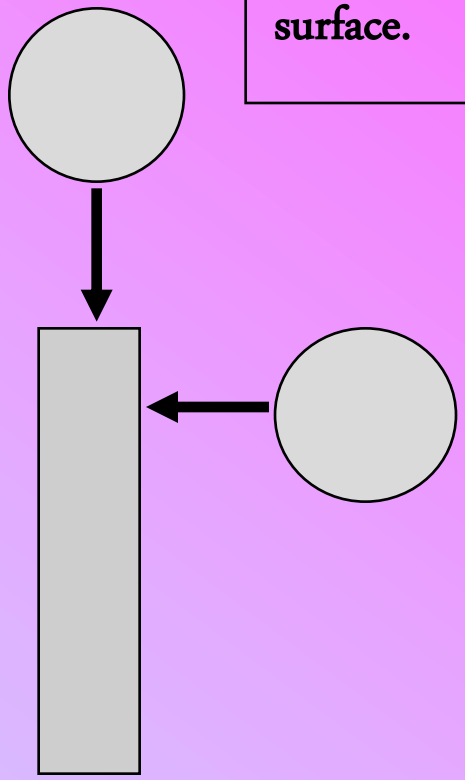
Angled Foot

Tightening Of Holding Down Bolts



Fixing Of Dial Gauge

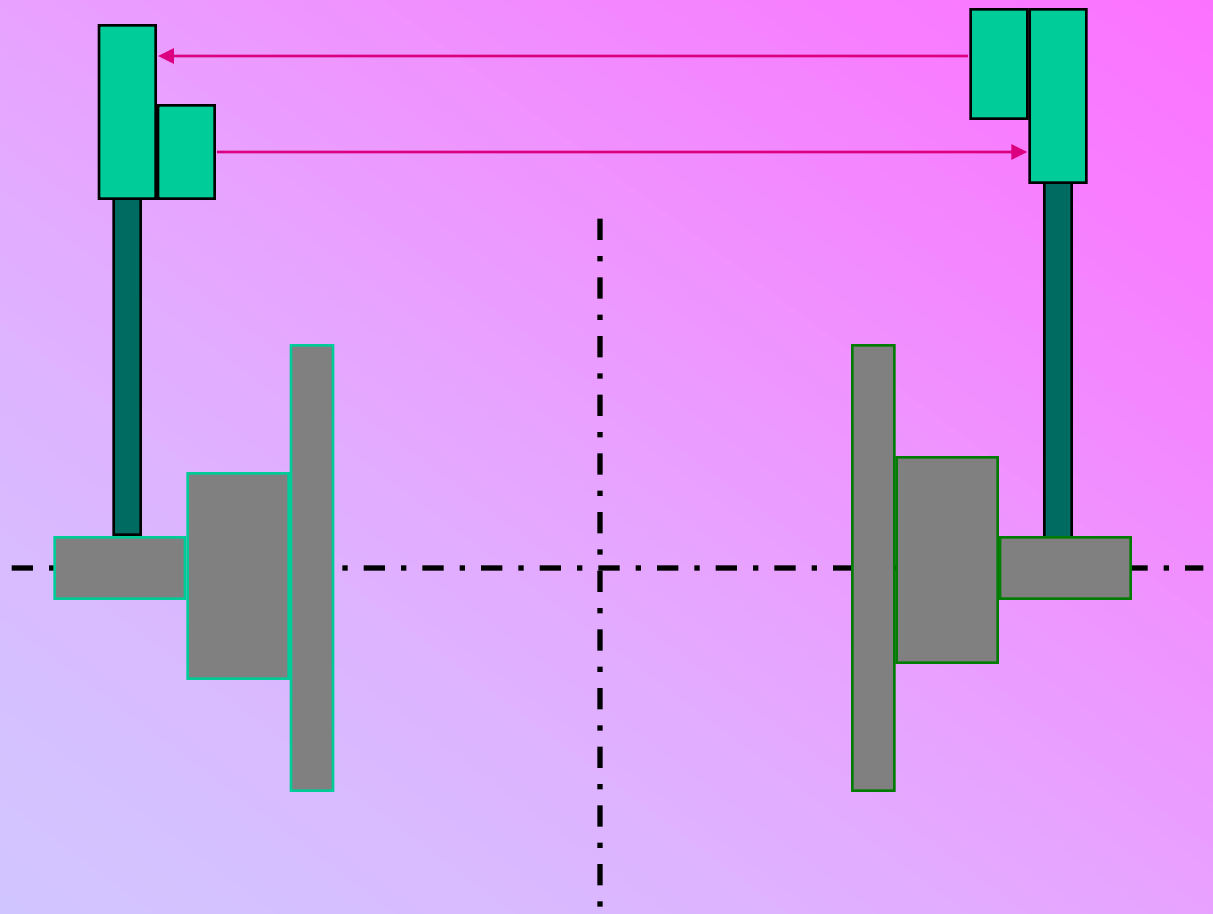
Perpendicular to the coupling surface.



Rules For Good Alignment

- Clean the machine base. Remove rust burrs etc.
- Use steel or brass shims.
- Check indicator sag.
- Check soft foot.
- Check dial gauges before taking readings.
- Use correct bolt tightening procedure.
- Don't lift the machine more than necessary.
- Try to put the stem of dial gauge perpendicular to the surface of coupling.
- Use jack bolts.

Laser Alignment



Laser

Light Amplified By Stimulated Emission Of Radiation

- Laser was originally emitted by charge sent through a gas mixture of Helium & Neon.
- Now it emitted by a low power semi conductor diode with collimating lenses.
- Modulated to avoid interference from other light source
- It is collinear.
- Single wave length of 670 nm.
- Class II Laser is used for Laser Alignment System.

Laser Alignment

Advantages:

1. Easy to use.
2. Use Reverse Indicator Method.
3. Machine does the calculations.
4. 0 - 20m max. working distance.
5. Selectable high resolution 0.1, 0.01, 0.001mm.
6. No indicator sag.
7. Soft foot measurement program.
8. Horizontal shaft alignment with mim 60^0 rotation.
9. Vertical shaft alignment program.
10. Thermal or offset compensation.

11. Machine train alignment program.

12. Cardon shaft alignment.

13. Straightness, Flatness, Perpendicularly,

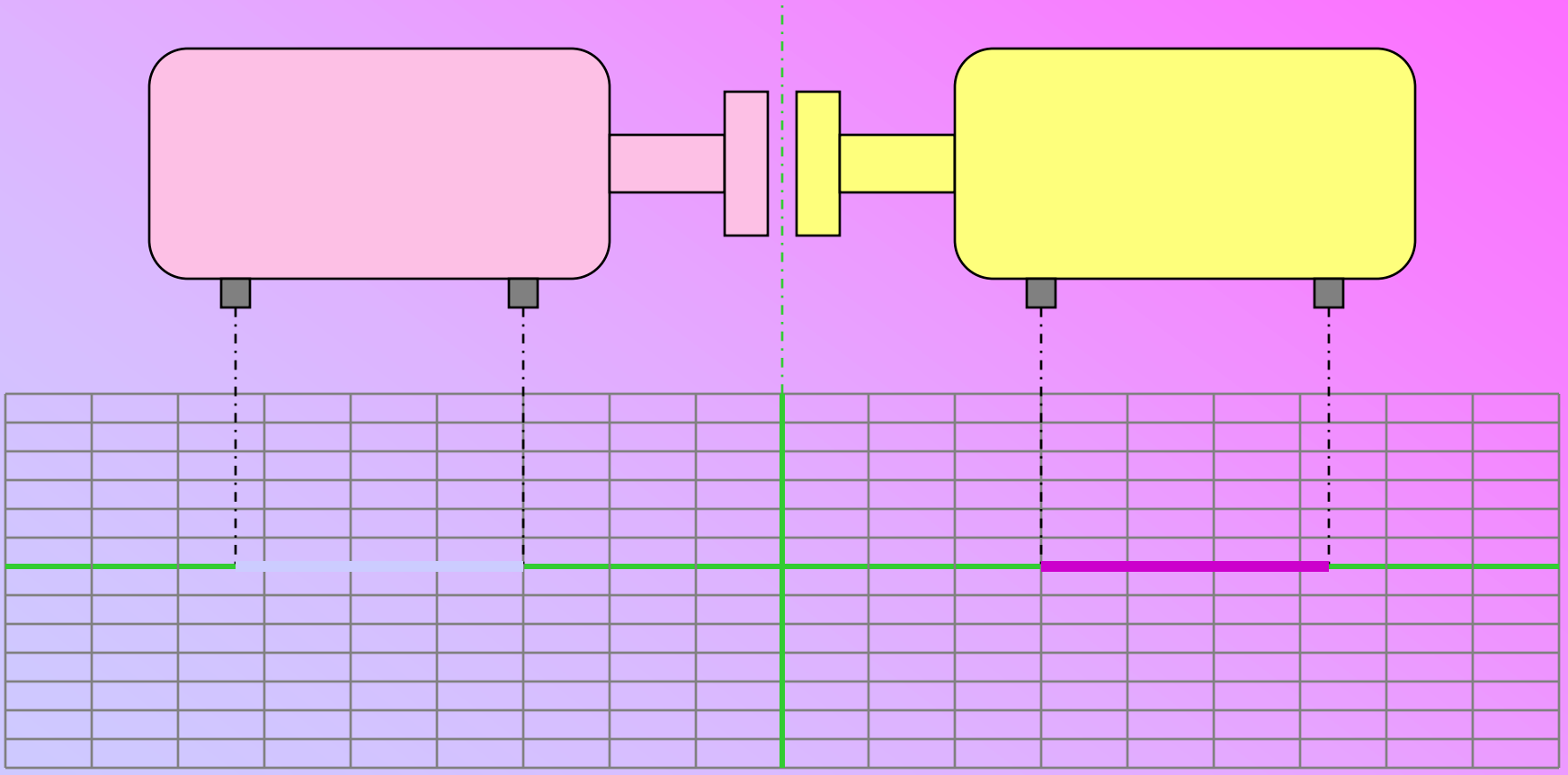
    Parallelism measurement.

14. Spindle alignment.

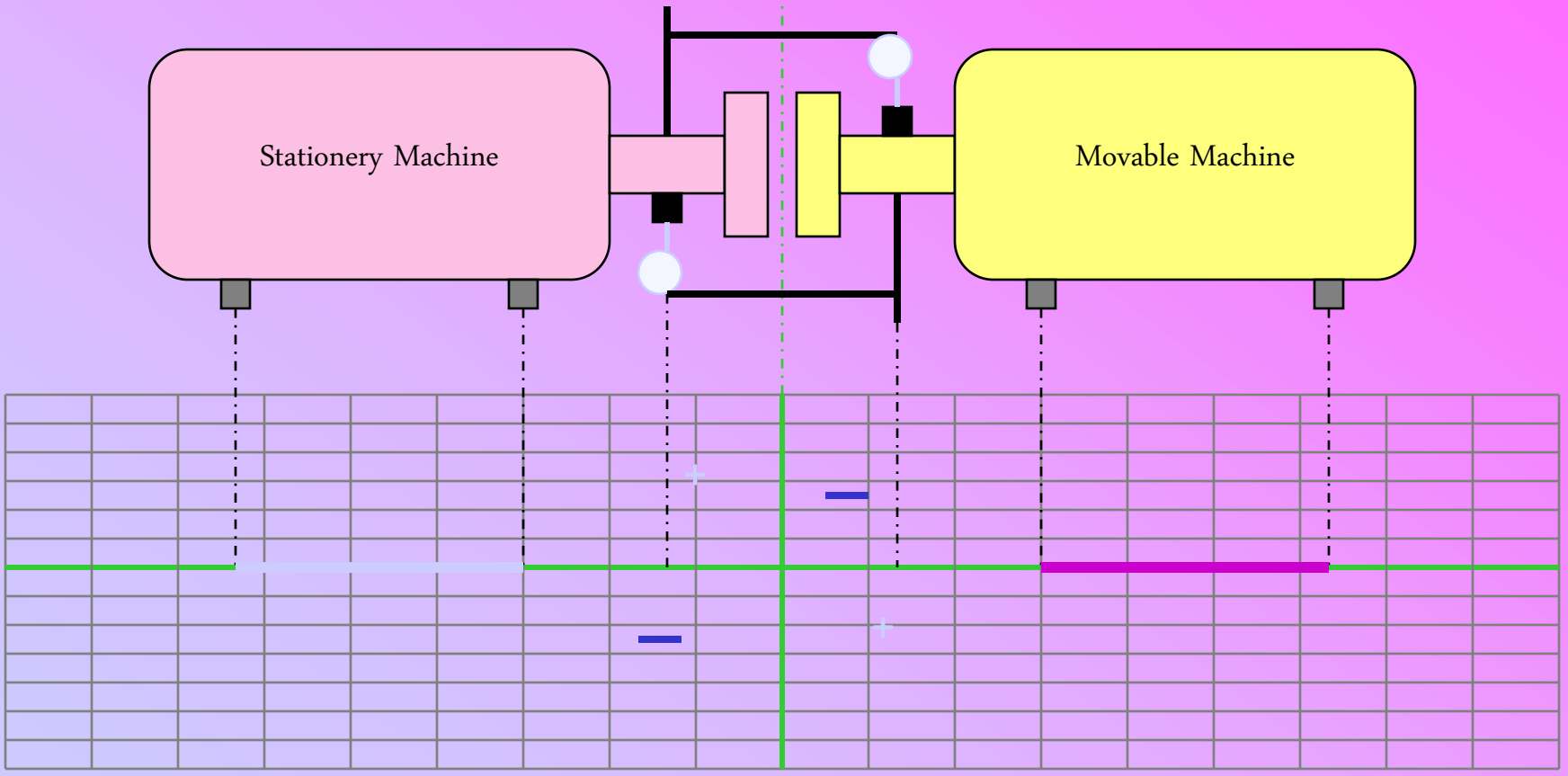
15. Static feet correction.

16. Continuos monitoring.

Graphical representation



Graphical representation



Graphical representation

Example 1

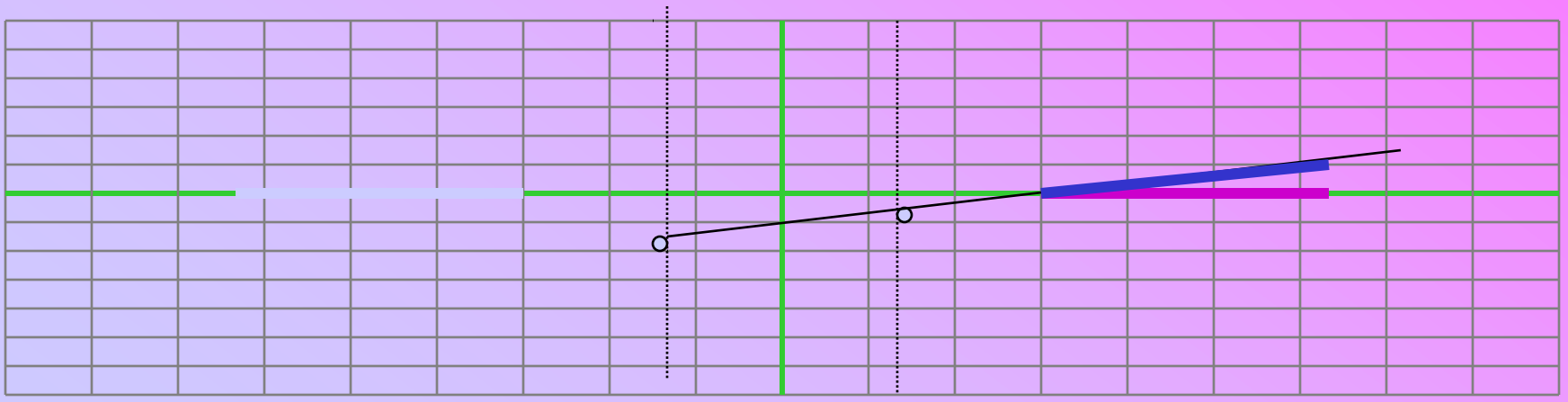
Scale: Y-axis = 10:1

X-axis = 1: 5

(Reverse Indicator Method)

SM Dial Reading: -1.50 mm

MM Dial Reading : +0.5 mm



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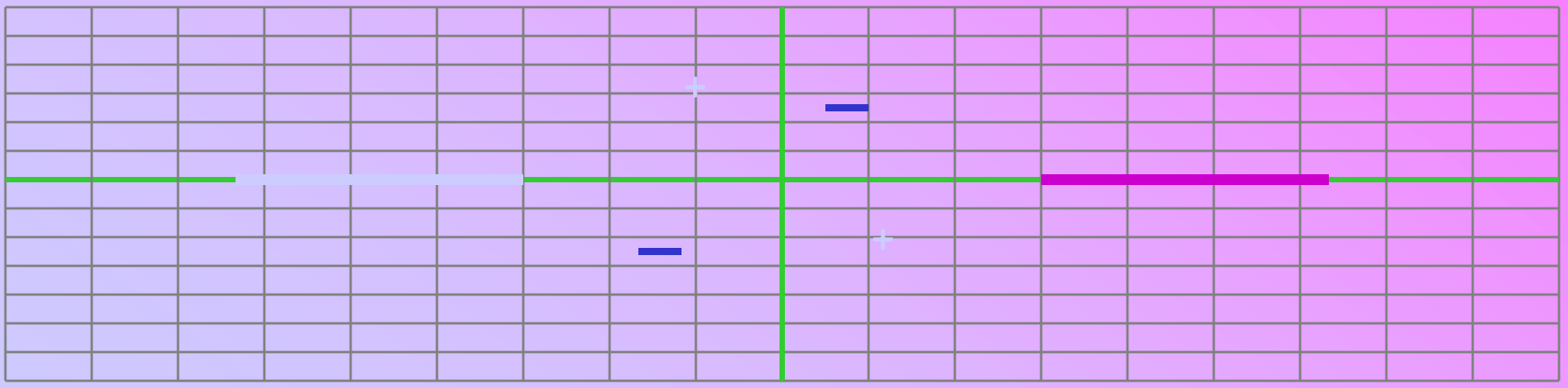


I can't thank you enough
Jacob Varghese