# Kinematic chain and servosizing

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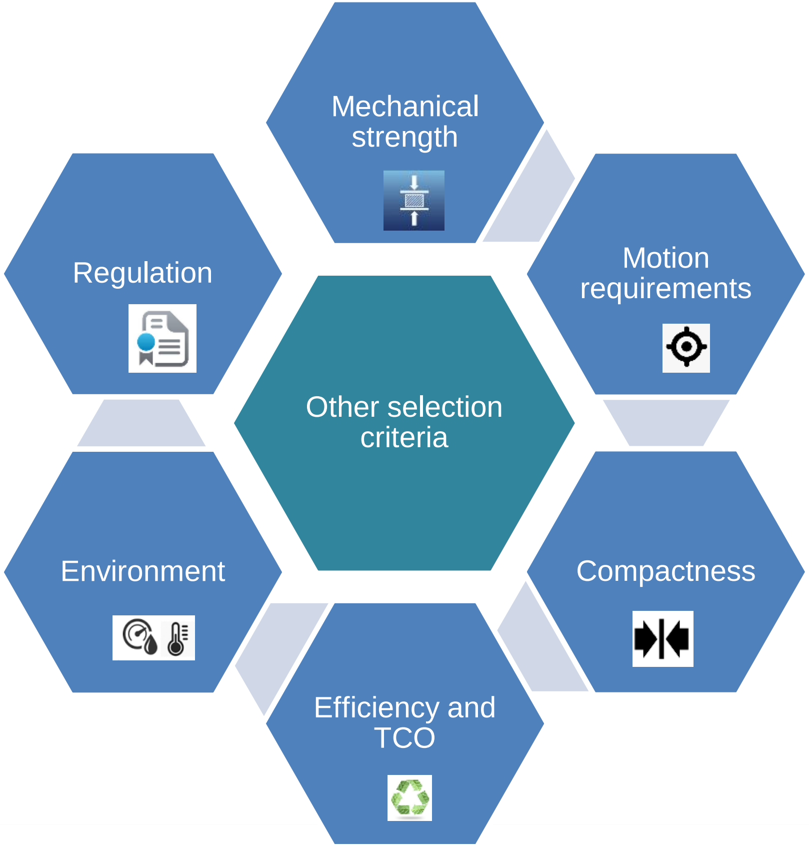
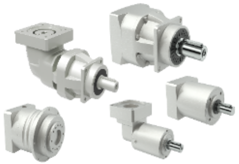
# Other selection criteria for a correct sizing of a kinematic chain



# Establishment of motion objectives and technologies / product category

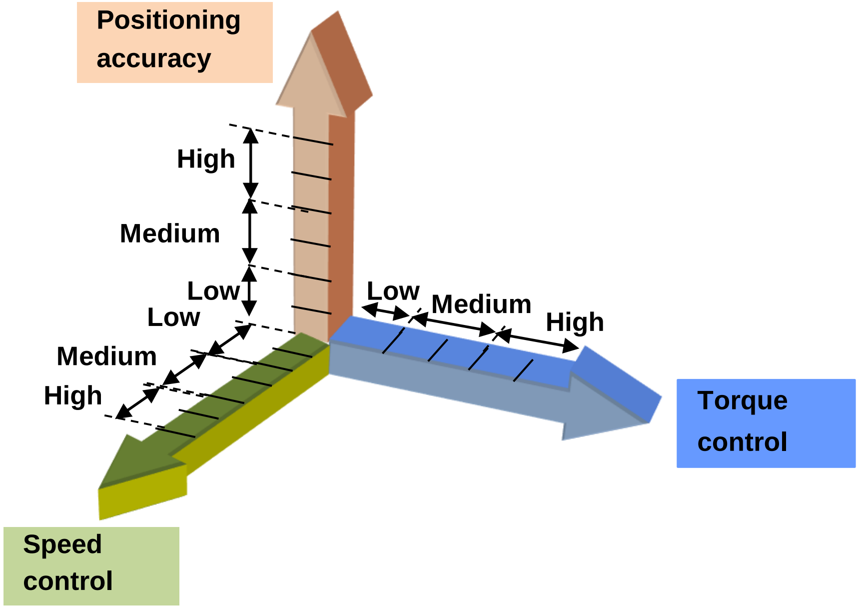
Inverters

Motors



Precision planetary gearboxes

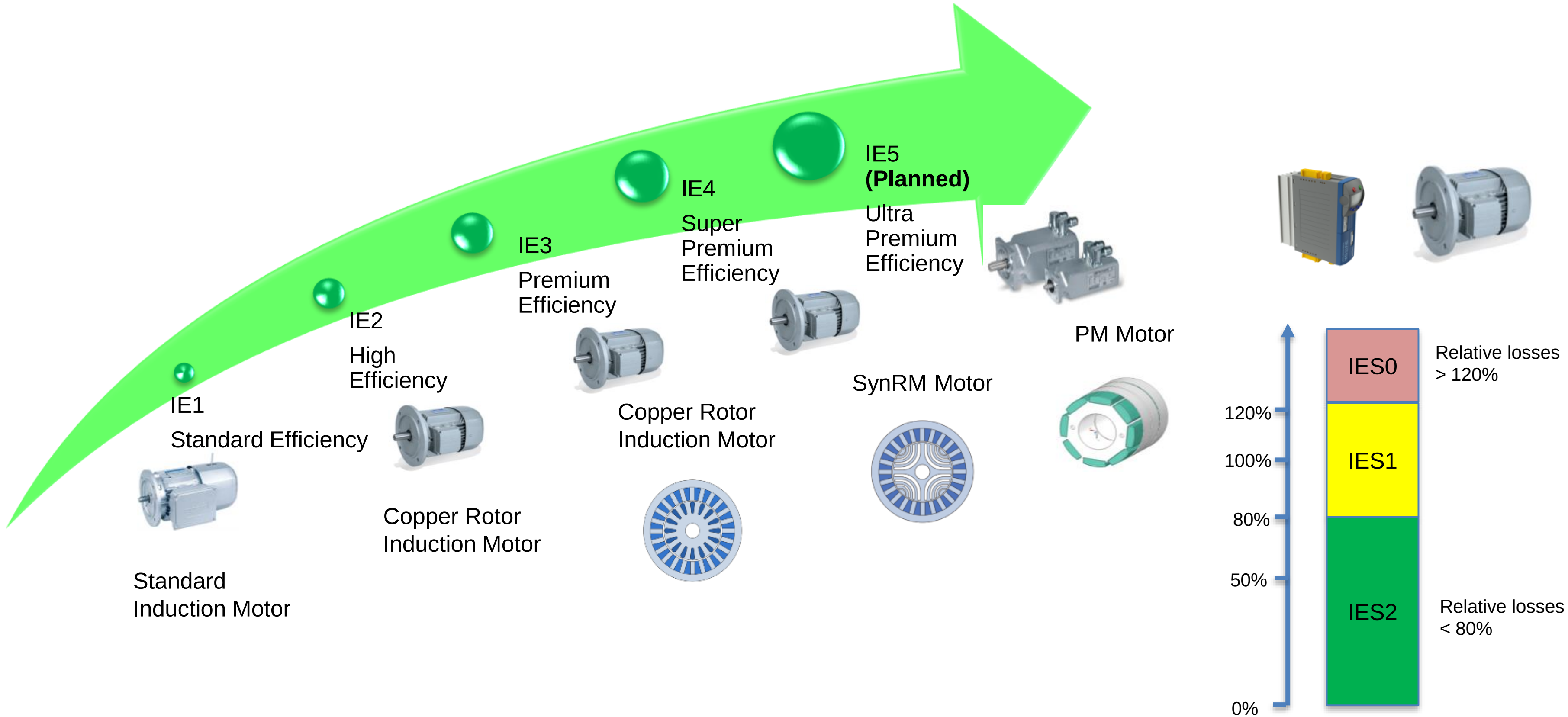
Industrial gearboxes



# Ways to save energy!

| | |
|---|---|
| **MOTOR TECHNOLOGY**<br>IE1 / IE2 / IE3 / IE4 | Up to 2-8% additional energy over standard motors |
| **GEARBOX TECHNOLOGY**<br>Efficiency 50% (worm gearboxes) – 98 % (planetary gearboxes) | Up to 48 % additional energy over worm gearboxes |
| **RIGID TRANMISSION ELEMENTS**<br>Gearbox eliminate friction and slippage associated with V-belts, pulleys, chains | Up to 12-15 % increase of efficiency |
| **VFD**<br>Smart control and optimizing accelerating / decelerating ramps & turning off when motor not in use. Power factor reduction | Up to 20-50 % increase of efficiency depending on application |
| **REGENERATIVE UNITS**<br>Recycling or sharing regenerative energy | Up to 70 % increase of efficiency (example hoisting) |
| **SERVOSIZING OPTIMISATION & INTEGRATED DESIGN**<br>Optimising the working point and whole cinematic chain | Up to 50 % increase of efficiency |

# Which is the better motor technology?

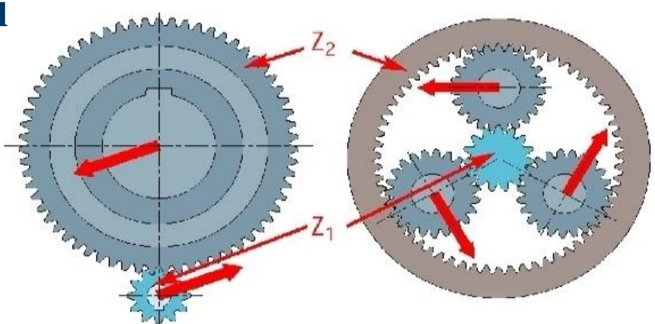


# Precision planetary gearboxes technologies

| | Industrial gearbox | Precision planetary gearbox |
|---|---|---|
| **High torque density** | *** | ***** |
| **Backlash** | ** | ***** |
| **Torsional stiffness** | ** | ***** |
| **Maximum torque capability** | *** | ***** |
| **High input speed** | *** | ***** |
| **Low inertia** | ** | ***** |
| **Lifetime lubrication** | * | ***** |
| **Fix ratio (no decimals)** | * | ***** |
| **Bearing loadability** | *** | ***** |
| | | |
| * Low Performance; ***** High Performance | | |

**Industrial gearbox**

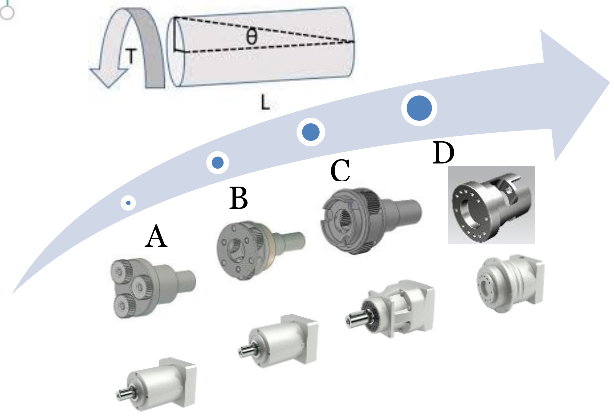
i = z2/z1

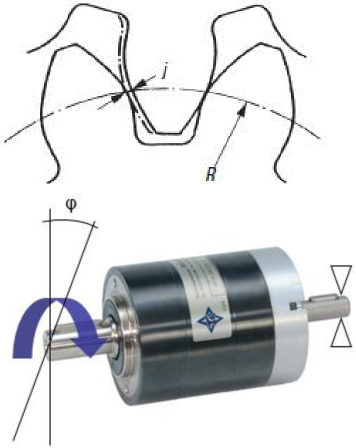



**Precision planetary gearbox**

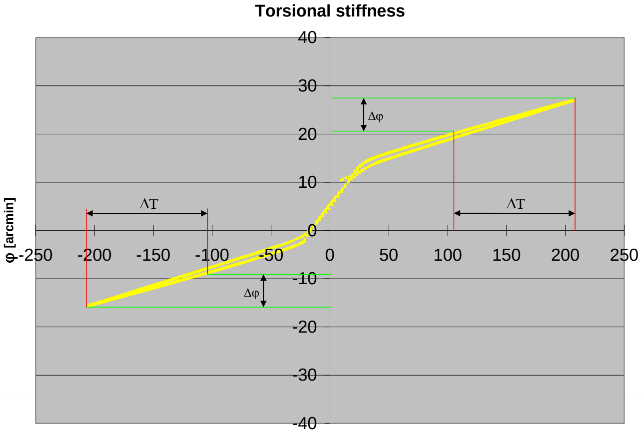
i= z2/z1 + 1

# Torsional Stiffness & Backlash




The **torsional stiffness** is defined as the quotient of the externally applied torque and the resulting twisting angle at the output of the **gearbox**. ... In order to determine this parameter, the **gearbox** is loaded with a continuously increasing torque up to the nominal value while the input shaft is locked.

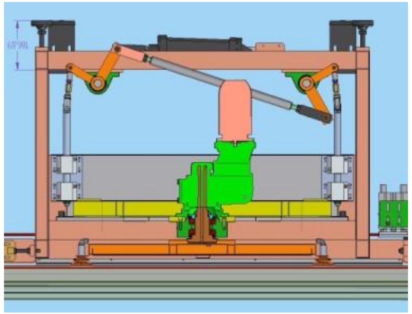



**Backlash**, is a clearance between mating gear teeth, is built into speed reducers to let the gears mesh without binding and to provide space for a film of lubricating oil between the teeth. This prevents overheating and tooth damage.

# Precision planetary gearboxes features for high positioning requirements

$$\Delta\varphi_{mech} = \Delta\varphi_{Backlash} + \frac{\tau}{c}$$

## Numerical example – Rotary Table (Glass lines)

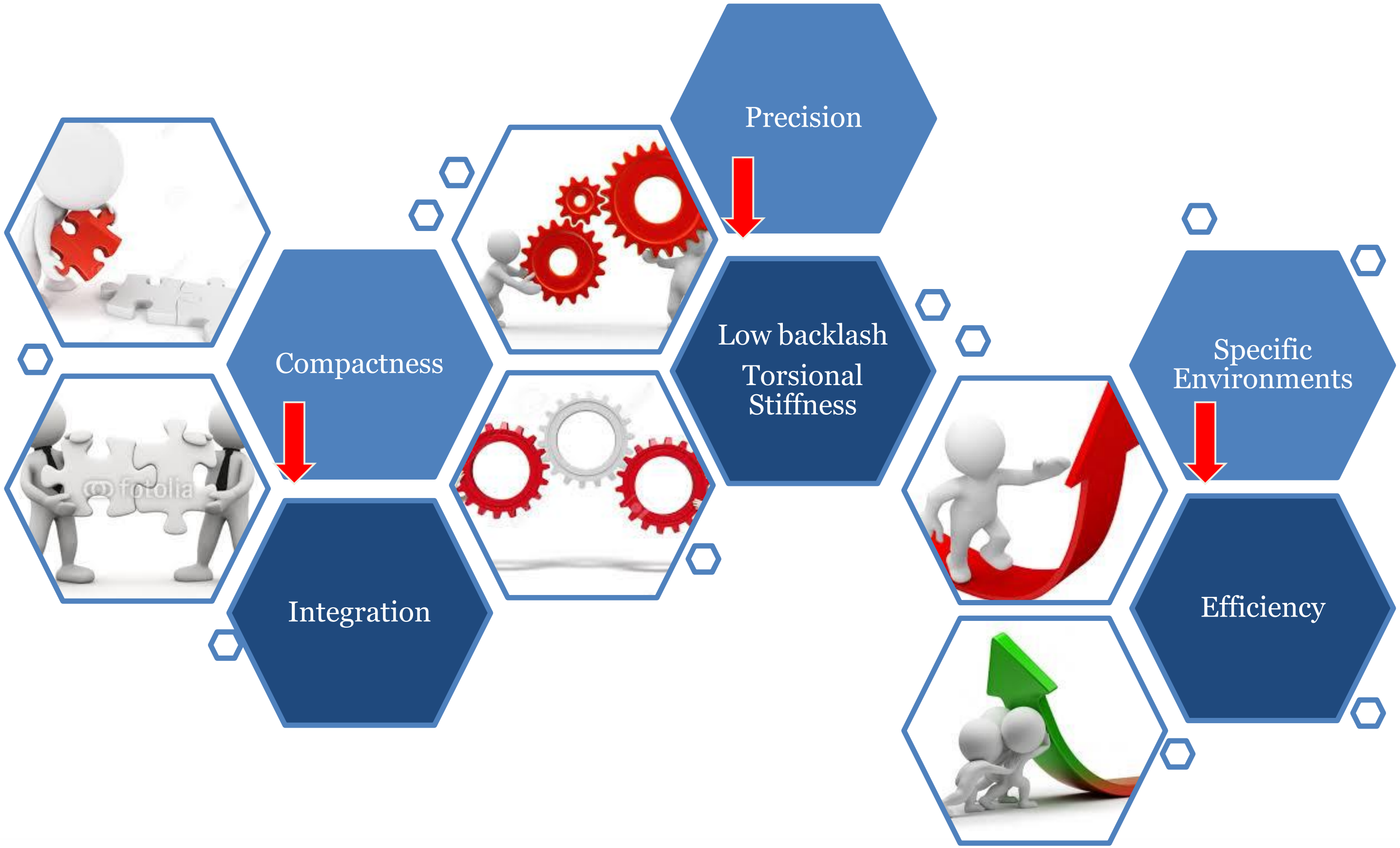


**Accuracy requested 0,141° = 8,5' arcmin**

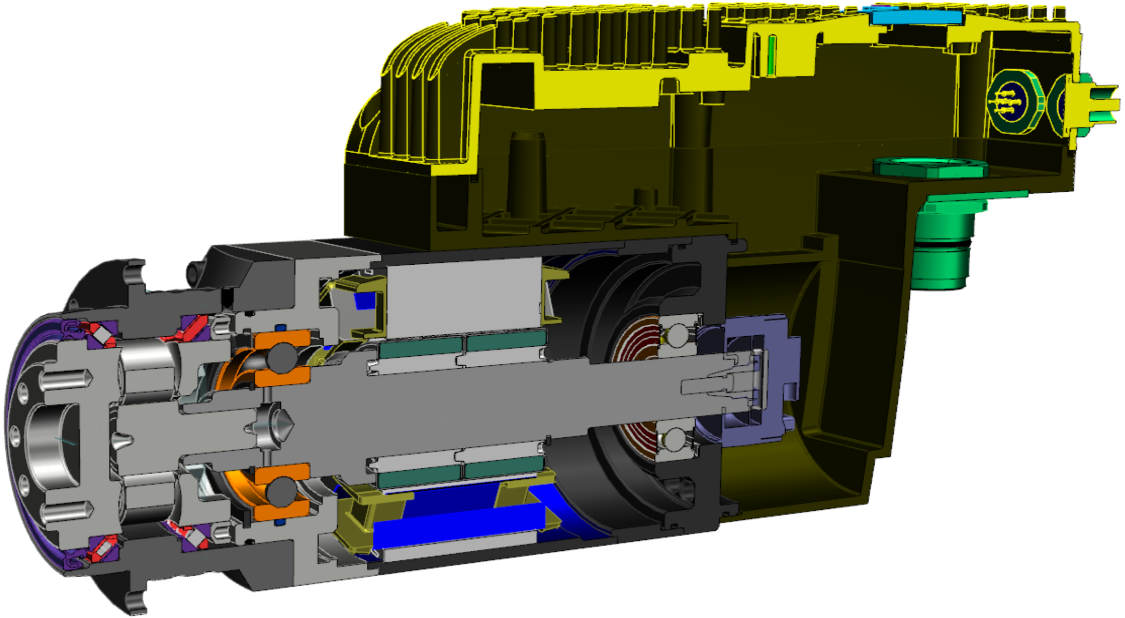
| | Gearbox rating | | M2req [Nm] | Misalignement (stifness) [arcmin] | Misalignement (backlash) [arcmin] | Total Missalignement [arcmin] | Requested Accuracy [arcmin] | |
|---|---|---|---|---|---|---|---|---|
| | CT [Nm/arcmin] | Backlash [LOW] [arcmin] | | | | | | |
| **Product A** | 167 | 4' | 700 | 4,19' | 4' | 8.19' | 8,5' | Meet |
| **Product B** | 83.5 | 3' | | 8,38' | 3' | 11.38' | 8,5' | Not meet |

**Higher Precision**

# Typical requirements of mechatronic applications



# How the designers answer to specific requirements?



Integrated solution versus common used solutions

Thank you!