

**Walter Koser:**

# Anforderungen und Eigenschaften von Miniaturlagern für Präzisionsgeräte

## ***Weltweite Fertigung***



***M+I Thailand***



***M+I S'pore***



***Rose Bearings UK***



***NHB, Pelmec Thailand***



***Pelmec S'pore***



***Shanghai Plant***

# Machined Components

## Bearings and Bearing-Related Products

**Small-sized ball bearings**



**Miniature ball bearings**



**Integrated-shaft  
ball bearings**



**Pivot assemblies**



**Rod-end & spherical  
bearings**

## Electronic Devices and Components Rotary Components

**Hard disc drive (HDD)  
spindle motors**

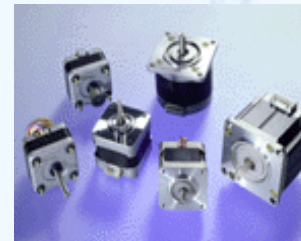


**Fan motors**



**Stepping motors**

**Hybrid-type**



**PM-type**



**Automotive motors**



**Special-type rotary components**

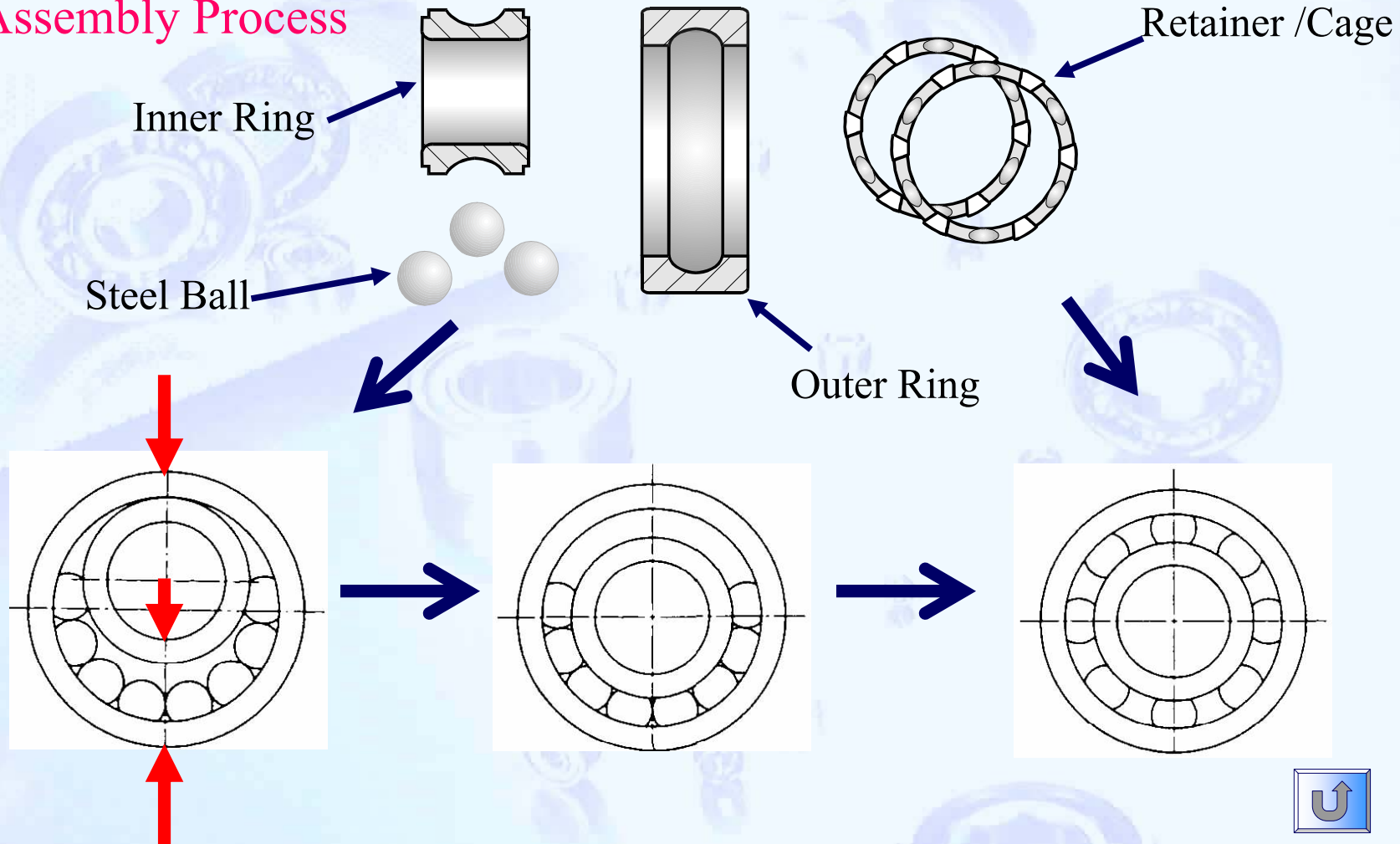


## Anforderungen an Präzisions-Wälzlager:

- Hohe Lebensdauer
- Geringste Reibung
- Höchste Rundlaufgenauigkeit
- Schmierung auf Lebensdauer
- Lastaufnahme in radialer und axialer Richtung
- Geringe Laufgeräusche
- Kostengünstig

## Bearing Production

### Assembly Process



# Kugellagerspezifikation

## Lagerluft

- Wahl der Lagerspiels

Schiebesitz (Lagerluft "vermindert")  
Bei Forderung: Kleines Spiel

**Passungsberechnung  
durch  
NMB**

Standard  
(Lagerluft "normal")

| NMB Spec. | von- bis<br>[μm] | DIN 625 | Bohrungs Ø<br>1,5-6 mm<br>Von - Bis<br>[μm] | Bohrungs Ø<br>6-10 mm<br>Von - Bis<br>[μm] |
|-----------|------------------|---------|---------------------------------------------|--------------------------------------------|
| M1        | 0 - 5            |         |                                             |                                            |
| M2        | 3 - 8            | C2      | 0 - 7                                       | 0 - 7                                      |
| <b>M3</b> | <b>5 - 10</b>    | C0      | 2 - 13                                      | 2 - 13                                     |
| M4        | 8 - 13           |         |                                             |                                            |
| M5        | 13 - 20          | C3      | 8 - 23                                      | 8 - 23                                     |
| M6        | 20 - 28          | C4      | -                                           | 14 - 29                                    |

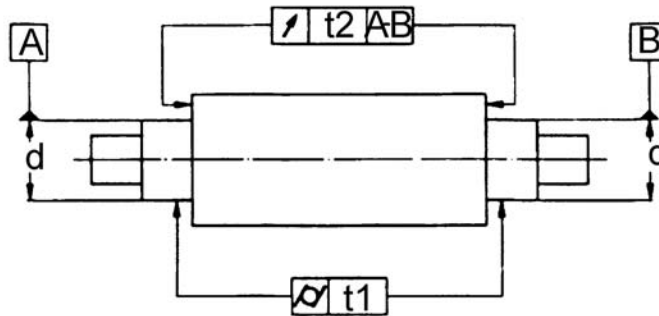
Preßsitz (Lagerluft "erhöht")

# Gestaltung des Lagersystems

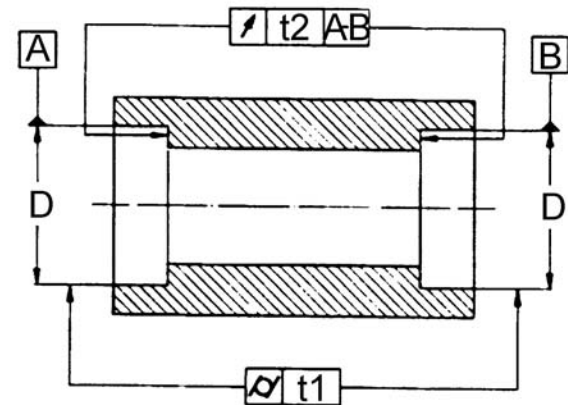
## Formtoleranzen

- Zylinderform und Planlauf

**Das Betriebsverhalten und die Lebensdauer der Kugellager ist entscheidend von der Gestaltung der Lagersitze abhängig !**



t1 Zylinderformtoleranz



t2 Planlauf-toleranz

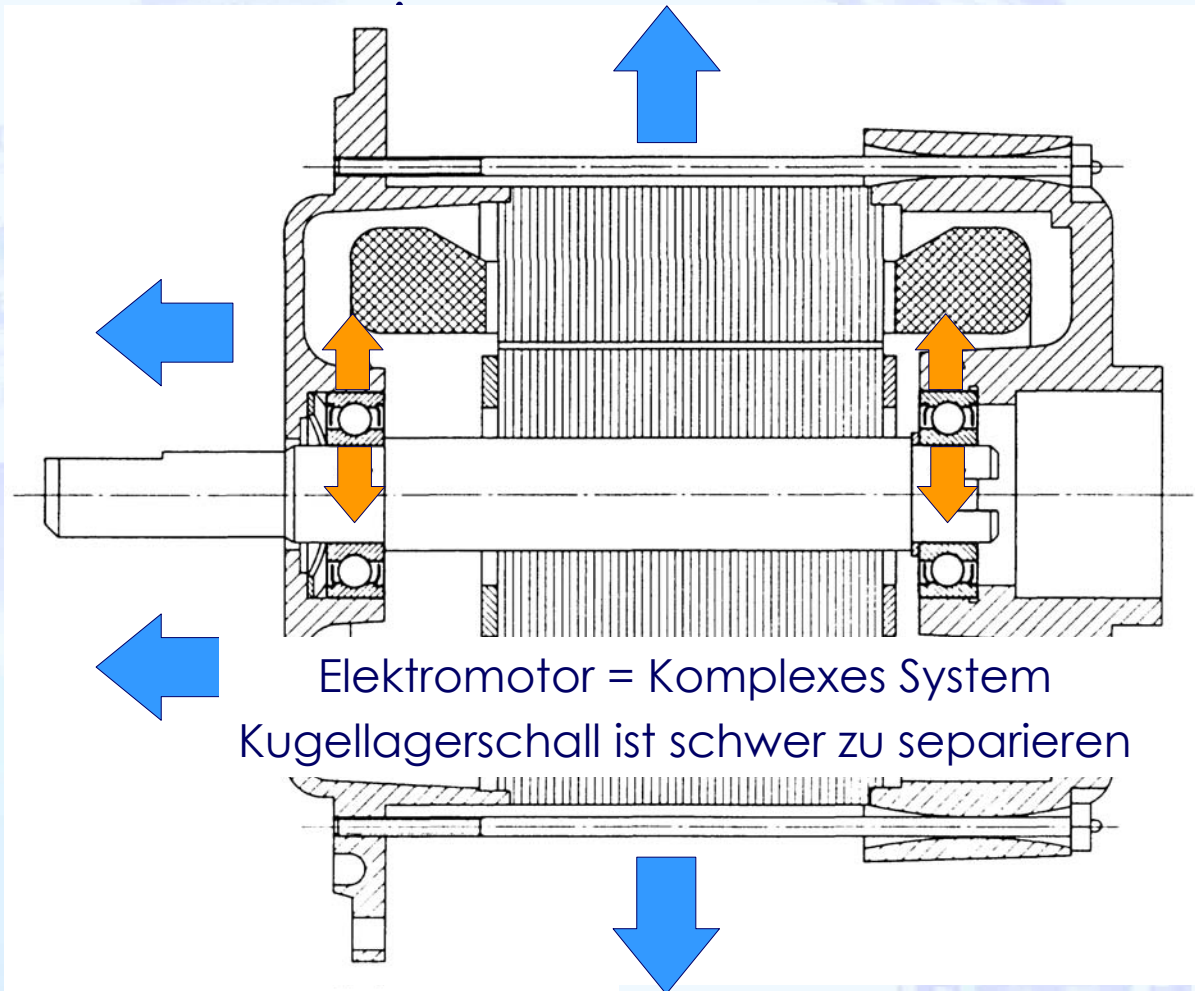
| Toleranzklasse Lager | Lagersitz-stelle | Zylinderform-toleranz t1* | Planlauf-toleranz t2 |
|----------------------|------------------|---------------------------|----------------------|
| A1 / P0              | Welle            | IT 5 / 2                  | IT 4                 |
|                      | Gehäuse          | IT 6 / 2                  | IT 5                 |
| A5 / P5              | Welle            | IT 4 / 2 1,5 µm           | IT 3 2 µm            |
|                      | Gehäuse          | IT 5 / 2 3,0 µm           | IT 4 4 µm            |

\* bezogen auf Radius

**Beispiel  
Lager R-830  
(639/3)**

# Kugellagerspezifikation

## Laufgeräusch



## Kugellagerspezifikation

### Laufgeräusch

- Kugellager haben Eigenschwingungen
- Parameter die Schwingverhalten (Laufgeräusch) beeinflussen:
  - Rundheit der Laufbahnen
  - Rundheit der Kugel
  - Oberflächengüte von Kugeln und Laufbahnen
  - Anzahl der Schwingungsmoden der Welle (durch Schleifen)
  - Struktur des Schmierstoffes
- 100% Geräuschprüfung bei NMB Kugellagern

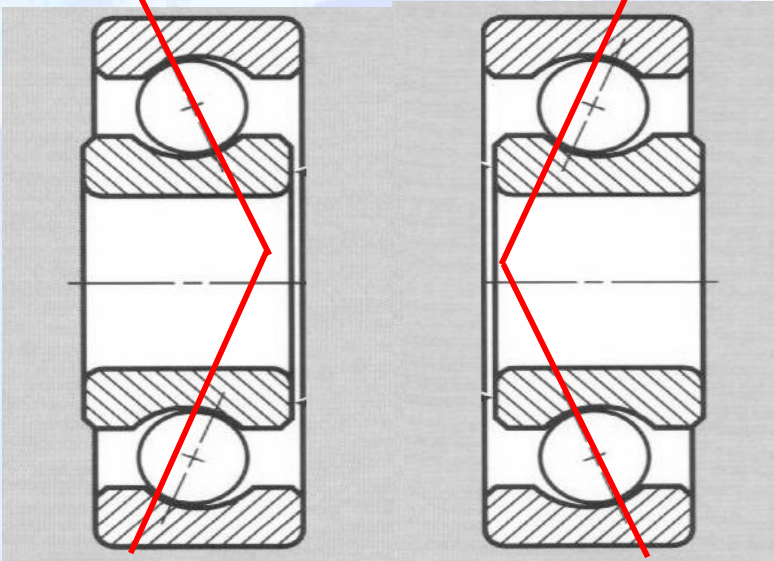


## Gestaltung des Lagersystems

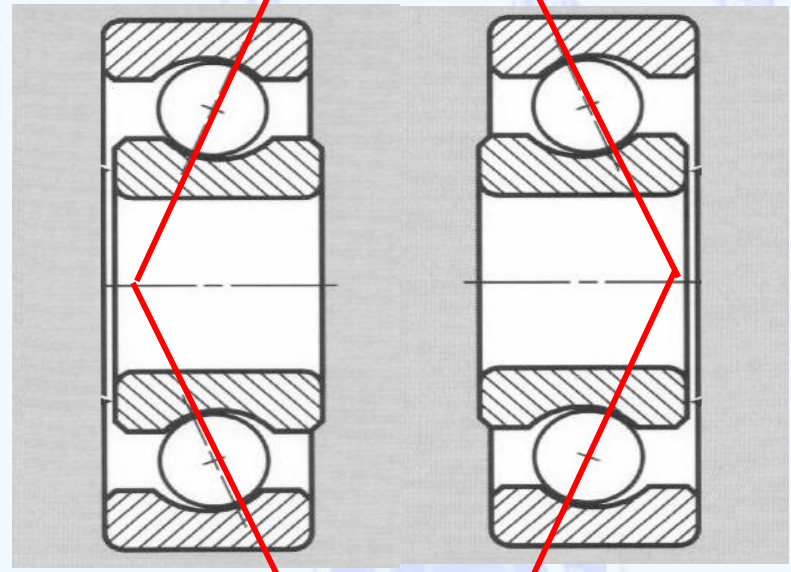
### Angestellte Lagerung

- Vorteile einer Vorspannung:
  - Definierte Innen- und Außenringposition
  - Erhöhung der Steifigkeit
  - Reduzierung von Laufgeräusche und Vibrationen

#### X-Vorspannung



#### O-Vorspannung

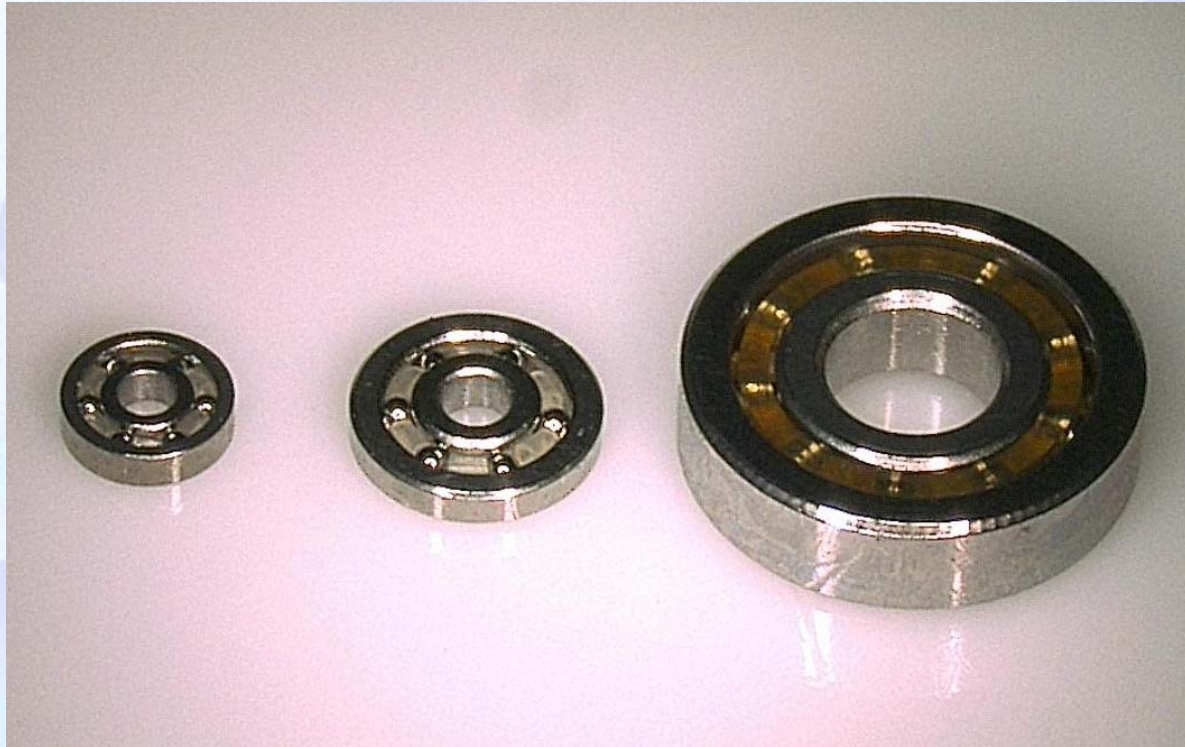


## Pivot assemblies

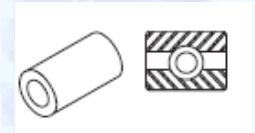
### Pivot Assemblies for HDD



# Ultra small bearings

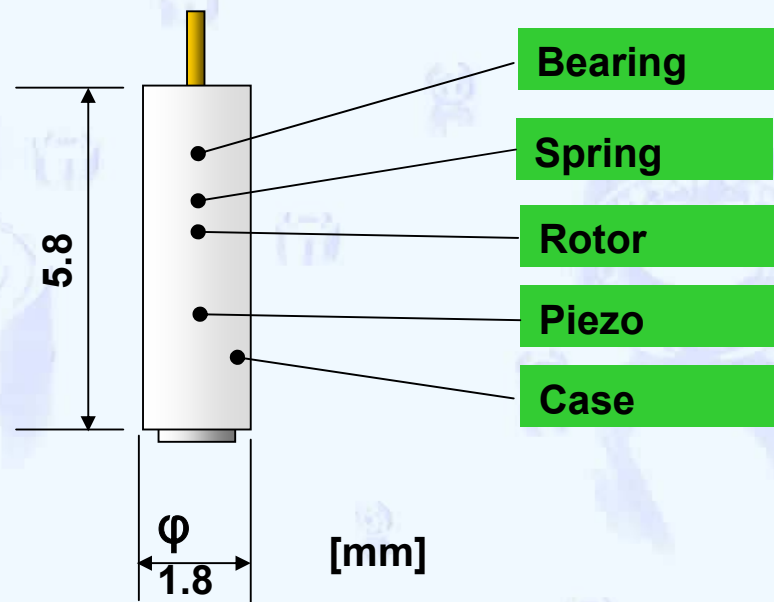
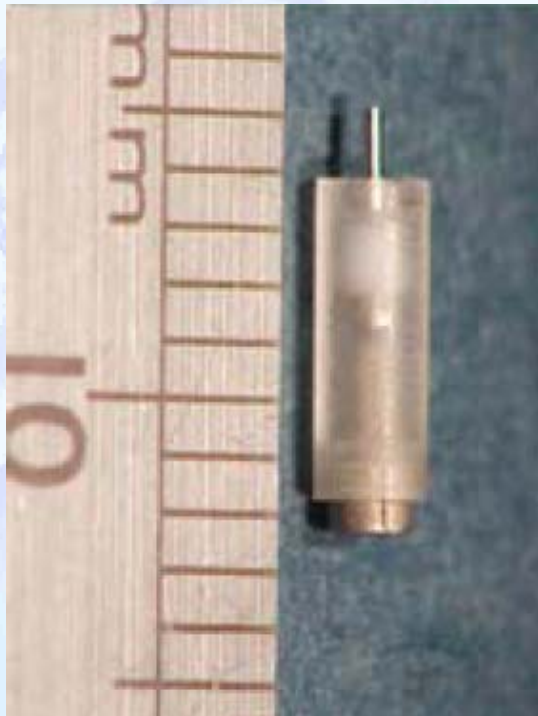


[Fig] SLUG CAGE



| P/N                 | D   | d   | B (O/R) | B (I/R) | BALL dia. | BALL qty. | CAGE | Picture |
|---------------------|-----|-----|---------|---------|-----------|-----------|------|---------|
| DDL-415X7ZVVY11MTMN | 4   | 1.5 | 1.1     | 1       | φ 0.5     | 9         | MN   | Right   |
| DCL-003EEY40TP1TU   | 2.2 | 0.6 | 0.4     | 0.5     | φ 0.3     | 6         | SLUG | Centre  |
| DCL-004TP1TU        | 1.5 | 0.5 | 0.4     | 0.4     | φ 0.25    | 6         | SLUG | Left    |

## Application example of ultra small ball bearing

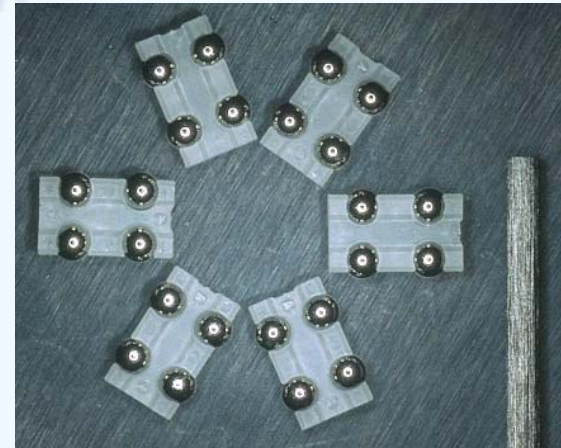
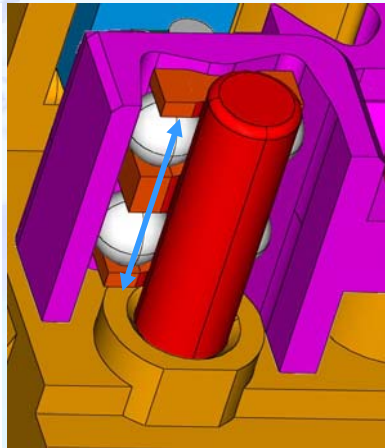


[ Ultrasonic motor for micro machine ]

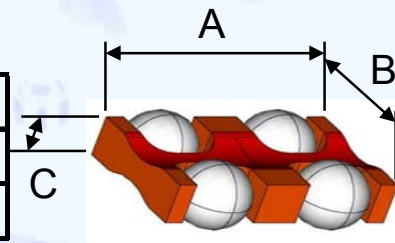
## Balls and Retainer assembly

DMS-001、-002

Autofocus lens actuator for Mobile Phone



| P/ N          | A    | B    | C    | Ball Dia |
|---------------|------|------|------|----------|
| DMS- 001F01JN | 2.58 | 1.65 | 0.48 | 1/ 32"   |
| DMS- 002F01JN | 2.30 | 1.35 | 0.40 | 0.635    |



# Spindle Bearings for Machining

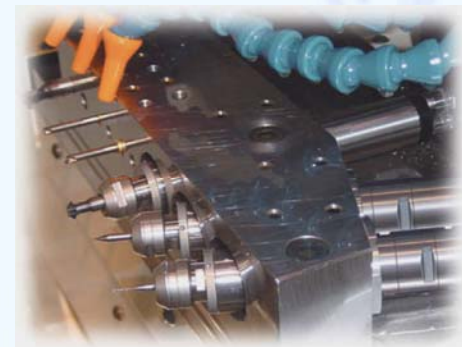
## 3.1 Spindle attachment CEMDR-1560X17SS

-130000 rpm air turbine with Radial Runout less than 2 um

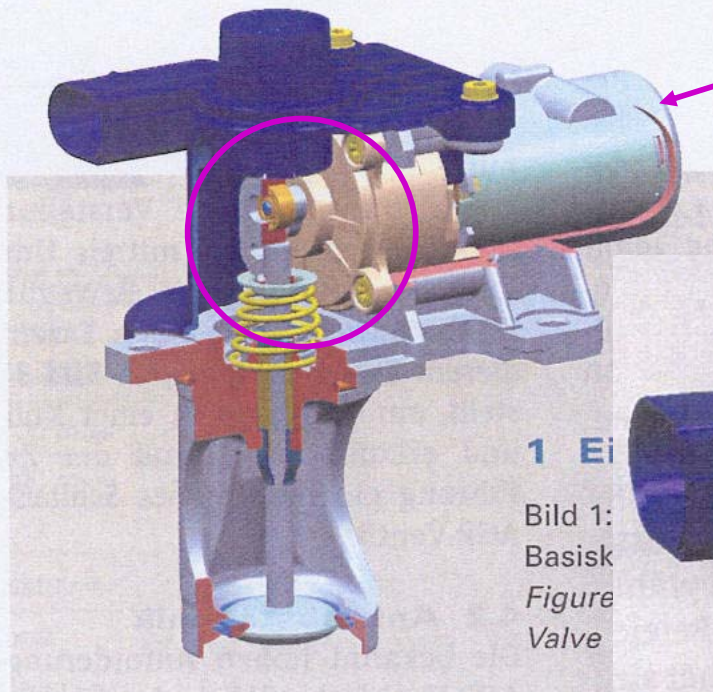


## 3.2 Spindle attachment MDL-1910X7SS

-50000 rpm air or electric turbine

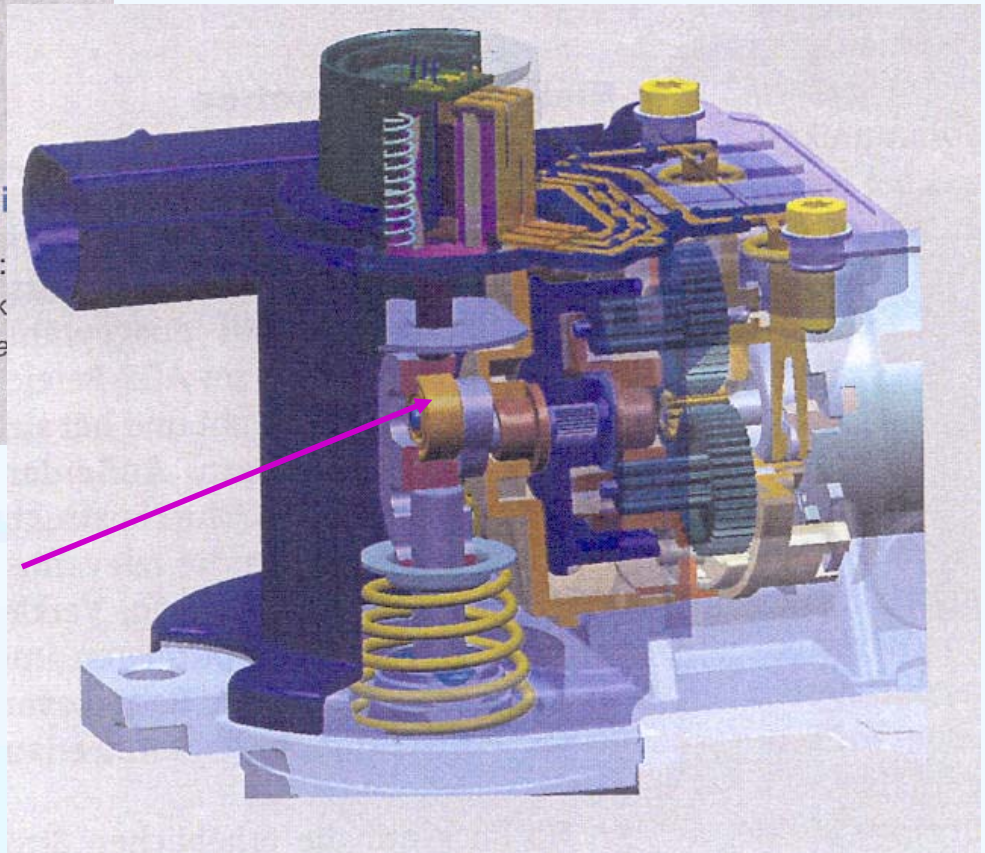


Stepping motor or gear motor  
(usually use ball bearing).

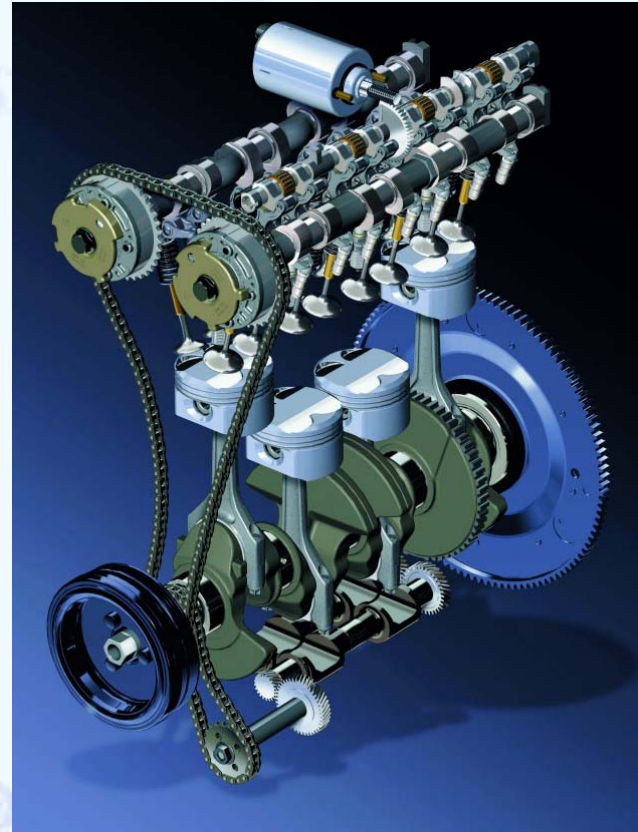


1 Ei  
Bild 1:  
Basisk  
Figure  
Valve

Bearing R-1030/830  
runs at guide rail.

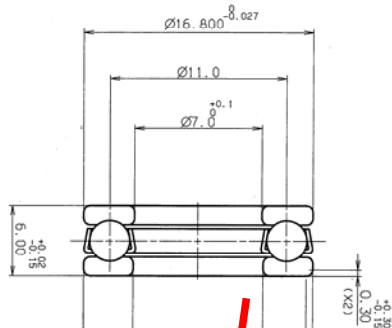


# BMW VVT

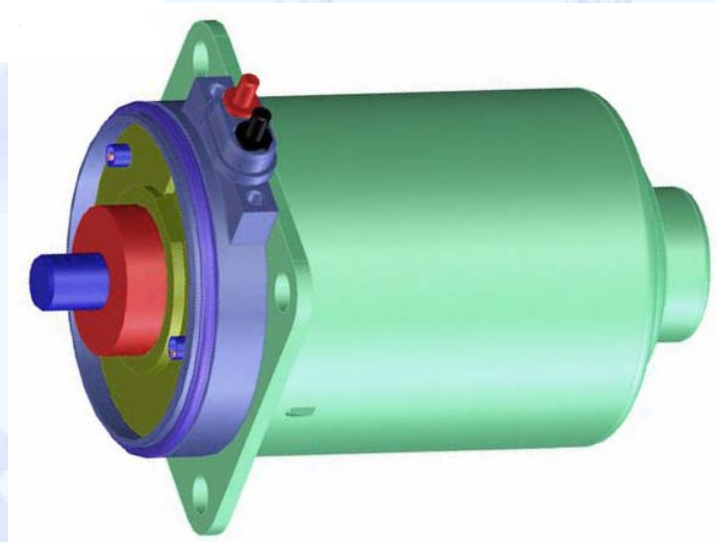
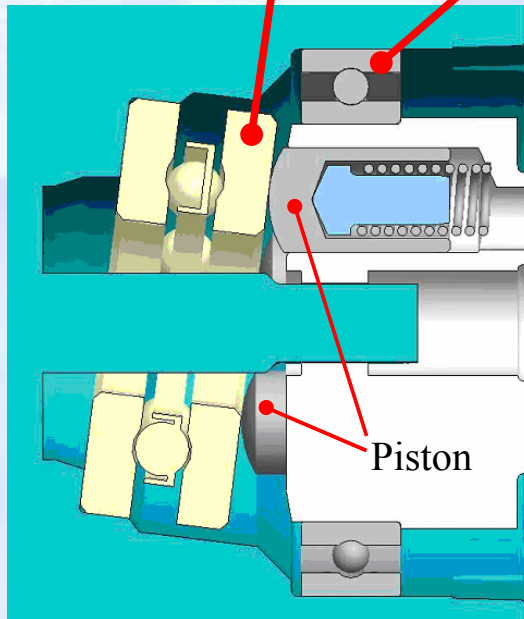
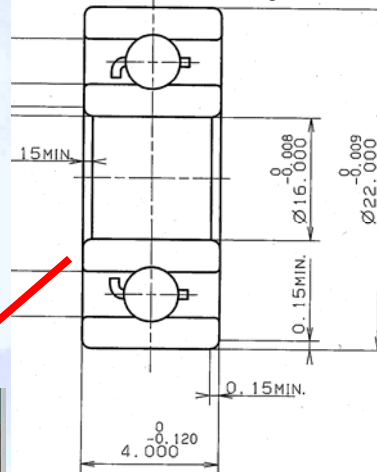


# Design for AWD drive

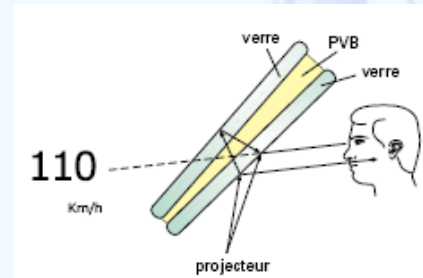
Thrust BRG CDT-1570



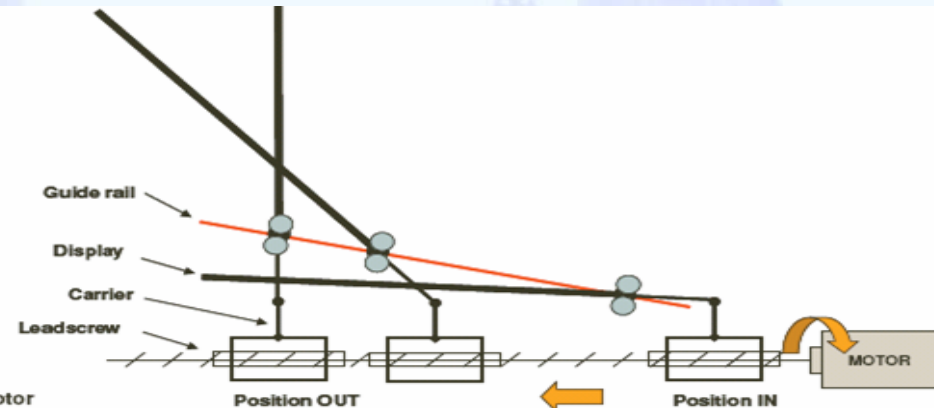
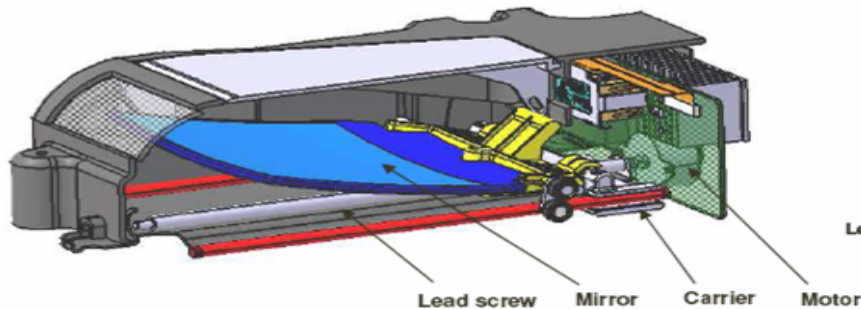
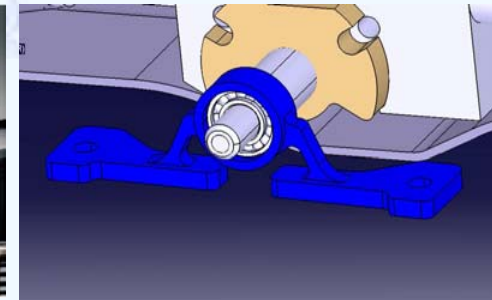
DDA-2216



A virtual image is projected from the instrument panel on the windscreen by use of different mirrors



With second generation of HUD there is a motor and a ball bearing. Driver can now adjust the position of virtual display to the seat position.



# Blood Pump

