

# **MINEBEA**

## **Technical Conference**

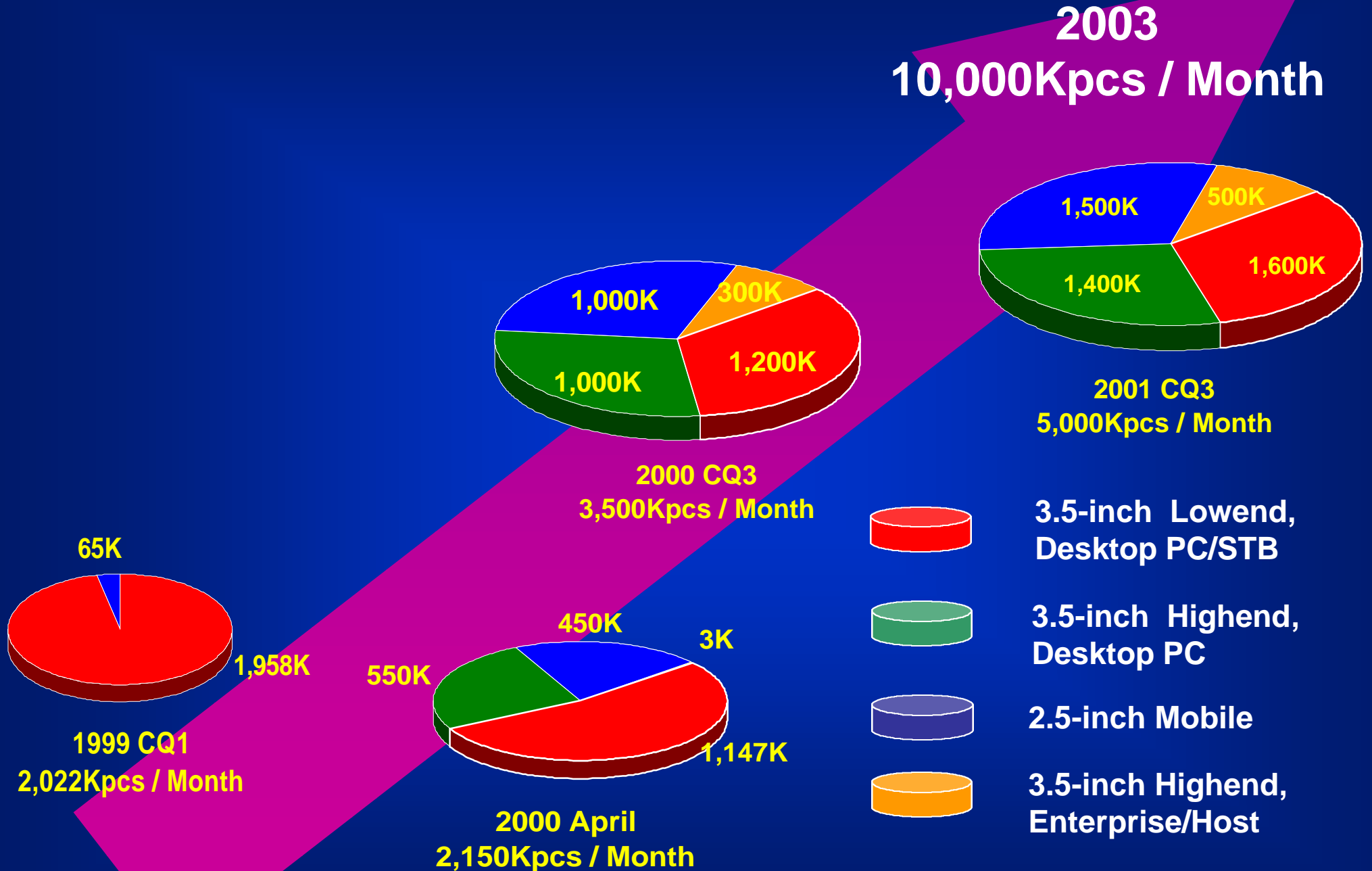
**~ HDD Spindle Motor & Bearing ~**

March 24, 2000

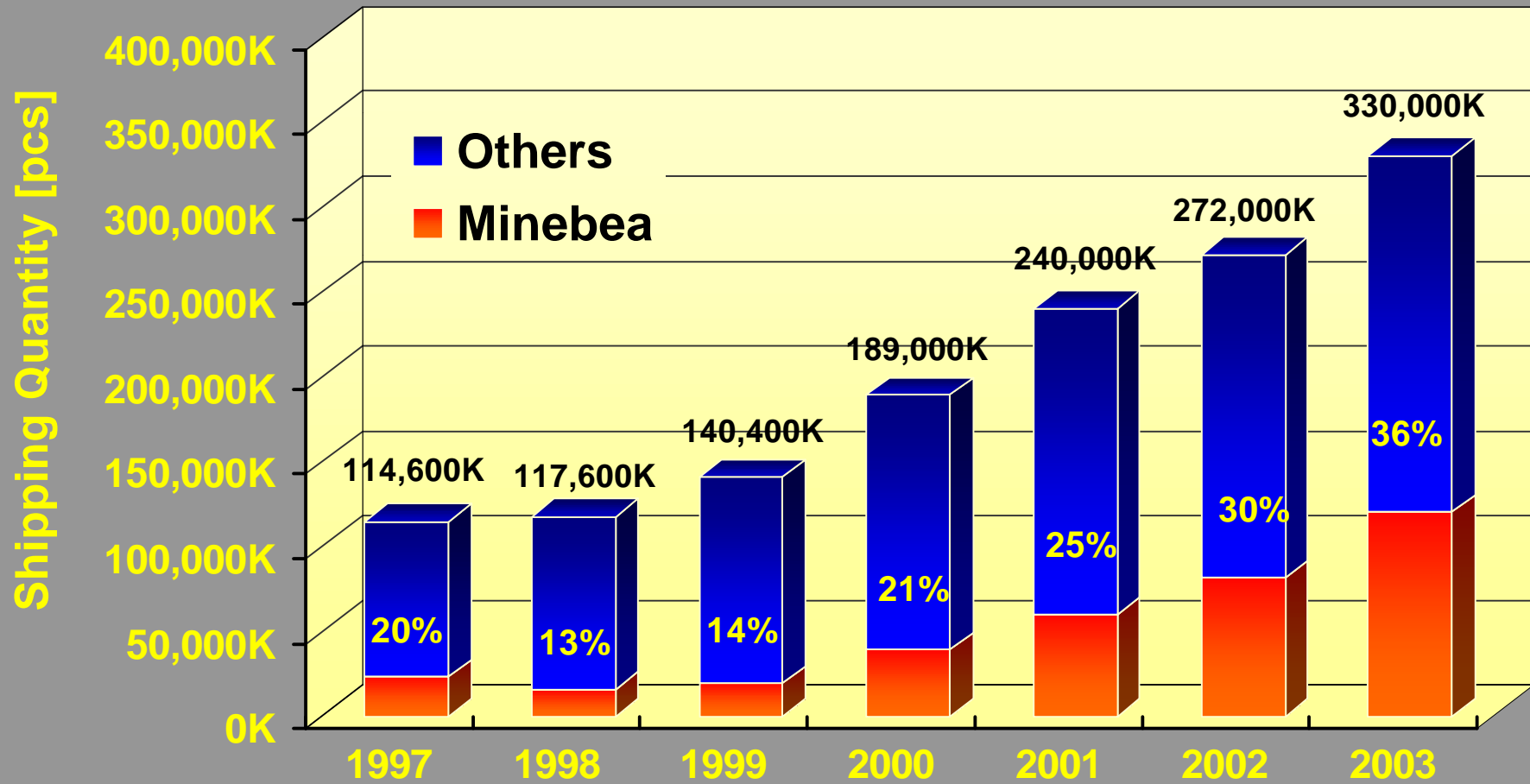
**NMB**

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- 1 . HDD Spindle Motor Business - Current Prospect
- 2 . RO Bearing Motor - Performance and Advantage
- 3 . Fluid Dynamic Bearing - Minebea Strategy
- 4 . Fluid Dynamic Bearing - Impact to Ball Bearing Business
- 5 . RO Bearing - Future Application
- 6 . Minebea Production Support and It's Organization
- 7 . Summary



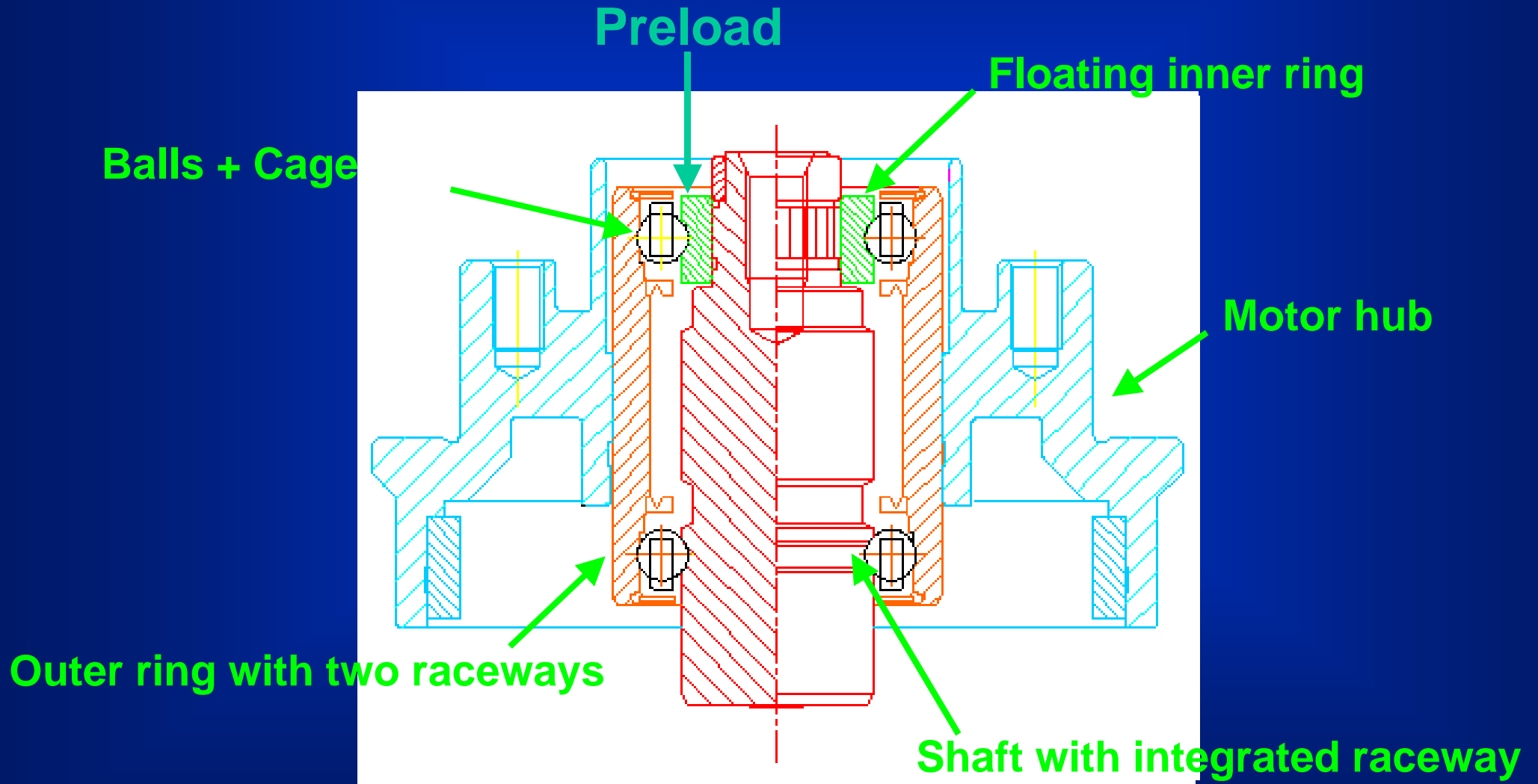
### HDD Spindle Motor Forecast



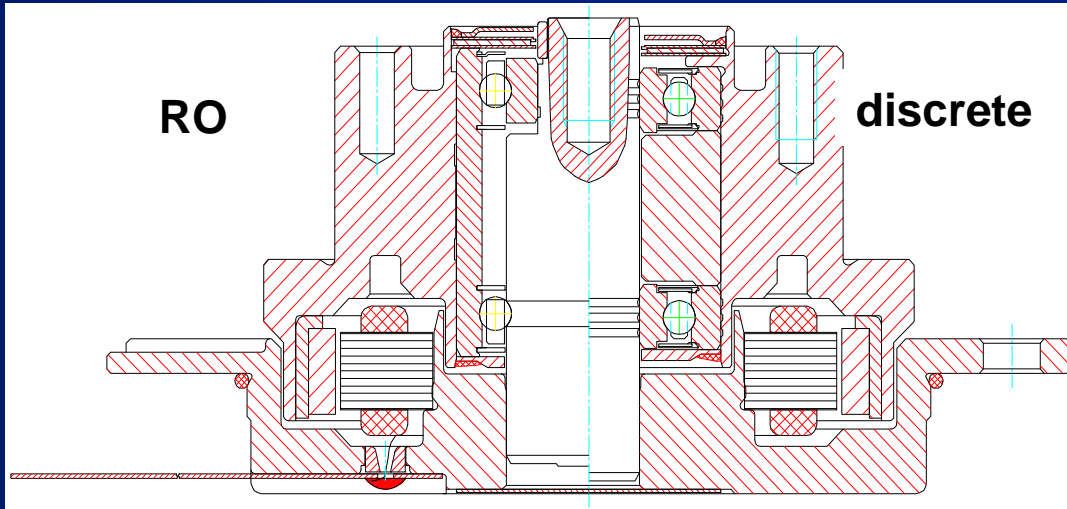
Annual production quantity K=1,000pcs

Excluding Minebea, Other Manufacturers total, referenced from Pixie Pinnacle Corporation

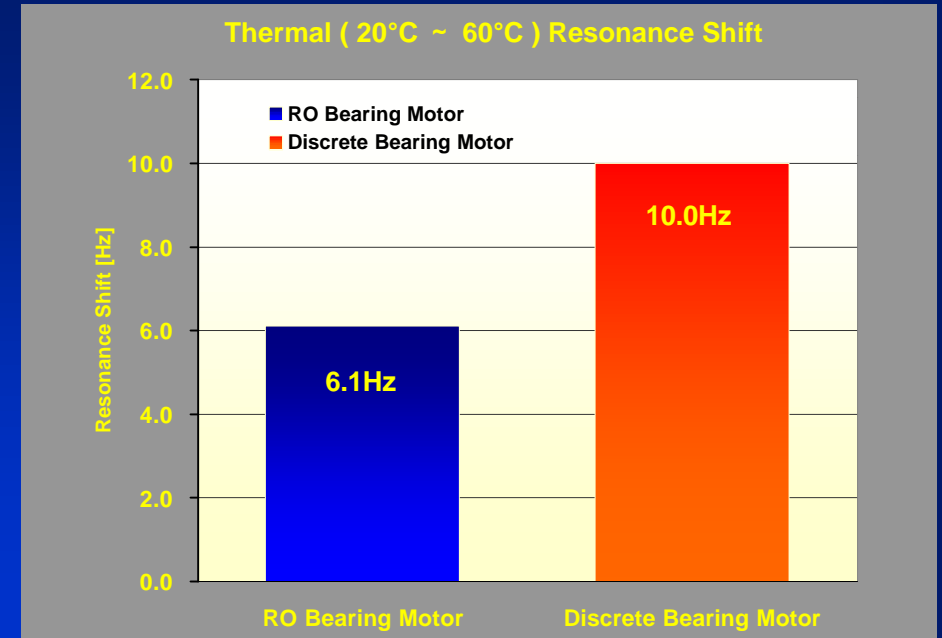
## Structure of RO Bearing



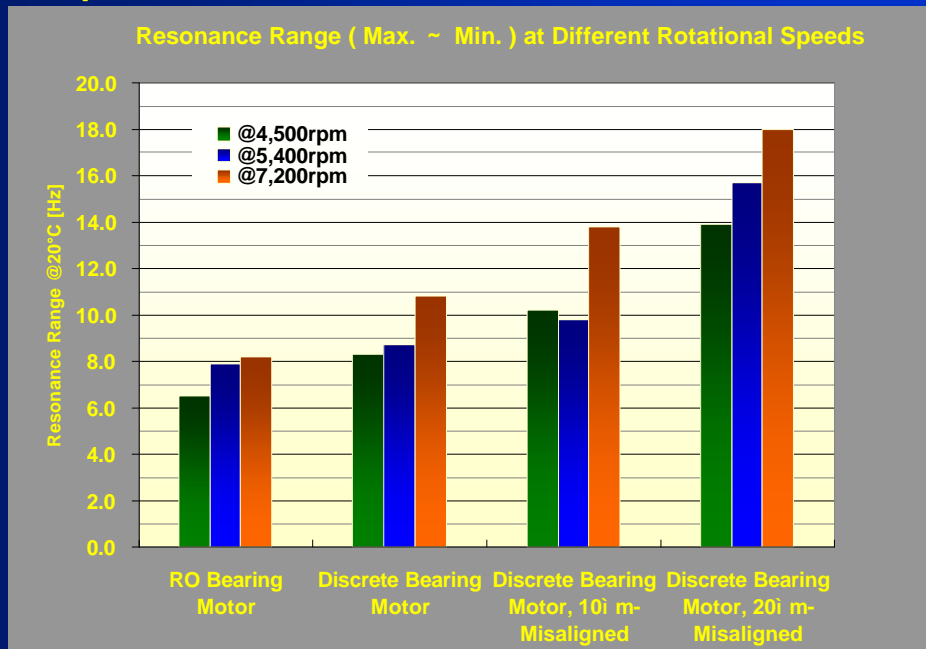
## 2. RO Bearing Motor – Performance and Advantage



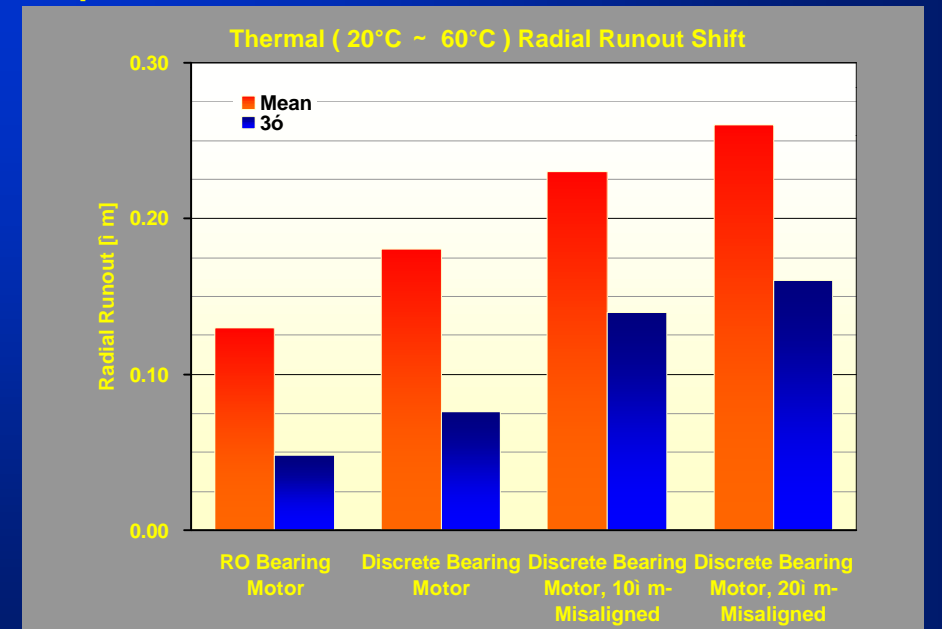
### Graph A



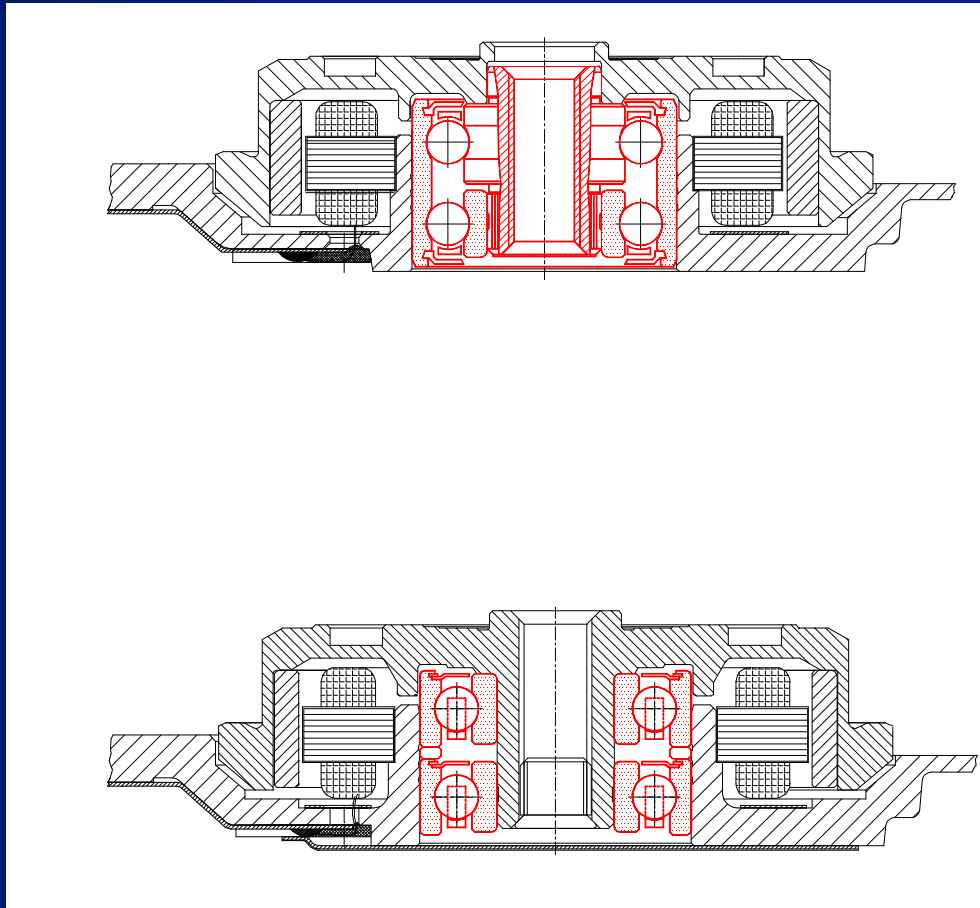
### Graph B



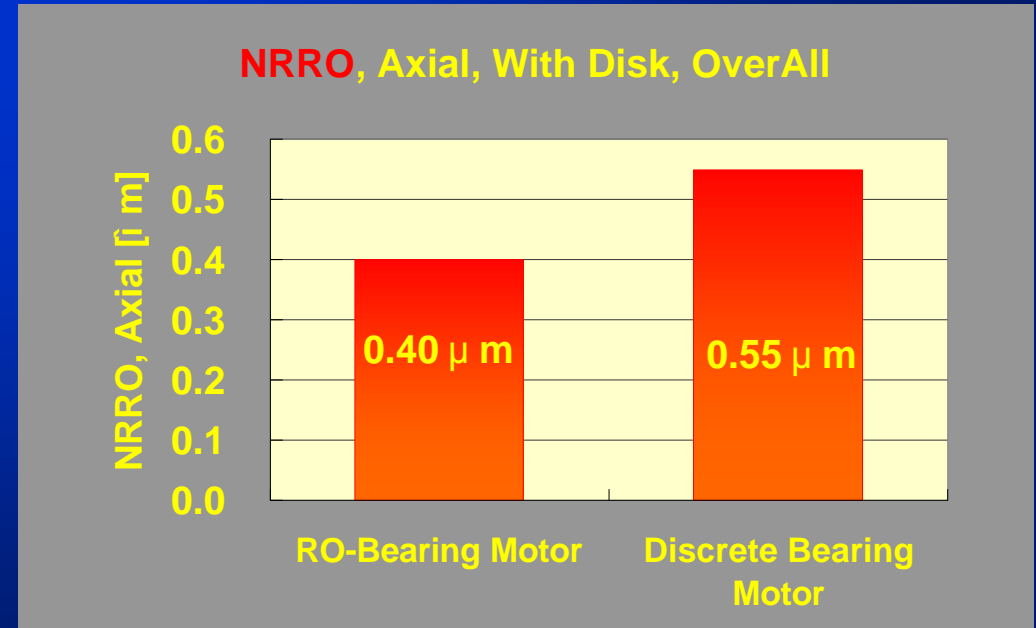
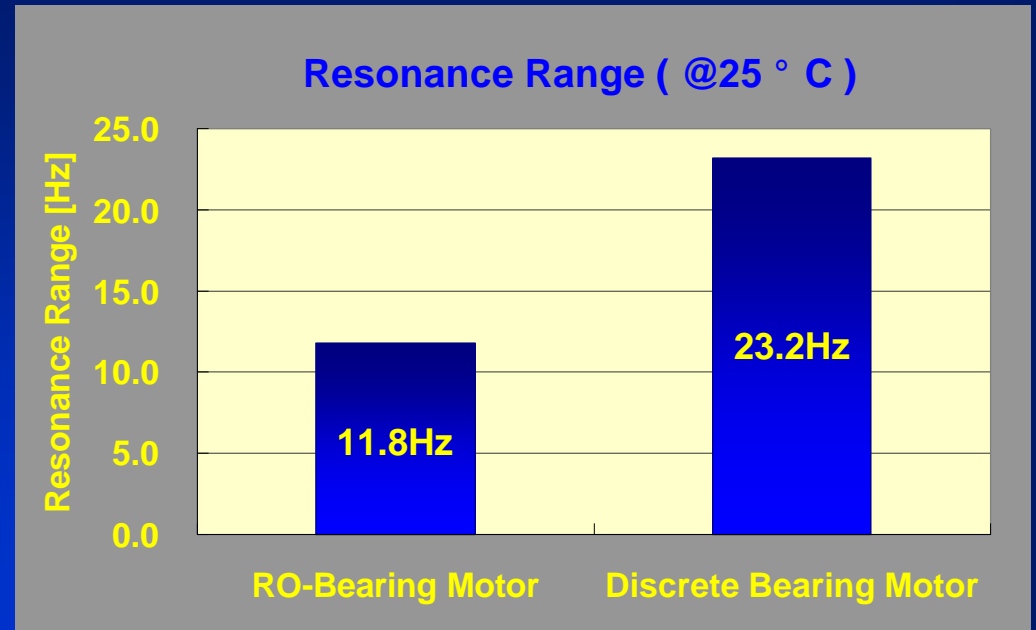
### Graph C



## 2.5 inch Spindle Motor Performance



~ RO Bearing stiffness results in smaller NRRO and narrower Resonance range. ~



## Technical Problem of Ball Bearings with Ceramic Balls

### Loosing of Preload

#### Ball Bearing with Steel Balls:

Same Ball and Ring Materials

=> Same Thermal Expansion

No Preload Loosing Problem in Temperature Variation

#### Ball Bearing with Ceramic Balls:

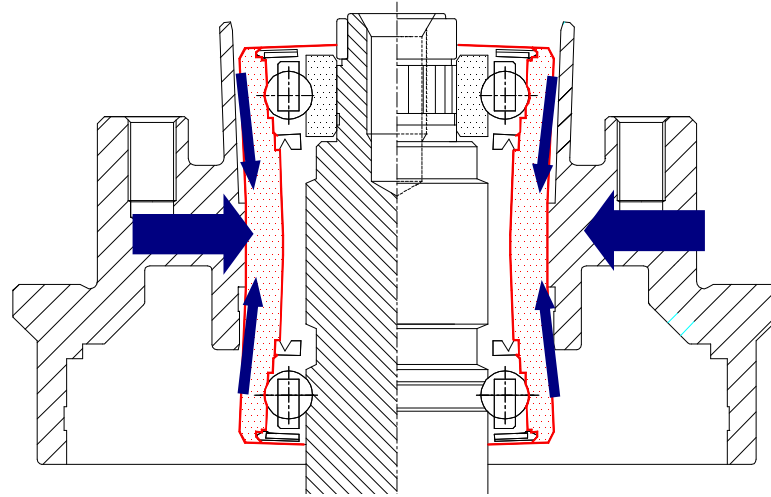
Different Ball and Ring Material

=> Different Thermal Expansion

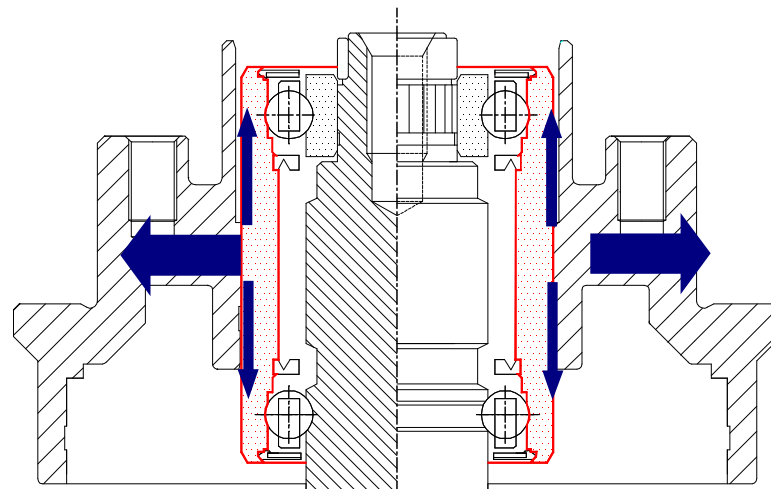
Preload Loosing Problem in Temperature Variation



## Prevention of the Loosing Preload in RO Bearing with Ceramic Balls

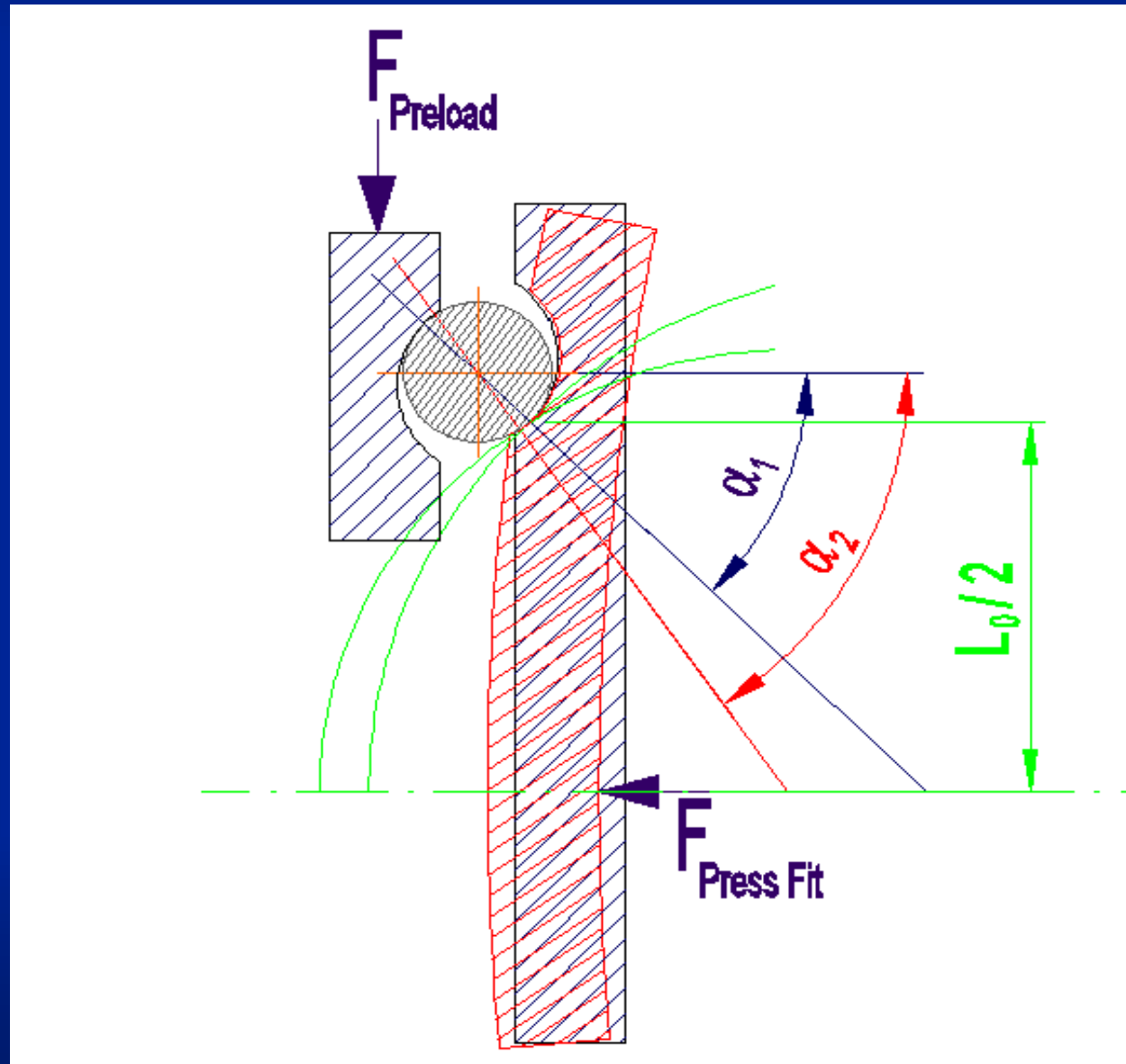


Room Temperature

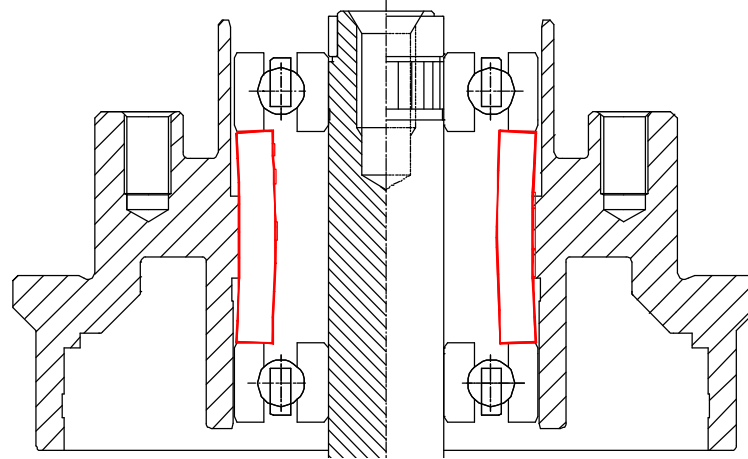


High Temperature

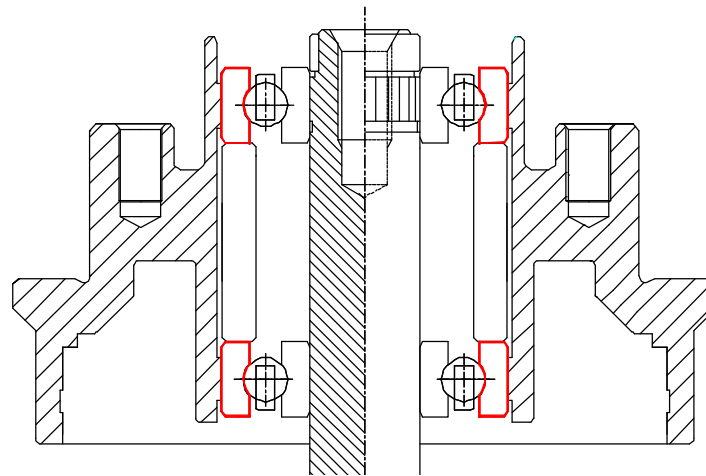
## Principle of Compensating the Preload



## Difficulty of Retaining the Preload in Discrete Ball Bearings with Ceramic Balls



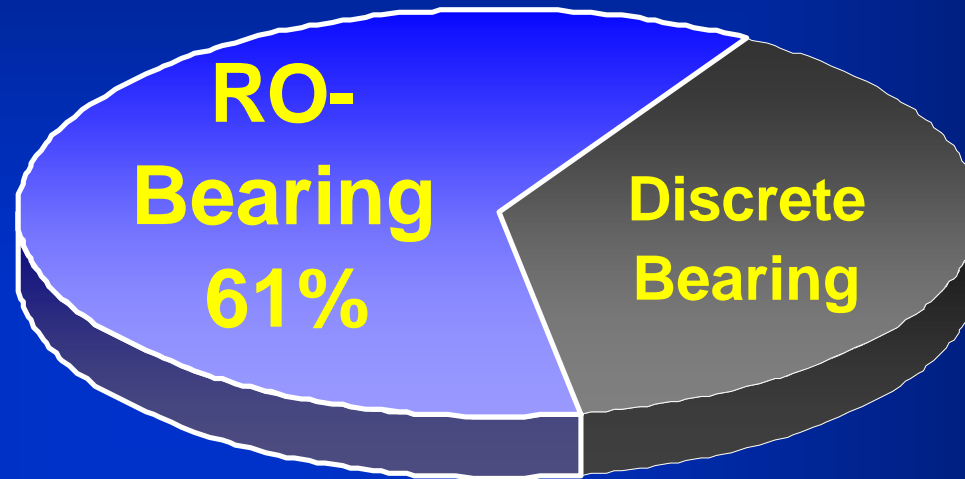
Compression of Spacer



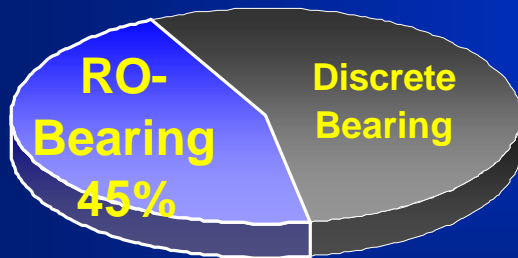
Compression of Outer Ring

**NO**

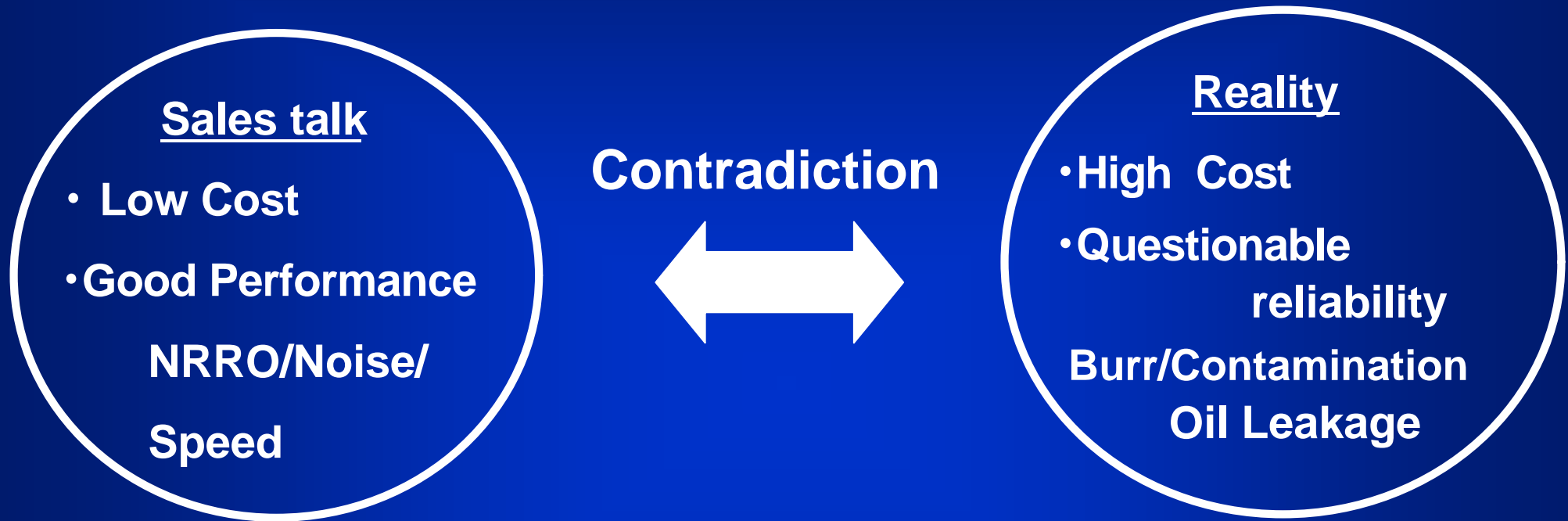
## Projection of RO Bearing Motor Production



**2000 CQ3**  
**3,500Kpcs / Month**



**2000 April**  
**2,150Kpcs / Month**



**Cost is a Key to the Success  
in FDB Business.**

## FDB developed by Seagate

**Capital expenditure:**

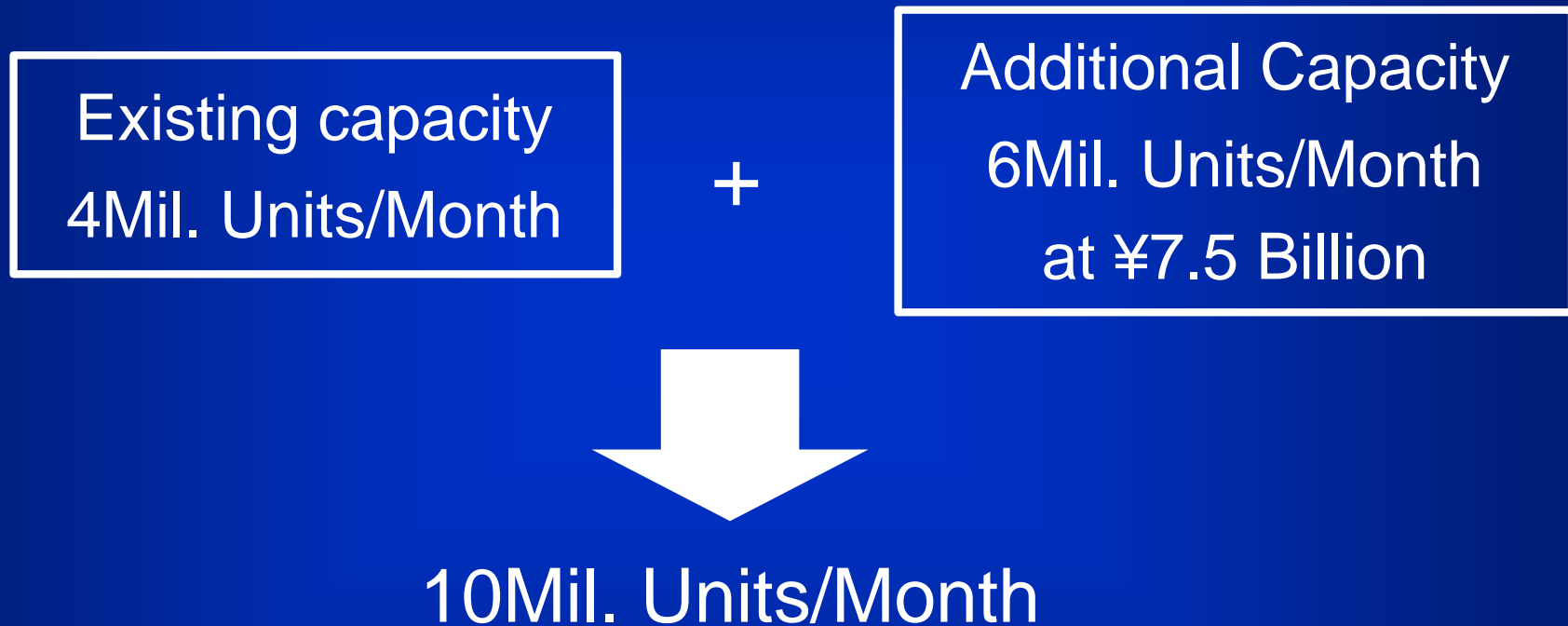
**2 Ball Bearings + 1 Shaft > 1 FDB**

**(Greater than)**

**Reliability: Excellent Design and know-how**

**(Burr Free, less Contamination and No Oil Leakage)**

## Capital expenditure for Additional HDD Spindle Motor Production Capacity



FDB Mass production starts within year 2000

## Spindle Motor Performance Comparison by Bearing Types

	Discrete	RO	Non Minebea's FDB
NRRO			
Life, High Speed Rotation			
Acoustic Noise			
Load Carrying Capacity			
Torque			?
Shock Torrelance			?
Thermal Characteristics			?
Cost Advantage			?
Rotating Direction	Both	Both	Specific
Ease of Assembly			?

(Note) RO : Ceramic Ball Type

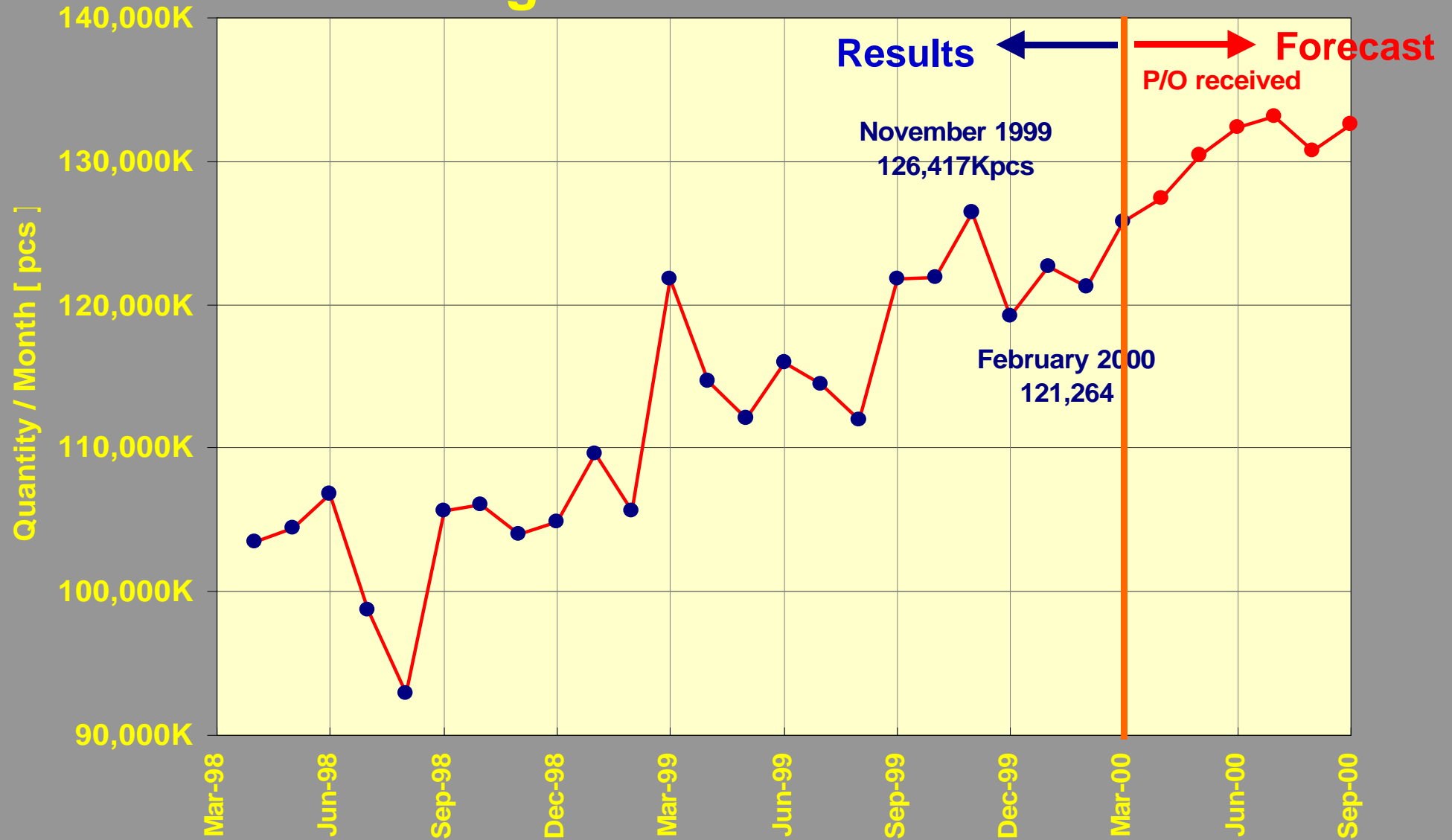


## Spindle Motor Performance Comparison by Bearing Types

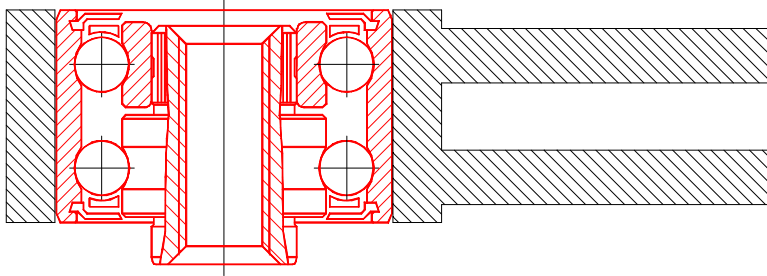
	Discrete	RO	Minebea's FDB
NRRO			
Life, High Speed Rotation			
Acoustic Noise			
Load Carrying Capacity			
Torque			
Shock Torrelance			
Thermal Characteristics			
Cost Advantage			
Rotating Direction	Both	Both	Specific
Ease of Assembly			

(Note) RO : Ceramic Ball Type

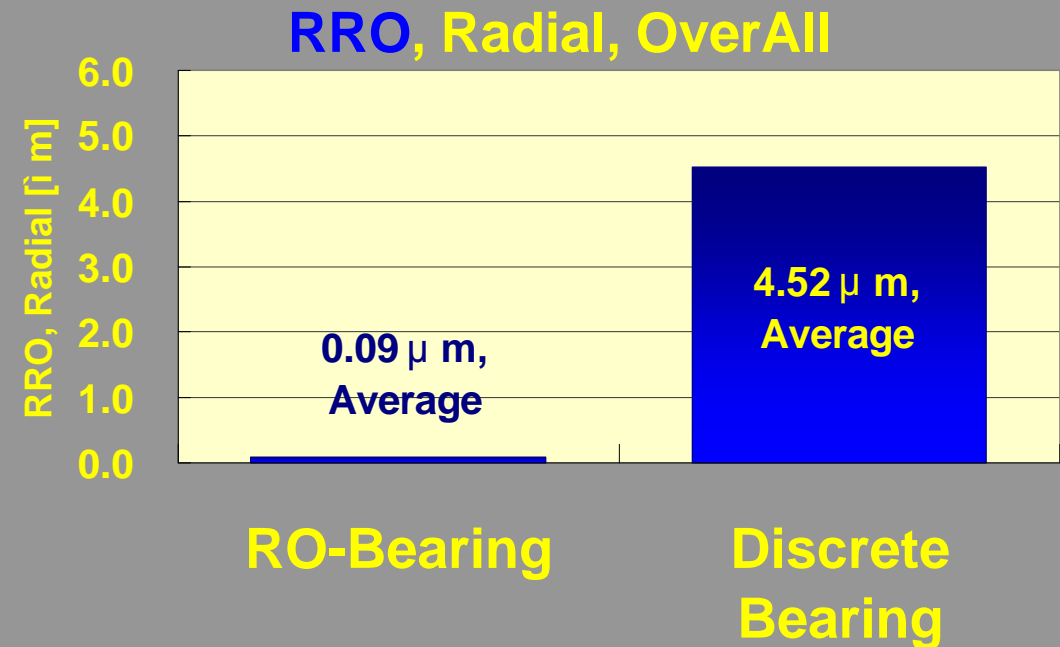
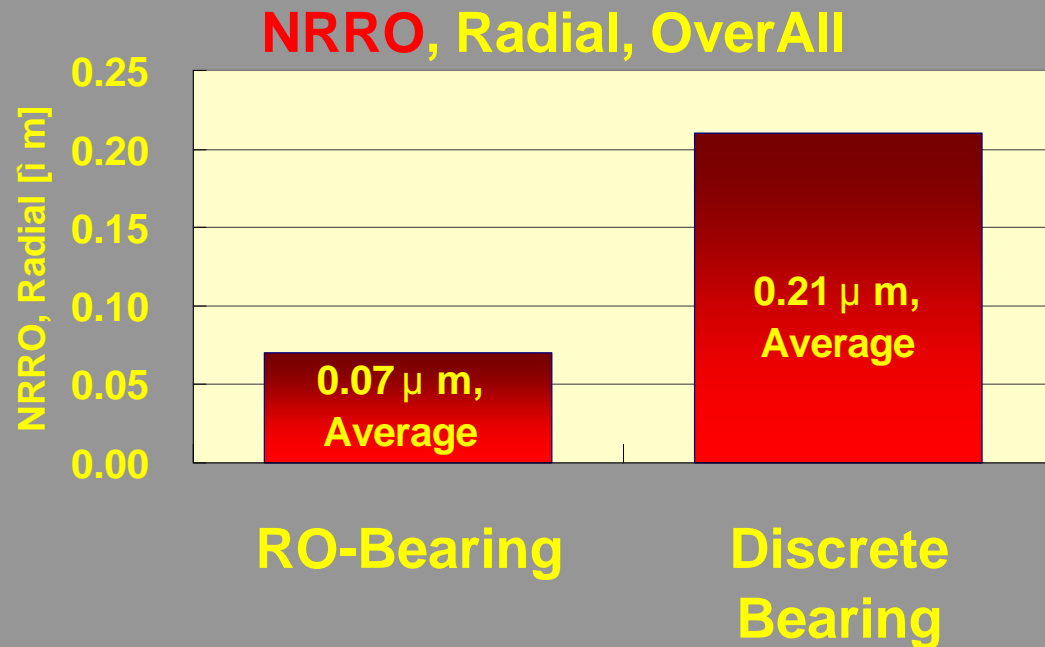
## Ball Bearing Sales Results & Forecast



**Eg.1 : Precision Pivot Assy.**

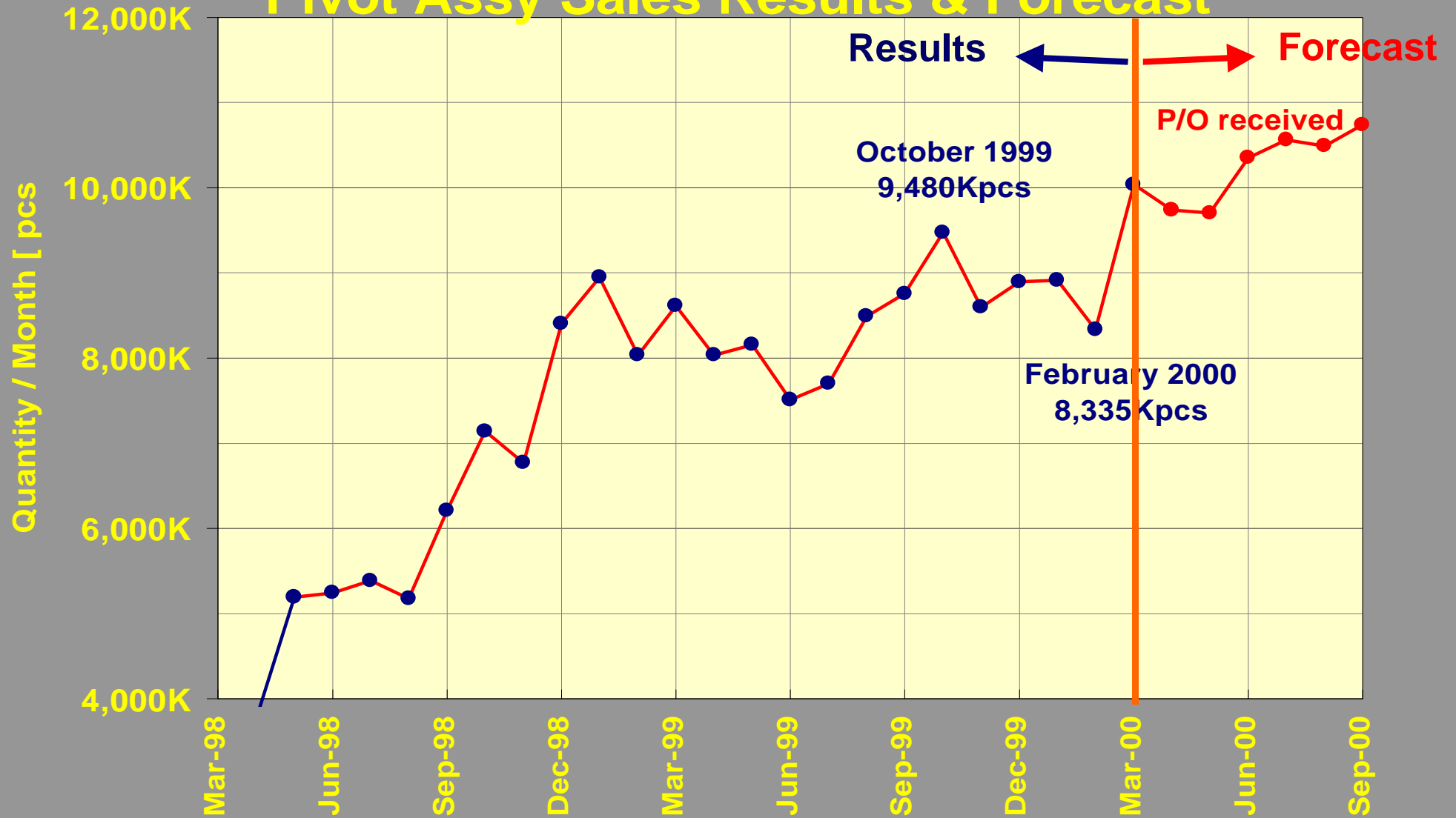


**Though we now have a strong demand of RO Bearing for HDD Spindle Motors, we will explore new applications.**

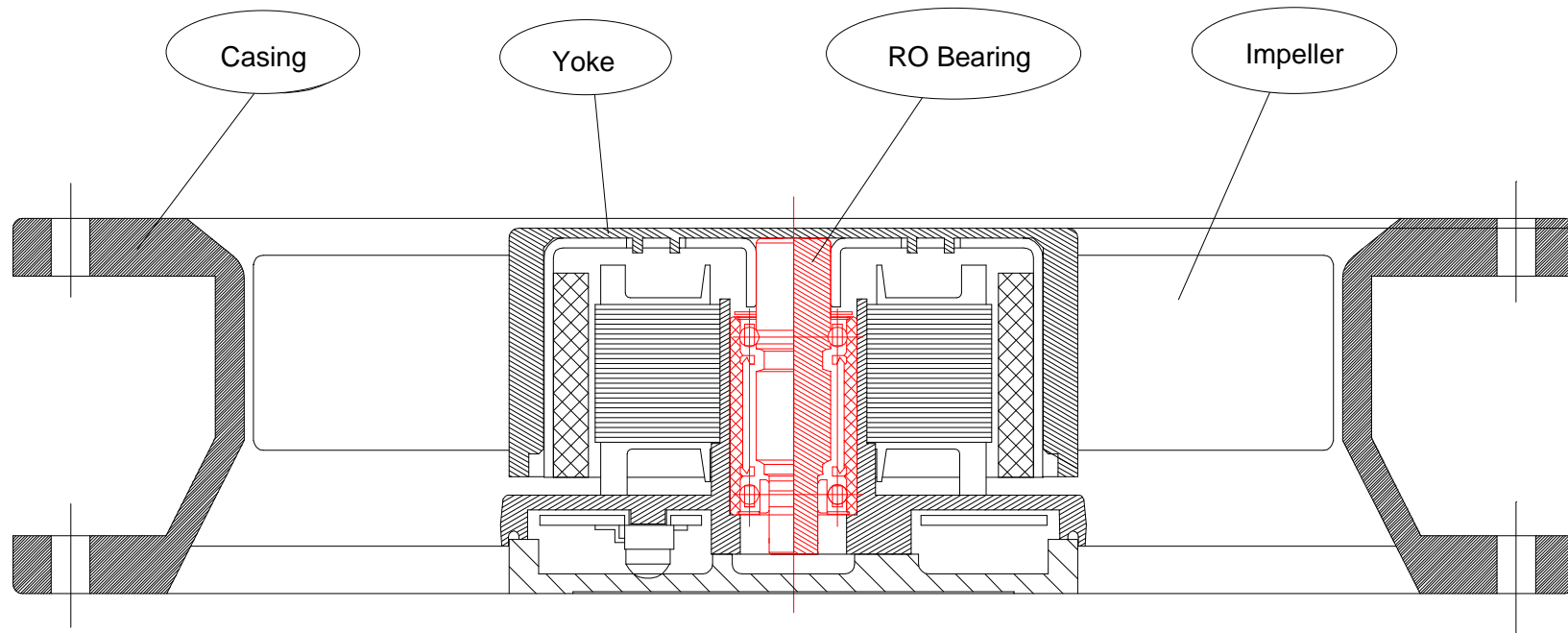


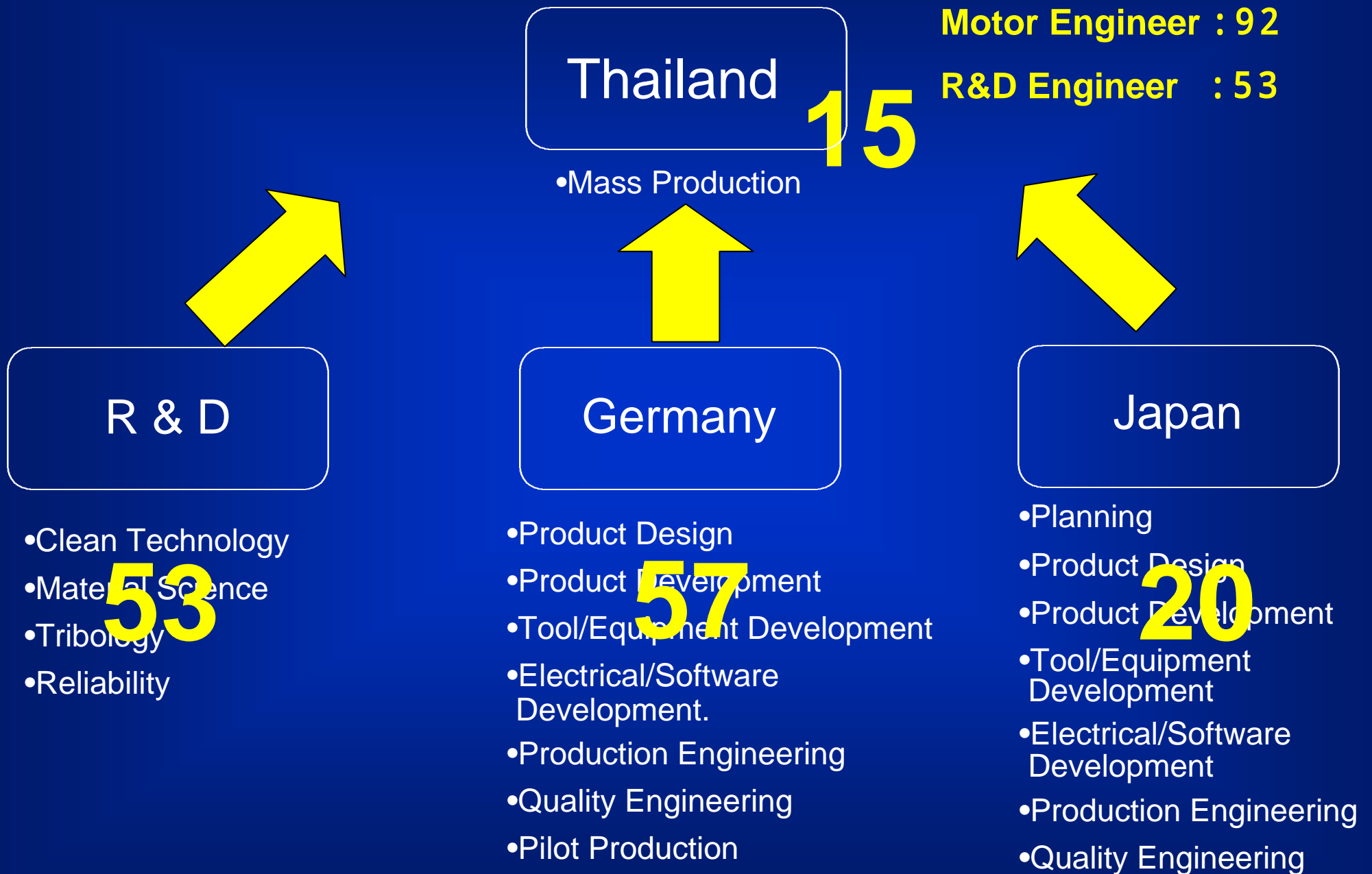
Rotating accuracy comparison between RO bearing and Discrete Bearing for Pivot Assy.

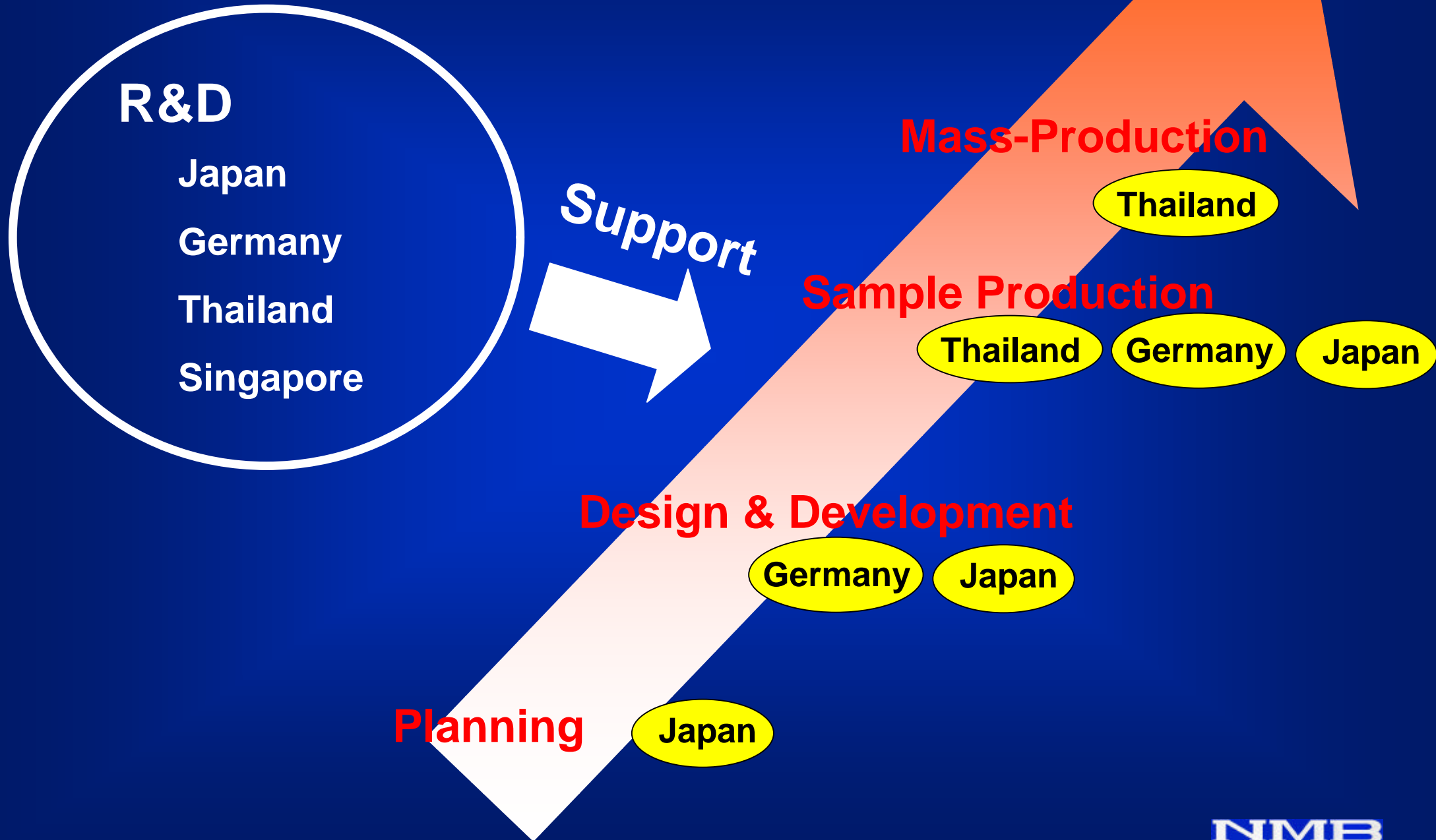
## Pivot Assy Sales Results & Forecast



# RO Bearing Fan Motor - Ultra High Performance & High Reliability -







- 1 . Minebea HDD Spindle Motor expects Strong Demand and Steep Growth.**
- 2 . Minebea HDD Spindle Motor continues to use RO Bearing because of its Superior Performance.**
- 3 . Minebea FDB has Advantages in both Cost and Reliability.**
- 4 . FDB does not Affect has Minebea's Current Ball Bearing Business.**
- 5 . RO Bearing will be used not only for HDD Spindle Motors but also for Other High Value Added Products.**
- 6 . Globalized R&D Production set up will enhance Minebea's Further Growth.**