On PKM with articulated travelign plate abd large tilting angles

LIRMM

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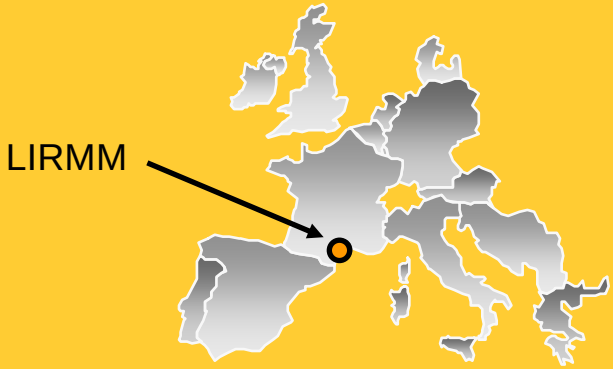


Goals of this paper

Propose a new kinematics with:

- 3 translations
- **2 rotations**

With large tilting angles

(ie with more than +/- 45 degrees for both)

For example for 5 axis milling

Presentation summary

Points adressed:

- General solutions to reach large tilting angles
- Solution for 5-axis (3T-2R) Eureka
- Modeling & Workspace
- Conclusion

Remote actuation

Constraint:

Actuators as close as possible to the base

Problem well known for one rotation.

Solutions :

- Remote actuation
- Hybrid architecture
- Redundancy
- « Natural » solutions
- Articulated traveling plate

Remote actuation

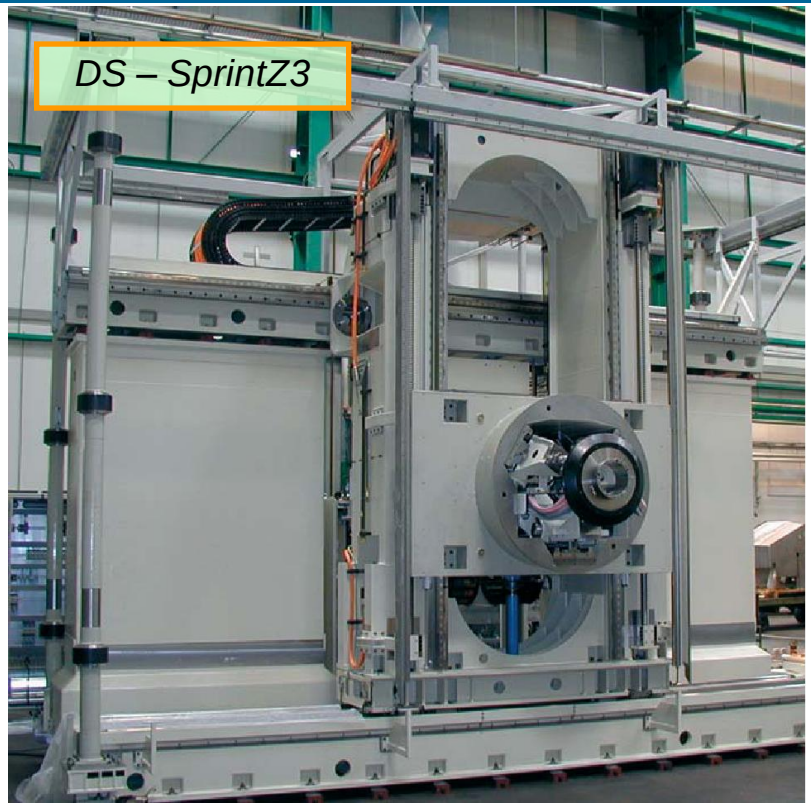
Revolute joint is added on the traveling plate and « tele-operated from the base

ABB flexpicker

⇨ Bad sevice life of elements

Hybrid architecture

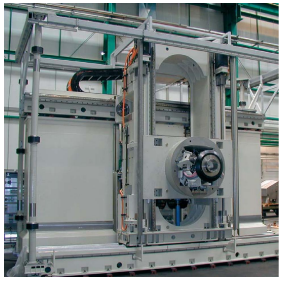
- Two mechanisms assembled in a serial way
- Each one can be optimized



⇨ High moving masses (Actuators far from the base)

Hybrid architecture

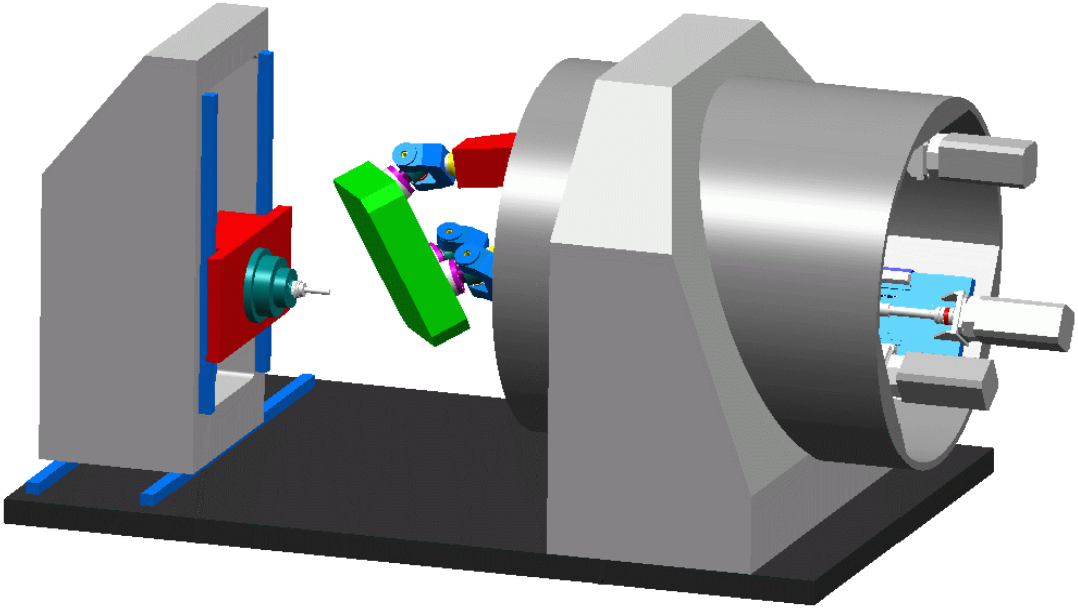
- Two mechanisms assembled in a serial way
- Each one can be optimized



⇨ High moving masses (Actuators far from the base)

Hybrid architecture

- Left hand / right hand
- Shared dofs



⇨ Not realistic for manipulation

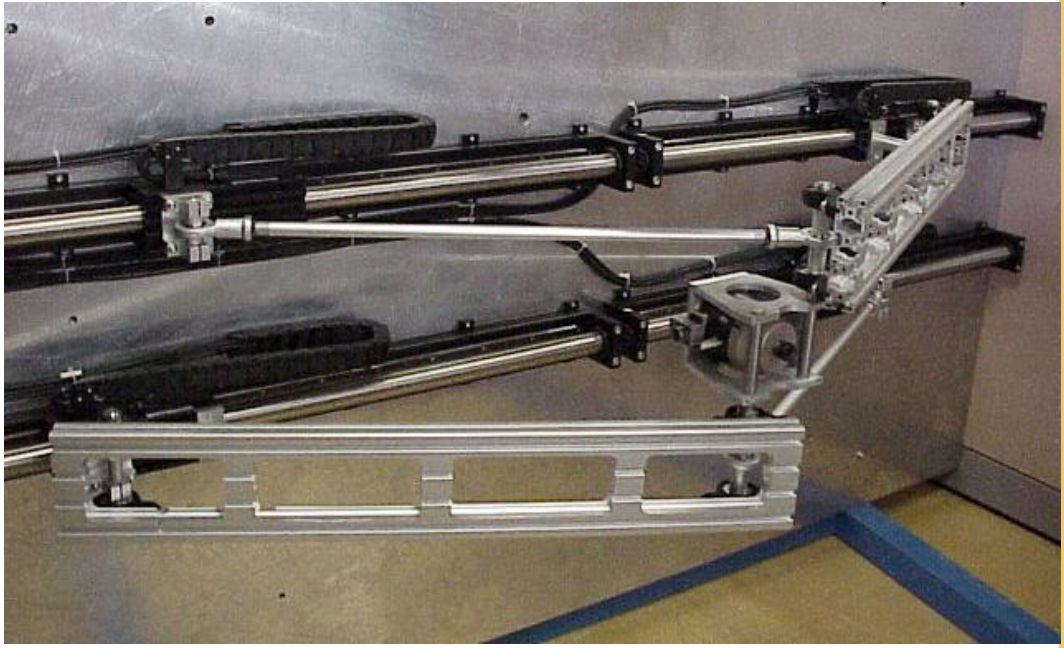
Redundancy

Several types of redundancy exist:

- Actuation redundancy
- Kinematic redundancy

Actuation Redundancy

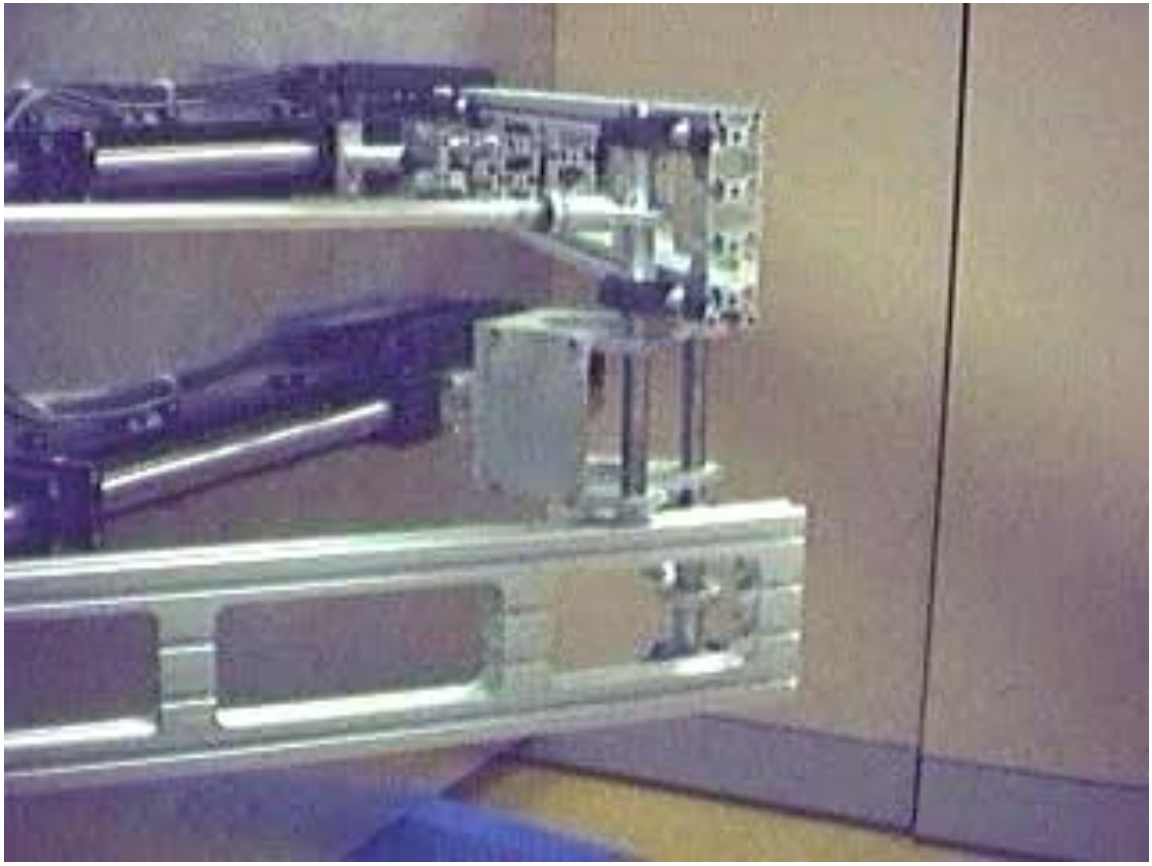
Generates internal forces



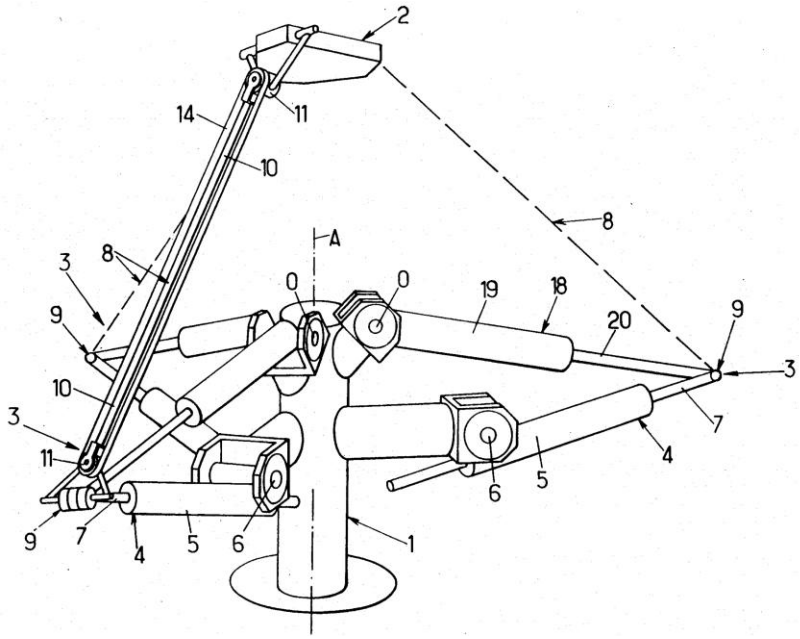
Archi prototype

⇨ Needs force control

Actuation Redundancy



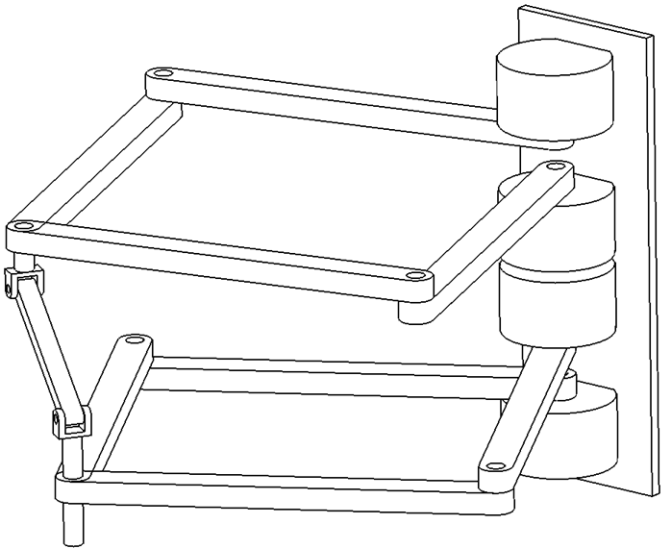
Kinematic Redundancy

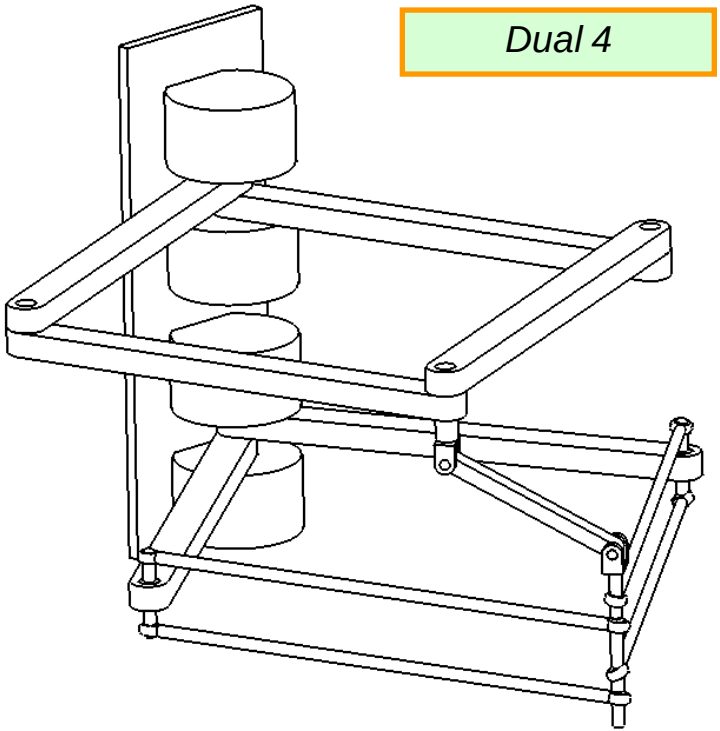


⇨ Complexity increases

“Natural” solutions

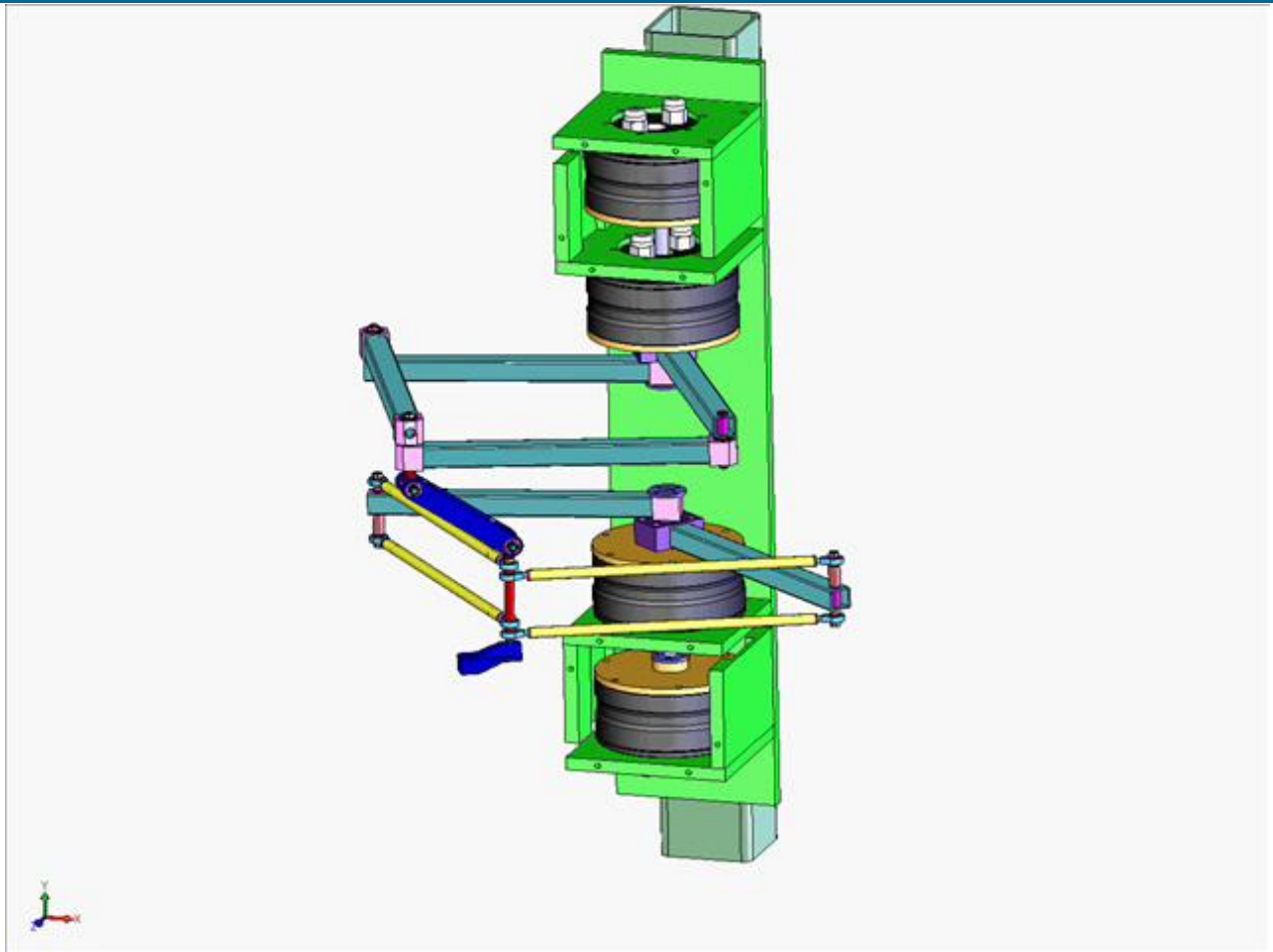
Nevertheless some « natural » solutions exist





⇨ Limited scope

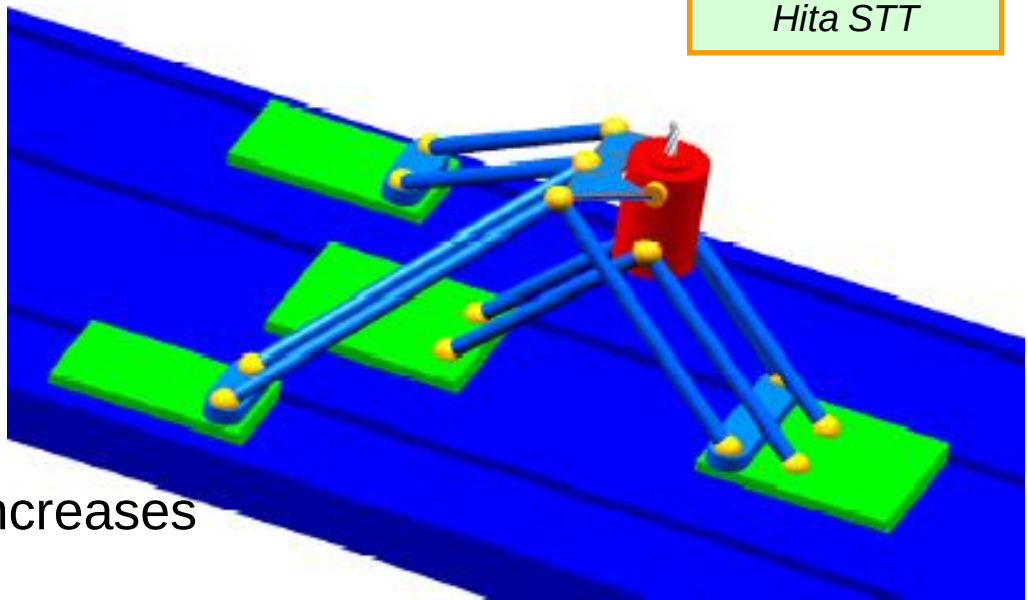
“Natural” solutions



Articulated traveling plate

- Traveling plate is splitted in several parts
- Supports motion transformation /amplification

Hita STT



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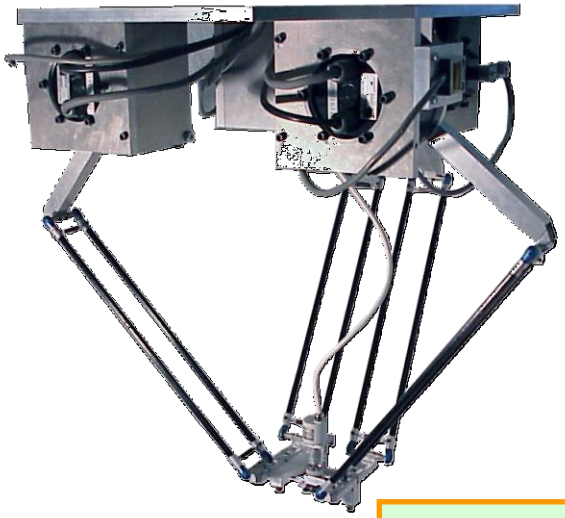
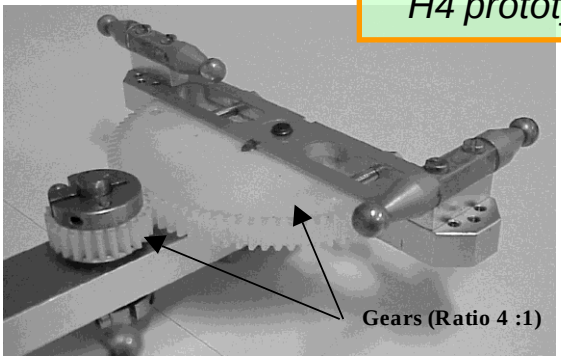
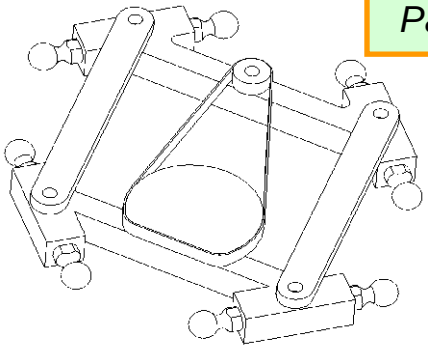
Articulated traveling plate



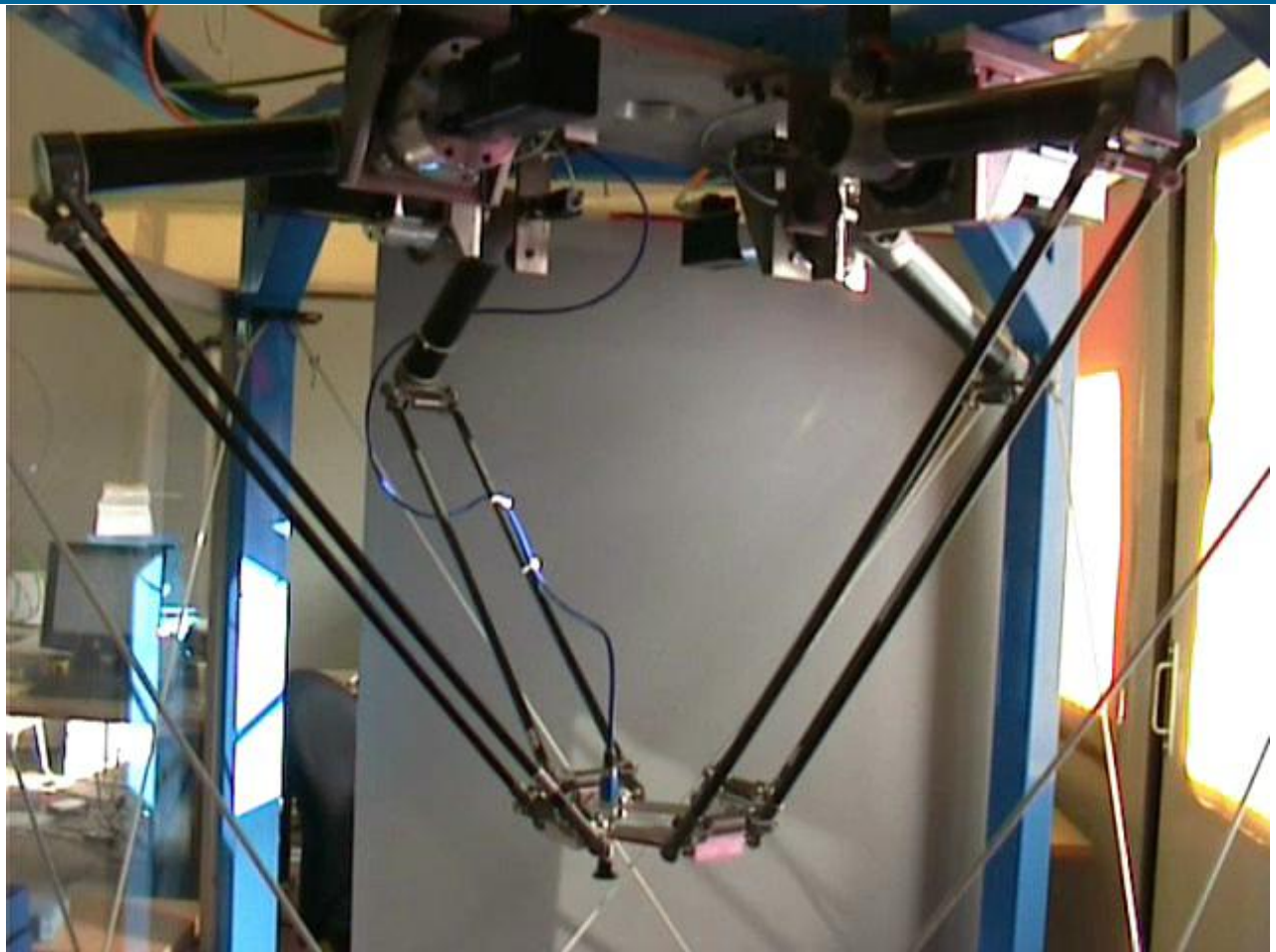
H4 prototype



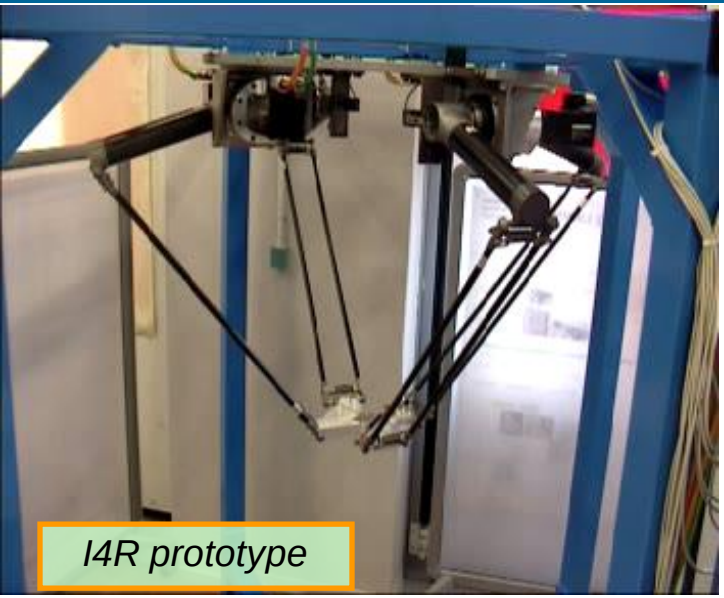
Par4 prototype



Articulated traveling plate: Par4

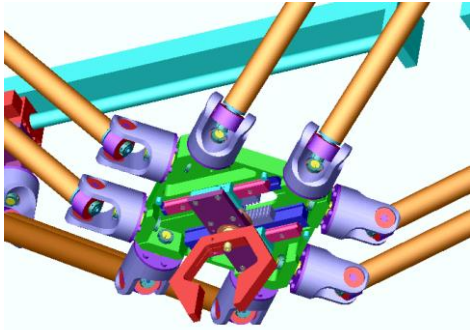


Articulated traveling plate



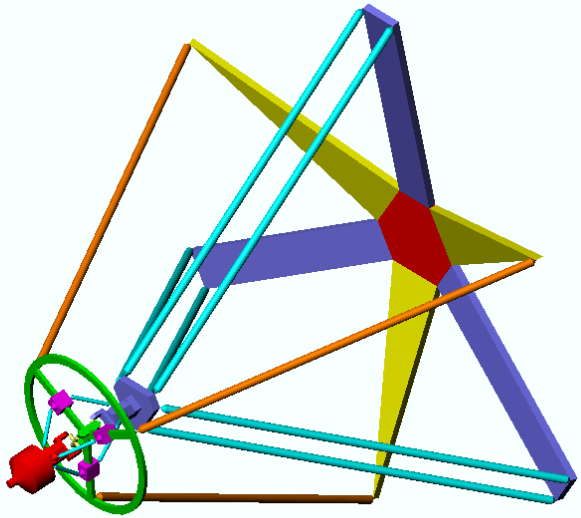
I4R prototype

I4L prototype

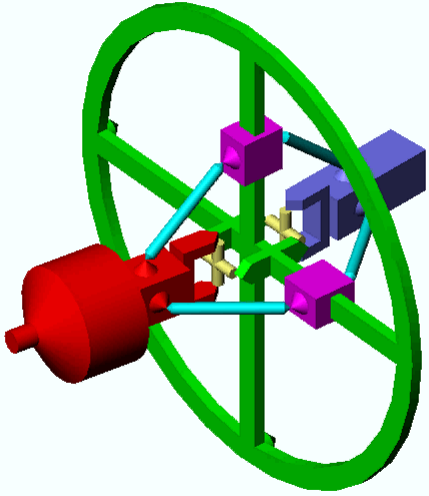


Articulated traveling plate

Articulated traveling plate



Twice mechanism

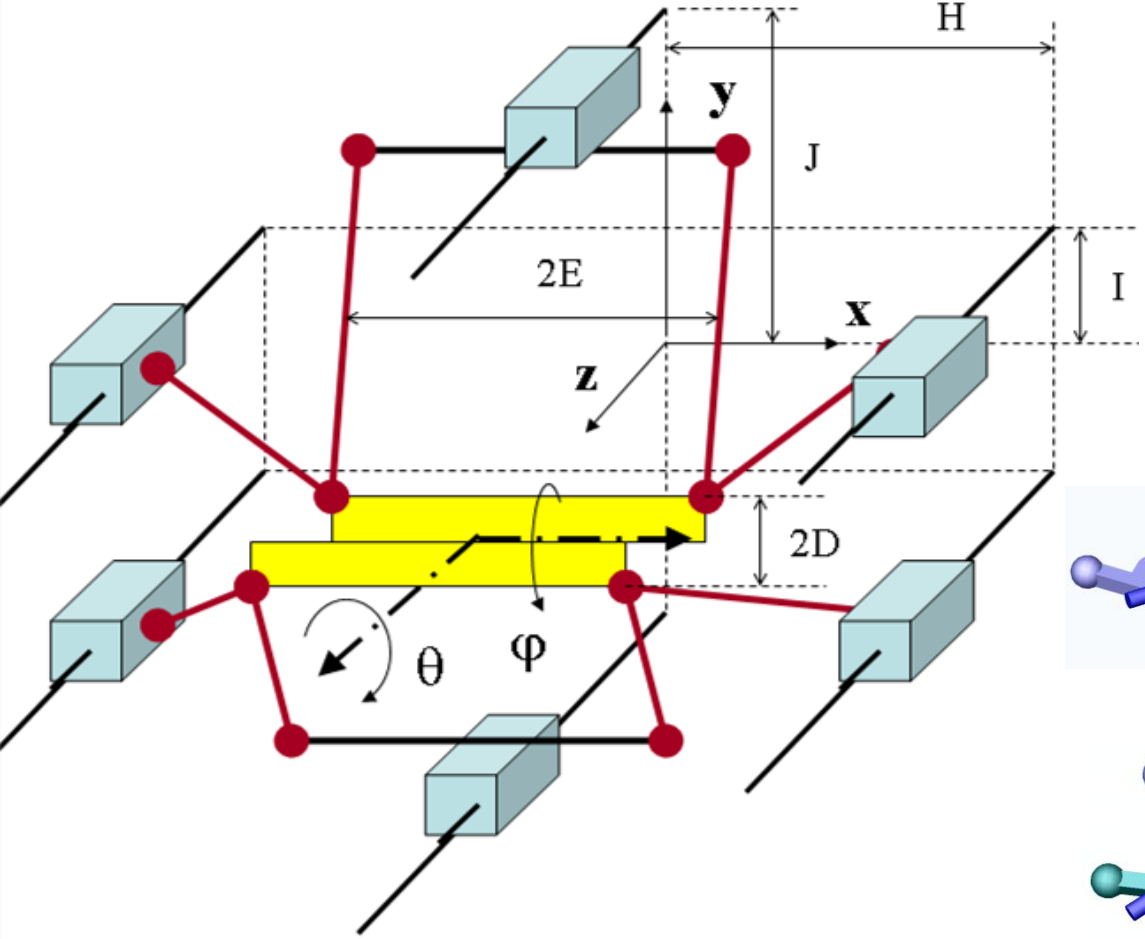


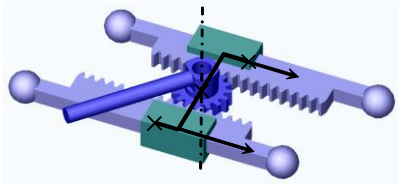
Back to our problem….

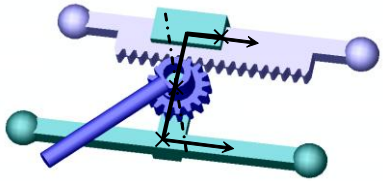
Find a new mechanism :

- 3T – 2R with large tilting angles
- Combine solutions presented before :
  - Articulated traveling plate
  - Redundant actuation

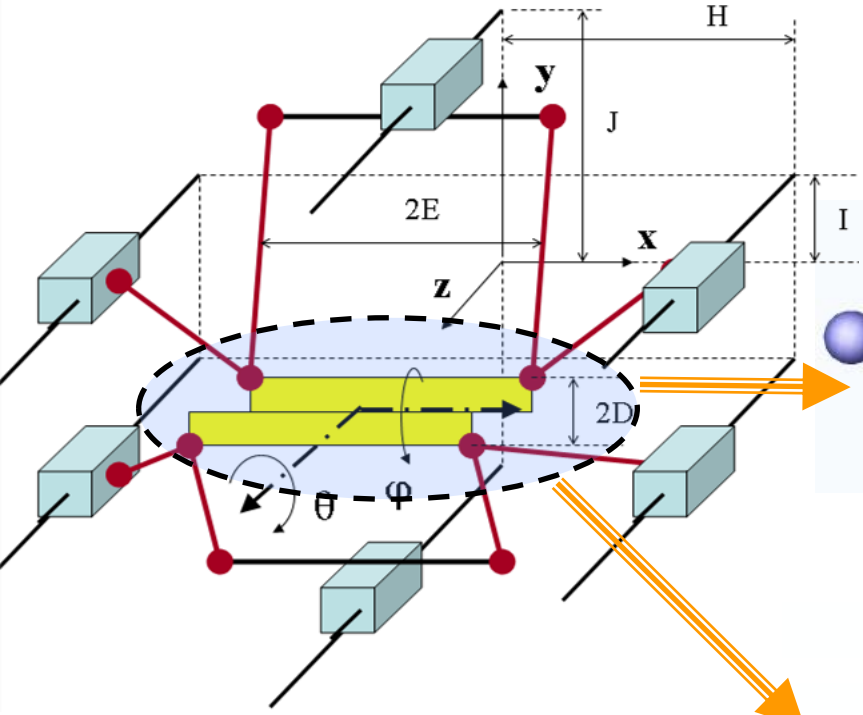
Kinematics of Eureka

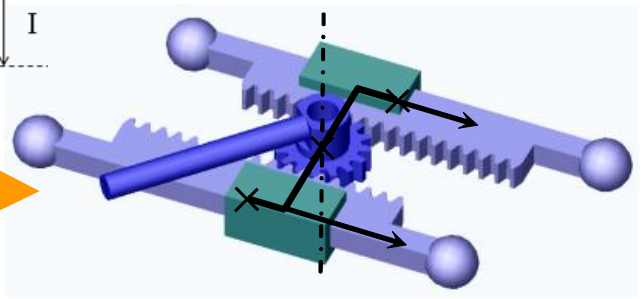




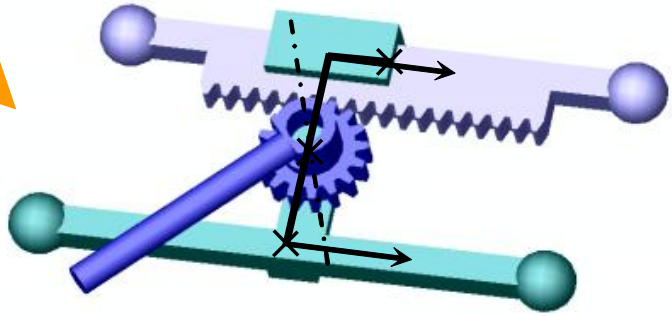


Kinematics of Eureka



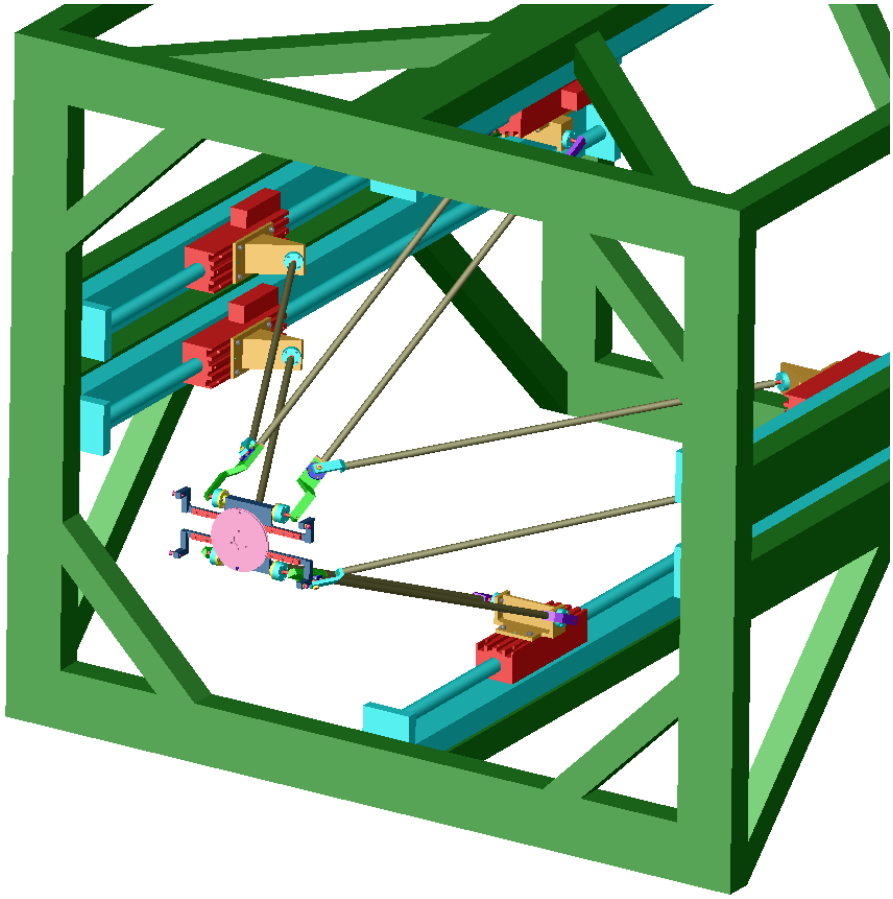


or



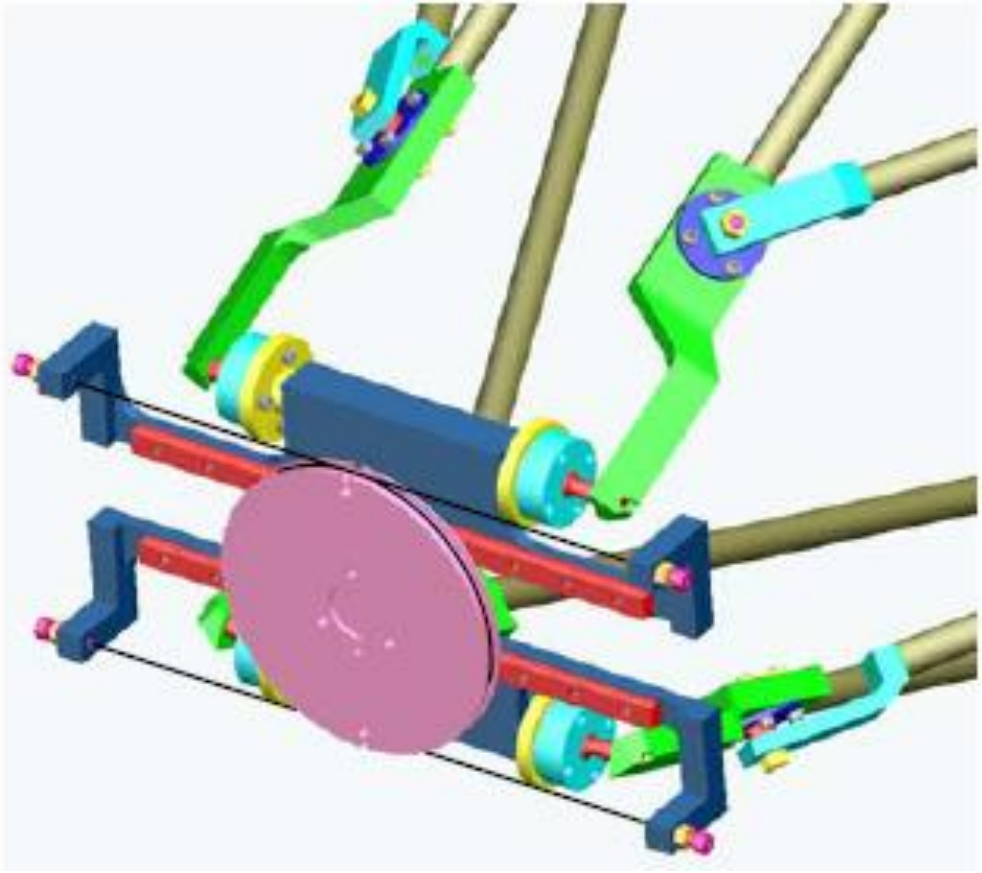
Kinematics of Eureka

Practical design

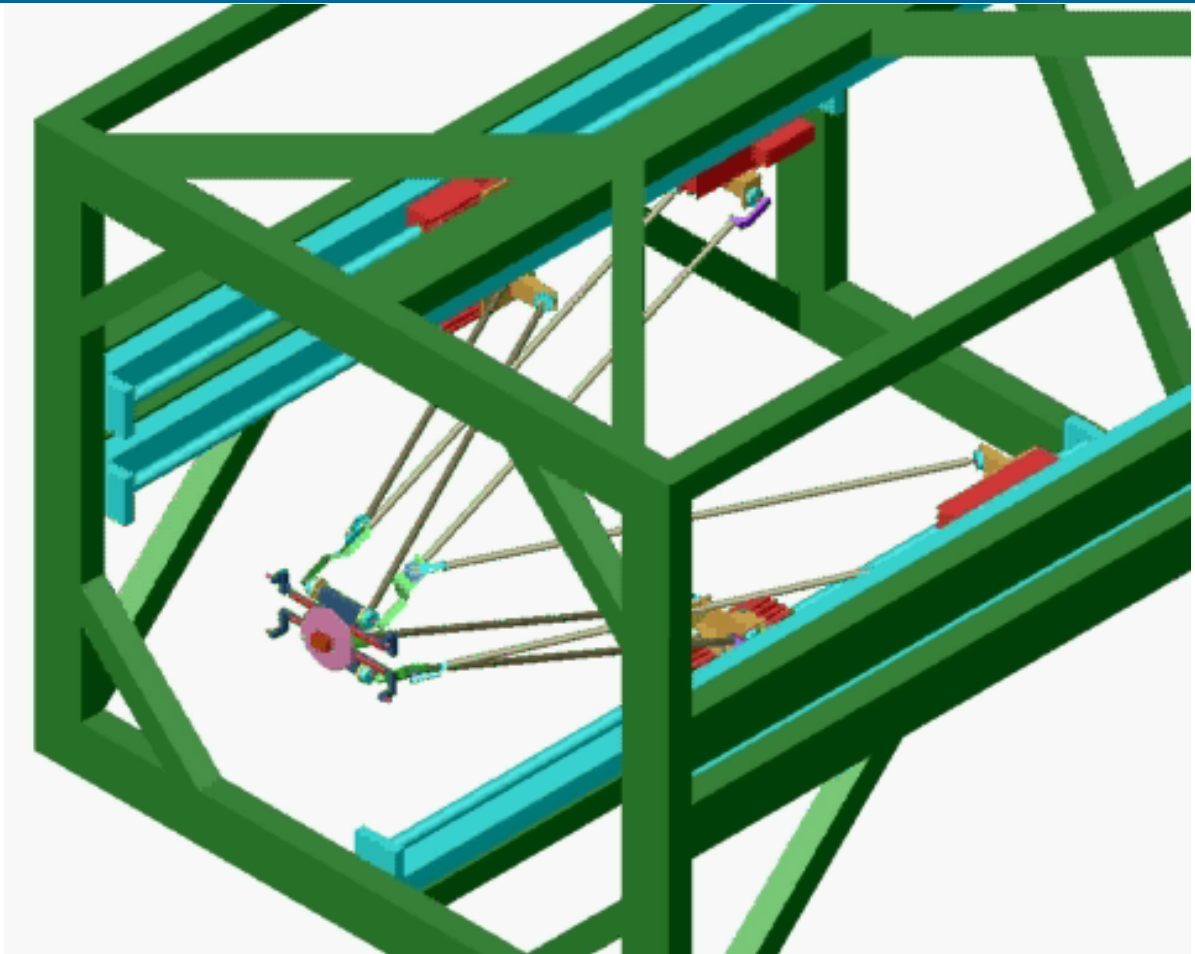


Kinematics of Eureka

Practical design



Kinematics of Eureka

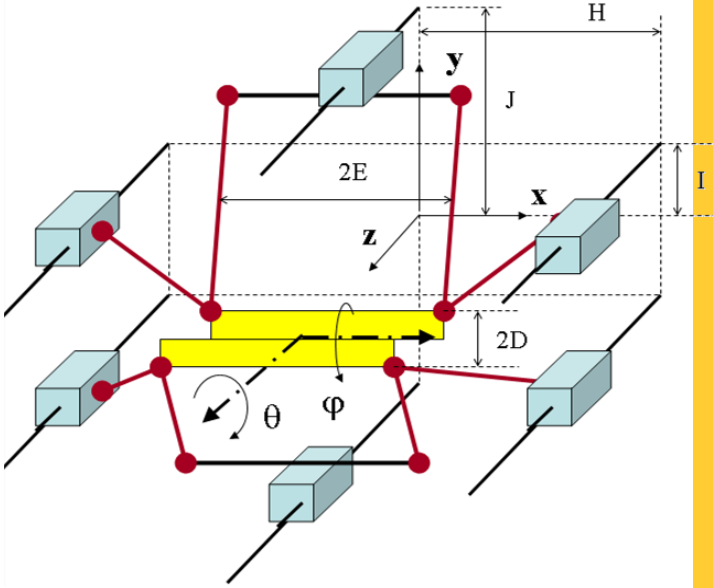


Modeling - workspace

⇨ Analytic direct and forward kinematic models for postion relationship

⇨ Classical linear models for velocity relationship

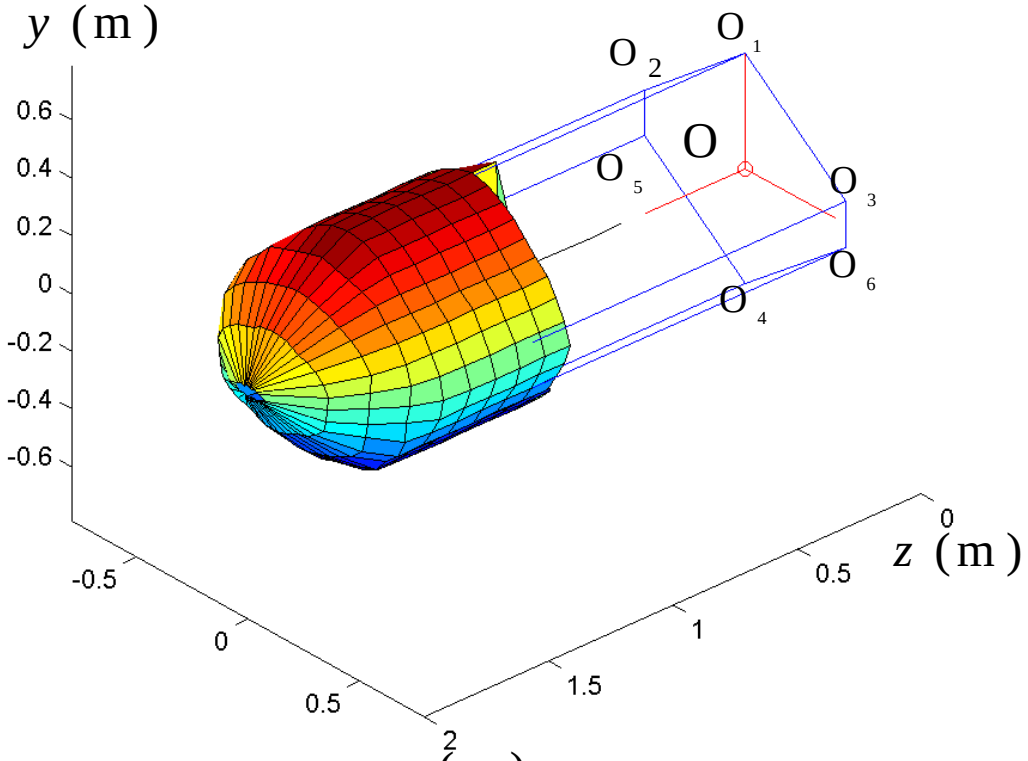
$$J_x \dot{x} = J_q \dot{q}$$



$$\begin{matrix} n^T & (s \times n)^T v & v^T n \\ n^T & (s \times n)^T v & 0 \end{matrix}$$

Diagonal matrix

Modeling - workspace

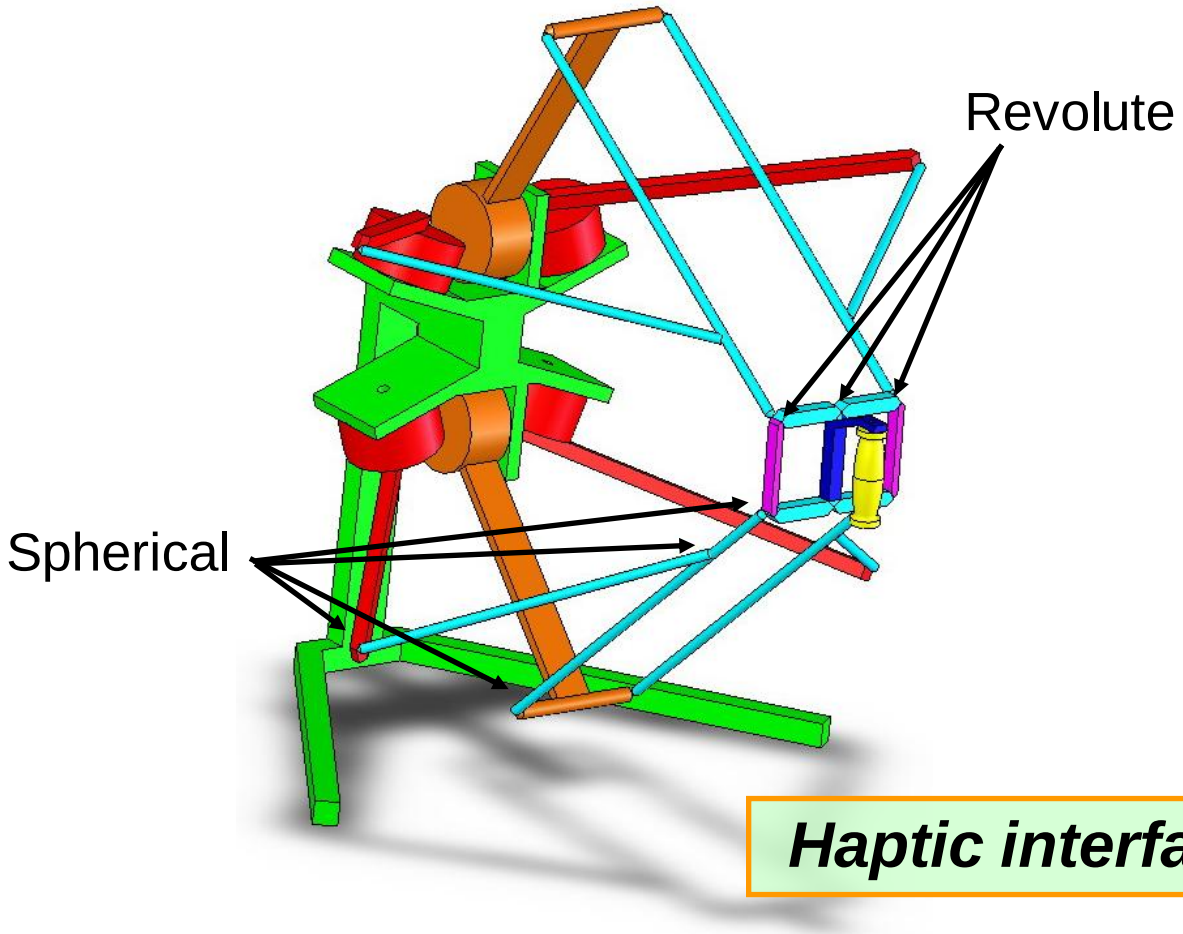


Workspace shape for $\mathrm{cond}(J_{q}^{i\,1} J_{x} W_{x}^{i\,1}) < 8$

Conclusion

- Presentation of several solutions to achieve large rotations with PM
- Presentation of a new kinematics with:
  - 2 rotational dof and
  - large workspace
- Emphasis on the next prototype ….

Conclusion



Haptic interface

Thanks !!!
to you and to my team…

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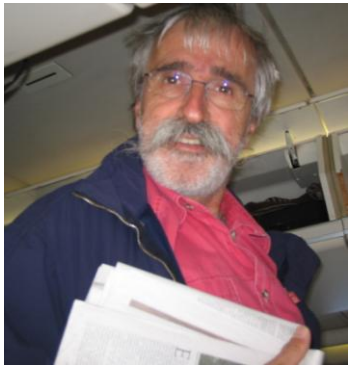

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