

# OPTIMAL LASER SYSTEM FOR MOTION ILLUMINATION

## PROBLEM DESCRIPTION

Training in many sports includes the practice of **harmonized strategic movements**. The laser system aims to **illuminate dynamic paths** of the players.

## Name of Research Group



The research topics are Operations Research, Combinatorial Optimization, Global Optimization, and Numerical algorithms.

## Company name

Company

**Bem 15 Kft.**

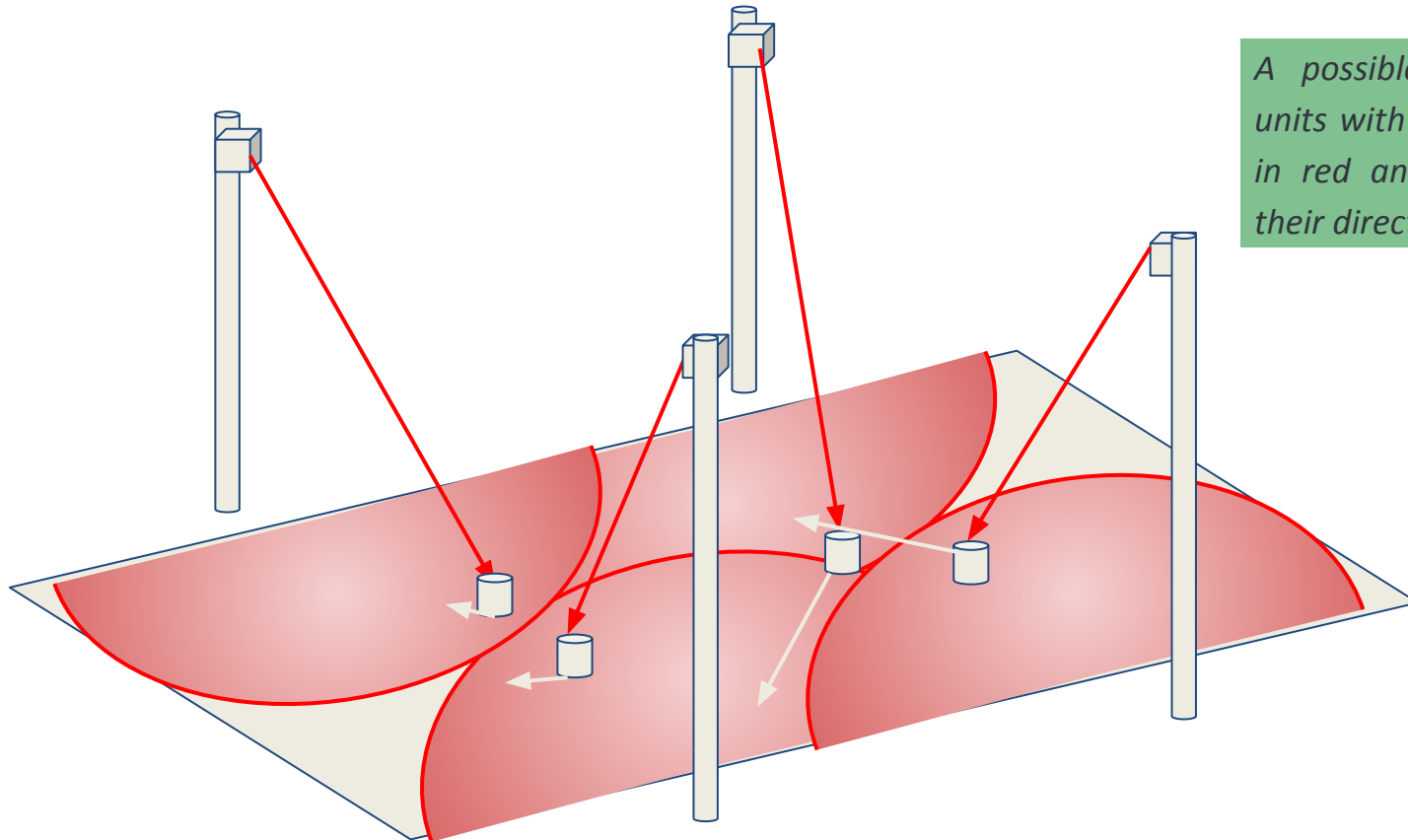
Bem 15 Kft. is a professionally and stable family enterprise. They have many innovative projects in many fields.

# OPTIMAL LASER SYSTEM FOR MOTION ILLUMINATION

H2020 SOCIETAL CHALLENGES  
PRODUCTIVE SECTOR: Sport, training, performance

## Challenges & Goals

Find the optimal number and placement of the lasers, and the best possible assignment of the objects to the lasers, such that in minimal cost the illumination is feasible and satisfies the visibility constraints.



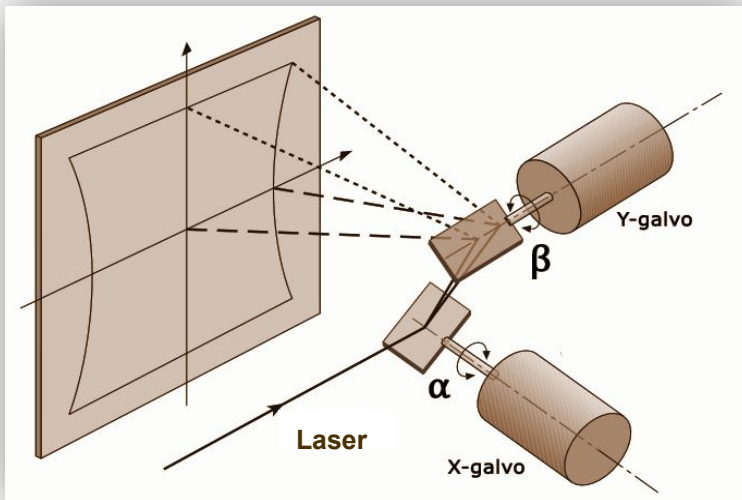
*A possible placement of laser units with their illumination area in red and some objects with their direction and speed.*

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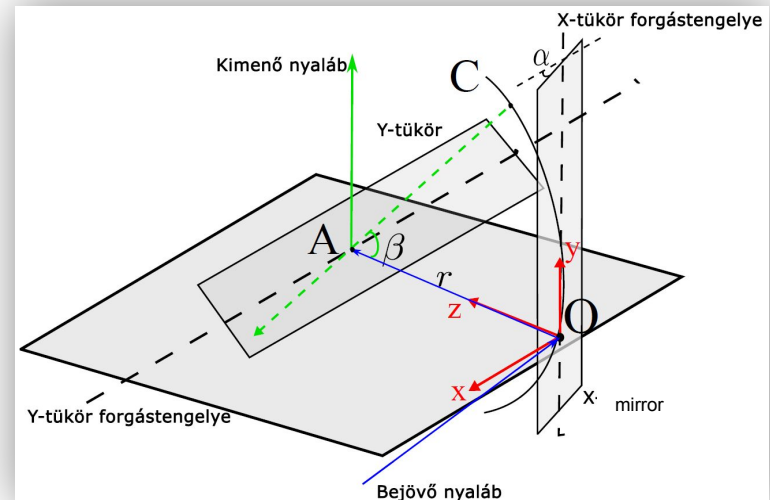
## Mathematical and computational methods and techniques applied

First, the optimal number and location of the lasers are determined modelling the problem as a rectangle covering problem, resulting in a Mixed Integer Linear Programming problem. In order to solve this hard problem, a new constraint generation approach is developed, that can solve any real-size problems.

Next, for a given dataset describing the dynamic paths of the players the assignment of players to lasers have to be determined, such that the brightness of each point satisfy the visibility constraints. This assignment can be seen as an online problem, as each assignment and illumination have to be done in milliseconds.



The illumination area of the laser by the galvo system



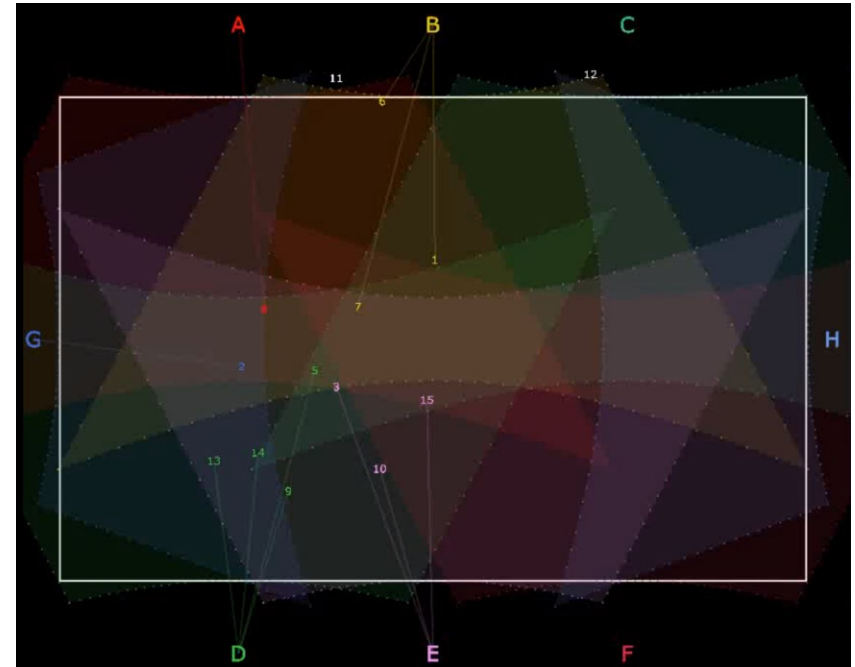
Modeling the mapping of the laser by the mirrors

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## Results & Benefits to the company

A Mixed Integer Linear Programming model, including a constraint generation approach is developed to solve the real-life location problem of the lasers minimizing the cost of the system.

The assignment of players to lasers to be illuminated by is done by heuristic procedures, maximizing the minimum brightness of the illuminated points. The control of the laser beam is done by a two-mirror scanner, through a digital-analog converter, which is controlled by the developed program.



*8 lasers with their area of illumination and the assignment of 12 players to the lasers.*

Possibility to control a laser system is proven, optimal locations of the laser units can be computed, and optimal brightness of the illuminated points is achieved.