

History of Development of the Flexible Pedestrian Legform Impactor (Flex-PLI)

November 3rd, 2011
Japan

Contents

1. Back ground

**2. History of Flex-PLI Development
(Overview)**

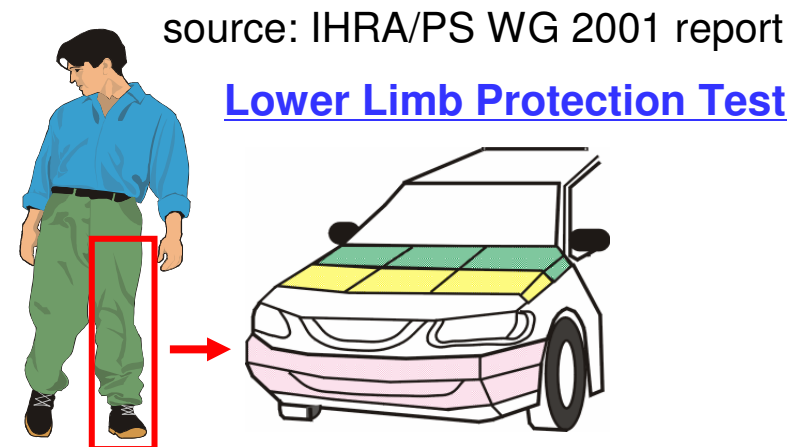
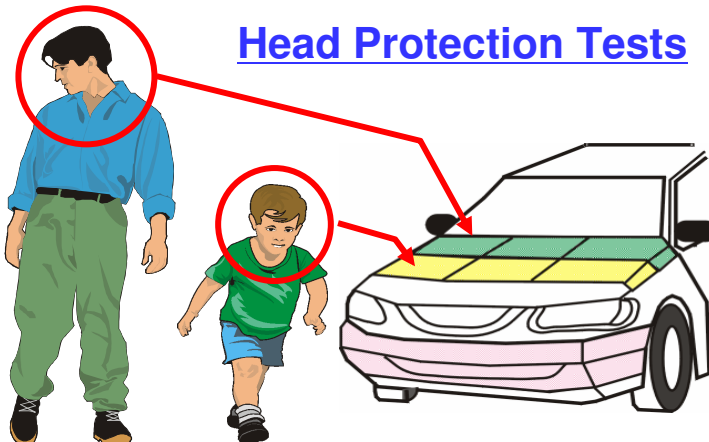
1. Back ground

1. Back ground

- Pedestrian Injured Body Regions -

(USA, Germany, Japan, and Australia : All Age Groups : AIS 2-6)

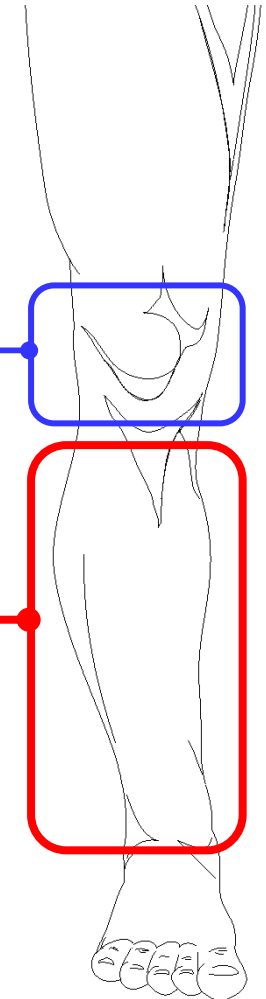
Body Region	USA (1994-1999)	Germany (1985-1998)	Japan (1987-1998)	Australia (1999-2000)	All Contries
Head	32.7%	29.9%	28.9%	39.3%	31.4%
Face	3.7%	5.2%	2.2%	3.7%	4.2%
Neck	0.0%	1.7%	4.7%	3.1%	1.4%
Chest	9.4%	11.7%	8.6%	10.4%	10.3%
Abdomen	7.7%	3.4%	4.7%	4.9%	5.4%
Pelvis	5.3%	7.9%	4.4%	4.9%	6.3%
Arms	7.9%	8.2%	9.2%	8.0%	8.2%
Lower Limbs	33.3%	31.6%	37.2%	25.8%	32.6%
Unknown	0.0%	0.4%	0.0%	0.0%	0.2%
TOTAL	100%	100%	100%	100%	100%



1. Back ground, contd.

- Lower Limb Injured Parts and Contact Locations - (USA, Germany, Japan, and Australia : Pedestrian Lower Limb : AIS 2-6)

AIS 2-6 USA, Japan, Europe, and Australia	Ages > 15 (Adult)				
Contact Location	Overall	Thigh	Knee	Leg	Foot
Front Bumper	1.6%	2.9%	7.0%	43.5%	2.9%
Top surface of bonnet/wing	2.1%	0.3%	0.1%	0.1%	0.2%
Leading edge of bonnet/ wing	4.7%	3.3%	0.5%	2.4%	0.1%
Windscreen glass	0.1%			0.1%	0.1%
Windscreen frame/ A pillars	0.5%	0.1%			
Front Panel	0.9%	0.9%	1.0%	3.2%	0.3%
Others	0.6%	0.4%	0.5%	2.6%	1.3%
Sub-Total	10.5%	8.0%	9.1%	52.0%	5.0%
AIS 2-6 USA, Japan, Europe, and Australia	Ages < 16 (Child)				
Contact Location	Overall	Thigh	Knee	Leg	Foot
Front Bumper	0.3%	3.0%	0.7%	4.8%	0.2%
Top surface of bonnet/wing	0.2%				
Leading edge of bonnet/ wing	0.4%	0.7%	0.1%	0.6%	
Windscreen glass	0.1%				
Windscreen frame/ A pillars					
Front Panel		0.5%	0.1%	0.3%	
Others	0.9%	0.5%		1.3%	0.5%
Sub-Total	1.9%	4.8%	0.9%	7.0%	0.7%

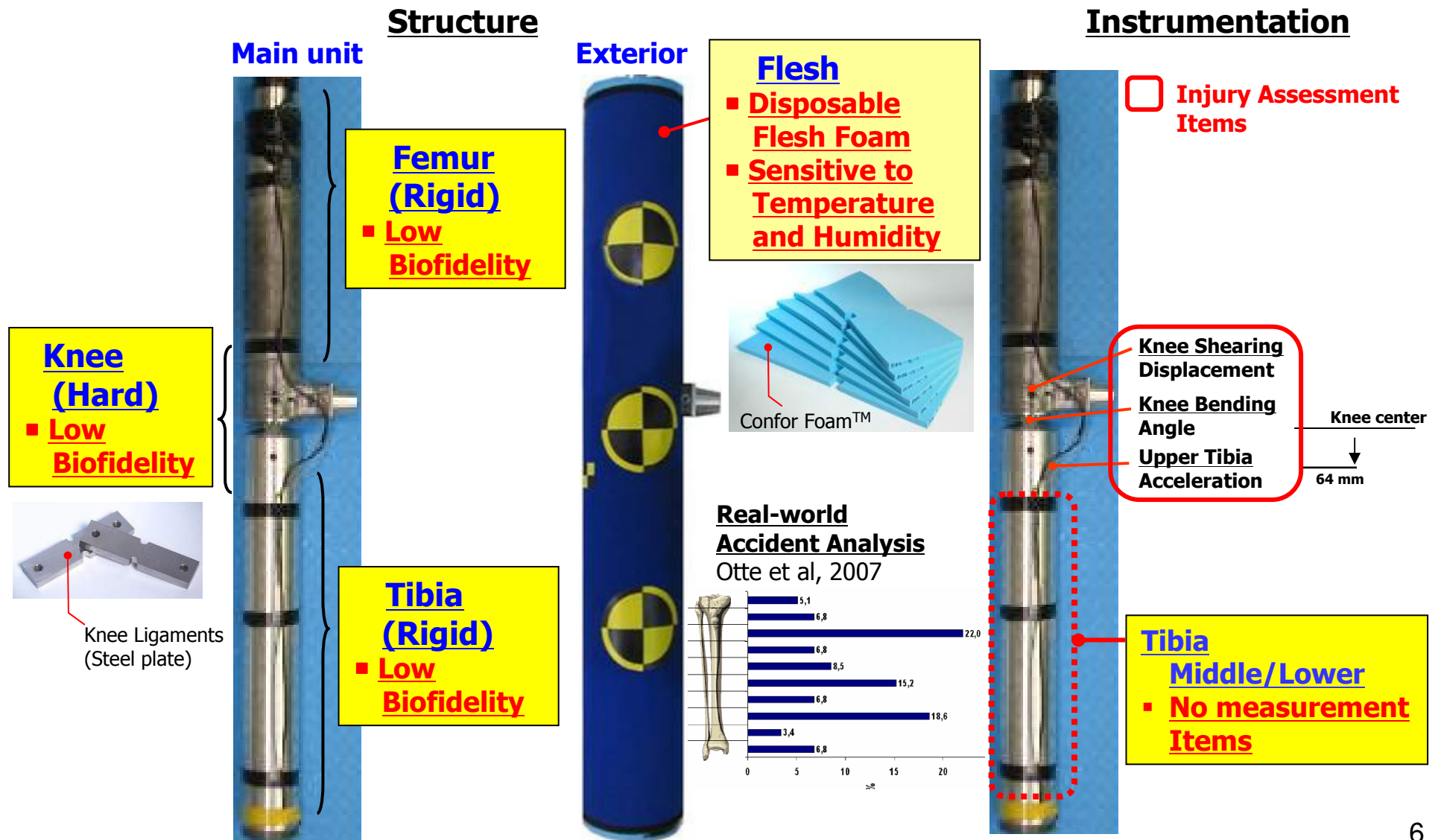


source: IHRA/PS WG 2001 report

1. Back ground, contd.

- EEVC Pedestrian Lower Legform Impactor -

Main Concerns: (1) Low biofidelity and (2) Insufficient Measurement Items



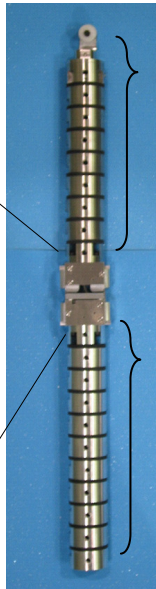
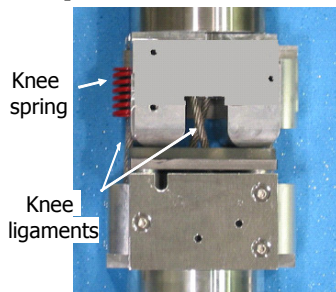
2. History of Flex-PLI Development (Overview)

2. History of Flex-PLI Development (Overview), contd.

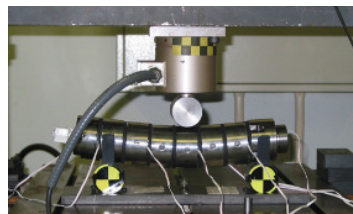
- [The Japan Automobile Research Institute \(JARI\)](#) and [the Japan Automobile Manufacturers Association, Inc. \(JAMA\)](#) initiated the development regarding [a biofidelic flexible pedestrian legform impactor \(Flex-PLI\)](#) from 2001.
- In 2002, its first version, [Flex-PLI 2002](#), was made.
- The impactor has [Flexible Long bones \(Femur/Tibia\)](#) and [knee ligament restraint system](#) like human ones.
- Besides, the impactor has [an capability to measure bending moment at multiple locations at Tibia and Femur](#).

Flex-PLI 2002

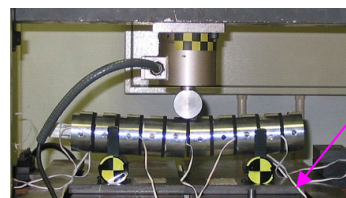
Knee Ligament Restraint System



Femur Flexible



Tibia Flexible



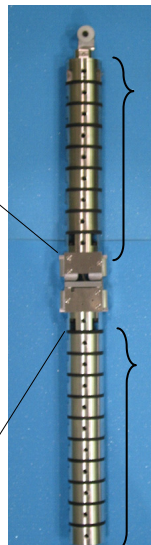
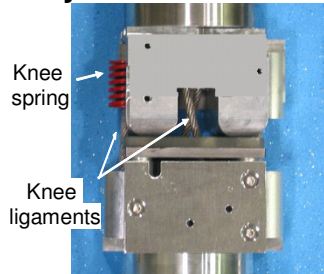
Measurement cables:
To measure bending moment at multiple locations at tibia and femur

2. History of Flex-PLI Development (Overview), contd.

- After the Flex-PLI 2002 development, several improvements were applied.
- GRSP/Pedestrian Safety Informal Working Group (IG-PS WG) interested in the capability of Flex-PLI, then, Flex-PLI technical Evaluation Group (Flex-TEG) were settled in 2005 under the GRSP/IG-PS WG to evaluate the Flex-PLI capabilities as a regulatory tool from Flex-G.
- Finally, the prototype of final version of Flex-PLI (Flex-GTR) were developed in 2009.
- Flex-TEG members were evaluated Flex-GTR capabilities, then they approved the Flex-GTR capabilities in 2010.
- After that, Flex-TEG chair country, Japan, submitted amendments regarding gtr and ECE to the GRSP using the Flex-GTR specifications, etc..

Flex-PLI 2002

Knee Ligament Restraint System



Femur Flexible

Tibia Flexible

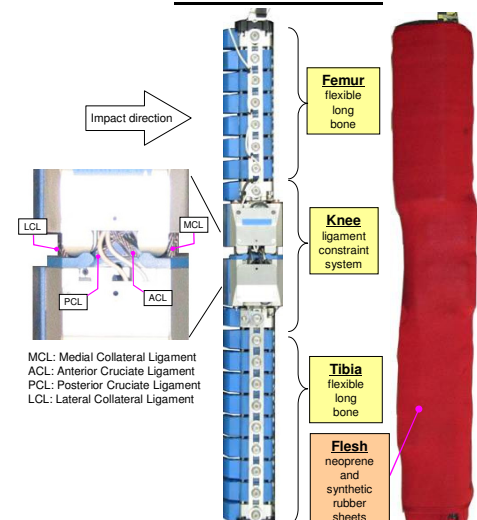
Flex-PLI
2003

Flex-PLI
2004

Flex-G

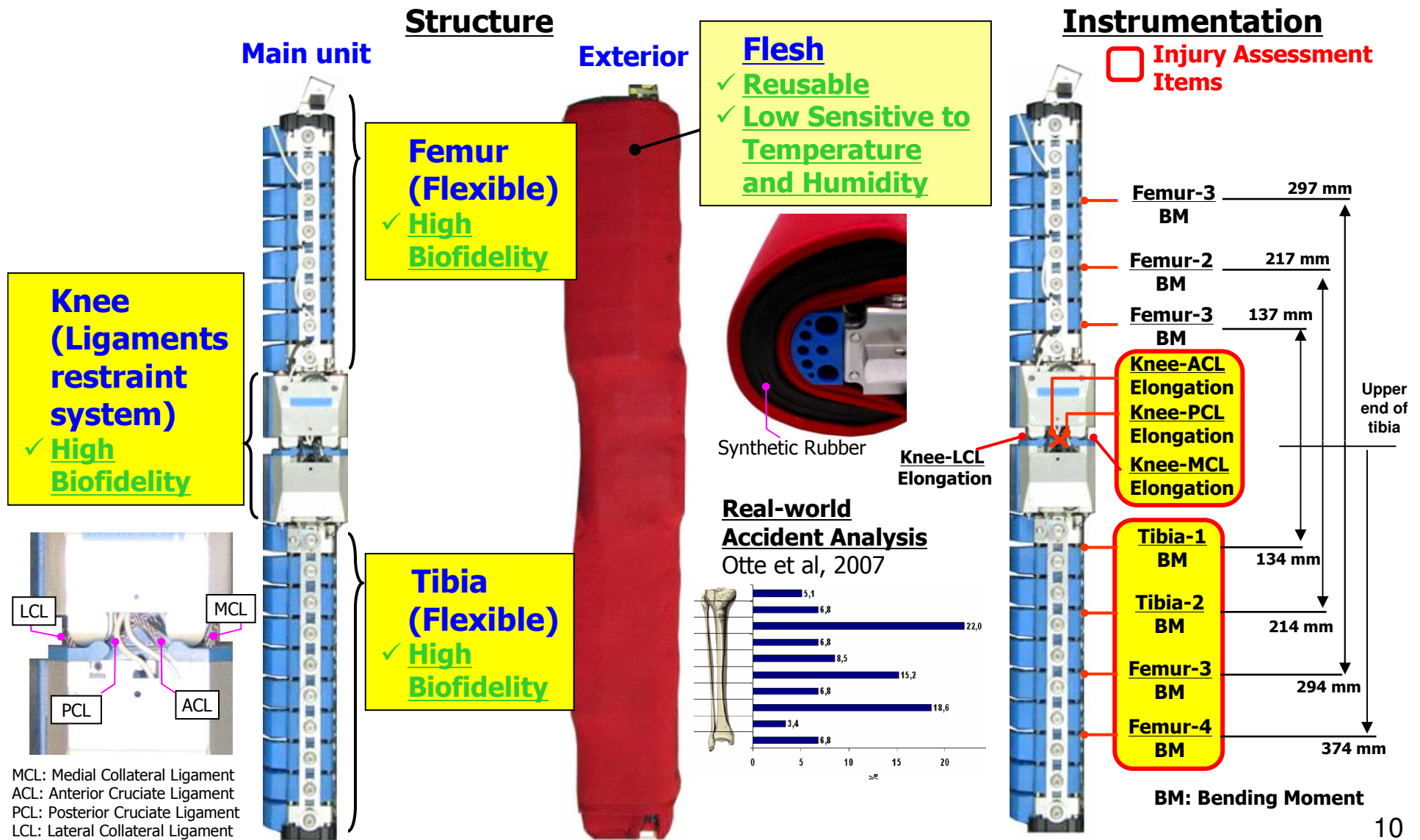
Flex-GT

Flex-GTR



Specifications of Flex-GTR-prototype

Main Achievements: (1) High biofidelity and (2) Multiple Measurement Items



2. History of Flex-PLI Development (Overview), contd.

- The Flex-GTR had been developed based on the discussions with the Flex-TEG members.
- Detailed information on discussions and achievements of the Flex-TEG regarding
 - **Biofidelity**
 - **Performance/Injury Criteria**
 - **Benefit**
 - **Durability**
 - **Reproducibility and Repeatability**
 - **Vehicle Countermeasures**of Flex-PLI are provided by another document.

Thank you for your attention!