

3th BRICS Working Group meeting on PHOTONICS

June 7, 2021



Kick-off meeting for subgroup activities

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Outcome of WG Photonics Meeting on October 13, 2020

1. **The WG has agreed that BRICS countries have to start preparation of a Road Map in Photonics for BRICS.** The VIP provides a platform for this initiative. Skoltech can volunteer itself to lead the preparation at initial stage.
2. **The WG Photonics stresses the importance of involving industry to joint STI projects.** It was agreed that the focal points will coordinate and induce this dialogue including sharing experience, identifying potential industry partners, including startups and spinoffs, as well as mechanisms for collaboration.



Next milestone – development of joint Road Map on Photonic for BRICS

The WG has agreed that BRICS countries have to start preparation of a Road Map on Photonics for BRICS. The VIP provides a platform for this initiative. Skoltech can volunteer itself to lead the preparation at initial stage.

Preparation of joint Road Map on Photonics for BRICS. Use VPI as a universal platform for this preparation.

Start of September 2021, before ministry summit STI BRICS.

Submission of the Road Map to STI Council BRICS.

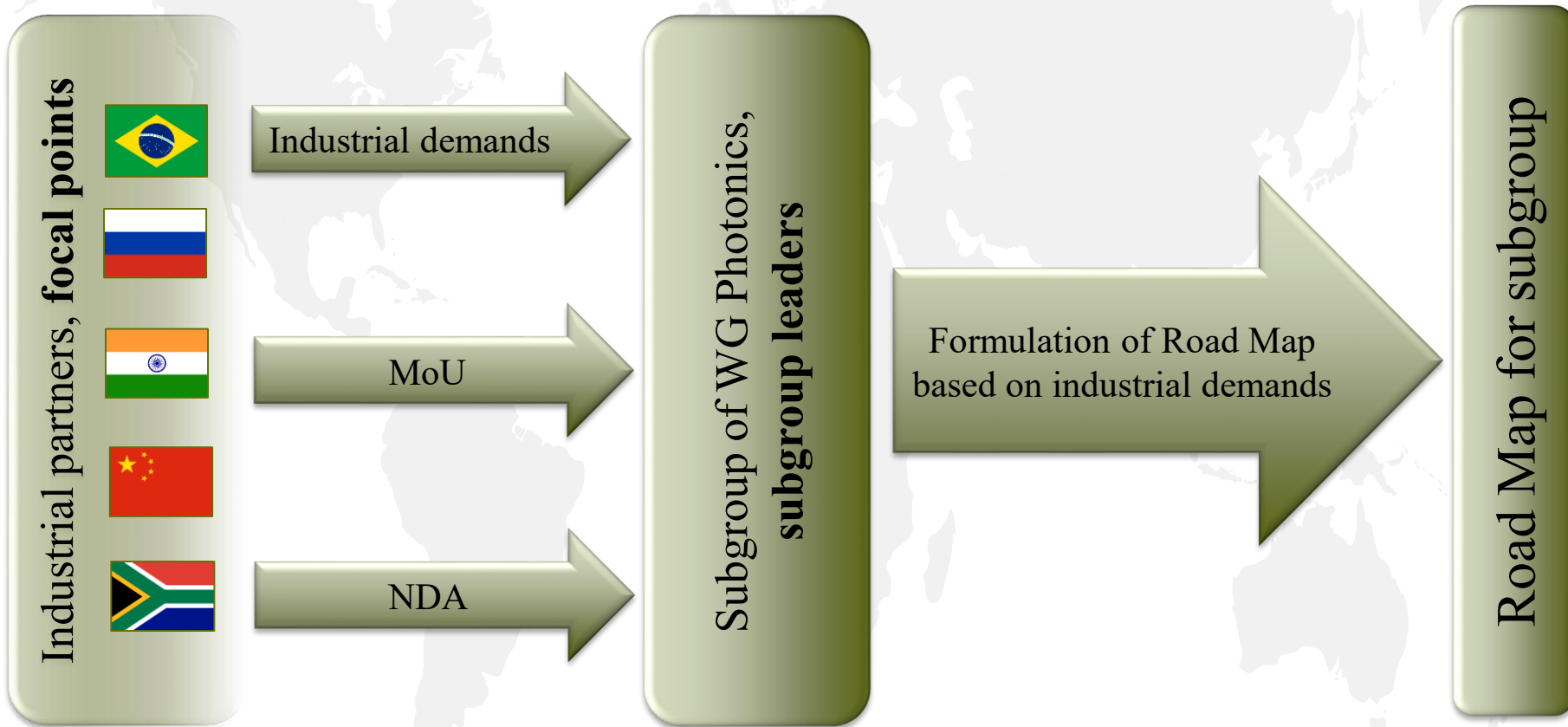
November 2021, ministry summit STI BRICS.

Decision about financial support of the Road Map.

After ministry summit STI BRICS.

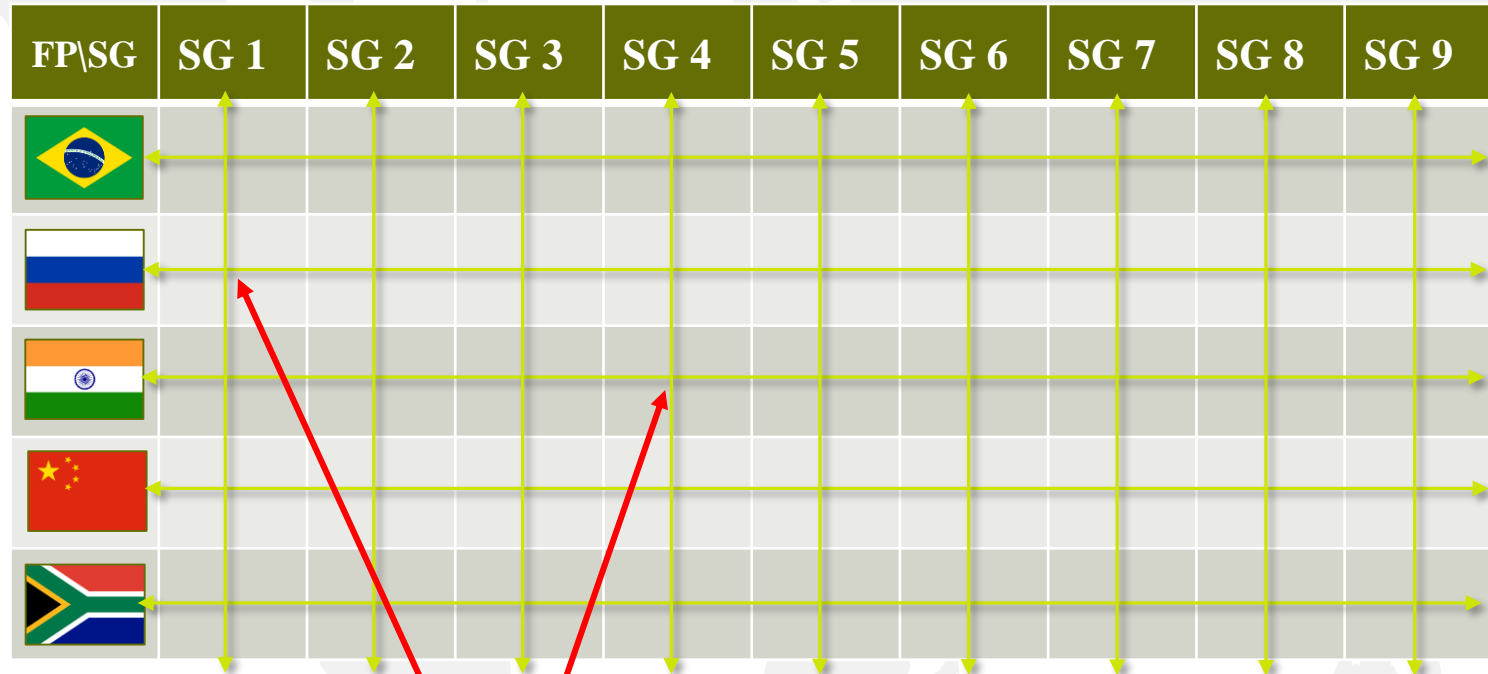
Road Map on Photonic for BRICS. Focus on industrial demands.

The WG Photonics stresses the importance of involving industry to joint STI projects. It was agreed that the focal points will coordinate and induce this dialogue including sharing experience, identifying potential industry partners, including startups and spinoffs, as well as mechanisms for collaboration.



It is expected that the subgroup leaders gather information about industrial partners through the focal points in each country.

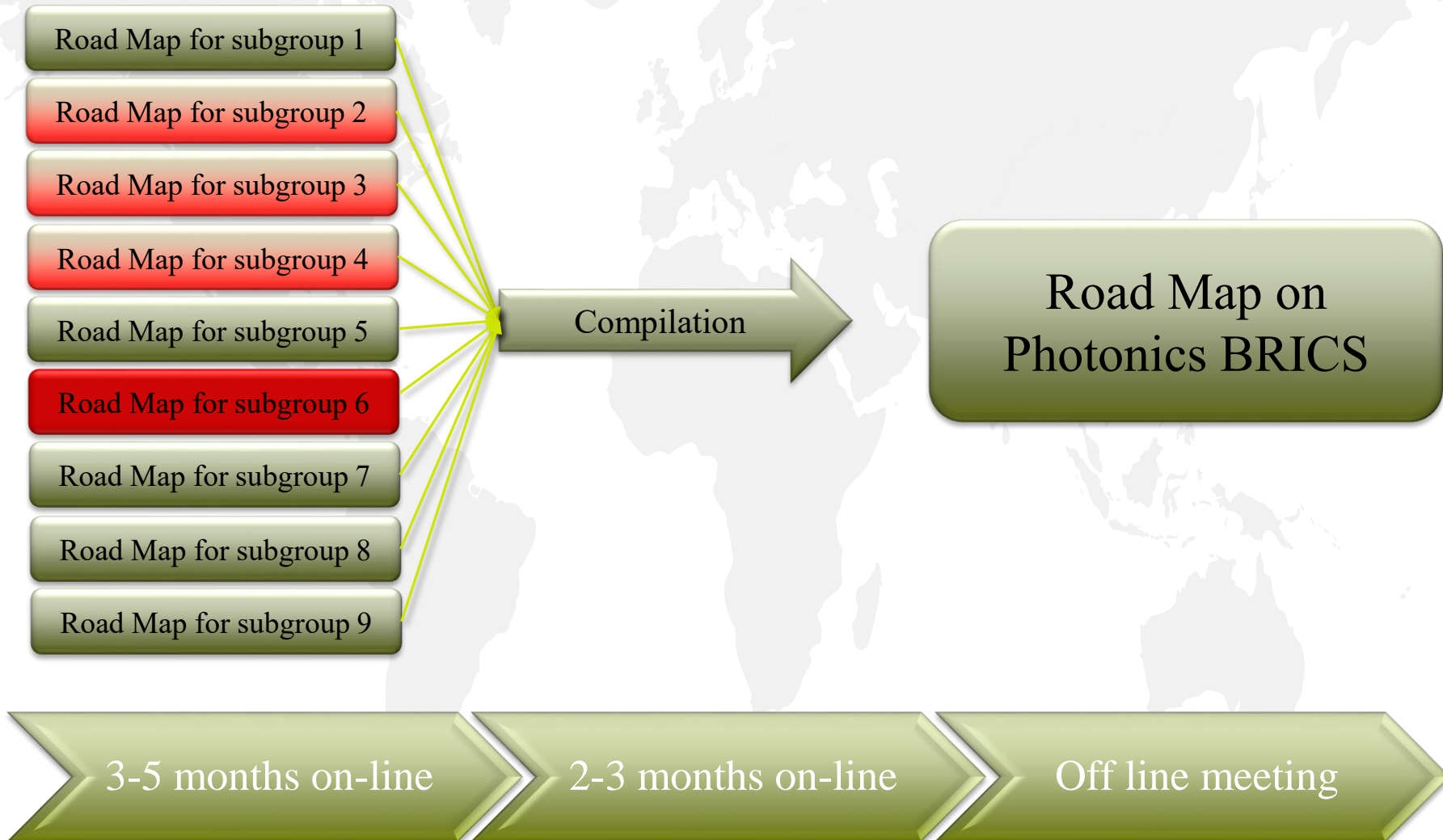
Subgroups and focal points – information exchange flow



Each crossing point corresponds to potential project.



Road Map on Photonic for BRICS – compilation of Road Maps of Subgroups





Subgroups – state on June 7, 2021

3. The recommended priority areas of cooperation for the next phase of BRICS Cooperation in Photonics are:
- 3.1 Photonic Integrated Circuits (PIC) for optical communication, microwave photonics, and optical sensor systems.
 - 3.2 High speed data transmission and processing (no leader).
 - 3.3 Microwave photonics (no leader).
 - 3.4 Photonic based sensor networks (no leader).
 - 3.5 Photonic quantum technologies, including PIC for Quantum Key Distribution and Quantum Computer/Simulator.
 - 3.6 Neuromorphic simulators/computers and neural networks based on PIC (no members, no leader).**
 - 3.7 Photonic applications in bio-medicine.
 - 3.8 Photonics for agriculture and food industry, including food lost and waist.
 - 3.9 Nanophotonics and metamaterials.
 - 3.10 NEW Cell Biology Photonics



VIP BRICS – platform for Road Map preparation

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ABOUT WORKING GROUP ASSOCIATION EDUCATION MEETINGS NATIONAL STRATEGIES CONTACT

BRICS Virtual Institute of Photonics

addressing social challenges with the strength of light

BRAZIL 🇧🇷 RUSSIA 🇷🇺 INDIA 🇮🇳 CHINA 🇨🇳 SOUTH AFRICA 🇿🇦

About Us

BRICS Virtual Institute of Photonics (BRICS VIP) is an internet platform aimed to coordinate activities in the frame of BRICS initiatives in area of Photonics. BRICS VIP is expected to become an instrument to create a BRICS Photonic Ecosystem (BRICS-PE), capable to address properly and timely modern and appearing social challenges using the photonic-based technologies.

Aim

The BRICS VIP is an active network integrating, managing, and coordinating different photonics related activities, establish and

1. Add one more topic: “Subgroups”.
2. Each subgroup leader is responsible for information about progress of the Road Map formation and putting on-line the respective data.
3. The information should include first of all outcome of consultations about the input from industrial partners.

Focus on Photonic Integrated Circuits – PICs

Future of photonic – nomenclature of PICs

Microelectronics



Discrete electronics

Qualitative transition



Modern microelectronics based on integrated circuits - ICs

1950

1960

1970

1980

1990

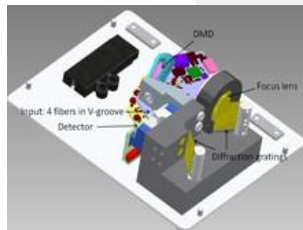
2000

2010

2019

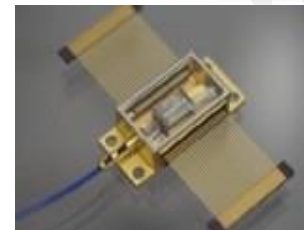
2010

Photonics



Discrete photonics

Qualitative transition



Semiconductor based PIC



Industrial standards for design and fabrication. Concept of foundries&PDK, MPW etc.

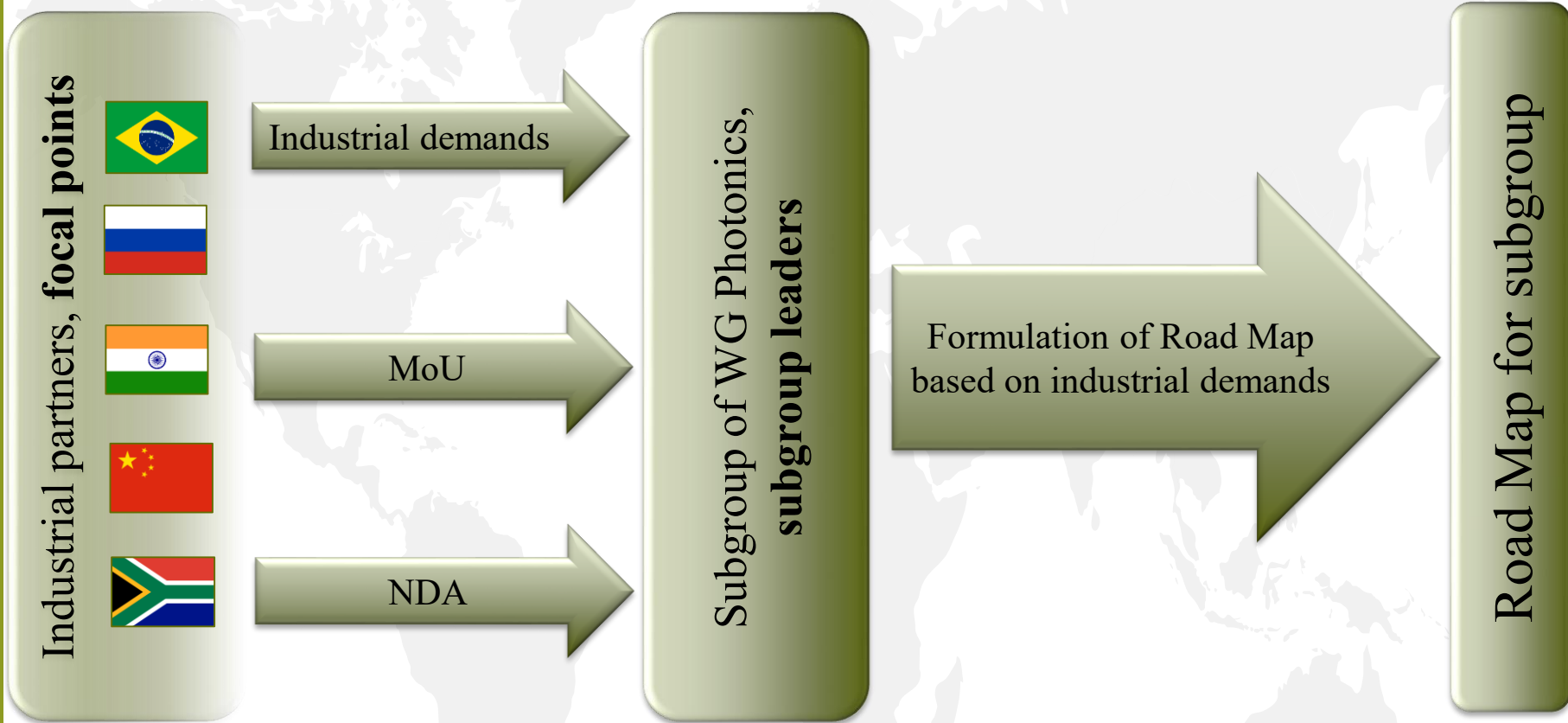


Photonic Integrated Circuits (PIC) for optical communication, microwave photonics, and optical sensor systems.

N	Priority areas of cooperation Subgroups	Country of Lead	Lead	Participants
1	Photonic Integrated Circuits (PIC) for optical communication, microwave photonics, and optical sensor systems.	Russia	Skolkovo Institute of Science & Technology, Prof. Arkady Shipulin	<p>Name: Hugo Enrique Hernandez Figueroa Affiliation: FOTONICOM - National Institute of Photonics and Optical Communications - University of Campinas (UNICAMP) E-mail: hugo@decom.fee.unicamp.br</p> <p>Name: Roberto Ricardo Panepucci Affiliation: Center for Information Technology Renato Archer E-mail: roberto.panepucci@cti.gov.br</p> <p>Name: Prof Deepa Venkitesh Affiliation: IIT Madras, Chennai India E-mail: deepa@ee.iitm.ac.in</p>

Welcome to join the Subgroup!

Photonic Integrated Circuits (PIC) for optical communication, microwave photonics, and optical sensor systems.



REQUEST TO FOCAL POINTS: I would greatly appreciate information about industrial partners willing to cooperate on PICs in the frame of BRICS



Photonic Integrated Circuits (PIC) for optical communication, microwave photonics, and optical sensor systems.

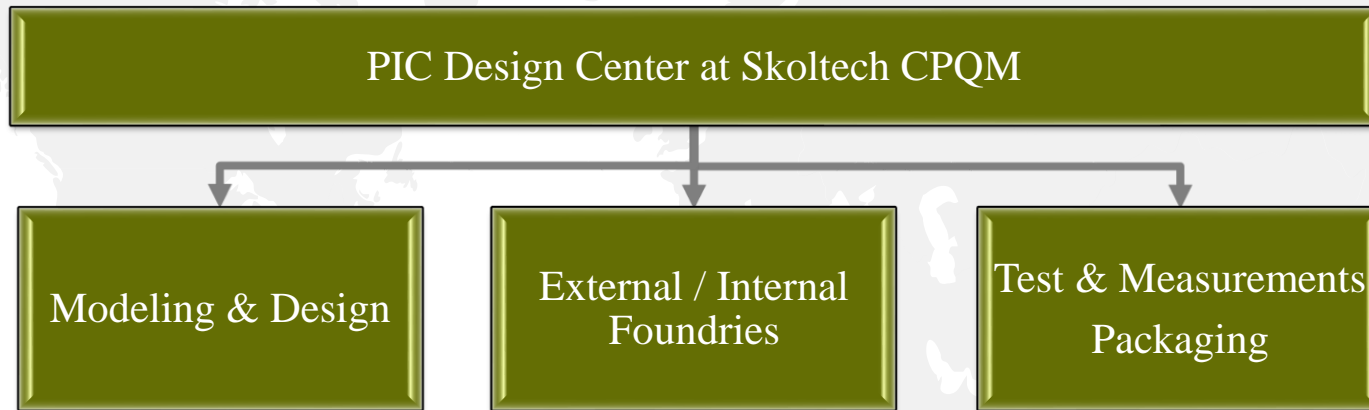
Industrial partners in Russia whom we have REAL contracts with NOW

- 1. Perm Photonic Cluster** – design and producing of PIC based tunable laser for sensor applications.
 - 2. Russian Rail Ways** – design and producing of transmitter for QKD communication systems.
 - 3. Oil industrial company** – sensor system for rectification tower.
- We still did NOT discuss participation of them in any kind of activities in the frame of BRICS.
 - We have to figure out WHY this participation will be profitable for particular industrial partner.
 - We have to figure out HOW to deal with (i) NDA and (ii) IP in case of BRICS cooperation.

Main question: what are the advantages for any particular industrial partner to work in the frame of BRICS cooperation?

Probable answer: (i) access to technology otherwise inaccessible or
(ii) any kind of privilege inaccessible outside of BRICS (tax, credits, markets etc.)

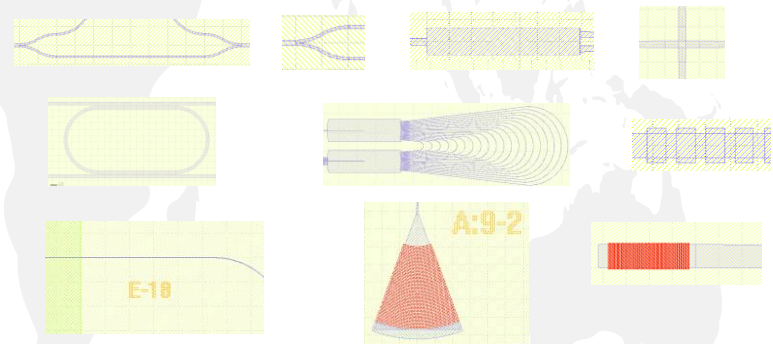
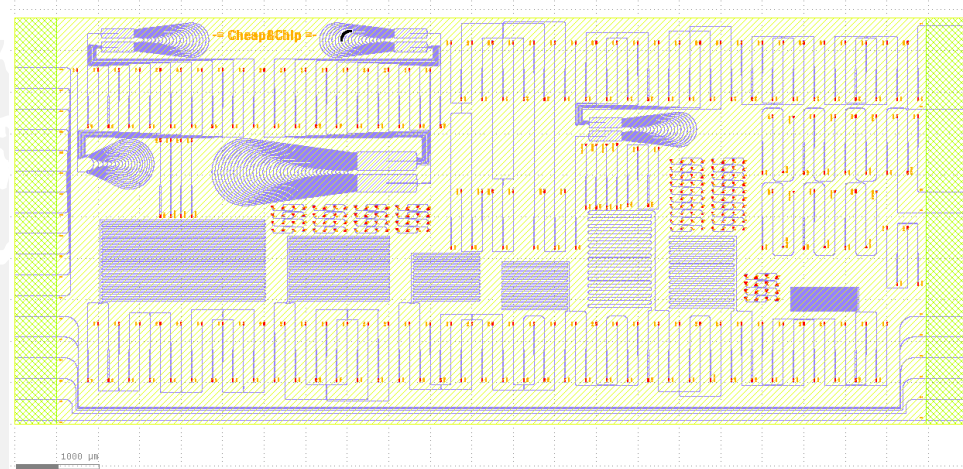
Design, Fabrication, Test, and Packaging



PICs - designed, fabricated, available

SOI PIC (Cornerstone) - Passive

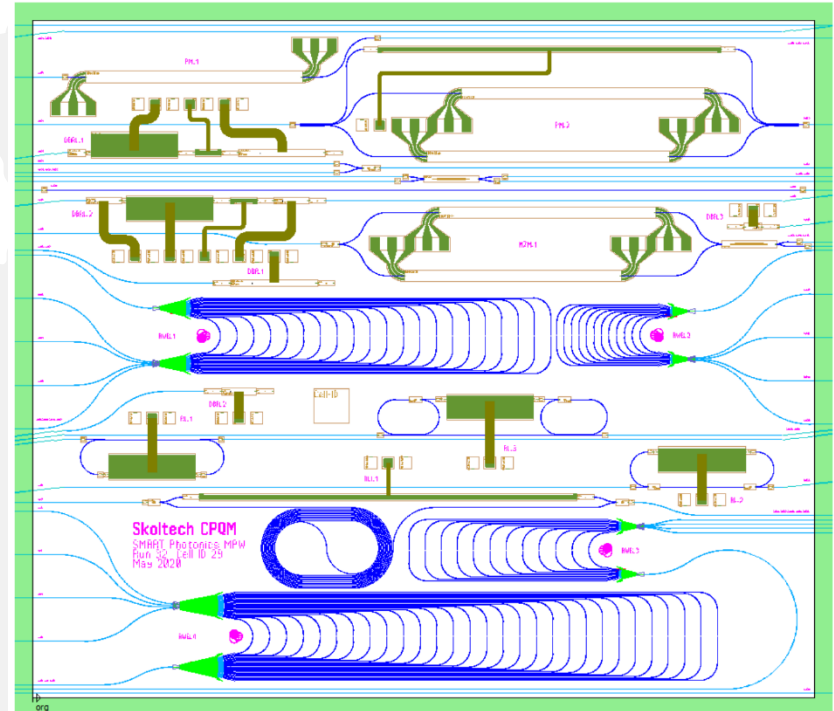
- Y-splitter
- MZI + delay line
- Delay lines
- Directional coupler (50/50; 90/10)
- MMI: 1x2; 2x2; 3x3
- Crossing
- Racetrack resonator
- Bragg grating (filter)
- AWG (4 types)
- Couplers
- Grating couplers
- Vertical / edge
- Edge couplers



PICs - designed, fabricated, available

InP PIC (SMART Photonics) - Passive, Active, HF

- Phase modulator 8 GHz
- Optimized amplitude modulator 8 GHz
- Triple phase modulator
- AWG (4 types)
- MZI + Delay line
- Tunable DBRs
- DBR lasers
- Ring lasers
- Passives (splitters, waveguides, etc.)
- Edge couplers



PICs - designed, fabricated, available

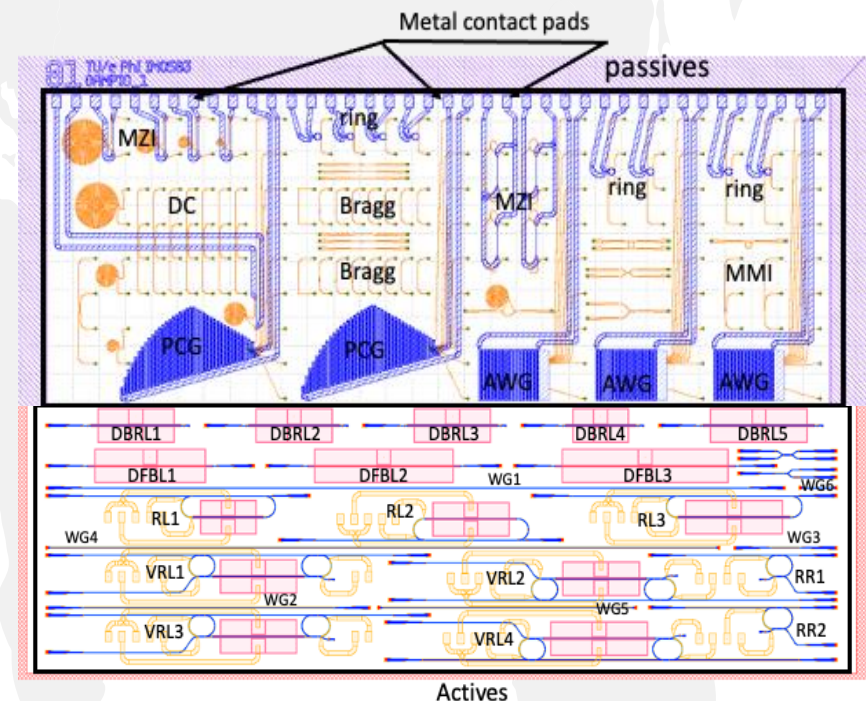
IMOS PIC (TU/e) - Passive, Active, HF

Passive + Heaters

- Waveguides / Direct couplers / Focusing couplers
- Delay lines
- MMI
- DBR
- Photonic Crystal reflector
- Ring resonators
- AWG (Arrayed Waveguide gratings)
- PCG (Planar concave gratings)
- PCG + assymtric MZI (Interrogators)

Active

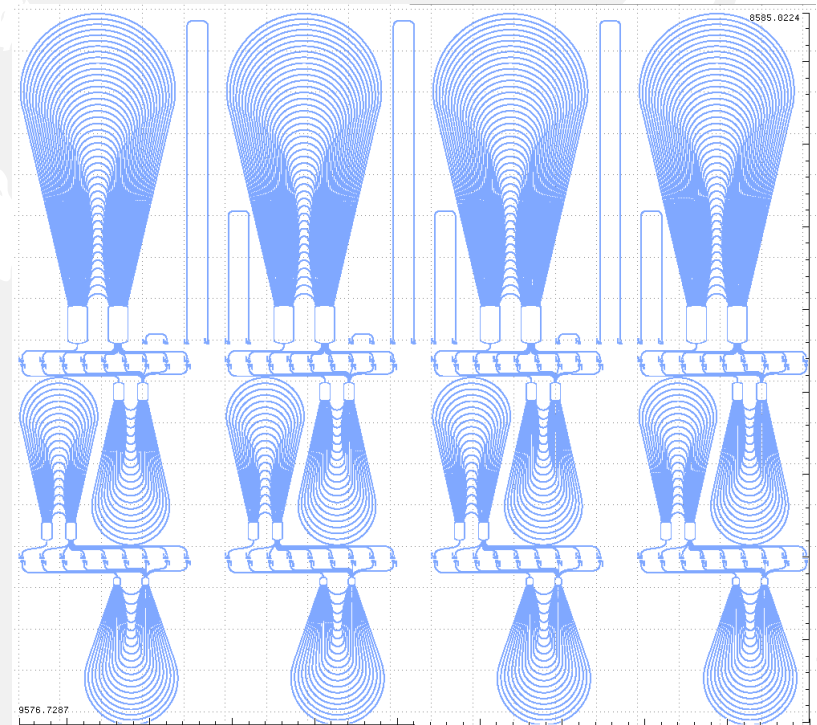
- DBR lasers
- DFB lasers
- Ring lasers
- Vernier ring lasers



PICs - designed, to be fabricated, available

SiN PIC (TiRphotonics) - Passive

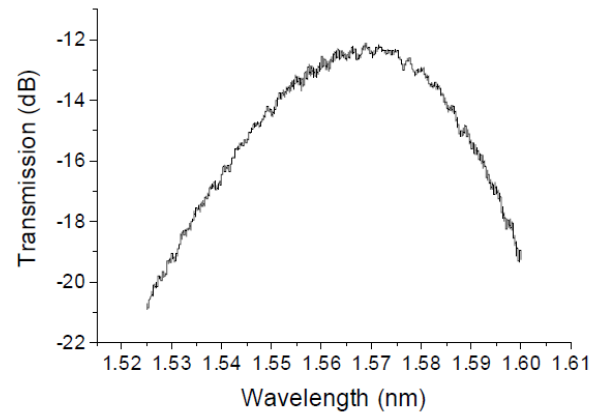
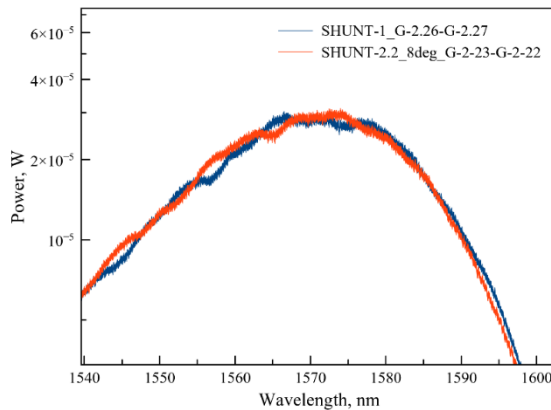
- AWGs (4 types)
- Grating couplers
- Waveguides / Bends
- Arrays



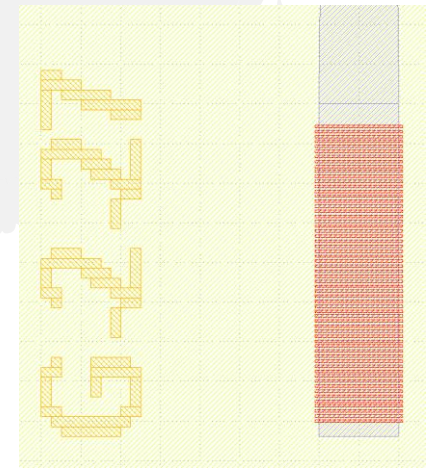
CPQM: PIC test results

SOI PIC (Cornerstone) – Passives

	Experimental	From PDK
Max. efficiency	6.4 dB	5.5 – 6.5 dB
1dB bandwidth	22 nm	>35 nm
Center Wavelength	1570 nm	1550-1580 nm



Grating couplers



Angle was 8deg instead of 10deg

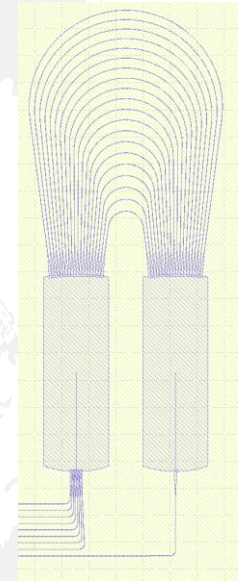
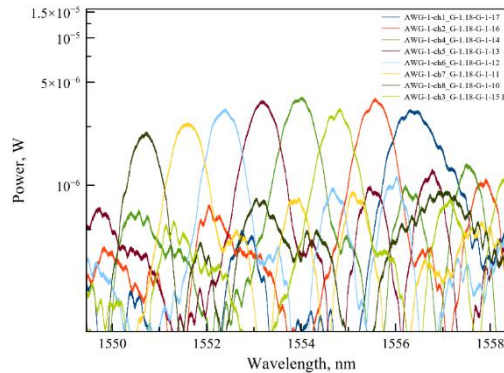
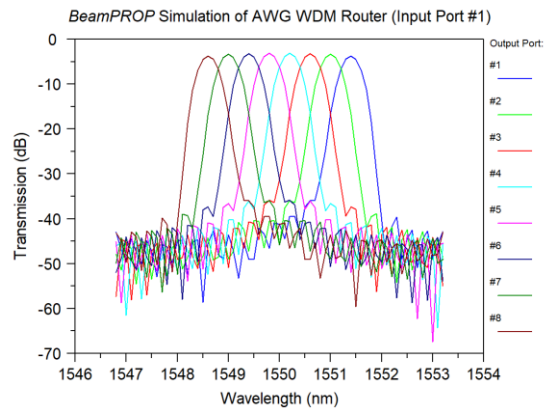
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CPQM: PIC test results

SOI PIC (Cornerstone) – Passives

AWG – 1 (high crosstalk)

	Simulated	Experimental
Channel spacing	100GHz (0.8nm)	0.801nm
Channel FWHM	100GHz (0.8nm)	0.750nm
Crosstalk	~ 3dB	~3dB
Noise floor (SMSR)	>30dB	~8dB
Central wavelength	1550	1553.5

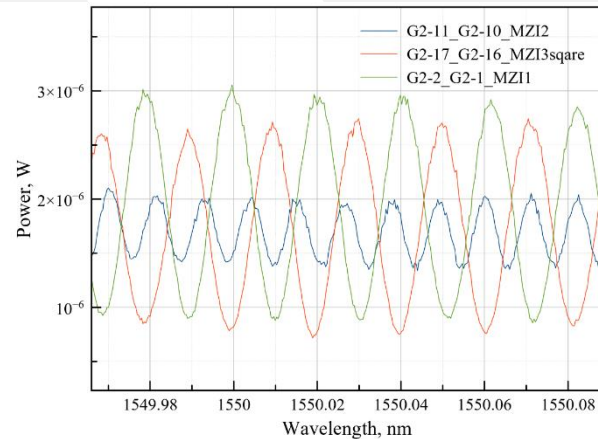
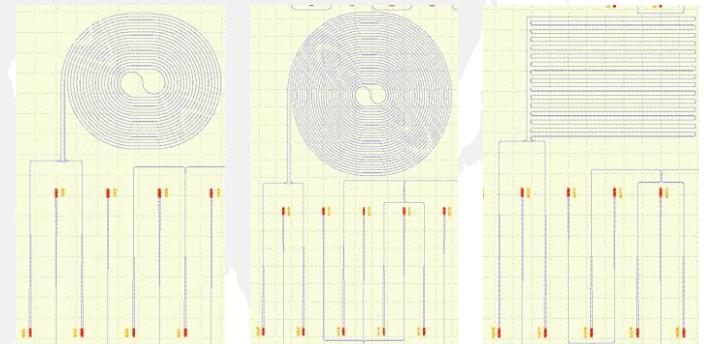


CPQM: PIC test results

SOI PIC (Cornerstone) – Passives

	Delay, ps	Wg losses, dB/cm
MZI_1	392.5 ps	2.40
MZI_2	721.5 ps	3.54
MZI_3	388.8 ps	2.23

Asymmetric MZIs

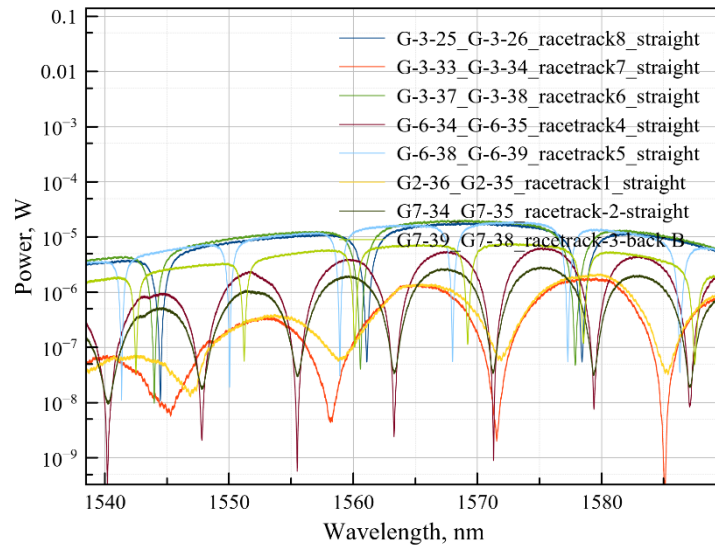


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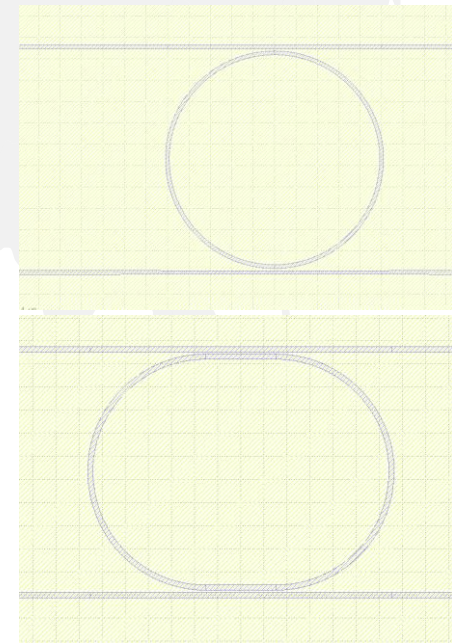
CPQM: PIC test results

SOI PIC (Cornerstone) – Passives

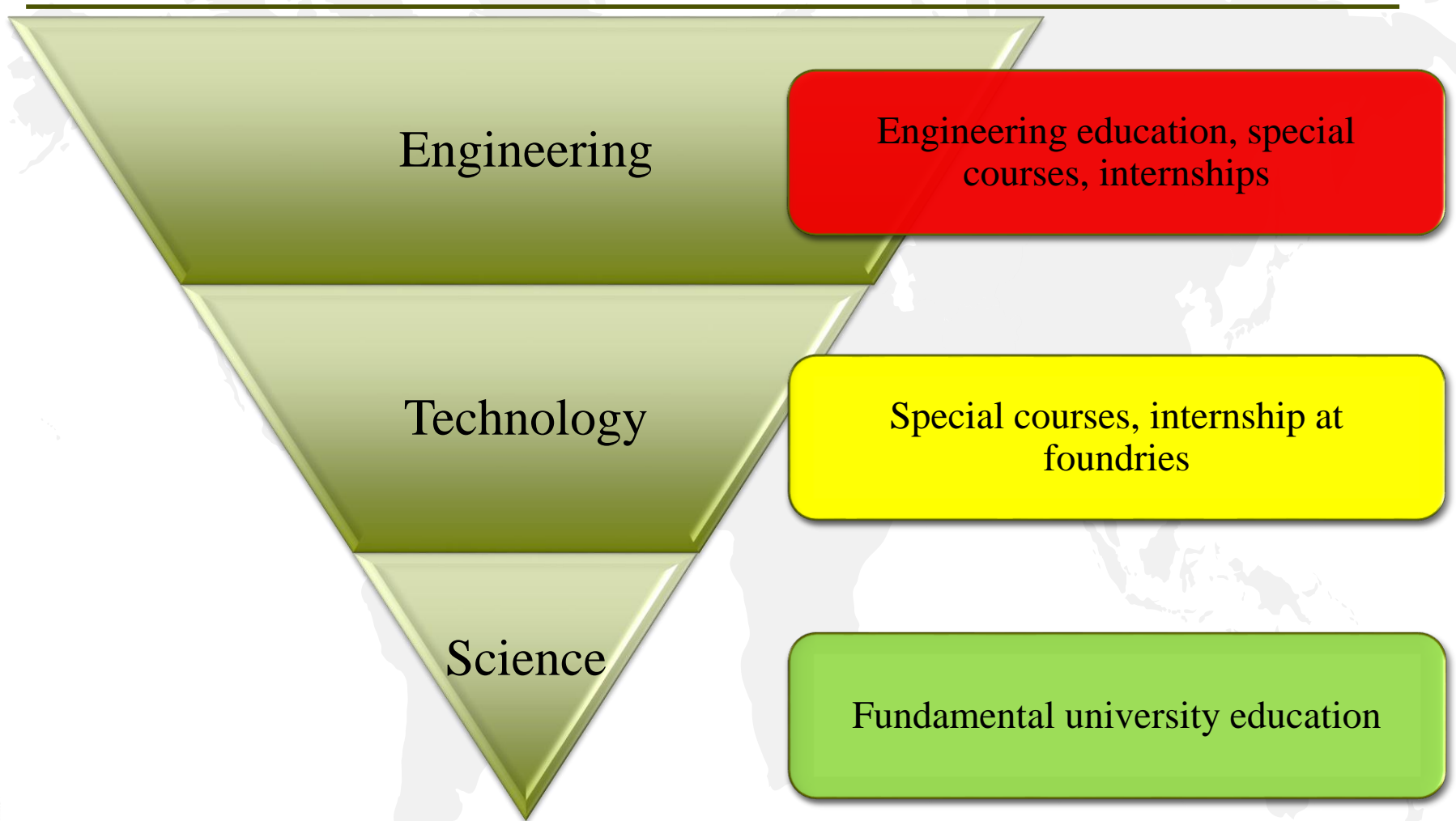
Q-factors: ~1700 and lower



Racetrack resonators



Education: new education track is required



The most critical part - is the engineering education.