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EU ITN (Initial Training Network)

INVISIBLES

INVISIBLES: a bunch of physicists…. who want to do physics !

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We want to build the

New Standard Model of Particle Physics

BSM because

1) Experimental evidence for new **particle** physics:

*** **Neutrino masses**

*** **Dark matter**

** Matter-antimatter asymmetry

2)Uneasiness with SM fine-tunings, i.e. electroweak:

*** **Hierarchy problem**

*** **Flavour puzzle**

BSM electroweak

* **HIERARCHY PROBLEM**

Fine-tuning issue: if BSM physics, why Higgs so light

Interesting mechanisms to solve it from SUSY;
strong-int. Higgs, extra-dim….

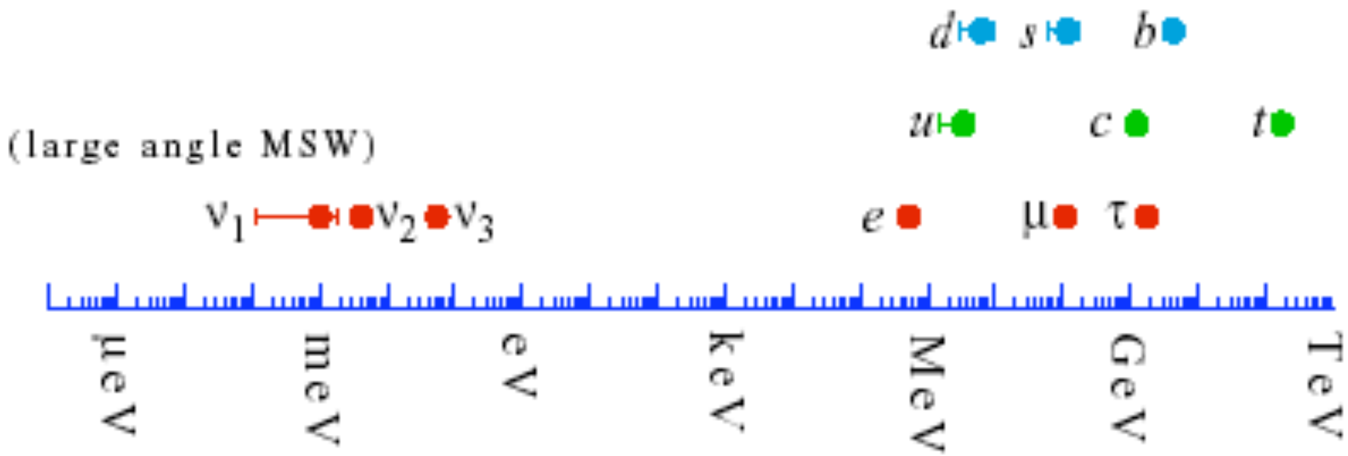
In practice, none without further fine-tunings

* **FLAVOUR PUZZLE :** no progress
BSM theories tend to make it worse

Understanding stalled since 30 years,

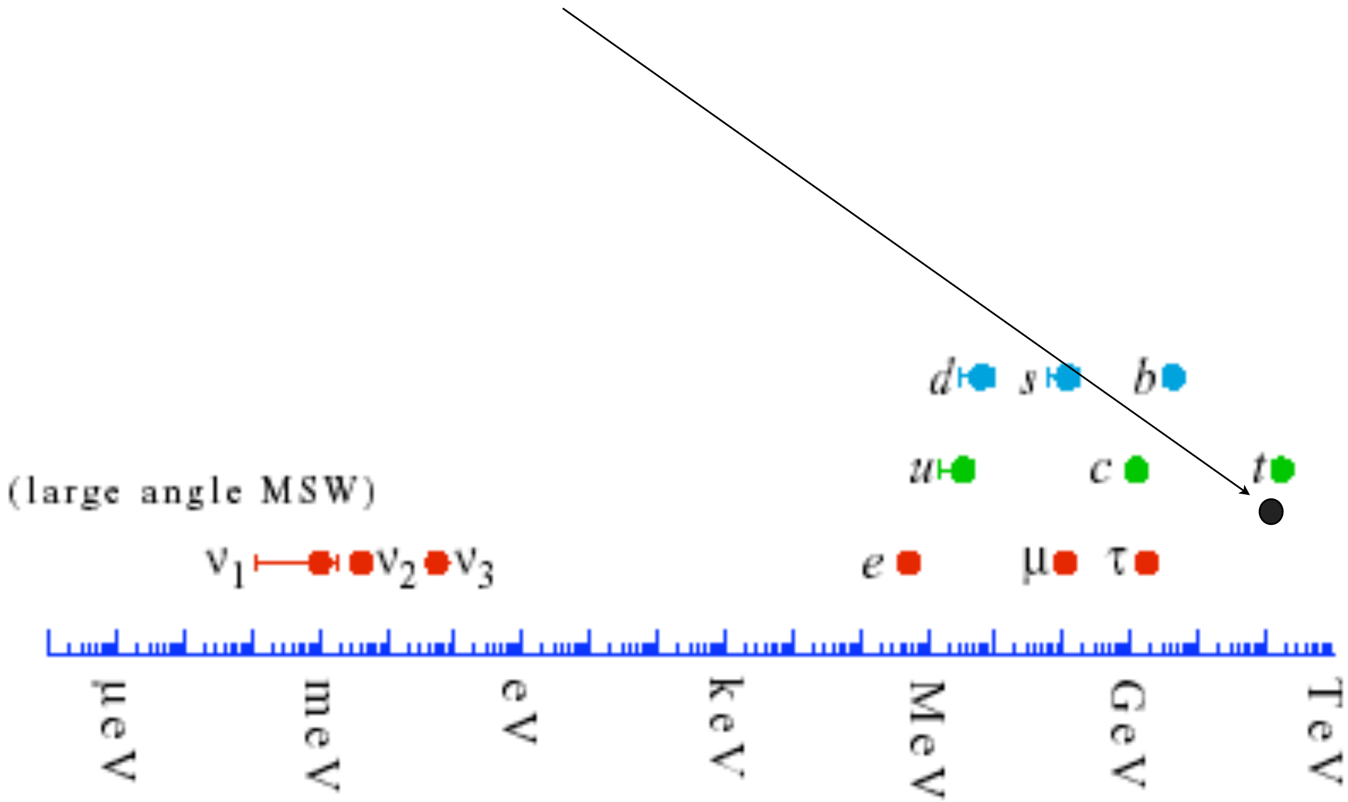
Only new B physics data AND neutrino masses and mixings

The Higgs mechanism can accomodate masses in SM... but neutrinos (?)



Neutrinos lighter because Majorana?

DARK FLAVOURS ?



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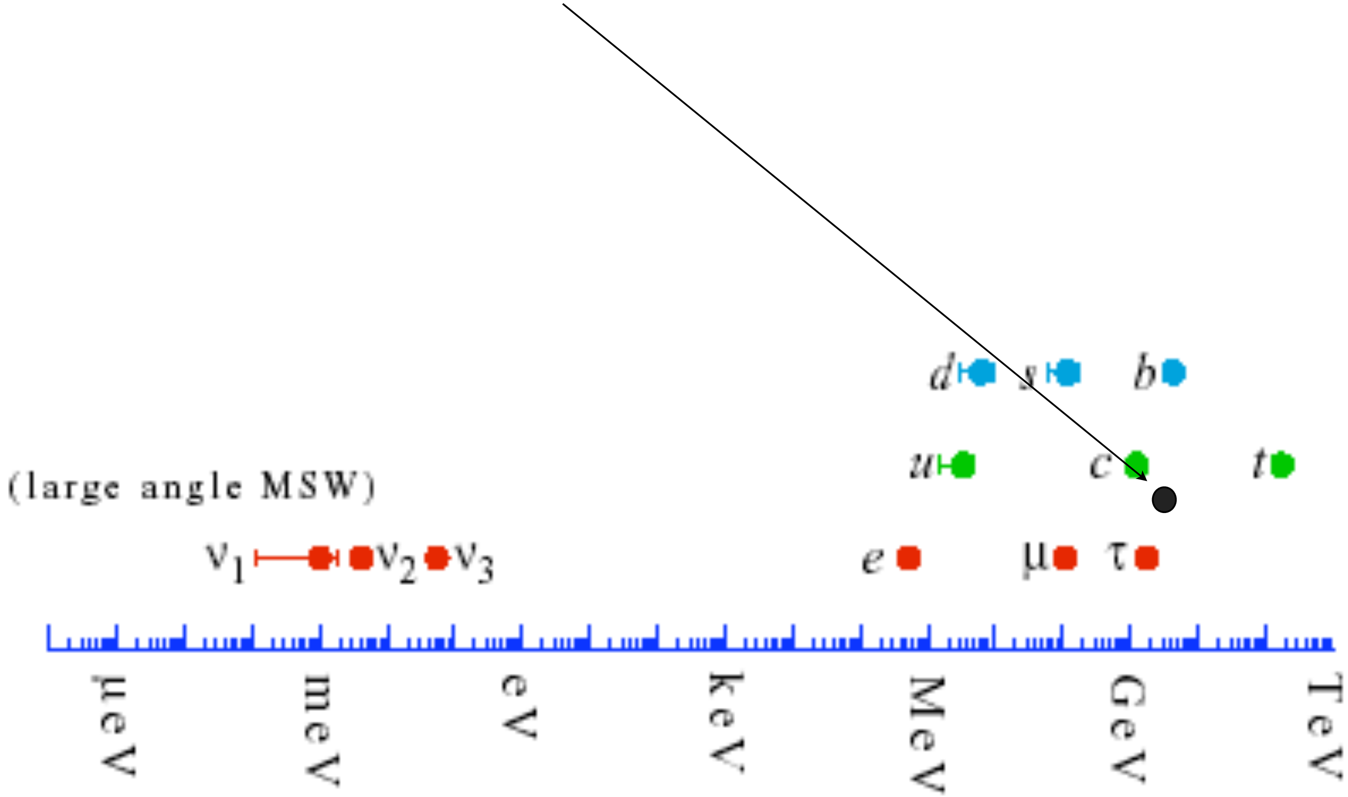

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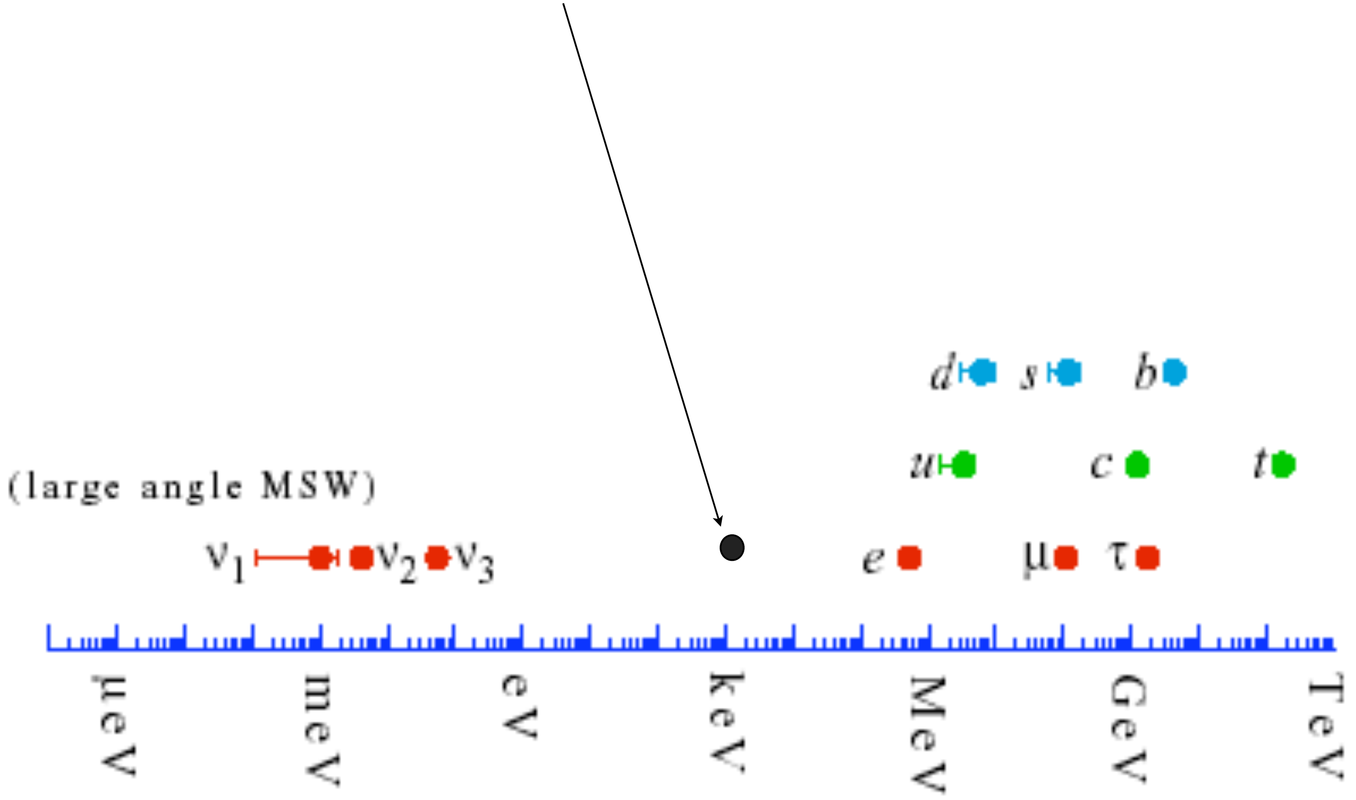

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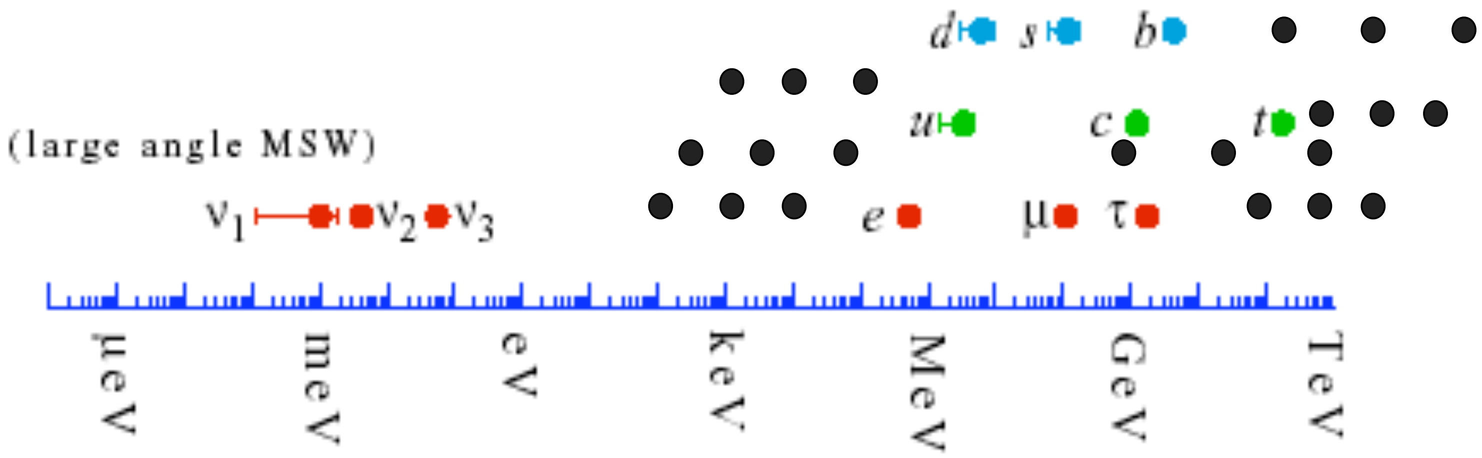

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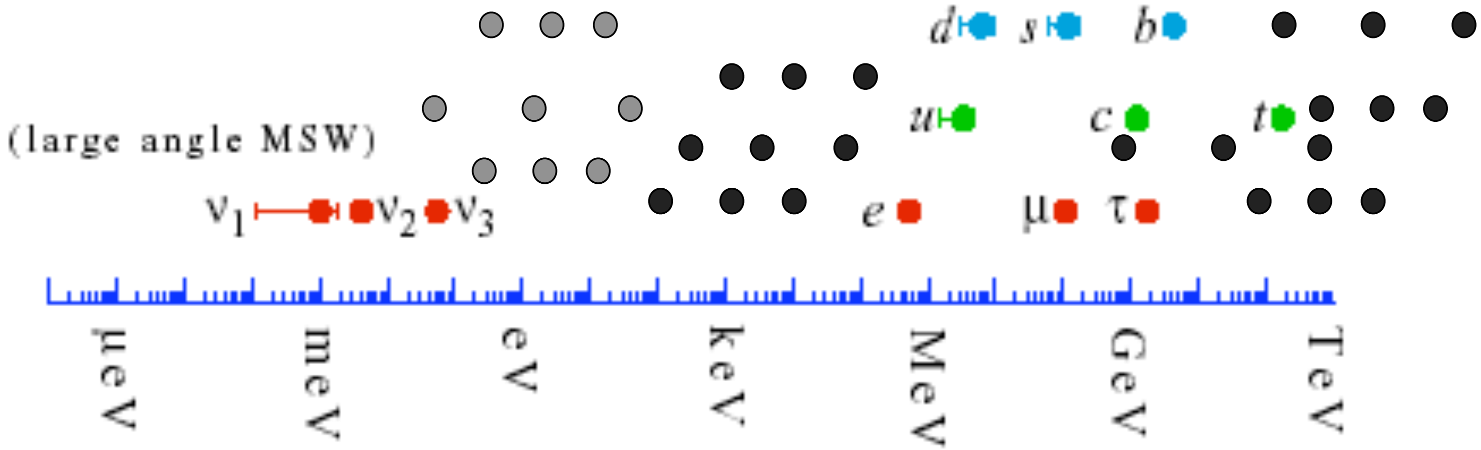

BSM because

1) **Experimental evidence** for new **particle** physics:

*** **Neutrino masses**

*** **Dark matter**

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2) **Uneasiness with SM fine-tunings,** i.e. electroweak:

*** **Hierarchy problem**

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INVISIBLES: a bunch of physicists.... who want to do physics !

We want to build the

New Standard Model of Particle Physics

The road to building the New Standard Model (νSM) of particle physics is clear: this theory needs to encompass the nature and properties of neutrinos and dark matter, as well as those of ordinary matter.

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We cannot do that alone:

Phenomenology in a network of

$\rightarrow$ {
- **theory and experiment**
- **particle physicists, astrophysicists and cosmologists**

to explore neutrinos, DM... and their connection

(with the background of the Higgs and DE quests)

Young scientists are essential for this

They will be the major asset, and the "glue", of INVISIBLES

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New Standard Model of Particle Physics

The road to building the New Standard Model (νSM) of particle physics is clear: this theory needs to encompass the nature and properties of neutrinos and dark matter, as well as those of ordinary matter. The mission of **Inνisibles** is to train the new generation of young researchers to accomplish this task, allowing them to build the necessary background in particle physics and astrophysics, and fostering their growth as independent researchers, within **the first transnational program focused on neutrino and dark matter physics.**

Scientists from 7 EU countries and 7 non-EU countries

* Core: neutrino and DM phenomenology


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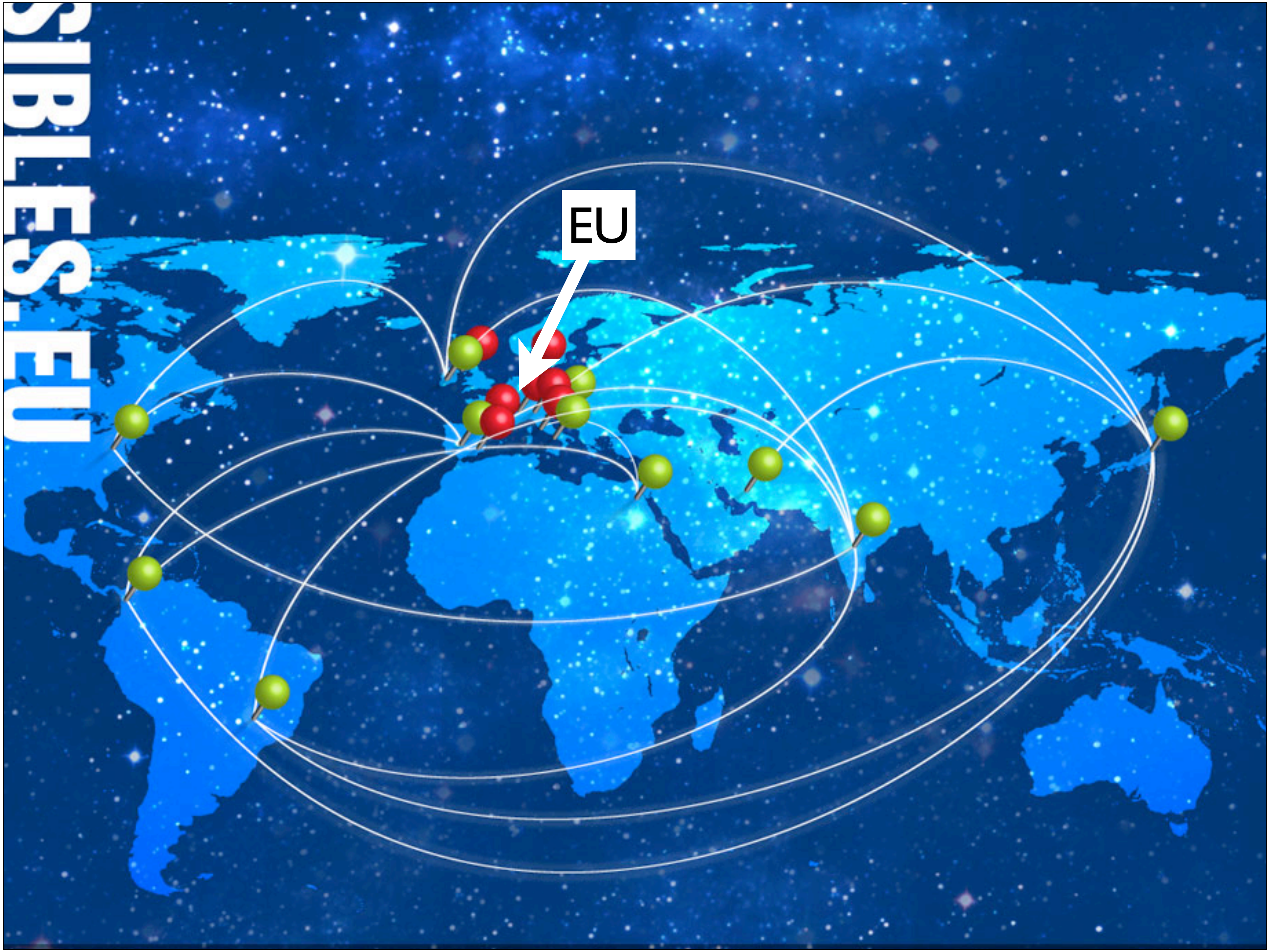
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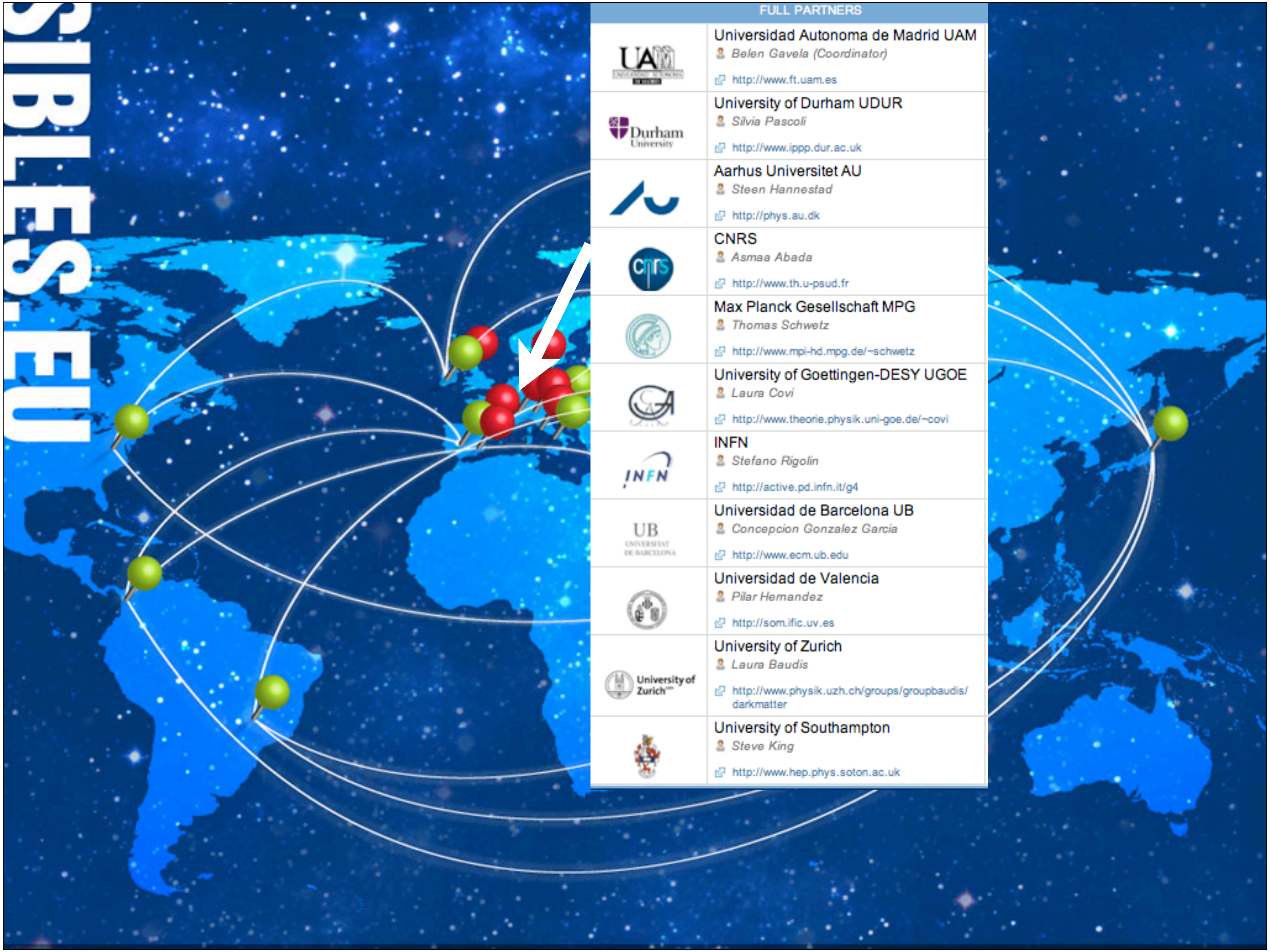

FULL PARTNERS		
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CNRS	*Asmaa Abada*	http://www.th.u-psud.fr
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University of Goettingen-DESY UGOE	*Laura Covi*	http://www.theorie.physik.uni-goe.de/~covi
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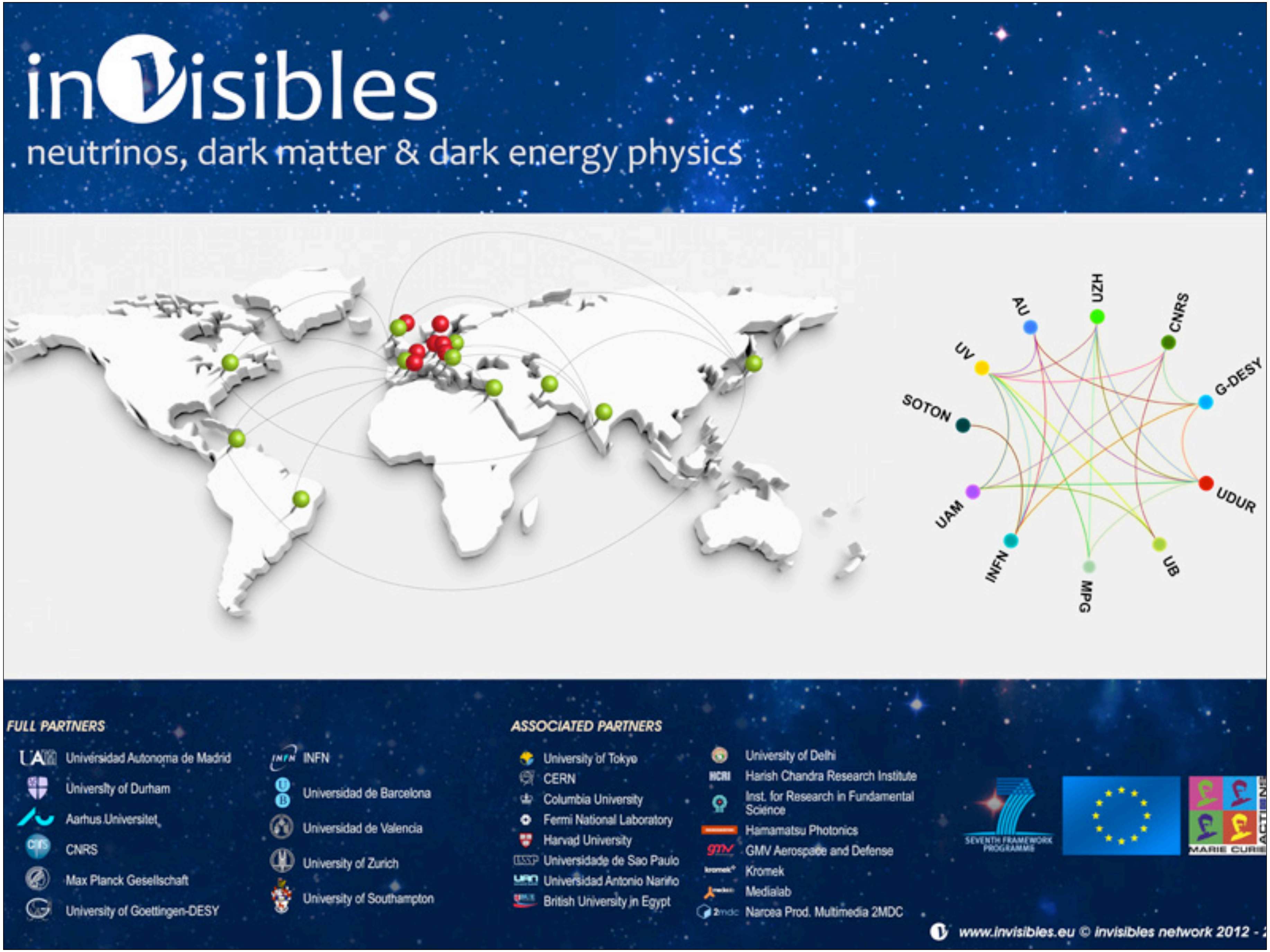
Universidad de Valencia	*Pilar Hernandez*	http://som.ific.uv.es
University of Zurich	*Laura Baudis*	http://www.physik.uzh.ch/groups/groupbaudis/darkmatter
University of Southampton	*Steve King*	http://www.hep.phys.soton.ac.uk


invisibles
neutrinos, dark matter & dark energy physics
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SOTON
UDUR
UAM
INFN
MPG
UB
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University of Durham
Aarhus Universitet
CNRS
Max Planck Gesellschaft
University of Goettingen-DESY
INFN
Universidad de Barcelona
Universidad de Valencia
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Universidad Antonio Nariño
British University in Egypt
University of Delhi
Harish Chandra Research Institute
Inst. for Research in Fundamental Science
Hamamatsu Photonics
GMV Aerospace and Defense
Kromek
Medialab
Narcea Prod. Multimedia 2MDC
SEVENTH FRAMEWORK PROGRAMME
MARIE CURIE
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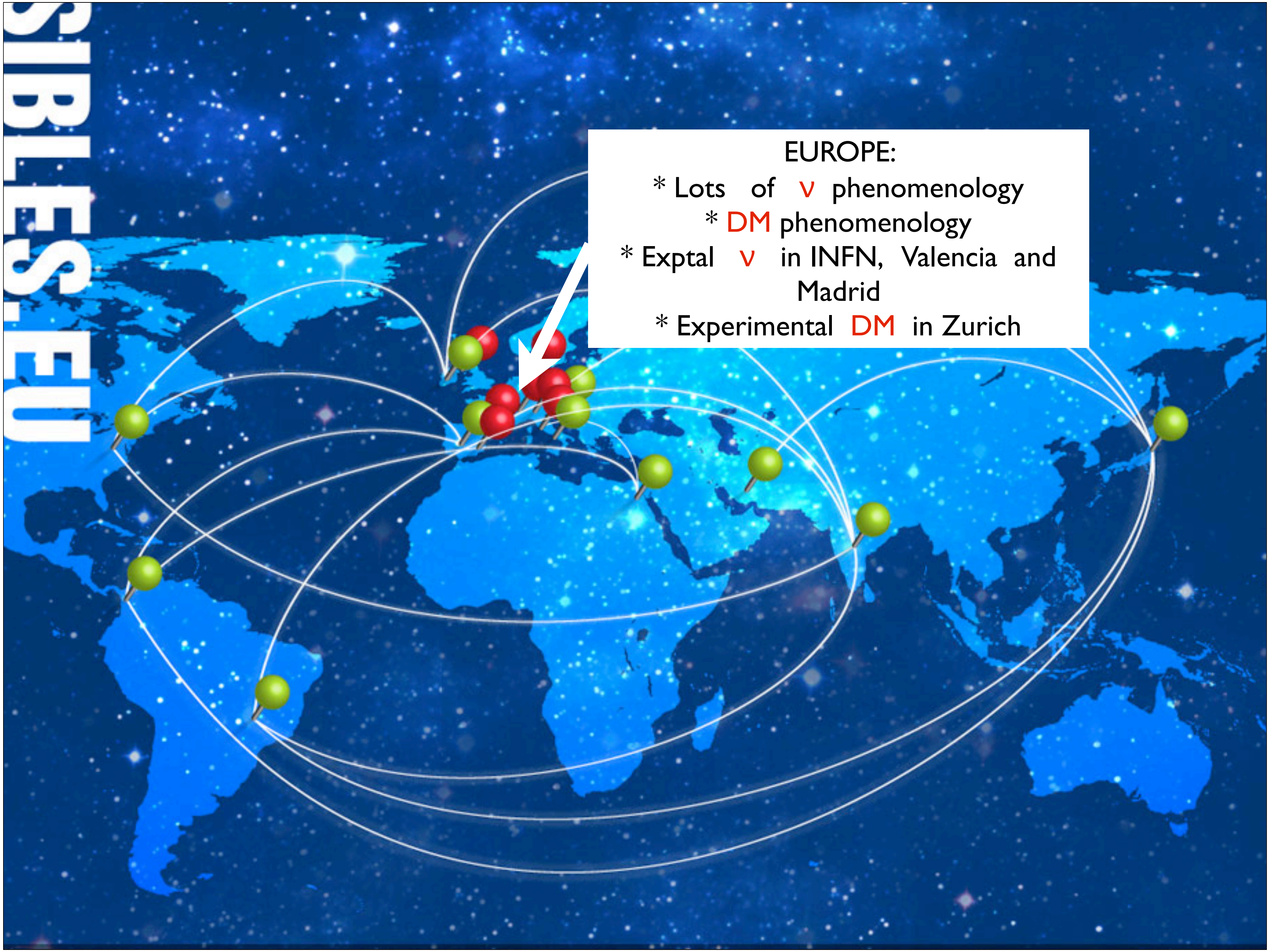
EUROPE:
* Lots of ν phenomenology
* DM phenomenology
* Exptal ν in INFN, Valencia and Madrid
* Experimental DM in Zurich
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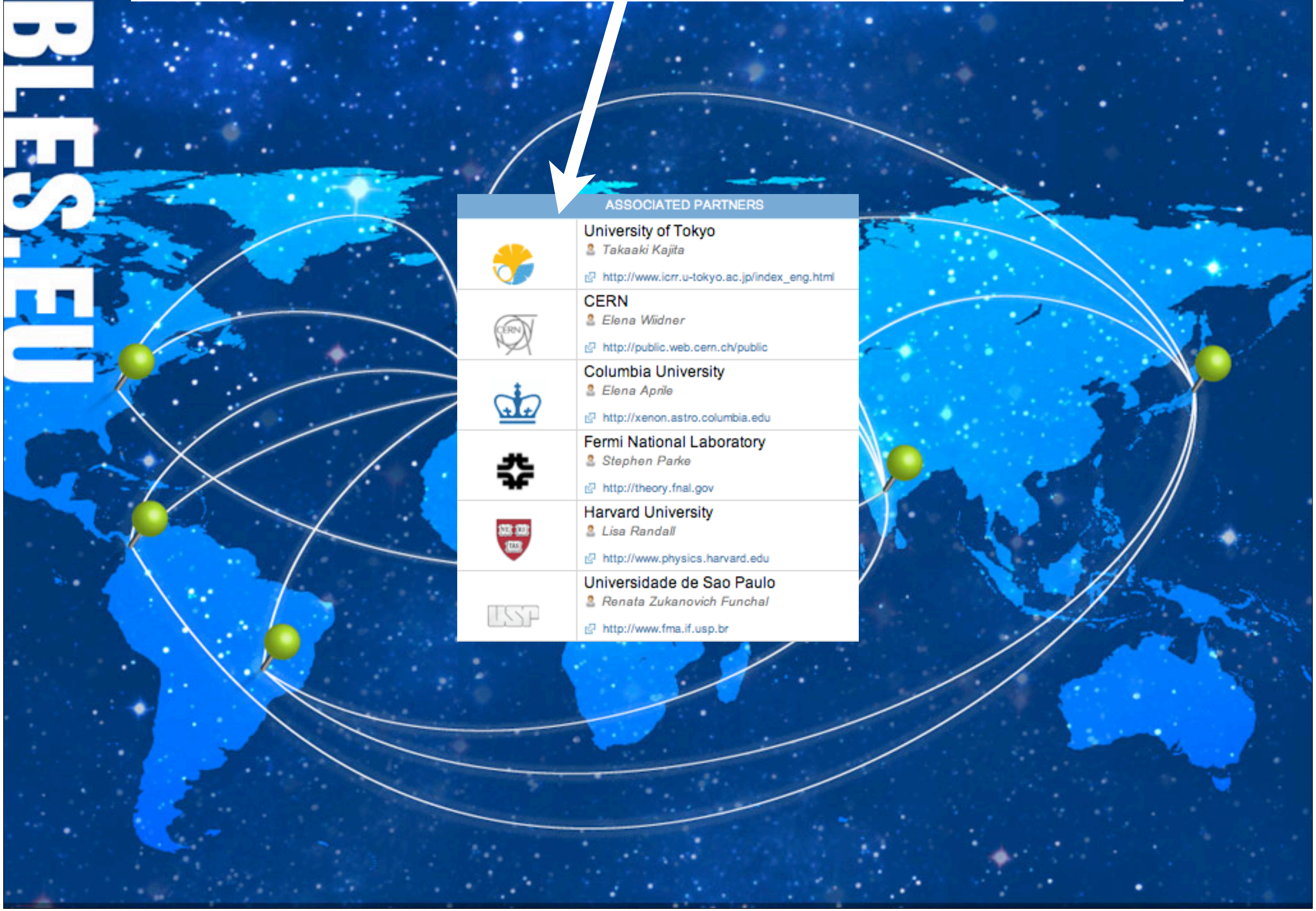
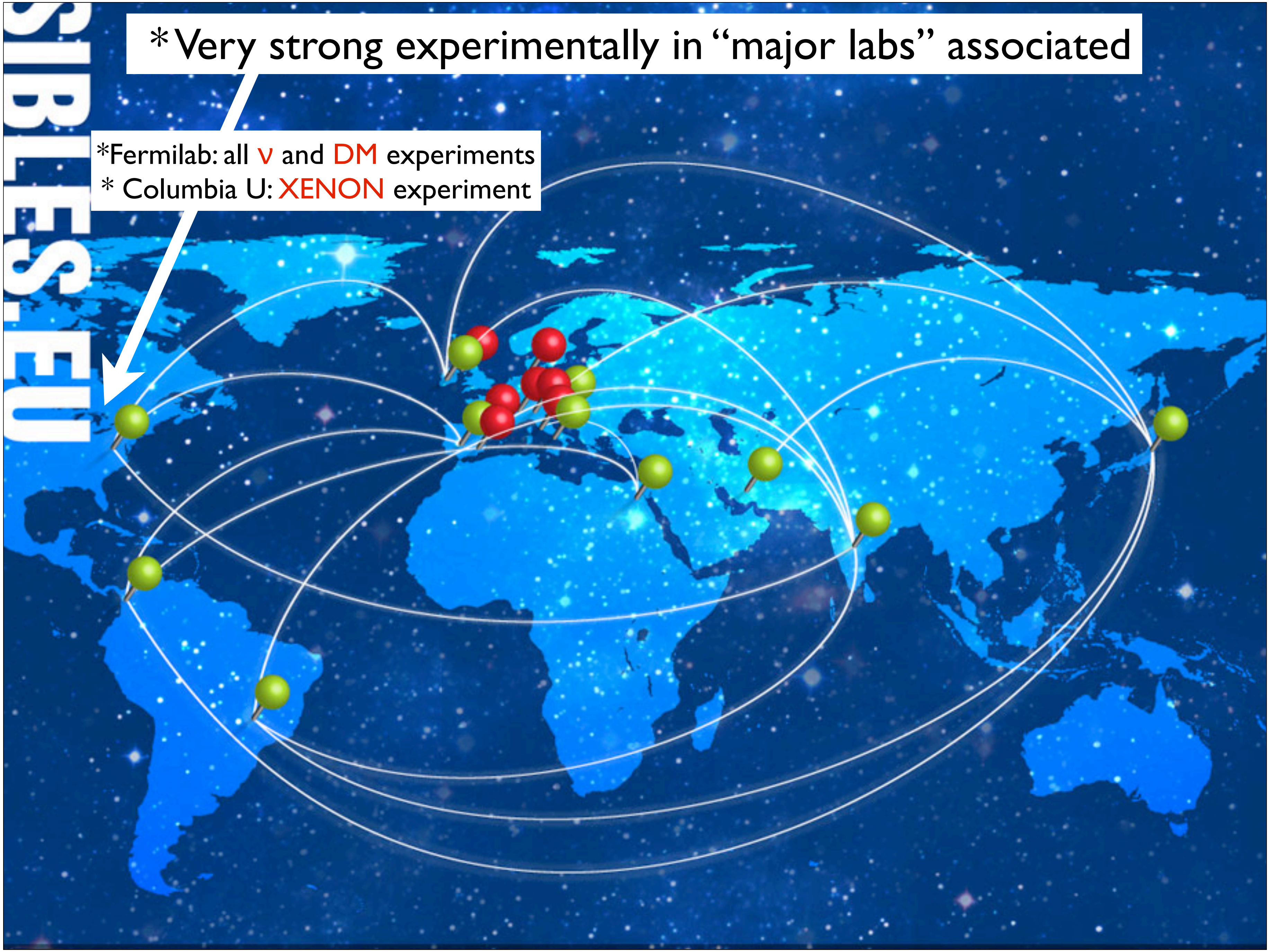
*Very strong experimentally in “major labs” associated





*Very strong experimentally in “major labs” associated
*Fermilab: all ν and DM experiments
* Columbia U: XENON experiment
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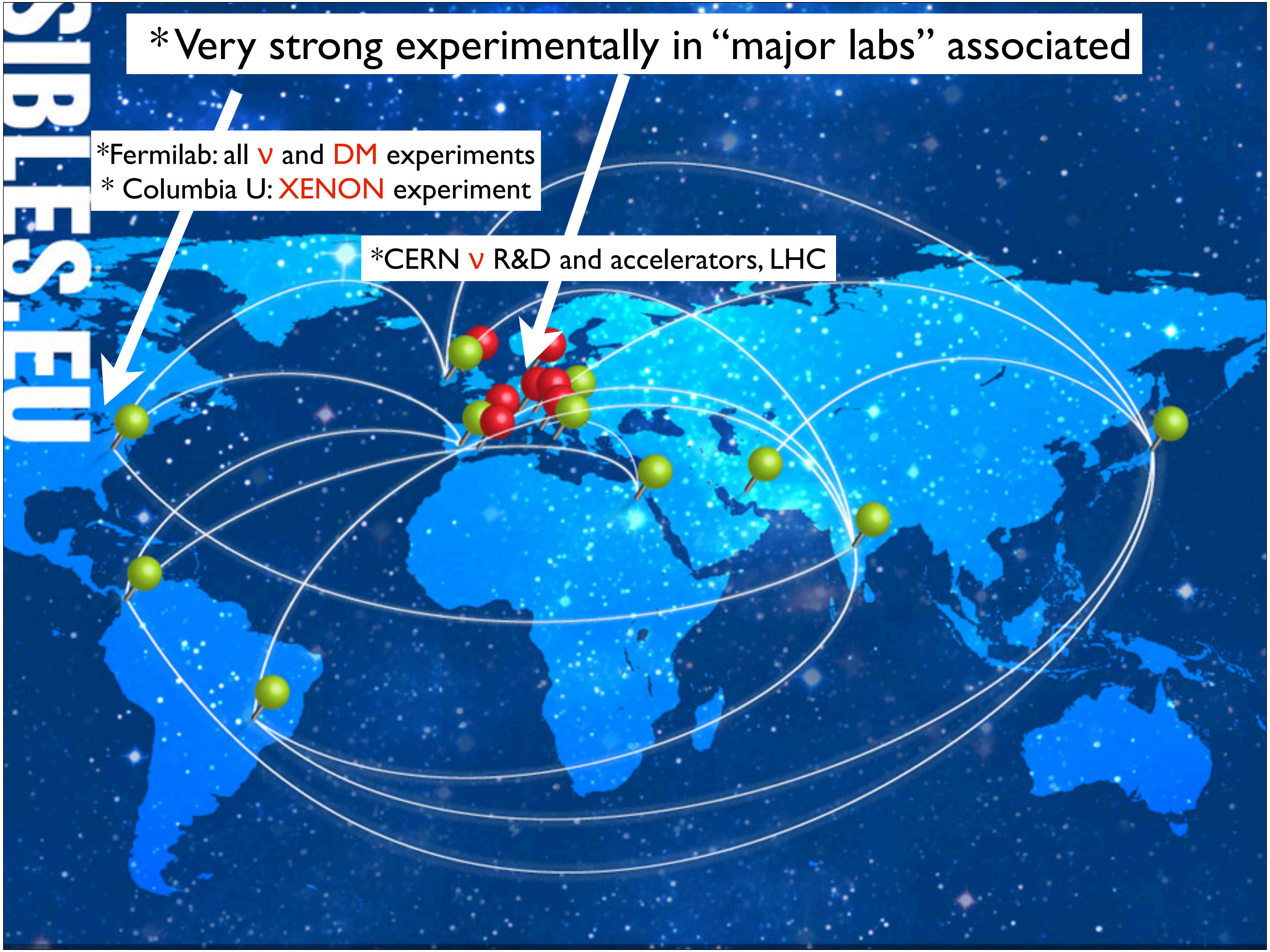
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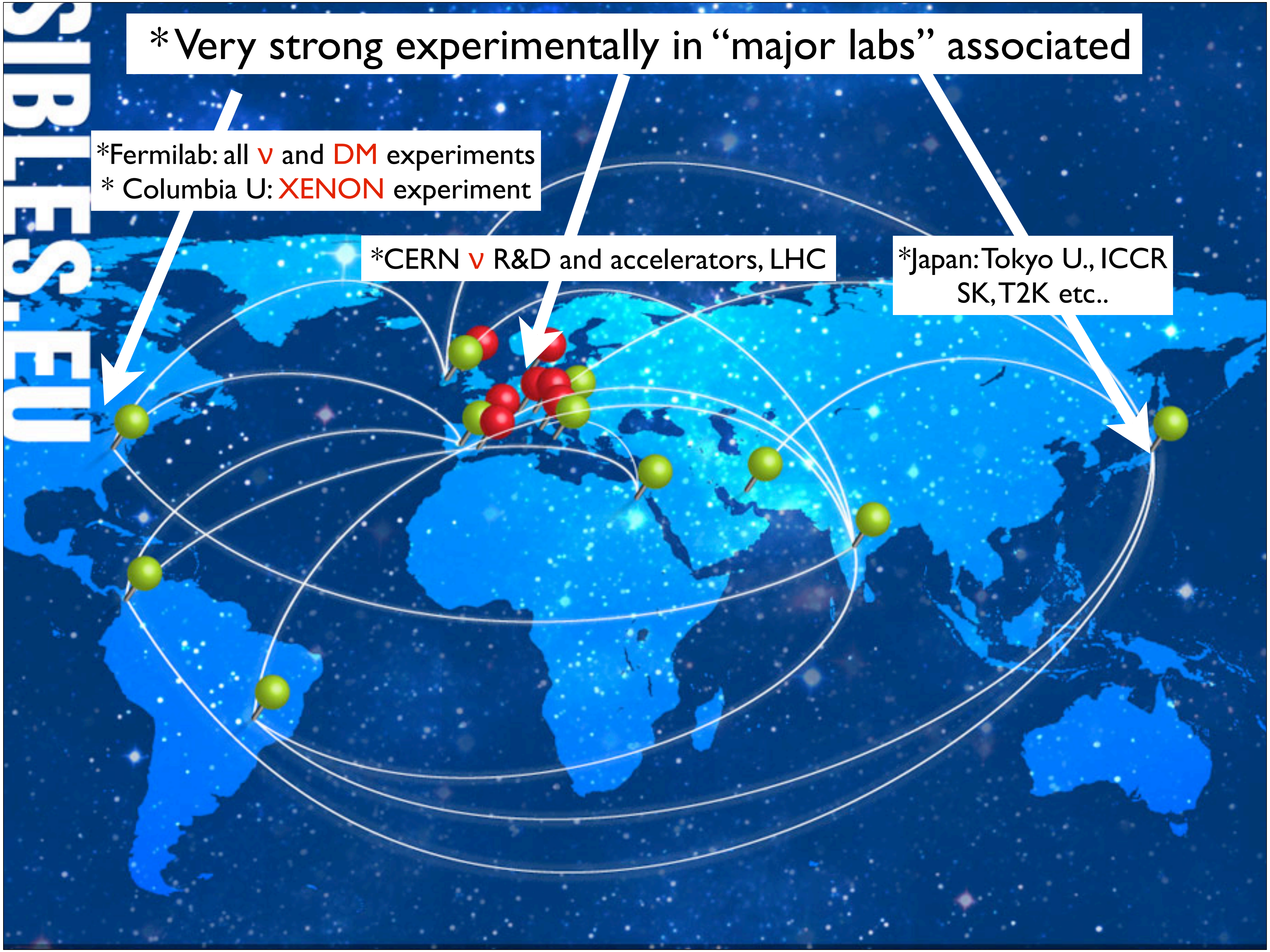
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SK, T2K etc..
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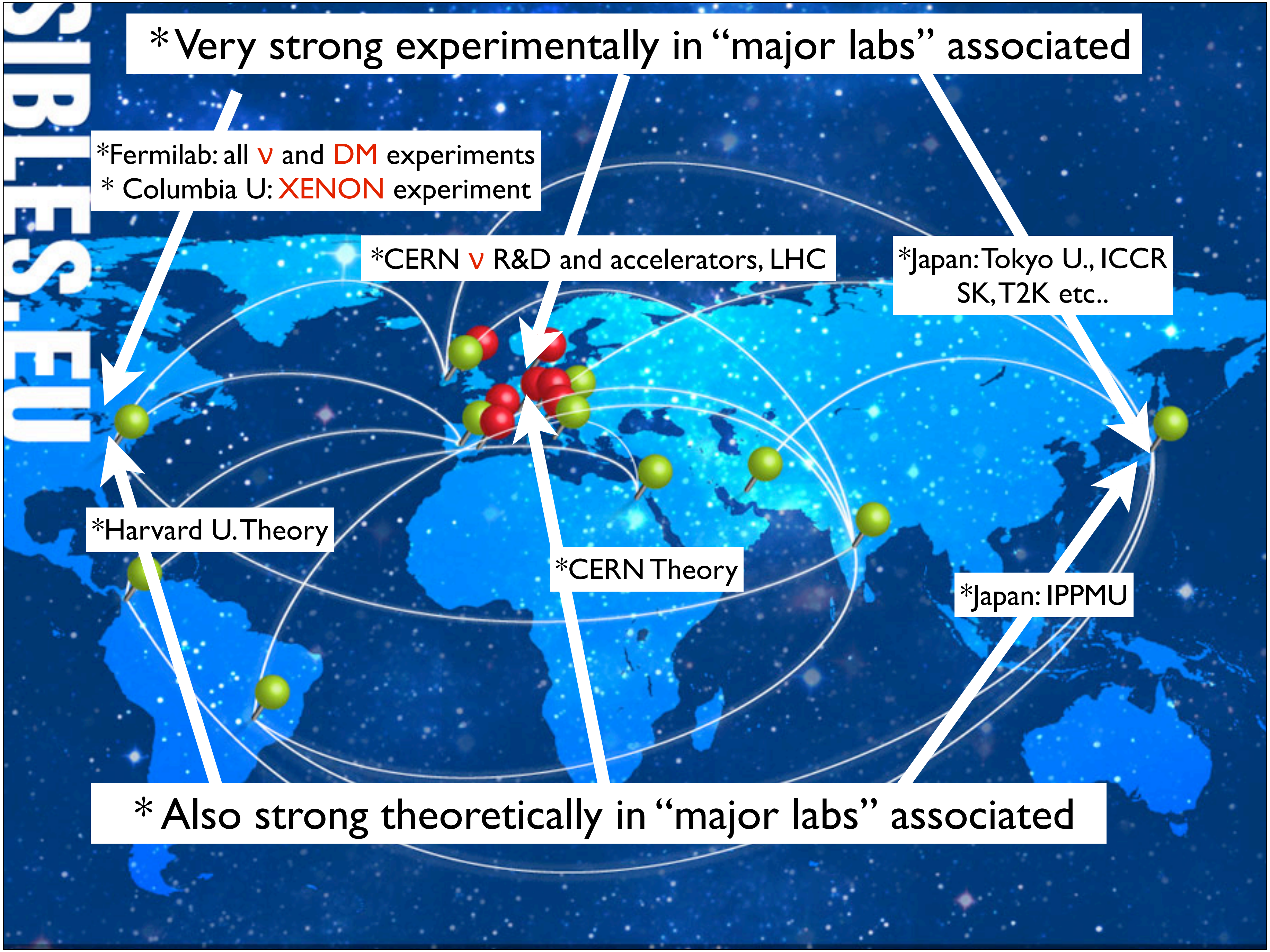

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*Fermilab: all ν and DM experiments
* Columbia U: XENON experiment
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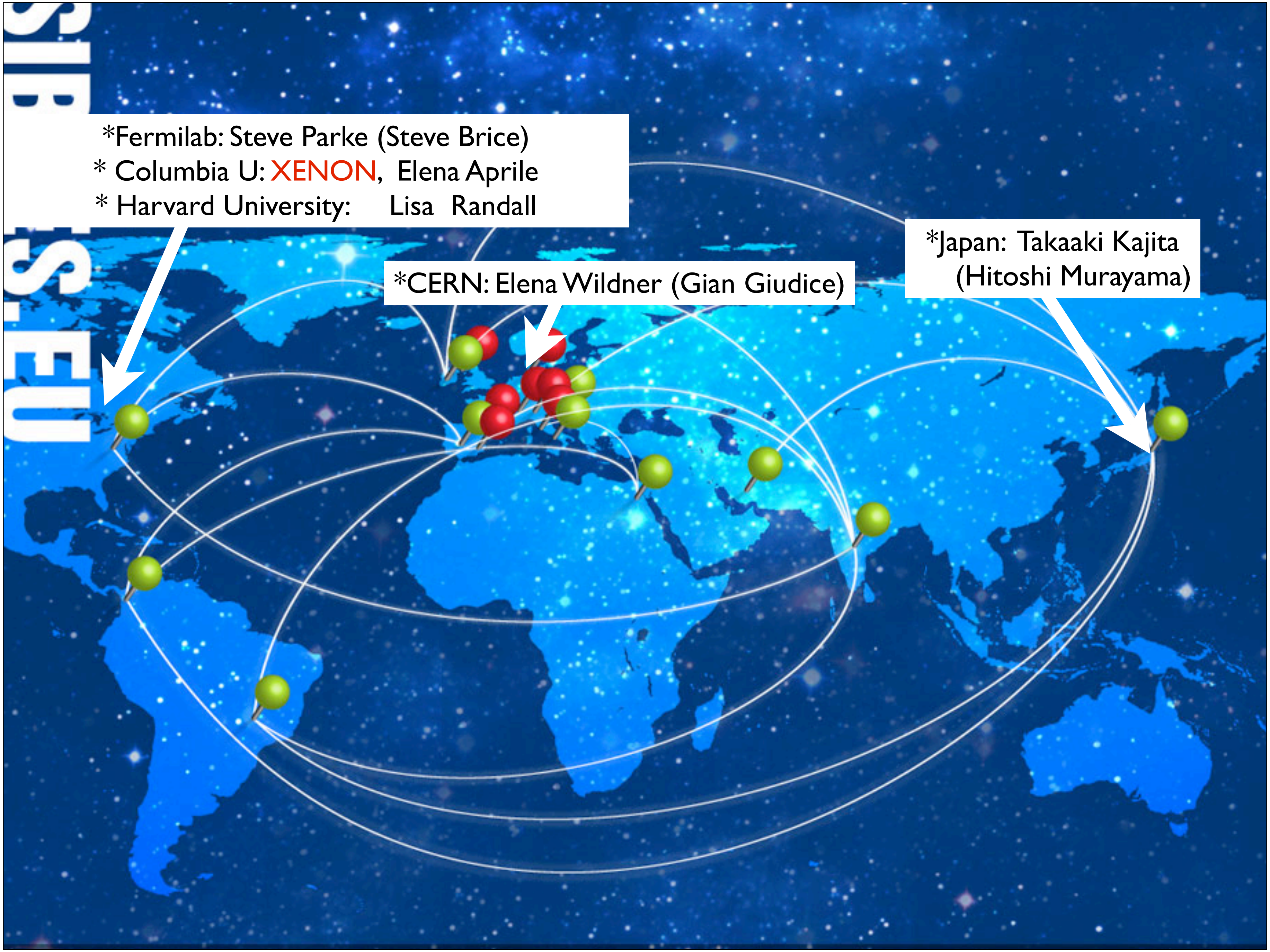
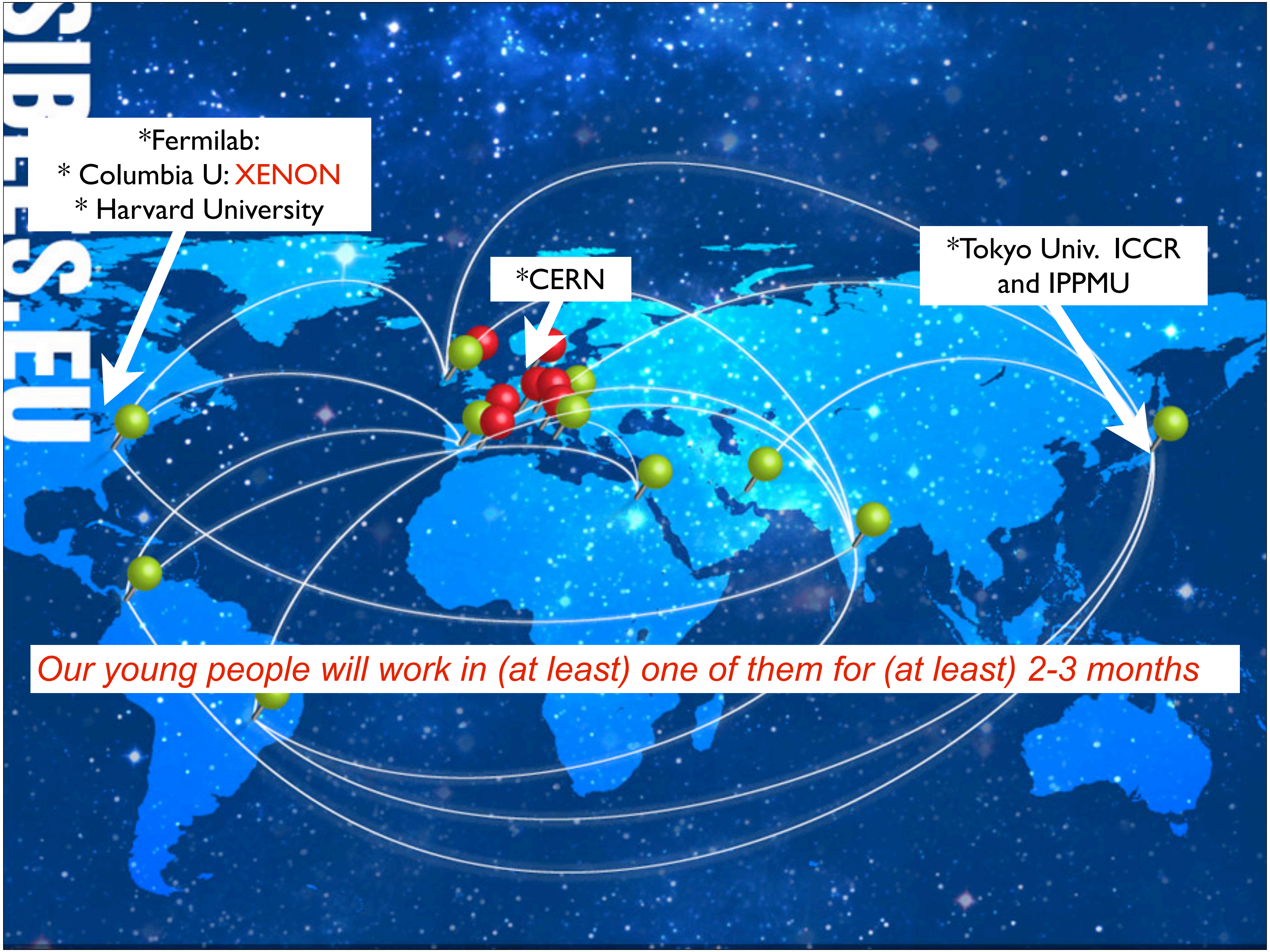
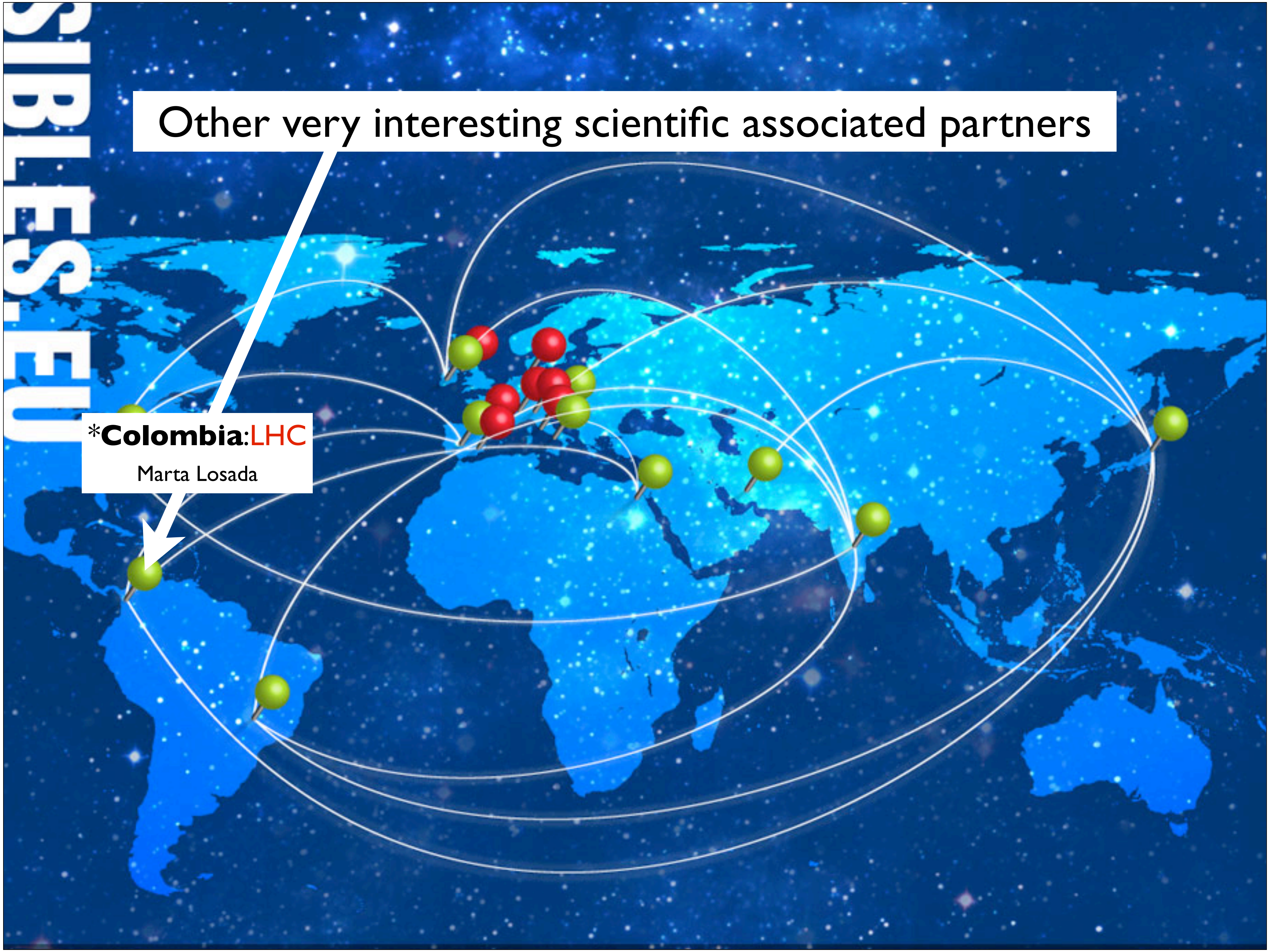
*Harvard U. Theory
*CERN Theory
*Japan: IPPMU
* Also strong theoretically in “major labs” associated


*Fermilab: Steve Parke (Steve Brice)
* Columbia U: XENON, Elena Aprile
* Harvard University: Lisa Randall
*CERN: Elena Wildner (Gian Giudice)
*Japan: Takaaki Kajita
(Hitoshi Murayama)


*Fermilab:
* Columbia U: XENON
* Harvard University
*CERN
*Tokyo Univ. ICCR
and IPPMU
Our young people will work in (at least) one of them for (at least) 2-3 months



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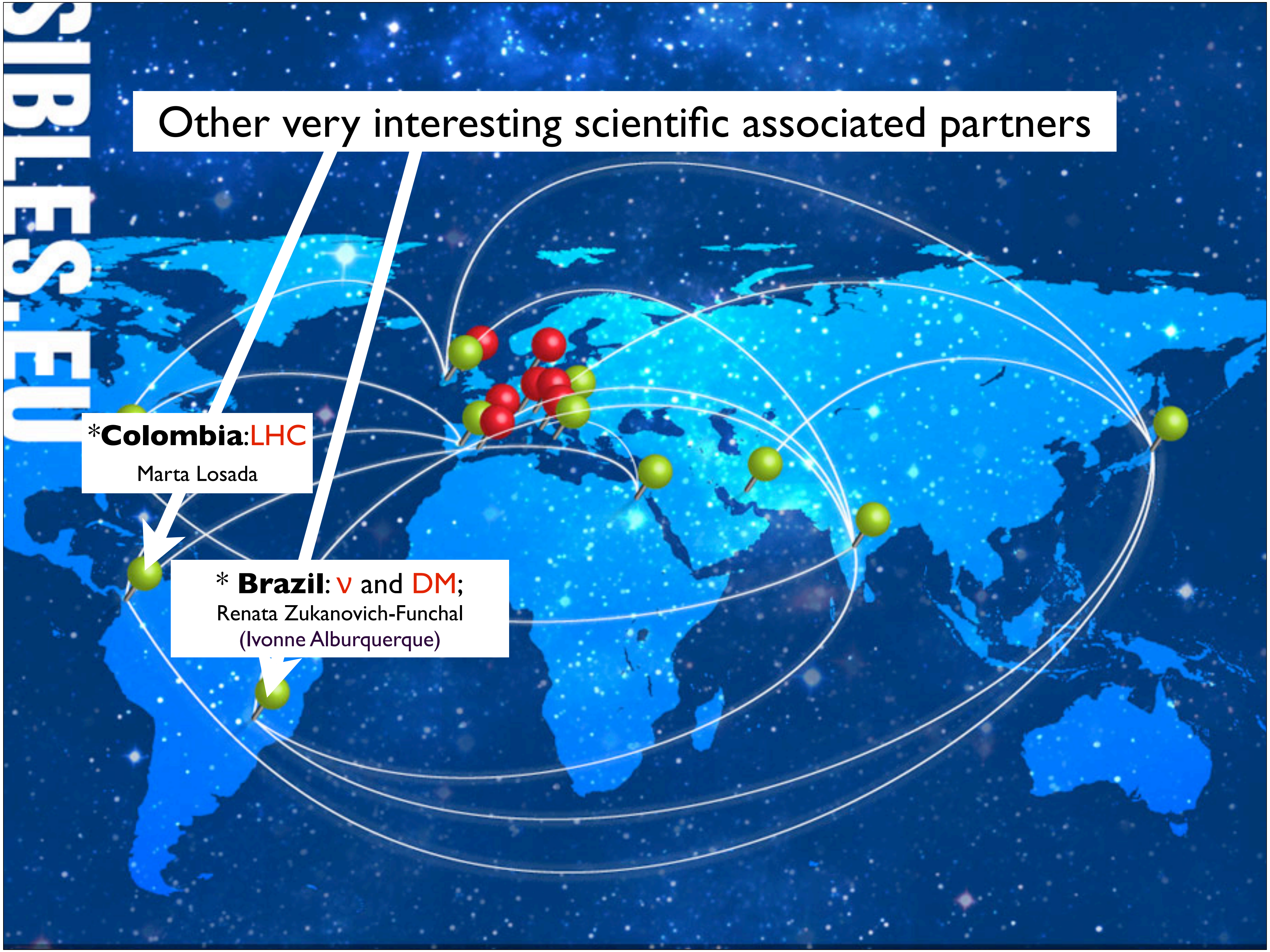
Other very interesting scientific associated partners
*Colombia:LHC
Marta Losada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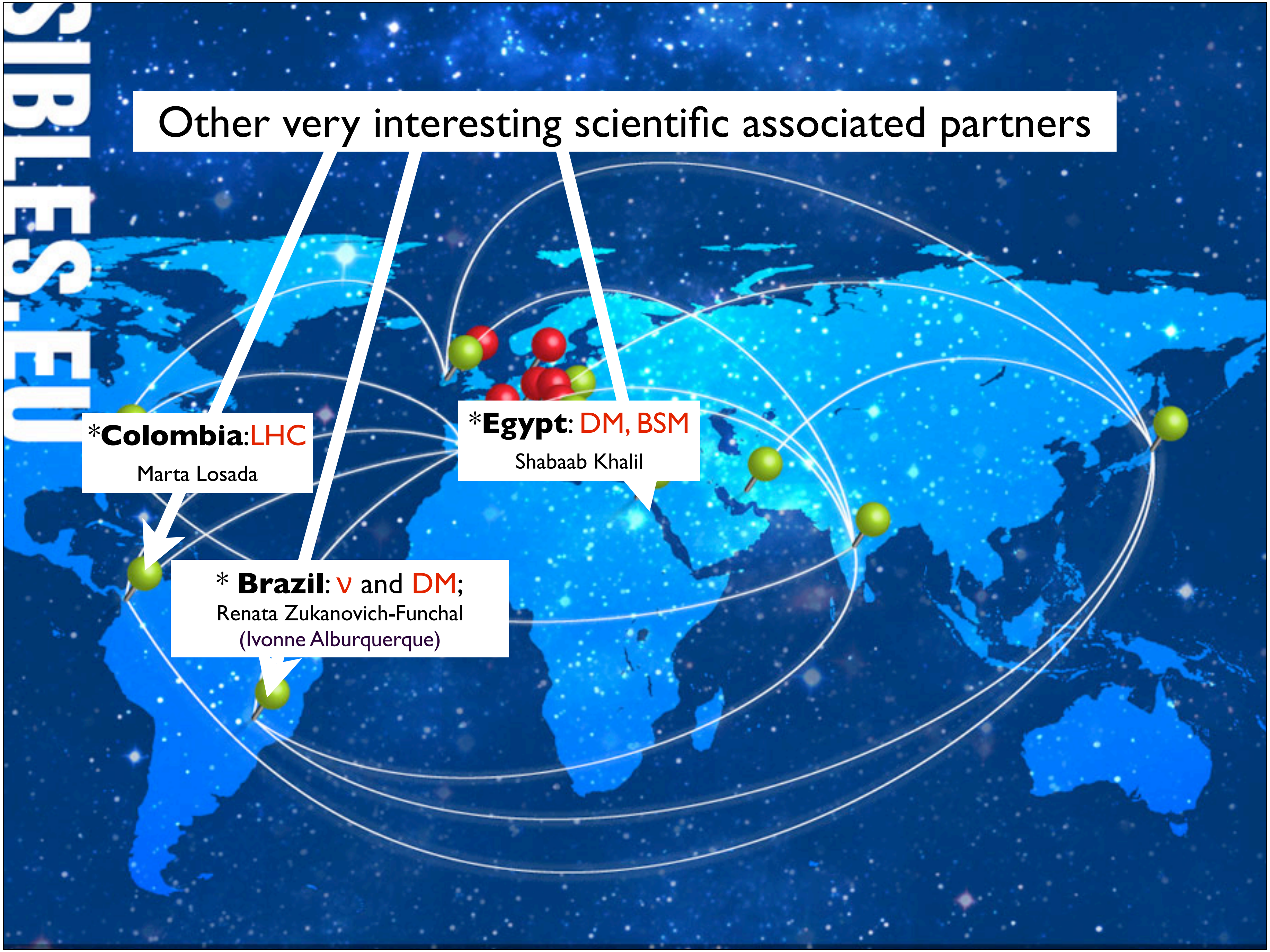
* Brazil: ν and DM;
Renata Zukanovich-Funchal
(Ivonne Alburquerque)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*Egypt: DM, BSM
Shabaab Khalil
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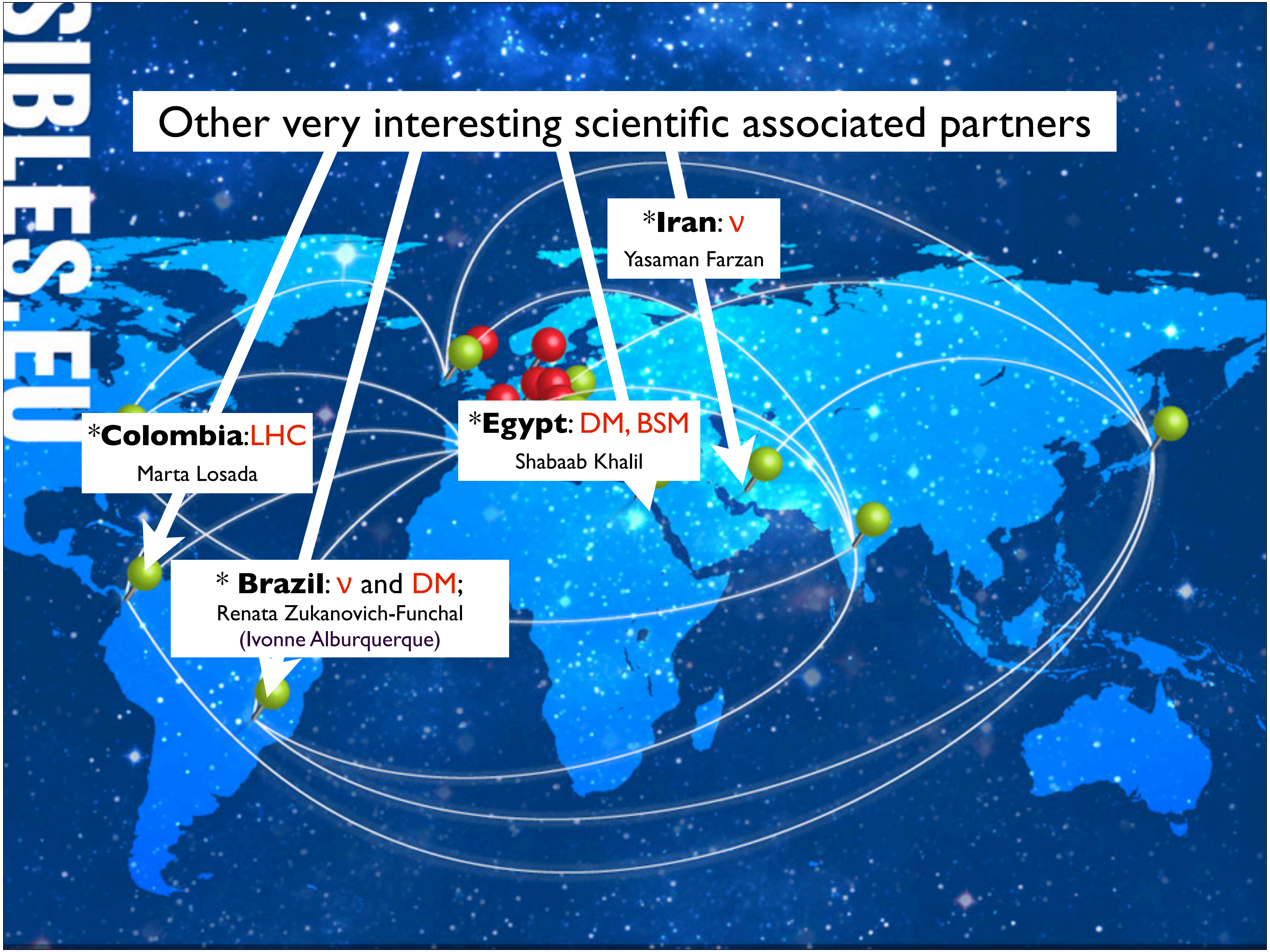

Other very interesting scientific associated partners
*Iran: ν
Yasaman Farzan
*Colombia:LHC
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*Egypt: DM, BSM
Shabaab Khalil
* Brazil: ν and DM;
Renata Zukanovich-Funchal
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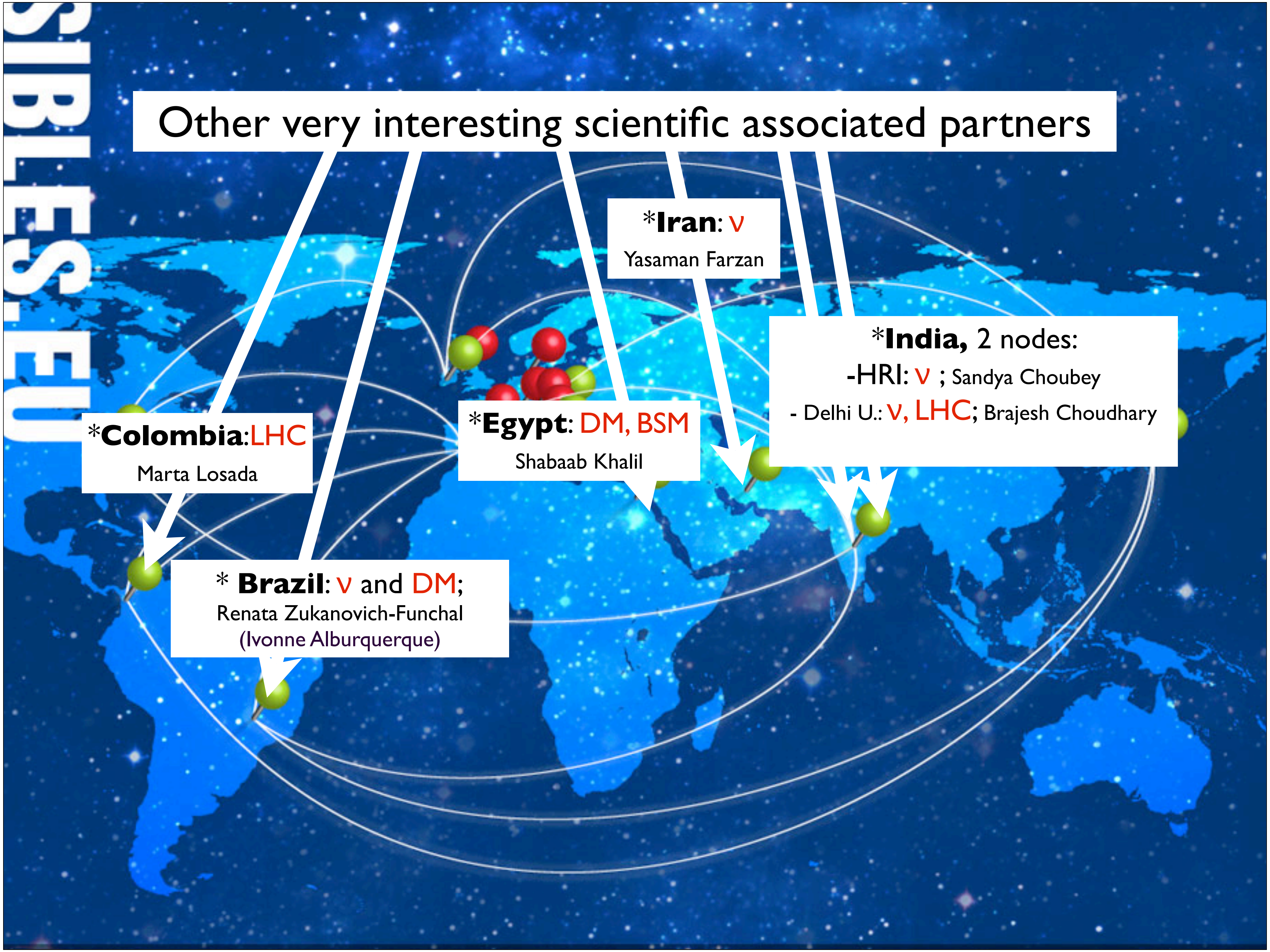

Other very interesting scientific associated partners
*Iran: ν
Yasaman Farzan
*India, 2 nodes:
-HRI: ν ; Sandya Choubey
- Delhi U.: ν, LHC; Brajesh Choudhary
*Egypt: DM, BSM
Shabaab Khalil
*Colombia:LHC
Marta Losada
* Brazil: ν and DM;
Renata Zukanovich-Funchal
(Ivonne Alburquerque)
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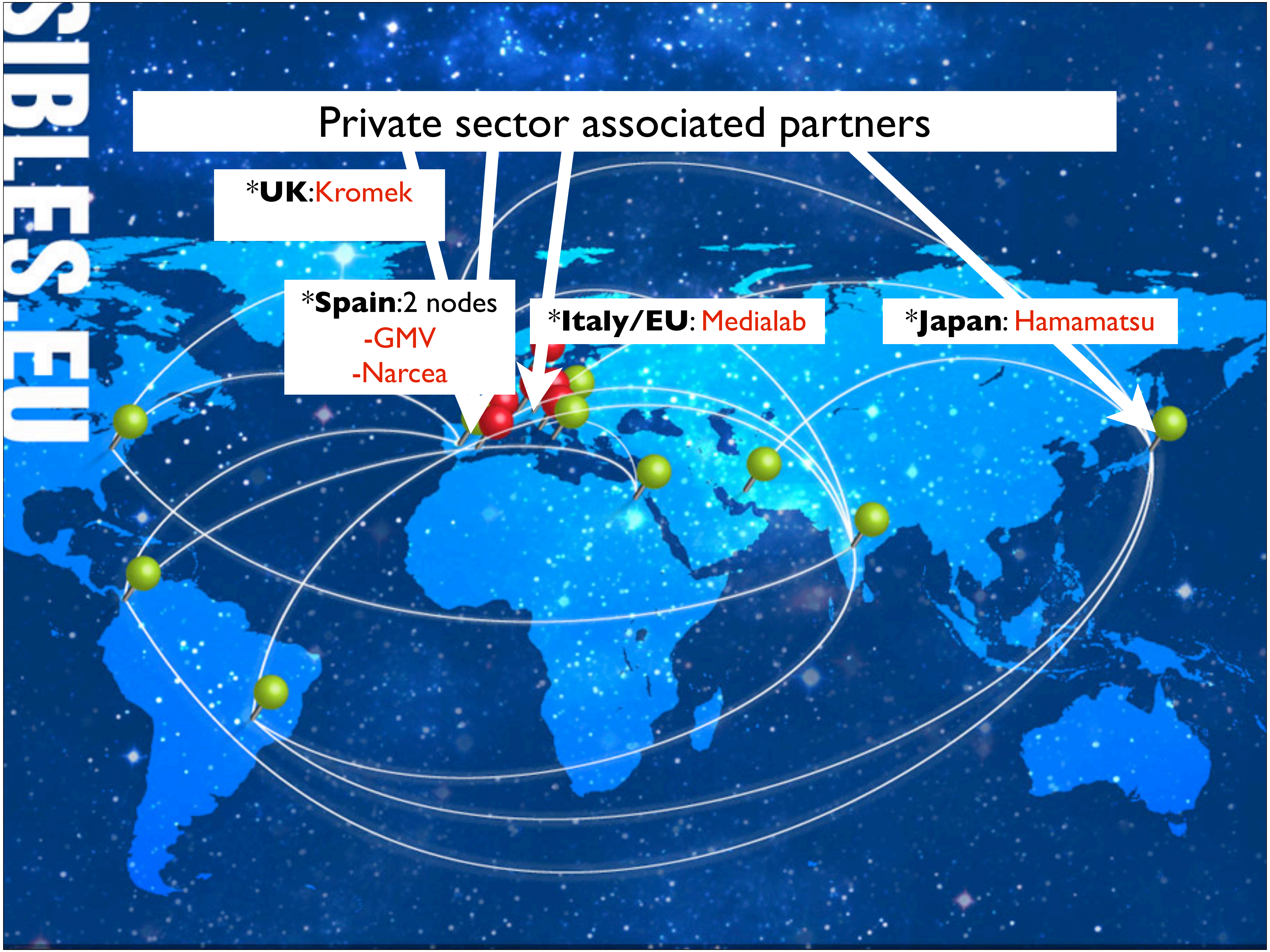
Private sector associated partners

Hamamatsu Photonics	*Yoshikazu Hakamata*	http://www.hamamatsu.com
GMV Aerospace and Defense	*Ana Curiel*	http://www.gmv.co
Kromek	*Max Robinson*	http://www.kromek.com
Medialab	*Enrico Balli*	http://medialab.sissa.it
Narcea Prod. Multimedia 2MDC	*Eduardo Ramos*	http://www.2mdc.com

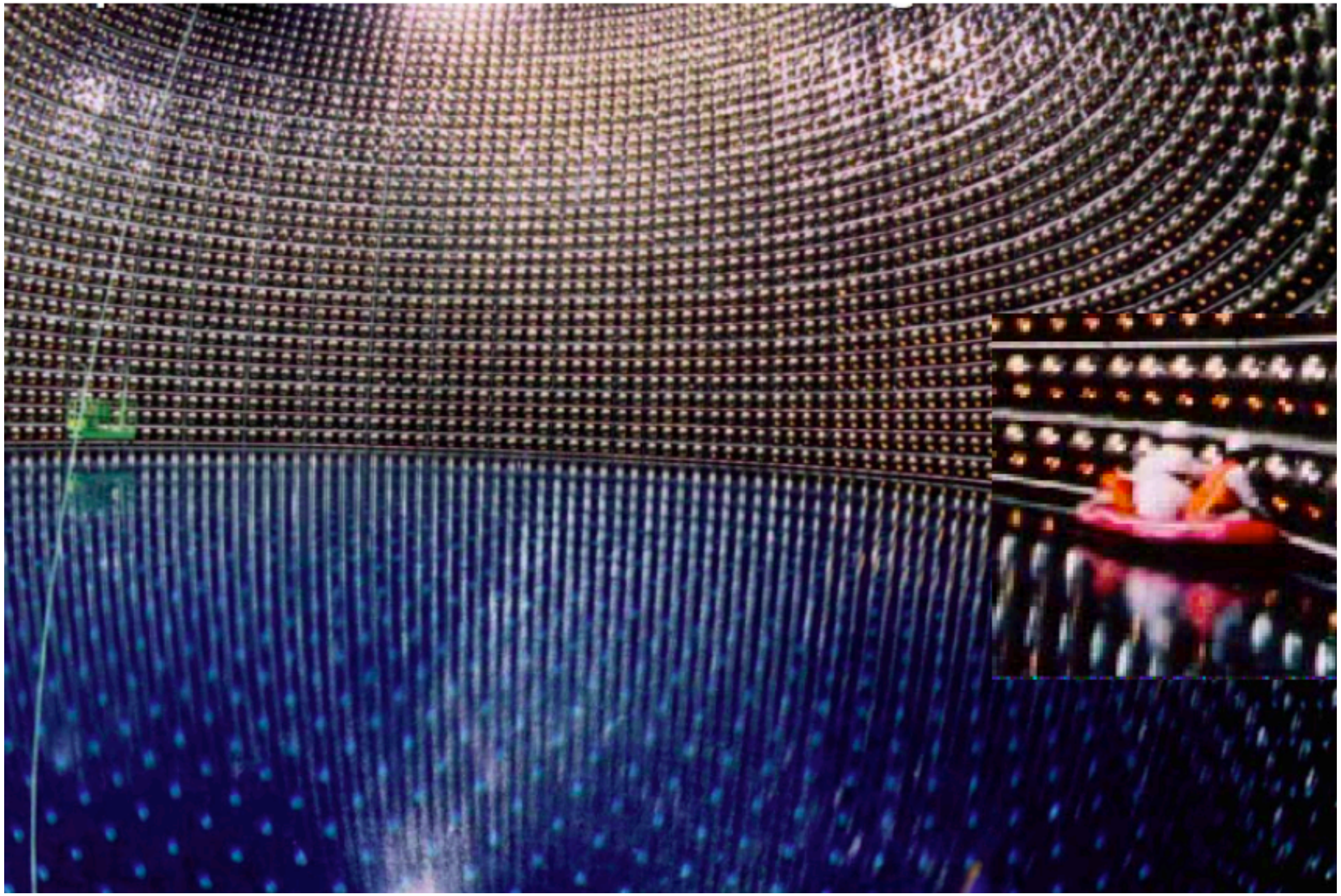


Private sector associated partners
*UK:Kromek
*Spain:2 nodes
-GMV
-Narcea
*Italy/EU: Medialab
*Japan: Hamamatsu

HAMAMATSU IN ν PHYSICS

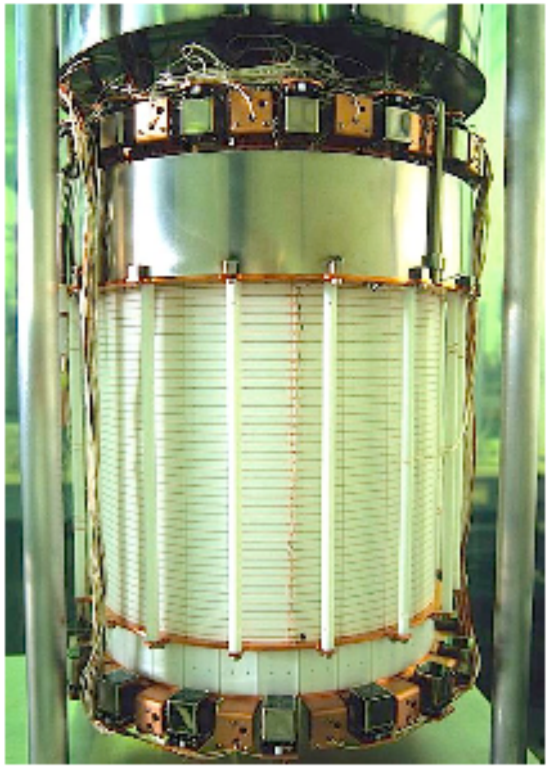
S U P E R K A M I O K A N D E

50000 tons of water
surrounded by photomultipliers

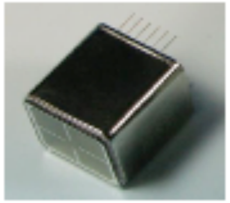


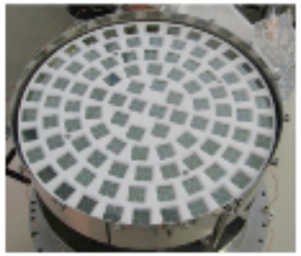
HAMAMATSU IN DM PHYSICS

XENON100

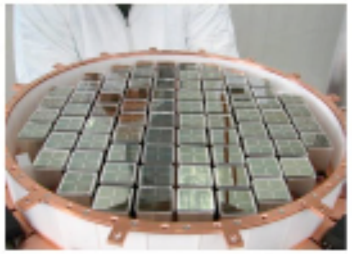


- 242 PMTs in two arrays + veto
- Hamamatsu R8520 (1"x1")
- Sensitive to xenon light (178nm)
- Low radioactivity
- QE ~23 % (top, veto) and ~33 % (bottom)
- Gain ~ $2x10^6$

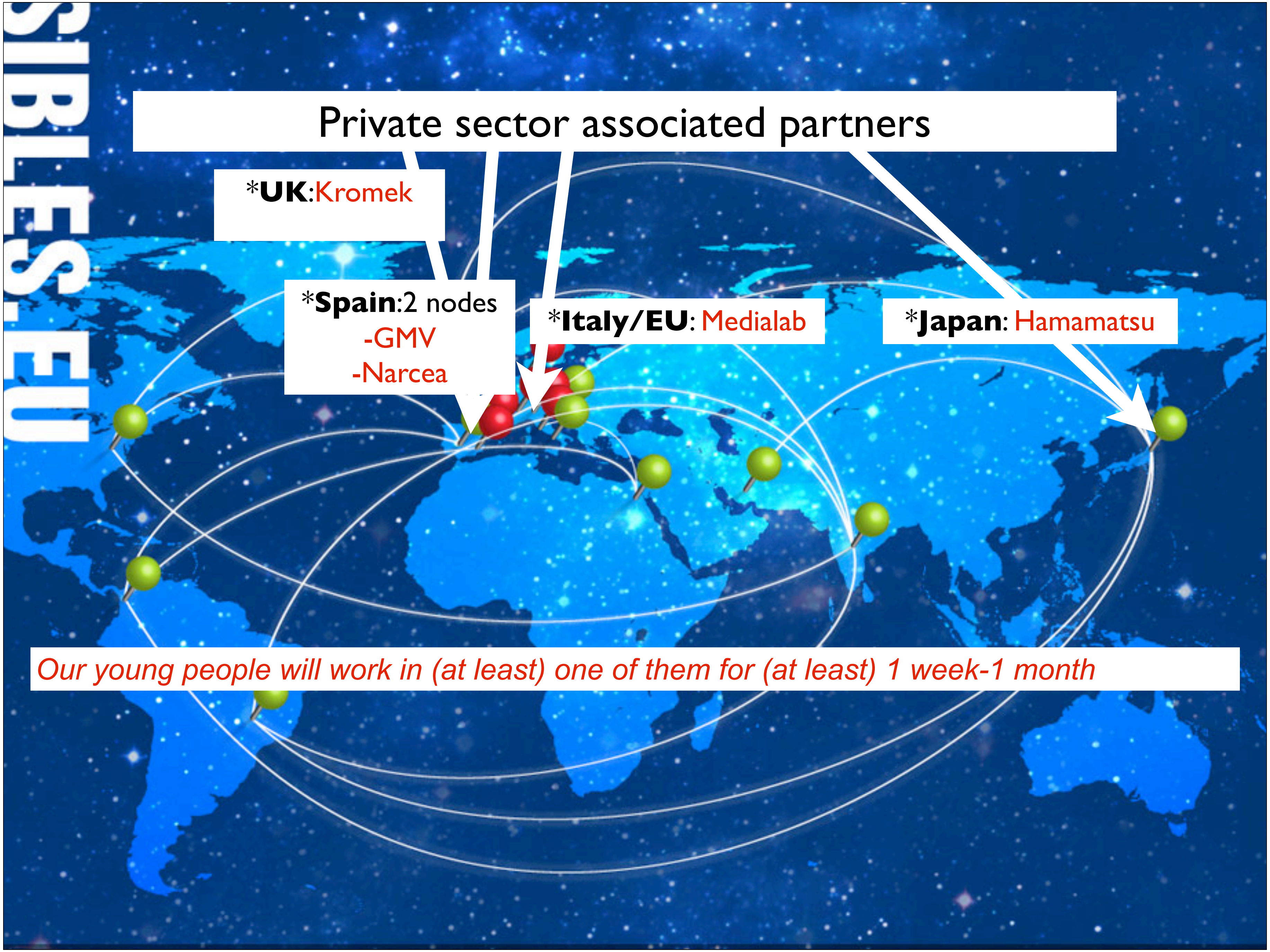




Top PMT array (98 PMTs)



Bottom PMT array (80 PMTs)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*Japan: Hamamatsu
Our young people will work in (at least) one of them for (at least) 1 week-1 month


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Help and support:

* Marcia McGowan

* Milvia Soumbounou

* Tiina Timonen