JUNO update

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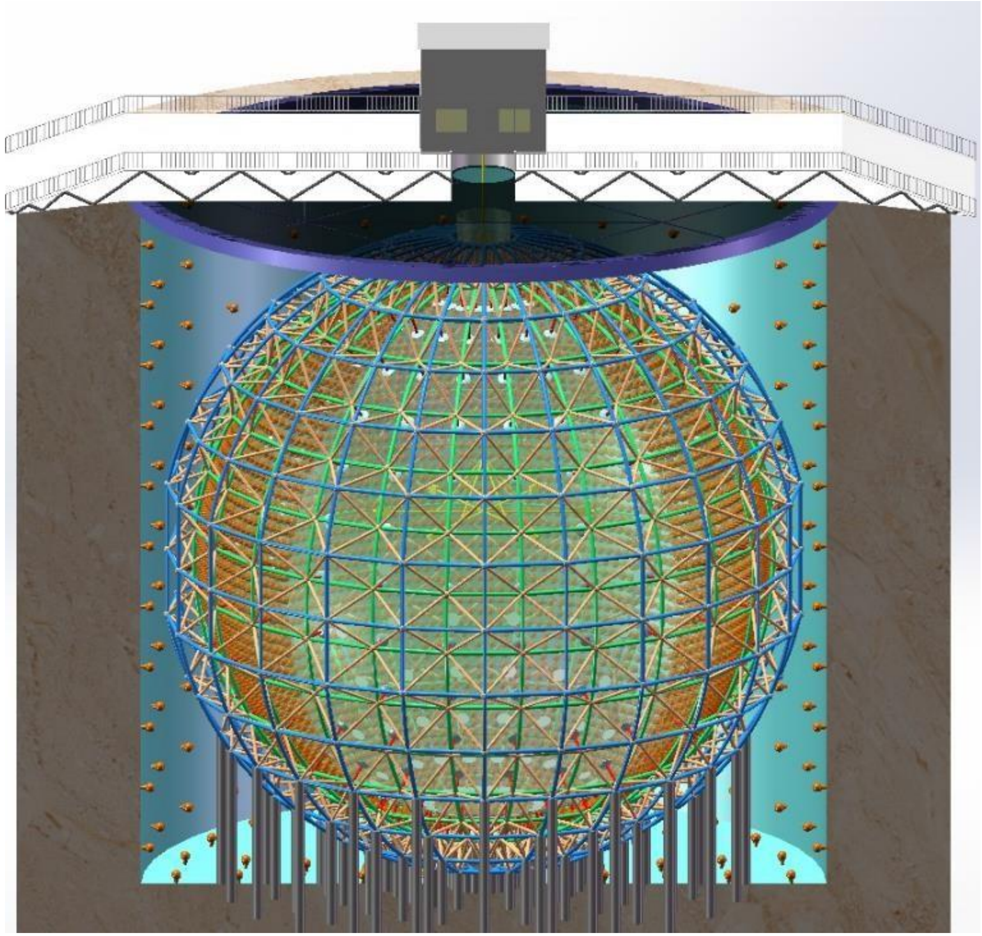
On behalf of the JUNO collaboration
INFN, Sez CT

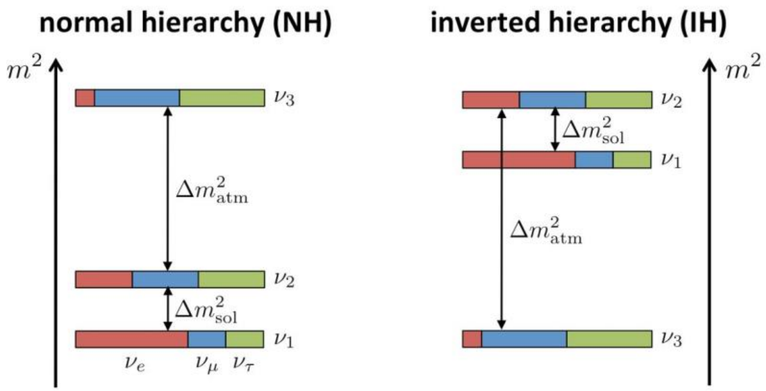
JUNO

Jiangmen Underground Neutrino Observatory

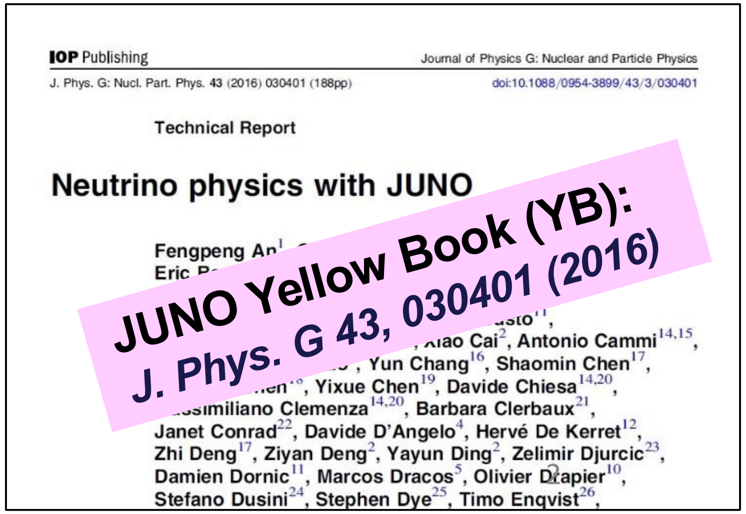


Massive:
~20 kton Liquid Scintillator (LS)
Underground:
~700 m overburden
High resolution:
3% / √E (MeV)
Precision energy scale: < 1%

Main physics goal:
➔ Determine Mass Hierarchy



Rich physics portfolio:
- Precision measurement of 3 oscillation parameters
- Supernovae neutrinos
- Atmospheric neutrinos
- Solar neutrinos
- Geoneutrinos
- Nucleon decay

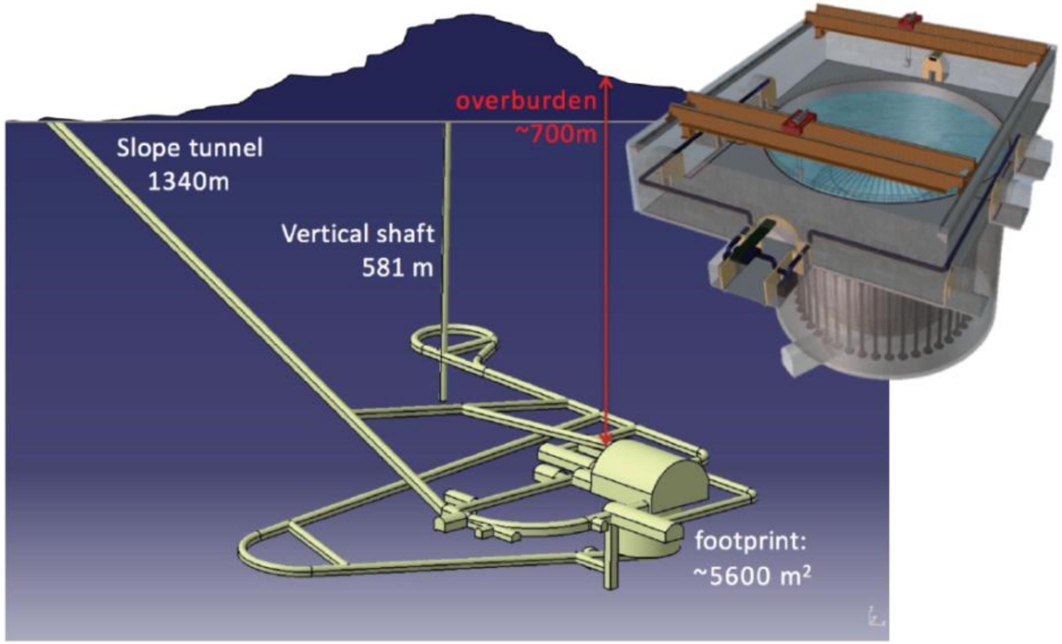


JUNO UPDATE

- One more physics item: Multi Messenger (MM)
- Already discussed trigger modification to support MM
- not clear, yet, impact on computing requirements

Civil constructions

- Slope tunnels and vertical shafts are finished
- Experiment cavern digging completed in Dec. 2020
- Detector installation will begin this summer.



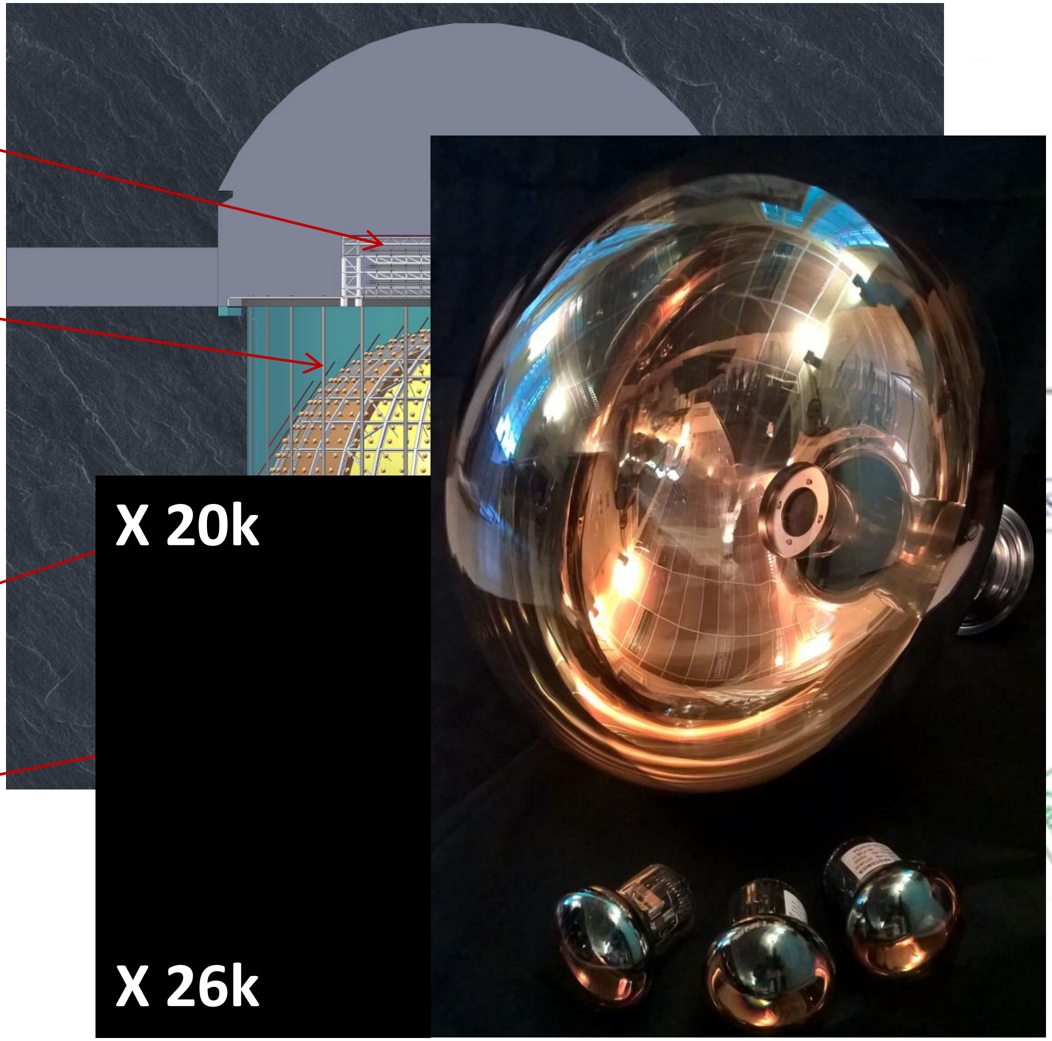
JUNO main components

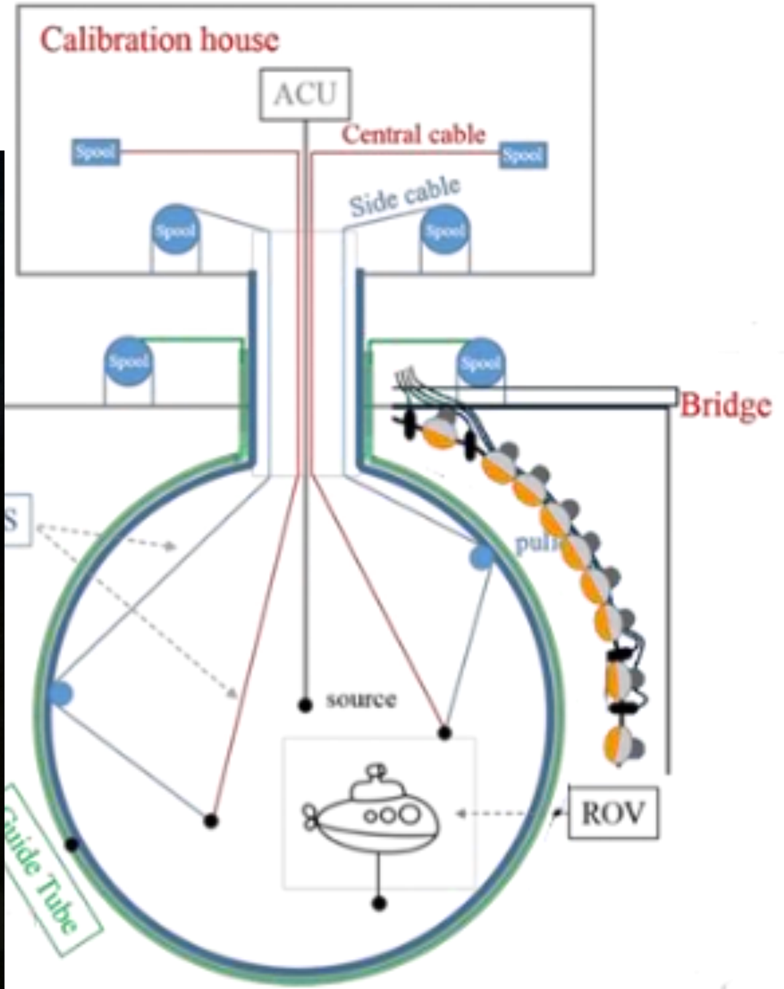
Top tracker

Earth magnetic field compensation coils

Veto PMT Support Structure

LED calibration





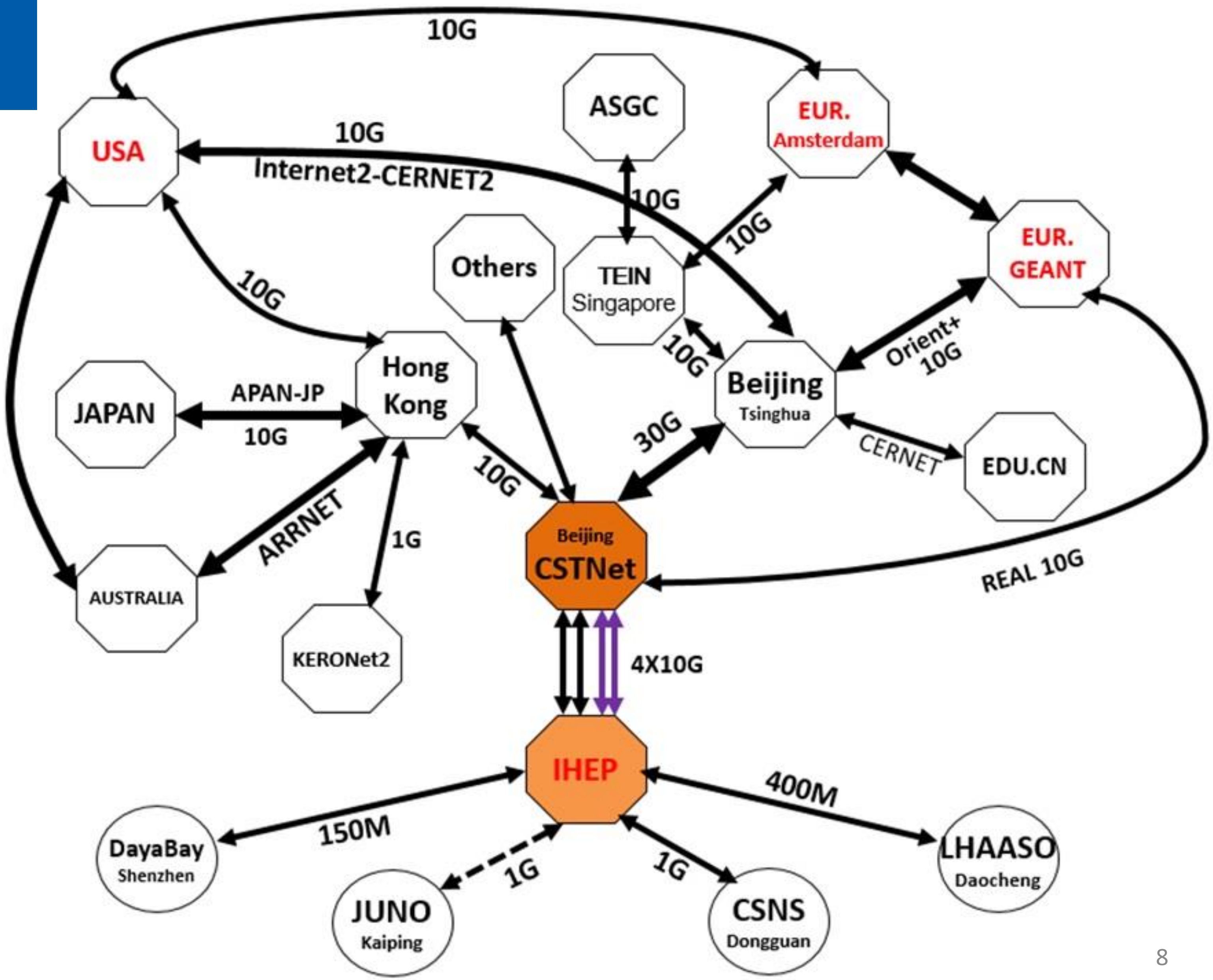
Progress update

- Acrylic spherical vessel panels in production
- Systems for Liquid Scintillator produced, waiting to be installed
- 20 inch PMTs: 15k NNVT MCP-PMT + 5k Hamamatsu R12860 already tested, potting in progress
- ~26k 3 inch PMTs produced
- JUNO-TAO (Taishan Antineutrino Observatory) expect to start operations in 2022

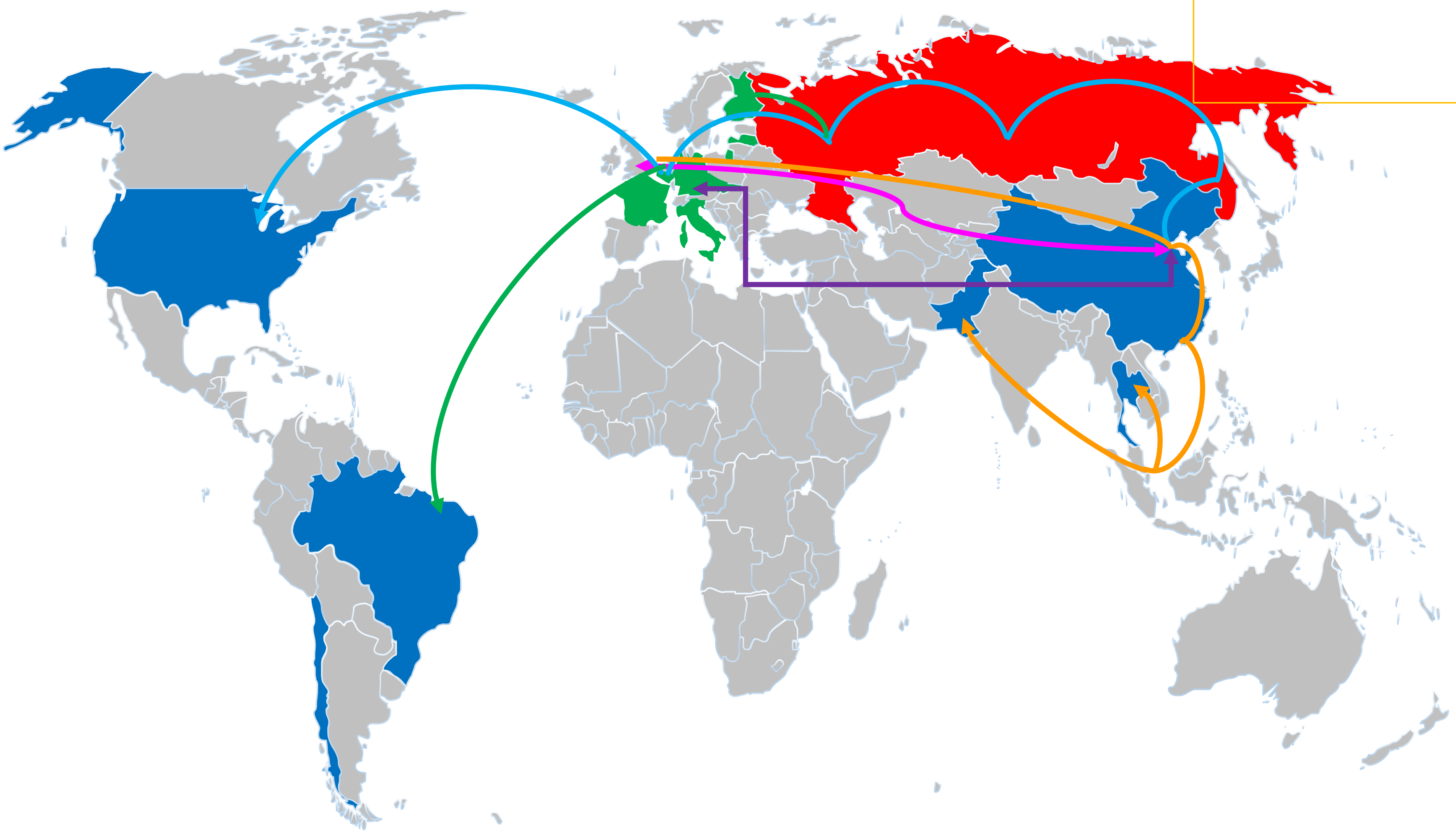
Data centers and roles

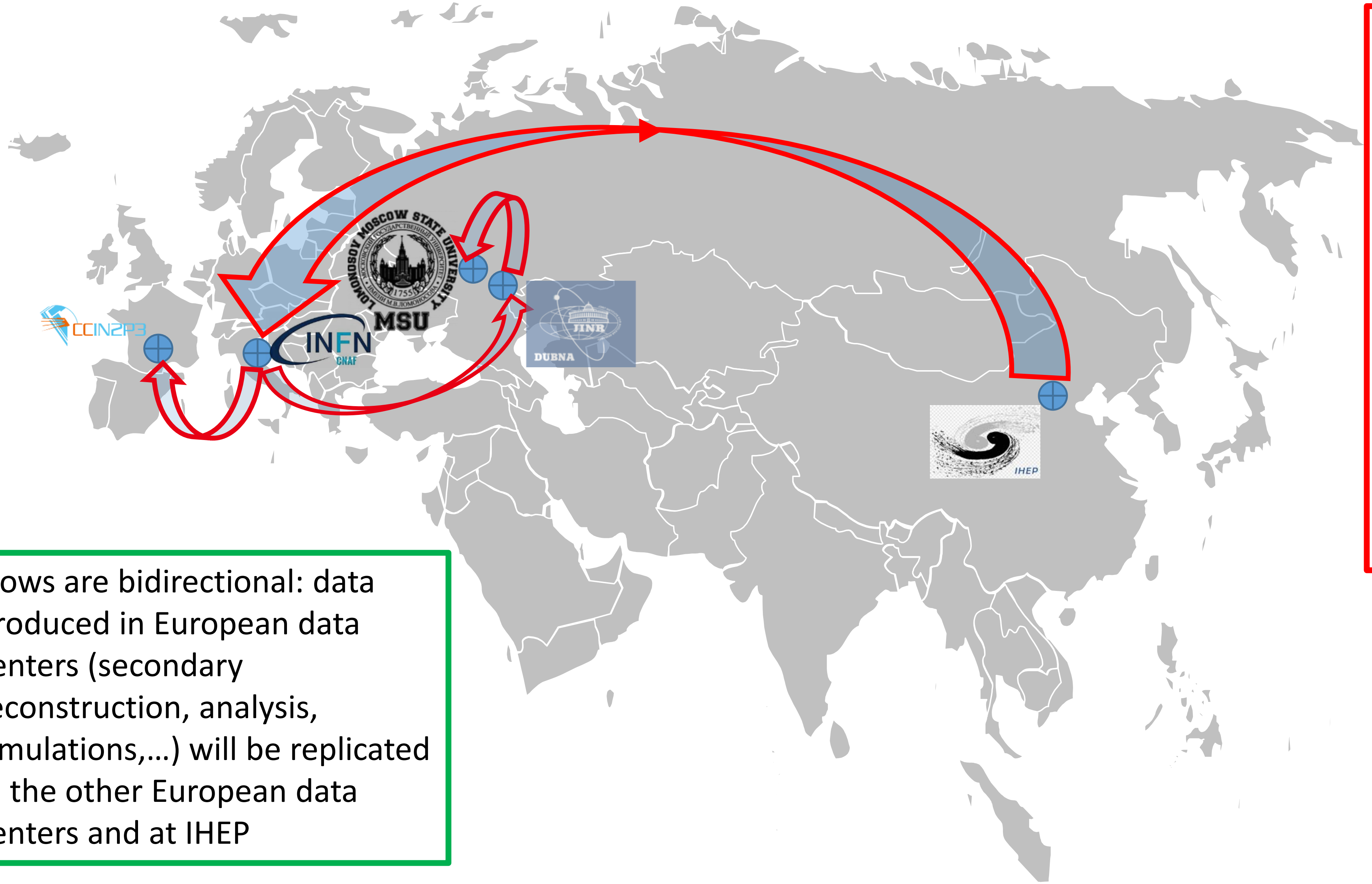
Kaiping	IHEP	CCIN2P3	INFN CNAF	MSU	JINR DUBNA
Data taking, event filtering					
	Main storage		Secondary storage		Secondary storage
	Data quality				
	First reconstruction		Secondary reconstruction		Secondary reconstruction
	Analysis	Analysis	Analysis	Analysis	Analysis
	Simulation	Simulation	Simulation	Simulation	Simulation

Data networks



Data networks





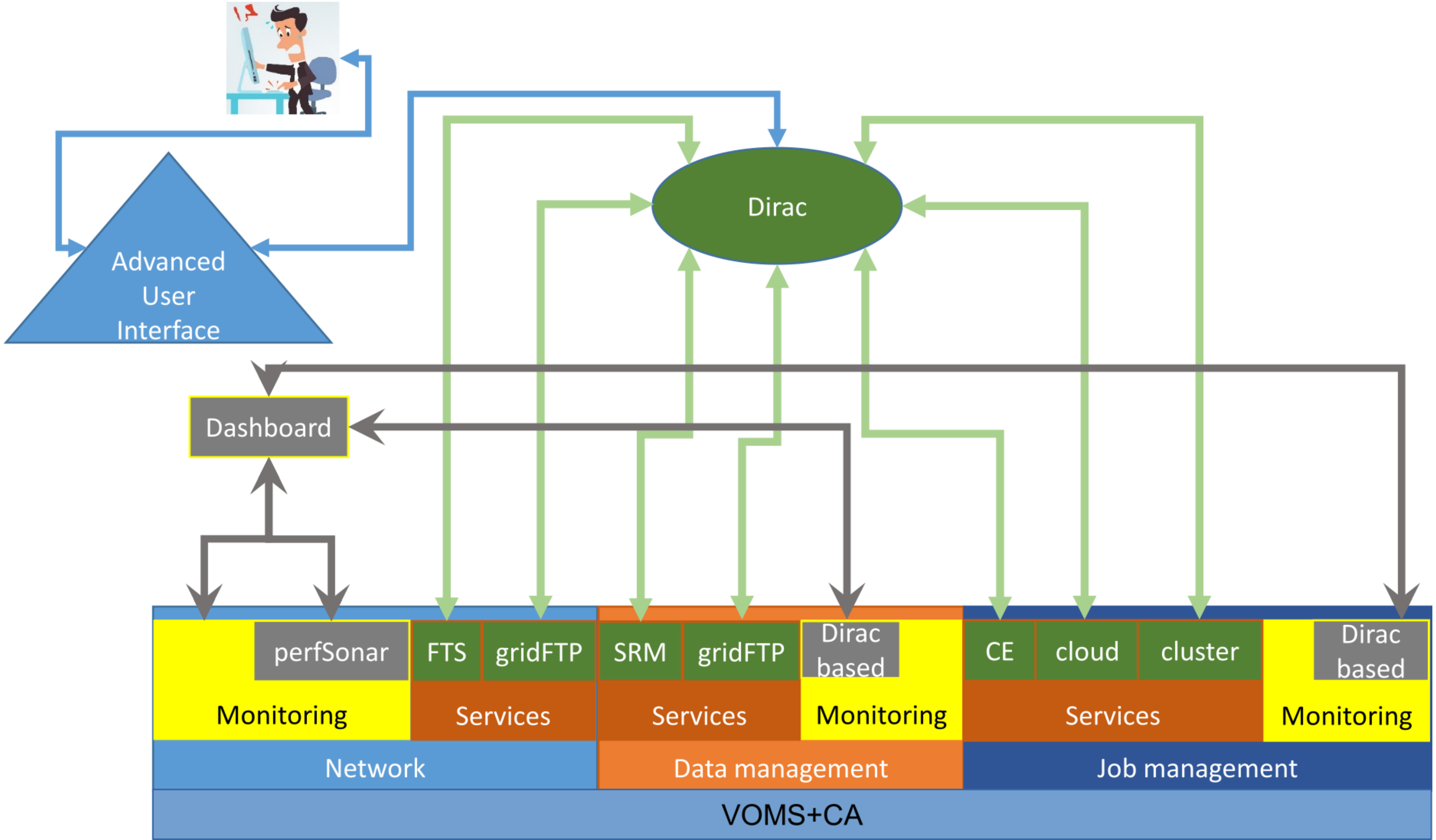
Data flows proposal

IHEP will receive data from experimental site and store them in master repository. At IHEP will run fast calibration and prompt reconstruction

1. IHEP main repository will be automatically replicated at CNAF
2. From CNAF data will be copied also to JINR
3. CC-IN2P3 will maintain a copy of part of the data at CNAF with the chance to access data physically at CNAF
4. JINR data will be accessed from MSU resources

Flows are bidirectional: data produced in European data centers (secondary reconstruction, analysis, simulations,…) will be replicated in the other European data centers and at IHEP

Distributed Computing Infrastructure design



DCI reviews

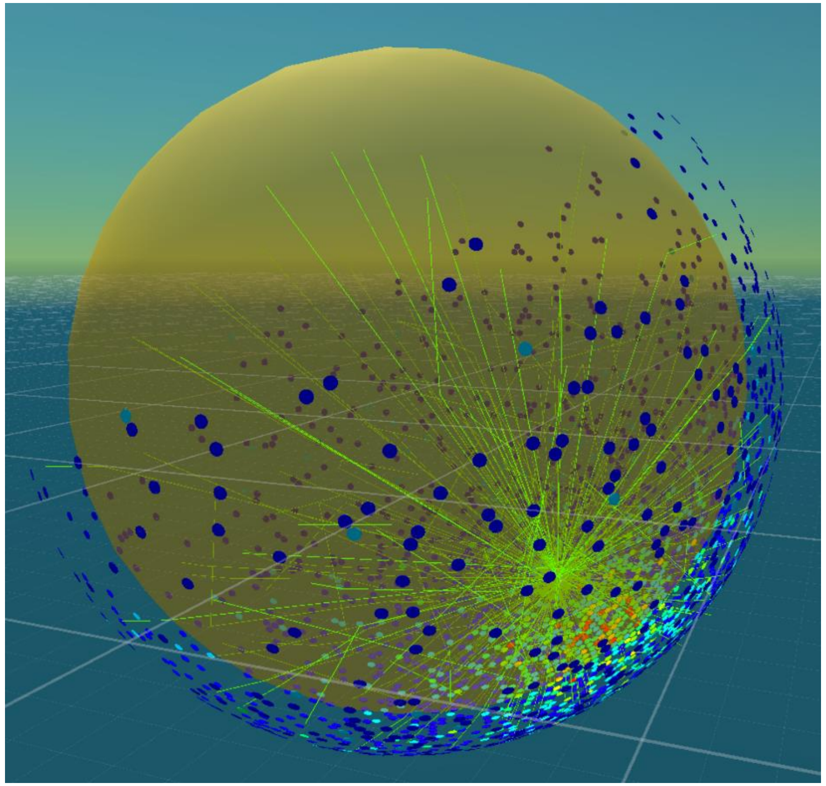
- In January 2020 first review for computing and DCI
- Results were quite good. Some suggestions, mainly about keeping DCI closely following WLCG; in detail, to give a try to:
  - IAM (VOMS)
  - RUCIO (DIRAC Data Management System)

UPDATE

- In January 2021 second review for DCI
- Results quite good, no relevant observations

DCI update

- Main points under observation:
  - RUCIO: working to a pilot testbed
  - IAM: waiting for compliants WLCG elements to be integrated, in view of X509 retirement
  - Data transfer protocols in gridftp replacement (httpd, XROOTD,…)



Thank you!!!

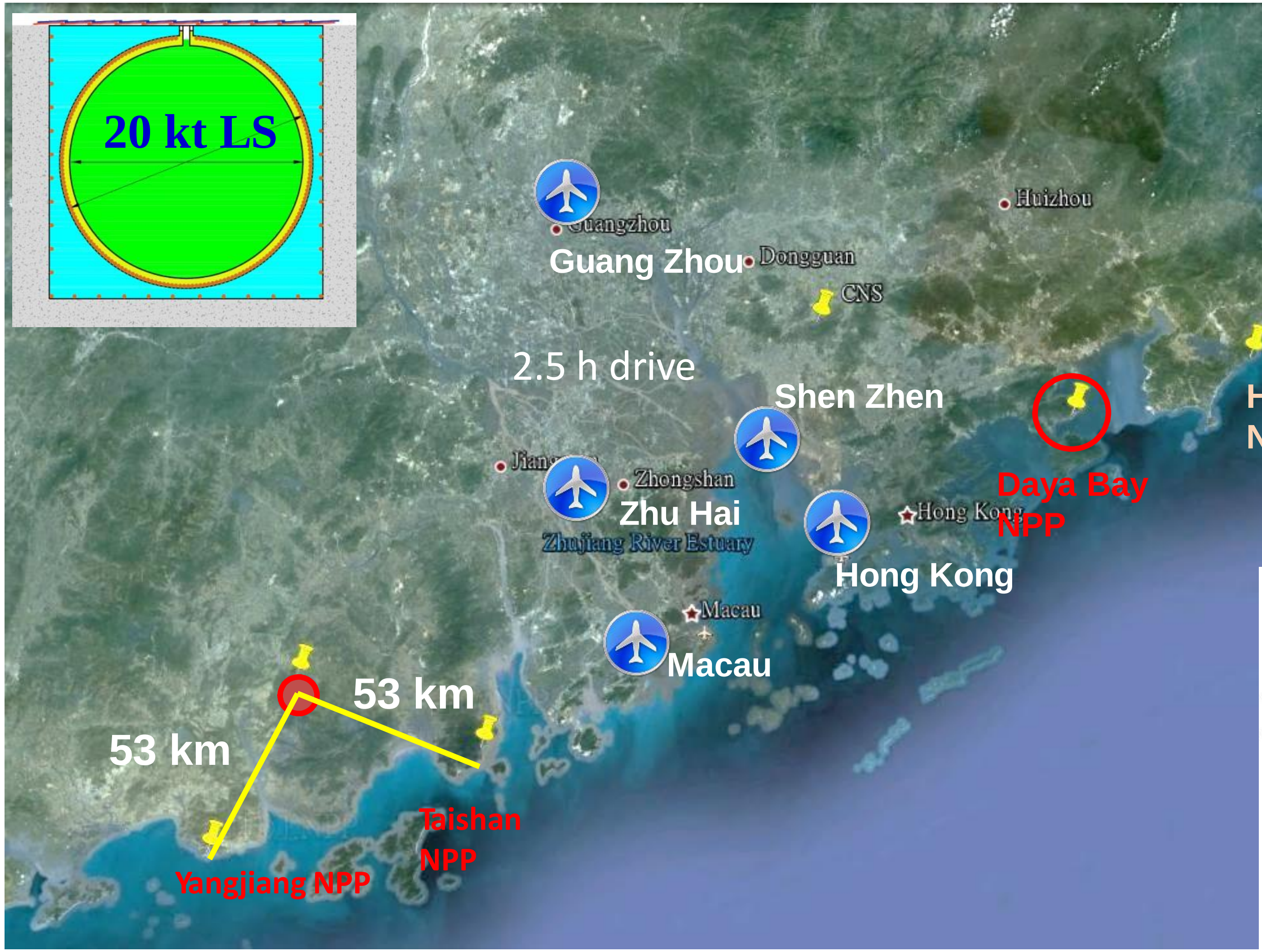
Any question?

Backup slides

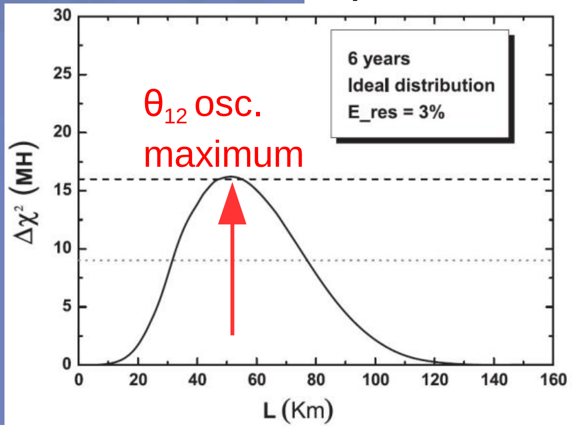
JUNO

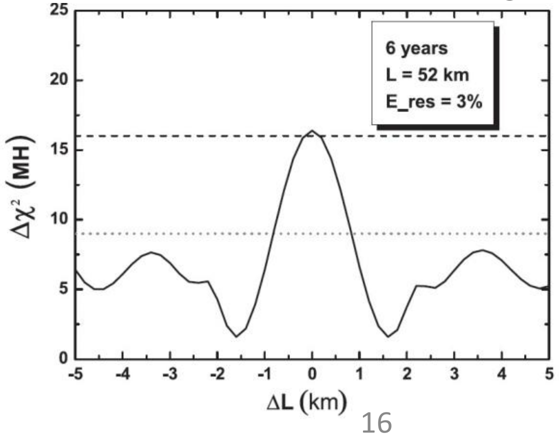
NPP	Daya Bay	Huizhou	Lufeng	Yangjiang	Taishan
Status	Operational	Planned	Planned	Under construction	Under construction
Power	17.4 GW	17.4 GW	17.4 GW	17.4 GW	18.4 GW

by 2020: 26.6 GW



optimized for neutrino mass ordering





JUNO collaboration

Country	Institute	Country	Institute	Country	Institute
Armenia	Yerevan Physics Institute	China	IMP-CAS	Germany	FZJ-IKP
Belgium	Universite libre de Bruxelles	China	SYSU	Germany	U. Mainz
Brazil	PUC	China	Tsinghua U.	Germany	U. Tuebingen
Brazil	UEL	China	UCAS	Italy	INFN Catania
Chile	PCUC	China	USTC	Italy	INFN di Frascati
Chile	UTFSM	China	U. of South China	Italy	INFN-Ferrara
China	BISEE	China	Wu Yi U.	Italy	INFN-Milano
China	Beijing Normal U.	China	Wuhan U.	Italy	INFN-Milano Bicocca
China	CAGS	China	Xi'an JT U.	Italy	INFN-Padova
China	ChongQing University	China	Xiamen University	Italy	INFN-Perugia
China	CIAE	China	Zhengzhou U.	Italy	INFN-Roma 3
China	DGUT	China	NUDT	Latvia	IECS
China	ECUST	China	CUG-Beijing	Pakistan	PINSTECH (PAEC)
China	Guangxi U.	China	ECUT-Nanchang City	Russia	INR Moscow
China	Harbin Institute of Technology	Croatia	PDZ/RBI	Russia	JINR
China	IHEP	Czech	Charles U.	Russia	MSU
China	Jilin U.	Finland	University of Jyvaskyla	Slovakia	FMPICU
China	Jinan U.	France	LAL Orsay	Taiwan-China	National Chiao-Tung U.
China	Nanjing U.	France	CENBG Bordeaux	Taiwan-China	National Taiwan U.
China	Nankai U.	France	CPPM Marseille	Taiwan-China	National United U.
China	NCEPU	France	IPHC Strasbourg	Thailand	NARIT
China	Pekin U.	France	Subatech Nantes	Thailand	PPRLCU
China	Shandong U.	Germany	FZJ-ZEA	Thailand	SUT
China	Shanghai JT U.	Germany	RWTH Aachen U.	USA	UMD1
China	IGG-Beijing	Germany	TUM	USA	UMD2
China	IGG-Wuhan	Germany	U. Hamburg	USA	UC Irvine

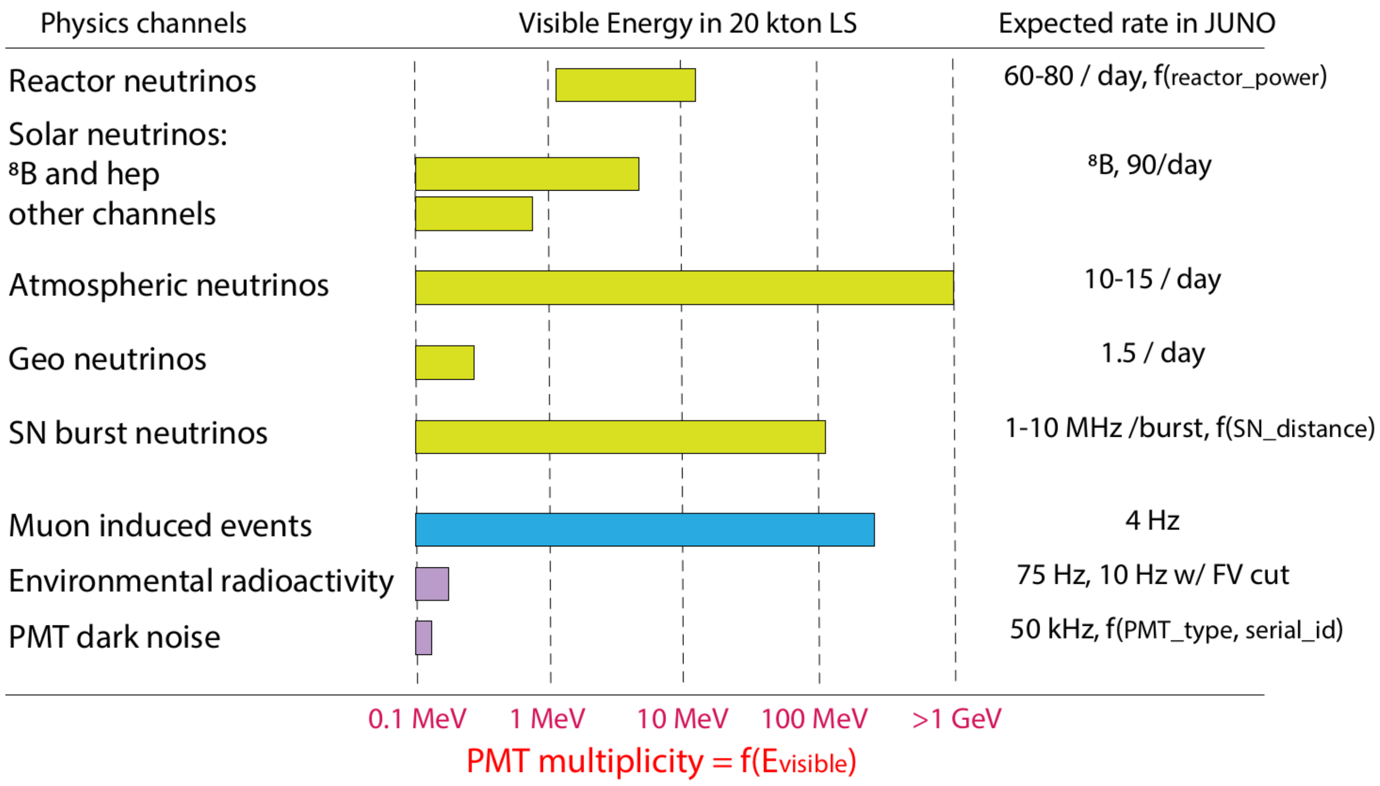
78 members

Computing model

- A lot of partner spread all over the world, requiring to access data for analysis
- Rersources are provided from partners involved in WLCG too
- Based on HEP – WLCG experience, relying on a grid-like infrastructure:
  - Estimated data volume and the needed resources
  - Evaluated networks
  - Identified data centers
  - Designed data flows and roles
  - Defined a first version of a distributed grid infrastructure

Data volume

Expected JUNO Event Rates and Visible Energy



Generic view

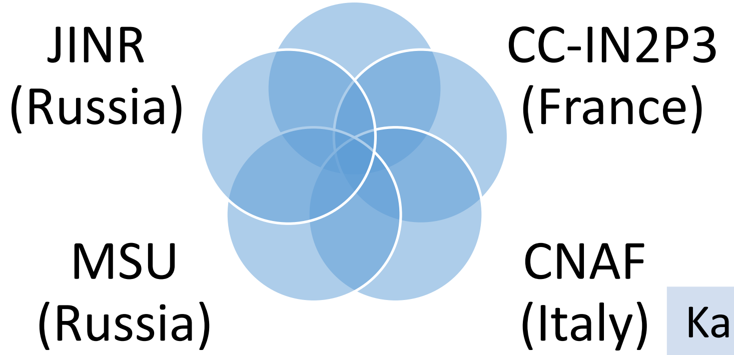
Data output from electronic: ≈ 1 EB/year

Given the expected number of events per day we estimate to cut data output at 2 PB/year.

Event type	Data size MB/s	Note
Vertex and time correlated	3	99.5% IBD, geo-nu, DSNB, ^{9}Li, fast-n, accidentals, etc,
Muon themselves	10?	Jilei's talk, > 100 MeV? nucleon decays
Event following muons in 1 ms	12	Neutrons, accidentals, store fired PMTs
High energy isolated events	3	3.5 – 100 MeV, cosmogenic isotopes, Michel electrons,, etc., store fired PMTs
Medium/low energy isolated events 1	8	R < 16m, 0.75-3.5 MeV, store fired PMTs
Medium/low energy isolated events 2	18	R>16m, 0.75-3.5 MeV, see slide 26
Minor energy	3	< 0.75 MeV, only store T/Q pairs
Total	54	No Huffman coding is required

Data centers

IHEP



	IHEP	CCIN2P3	INFN CNAF	MSU	JINR DUBNA
Kaiping (JUNO)	1 Gb/s				
Generic	20 Gb/s IPv4 20 Gb/s IPv6	10 Gb/s	20 Gb/s	10 Gb/s	10 Gb/s
LHCOne	yes	Yes	100 Gb/s	Yes	10 Gb/s
DC Storage (PB)	5+15	70+30	80+33	n.a.	11+12
DC Computing (core)	18,000	38,000	40,000	n.a.	17,000
Storage (disk)	2000 TB	44 TB	620 TB	60 TB	600 TB
Cores	2500	210	400	32	2000