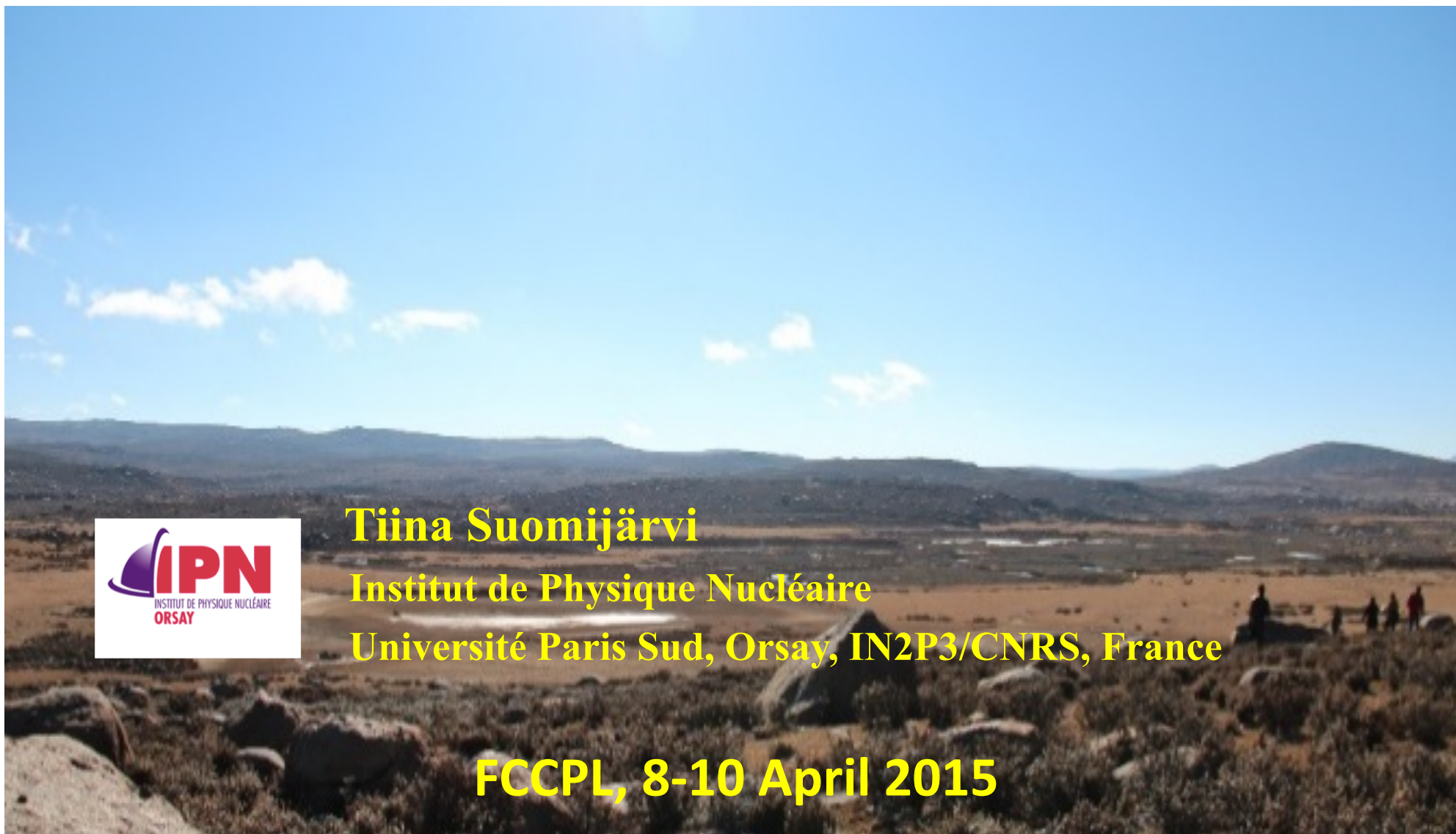




R&D and simulations for LHAASO



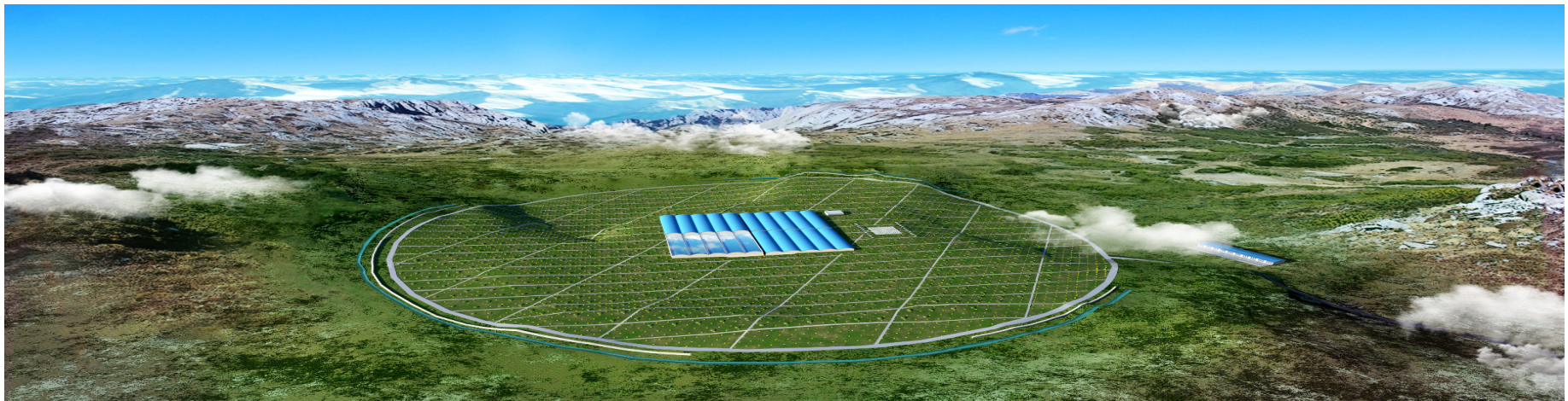
Tiina Suomijärvi

Institut de Physique Nucléaire

Université Paris Sud, Orsay, IN2P3/CNRS, France

FCCPL, 8-10 April 2015

LHAASO Project



Science case for LHAASO

Survey of the gamma sky above 100 GeV

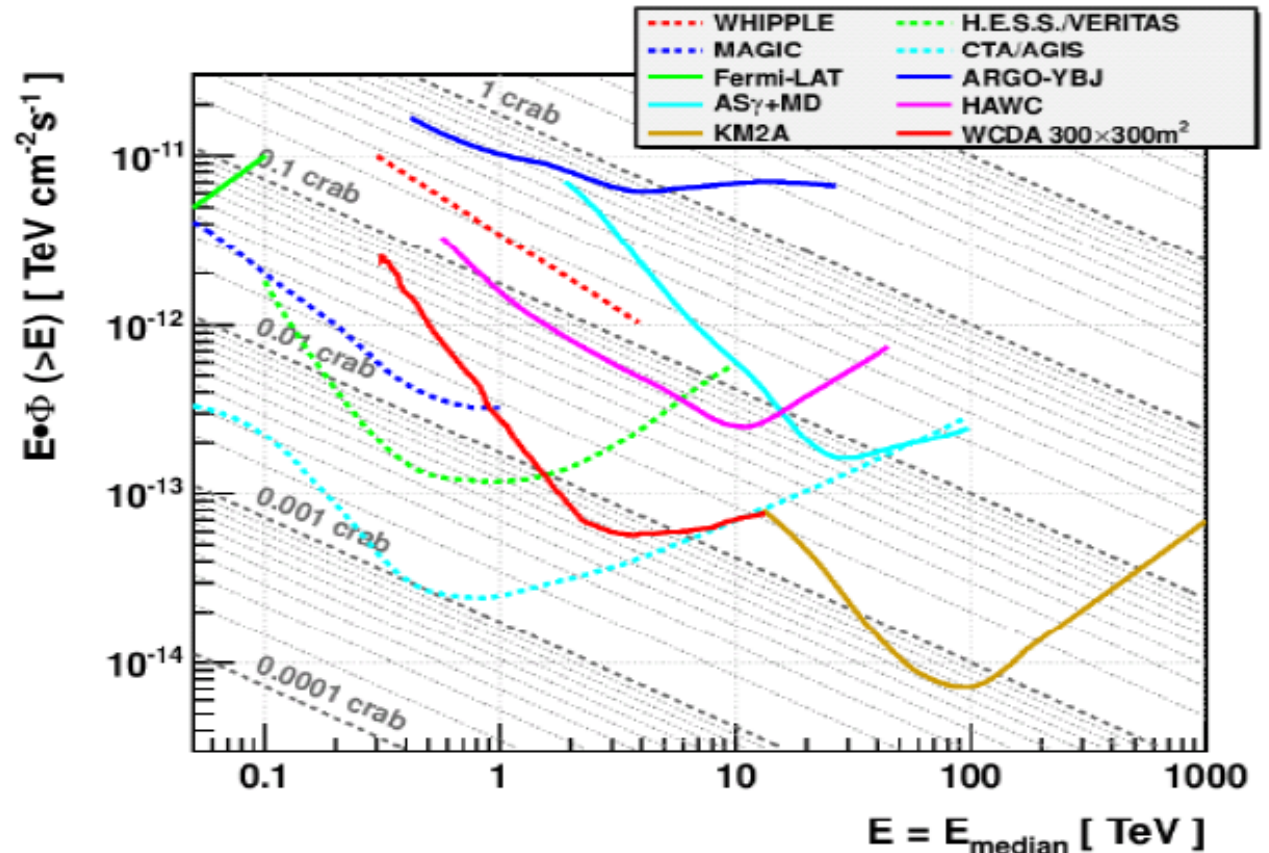
- Observation of extended sources
- Observation of transient sources
- Observation at very high energies (above 30 TeV)

Search for cosmic-ray origin among galactic gamma-ray sources

- Visibility for hadronic origin and charged particle acceleration

Measurement of cosmic rays above 30 TeV

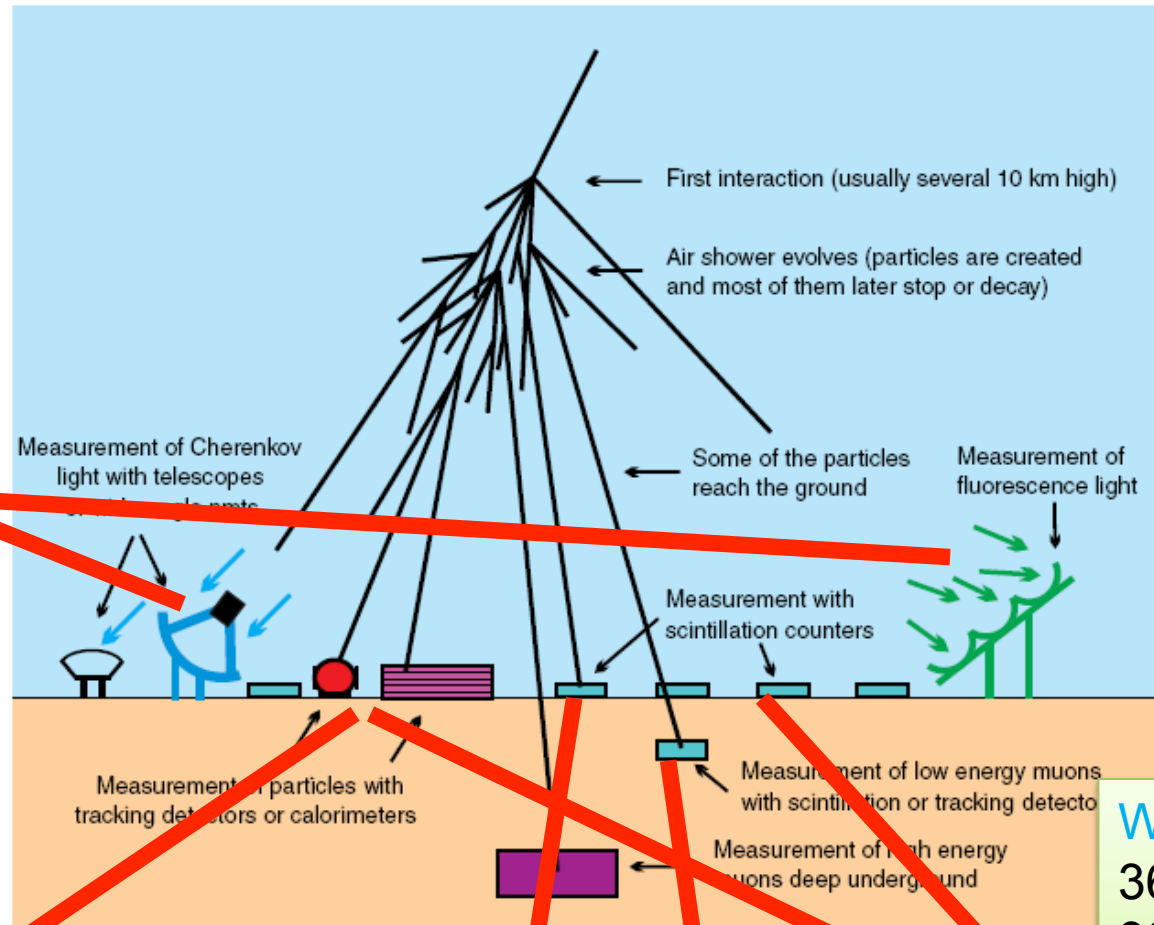
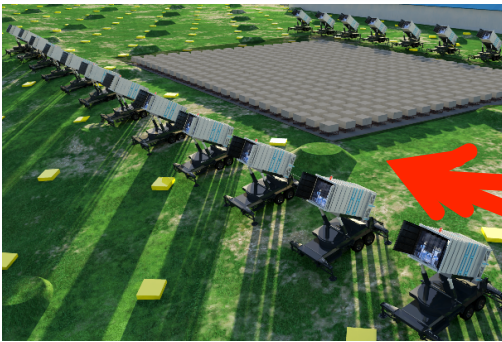
- Bridge between direct and indirect measurements
- Unprecedented statistics for anisotropy studies in the knee region



Hybrid detection of EAS by LHAASO

WFCTA:

24 telescopes
1024 pixels each



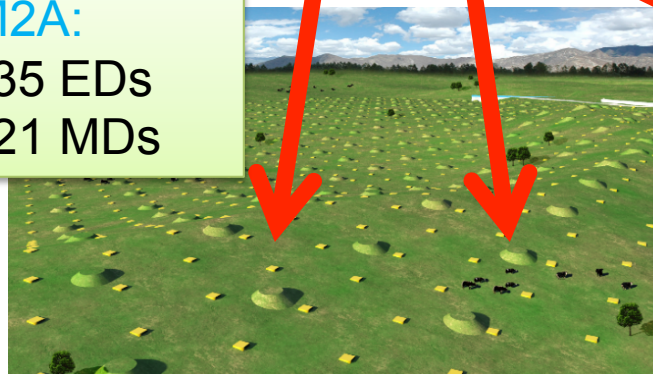
SCDA:

452 detectors



KM2A:

5635 EDs
1221 MDs



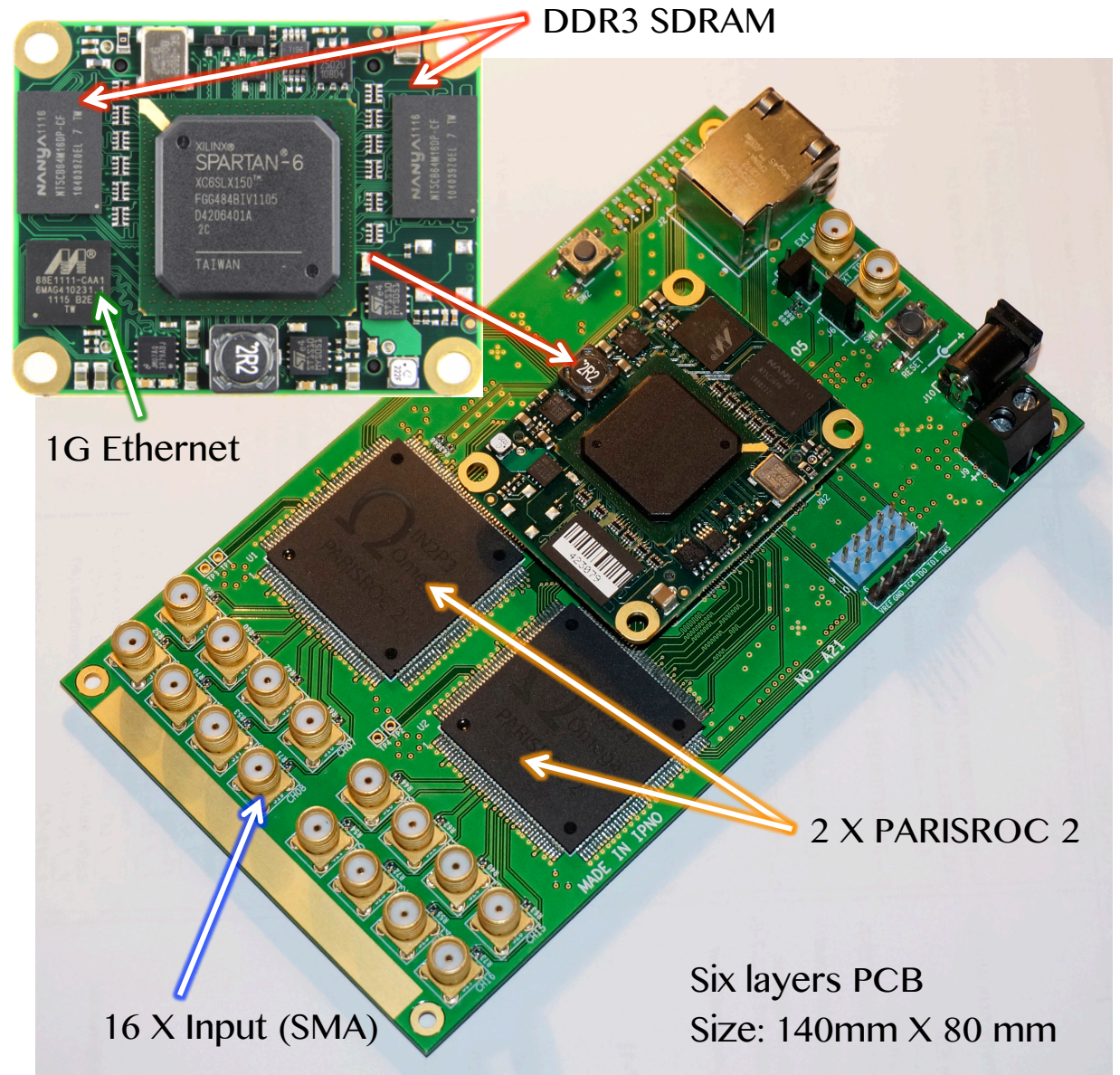
WCDA:

3600 cells
90,000 m²



FEE for WFCTA

- Development of FEE (see talk of Yingtao Chen)
- Collaboration: IPNO-OMEGA-IHEP, University of Yunnan
- PhD student: Yingtao Chen

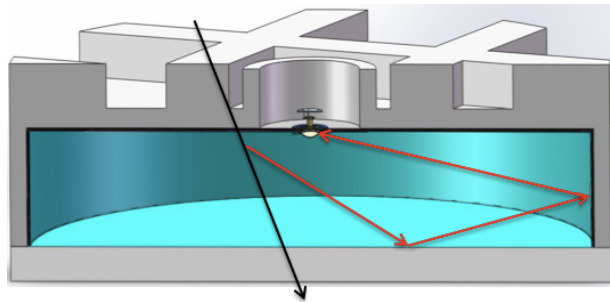


Simulations for KM2

MD

Parameters of the tank :

- Diameter : 6.8 m / High : 1.2 m
- 1 PMT at the center

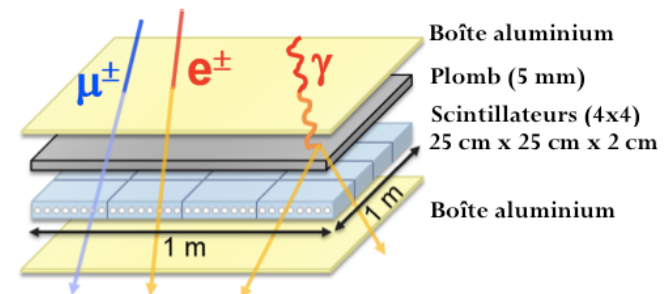


First order : Only muons reach the tank
→ No taking into account of the layer of 2.5 m

ED

Simulation of scintillators

- Dimensions : 4 x (0.25 x 1) m
- Thickness of scintillator : 2 cm
- Layer of lead : 5 mm
- Optic fiber -> PMT
- Scintillator : Anthracen ($C_{14}H_{10}$)



- Simulation of probabilities to interact in Lead/Scintillator with Geant4
- Implementation of the various processes of interaction for gamma, electron, muon in lead/scintillator

Collaboration: IPNO-IHEP

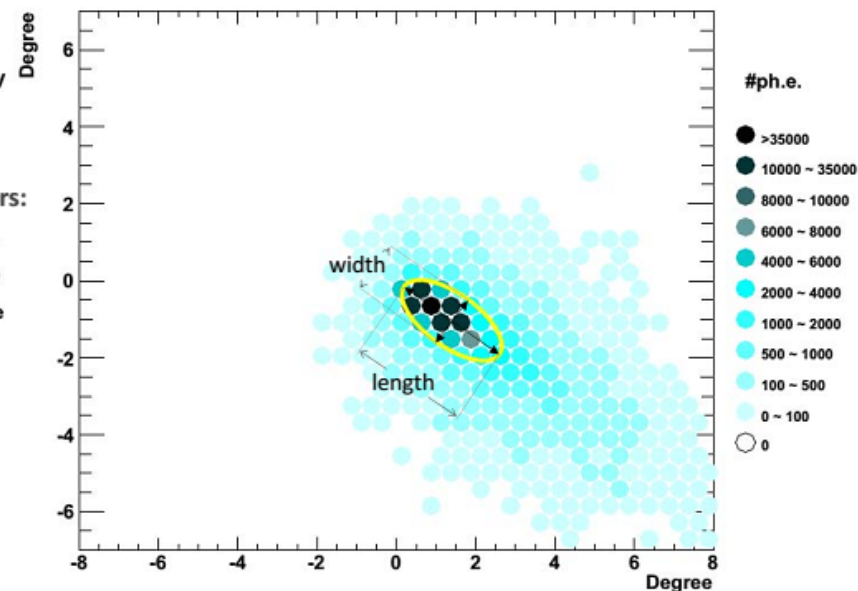
PhD student: Diane Martraire, now post-doc in IHEP

Simulations for WFCTA

WFCTA in LHAASO project:
32 × 32 PMTs in each camera
16° × 14° F.o.V.
~ 0.5° pixels



Pri. energy: 3.1 PeV
Zenith: 0.0 degree
R_core: 59.44 m
Hillas Parameters:
SIZE: 2.23e+05 p.e.
lenth: 1.496 degree
width: 0.682 degree



Simulations with Corsika
Preparation of the reconstruction program

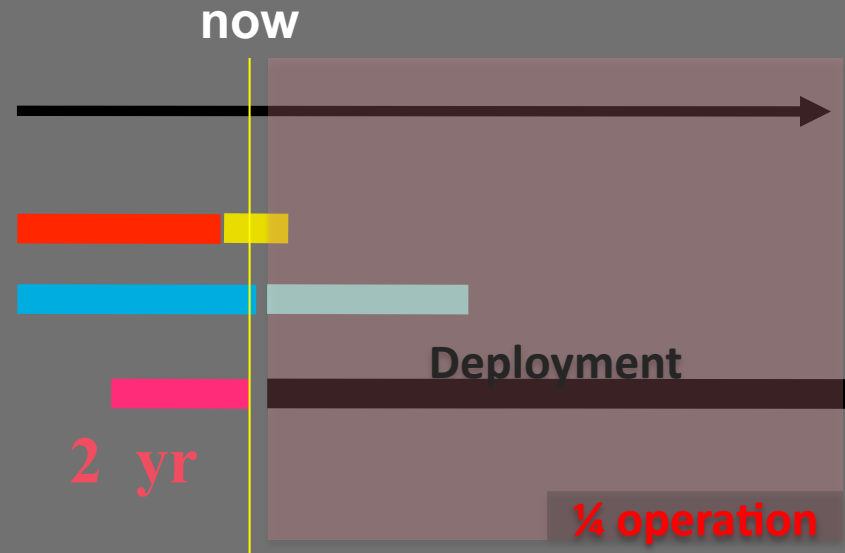
Collaboration: IPNO-IHEP
PhD student: Zizhao Zong

Status of LHAASO

- **LHAASO proposal has been reviewed by the third party committee last month. All comments by reviewers are positive. This paves the road to starting the civil construction in this year.**
- The local government has approved the LHAASO site in August 2014 with the local funding for infrastructures.
- Geo survey was done few months ago.
- Civil construction design is started for both field preparation and buildings.
- Environment impact evaluation and feasibility reviewing are in progress by professional teams.
- The detector designers are finishing the TDR report based on the Engineering arrays at scales of 1% of the full project done at ARGO-YBJ site in Tibet.
- **Construction is expected to start this year.**

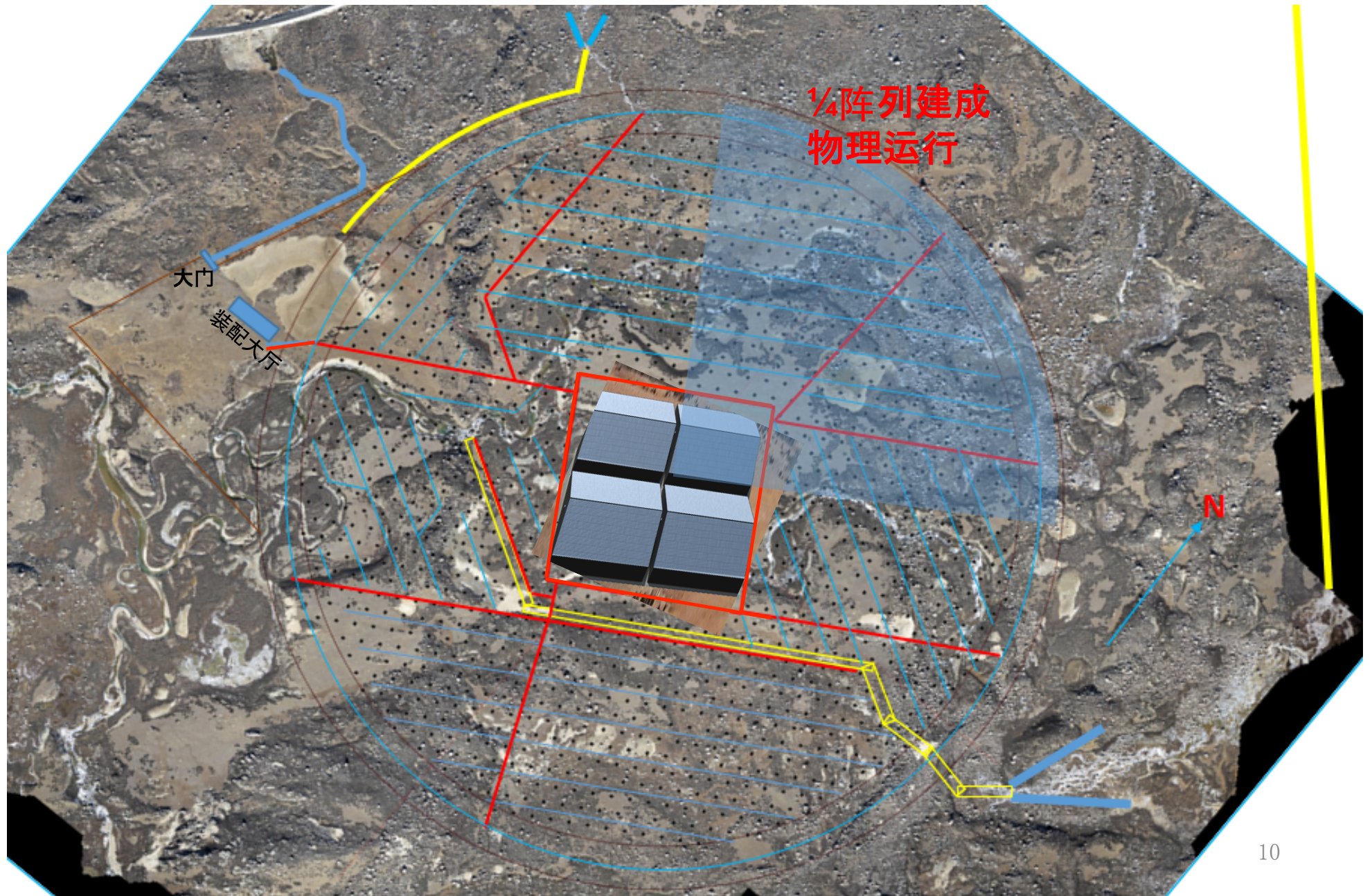
Time Schedule

- **Detector R/D:** 1.5yr
- **Electronics R/D:** 2 yr
- **Production:** 1.5 yr
- **DAQ R/D** 0.5 yr
- **Deployment:** 4 yr
- **1%prototype Oper:** 1 yr
- **¼ operation:** 2 yr



	LHAASO construction (month)		
Civil construction	24		
Detector production	36		
Deployment		36	
¼ operation		28	
Full operation			2

¼ operation





International collaboration

France ?: IPNO
OMEGA
U. Montpellier

Italy: U. Rome I, II, III
U. Torino
U. Naples

Russia: RAS
INPR
Thailand

Auger-LHAASO link

- PMTs from HZC-Photonics (Hainan)
- Scintillators from GNKD company (Beijing)
- Exchange of expertise on WCD detectors (used by both experiments)
- LHAASO members visited Auger site last November
- Planning started for a next generation large scale cosmic-ray observatory!

Funding request for FCPPL

- Zhen Cao obtained 1.1 M CNY from CAS for our collaboration.
- T. Suomijärvi was invited by CAS as visiting professor for 2 months in IHEP in 2014.
- Organization of “High Altitude “ workshop in Paris, May 2014

Request from FCCPL:

- For the French groups:
 - LHAASO workshop in China: $3 \times 1500\text{€} = 4500\text{€}$
 - Discussions on electronics in IHEP: $2 \times 1500\text{€} = 3000\text{€}$**Total = 7500€**
- For the Chinese groups:
 - Discussion on simulations in Orsay: $2 \times 20000 \text{ CNY} = 40000 \text{ CNY}$
 - Discussion on relevant Physics topics in Orsay: $4 \times 20000 \text{ CNY} = 80000 \text{ CNY}$**Total = 120000 CNY**

Conclusions

- LHAASO observatory
 - Unique at 10 TeV gamma monitoring
 - Window for evidence for hadronic origin of cosmic rays
 - Provides also crucial CR data around the knee region
 - Complementary for CTA!
- Collaboration: IPNO, OMEGA, IHEP, University of Yunnan
- Common work: FEE electronics, simulations, preparation of shower reconstruction programs
- Student and post-doc exchange
- Exchange of expertise between Auger and LHAASO
- Towards a next generation large scale cosmic-ray observatory!