

AIDA<sup>2020</sup>

# AIDA WP11 Transnational Access to Irradiation Facilities

Marko Mikuž

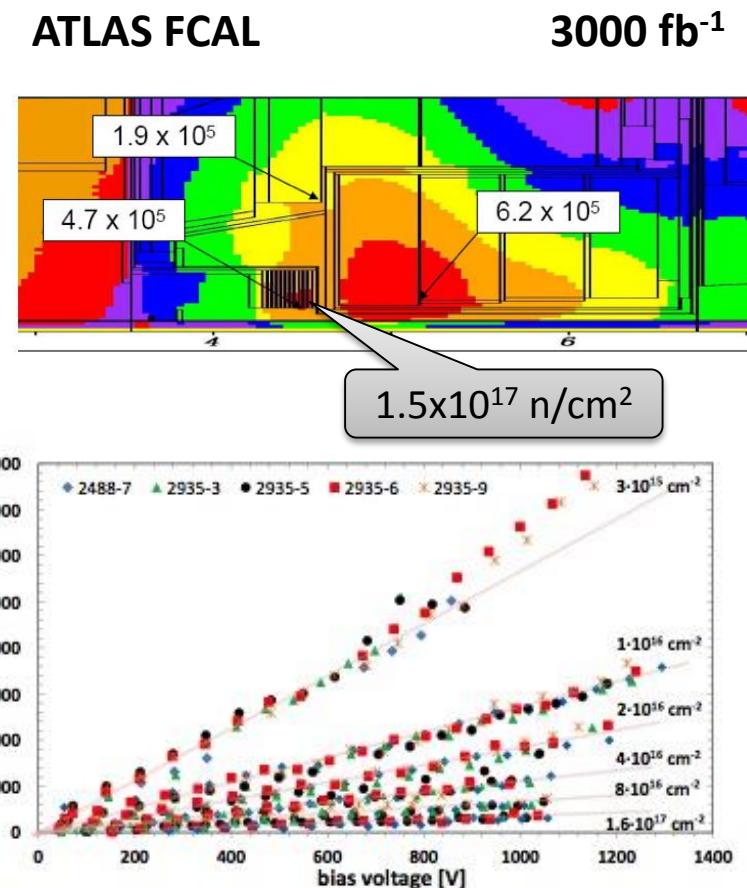
Univ. Ljubljana & Jožef Stefan Institute

Ljubljana, Slovenia

BTTB5, Jan 26<sup>th</sup>, 2017

# User Challenges I

- $10^{17}$  ballpark
  - Motivated by forward calorimetry
  - Silicon shown to survive  $>10^{17} \text{ cm}^2$
  - Other “exotic” materials proposed
- Comment: a whole new game
  - Activation non-trivial
  - Prediction essential: exact BoM!
  - Shielding, cool-off, transport...



*JINST 8 P08004 (2013)*

# User Challenges II

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- Both ATLAS and CMS will start tracker construction for HL-LHC during AIDA 2020
  - Solicited feedback, not received yet
- $10^{16}$  ballpark
  - Innermost layer(s) of trackers
  - Silicon shown to work in laboratory conditions at high bias
    - Technology options remain, engineer system to survive HL-LHC lifetime
- $10^{15}$  ballpark
  - Outer part of trackers, huge surface because all Si
  - n<sup>+</sup>p silicon is on track for large scale orders
- HV/HR CMOS could enter in both ballparks
  - Additional load to verify functionality after irradiation
- Manufacturer verification, QA during production

# User Challenges III

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- Larger, more complex objects
  - Detector modules
  - Need power, cooling, read-out
  - Observe deterioration of complete system
  - SEE at same time
- Dedicated SEE evaluation
  - Needs power, read-out, cooling
  - HEP spectrum difficult to match
  - Heavy ions (large LET) provide worst case scenario
    - No SEE observed -> success ☺, SEE difficult to quantify ☹
- Very large objects
  - Muon chamber need large area photon irradiations

# TA facilities offered under WP11

## Irradiation Facilities:

- 11.1: CERN IRRAD & GIF++, Switzerland
  - 24 GeV protons, mixed field, gammas
- 11.2: JSI TRIGA reactor, Slovenia
  - Reactor neutrons, gammas
- 11.3: KIT KAZ, Germany
  - Accelerator protons 23 MeV
- 11.4: UCLouvain CRC, Belgium
  - Accelerator neutrons (NIF), heavy ions (HIF)
- 11.5: UoB MC40 Cyclotron, United Kingdom
  - Accelerator protons 27 MeV

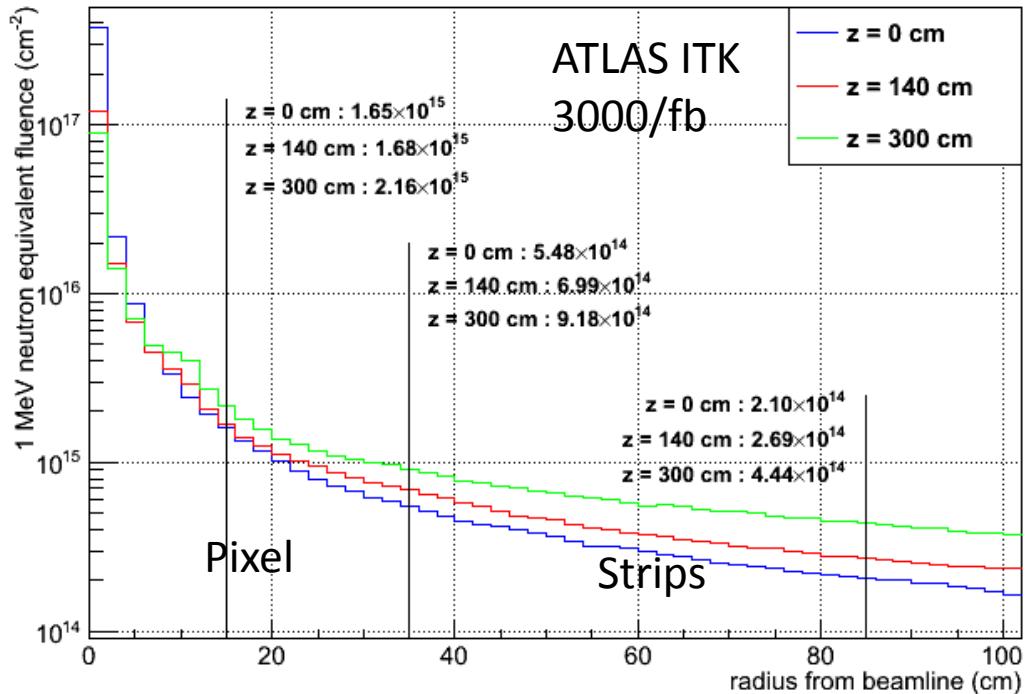
# How to meet the challenges ?

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- FW calorimeter R&D
  - Neutrons @ JSI, Mixed @ CERN IRRAD
- Tracker
  - R&D: Protons @ CERN IRRAD, Neutrons @ JSI
  - QA: add low energy protons (KIT, Birmingham, UCL) and UCL neutrons
- SEE: CERN IRRAD, Heavy Ions UCL
- Muons: CERN GIF++

# LHC Particle Cocktail

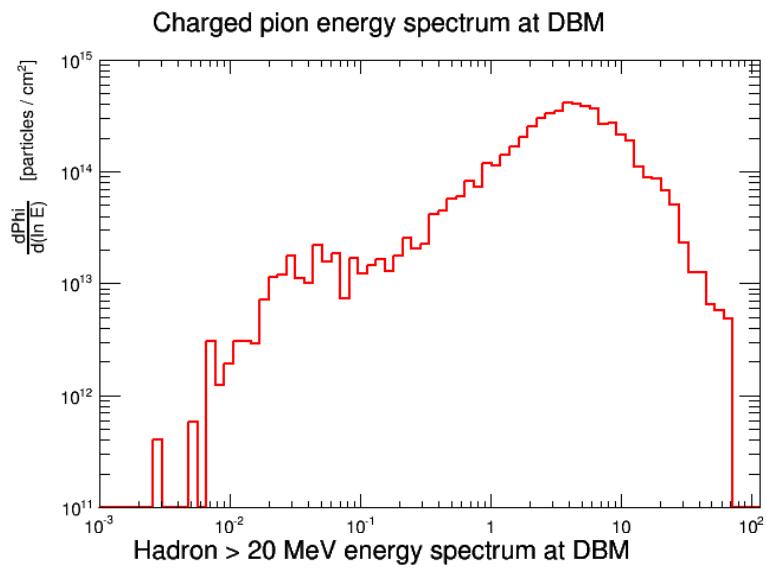
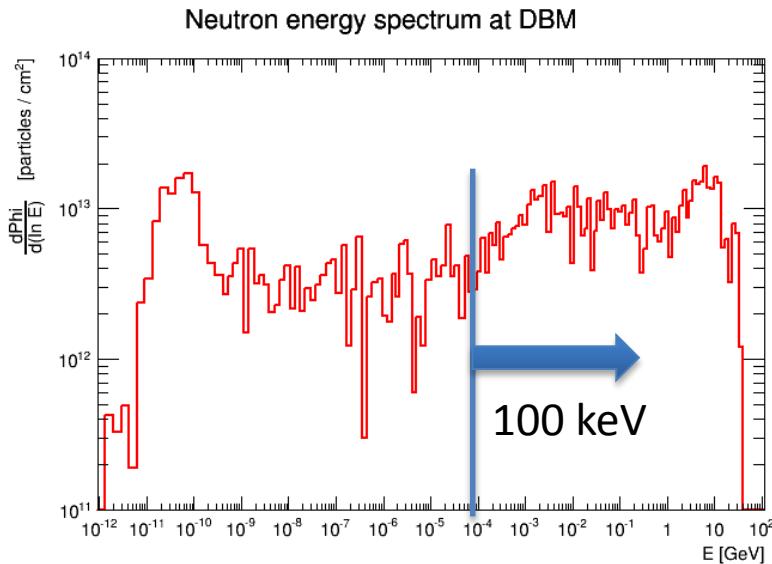
1 MeV neutron equivalent fluence



Location	1 MeV n. eq. ( $\text{cm}^{-2}$ )	Protons	Pions	Neutrons	Dose (kGy)
( $r=28 \text{ cm}$ ; $z=0 \text{ cm}$ )	$6.9\text{e+}14$	7.8%	38.5%	53.7%	329
( $r=28 \text{ cm}$ ; $z=117 \text{ cm}$ )	$8.9\text{e+}14$	13%	31.8%	55.2%	418
LS ( $r=100 \text{ cm}$ ; $z=0 \text{ cm}$ )	$1.7\text{e+}14$	6%	13%	81%	34
LS ( $r=100 \text{ cm}$ ; $z=117 \text{ cm}$ )	$2.1\text{e+}14$	6.2%	10%	83.8%	38

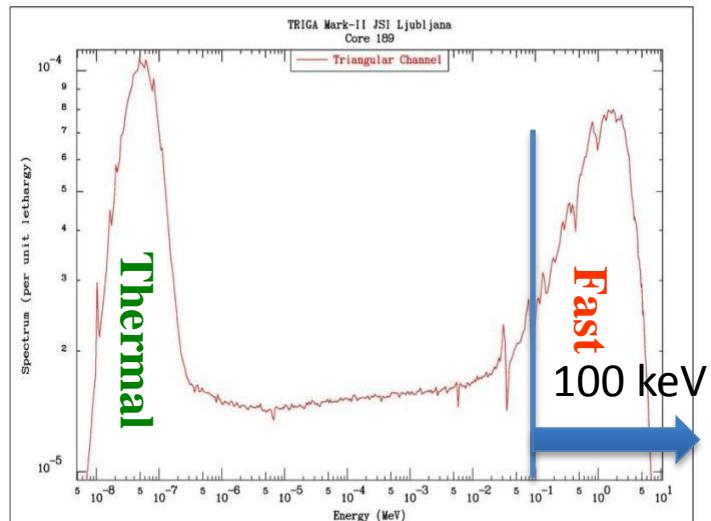
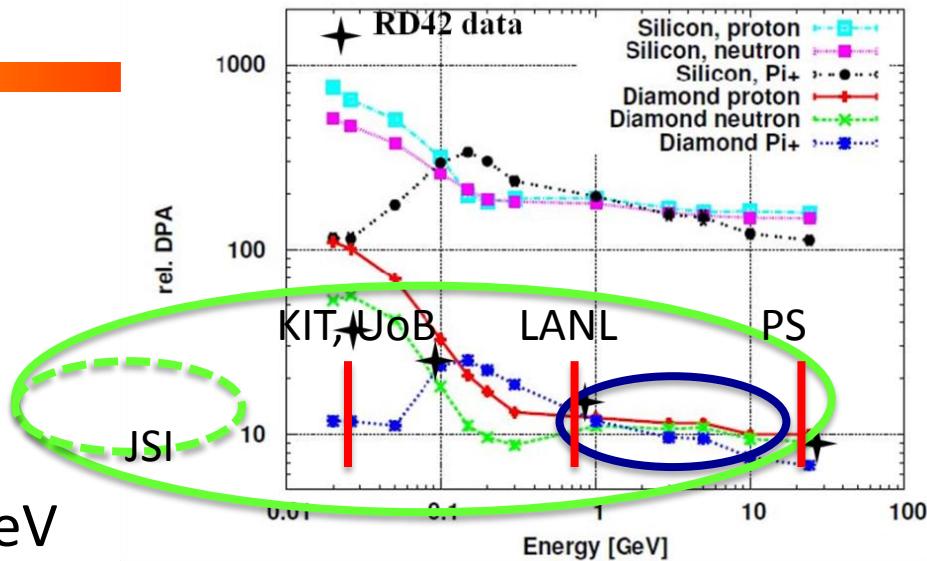
# LHC Radiation – Spectra @small r

- Pions, neutrons, hadrons
  - Pions, hadrons peak at  $\sim 5$  GeV
    - 90 % above 500 MeV
  - Neutrons flat to  $\sim 30$  GeV



# Facilities Matching

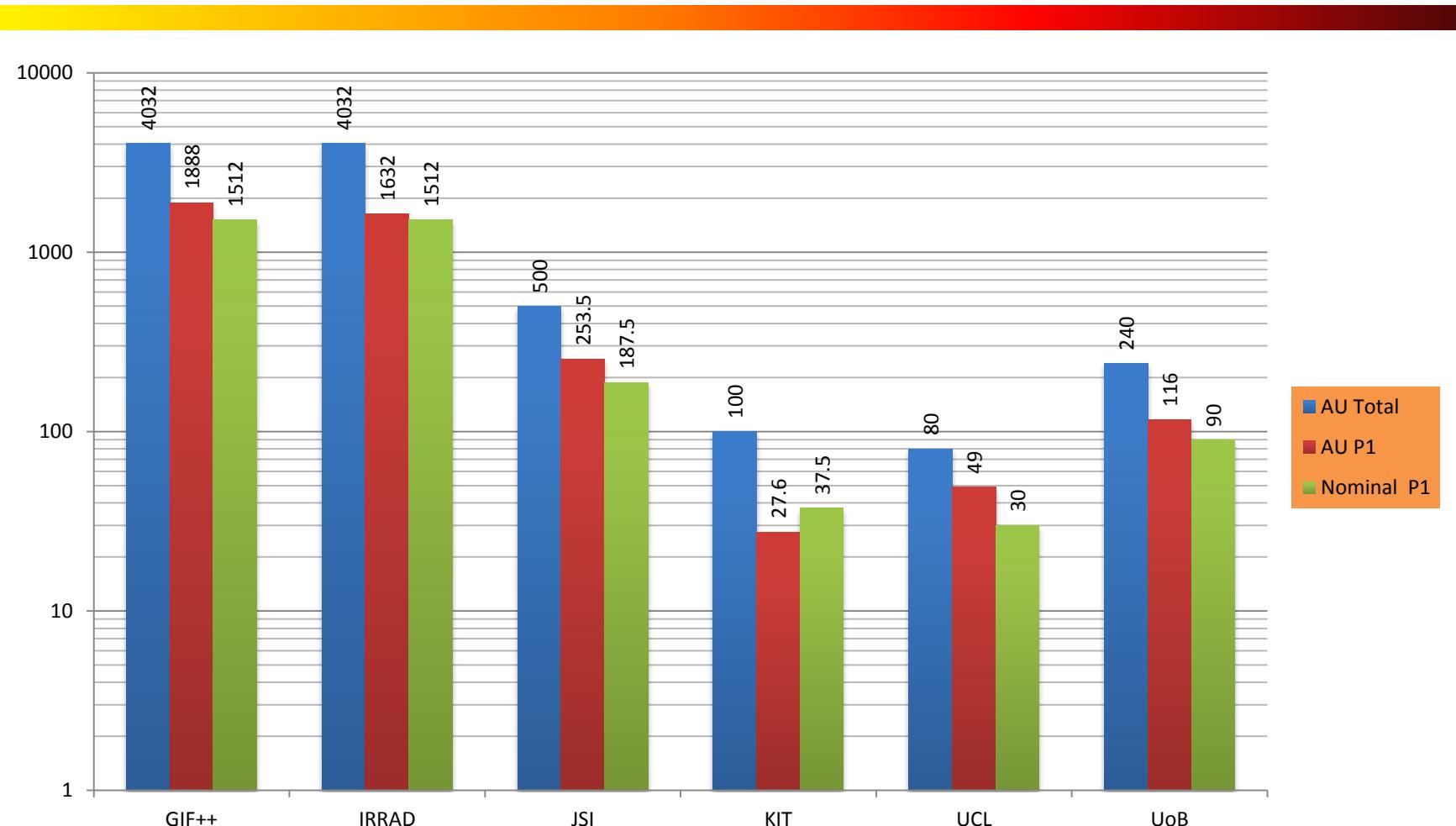
- IRRAD2 (PS) protons
  - A bit on the high side
  - ~same damage expected
  - KIT & UoB well below
- JSI neutrons
  - Cover spectrum up to 5 MeV
- Not really ideal, but that's what we have
- Believe in NIEL scaling ?
  - violations observed in Si
  - KIT & UoB scaling verified, but surprises possible



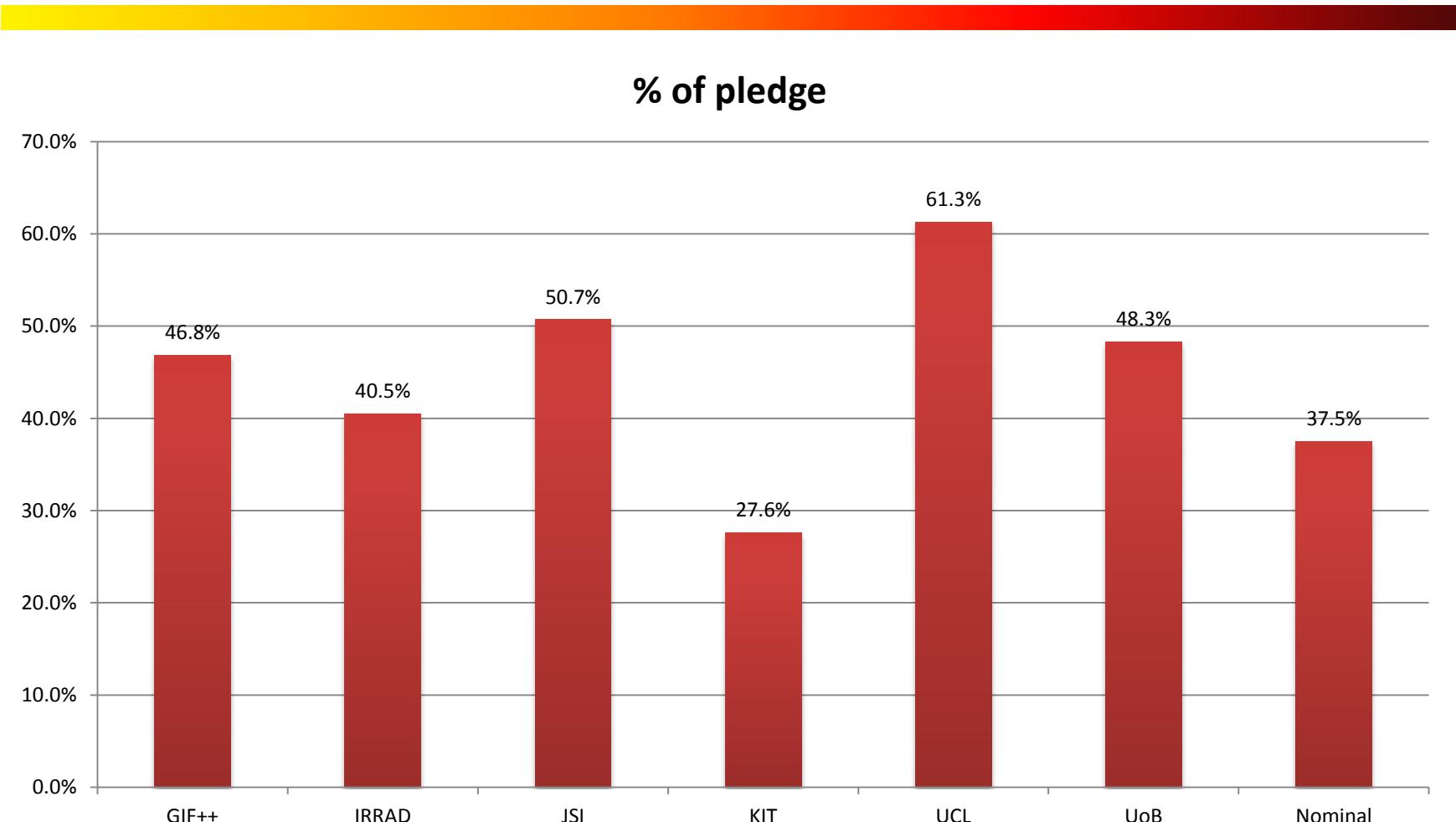
# 4y Pledge & P1(M1-18) Usage

Facility	AU Total	Users Total	Projects Total	Project app. P1	Users P1	AU P1
GIF++	4032	50	20	8	40	1888
IRRAD	4032	60	30	8	37	1632
JSI	500	150	50	48	126	253.5
KIT	100	90	30	14	47	27.6
UCL	80	50	10	5	19	49
UoB	240	180	60	7	22	116
$\Sigma$ (WP11)	8984	580	200	90	291	3966

# Usage of Access Units in P1



# Fraction of P1 AU to pledge



# Conclusions

- CERN: GIF++/IRRAD:
  - on schedule
  - can do more, but without support for outside users
- JSI:
  - a bit ahead, but within reasonable tolerance
  - tangential channel (additional load) commissioned (D15.9)
  - charge for add-on projects if (projected to) run out of AIDA funds
- KIT:
  - somewhat low usage, heavier demand when module QA for HL-LHC trackers
  - partially already the case
- UCL:
  - fully caught up, most % AU usage of all (small overall allocation)
  - all projects HIF oriented (SEE/SEL), PR seems to have worked ?!
- UoB:
  - a bit ahead, small allocation

TA irradiation scheme in AIDA2020 WP11 well under way