WP15 Report
Upgrade of beam and irradiation test infrastructure

Federico Ravotti (CERN) & Marcel Stanitzki (DESY)

AIDA-2020 Second Annual Meeting - LPNHE

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WP 15 Structure

- **Task 15.1**: Scientific coordination (CERN, DESY)
- **Task 15.2**: Improvements of test beam infrastructure for high precision tracking (CERN, DESY)
- **Task 15.3**: Improvements of the DESY test beam infrastructure (DESY)
- **Task 15.4**: Improvements of the test beam infrastructure at LNF (INFN)
- **Task 15.5**: Improvements of the infrastructure for irradiation tests (CERN, INFN, VU, INRNE, JSI, USFD*)

*associated partner linked to CERN

WP 15 Session (Tue. Afternoon)

WP15.1 - Welcome & Introduction	Federico Ravotti et al.	**Task 15.1**
Salle des Conseils- 1213-RC-11, LPNHE	14:30 - 14:40	
WP15.2 - Improvements of test beam infrastructure for high precision tracking	Dimitra Tsionou	**Tasks 15.2 - 15.3 (DESY activities)**
Salle des Conseils- 1213-RC-11, LPNHE	14:40 - 15:00	
WP15.3 - Improvements of the DESY test beam infrastructure	Dimitra Tsionou	
Salle des Conseils- 1213-RC-11, LPNHE	15:00 - 15:20	
WP15.5 - Transport system for large objects at Ljubljana JSI TRIGA reactor	Marko Mikuz et al.	
Salle des Conseils- 1213-RC-11, LPNHE	15:20 - 15:40	
WP15.5 - GIF++ Gas System Upgrade	Roberto Guida	
Salle des Conseils- 1213-RC-11, LPNHE	15:40 - 16:00	
		Task 15.5
WP15.5 - IRRAD Facility Infrastructure Upgrade	Blerina Gkotse	
Salle des Conseils- 1213-RC-11, LPNHE	16:30 - 16:50	
WP15.5 - Si for large fluence irradiation monitoring	Juozas Vaitkus	
Salle des Conseils- 1213-RC-11, LPNHE	16:50 - 17:10	
WP15.5 - Cosmic-rays tracker improvements & augmented reality event-display for GIF++	Davide Boscherini et al.	
Salle des Conseils- 1213-RC-11, LPNHE	17:10 - 17:30	
WP15.5 - Istantaneous dose-rate monitor for GIF++ Facility	Plamen Stoianov Iaydjiev	
Salle des Conseils- 1213-RC-11, LPNHE	17:30 - 17:50	
News about WP15.5 - Cold irradiations at Birmingham Proton Facility	Richard French	
Salle des Conseils- 1213-RC-11, LPNHE	17:50 - 17:55	
News about WP15.4 - Improvements of the test beam infrastructure at INFN-LNF	Paolo Valente	
Salle des Conseils- 1213-RC-11, LPNHE	17:55 - 18:00	

News about USFD activities (Task 15.5)

News about INFN-LNF activities (Task 15.4)

- About 20 people in the room
- Interesting technical discussions with facilities coordinators / sharing ideas
- First “feedback”: emphasize the AIDA-2020 specific contributions within the tasks

Milestones & Deliverables

- Upcoming (M24)
  - Milestones
    - ❑ **MS59**: Silicon strip reference tracker hardware ready (WP15.3)
      → **Will be delayed**
  - Deliverables
    - ❑ **D15.1**: CERN pixel beam telescope for the PS (WP15.2)
      → **Already Published**
    - ❑ **D15.6**: CERN proton facility upgrade (WP15.5)
      → **Being prepared**
    - ❑ **D15.10**: GIF++ gas system (WP15.5)
      → **Being prepared**

Task 15.1: Scientific Coordination

- WP15 satellite meeting at BTTB

- The BTTB series has been a very successful format for:
  - test beam & irradiation facilities users
  - beam telescope users
  - facility coordinators

- WP15 has a large overlap of activities and participants with BTTB
  (in particular within Tasks 15.2, 15.3 and 15.4)

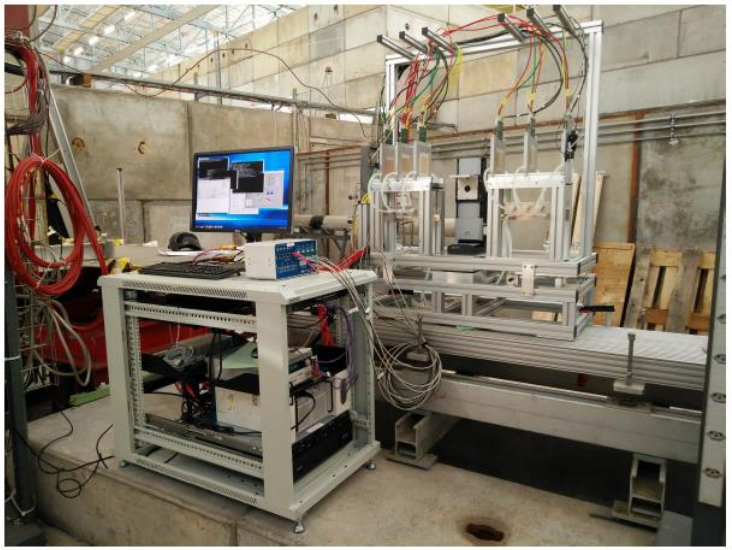
- Upgrade activities for irradiation facilities (Task 15.5) are driven by user requirements

Task 15.2: Telescope for the CERN PS

7th EUDET-type telescope for CERN PS

- **AZALEA** = **A**ida2020 **Z**ero-suppressed Acquisition **L**ocated at the **E**ast **A**rea
- **From Nov. 2015:** Starting purchasing with Henric Willkens
- **Jan.-June 2016:** Mech. and el. Production and setup at DESY
- **July 2016:** Commissioning at DESY TB22
- **Sept. 2016:** Installation at CERN PS T10
- **Results: MS32 and D15.1**
  - Hardware/timing in MS32 (ach. 31/10/16) "Pixel Telescope Hardware assembled"
  - Results in D15.1 (achieved 27/03/07) "CERN pixel beam telescope for the PS"

D15.1 ACHIEVED



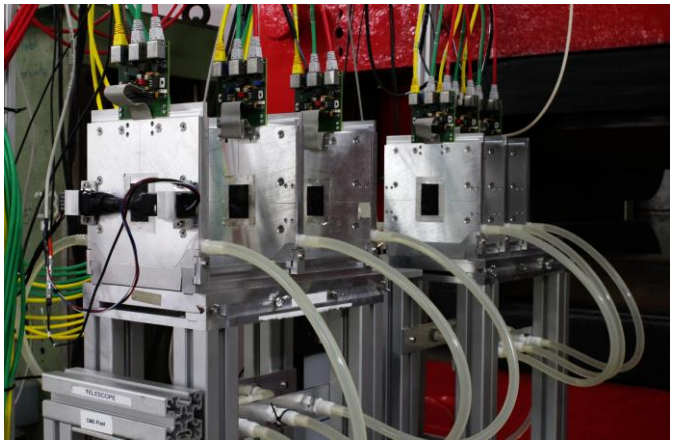
Task 15.2: EUDET-Style Telescopes around the World

EUDET-type beam telescope family

No.	Name	Location	Funded by	Year
1	**AIDA Telescope**	CERN SPS	EUDET/AIDA FP6/7	
2	**ANEMONE**	Bonn	U Bonn	2011
3	**ACONITE**	CERN SPS	ATLAS	2012
4	**DATURA**	DESY	DESY	2012
5	**CALADIUM**	Fermilab	Carleton U	2013
6	**DURANTA**	DESY	DESY	2015
7	**AZALEA**	CERN PS	AIDA-2020	2016

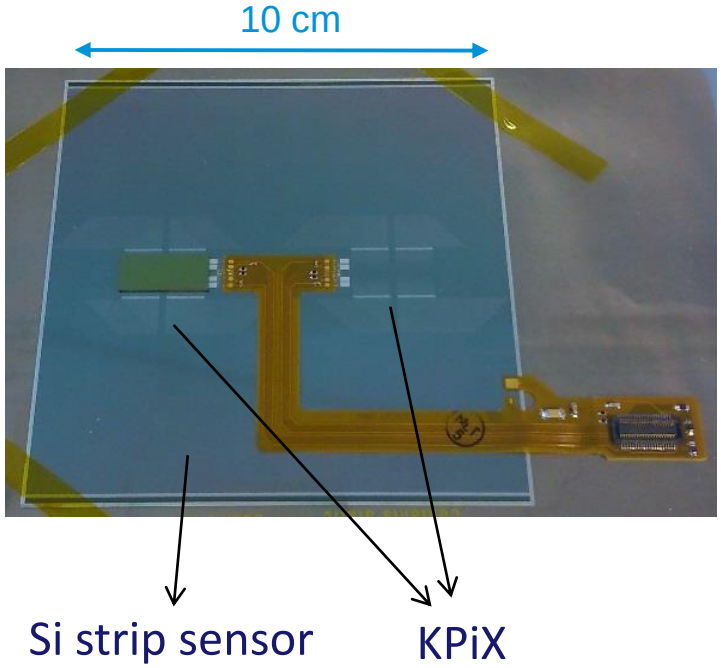
- **Users can go to different test beam facilities and use the same beam tracking infrastructure**

Telescope Support
portal: http://telescopes.desy.de
contact: telescope-coor@desy.de



Task 15.3: Improvements of the DESY test beam infrastructure

WP15.3.1: External silicon tracker for 1T magnet in the DESY test beam

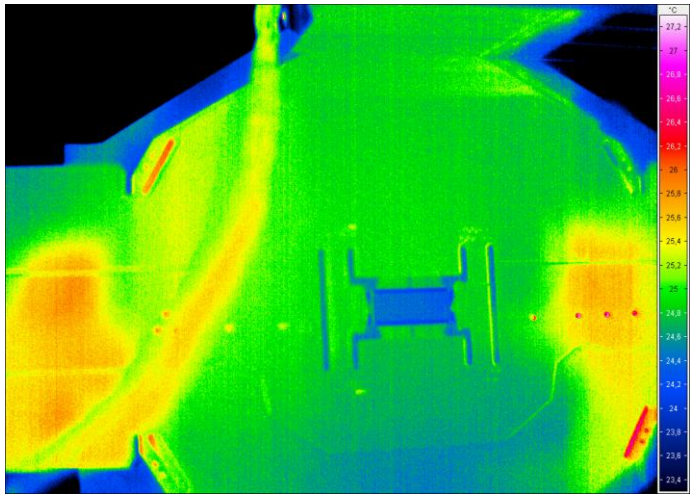


- KPiX chip will be used to read out the Silicon sensors
- DAQ hardware and software setup already at DESY
- Sensors that fulfil the required characteristics (spatial resolution <10μm) have been identified
- Requirements severely limit sensor choice
- **DESY has placed an order Mid November 2016 with Hamamatsu for a production of 25 Silicon strip sensors**
  - Total cost 49K (including NRE mask cost and production of 25 sensors)
  - Lengthy process beyond our control
  - **Confirmed delivery date: end of July 2017**

Delay of MS59 (M24) inevitable

Task 15.3: Improvements of the DESY test beam infrastructure

- Having the tracking sensor so late is an issue
- **But:**
  - we already have a KPiX plus an ECAL sensor → DAQ-wise identical
  - using this for development & DAQ integration
  - beam test in May at DESY
- other components status:
  - mechanical structures (“cassettes”) are currently being designed after successful thermal tests
  - power supply system has been decided, will be ordered soon
- DAQ & EUDAQ2 integration:
  - new Postdoc starts April 1st
  - close collaboration with WP5



Task 15.3: Improvements of the DESY test beam infrastructure

- **The sensors will be late, hence MS59 will slip**
  - Estimate now to have completed and tested modules by **November 2017**
  - Other hardware will be ready before that
- **Impact on D15.2**
  - **Expect to be on time for D15.2 in M36**

D15.2 (M36)

- **Rationale**
  - DAQ can be already tested and integrated with ECAL sensor
  - First test beam in May 2017
  - Other components will all be ready and waiting, when the sensors are back
  - New Postdoc starting on April 1st with 100% on AIDA-2020 WP15.3
  - Weekly status meetings to track progress
  - **Currently we have 3.5-month contingency till M36**

Task 15.3: Improvements of the DESY test beam infrastructure

WP15.3.2: Environmental parameter monitoring for DESY test beam areas

- **Common rack-based slow control system (commercial)**
- **Milestone report MS33 was delivered on time**
- **Current Activities:**
  - Testing of all the sensors and the logging software
- **Plans:**
  - Integrate slow control data in EUDAQ2
  - Early user test in July 2017 (Summer Students)
  - Roll-out for user operations in fall 2017
  - Write report
- **D15.3 on time for M30**

D15.3 (M30)

Task 15.4: Improvements of the test beam infrastructure at LNF

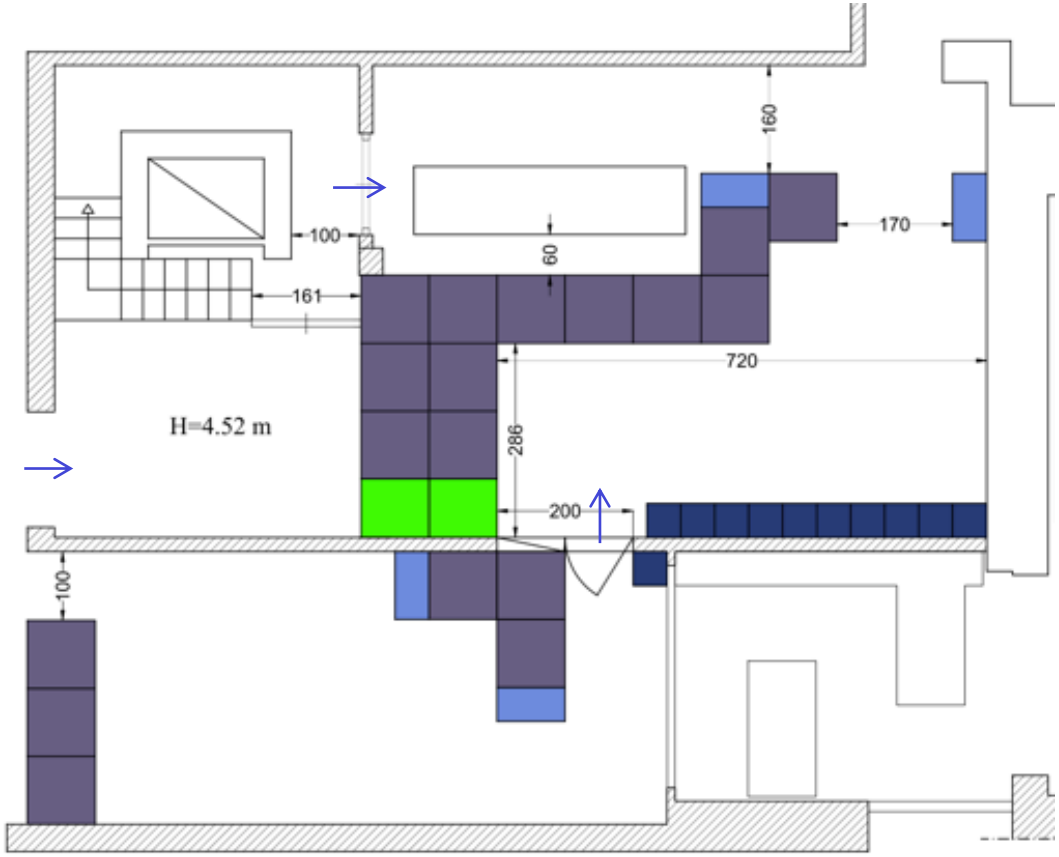
Additional beam line equipment:

Delay on:	**Milestone MS34** – ***New Frascati beam line components installed***
Delivery date in Annex 1:	M18 (October 2016)
Expected delivery date:	M30 (October 2017)
Short justification for delay	Delay in funding of additional magnets and vacuum components from INFN due to general review of the overall Beam Test Facility (BTF) upgrades project.

MS34 DELAYED (M18 → M30)
D15.4 (M30)

- **Actions since November 2016**
  - Workshop with 20 companies in the field of magnet construction, in order to:
    - Have magnets with a very good correspondence with specifications
    - Speed-up delivery & better control on design and validation phase (magnetic measurements)
    - Improve KTT
  - Provide to the producer an advanced design of the required magnets
  - Delay on the bids w.r.t to the schedule IS re-absorbed by the fact that the designs are practically already done by LNF

Task 15.4: Civil Engineering



- For speeding up the execution of the building modifications, we **removed the motorized shielded door** (on the side of the external wall), replacing it with a removable structure of concrete blocks (chicane)
- Much easier (and cheaper): the only modification to the building structure is the opening of two (normal) doors

Task 15.4: Status April 2017

- All bids for magnets procurement out ~~by the end of January~~ March
  - But **we will provide to the supplier a detailed design**
- Civil engineering ~~preliminary~~ project approved
  - Working on the executive one (external company)
- BTF closed to the users from **mid July** (apart 2-3 weeks in Sep.)
- Design slightly modified in order to avoid modifications of the line inside the LINAC tunnel
  - Brings interference with the operation of the collider complex to ≈0
  - Easier installation (and alignment)
  - Also requires 1 quad less (slightly increased the gradient of the other quads)
- Vacuum requirements relaxed: the two BTF lines will be separated by the main LINAC vacuum by a 0.5 mm Be window (already existing); design modified in order to host pumping ports
  - Vacuum components design on-going

Project reviewed and simplified, final version being prepared

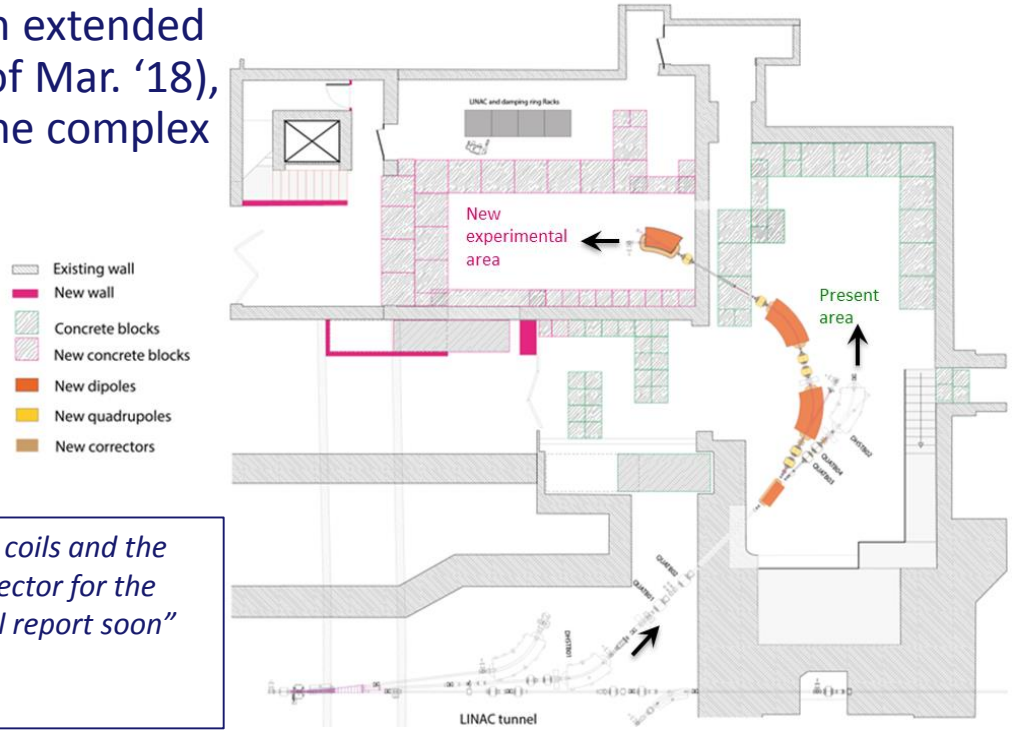
- Infrastructure and installation:
  - Thermic, hydraulic and electric calculations completed
  - Specs for “on-the-shelf” power supplies
  - Cooling and power supply for new line started

Task 15.4: Impact on D15.4

- **A lot of effort made to re-gain a few month!**
- **Considering the time margin needed for:**
  - Magnetic measurements (in house to speed up delivery time)
  - Installation
  - Commissioning of the new line
  - In addition, DAFNE collider run has been extended by three months (from Dec. '17 to end of Mar. '18), also shifting maintenance schedule of the complex in the next months.

D15.4 (M30 → M35)

- **Request to move the deliverable from M30 to M35**
  - 5 month slippage
  - Compared to 12 month for MS34



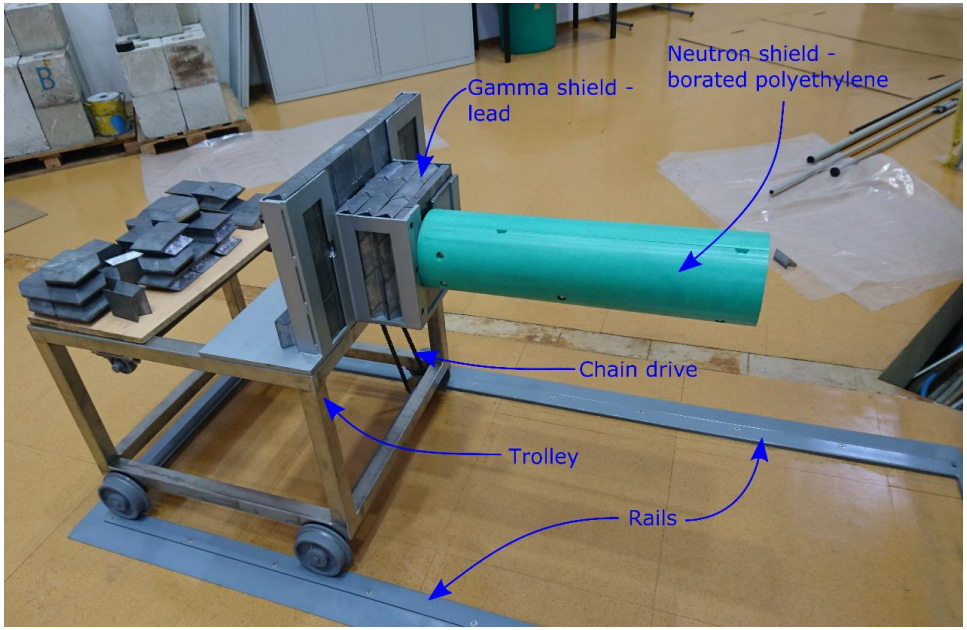
P. Valente *(April 3rd): "we are already buying the conductor for the coils and the pure iron for the DC magnets for speeding up. (…) The tracking detector for the new line is working, we are now analysing data, this deserves a full report soon"*

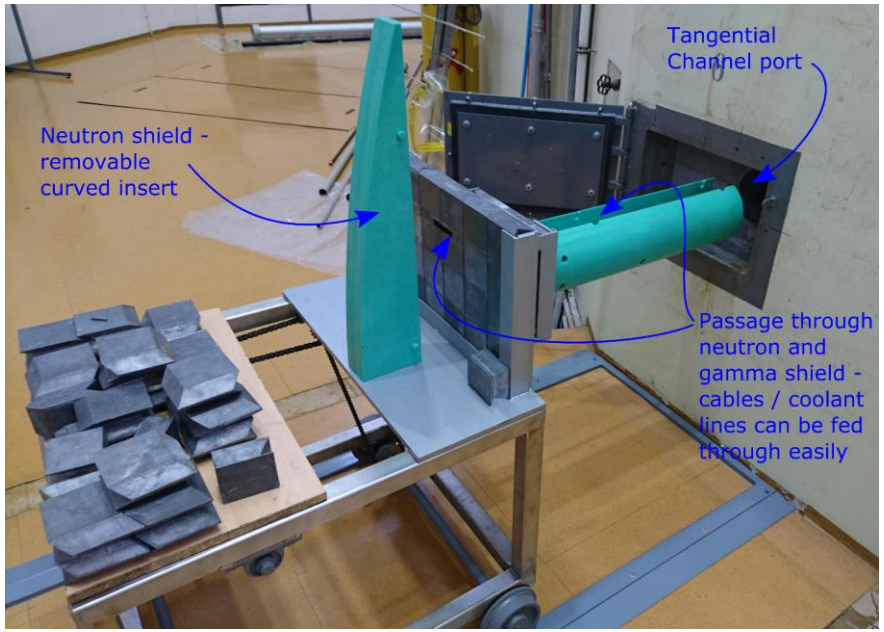
– **MS70 (M30)**

Task 15.5: Improvements of the infrastructure for irradiation tests

- D15.6 – CERN Proton Facility Upgrade **M24**
  - contactless fluence monitor (VU) 
  - IRRAD samples & users management software / storage area equipment (CERN)
  - CERN online database on irradiation facilities of interest for HEP (CERN)
- D15.7 – RadHard instrumentation for CERN Proton Facility (CERN) **M44**
- D15.8 – Cold Irradiations at Birmingham Facility (USFD) **M36**
- D15.9 – Large objects transport system for JSI neutron irradiations (JSI) 
- D15.10 – Upgrade of GIF^{++} Facility gas system (CERN) **M24**
- D15.11 – GIF^{++} Facility Upgrade **M48**
  - instantaneous dose-rate monitor (INRNE)
  - improved cosmic-rays tracker & demonstrator of augmented reality (INFN)

Task 15.5: JSI TRIGA Reactor Transport System



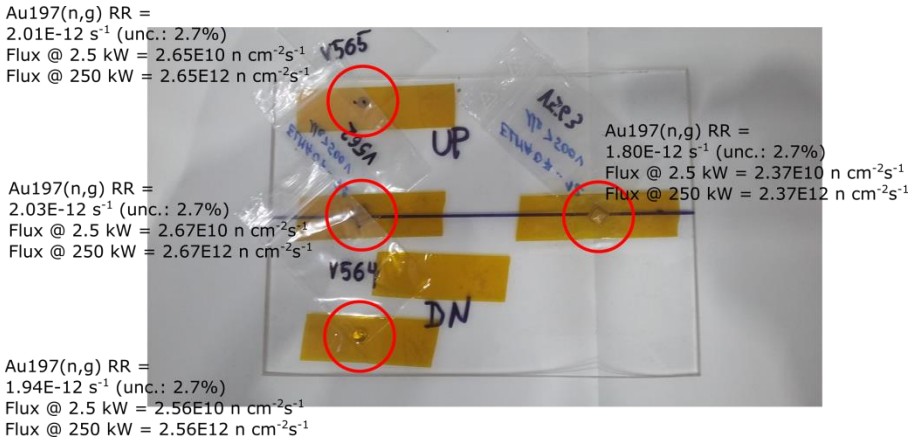


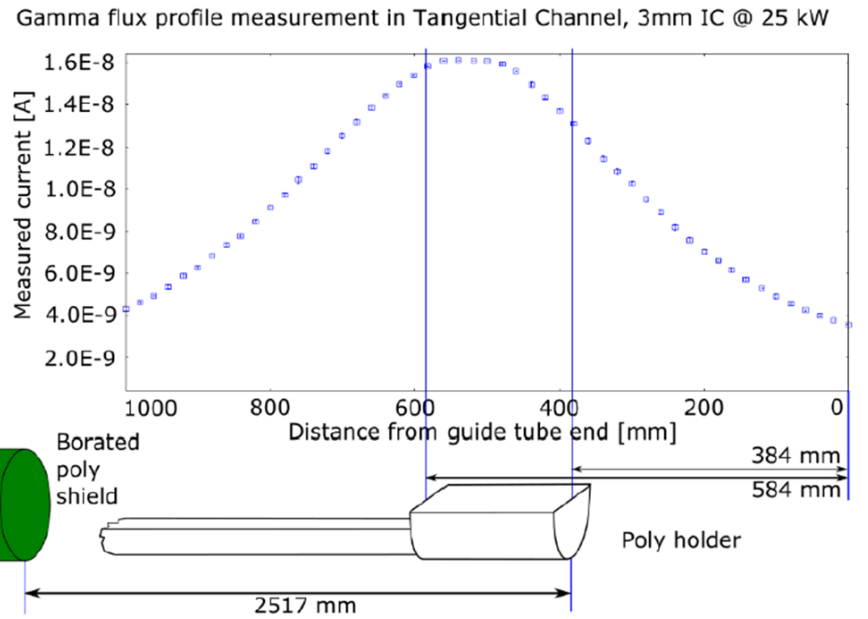
- The **design and construction of the irradiation device** / transport system for large object irradiations at the JSI TRIGA reactor **has been successfully achieved**
- Max. lateral dimension in the channel is 14.6 cm. The device is operational and enables on-line irradiation testing with fast neutron flux >2×10^{11} n/cm^2/s
- Early 2017: Experimental verification of the n spectra and n and γ flux profiles

D15.9 ACHIEVED

Task 15.5: JSI Channel Commissioning Measurements

- Flux measured by Au 197(n,γ)
  - measures (mostly) thermal flux
  - scaled by simulated spectrum to total flux
- Au - measured total flux 2.67e12 n/cm^{2}s
  - uniformity < 10 % on 10 cm x 10 cm
- PIN - measured NIEL flux 3.9e11 n/cm^{2}s
  - NIEL hardness factor for total spectrum 0.146
  - hardness factor for E_n > 0.1 MeV: 0.83
- Twice the predicted value !





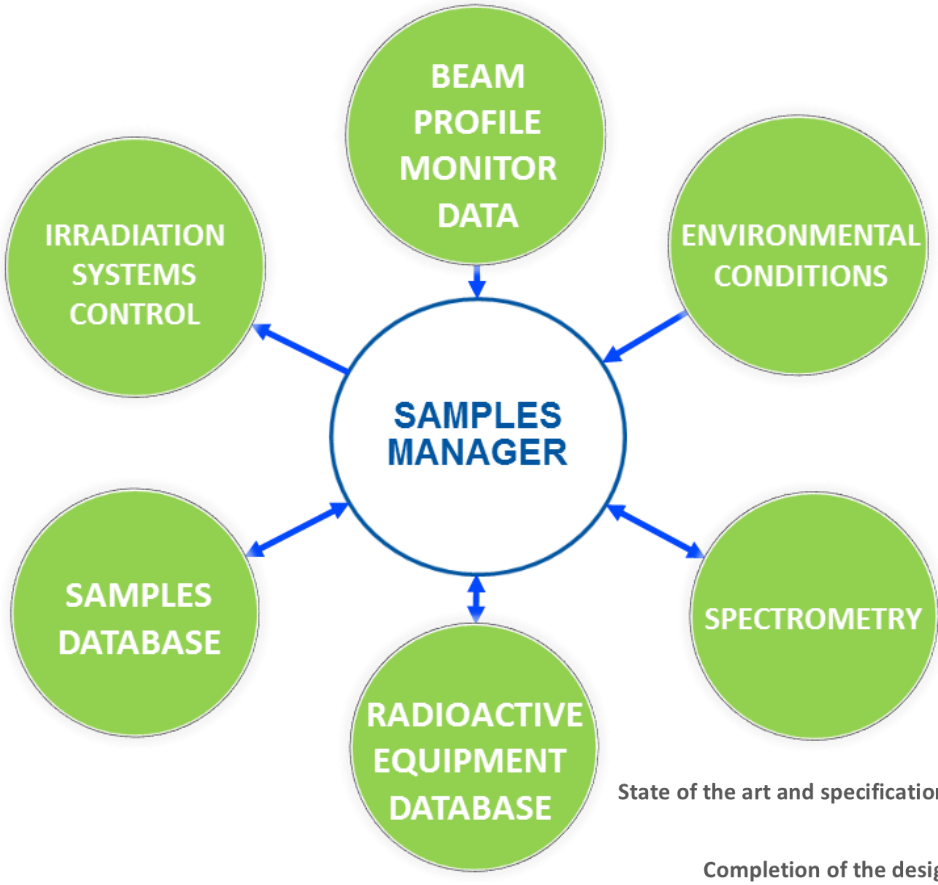
- Measured gamma flux profile
- Dose rate several 10 kGy/h (very preliminary!!)
- Resulting in several kGy for 10^{14} $n_{eq}cm^{-2}$

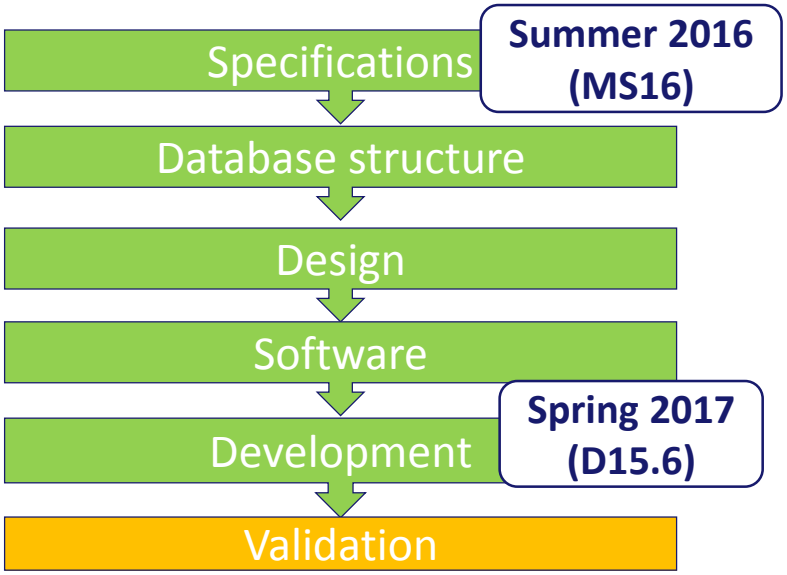
Task 15.5: CERN Proton Facility

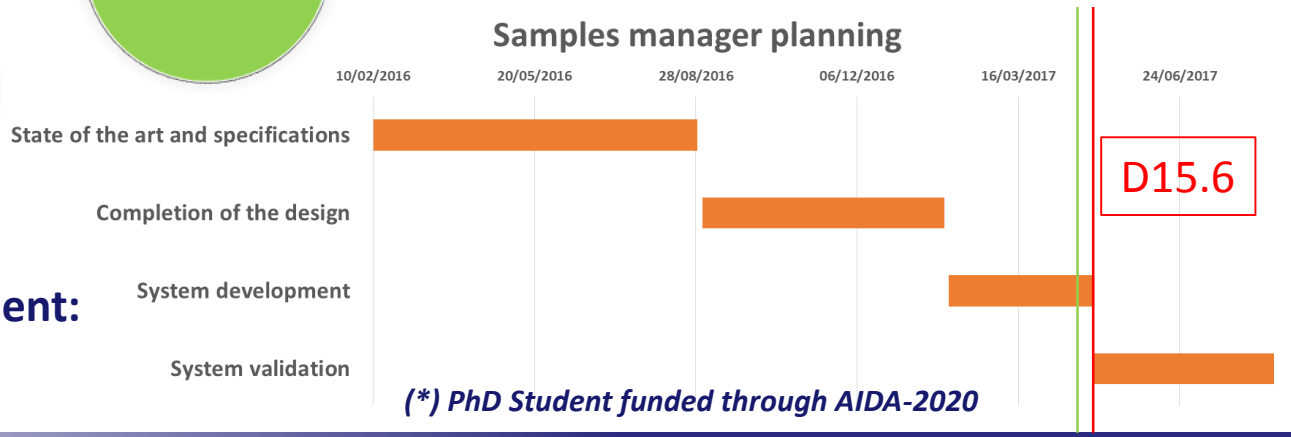
- **D15.6: CERN proton facility upgrade**
  - Facility management system, storage area, contactless fluence monitor and online database on irradiation facilities are operational at the CERN proton facility.
  - **MS16, MS35**
  - **Due M24**

- **D15.7 : Radiation-hard facility instrumentation for the CERN proton facility**
  - Beam profile monitor operational, box allowing to irradiate samples at -40 degrees C installed in the beam line and sample holders on radiation hard material produced and tested up to 10^{17} p/cm^2.
  - **MS36,** MS85 (M36)
  - **Due M44**
  - See more details on B. Gkotse' s presentation on WP15 session

Task 15.5: CERN Proton Facility Samples Manager



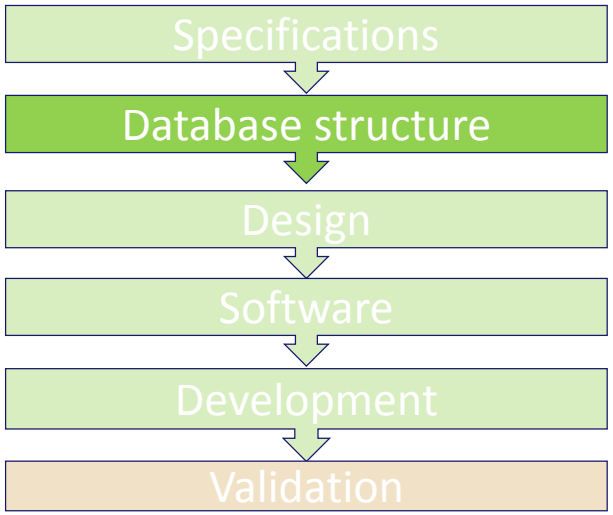


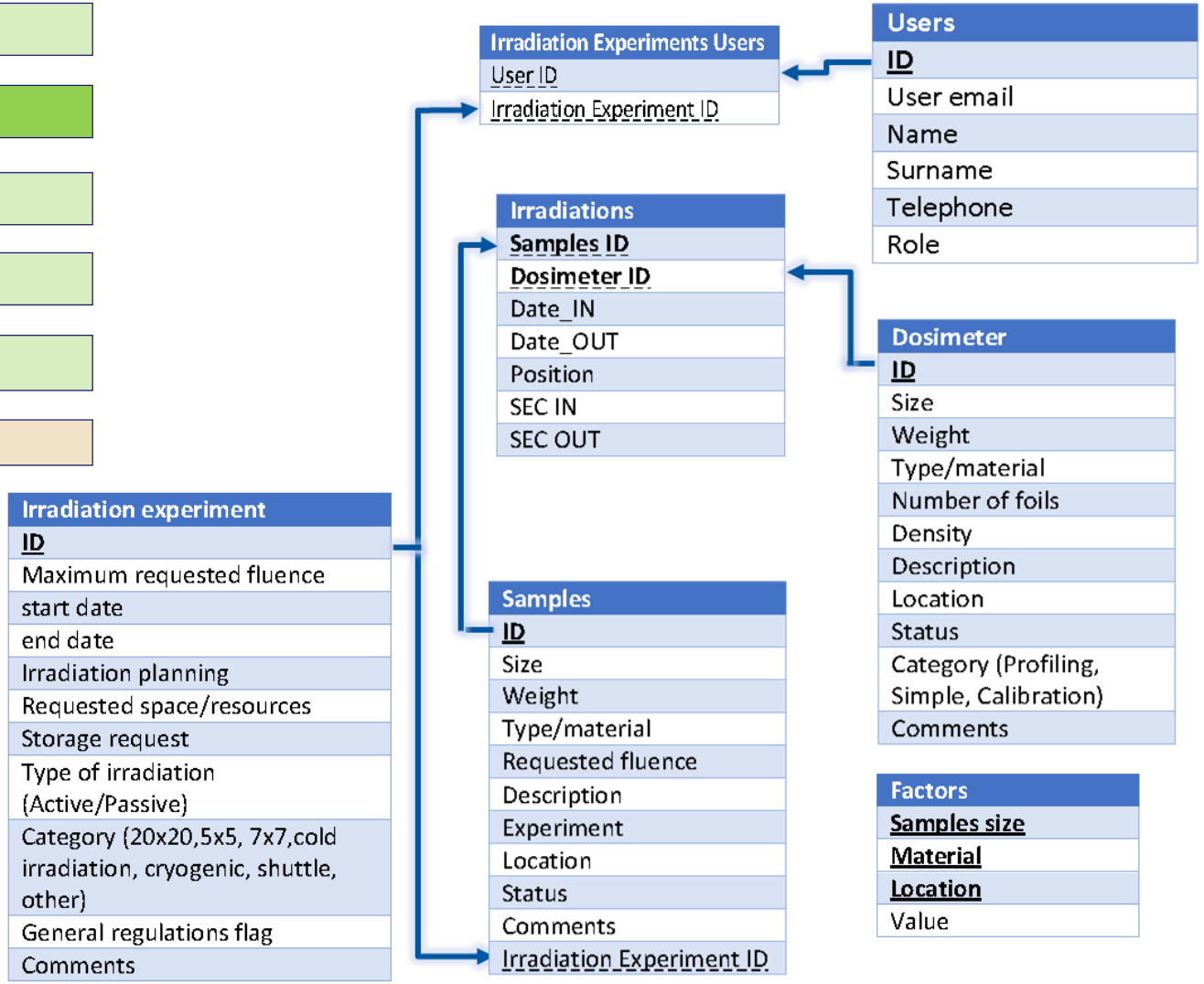


Detailed Specification document: AIDA-2020-MS16

(*) PhD Student funded through AIDA-2020

Task 15.5: CERN Proton Facility Samples Manager

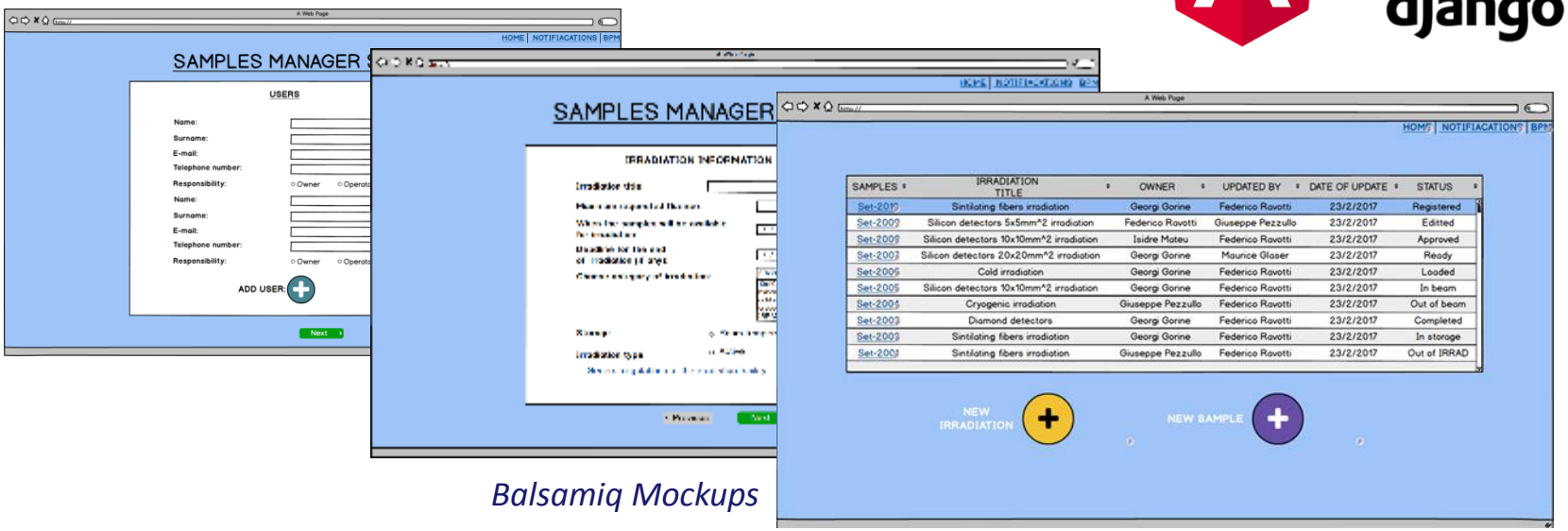




Task 15.5: CERN Proton Facility Samples Manager

- Specifications
- Database structure
- Design
- Software
- Development
- Validation

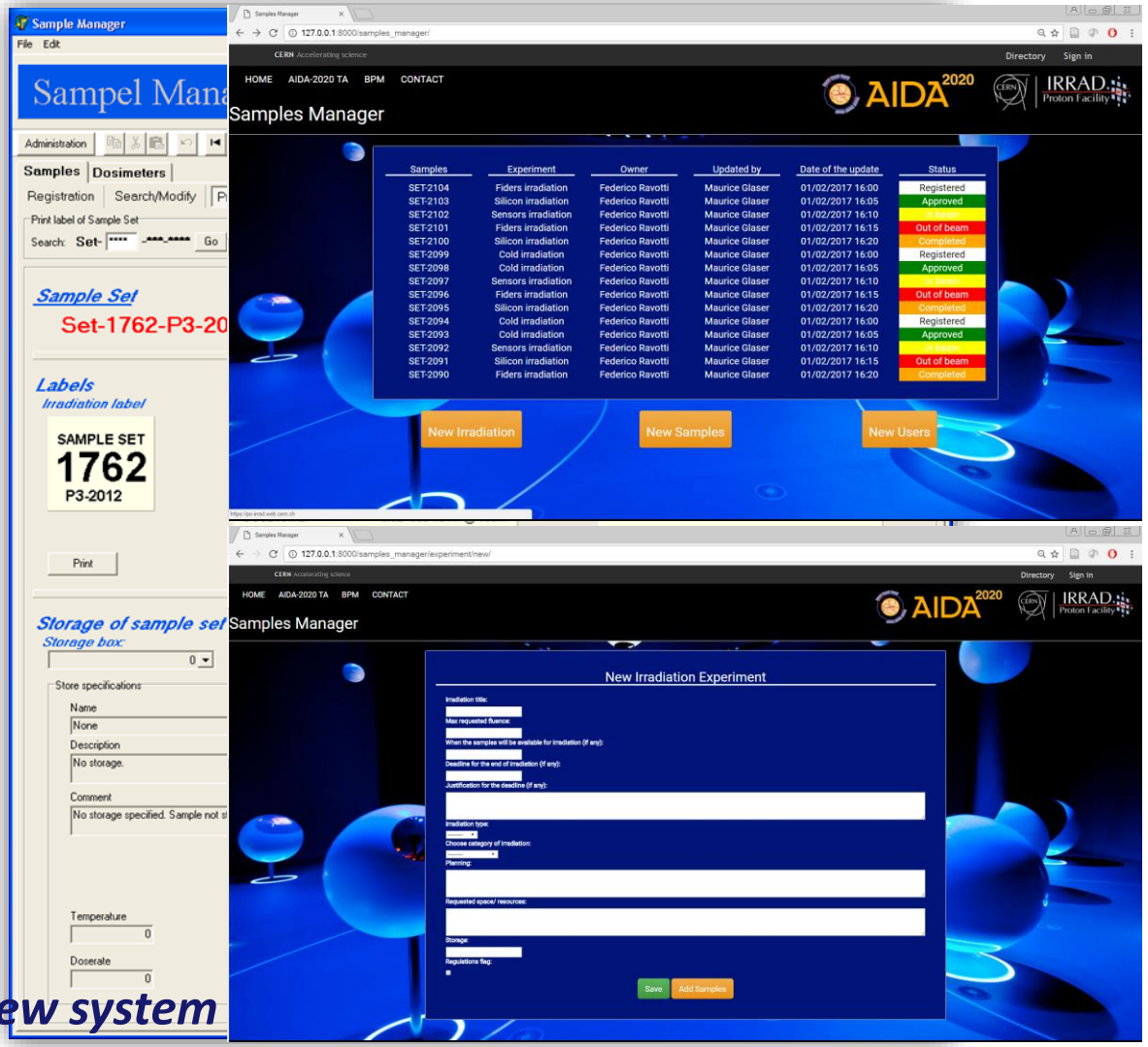
- Design of the interfaces according to the specifications and the requirements of the users and the coordinators
- Design with *balsamiq* mockups
- Software development with *Oracle* database, *Django*, *Bootstrap* and *Angular*



Balsamiq Mockups

Task 15.5: CERN Proton Facility Samples Manager

- ✓ **Centralised system** for the overall IRRAD facility operation
- ✓ Interfaces **customised according to users**
- ✓ **Overall display** of the beam and environmental conditions
- ✓ **Compatible** with the CERN computing infrastructure and procedures (TREC)
- ✓ **Secured** with the CERN authentication system (SSO)

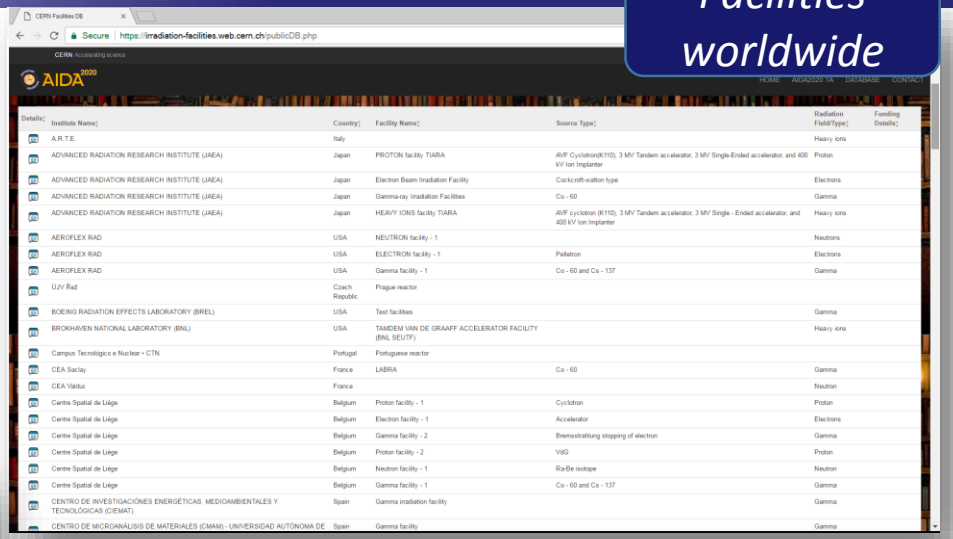


Old system ***New system***

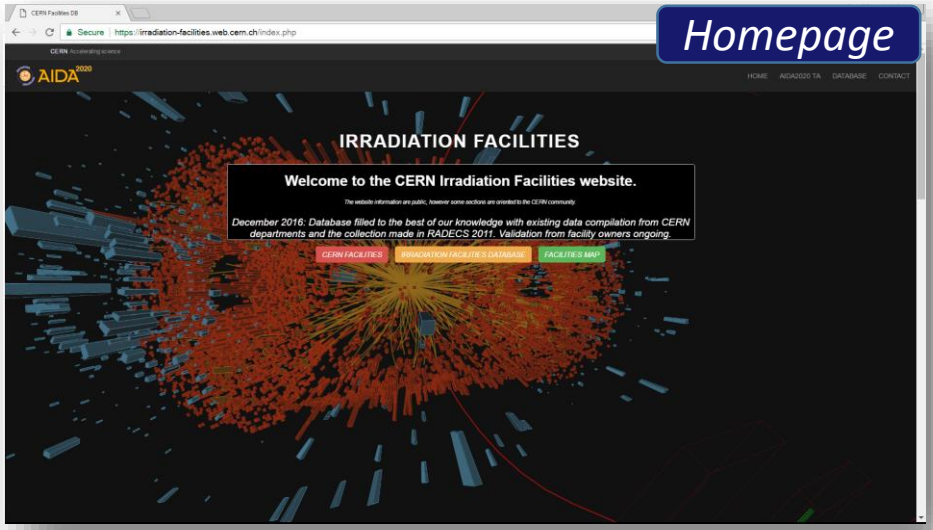
Task 15.5: CERN Proton Facility Irradiation Facilities Database

- Deliverable in EU-project **AIDA-2020**
- Unified entry point for irradiation facilities at **CERN** and **worldwide**
- Essential (but exhaustive) collection of information
- **182 entries** initially loaded
- Data validation in progress since Feb. 8th

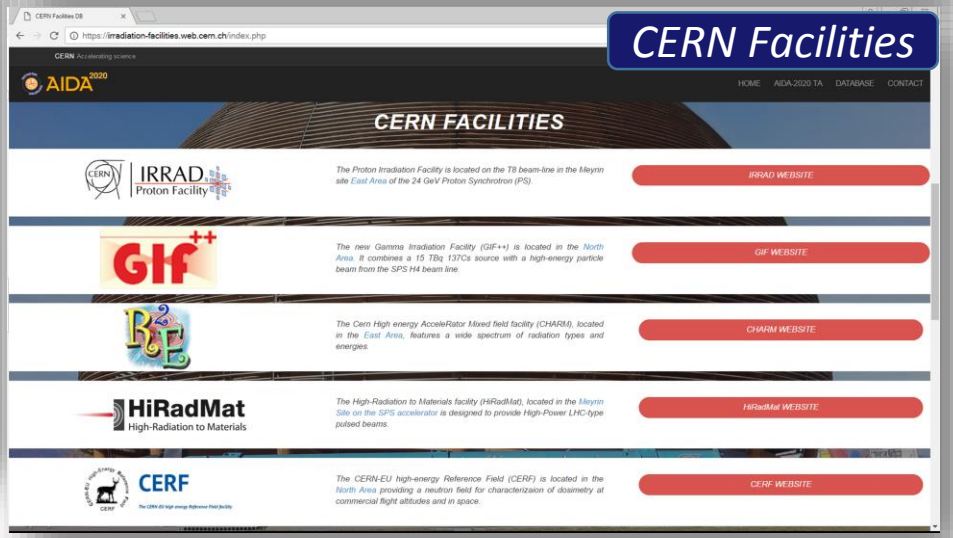
Facilities worldwide



Homepage



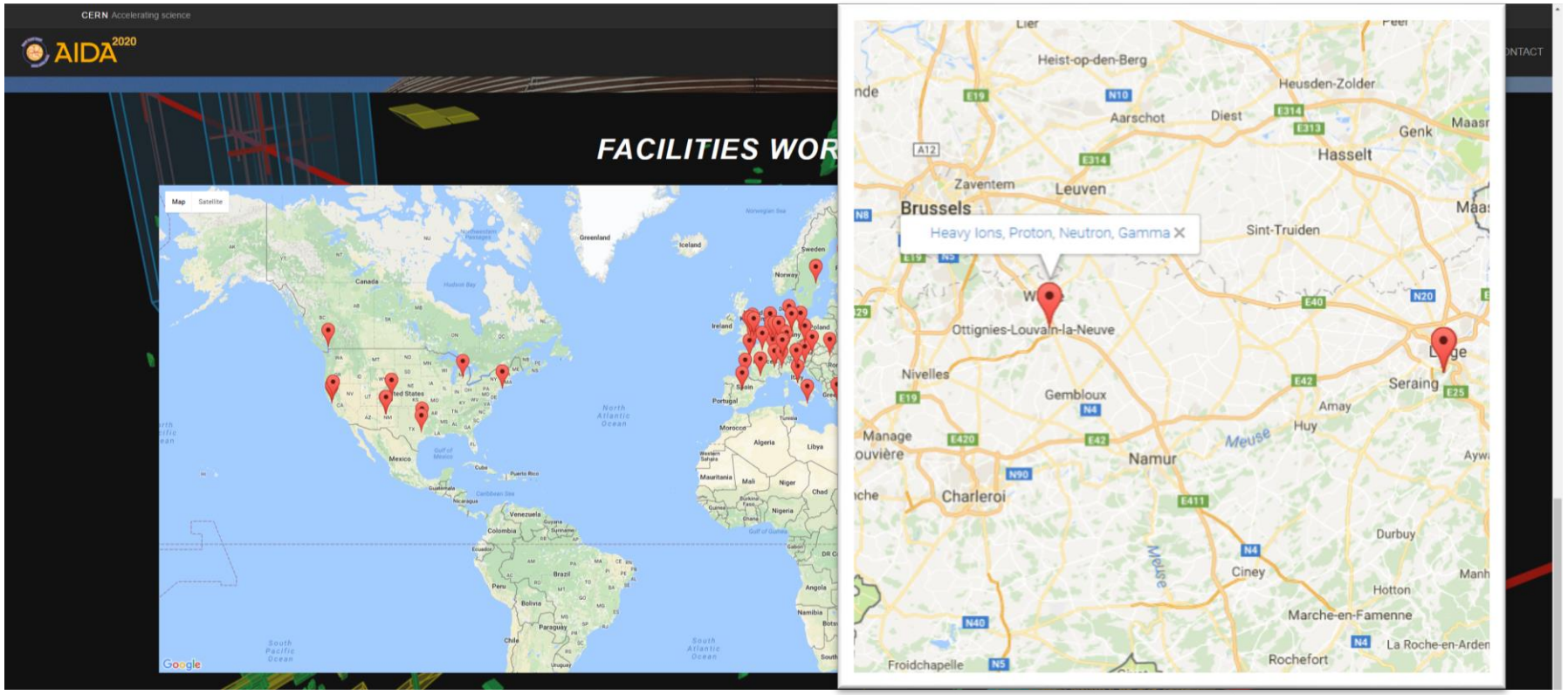
CERN Facilities



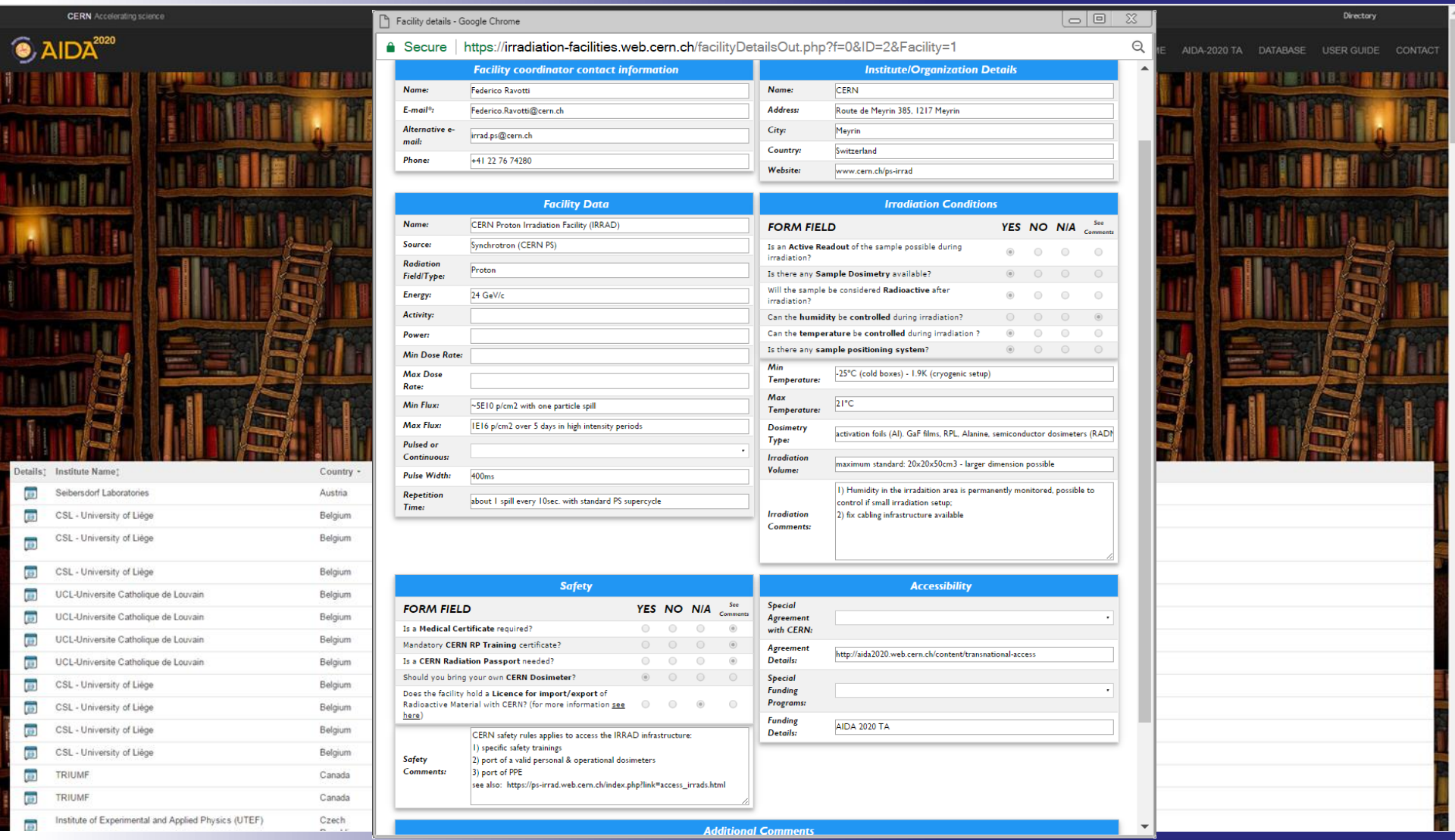
irradiation-facilities.web.cern.ch

Task 15.5: CERN Proton Facility Irradiation Facilities Database

- **Open access** data, secured with the CERN authentication system (SSO)
- Search filters by country, source or radiation field
- Irradiation facilities worldwide map
- Possibility to **ADD** a new facility and **EDIT** an existent one by the **facility coordinator**
- **Auto-maintenance** (regular reminders)



Task 15.5: CERN Proton Facility Irradiation Facilities Database



Task 15.5: CERN Proton Facility Irradiation Facilities Database

- **42 entries have been validated so far by the *Facility Coordinators***
- **The website has been visited ~350 times**

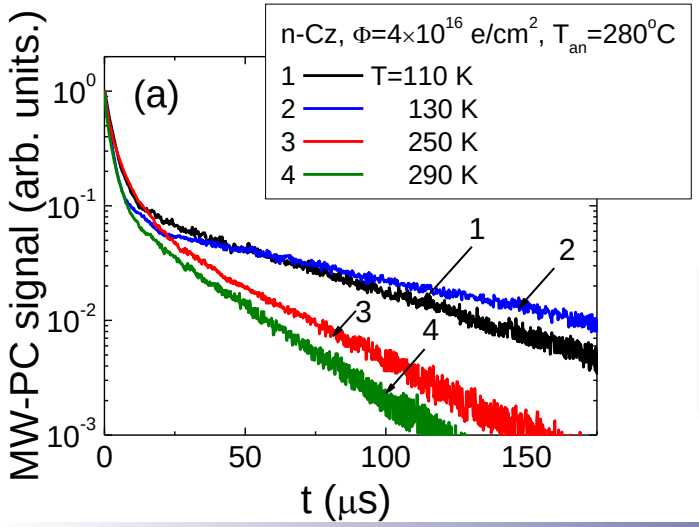
Follow up:

- Send **second reminder** to the *Facility Coordinators* that did not reply yet
- Article on **AIDA-2020 newsletter** being released
- Send the first **"annual" validation** reminder (test the notification system) by the end of 2017
- Contact CERN colleagues to **remove outdated information** from old CERN websites

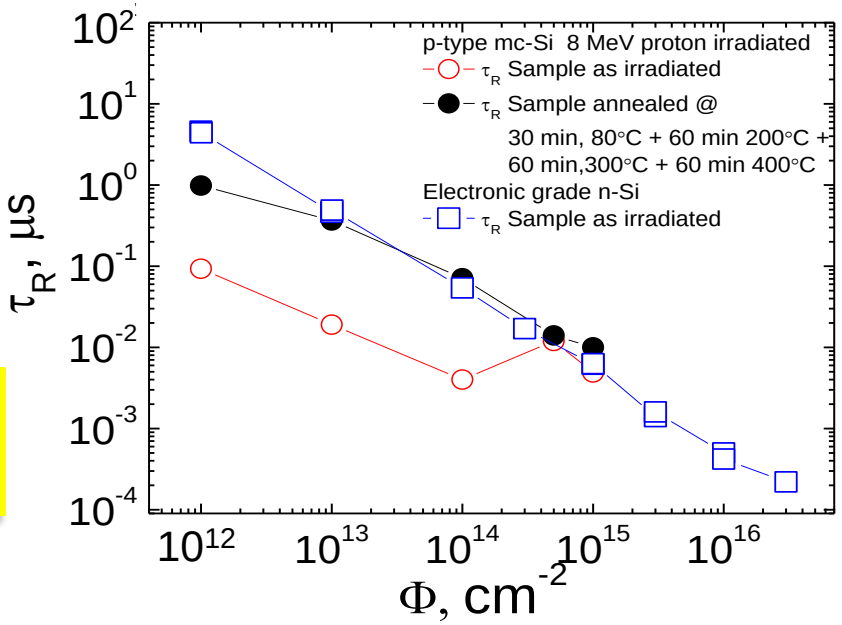
Task 15.5: CERN Proton Facility - Contactless fluence monitor

General view of the dosimeter with two-type sample chambers

- The pure c-Si high resistivity materials appear to be the best option for reliable monitoring of hadron irradiations over wide fluence range from 10^{11} to 5×10^{16} cm^{-2}.
- Silicon material used in the microelectronics can be also recommended for high fluence monitoring.
- Further recombination and trapping studies



MS35 ACHIEVED



Task 15.5: Cold Irradiations at Birmingham Facility – LN_2 Cooling

D15.8 (M36)

- The University of Birmingham Cyclotron irradiation facility provides limited access to enable new development of the system.
- To ease pressure on the schedule a **duplicate scanning system and cold box** has been produced by Sheffield.
- Over the course of 2016, using irradiation running data and evaluation in Sheffield, the **prototype cold box has been evaluated and proven to work reliably** with better cooling to prevent silicon sensor annealing.
- The **new cold box design is completed (MS36)**.
- Waiting for a workshop slot to be available to begin production – **Plan: end 2017**.
  - Due to the low level of funding from AIDA2020 and removal of a UK-ALTAS staff post at USFD, it is prohibited to request a production advancement at this time.

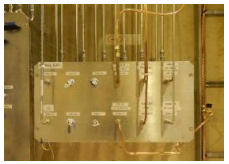
Task 15.5: GIF++ Gas System Upgrade

R&D on gaseous detectors at GIF++:

- mainly detectors for **muon systems of the LHC experiments**
- about 15 setups (between 20-30 detectors)
- **real size detectors and prototypes** (several m^2 active surface each)
- 7 different types of muon detector technologies (CSC, DT, GEM, GRPC, MM, RPC, TGC)
- test duration varies from few months to years

Task 15.5: GIF++ Gas System Upgrade

The gas systems infrastructure is a key element for successful R&D programs at GIF++



- New **mixing units** have been developed and built
  - → **Installed and operational**
- Additional **gas-distribution panels** have been included at supply & at gas system
- New **gas recirculation modules** have been developed and built
  - → one operational since 2015, **one since 2016 and one recently installed**
- Further developments ongoing to have gas recirculation systems allowing operation of detectors requiring high gas filtering capacity
  - → New **design for an automated purifier** (ATLAS and CMS RPC R&D)
- Gas analysis and especially **gas chromatography** are available to all GIF++ users
  - → GC operational since beginning 2016
  - → **Second IR analyser installed in 2016**
  - → Automated **O_2/H_2O analysis rack** available in 2017

D15.10 on Track for M24 (report being prepared)

(*) supported by Tech Students funded through AIDA-2020

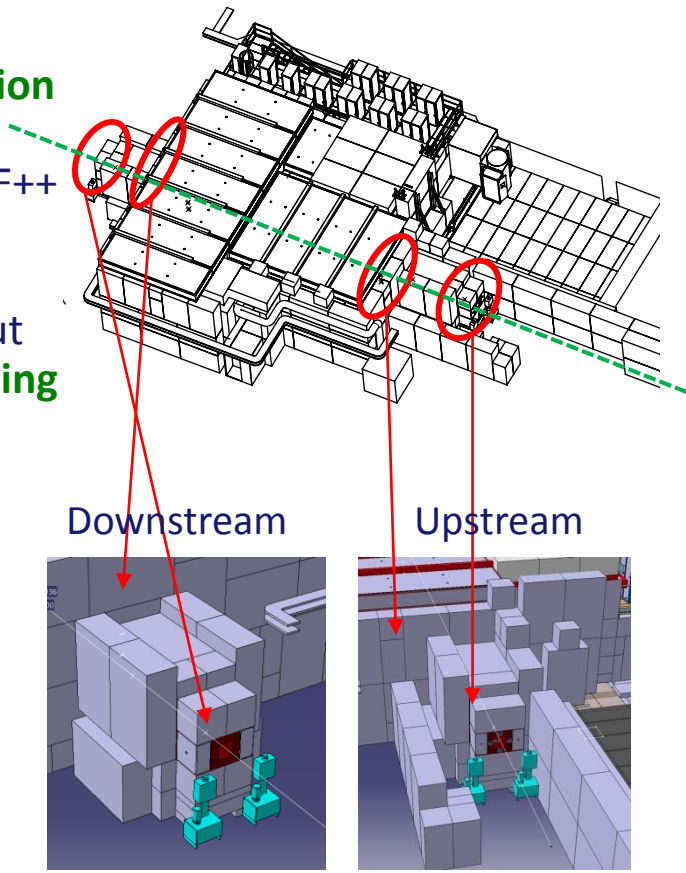
Task 15.5: GIF++ Facility Upgrade

Improved cosmic-rays tracker:

The design of the chambers for the GIF++ cosmic tracker extension has been completed.

- New RPC chambers to instrument the vertical walls of the GIF++ bunker are in preparation
- Chamber mechanics is at CERN
- Production of chamber active elements (gas volumes, readout panels) planned for next summer (**material for electrodes being purchased**)
- Chamber position to be finalized according to constraints

MS37 ACHIEVED



Augmented reality demonstrator:

- Waiting for the DAQ system to be ready
- **starting soon too develop software with simulated data for test purposes**
- Setup of the infrastructure will start soon:
  - installation of position markers inside the bunker
  - development of software for the observer position reconstruction (3D-coordinates inside GIF++ bunker)

MS86 (M36)

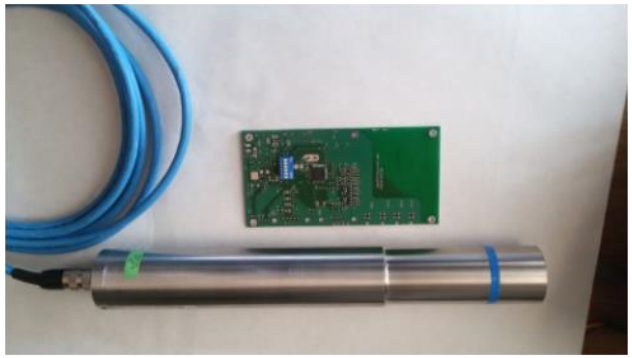
D15.11 (M48)

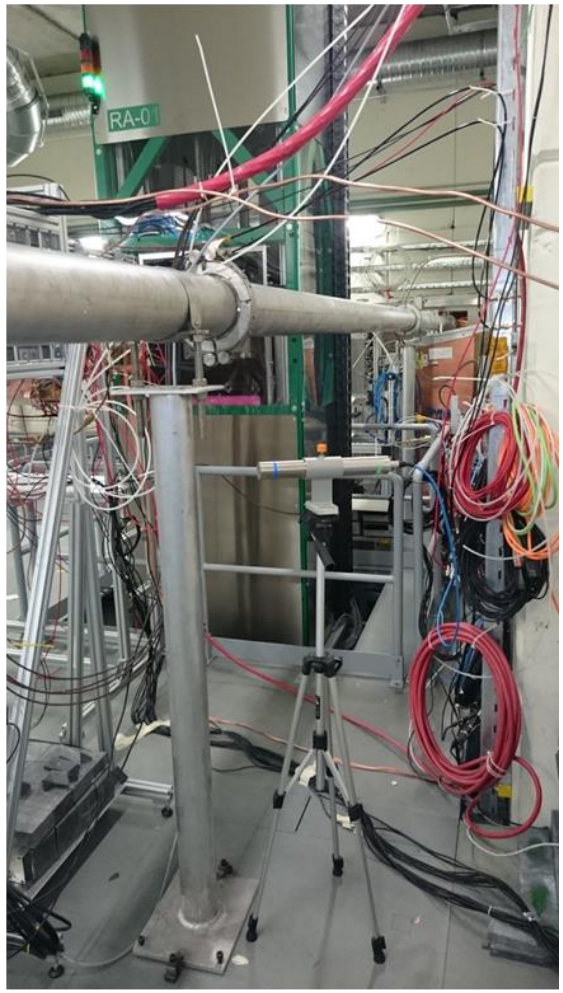
Task 15.5: GIF++ Facility Upgrade

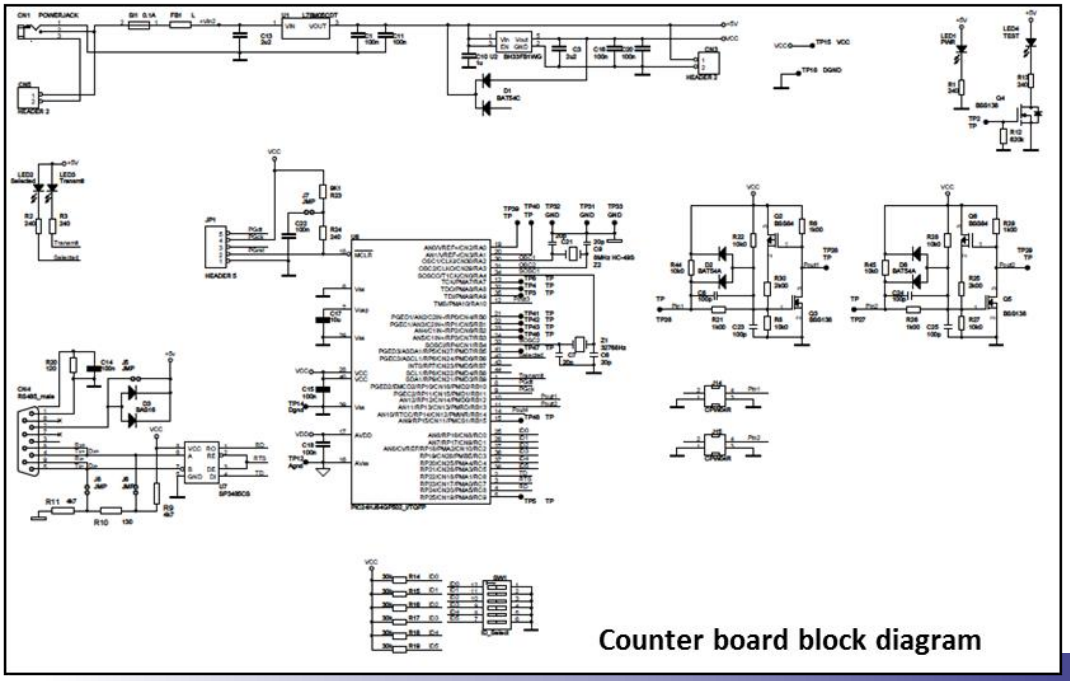
2. Instantaneous dose-rate monitor for GIF++ - AIDA2020

The first version of the 2 – channel counter board designed at INRNE, Sofia was tested at GIF++ - June 2016.

Final design – 8-channel dose rate monitoring board design and test – 2017/2018







Counter board block diagram

Berthold GM Technical Data

Dose Rate Range – 500nSv/h – 3mSv/h

Energy Range - 65 keV – 1,3 MeV (+/-40%)

Intrinsic Background – approx. 0.015 cps

Calibration Factor – 7,05 µSv/h per cps

MS85 (M36)
D15.11 (M48)

Thank you for your attention!