

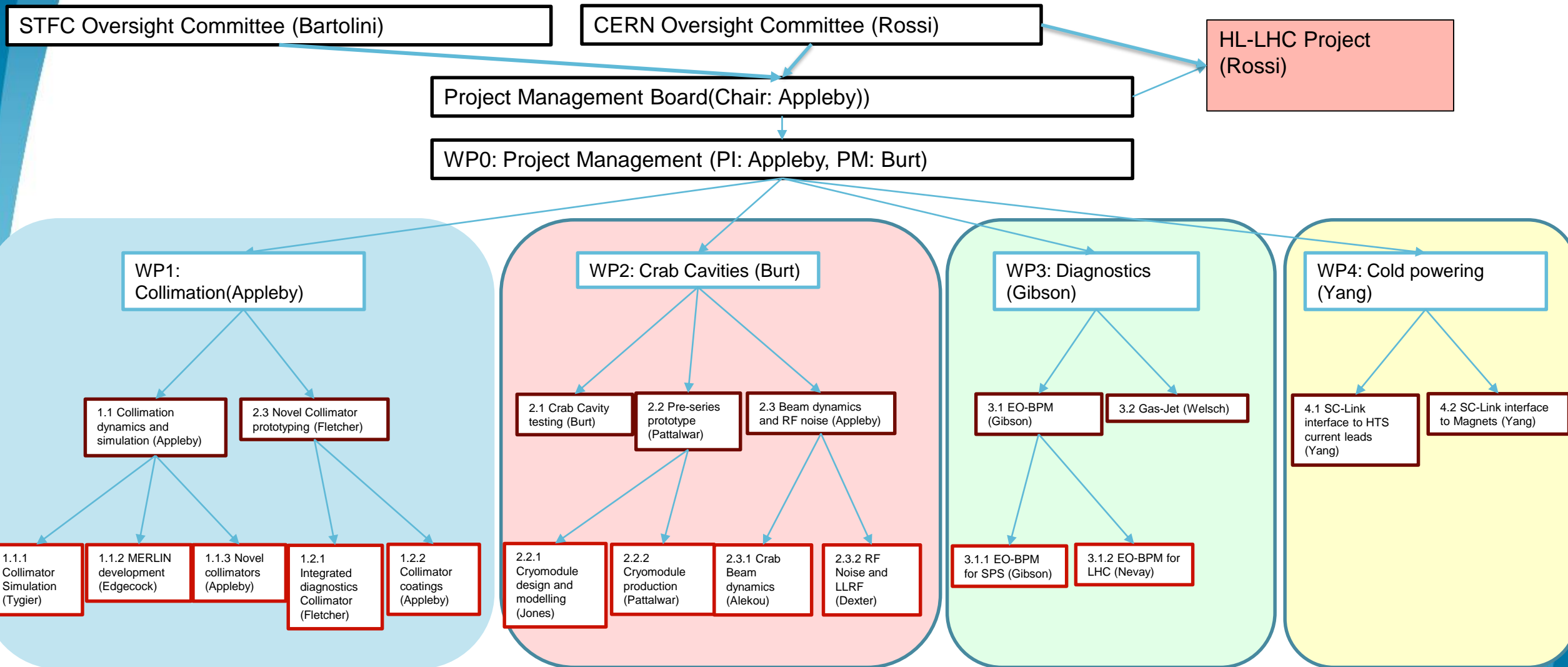


Status of UK contribution to HiLumi (and outlook for accelerator R&D for HEP)

Grahame Blair
UKRI-STFC

CERN 15th October 2018





UK-WP1: Advanced collimation

Task 1: Simulation and novel concepts:

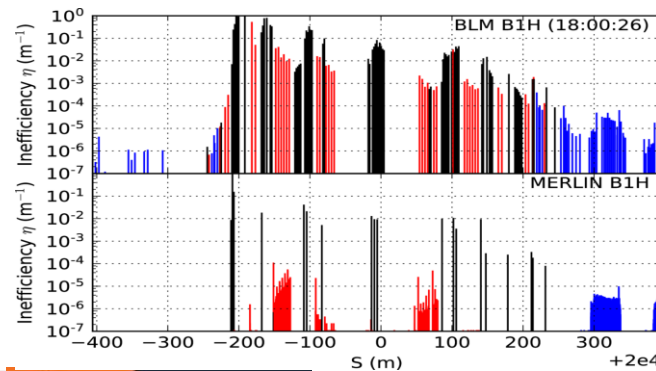
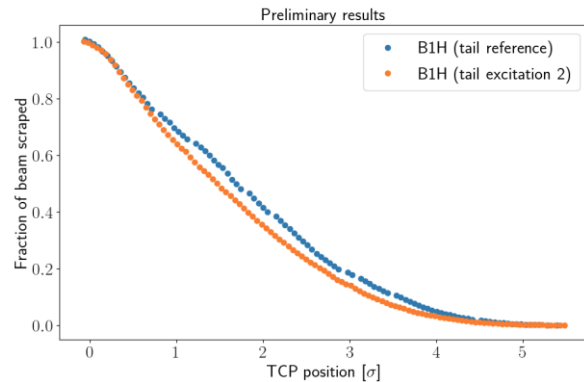
University of Manchester/CI/RHUL/Hudd/CERN

- **Aim:** Explore collimation performance, develop new tools and create novel collimation schemes.

-> Design of two-stage collimation schemes, active halo control, tested experimentally.

-> Analysis of run 2 loss maps and verification of HL-LHC collimation scheme performance

-> New code development : MERLIN (and BDSIM)



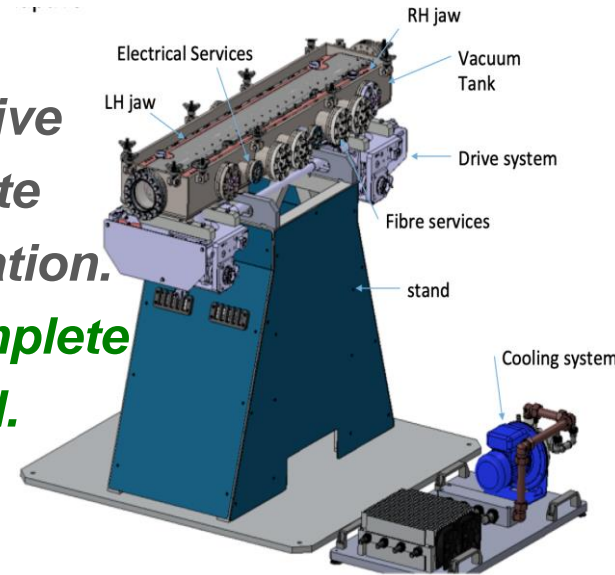
Task 2) Adaptive collimation system (ACS)

University of Huddersfield

- **Aim:** Develop a reactive Collimator to compensate For thermal jaw deformation.

-> Prototype design complete and being manufactured.

Design validated in full Simulation suite.

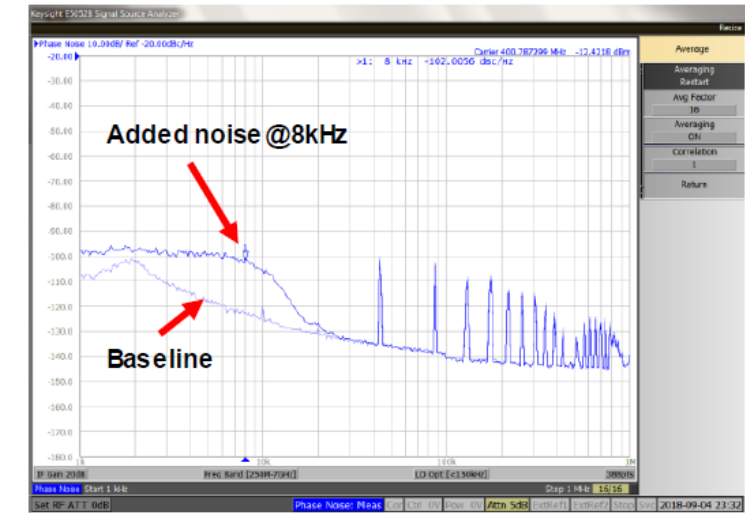
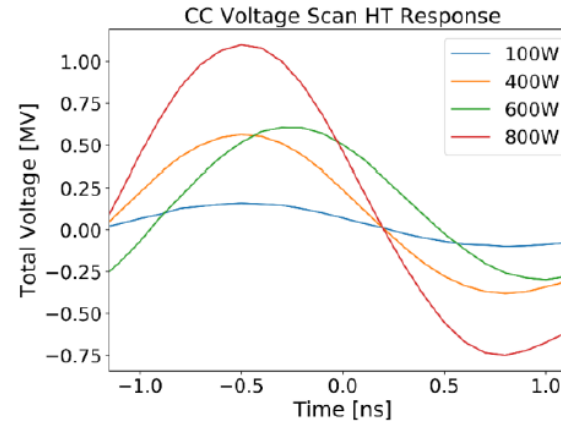
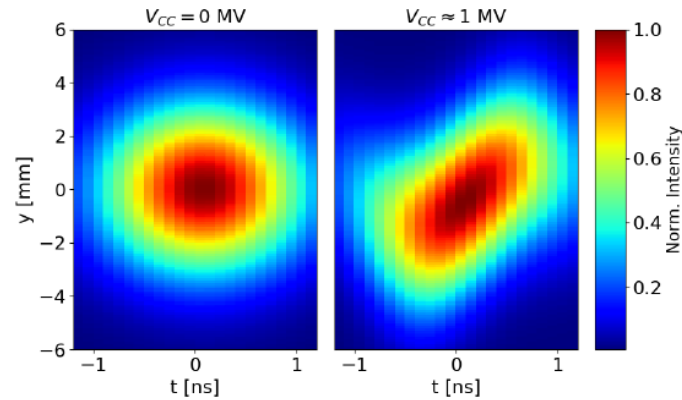


HL-LHC-UK phase 2

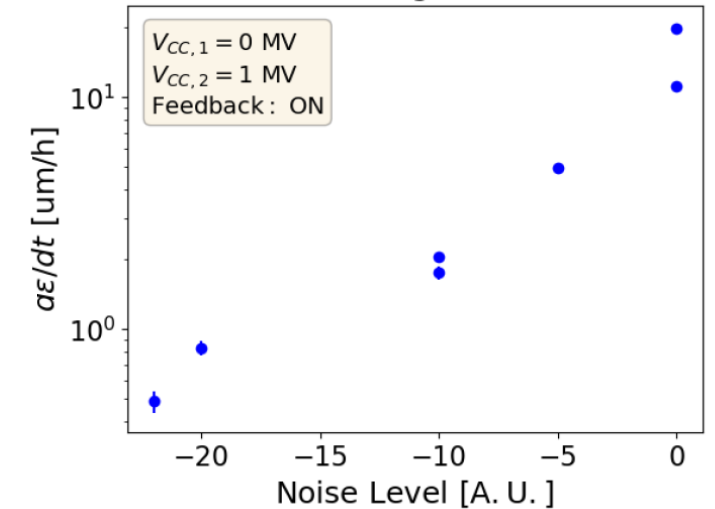
Manchester and RHUL are proposing to perform beam related measurements in run 3, tied to an operation-focus simulation programme, and develop the novel collimation layouts and hardware.

Crab SPS Tests

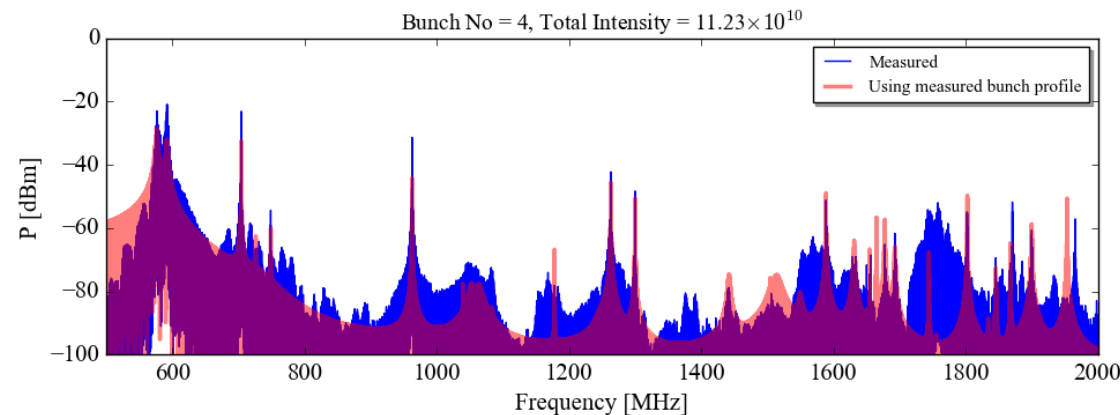
Crabbing Voltage from Head-Tail Monitor
2018-05-23 17:02:39



Vertical Emittance Growth during MD5



- Worlds first crabbing of a proton beam, and first operating compact crab cavity demonstrated on 23rd May 2018
- UK team a key part of SPS tests of crabs with key involvement in beam measurements, impedance, LLRF, cavity testing and beam simulations.

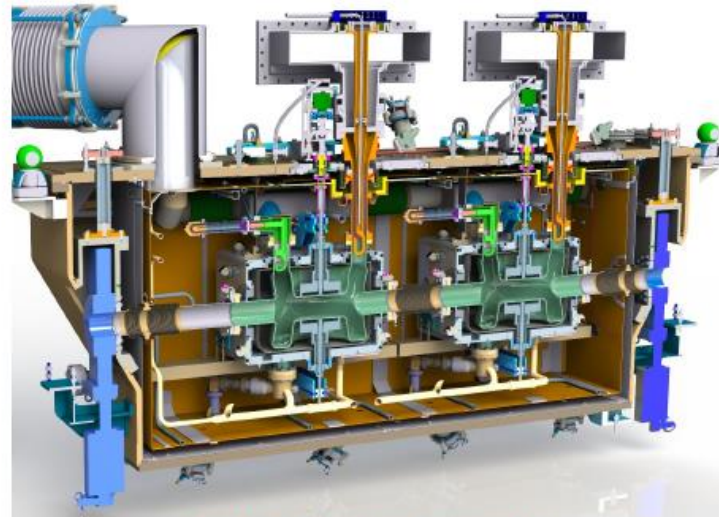


Crab Pre-series Cryomodule and HL-LHC-UK2

RFD Pre-series Cryomodule to be assembled at DL in 2020. Area for cryostating, lifters, trolleys, tooling and clean rooms are currently being prepared

In HL-LHC-UK2 we propose to build the double quarter wave cryomodules for HL-LHC at Daresbury.

In addition we propose to provide support to CERN on cavity production, cavity testing, and the SPS tests of the RFD pre-series.



DQW SPS Prototype Cryomodule



UK-WP3: Developing Diagnostics for HL-LHC

Task 1: Electro-optic beam position monitor:

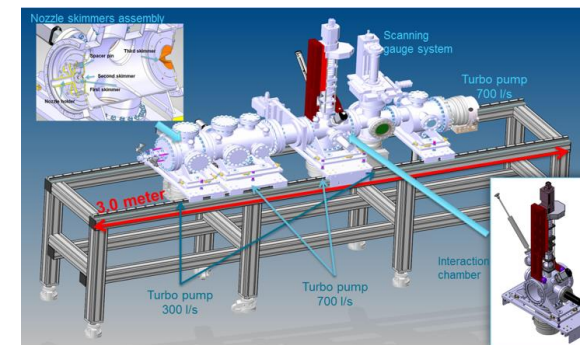
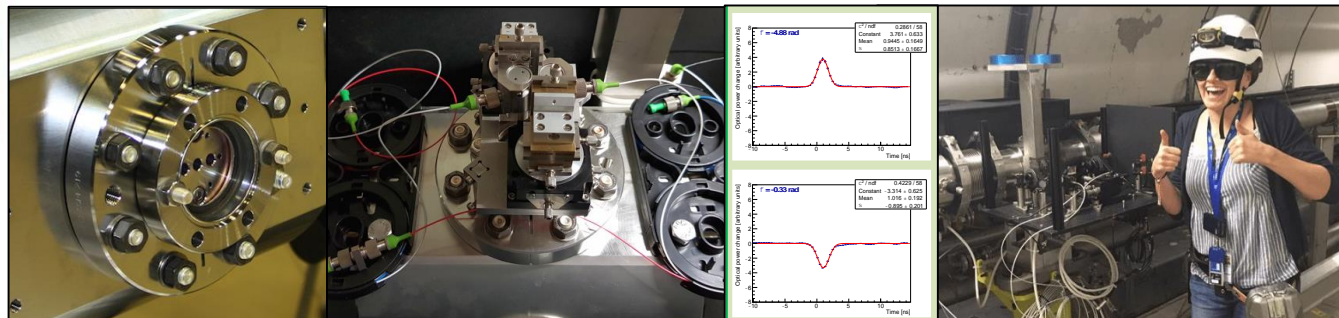
S. Gibson et al, Royal Holloway, U. of London - CERN

- **Aim:** rapid intra-bunch measurement of crabbed bunch shape & instabilities, by replacing BPM pick-ups with ultrafast eo-crystals.
- EO-prototype observed first SPS beam signal in Dec 2016; tune successfully measured in 2017.
- Beam signals match well with CST simulations and with results from optical bench tests.
- Beam signal enhanced by a compact, fibre interferometer design: recent results at IPAC 2018.

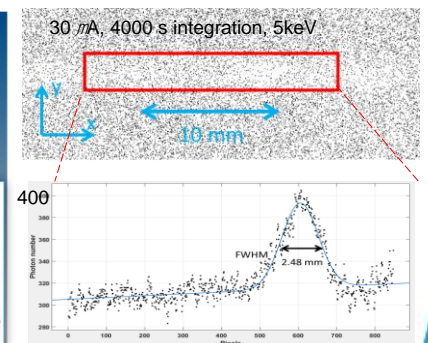
Task 2) Gas-jet beam profile monitor

C. Welsch et al, University of Liverpool-GSI-CERN

- **Aim:** to monitor overlapping beam profiles in hollow e-lens using a supersonic gas jet.
- Simulation studies performed to optimise monitor resolution.
- Prototypes developed at Cockcroft test bench, demonstrating gas jet fluorescence technique.
- New e-gun and optics reduce integration time for image acquisition by factor >10 .



New optical system with upgraded electron gun



UK2-WP3: Delivering Diagnostics for HL-LHC

Task 1: Electro-optic beam position monitor:

S. Gibson et al, Royal Holloway, U. of London - CERN

Full demonstrator phase: 2020-2023

- The team propose to collaborate with UK optics industry to produce the ultimate compact pick-up, based on our fibre-coupled eo-waveguide design.
- Propose delivery of one complete, multiple pick-up EO-BPM demonstrator for tests at LHC, to fully prove technology readiness before production:

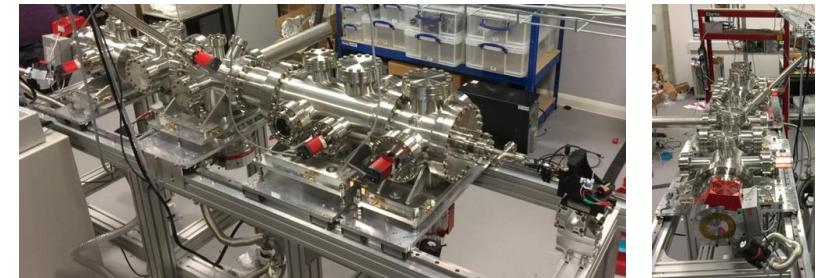
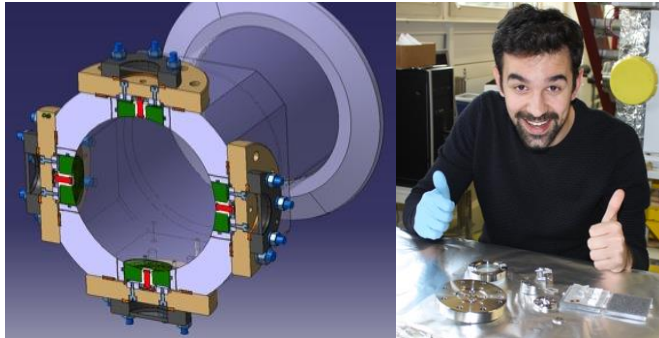
Task 2) Gas-jet beam profile monitor

C. Welsch et al, University of Liverpool-GSI-CERN

- propose to develop a minimally-invasive device, suitable for operation at the HL-LHC.
- Propose to finalise the parameters associated with the fluorescence technique, including gas species and optimization of the detector integration time, by building on core UK expertise and leadership in this area.

Production phase: 2024/25

- RHUL propose to manufacture and deliver four sets of EO-BPMs for HL-LHC, including lasers and fibre optic readout.



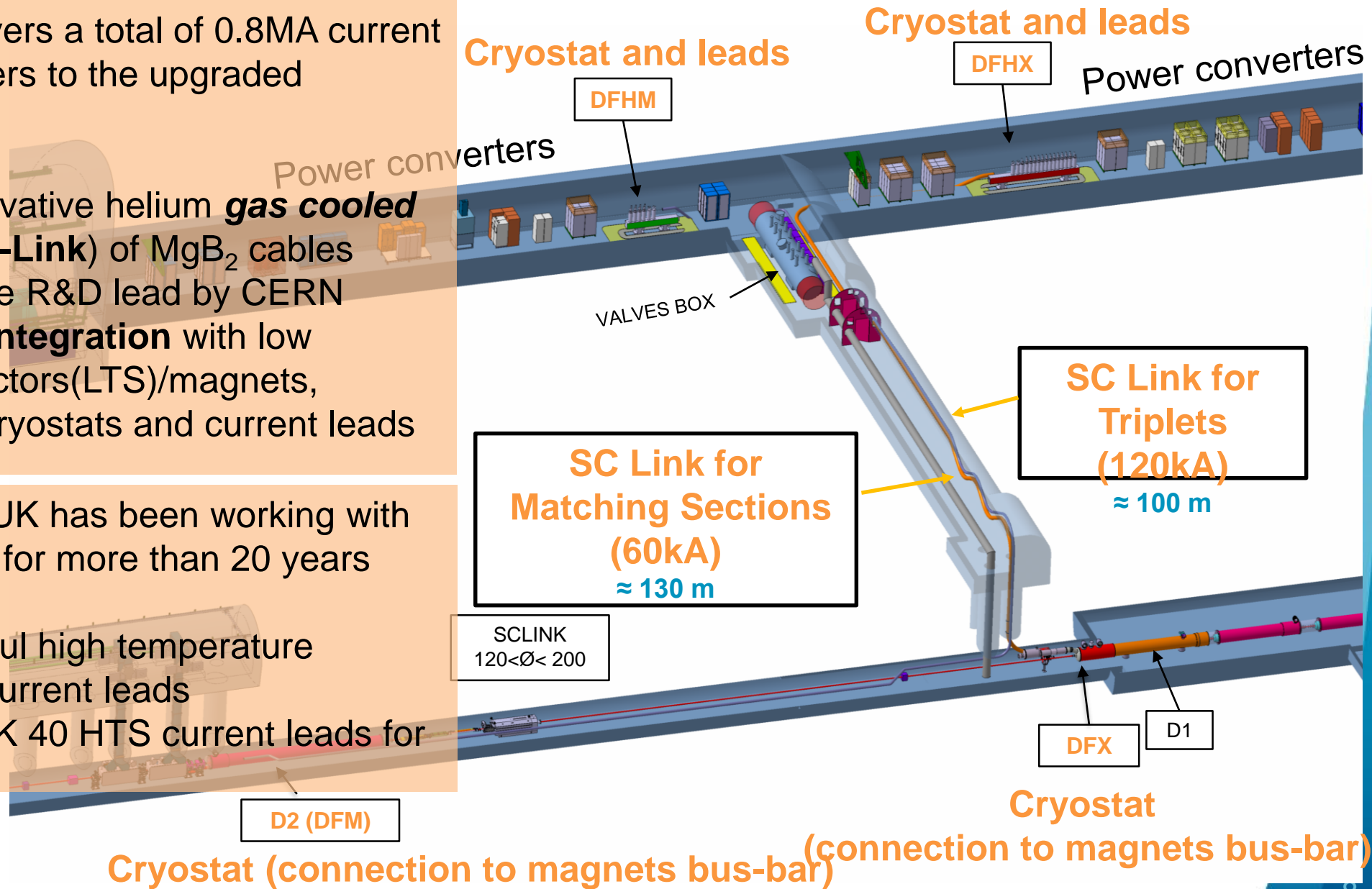
Remote Cold Powering of HL-LHC

HL-LHC cold powering delivers a total of 0.8MA current from remote power converters to the upgraded magnets at IP1 and IP5:

- To be realised by an innovative helium **gas cooled** superconducting link (**SC-Link**) of MgB_2 cables
- Supported by an intensive R&D lead by CERN
- Requires novel **system integration** with low temperature superconductors(LTS)/magnets, cryogenics, long length cryostats and current leads over 100m distance

Southampton University at UK has been working with CERN for on cold powering for more than 20 years

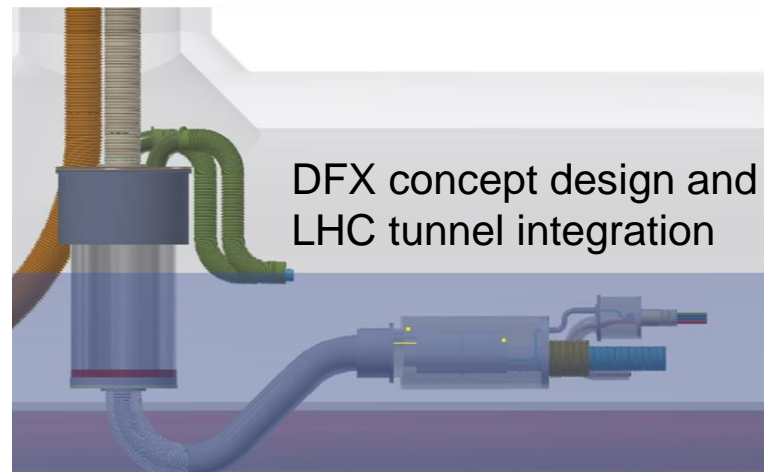
- Started with the successful high temperature superconducting (HTS) current leads
- Contributed with Pirelli UK 40 HTS current leads for the LHC



Remote Cold Powering of HL-LHC

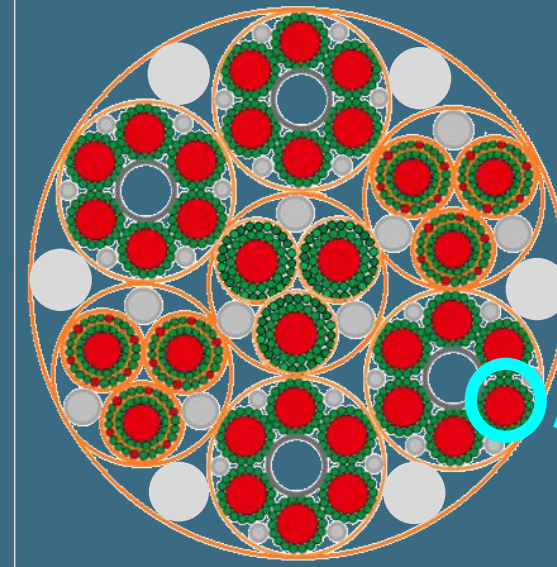
Southampton University at UK has been working on HL-LHC since the beginning

- Performed the 1st high current tests of MgB₂ cables in helium gas (**EUCARD**)
- Developed a novel design of SC-Link distribution feedbox (DFH) to HTS current leads (**FP7-HiLumi**), adopted for HL-LHC series
- Working on the electromagnetic and thermal stability of SC-Link and design/build a prototype of low temperature distribution feedbox (DFX) to LTS and for SC-Link cooling control (**CERN/STFC: LH-LHC-UK**)
- Plan to focus on the series production of the 10 DFX/DFM cryomodules and participating in the system tests, operation definition/tuning, and commissioning of SC-Link cold powering (**HL-LHC-UK2**)

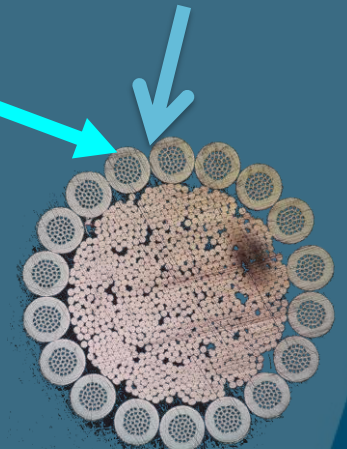


CERN SC-Links / MgB₂ cable configurations for the triplets

- *Multiple circuits to be spliced to LTS and HTS in DFX and DFH respectively*
- *Total nominal current 120kA*



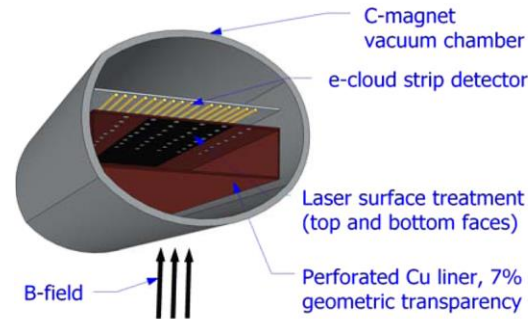
Subunit cable (3kA)
 $\Phi_{\text{cable}} = 6.5 \text{ mm}$
Core: 12 mm² Cu
 $\Phi_{\text{wire}} = 0.15 \text{ mm}$
46×19 wires
Tw=15/45 mm



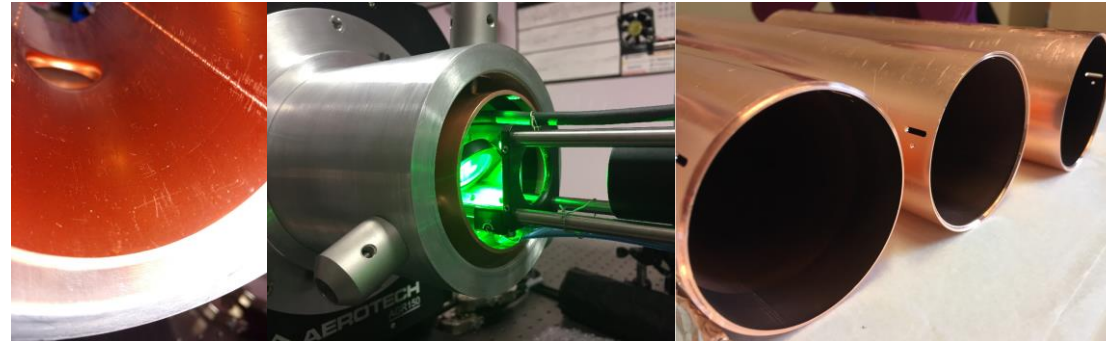
Courtesy of Amalia Ballarion

(Dundee: ST/P00086X/1)

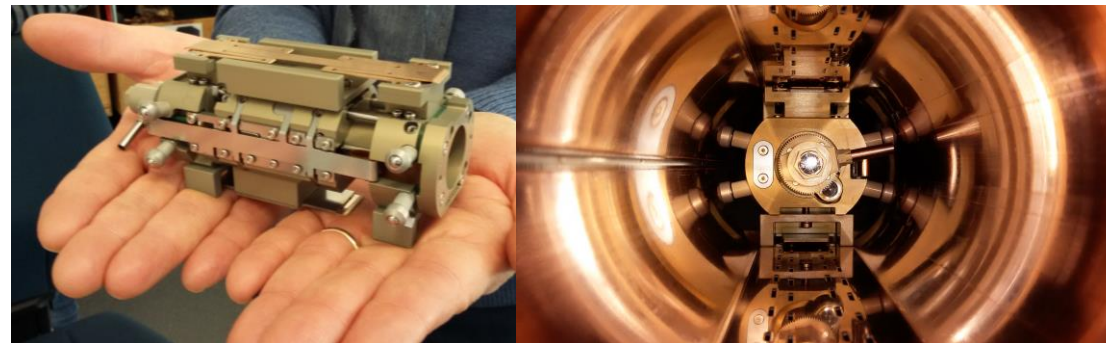
2016: LESS treatment of a copper liner and monitoring the electron cloud current in a dipole magnet in the SPS accelerator at CERN – complete suppression of e-cloud



2017: LESS treatment of the COLDEX beam screen and SPS test – complete suppression of e-cloud



2018: Development of an automated robotic system for *in-situ* LESS treatment of HL-LHC beam screens



Outlook for accelerator R&D for HEP

- The UK is about to enter a Spending Review in 2019. The current assumption is approximately flat funding, but other uncertainties may dominate.
- Main UK interests for high energy physics are:
 - Specific grants for HL-LHC and AWAKE
 - future colliders (ILC, CLIC, laser plasma wakefield etc.) via institute grants to the accelerator institutes (CI, JAI) and ASTeC.
- For HL-LHC, the Sol went to our Accelerator Strategy Board that recommended inviting a full proposal to our peer review process. Current grant runs formally to March 2020.
- Within the newly formed UK Research and Innovation new funding has been made available for targeted schemes (ISCF, GCRF, SPF, FIC...) with a focus on interdisciplinarity, industrial return and international collaboration. We should remain alert to possibilities.