

Status report of the LHCf experiment: preparation for data taking

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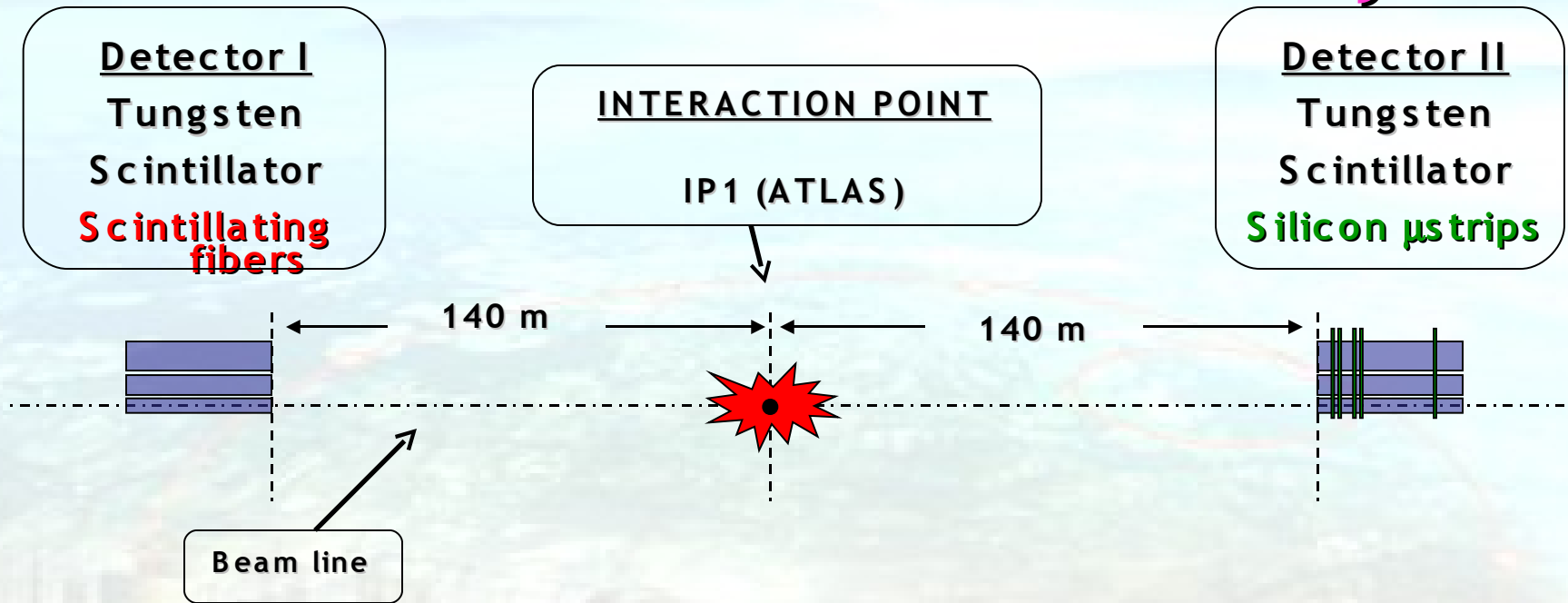
LHCf Physics Topics - Short summary!

- ✓ **Experimental measurement:**
 - Precise measurement of γ and π^0 spectra in the very forward region at LHC

- ✓ **7 TeV + 7 TeV in the c.m. frame \rightarrow 10^{17} eV in the laboratory frame:**
 - We can better simulate in the biggest's world laboratory what happens in nature when a Very High Energy Cosmic Ray interacts in the atmosphere

- ✓ **Why in the very forward region?**
 - Because the dominant contribution to the energy flux in the atmospheric shower development is carried on by the very forward produced particles

LHCf: location and detector layout

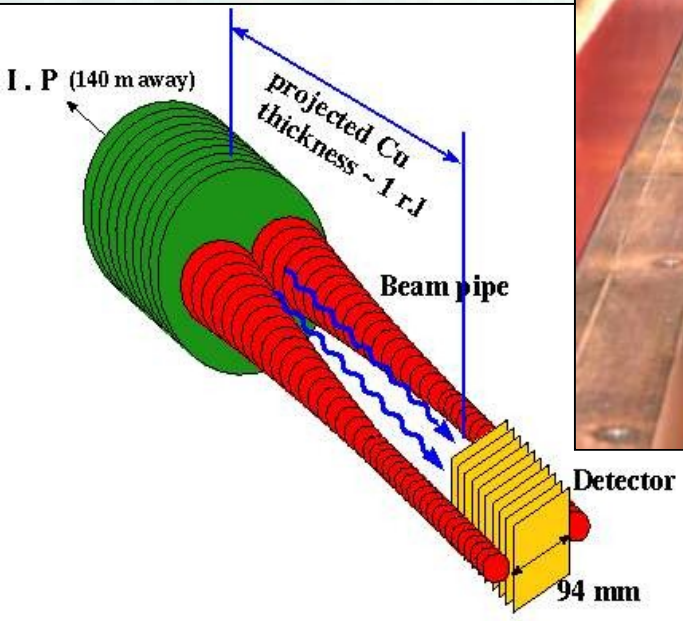
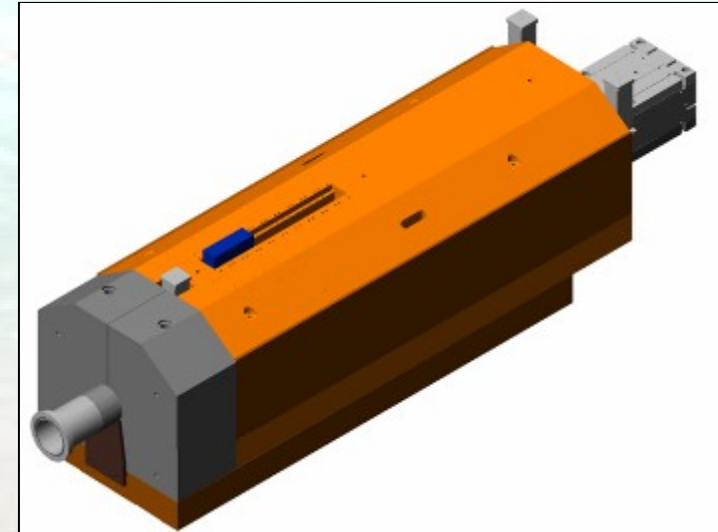
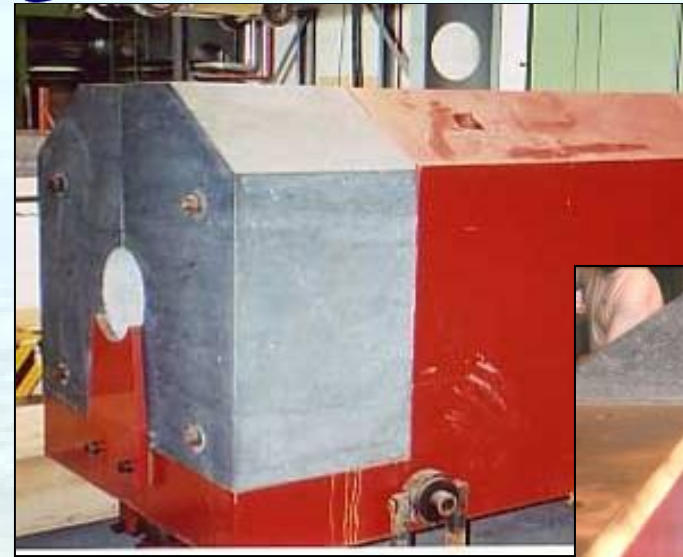


Detectors should measure energy and position of γ from π^0 decays \longrightarrow m. calorimeters with position sensitive layers

Two independent detectors on both side of IP1

- ✓ Redundancy
- ✓ Background rejection (especially beam-gas)

Detectors installed in the TAN region, 140 m away from the Interaction Point, in front of luminosity monitors



*Here the beam pipe splits in 2 separate tubes.

*Charged particle are swept away by magnets!!!

*We will cover up to $y \rightarrow \infty$

Detector #1

2 towers 24 cm long stacked vertically with 5 mm gap

Lower: 2 cm x 2 cm area

Upper: 4 cm x 4 cm area

Absorber

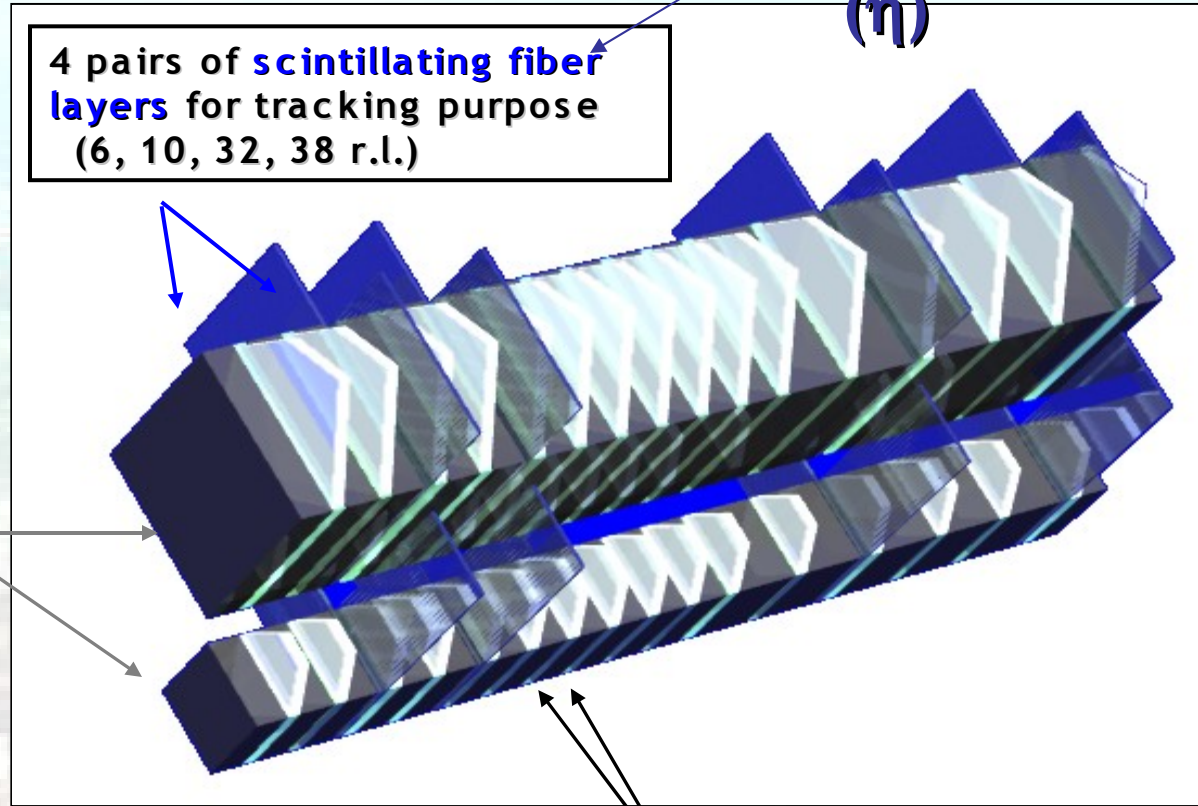
22 tungsten layers
7mm - 14 mm thick

($W: X_0 = 3.5\text{mm}$, $R_M = 9\text{mm}$)

Impact point

(η)

4 pairs of **scintillating fiber layers** for tracking purpose
(6, 10, 32, 38 r.l.)



Energy

16 scintillator layers
(3 mm thick)

Trigger and energy
profile measurements

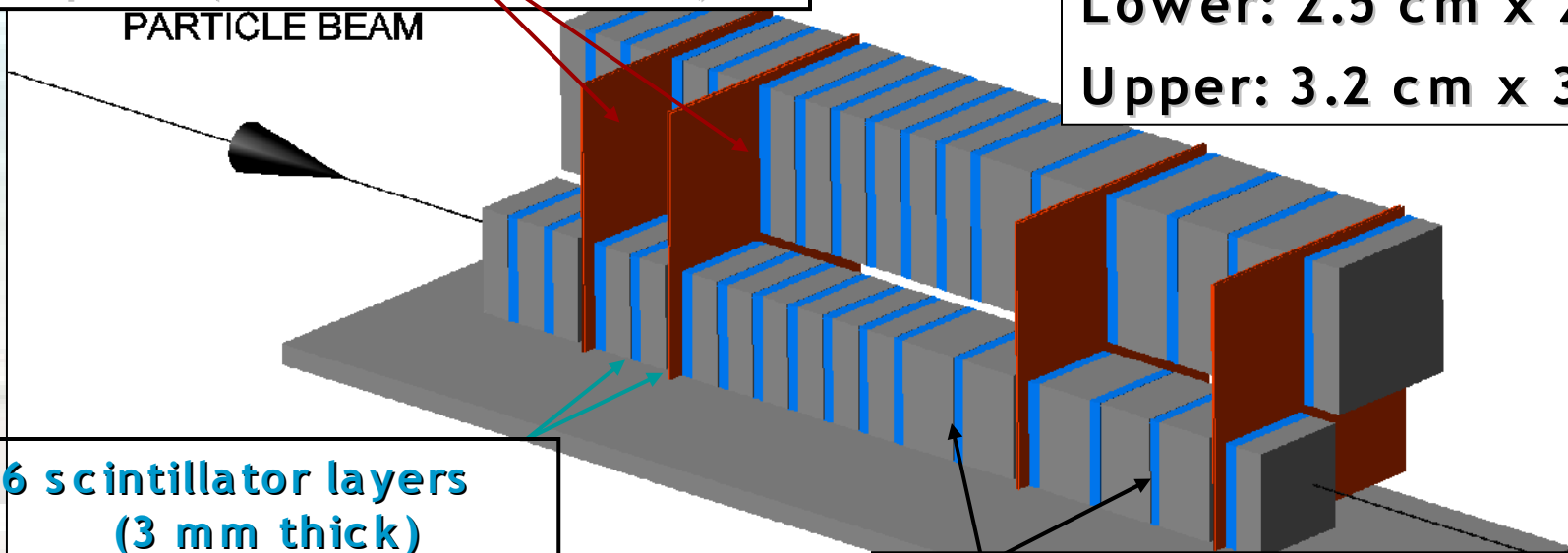
Detector # 2

We used LHC style electronics and readout **Impact point**

4 pairs of **silicon microstrip layers** (6, 12, 30, 42 r.l.) for tracking purpose (X and Y directions)

2 towers 24 cm long stacked on their edges and offset from one another

Lower: 2.5 cm x 2.5 cm
Upper: 3.2 cm x 3.2 cm



16 scintillator layers (3 mm thick)
Trigger and energy profile measurements

Absorber
22 tungsten layers
7mm - 14 mm thick (2-4 r.l.)
(W: $X_0 = 3.5\text{mm}$, $R_M = 9\text{mm}$)

Energy

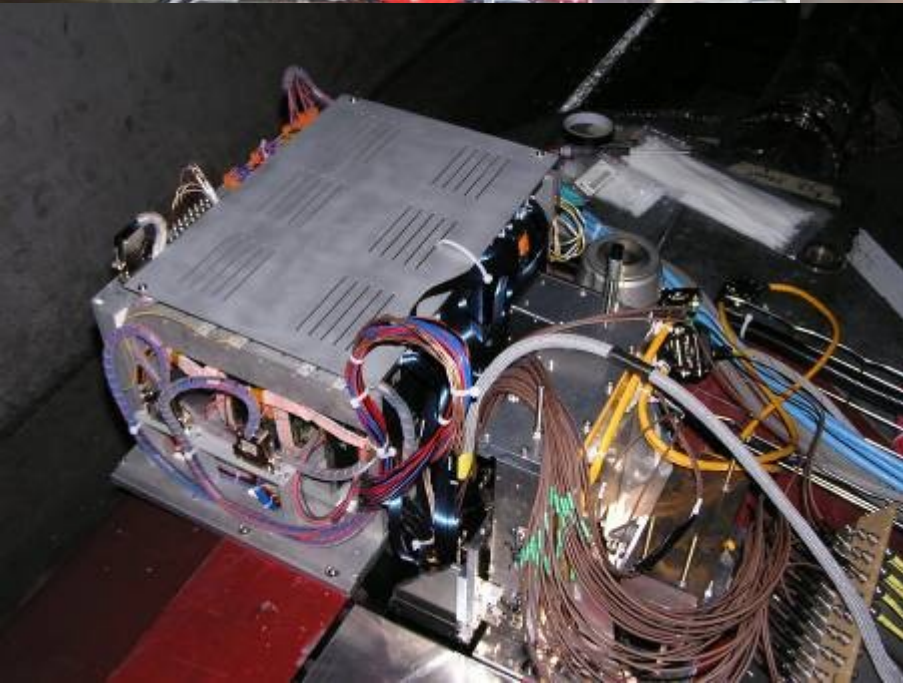


Installation

- ✓ **Final installation was completed in January 2008**
- ✓ **No major problems have been found**
 - **Quartz fiber for laser calibration has been re-installed**
- ✓ **Both Arm 1 and Arm 2 are working fine**
- ✓ **No additional noise is found in the detectors, despite 200 m long power lines and signal cables (for the scintillators)**

Detectors in place

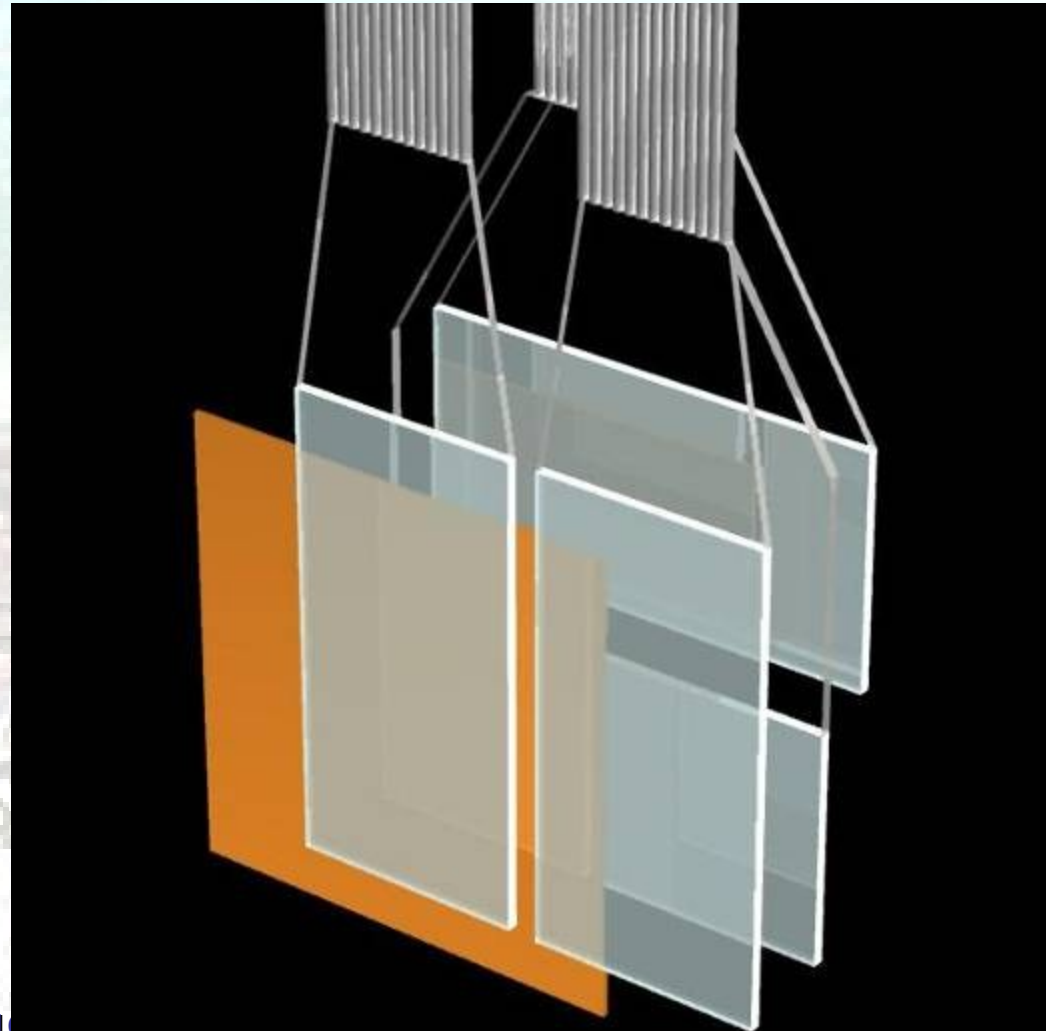
Installation performed in two phases:
Pre-Installation (2007)
Baking out of the beam pipe (200 °C)
Final Installation (Jan 2008)



ATLAS ZDC

Front Counter

- ✓ 2 fixed Front Counters were installed in front of Arm 1 and Arm 2
- ✓ They will not move with Arm 1 and Arm 2
- ✓ They are segmented in 2 x and 2 y slices
- ✓ Very useful to check the beam quality and hence decide to move Arm 1 and Arm 2 in the operating position from the 'garage' position



After the installation... .

✓ After the installation was completed, a lot of work on:

- DAQ

- New VME board to increase DAQ rate up to > 1 KHz
- Integration of all the subsystem (Using MIDAS frame)
- Analyzer to check the data quality and online monitor

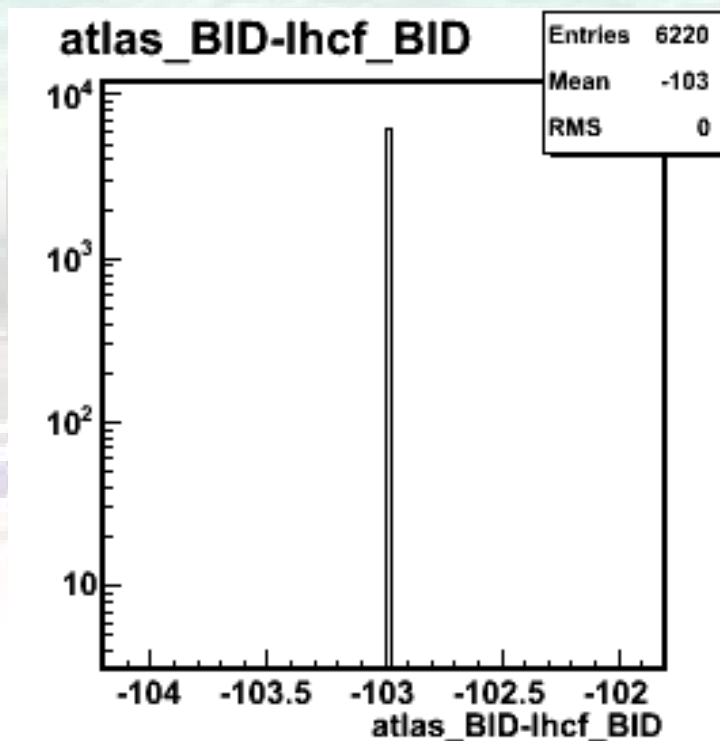
- Slow control software to control and monitor:

- Power supplies
- Manipulator
- Temperature monitor

- LHC interface

- New NIM style board (CIBU) to send 'PERMIT' to LHC (KILL the beam in case of high rate)
- Handshaking software signals (DIP standard) for Injection, Adjust and Beam Dump
- LHCf Physics information (beam position, rate, background etc.)

- ✓ To have the possibility to identify the events common with Atlas we implemented a synchronization method based on the L1A signal generated by Atlas.
- ✓ We receive Atlas L1A and we store the time stamp of this signal in our DAQ system.
- ✓ We can really correlate the Atlas events with the LHCf ones!



Atlas Bunch ID - LHCf Bunch Id

From the 2007 SPS beam test analysis we can conclude that the detectors fulfill the requirements to reach the physics goals indicated in the TDR

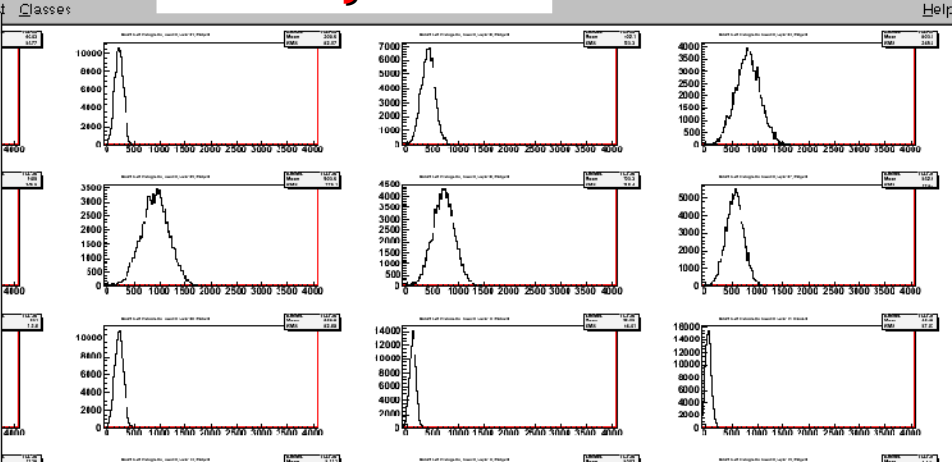
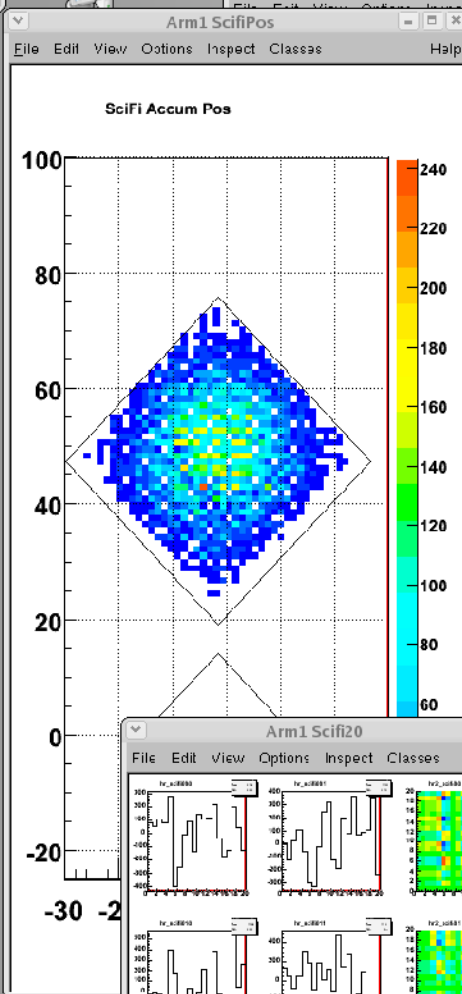
Preparation for data taking

The LHCf control room has been prepared and fully equipped in the Atlas area

- Furnitures
- Telephones
- Air conditioner
- Network
- Computers
- Printers
-



Dummy event



SMidas connected to lhcfdaq

File H stc Option

Linear/Log Y
 Linear Y Log Y

Calibration
 raw cal1 cal2 cal3 cal4

Accumulation
 single accum1 accum2

ADC Range
 high low

Update Auto

Arm#1 Event Status

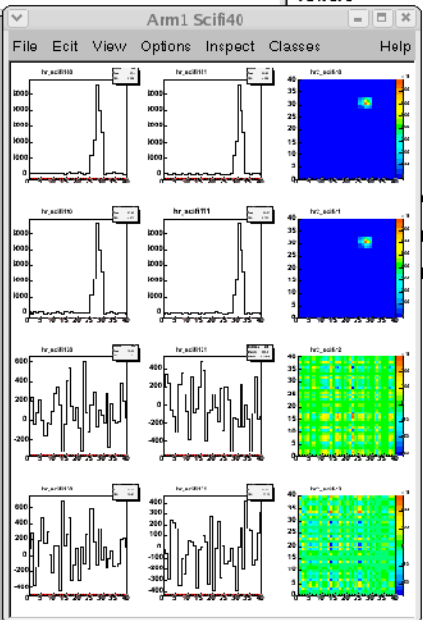
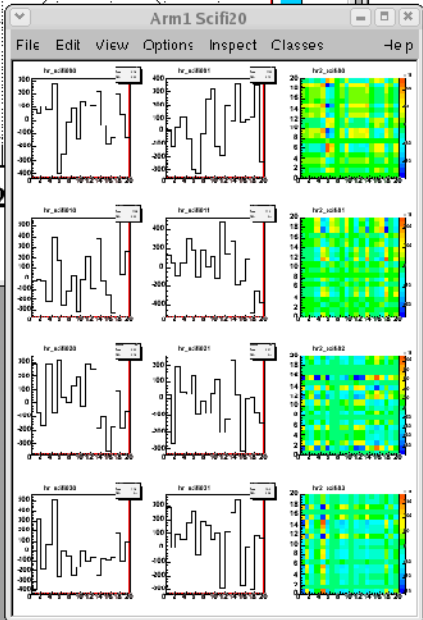
Tower0

24	237	394	911	1065	979	843	681	314	305	4	89	-70	-23	-49	12
5	23	61	109	143	123	93	80	35	27	15	6	-3	4	-2	-10
-79	-40	110	126	-89	-34	-102	14	-60	-127	13	23	-1	-75	28	-111
5	16	0	-4	12	-13	-4	6	2	0	-1	-1	10	2	4	-7

1221567051 0

Scaler_GPIO0 Scaler_GPIO1

CLK 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0



Arm#1 Flag Status

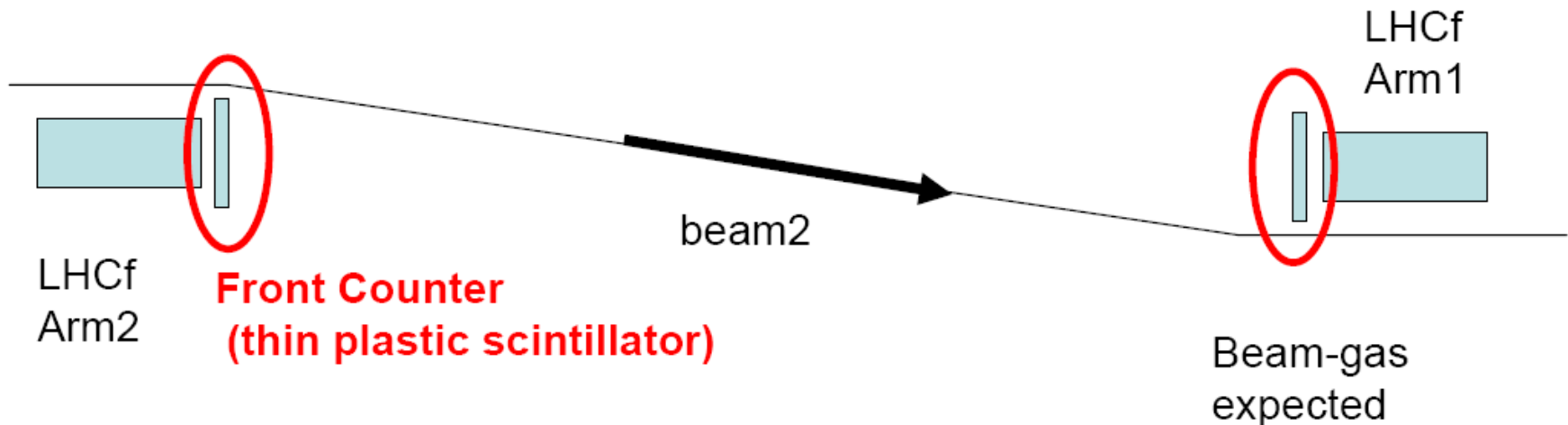
Scaler_GPIO0_F1	Scaler_GPIO0_F2	Scaler_GPIO1
BPTX1	Discr_TS0	Arm#1 Enable
BPTX2	Discr_TS1	Arm#1 Shower Trg
LASER	Discr_TS2	Arm#1 L3T
NO USE	Discr_TS3	NO USE
L2TA	Discr_TS4	Arm#2 Enable
L2TB	Discr_TS5	Arm#2 Shower Trg
L2TC	Discr_TS6	Arm#2 L3T
L2T_L1T	Discr_TS7	NO USE
NO USE	Discr_TS8	BPTX1
Shower Trg_TS	Discr_TS9	BPTX2
Shower Trg_TL	Discr_TS10	L1A
Beam Flag	Discr_TS11	NO USE
Pedestal Flag	Discr_TS12	Arm#1 FC Trg
Laser Flag	Discr_TS13	Arm#2 FC Trg
Enable Flag	Discr_TS14	L2TC
	Discr_TS15	NO USE
	Discr_TL0	Arm#1 FC ch0

LHCf sends signals to LHC through the DIP system.
Link have been tested and it works fine!

Important for machine tuning!

- ✓ Experimental status (On/Off, Gain, etc.)
- ✓ Detector position (Garage/Operating, position in mm, etc.)
- ✓ Luminosity rate (Single and Double Arm)
 - Front Counter rate (single Arm, double Arm coincidence)
 - Small tower rate (single Arm)
 - Big tower rate (single Arm)
 - Double Arm coincidence rate (FC.AND.Towers in opposite sides)
- ✓ Horizontal and Vertical position of the Beam (every 10000 events or in the whole RUN)
- ✓ Injection Inhibit
- ✓ Handshaking signals (Injection, Adjust, Beam Dump)

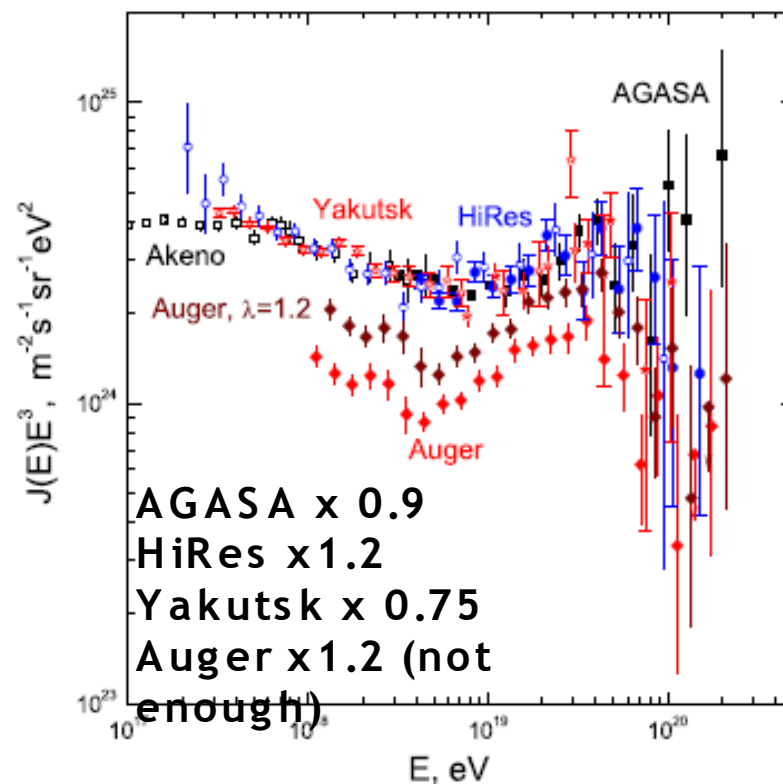
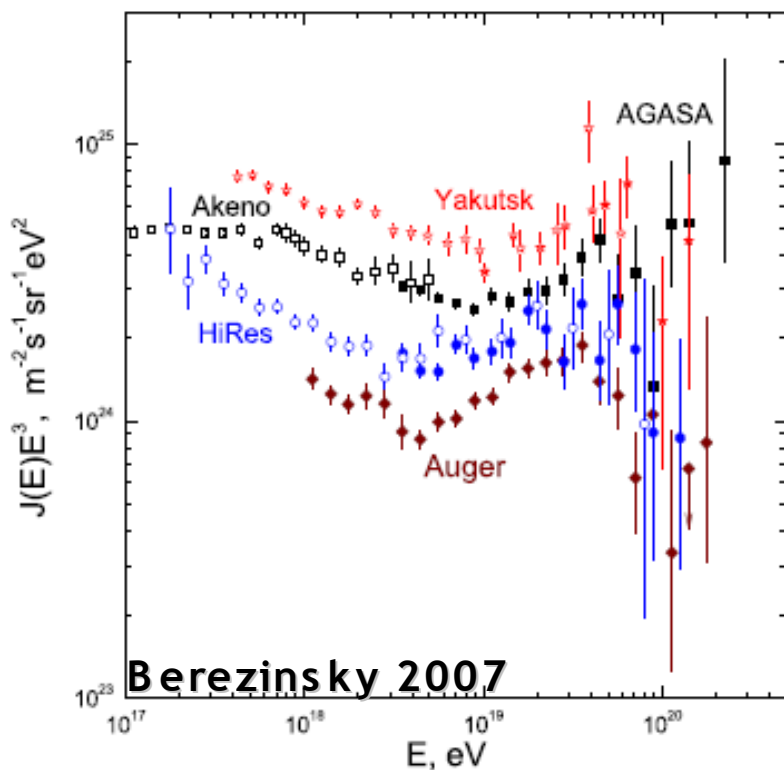
- ✓ On September 10 we observed some signals on Front Counters, with Arm1 and Arm2 in garage position for safety reasons
 - That day the Atlas BPTX signal was still not available (no info on the real bunches in the Atlas zone)
- ✓ On September 11 Atlas gave us the synchronized BPTX signals, and we could take Front Counter data by using this signal (still in garage position)
- ✓ **We are measuring Beam-Gas from the Beam2 on Arm1 side**



A 'practical' approach

From the practical point of view LHCf's measurements will be used to calibrate the Monte Carlo codes heavily used in the Cosmic Ray analysis

- VHECR energy spectra



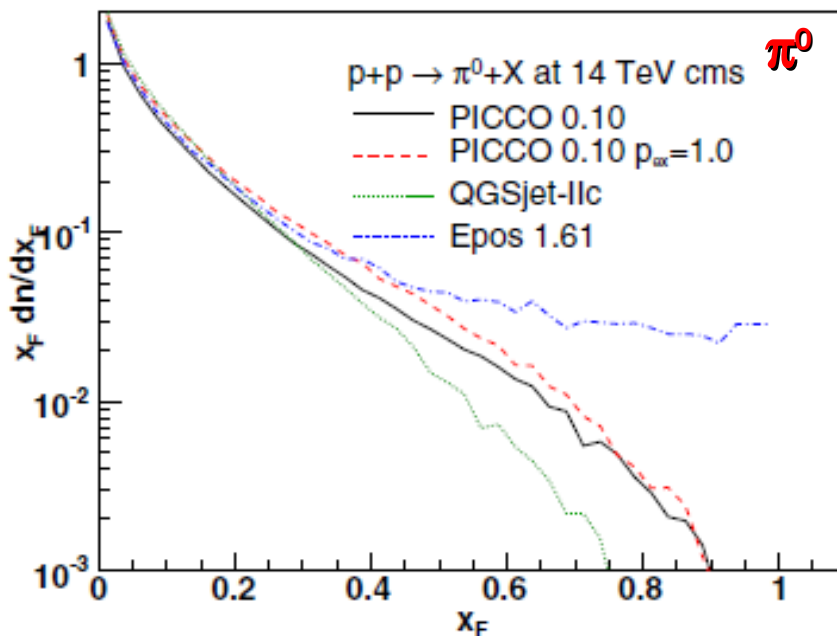
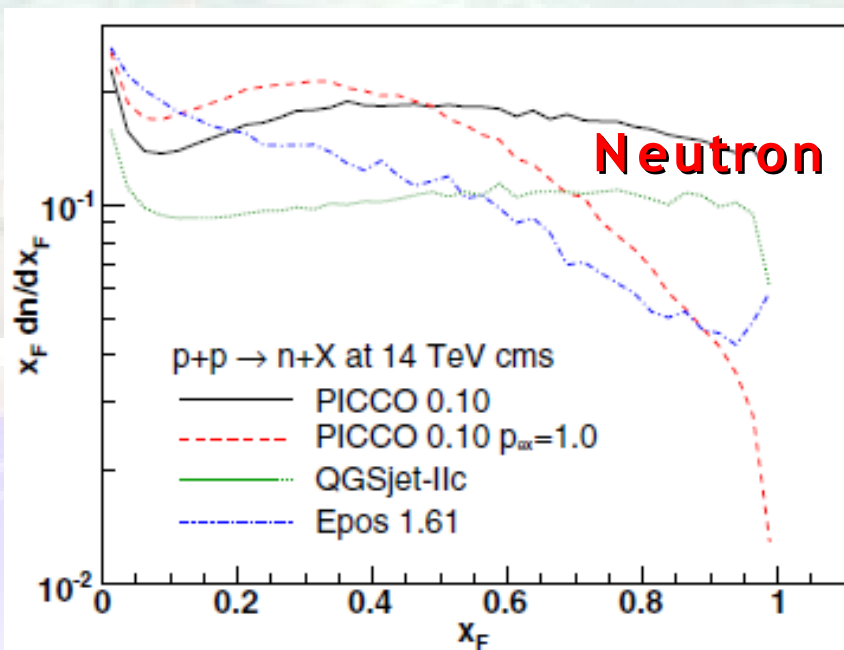
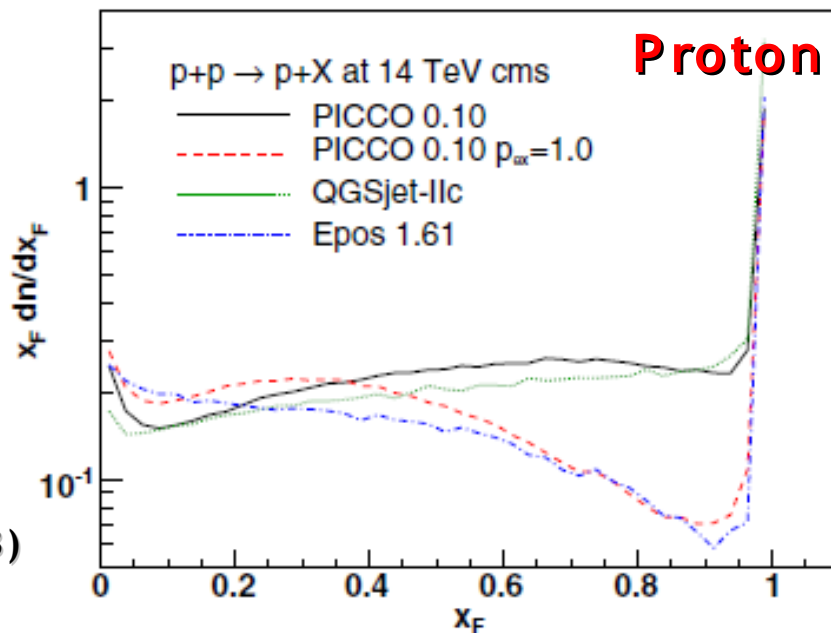
INFN While waiting for collisions... .



A short comment on new models:
PICCO, EPOS

Very big interest in LHCf data and in this physics field

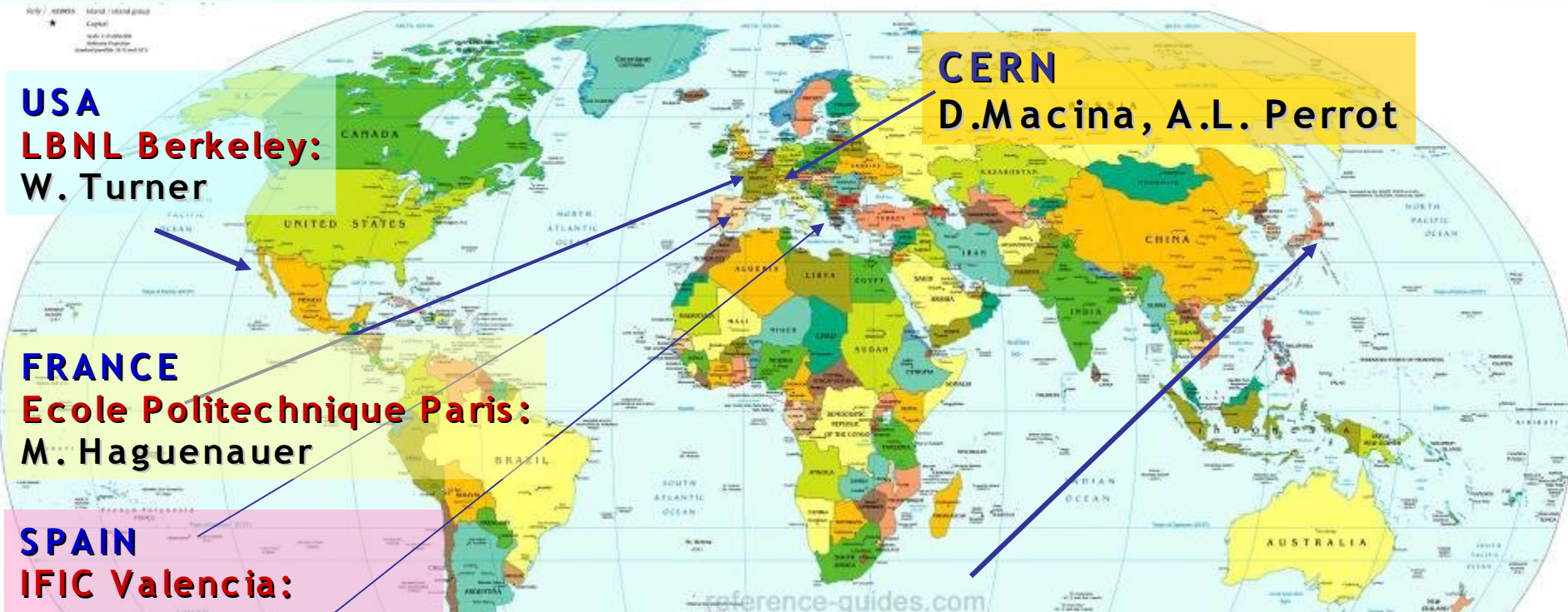
Drescher, Physical Review D77, 056003 (2008)



Conclusions

- ✓ A lot of work has been done in 2008
- ✓ Installation completed
- ✓ Preparation for running completed
- ✓ Identification of events common to Atlas and LHCf is ok
- ✓ First beam gas events acquired
- ✓ We are ready to send our info to LHC for beam tuning

The LHCf Collaboration



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