

# DAΦNE performances during the KLOE-2 data-taking

Catia Milardi  
on behalf of the DAΦNE Team

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# The DAΦNE Team

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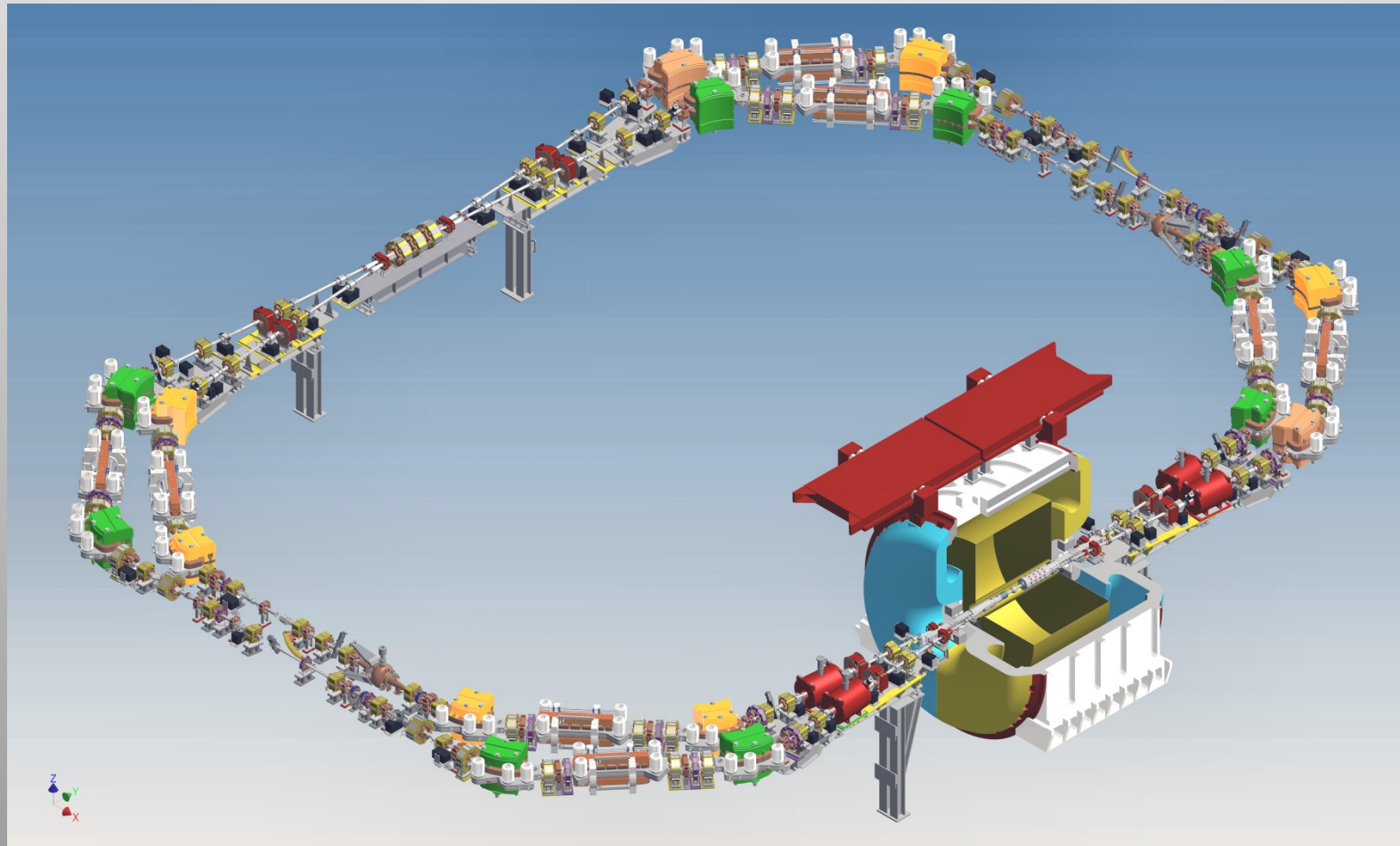
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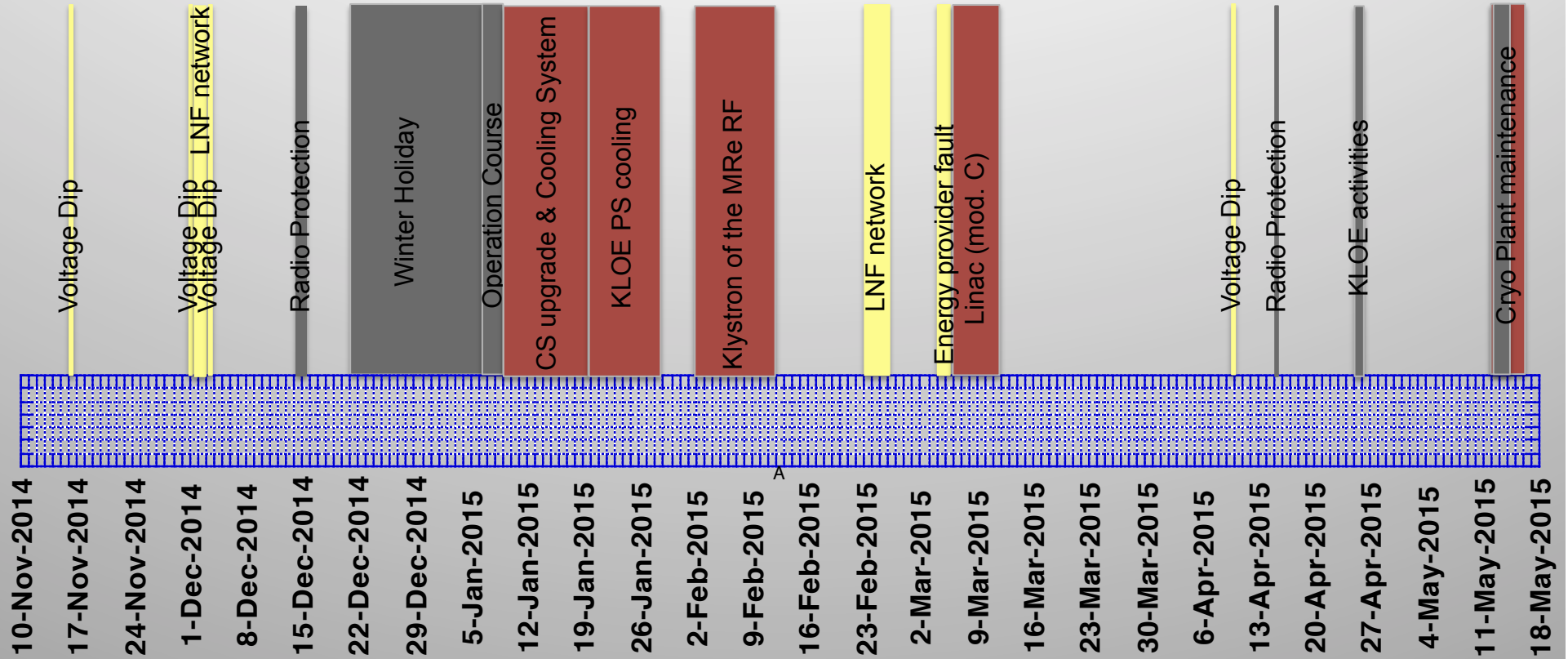
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- *Machine developments*
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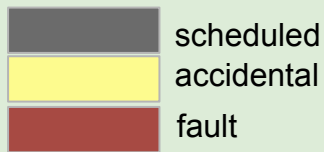
# DAΦNE and KLOE-2



# Collider downtime



## STOP



- Only events interrupting machine operation for more than half day are reported
- Minor faults are usually recovered in few hours and their impact on operation can be deduced from UPTIME

# RF Klystron replacement



The Klystron of the RF cavity on the electron ring has been:

- removed
- replaced with a spare part already mended in house
- conditioned
- damaged klystron has been repaired in the DAFNE hall

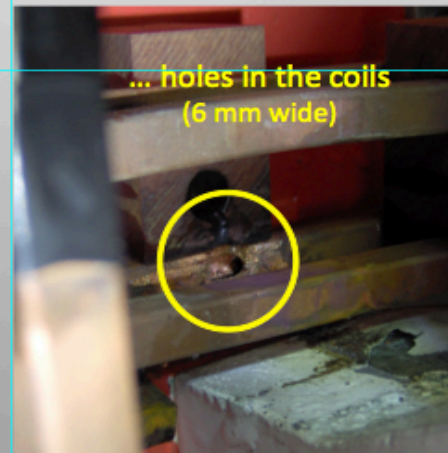
After 10 days 1.6 A have been stored in a stable  $e^-$  beam

# Wiggler Cooling System

On November 2014 the slide below has been presented

## High pressure cooling water circuit

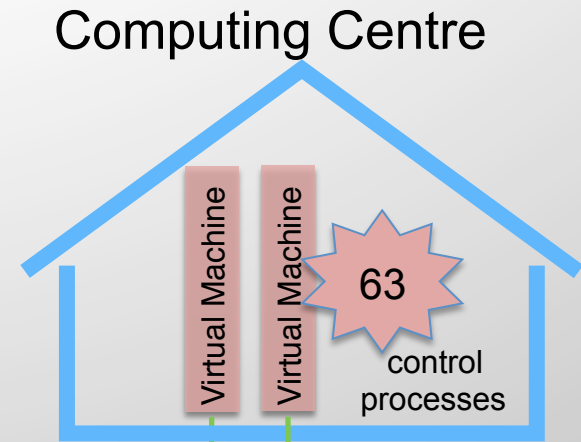
flow rate almost halved in order to prevent:  
holes in the wiggler coils  
rubber pipes damaging  
In order to avoid destructive faults we experienced in the past



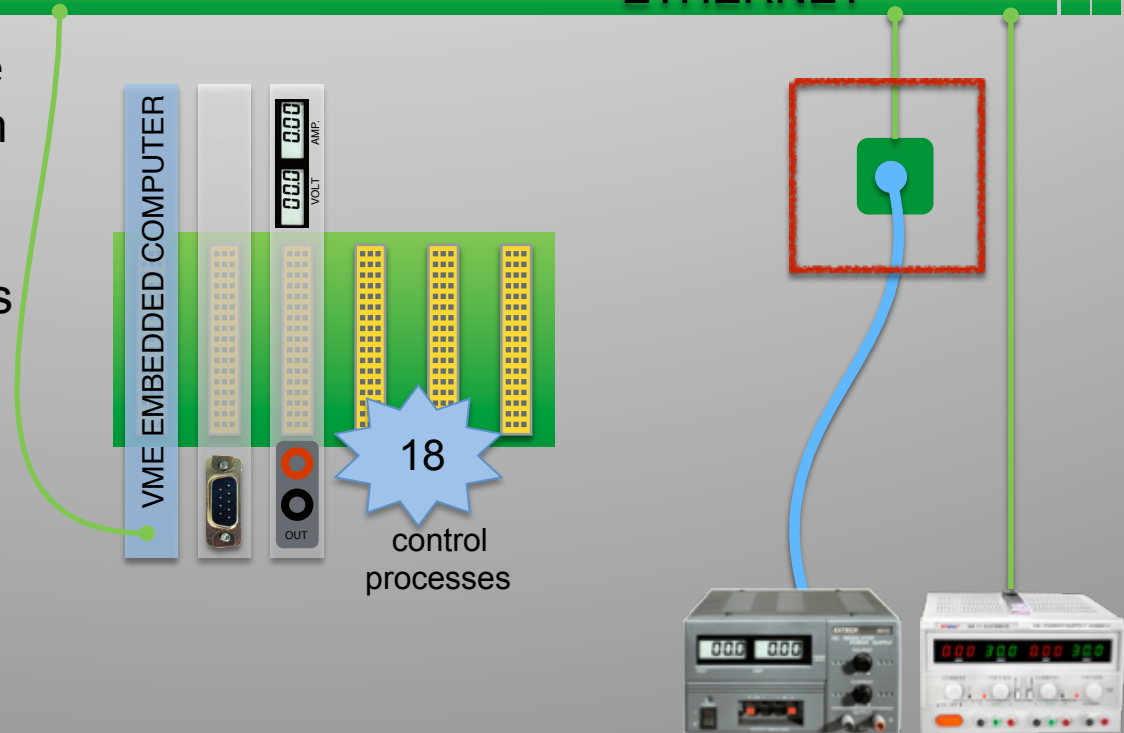
Since then this fault no longer occurred

# Control System

- The number of Virtual Machines has grown to 24 (hosting 63 control processes). By reducing the number of processes on VME embedded computer, the bus-error events on VME dropped nearly to zero

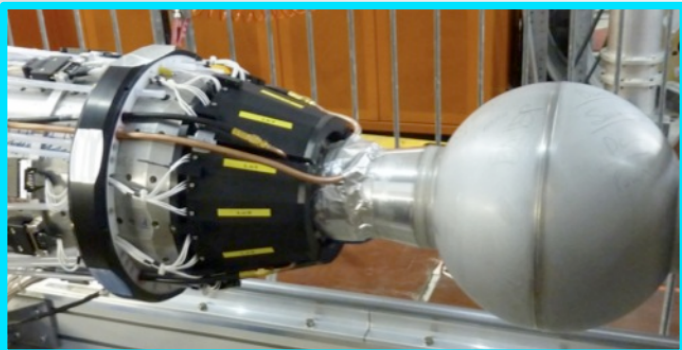


- The Network Uplink with the Computing Centre has been enhanced (10 G) in order to improve the command/data flow among virtual machines and front-end devices



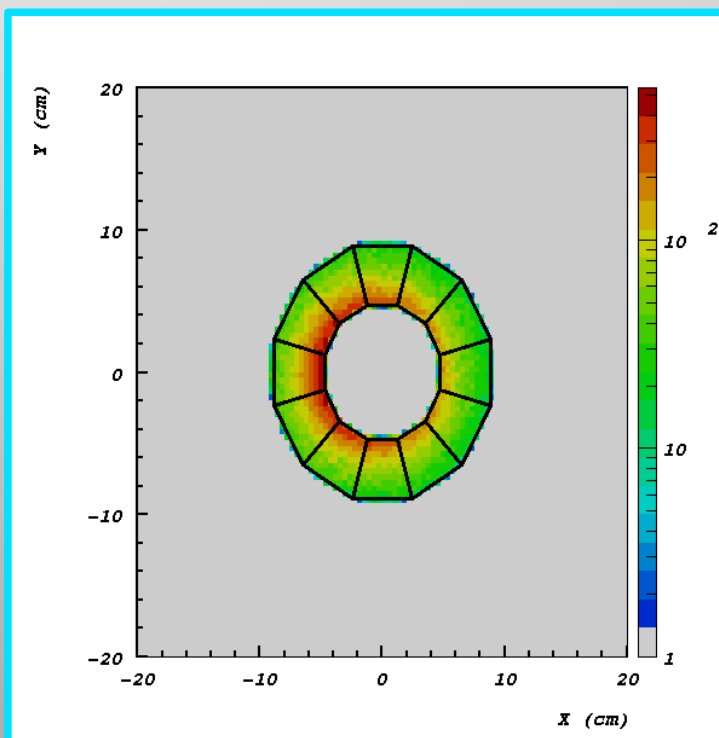
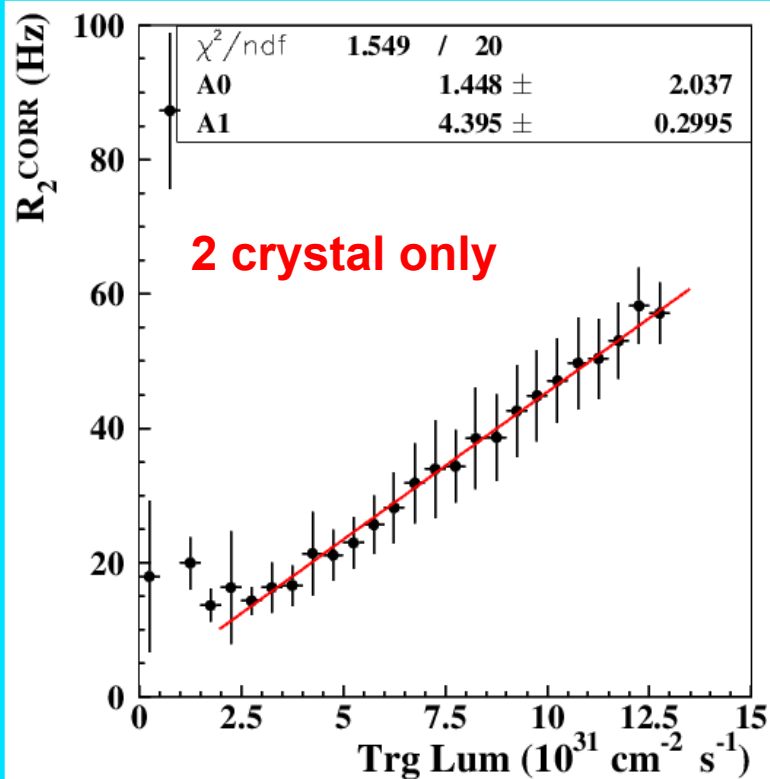


# DAΦNE Luminometer



Luminometer based on CCAL-T calorimeter of KLOE-2 (2 side coincidence) near the IP

MC expectation for Bhabha Events in one of the two CCAL-T



Good linearity with small background contribution (<10%). Too slow with 2 crystal only (40-70 Hz @  $10^{32} \text{ cm}^{-2} \text{ s}^{-1}$ )

# Machine Developments

Machine developments have been limited to very few aspects in favour of the experiment data taking

- Number of colliding bunches have been increased in the range  $93 \div 103$  maintaining almost the same total current thus reducing:
  - Touschek contribution to background
  - Impact of microwave instability threshold
- A new working point has been adopted for the MRe
- Extensive adiabatic collider optimization & luminosity fine tuning

# Working Point Studies

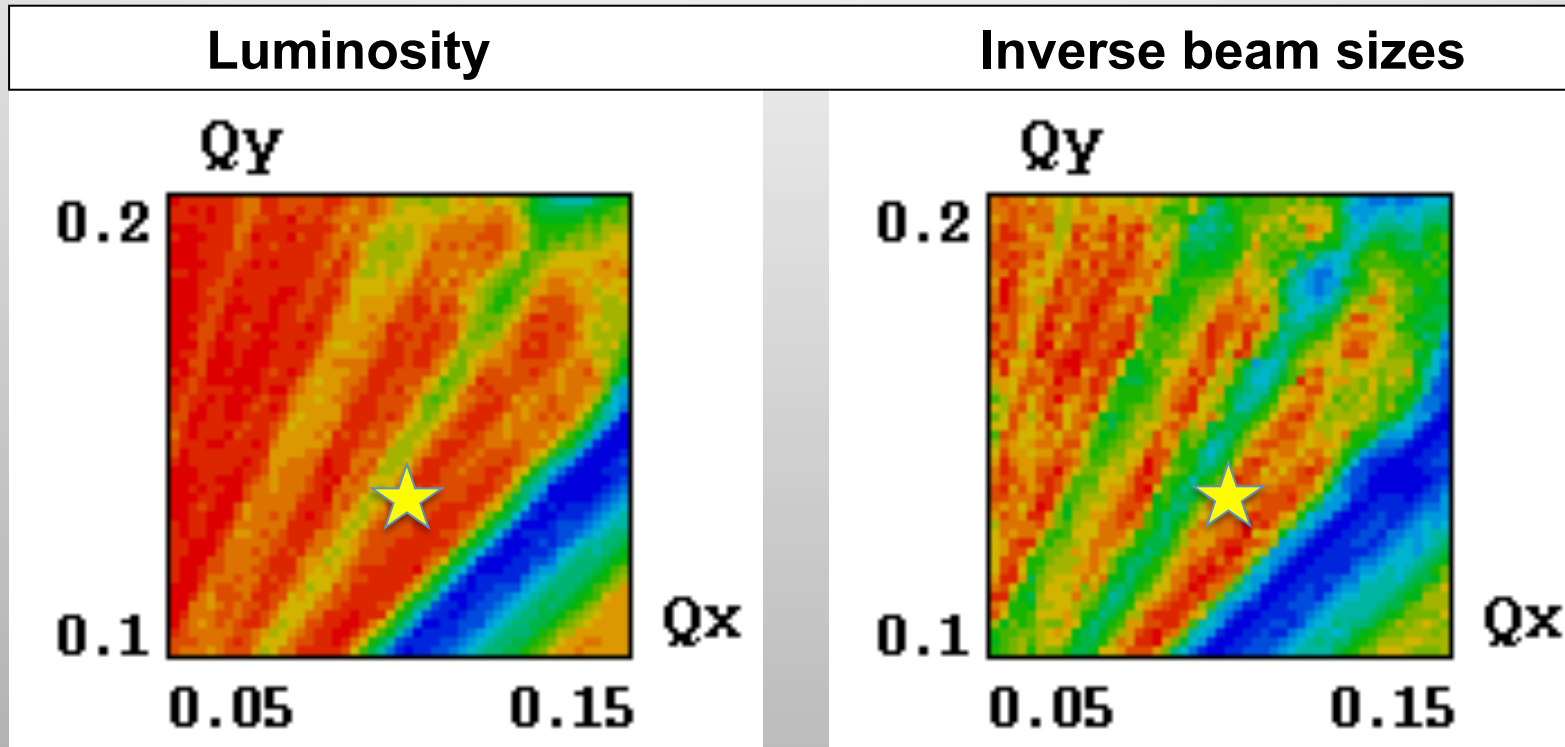
Lifetrack is a fully symplectic 6D weak – strong simulation code allowing for simulations including:

- non-linearities
- coupling
- chromaticity
- beam-beam
- large crossing angle
- beam crabbing

The code provides:

3D density of weak beam  
specific luminosity and beam lifetime  
DA and FMA

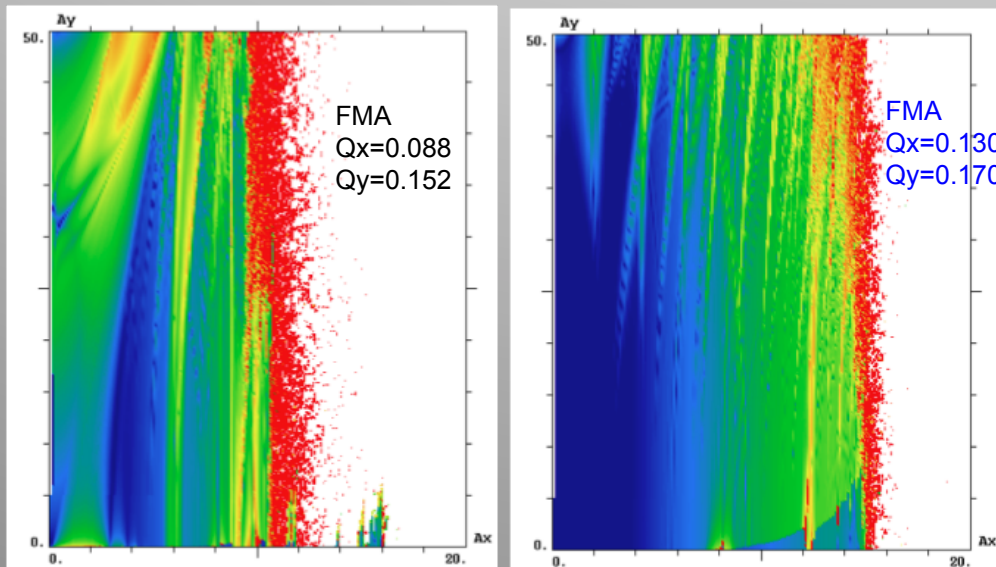
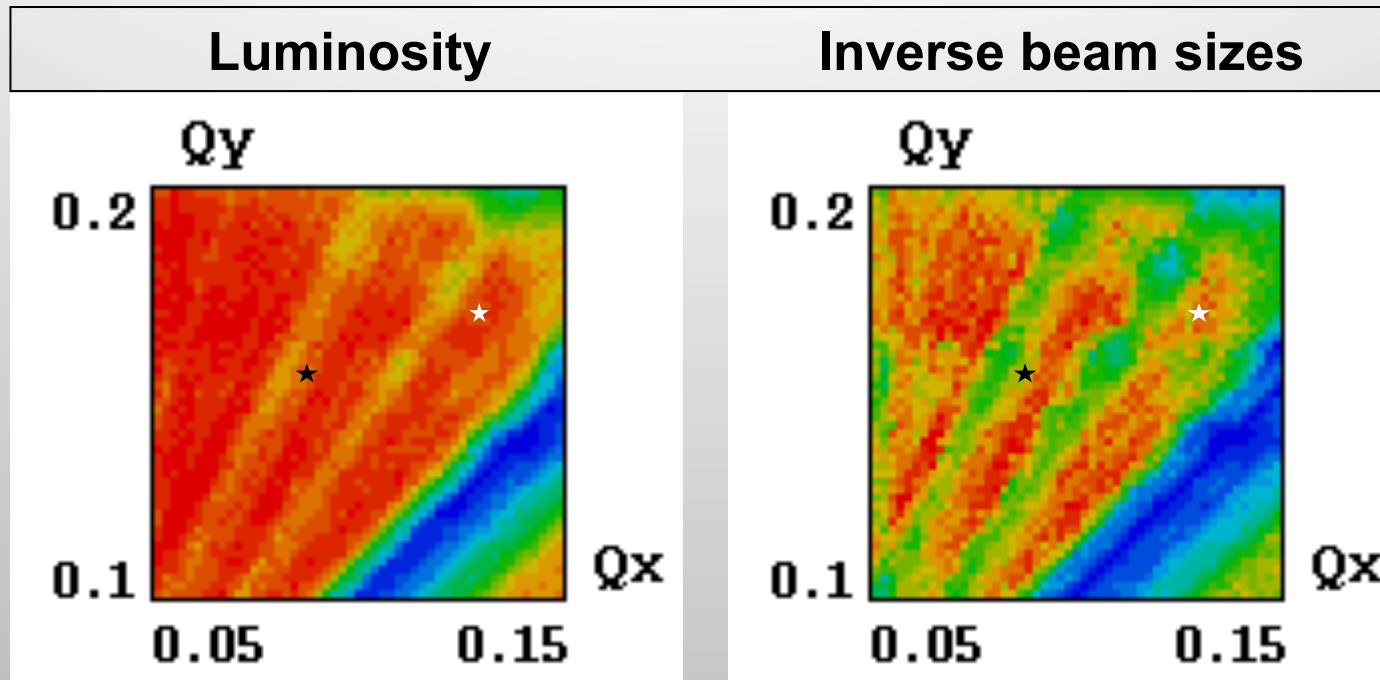
# $e^+$ Working Point Scan



$e^+$   $Q_x=0.0980$ ;  $Q_y=0.1305$

MRp was already close to the optimal WP 

# e<sup>-</sup> Working Point Scan



MRe was moved to the optimal WP

**$Q_x=0.135$        $Q_y=0.17$**  ★

obtaining:

- improved injection efficiency
- higher beam lifetime
- Reduced background
- higher luminosity

# Orbit stability in MRp

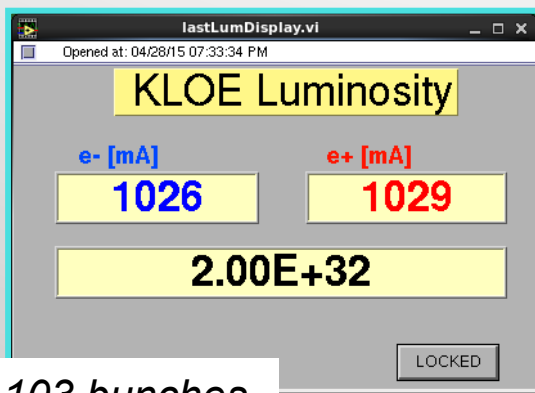
Operation profited from recovering stability of the  $e^+$  beam orbit

A random vertical orbit ( $-0.5 \text{ mm} \leq A_{pp} \leq 0.5 \text{ mm}$ ) perturbing collision was observed since long time

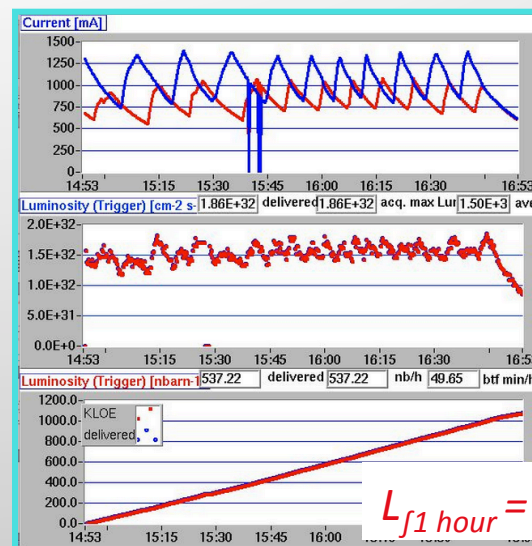
The effect has been correlated to the ICEs

Thanks to beam scrubbing (1373 Ah stored in MRp since Nov 2013) it has been possible to switch off 6 ICEs without loosing efficiency in controlling e-cloud detrimental effects

# Peak Luminosity



103 bunches

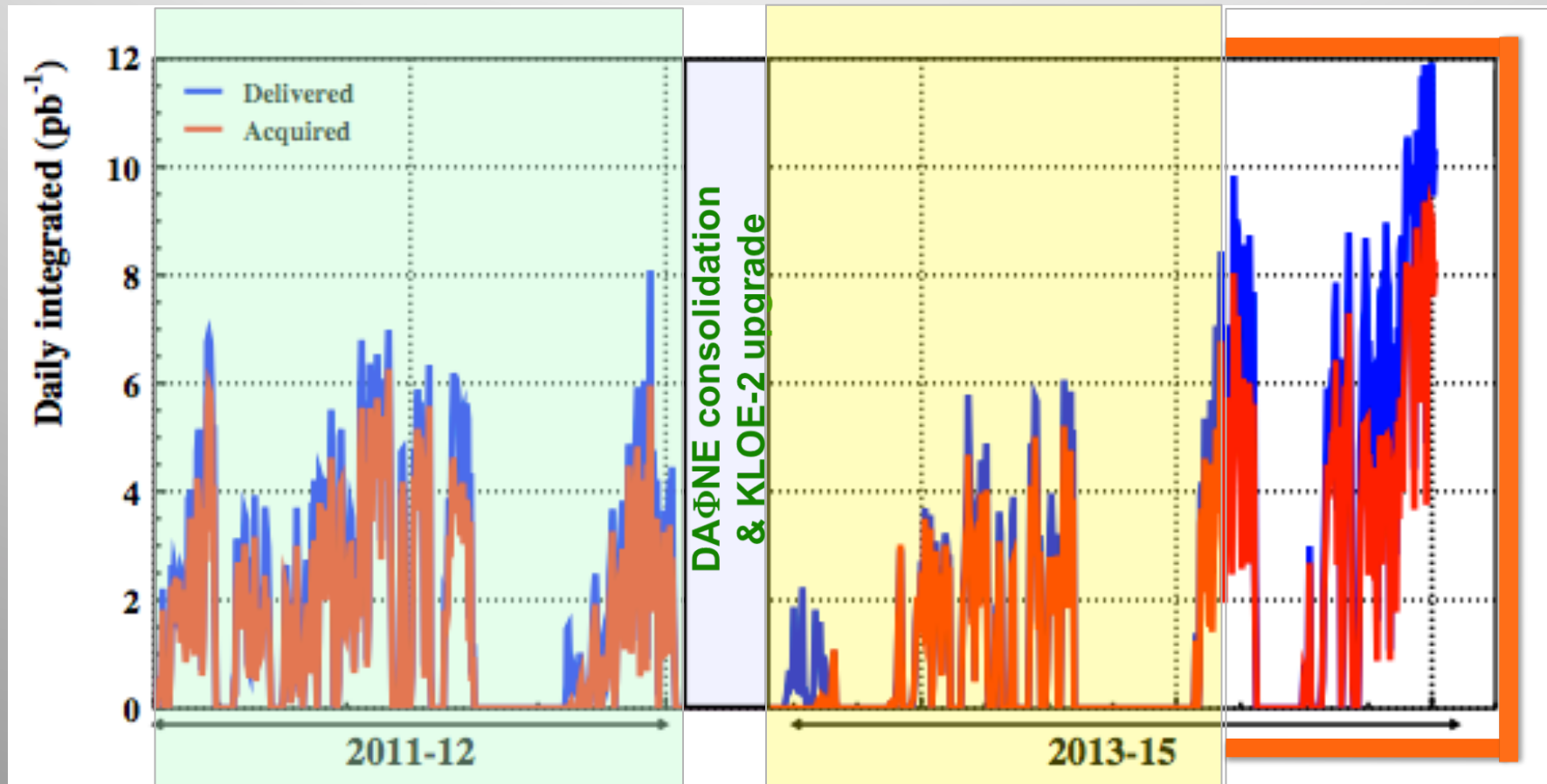


	DAΦNE CW upgrade SIDDHARTA (2009)	DAΦNE KLOE (2005)	DAΦNE (CW) KLOE (2012)	DAΦNE (CW) KLOE-2 (2014)
$L_{\text{peak}}$ [ $\text{cm}^{-2}\text{s}^{-1}$ ]	$4.53 \cdot 10^{32}$	$1.50 \cdot 10^{32}$	$1.52 \cdot 10^{32}$	$2.0 \cdot 10^{32}$
$I^-$ [A]	1.52	1.4	0.93	1.03
$I^+$ [A]	1.0	1.2	0.72	1.03
$N_{\text{bunches}}$	105	111	100	103

$L_{\text{peak}}$  exceeds by a **33%** the best luminosity ever achieved, at DAΦNE, during operations for an experimental apparatus including high field detector solenoid.

**Background** presently has been **considerably reduced** especially the component due to the  $e^-$  beam

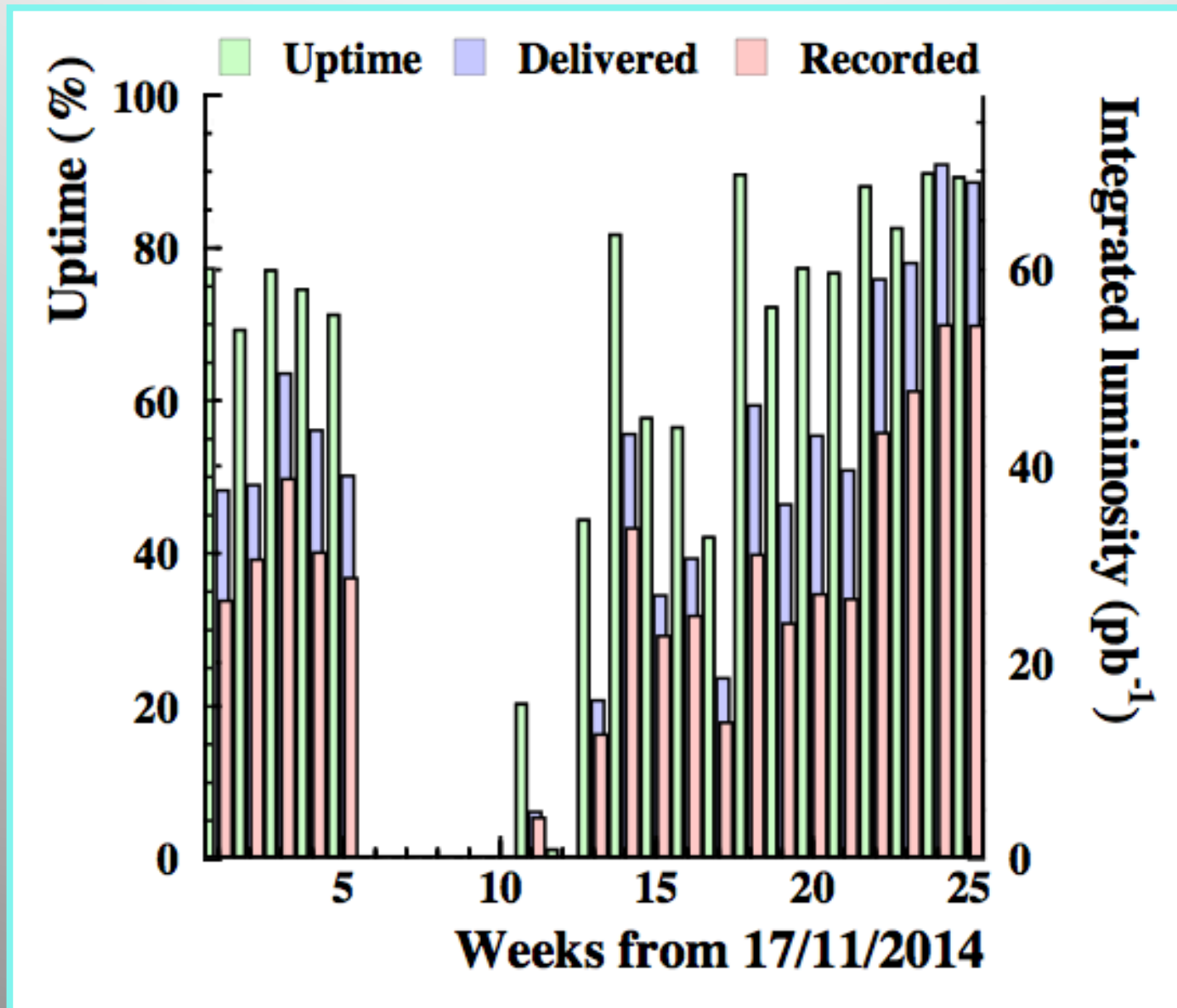
# Daily Integrated Luminosity



KLOE-2 data taking

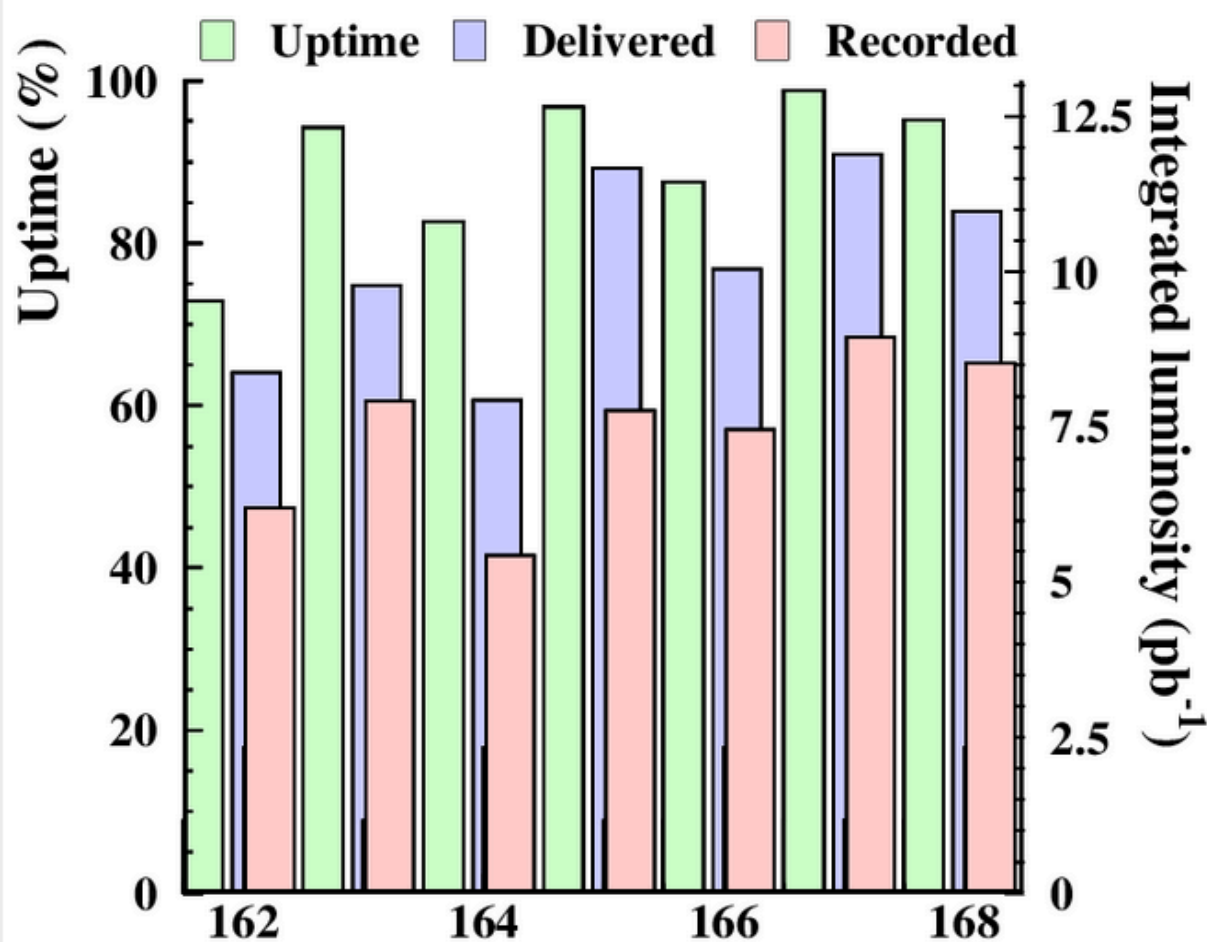


# Weekly performance



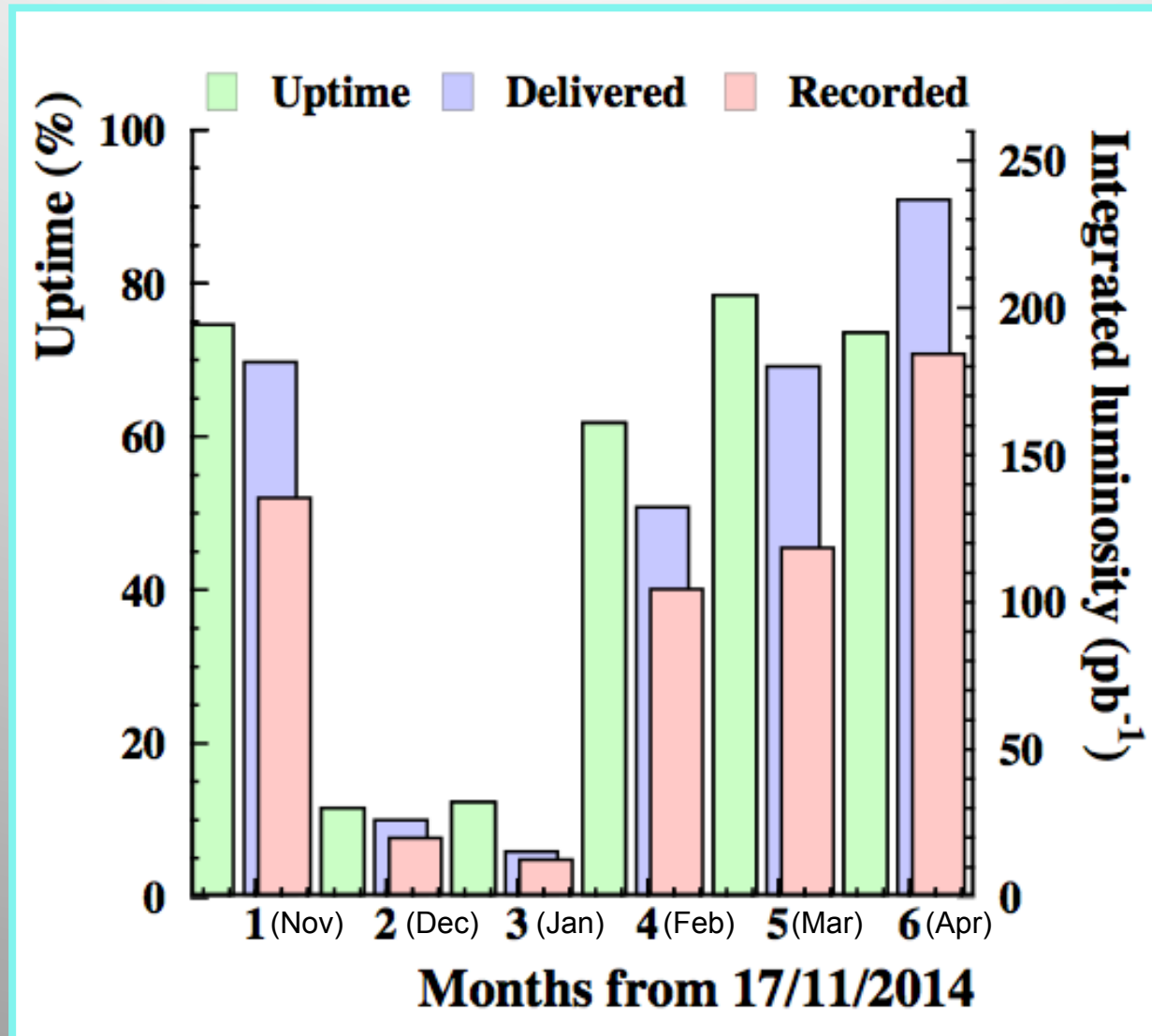
# Best Weekly Performance

Delivered (week)	Acquired on disk (week)
71 pb <sup>-1</sup>	53 pb <sup>-1</sup>



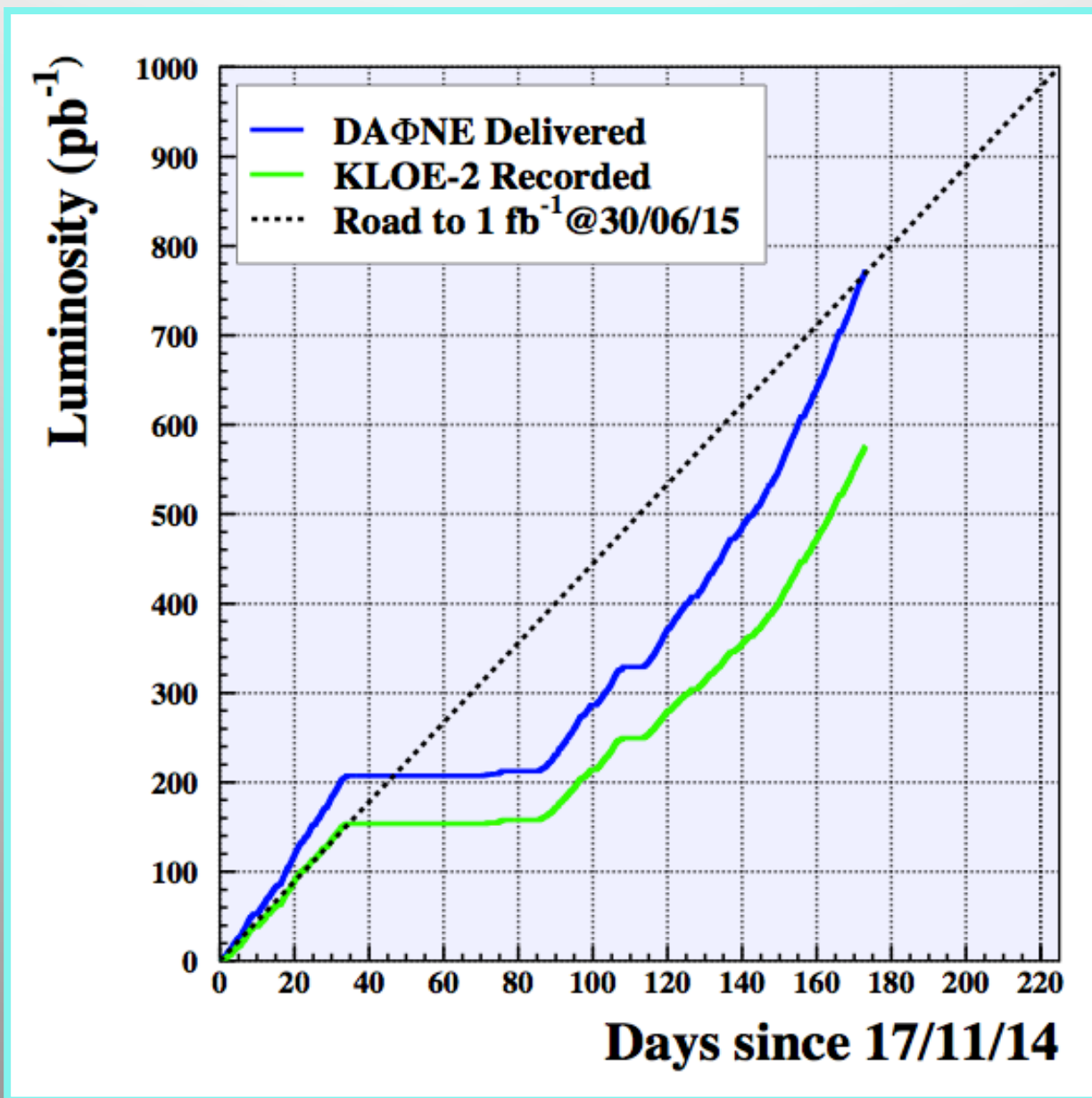
**Best week so far (20 ÷ 27 April 2015)**

# Monthly performance



$$\int L_{\text{del}} = 271.2 \text{ pb}^{-1} \quad (\text{April } 11^{\text{th}} \div \text{May } 10^{\text{th}})$$

# Data Taking Roadmap



# Further Developments

A considerably higher luminosity might be attained by:

- CW-Sextupoles allignement
- betatron coupling optimization
- Pushing the microwave instability threshold toward higher current by new optics configuration (higher  $\alpha_c$ )
- Feedback noise reduction
- Tuning the interplay between RF 0-mode feedback and longitudinal feedback

# DAΦNE manpower

*In the last six months the DAFNE scientific staff lost four people two of them senior scientist*

*Due to new project becoming more and more demanding the involvement of several colleagues decreased considerably*

*There has been no new entry*

*By the end of this month we will lose four expert Technicians in the Operation Group*

# Conclusions

*DAΦNE performances are evolving in a positive direction:*

- operation is stable and reproducible*
- peak and integrated luminosity are growing*
- background due to the  $e^-$  beam has been reduced by a 20%*

*There are many ideas to further improve the present situation*

*The KLOE-2 data-taking is going on and, despite some breaks, we are honoring the subscribed agreements*

*$\int L \sim 771 \text{ pb}^{-1}$  has been already delivered*

*Uptime and reliability of the DAΦNE subsystems are improving, but still require attention, work and some investment*

# Acknowledgement

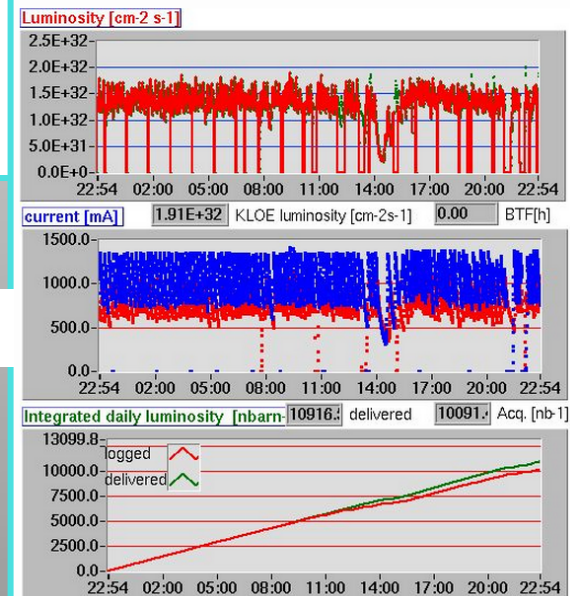
I want to thank the Colleagues in the Operation Group:

*Baldini G., Battisti, Beatrici, Belli, Bolli, Ceccarelli G., Ceccarelli R., Cecchinelli, Clementi, Coiro, De Biase, De Giorgi, Ermini, Fontana, Fusco, Gaspari, Giacinti, Iacuesa, Iungo, Marini, Martelli, Martinelli, Mencarelli, Monteduro, Pellegrini, Piermarini, Quaglia, Rossi, Sardone, Scampati, Sensolini, Sorgi, Sperati, Spreccacenero, Strabioli, Tonus, Troiani, Zarlenga, Zolla*

They made an excellent work!

**... Sunday .....**

KLOE Luminosity History: 03/05/2015

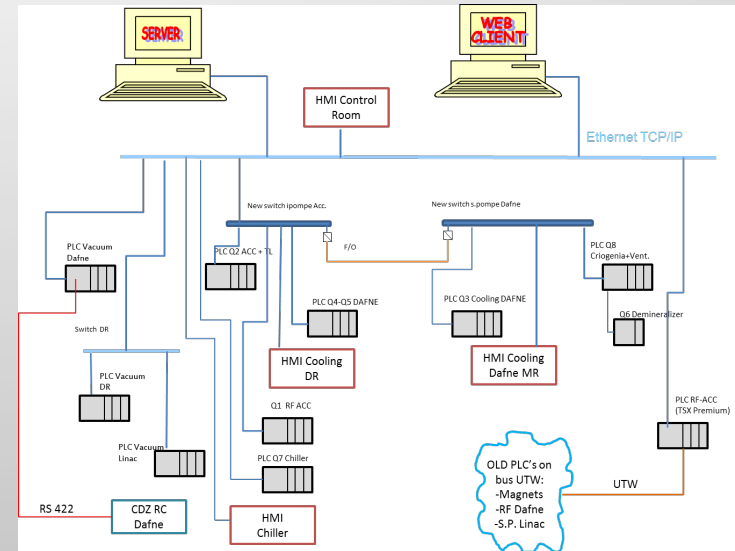
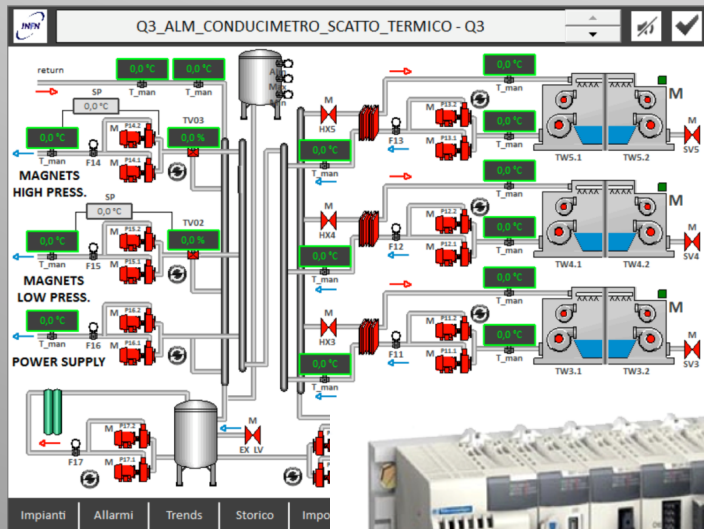




*Thank you for your attention*

# Ancillary plants Control System

A new supervision and control system, based on an industrial SCADA MOVICON, performs a smarter management of the installation. The renewed PLC's and previous devices are under control of a unique supervision system.

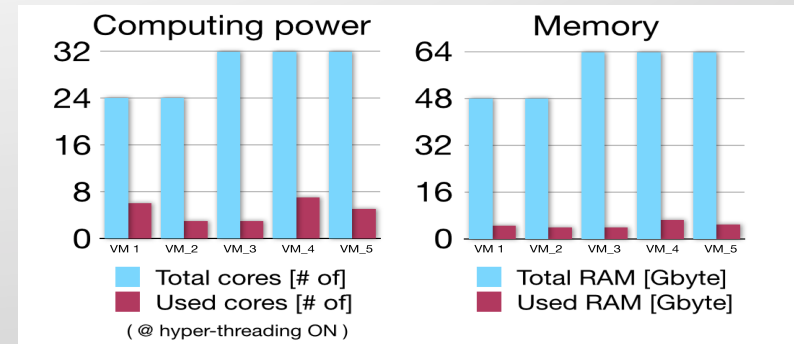


- Efficient and user friendly tools give access to subsystem information (data, alarm, faults) allowing a very useful data analysis
- Stability of the power supplies temperatures has been improved

# Control System

## *The Control System architecture has been deeply modified:*

- *Most of the VME bus platform have been dismissed*
- *The whole data flow has been redirected to the network*
- *An Object Caching service (Memcached) hosts the live data*
- *Large part of the front-end boards (serial, DAQs, ADCs, etc.) replaced by network devices, which allowed for the porting of many control programs to remote Linux virtual machines.*
- *Using serial device servers instead of serial communication boards, permitted to increment the number of daisy chain lines (RS-422) employed in connecting the magnets' power supplies.*
- *Almost all distributed front-end VME processors (forty-five 68030 custom boards) with Intel boards, run Linux.*
- *New Linux servers for the core services (NFS, DHCP, diskless boot, MySQL, memcached) and for the SunRay™ thin-clients employed as consoles.*



## *Computing and memory resources available for the virtual machines*

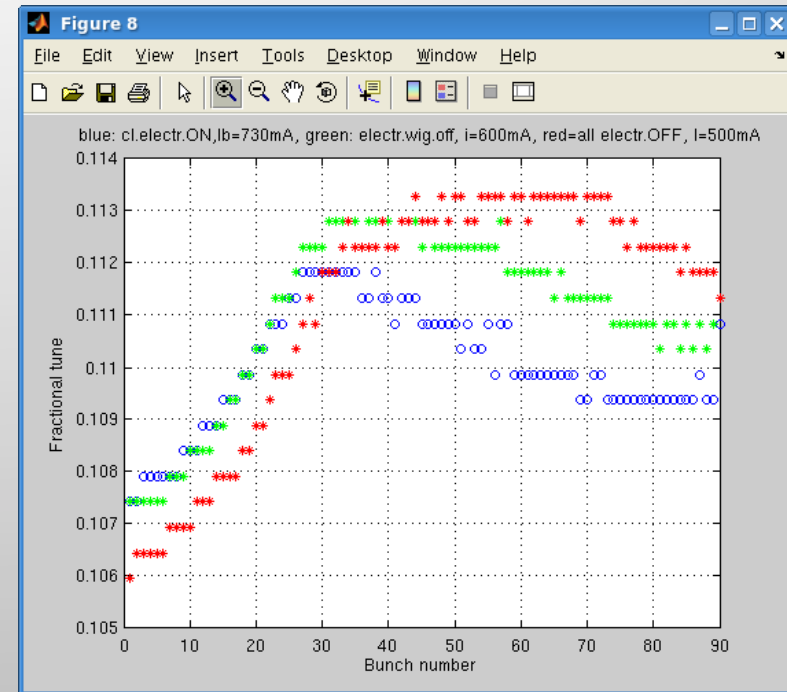
- **DCS is now more performable, reliable and its overall uptime significantly increased**
- **commutation of the injection system between the e<sup>+</sup> and the e<sup>-</sup> operating modes is now considerably faster thanks to the increased number of daisy chain connecting the relative power supplies**

# *e-cloud Mitigation*

The **electrode power supplies** have been replaced with devices providing a maximum negative voltage of 500 V, the change of polarity was intended to limit the current delivered by the power supplies

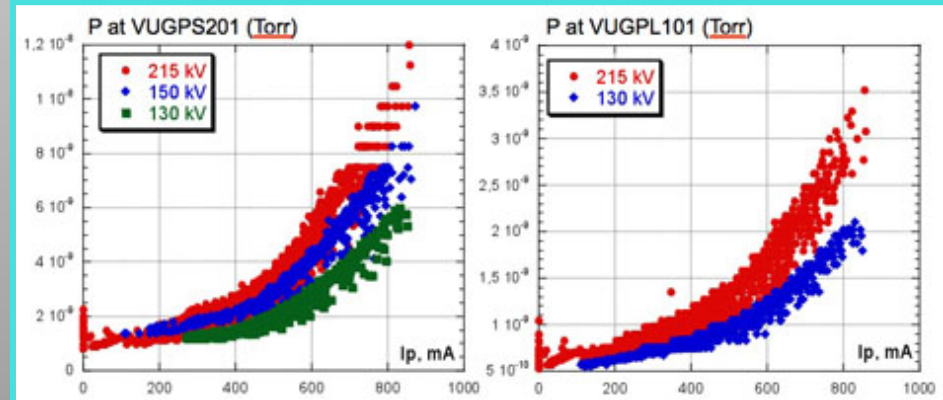
New setup test:

$I^+ = 700$  mA in 90 contiguous bunches

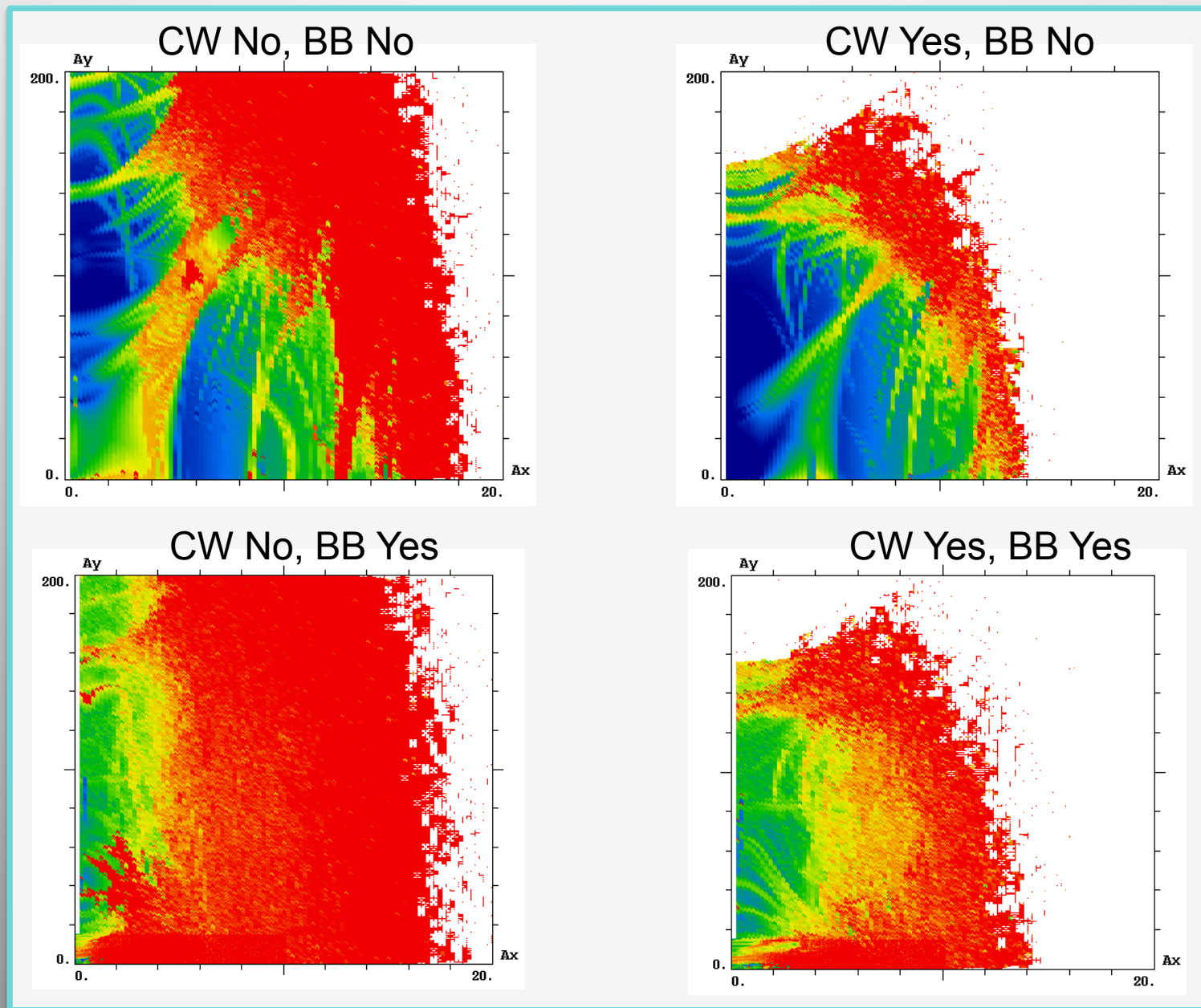


e-cloud induced effects have been mitigated also by:

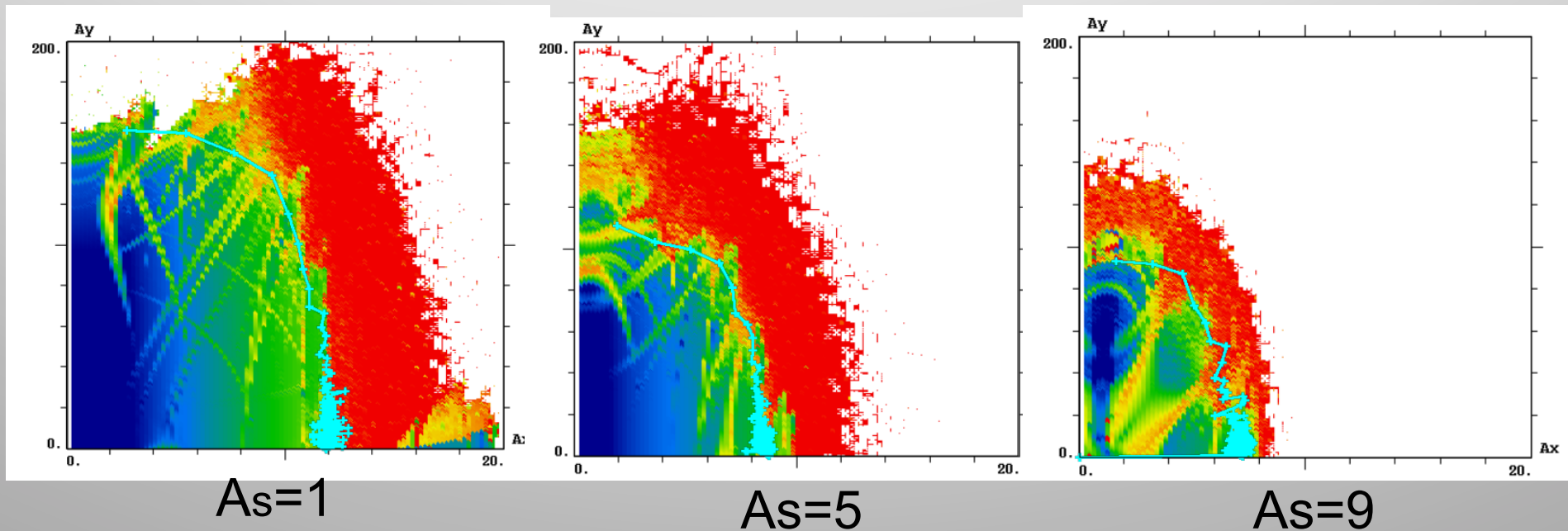
- Moving  $\xi_x$   $\xi_y$  to higher positive values
- lengthening the bunch by reducing the RF cavity voltage



# Electron ring dynamic aperture

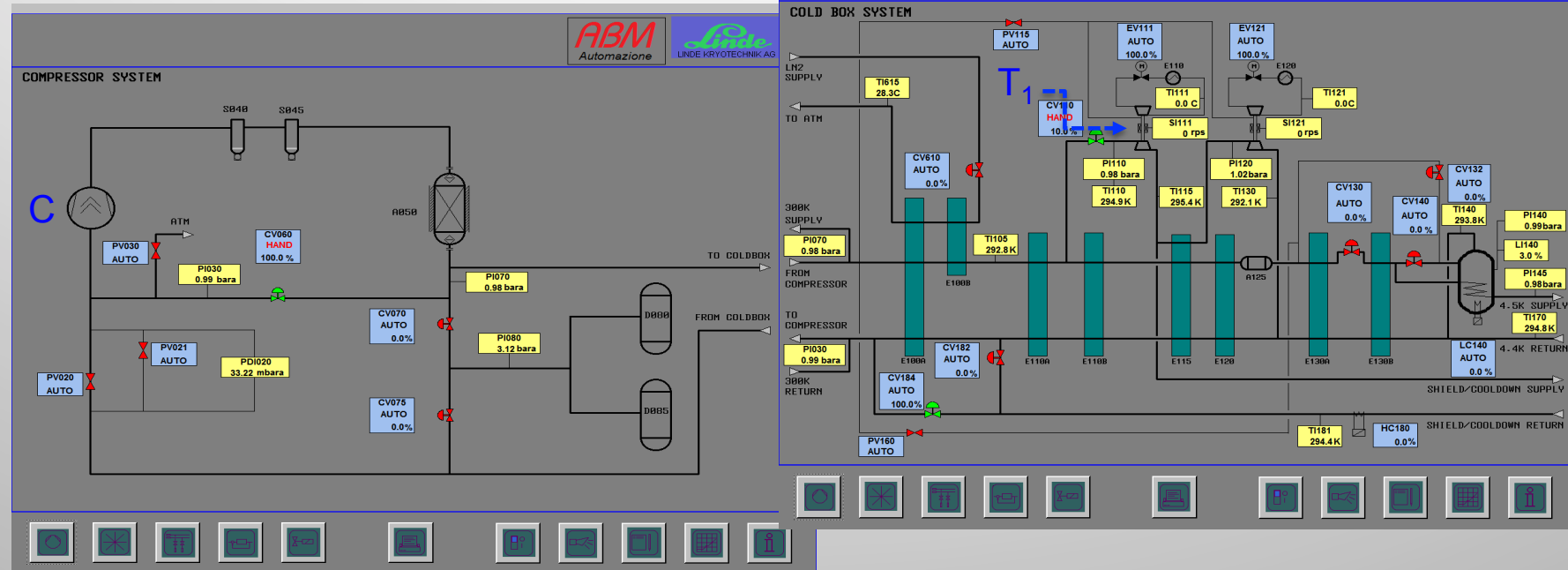


# Electron ring dynamic aperture



Dynamic apertures have been simulated by using a new tool (*lifetrack* embedded in *MAD-X*) developed for HL-LHC and tested with the DAFNE optics

# Cryogenic plant



All started with an anomalous  $DP_{T1-C} \sim 3 \text{ b}$  (Jan 2014)

KLOE solenoid warmed up and cleaned (Aug 2014)

Since Spt 2014:

- some air leakage found and fixed after extensive checks
- seal of the compressor screw replaced
- oil contamination detected before the cold box first turbine imposing washing the Cold Box circuit by acetone
- oil contamination in the gas management system -> washing

Technical assistance and support from Linde