PMT status

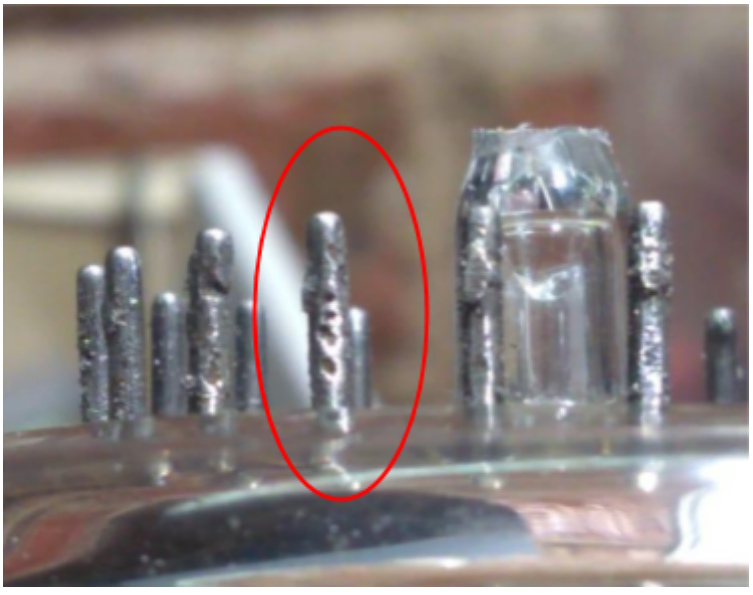
PMTs lost due to corrosion

Recently, 3 pmts were found with some pin completely destroyed due to corrosion process plus one with the pin partially destroyed (probably can be repaired) during the preparation of the new batch of pmts for next PMT week.

PMT SNumber	Pin Corroded	Detector	Position in Tank
5426	T8 and T13	Frias Jr. (ID 1841)	pmt3
1787	T9	Tom (ID 425)	pmt1
3621	T9	Agua de Diaz (ID 665)	pmt2

This is alarming since until now, we only lost two pmts with some pin completely destroyed across this nine years of pmt maintenance (plus three pmts with some pin partially destroyed that were recovered) .

The corrosion is present in almost all pmts in different levels. In picture below it's showed a pin with holes due to corrosion. Those pins get so weak and are easy to broke. This example is very common.



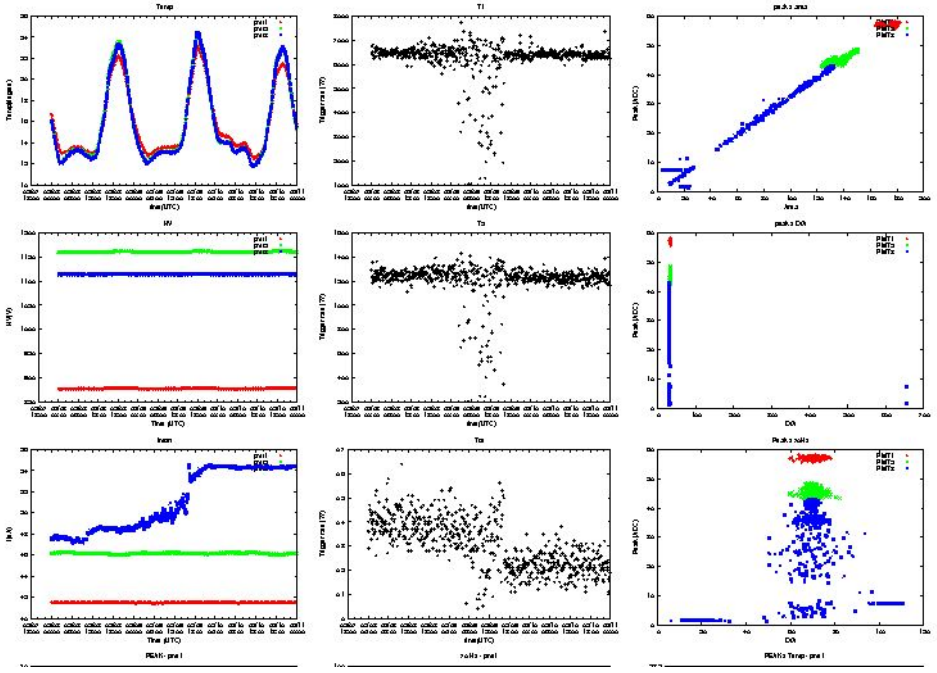
You can find some statistics about corrosion in pmts in appendix

Variations in the stock of pmts

The number of spare pmts remain more or less constant since a few years, despite the loss of some pmts every year. These are due to a recovery of a group of pmts that was not considered as good but not completed discarded. In report of Malargue meeting November 2015 they figured as "40 pm under study". Recently we finished to test them and many were recovered.
Another group of discarded pmts because of darkrate problems were also recovered wen we spend more time for cooldown test (24 hours instead 2.5 hours) as was proposed for those chinese pmts with the same problem: the extension of time to discharge the pmts allow to pass successfully the darkrate test for near all pmts.
The bach of 10 chinese pmts also increment the number of spare.
The number of discarded pmts it's growing slowly: 167 in November 2015 and 214 until now, means 47 more discarded pmts in 2.5 years, or near to 20 by year.
We achieve to compensate this lost by recovering some discarded pmts or new pmts but since now we don't have any more pmts in those conditions.
Currently, the number of pmts available to reconditioning is 87 but we will know how many of them will work properly after they being tested.

Imon and signal problem, (Imon increase and signal drop to zero)

We detected this problem in the year 2014, in our analysis we observed that some PMTs with Imon-signal problem returned from the field with the same problem (Imon-signal), or the PMT returned without photocatode, or square problem, or a small part had a visible problem of internal solder (presents an internal electric arc). After to do the test bench to the bases of PMTs and verify the correct functionality, we decided turn off the PMTs with Imon and signal



problem in the field and after some hours, we turned on again the PMT. Then we observed that the problem disappear in some cases. We think that in these cases the problem is a bad contact inside of PMTs, and when you shut down the power, the pieces return to the normal temperature and the contact between the pieces return to the normal state. In other cases the problem can be produced for contamination inside of PMT when the PMT is crack and loose part of the photocatode.
For the moment we have 25 PMTs in this condition in SDEco and others in the field, that are working after realized the procedure mentioned.(turn off/on)

Appendix

Corroded pins

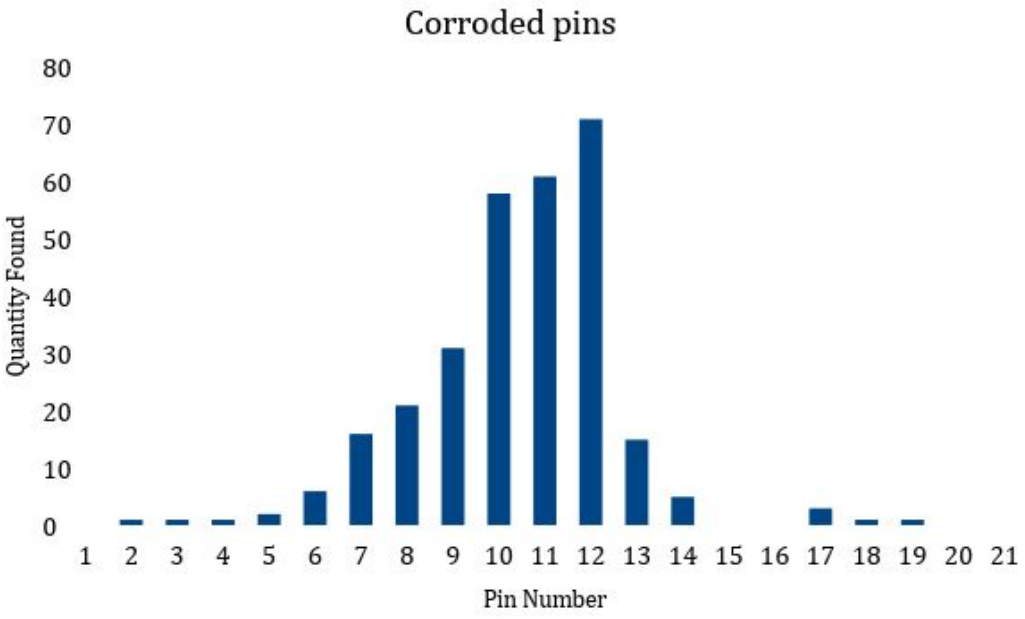
*We study a batch of **195** pmts cleaned during 2012-2013*

From these:

50 doesn't have any corrosion on pins

145 with at least one pin corroded

Percentage of pmts with corroded pin: **74.35 %**

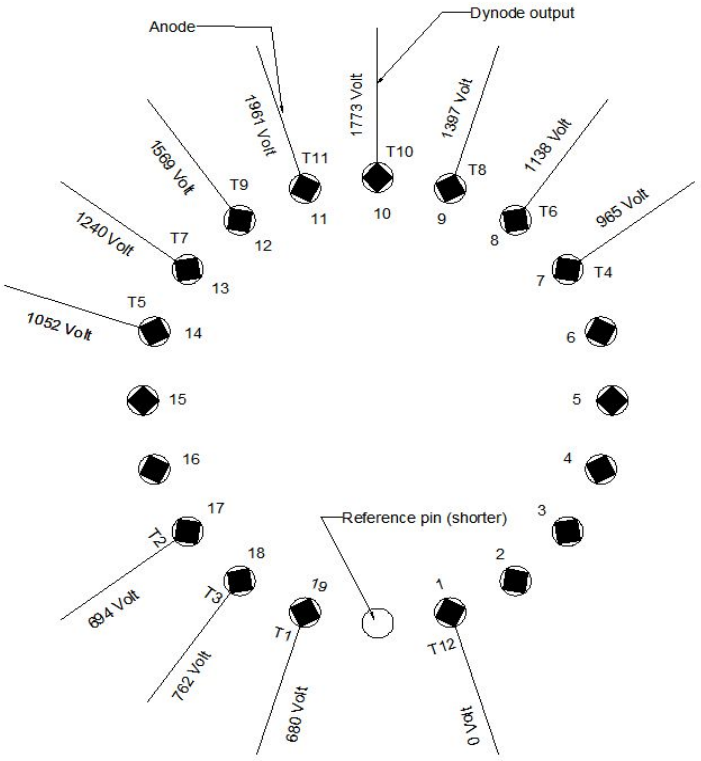


Taking in account the relative position of the corroded pin we can get some conclusions.

As is shown in the graphics, the most frequently corroded pins are those close to pin number 11 (Anode, high voltage).

The next picture it is a diagram of the position of each pin in the pmt

It is clearly a correlation between corrosion and High voltage.



Correlation with aging

Another correlation with aging is showed in the next graphics. There is more probability to have corrosion in the oldest pmts. Years 2003 and 2004 are not so significant due to the low number of installed detectors in the field (only 100 during 2003 and less than half array during 2004)