Subject: Ion Effects
Posted by wiene on Thu, 28 Jun 2007 10:24:27 GMT
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Below are Ron's minutes of the meeting on ion effects at DESY on June 2, 2007:

WP#30 Special discussion on ion effects
2 June 2007, 14:00-ca.17:00
Sem Room 1
DesyHH

Chair: Takeshi

Talks:

Ron - Boundary conditions, Beijing report
Adrian - TPC occupancies
Astrid (presented by Martin) - Space charge
Akira - GEM gating
Vincent - Gas possibilites
Dean - Ideas on how to measure/correct for ions using photoelectrons
Everybody - Concluding discussion

All talks are avialable at the LCWS07 site:
http://ilcagenda.linearcollider.org/materialDisplay.py?sessi onId=144&materialId=1&confId=1296

Summary
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1. Ron reminded of the Snowmass 2005 and other work which is summarized in our Beijing TPC report (now published as LC Note LC-DET-2007-005 (see http://flcweb01.desy.de/lcnotes/).

-Space charge effects can be minimized by choosing a gas with large \omega\tau.

-The Star TPC review Oct.2006 estimates mean for us (large \omgea\tau) up to 200fC/cm3 in the volume would give rise to about 10cm drift-electron dispacement over the full drift, and this is the magnitude of the B-field effects we have to correct.

-Back-of-the-envolope and the Tesla TDR estimates give 0.5% occupancy for nominal backgrounds and about one fC/cm3 in the volume assuming 100e per occupied voxel. (Adrian at this meeting give more solid numbers based on simulation, and his numbers are lower as seen below).

-In the sheet, the density might be as large as 100 fC/cm3, but the sheet is thin next to the Gem/Micromegas plane so its effect should be small (must be simulated). In the volume, the sheets can be eliminated by gating between trains.

-The correction for space-charge and B-field (antiDID) of about 1 cm means measuring the effects to 2x10-5, the tools for doing this are known (see the Beijing report); this order of correction was achieved by the Aleph TPC.

-The distortion effects and thier correction can and must be studied further by simulation.

-When thinking of the solution to the space-charge issue, we should not compromise the point resolution or the dE/dx resolution.

2. Adrian's study of the backgrounds (based on Guinea Pig) and their effect on TPC occupancy have now advanced to a rather sophisticated level. He described in his talk the various background sources. The main result on occupancy is seen in slide 12, where it is seen that we would expect on average about 0.04% occupancy (the radial dependence is on slide 13) for the pad sizes we are now considering, which is an order of magnitude lower than the TDR days. That plot also demonstrates what we have said since the beginning (2001) that we should make the granularity as fine as possible to reduce the background occupancy as much as possible. Adrian's slide 14 on the electron space charge for 100 BX must be multiplied by 150 since the ions take about one second to drift out (worst case) and itegrate over 15000 BX (near the anode); nevertheless, Adrian's values are an order of mignitude lower than above, point 1. Note that backgrounds from minijets and muons are not yet included in Adrian's simulations.

3. Astrid's thesis work was reported by Martin. She has developed a tool which can be used to study the ion-sheet effect. It is based on Heeds, Magboltz and Gem charge-transfer parameterization. It gives the charge density in the back-drifting ion sheet (slides 5, 6, 7). This can be used
for optimizing Gem settings and simulation distortion effects due to the sheets.

4. Akira, and CDC colleagues have studies many properties of gating using wires or Gems (the micromesh-gating was not reported on). The ExB effect for wire gating seems to deteriorate about 10% of the gap between the wires. For Gem, many ideas were looked into; no attempt will be made here to summarize all of the facits of the parameters simulated and/or measured; Akira's slides are the best summary of the understanding. The conclusion for the moment is that a Gem gate should have larger holes, thinner Gem, a low drift field and high (but not too high) transfer field: in that case the electron transmission up to 70% might be possible (is this enough?). The basic idea was to decide on a scheme using Gem gating and then to test it at using the MPTPC at Kek or, see Akria's final slide no. 21, at the 5T magnet at Desy.

5. Vincent gave a nice review of issues and numerical values for the electron and ion drift properties. Possible solutions involve exotic ideas (e.g. choosing a gas with fast ions or making a very short TPC) and less exotic possibilites (e.g. gating to avoid the sheets in the drift volume). He points out that the first thing to do is more simulation work in order to understand the magnitude of the effects. (One comment to his
"extra slide" No.16: the Star TPC has such a sheet, but a cylindrical one due to a mismatch between the wire grids on the inner and outer sectors. The correction for this distortion is rather well understood.)

6. Dean explained his proposal to study ion distortions at the LCTPC using the displacement of photoelectrons emitted by a pattern on the cathode illuminated by UV light. This interesting technique will be tested at LP1.

7. Discussion (Takeshi et al): no show-stoppers were identified
and simulations indicate that the effects may be smaller than originally estimated. We agreed that these studies must be continued so that we have a robust strategy for handling such corrections by the time the ILCTPC roles around.

Subject: Gas Sealing
Posted by oschaefer on Thu, 20 Sep 2007 14:19:49 GMT
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Dear all,
In yesterday's phone meeting there was a partly quite puzzled discussion going on about the shape of the O-ring grooves of the LP-TPC endplate. Since I put quite some effort and "research" into the design of the O-ring sealing of the electronics-testing prototype of the University of Rostock, I would like to share the results from this with you:

There are basic requirements for a groove that have to be fulfilled: First of all a very good surface quality is necessary. For the walls of the groove 0.4 µm (16 µin) Roughness Ra, for the top and bottom surface 1.6 µm (63 µin) Ra. The manufacturers told me that the shape of the groove doesn't really matter, as long as these surface qualities can be guaranteed.

Since it is easiest to produce a high quality rectangularly shaped groove this one is usually preferred. For high pressure applications triangular (nowadays trapezoidal with larger length open) grooves provide certain advantages. By using them, the effect of the O-ring being pressed into the tiny opening between the two contacting surfaces (so called extrusion) is moderated. However, there are other ways to achieve that goal nowadays (so called supporting or thrust rings). Also it is more laborious to produce these groove types with a sufficient surface quality, since you need specially shaped tools to cut precise radii and angles. We should also not forget that these solutions are only necessary for applications, where the O-Ring itself is deformed by the overpressure - seriously something like 70 bars.

For the purpose of holding the O-ring in place e.g. in a heavily moved lid, there is also a trapezoidal groove in use, where the smaller side is open. The O-ring may be inserted there once and will be safely kept in place. However disregarding the complicated turning of such a groove, involving several steps, it has other drawbacks: removing of the O-ring from such a groove will most likely result in its destruction. Much attention has to be paid to the edges of the groove, they have to be rounded with a certain radius in order not to damage the O-ring when inserted.

A special situation is given, if an O-ring sealing is used for gases or vacuum. Since gases can penetrate such a sealing easier than liquids (on which the dimensioning in industry standards usually rely on) special modifications have to be done. Some manufacturers have developed recommendations for such applications. These actually change a little bit the working mechanism of the O-ring seal. In a conventional O-Ring seal the medium that shell be sealed is allowed some space to have full contact to the O-Ring and deform it, press it onto the opposite side of the groove. Thus the O-ring groove has to provide some extra spacing in order to allow the medium to enter it. That's why the groove, you usually find in the standards (DIN, ISO, ...) are quite a bit wider than the O-ring diameter.

For applications involving gases, however, the concept changes such that one tries:
1. to cover as much surface as possible with the O-ring (in order to moderate possible scratches)
2. to block any possible way the gas could take through the groove

That leads to the famous four point contact, mentioned by Dan. Here the groove is dimensioned such, that in the compressed state the O-Ring contacts all four surfaces of the groove. This concept is widely used in vacuum applications, as the pressure of max. "-1 bar" directing inside the vessel is not enough to make the mechanism used for liquids work efficiently enough. Our application with 4 mbar overpressure ranges in the same category.

I used such a rectangular groove (3.03 mm x 4.6 mm) for a 4.0 mm thick O-ring with 215 mm inner diameter made of NBR 70 ("normal rubber") for my chamber. I tested the gas sealing of the chamber and found no measurable pressure loss at all, having it under pressure for two weeks. The grooves where machined into an aluminium alloy called here AlMgSi1. In order to protect the surface of the aluminium I decided to have it anodized. This process is, I think, very recommendable for aluminium parts since:
1. it increases the surface hardness to the level of corundum an such protects the groove very well against later damages caused by handling,
2. In the pre-process for this process minor scratches produced accidentally during machining are levelled
3. one can colour the surface in a very scratch resistive way (was an issue for me, since I plan to use it with laser tracks at a later stage)
4. it doesn't cost much

One drawback is, that the optical quality of the surface depends on the alloy. By chromatisation

(?) one can keep aluminium surfaces permanently elctrically conductive (may be important for grounding).

In my case, were the groove was machined to fit exactly the inner diameter of the O-ring I observed a "fall out probability" of 50%. The manufacturers state, that the O-ring should be stretched to less than 3% to 5% of the original diameter, when build in. This little underdimensioning could be used to hold the O-ring inside the lid, which would avoid the complications introduced by a trapezoidal groove.

Something, that could interest Dan is that I also used the O-rings in a quadratically arranged groove (instead of the usual circular). Here the manufacturer states, that the bending radius in the corners shell be at least 4 times the O-ring thickness in order not to introduce additional material stress to the rubber, causing leaks. Specially shaped O-rings could be manufactured if this limit can not be reached, but they will be very expensive, since the tools have to be machined for manufacturing them.

Other things to consider are:
- Hardness: 70 Shore is the standard O-ring, softer ones (smaller numbers) should be even better for our application, since the are flowing better into small distortions of the surfaces.
- chemical resistivity: Viton could be good, since it resists most chemicals and comes in many versions. NBR (normal rubber) seems to be good enough for non aggressive Argon mixtures, like the ones used at DESY. (I'm thinking of CF4 as a problematic gas here). PTFE of course is also a good material, but it can not be greatly deformed and thus requires an even different groove-design.
- storage: O-rings shell be stored at room temperature, dry, light protected, oxygen protected, ozone protected. Depending on the material they can be stored such for 5 (NBR) to 20 (Viton) years before loosing functionality.

Oh yes: all the things stated above are mainly considering a static sealing, if you have to seal moving parts, like pistons, it's again different and other problems occur.

A very helpful source of information I found in the Technical manual ("O-ring book") of a company named ERIKS http://o-ring.info/en/downloads/technical-manual-o-rings/. Also radiation influence is discussed in there. But also standards, and other more or less up to date books about O-rings where regarded.

Please consider also, that O-rings are only one way of a sealing design for our application. I have heard for example, that Aachen is thinking/designing a flat gasket, which, due to it's larger surface, could provide some advantages as well.

I hope these remarks will be helpful for the further discussion of this matter.

Cheers,
Oliver.

Subject: Re: Gas Sealing
Posted by settles on Fri, 21 Sep 2007 14:13:33 GMT
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Thanks Oliver,
As I said in the meeting yesterday, for the Aleph TPC we
used

> For the purpose of holding the O-ring in place e.g. in a heavily moved lid,
> there is also a trapezoidal groove in use, where the smaller side is open.
> The O-ring may be inserted there once and will be safely kept in place.

because the 36 sectors each took on all possible orientations in space
while being inserted using the "handling tool". This worked very
satisfactorily...
Cheers,
Ron
n Thu, 20 Sep 2007, [iso-8859-1] Oliver Schäfer wrote:

> Dear all,
> In yesterday's phone meeting there was a partly quite puzzled discussion
> going on about the shape of the O-ring grooves of the LP-TPC endplate. Since
> I put quite some effort and "research" into the design of the O-ring sealing
> of the electronics-testing prototype of the University of Rostock, I would
> like to share the results from this with you:
>
>
...

Subject: Re: Gas Sealing
Posted by oschaefer on Mon, 24 Sep 2007 10:52:59 GMT
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... indeed here is a decision to take:

The trapezoidal groove provides absolute protection against the O-ring falling out. The price for this is more complex machining and decreased accessability (important for cleaning) of the O-ring.

The rectangular groove designed to the standards gives 50% "fall out prabability" if turned over by 180° and is likely to hold on sufficiently for the expected mounting procedures, when chosen a bit smaller or larger (2% maybe) in diameter than the groove.

The question now is, wether the trapezoidal groove could be machined with sufficient precision - especially regarding the surface. This is even more important for the trapezoidal groove than for the rectangular one because the concept of "four point contact" can not be applied in a sensible way here.
So the question is first of all a practical one for the manufacturer of the endplate (--> tools?).

The manufacturer comments on this: "[...]This groove shape is very uncommon and laborious to machine. It should only be applied, when it is absolutely needed[...]" So we should ask ourselves - do we really need it?
In case of ALEPH there where parts with complex geometries and probably handling was also more difficult, there a trapezoidal groove surely was a simplification for the assembly.
In our case handling will (hopefully) be much easier and controlled, so that we can (imho) lack the comfort of a trapezoidal groove for the assembly.

Cheers, Oliver.

Subject: Re: Gas Sealing -- the Aleph experience
Posted by settles on Tue, 25 Sep 2007 06:48:03 GMT
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Hello Oliver,
Doing this dialog via the forum involves unnecessary administration and doesn't make much sense to me.
It's like scratching your left ear with your right hand behind your head. It prevents, rather than promotes, distribution of the information to the right people unless all of the right people use the forum, which they don't.
Anyway, the handling of the ILC TPC sectors will be essentially the same as for the Aleph TPC sectors, therefore we must think of this fact and not just of the Eudet situation.
In Aleph we machined trapaziodal oring grooves, small side outside, in "geschnetzeltes GFK from Stesalit" (fibreglass) material, so the complication due to the trapezoid can't be that big of a deal.
Also the production of the TPC sectors is not a mass-production operation so it won't be done for thousands or millions of times and a little extra machining work plays a negligible role in the

overall effort and timescale. Preventing the orings from falling out during manipulation will be an essential function for the LCTPC sectors.

In Aleph the gas-tightness in fibreglass was ensured by using a thin coating of vacuum grease on the orings. Also 2-surface contact was entirely adequate for 6mbar overpressure (in the LCTPC it will be 2mbar). Since the Aleph TPC worked extremely well during 12 years of operation, we don't have to do too much of "reinvention of the wheel", although we should of course think of improvements since the Aleph TPC was not perfect...

Cheers,

Ron

Subject: Re: Gas Sealing -- the Aleph experience
Posted by oschaefer on Tue, 25 Sep 2007 12:13:29 GMT
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Sorry Ron,

we probably misunderstood:
I wasn't considering the ILC-TPC, when I made my comments. I was only commenting on the LP-TPC and there I doubt the benefit of a trapezoidal groove, since the handling will be much less an issue.
One might argue of course, that we (as a new community) could practise and gain experience with the trapezoidal groove type, but since the later manufacturer of the ILC-TPC is far from being known now, I think it's still a bit early for that.
For the ILC-TPC one surely should consider trapezoidal grooves again, as well as completely different sealing methods.

Cheers, Oliver.

Subject: Re: Gas Sealing -- the Aleph experience & the LP
Posted by settles on Tue, 25 Sep 2007 14:58:47 GMT
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Hello Oliver,

It is clear that, everything for the LCTPC we can learn how now on the LP, we should try out now. That is the purpose of the LP. Also if MPI-Munich can make trapezoidal holes, anybody can...

Cheers,

Ron