Calibration and reconstruction - Plans for the TPC reconstruction at LIPI

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Backgrounds

- October 2014 - First contact with TPC group
- November-December 2014 - Setting up LIPI-TPC group
  - Several informal meetings with **Kai Schweda**
  - Decided LIPI's topics:
    - Space charge distortions and corrections
    - TPC data compression
- Until now
  - Production site in LIPI (Aliroot)
  - Capacity building on LIPI team

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Plan for Space-Charge Corrections (I)

- Current situation as in ALICE-TDR-016:
  - The tightest constraint: available time on-line.
- Focus #1: Fast solution of Poisson's equation (PE):
  - Start with existing method (relaxation method), simultaneously explore the literature for other methods.
  - Spectral method seems to be the most promising.
- Focus #2: Interface and Implementation:
  - Input: Data and Simulation, compressed or non-compressed, grid.
  - Different algorithm/code for PE Solver: GPGPU, Multicore CPU.
  - Output: Potential and field.

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Plan for Space-Charge Corrections (II)

- Personnel:
  - Junior: 1 PhD student with computer science background (possibility for another 1).
  - Senior: Rifki Sadikin (computer scientist) and Suharyo Sumowidagdo (physicist).
- Local facilities in Bandung & Cibinong:
  - LIPI ALICE clusters are on-line and running job.
  - GPU card NVIDIA Tesla M2075 (448 core) available for testing GPGPU algorithm.

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Aliroot Instalation at LIPI

- Exploring the **AliTPCSpaceCharge3D** class.
- Current situations:
  - There are 2 implementations for calculating the Space charge:
    - Analytic '2Dx2D' (old code by Stefan Rossegger).
    - Numeric full 3D based on Poisson Relaxation
- Issues: since LIPI network used proxy, unable to use Alien (sending job to Grid)

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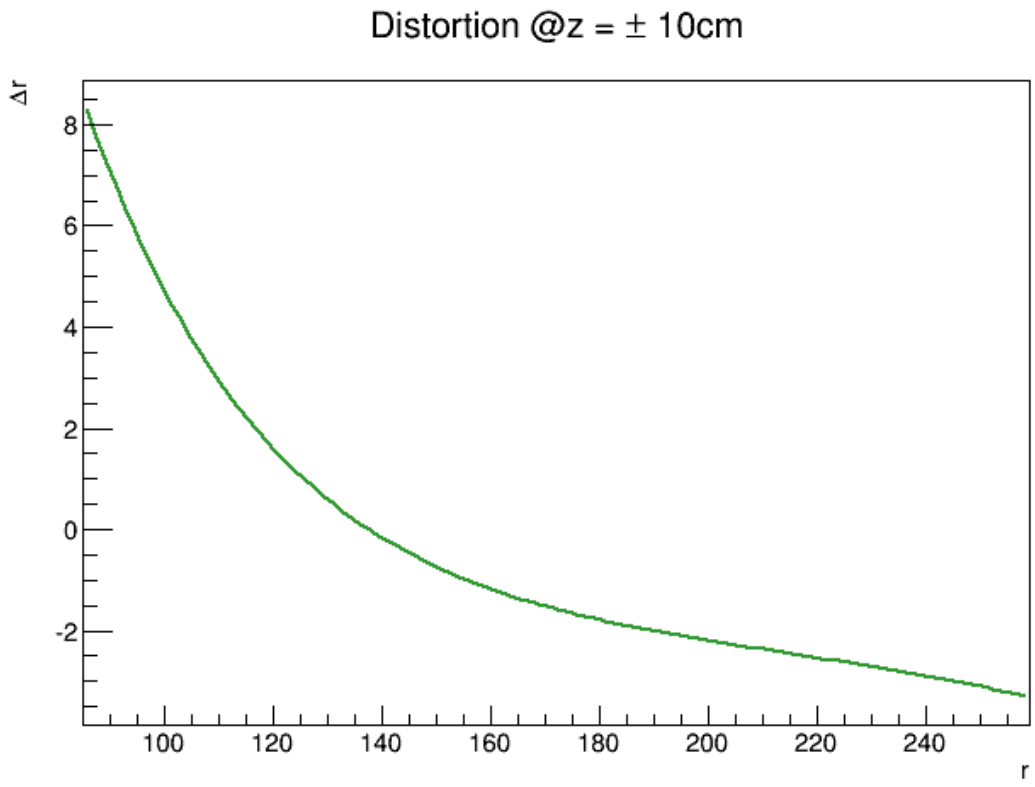
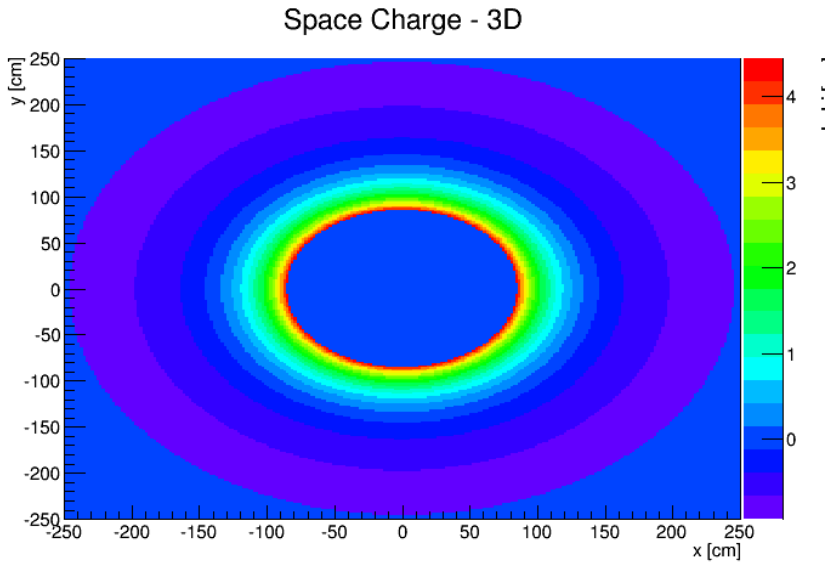
Script Running with **AliTPCSpaceCharge3D** (From **Jens Wieschula**)

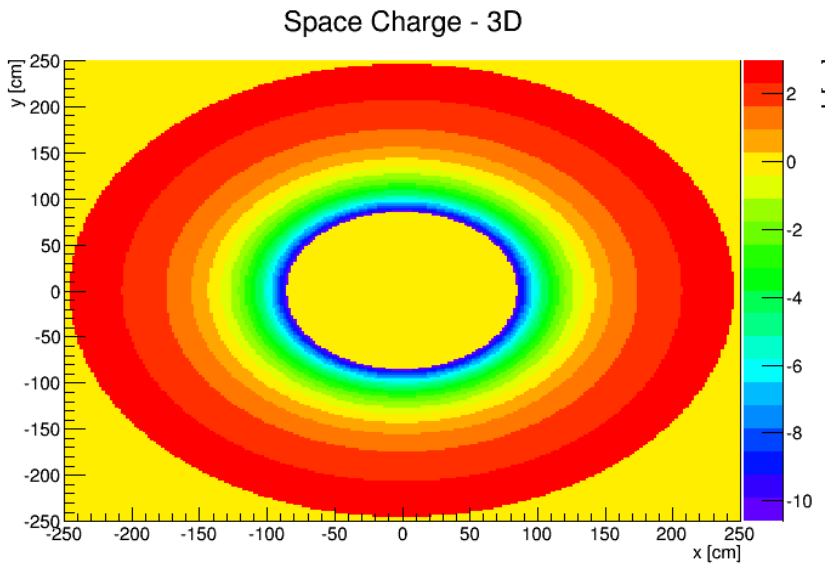
```
AliTPCSpaceCharge3D *spaceCharge = new AliTPCSpaceCharge3D;
spaceCharge->SetSCDataFileName("SpaceChargeMap.root");
spaceCharge->SetOmegaTauT1T2(0.32,1.,1.);
spaceCharge->InitSpaceCharge3DDistortion();
spaceCharge->InitSpaceCharge3DPoisson(129, 129, 144, 100);
spaceChargw->AddVisualCorrection(spaceChargeRef,1);
TF1 *fdistRDriftS5 = new
TF1("fdistRDriftS5",
"AliTPCCorrection::GetDistXYZIntegrateZ(x,x*tan(0.17),10,0,1,1)",
85,250);
fdistRDriftS5->SetLineColor(kGreen-2)
fdistRDriftS5->SetTitle("Distortions␣@z␣=␣#pm␣10cm;r;#Deltar")
fdistRDriftS5->Draw("")
spaceChargeRef->CreateHistoDRPhiinXY(10,250,250)->Draw("colz");
spaceChargeRef->CreateHistoDRinXY(10,250,250)->Draw("colz");
```

Radial distortions vs. radius



2D plots of distortions





Short-term Plan

As suggested by **Marion Ivanov**

- Start modification and documentation on 3D Poisson Relaxation and 2D+2D Implementation
- Define the interfaces
  - Should be aware of use cases.
  - Condiser other distortions
  - Define fast data structure to keep and evaluate of E filed map
  - Start from `TPC/Base/AliTPCCorrectionLookupTable.h`

Plan for the TPC software

- Plan to learn on TPC reconstruction software with Heidelberg group in the beginning of 2015.
- Will send 2 persons (1 senior, 1 master)
  - Senior staff will supported by LIPI (At most 2 months).
  - The master (who we are expecting to pursue Ph. D.) will supported by ALICE.

Fast PE Solver: Spectral Method

- A *global* method instead of local one.
  - Try to approximate the solution at all space instead at the limited grid points.
  - Ideal when the solution will be used many times.
- Approximate the solution to PDE by expansion in a complete set of orthogonal functions.
  - Fast convergence: exponentially.
  - Suitable for smoothly varying functions (such as space-charge distributions).
  - Since the potential is known in terms of series expansion, the field *can be expressed* in series expansion: can avoid numerical derivatives.

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Spectral method: Early thoughts

- A few approaches already exist for TPC case:
  - Poisson's equation inside a cylindrical annulus region, with a Dirichlet boundary condition (Note: previous works on a full cylindrical is not usable as they are focusing on handling the singular r = 0/z axis).
- Re-dimension/Re-size the calculation grid.
  - Grid dimension in each direction (radius, azimuthal, z) should be powers of two (anticipating FFT etc).
  - Re-dimension the r and/or z direction to unity should be considered with performance as the basis for selection. (dimension change imply many, e.g. basis functions)
  - If possible: Each TPC half should be solved separately and in parallel.

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Spectral Method: Literature

1. Numerical Recipes (3rd edition only), Section 20.7
2. Scholarpedia and Wikipedia article on spectral method.
3. We are digging in the literature to find candidate solutions to be implemented.

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Summary and Outlook

- The TPC software group of LIPI just in the beginning phase.
- In the process of understanding existing code.
- We are expecting to contribute on Space-charge distortion and Compression.
- Define the interface for modular software.
- Plan to implements the existing code to GPGPU, implement other Poisson Relaxation method (such as Spectral solution).

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Thank You