

# Ecal Geometry Status

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## ➤ Introduction

*Ecal geometry modifications required:*

- **Rotation of crystals by  $\delta$  parameter around Y (fan out)**
- **Sage parameter  $dY$  for each layer**

*From survey data*

- **Shifts along X,Y,Z axes for top and bottom modules independently**
- **Rotation parameters  $\alpha$  and  $\gamma$  for top and bottom modules independently**

## ➤ Sage and “fan out” parameters

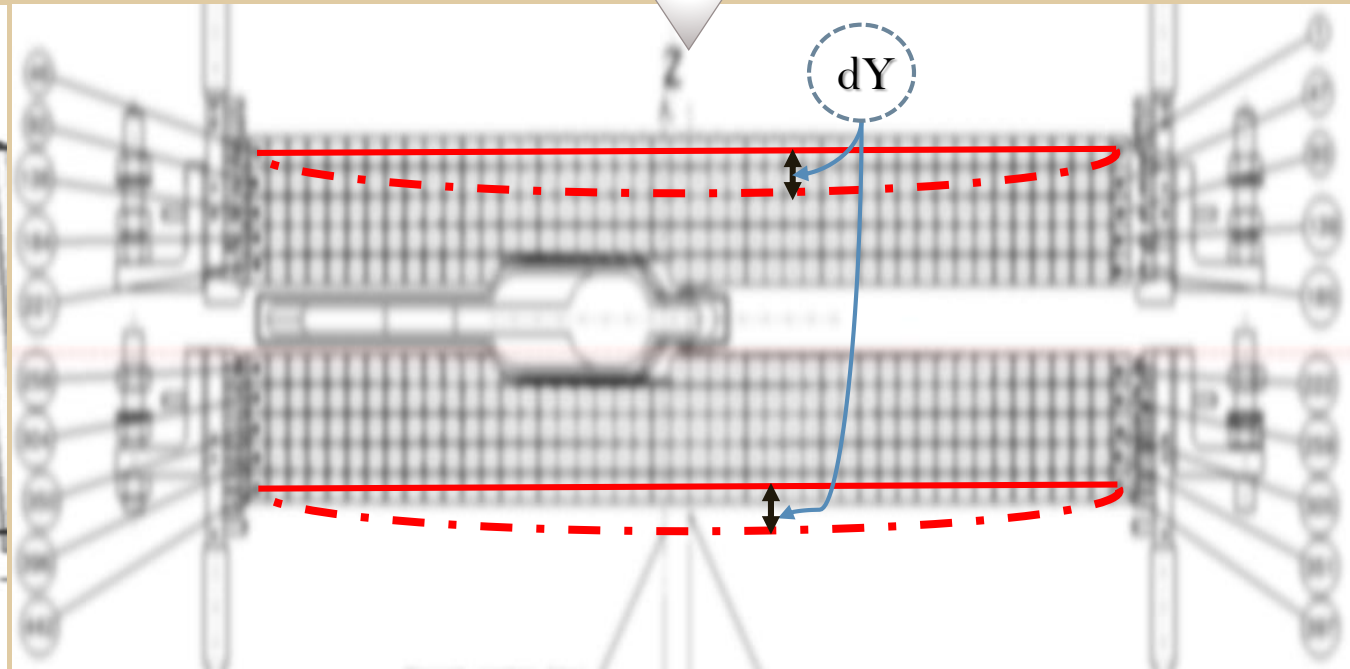
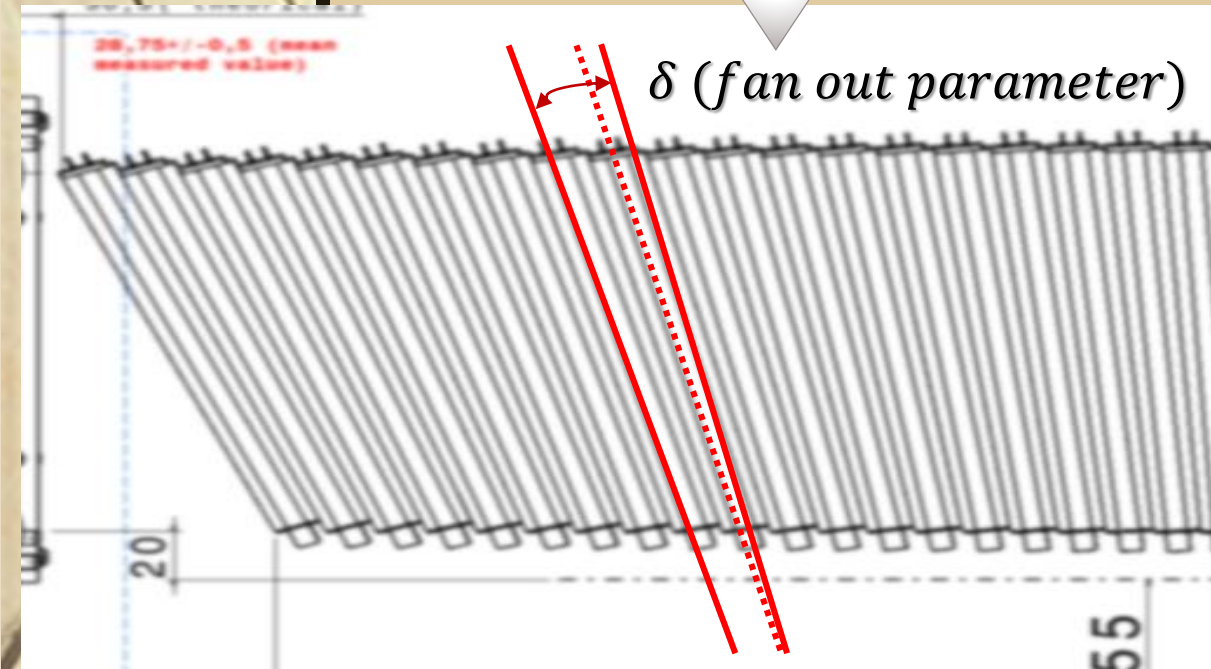
- $\delta$  in  $X$  axis due to the glue on the edge of the APD



- The sage of each raw due to the weight

$$dY = 40\mu \text{ front frame}$$

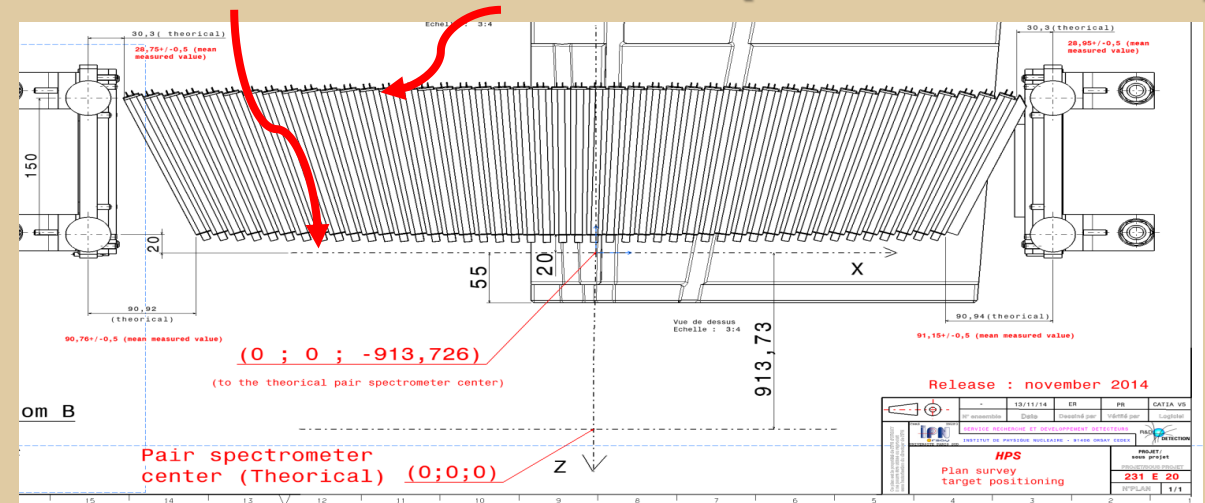
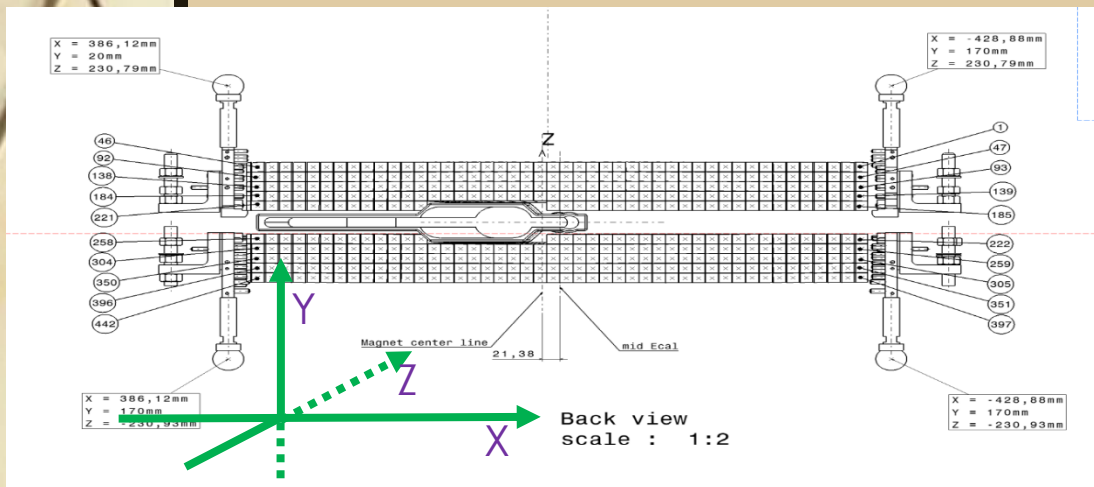
$$dY = 90\mu \text{ backward frame}$$



# ➤ Crystal position modified by $\delta$ and $dY$

			<i>crystals front face true position</i>			<i>Crystals back face true position</i>		
<i>N</i>	<i>layer</i>	<i>column</i>	<i>X(mm)</i>	<i>Y(mm)</i>	<i>Z(mm)</i>	<i>X(mm)</i>	<i>Y(mm)</i>	<i>Z(mm)</i>
1	5	23	331.93	82.17	23.06	392.66	93.50	170.65
2	5	22	317.42	82.16	22.94	375.58	93.55	171.56
3	5	21	303.01	82.15	22.83	358.58	93.61	172.43
4	5	20	288.70	82.14	22.72	341.67	93.66	173.26
5	5	19	274.48	82.13	22.61	324.82	93.71	174.05
6	5	18	260.34	82.12	22.50	308.04	93.75	174.78
7	5	17	246.28	82.11	22.39	291.33	93.80	175.47
8	5	16	232.29	82.10	22.28	274.68	93.84	176.12
9	5	15	218.37	82.09	22.17	258.08	93.87	176.72
10	5	14	204.51	82.08	22.06	241.53	93.90	177.27
.....	.....	.....	.....	.....	.....	.....	.....	.....

**List of crystal positions for the center of the front and back face (Emmanuel Rindel)**

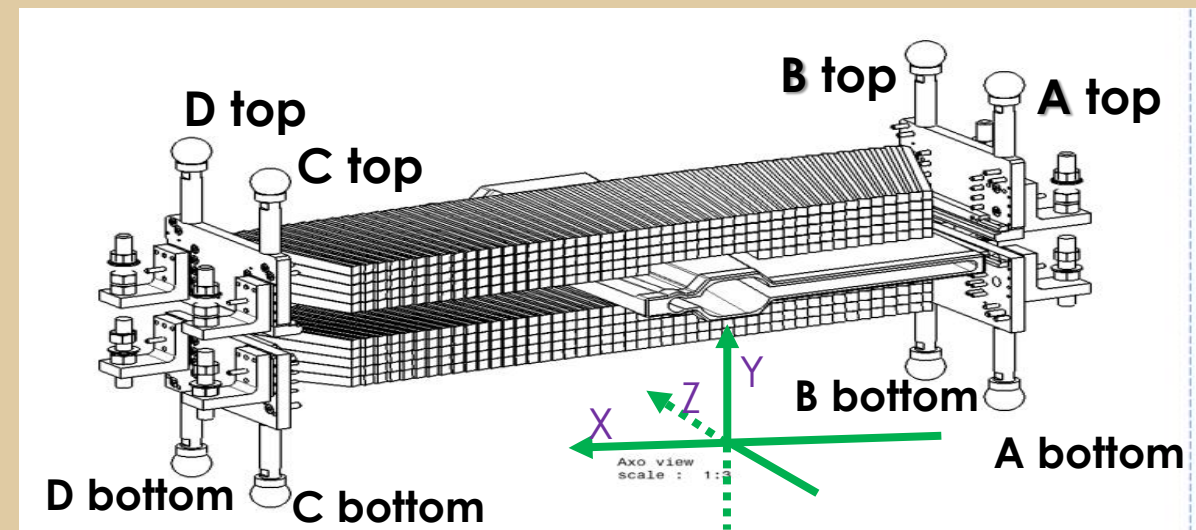




# ➤ Survey parameters

	Theoretical [mm]			Survey - Aug 15 [mm]			THEO-SUR [mm]		
	X	Y	Z	X	Y	Z	X	Y	Z
CTOP_A	-297.62	230.79	933.73	-298.67	233.7	939.11	1.05	-2.91	-5.38
CTOP_B	-297.62	230.79	1083.73	-298.25	233.86	1089.02	0.63	-3.07	-5.29
CTOP_C	517.38	230.79	933.73	516.53	233.26	938.25	0.85	-2.47	-4.52
CTOP_D	517.38	230.79	1083.73	517.07	233.24	1088.29	0.31	-2.45	-4.56
CBOTT_A	-297.62	-230.93	933.73	-299.94	-232.07	937.16	2.32	1.14	-3.43
CBOTT_B	-297.62	-230.93	1083.73	-296.81	-232.44	1086.27	-0.81	1.51	-2.54
CBOTT_C	517.38	-230.93	933.73	517.21	-231.41	935.97	0.17	0.48	-2.24
CBOTT_D	517.38	-230.93	1083.73	517.44	-231.45	1086.01	-0.06	0.52	-2.28

- $\vec{T}_{top}$  - Translation vector for top module
- $\vec{T}_{bot}$  - Translation vector for bottom module
- $R_z(\alpha)R_y(\beta)R_x(\gamma)$  - rotation for each module



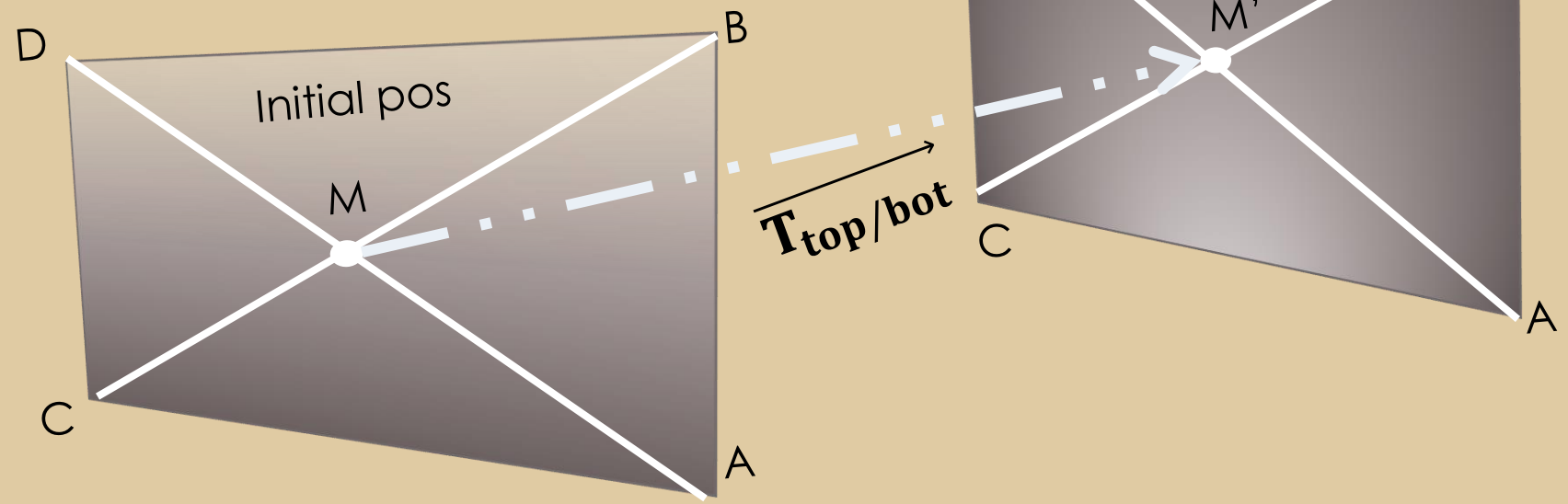
## ➤ Define Translation vectors

- Consider “center mass” of A,B,C,D
- Translation of CM vector is defined as:

- $\vec{T}_{\text{top/bot}} = \vec{M}_{\text{top/bot}}^{\text{sur}} - \vec{M}_{\text{top/bot}}^{\text{ini}}$ , where  $\vec{M}_{\text{top/bot/ini}} = \begin{pmatrix} X(A, B, C, D)/4 \\ Y(A, B, C, D)/4 \\ Z(A, B, C, D)/4 \end{pmatrix}$

- $\vec{T}_{\text{top}}(x,y,z) = (-0.71, 2.725, 4.9375)$

- $\vec{T}_{\text{bot}}(x,y,z) = (-0.405, -0.9125, 2.6225)$



# ➤ Define rotation parameters

- $A, B, C, D$  - not coplanar
- $plABCD$  - Average plane calc. for top and bottom
- $\hat{R} = R_z(\alpha)R_y(\beta)R_x(\gamma)$  - rotation matrix
- $\overrightarrow{N_{plABCD}} = \hat{R} \overrightarrow{N_{plNom}}$  -  $\hat{R}$  turns nominal plane to ABCD
- $\overrightarrow{N_{plABCD}}, \overrightarrow{N_{plNom}}$  - unitary normal vectors

$$\alpha = \frac{xx_0 - y(y_0 \cos \gamma - z_0 \sin \gamma)}{x(x_0 + z_0 \cos \gamma) + (y_0 \cos \gamma - z_0 \sin \gamma)^2} \quad \beta = 0 \quad \gamma = \arctg\left(\frac{z - z_0}{y_0}\right)$$

angle[deg]	plane ABC	plane ABD	plane ACD	plane BCD	plane ABCD average	plane Nom
plane ABC	top bottom	1.27E-02	0.06876473	0.06988579	0.034960611	0.068575055
plane ABD	2.36E-02		0.06994115	0.06875466	0.034983166	0.075153609
plane ACD	0.127794275	0.130398232		1.26E-02	0.03495798	3.18E-02
plane BCD	0.162602756	0.177060667	0.090174809		0.034925184	4.42E-02
plane ABCD average	0.06801076	0.07762304	0.064057791	0.073691809		0.073691809
plane Nom	0.150370594	0.159615894	4.87E-02	4.42E-02	0.04590212	

# ➤ Geant 4 position

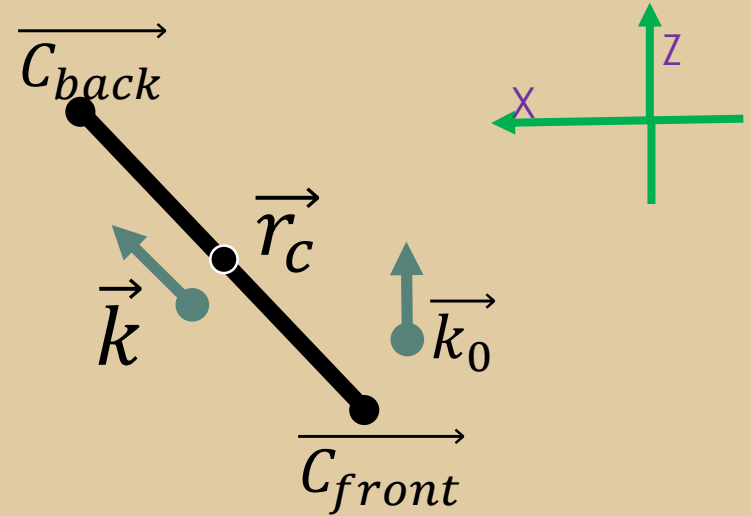
- $\vec{r}_c(x_c, y_c, z_c)$ - as translation parameter for each crystal
- $\theta(\varphi, \vartheta, \omega)$ - as rotation parameter for each crystal
  - $M(\varphi, \vartheta, \omega)$  – rot. Matrix by Euler angles
  - $\vec{k} = M(\varphi, \vartheta, \omega) \vec{k}_0$  - to find  $\theta(\varphi, \vartheta, \omega)$

- **Initial position of crystal (-5, -16):**

- $\vec{C}_{front}(-163.57, -82.14, 22.28)$
- $\vec{C}_{back}(-205.79, -93.82, 176.17)$

- **final position of crystal (-5, -16) :**

- $\vec{C}_{front}(-163.242, -80.039, 19.859)$
- $\vec{C}_{back}(-205.456, -91.949, 173.733)$



$$\varphi = -\arccos\left(\frac{y}{\sin\vartheta}\right)$$

$$\vartheta = \arccos\left(\frac{z}{z_0}\right)$$

$\omega = 0$ , no rot around Z

## Crystal Geant4 position:

$$\vec{r}_c(-184.349, -85.994, 96.796)$$

$$\varphi = 74.246, \vartheta = 15.91, \omega = 0$$





## ➤ Summary

- What is done:
  - *Sage and fan out parameters are implemented*
  - *Full shift in XYZ directions for Ecal modules*
  - *Rotation of Ecal modules separately*
  - *Ecal position correction applied by 5 parameters for each module –  $\vec{T}(x,y,z), R(\gamma,\alpha)$*
  - *Corrected positions for crystals are obtained*
  - *Converted to Geant 4 readable data*

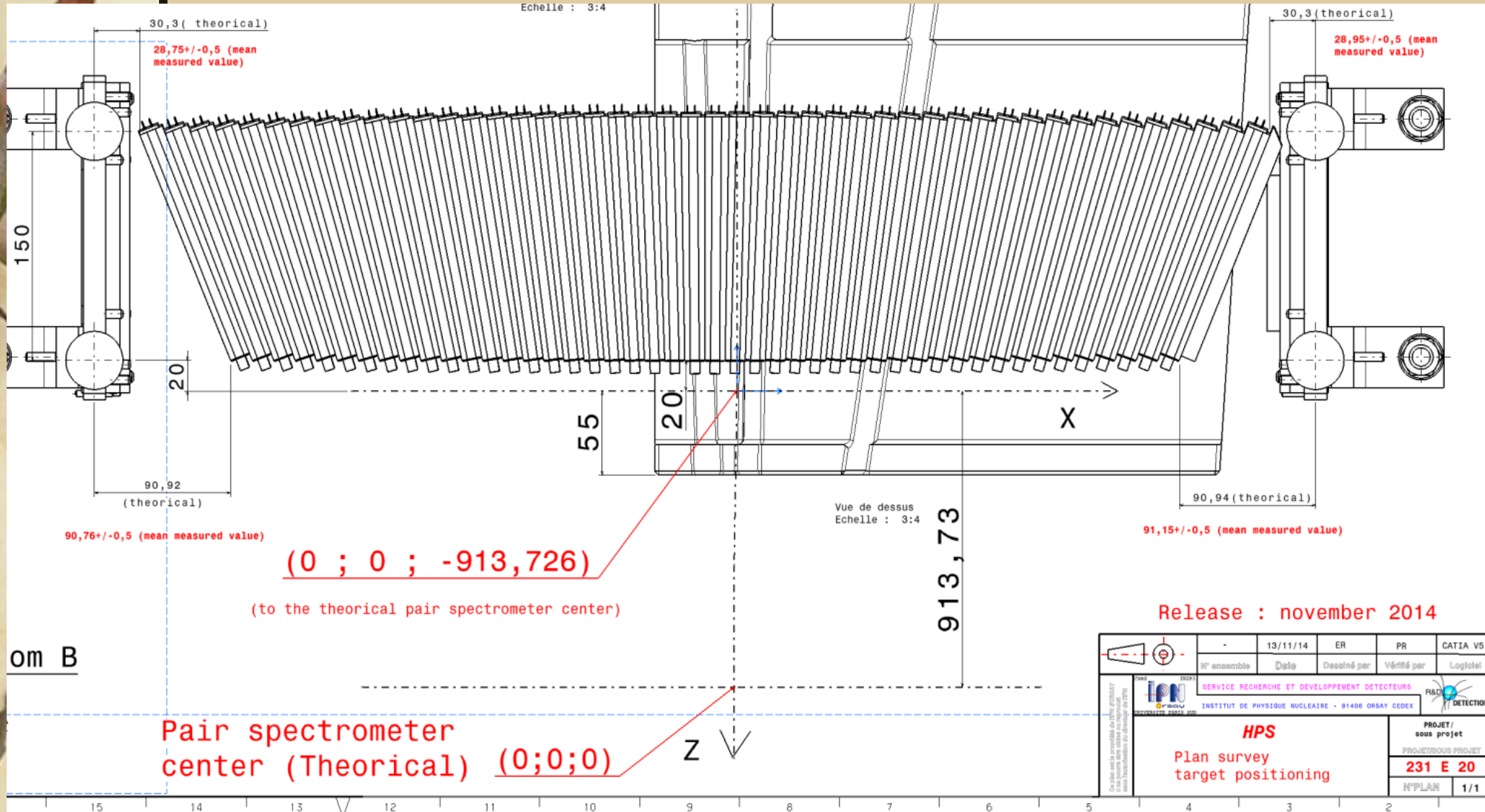


## ➤ Summary

- **What needs to be done:**
  - **Careful integration of calculations to hps-java.**  
Right now calculations are independent
    - inputTextFile is loaded with crystal positions
    - The corresponding modifications are done
    - The list of crystals with new positions readable for Geant4 is the output
  - **Check the new positions of crystals**
  - **If it is where it should be:**
    - 5 parameters probably would be nice to have in database
    - Probably you would like to make some things more sophisticated, let me know
  - **If we will have separate mother volumes for top and bottom, 5 parameters should apply to mother volumes**



**Thank You !!! :)**



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SERVICE RECHERCHE ET DEVELOPPEMENT DETECTEURS INSTITUT DE PHYSIQUE NUCLEAIRE - 91406 ORSAY CEDEX						
<b>HPS</b> Plan survey target positioning						PROJET/ sous projet <b>231 E 20</b>
N° PLAN						<b>1/1</b>