

INTERNATIONAL
MASTERCLASSES

hands on particle physics



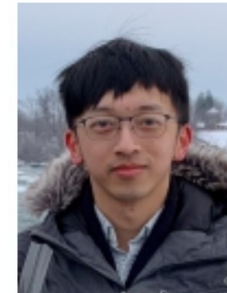
Pavia, 28 Febbraio 2025

Masterclass di Fisica: 28/02/2025

Fri, Feb 28
VC 1: ATLAS Z
16:00 CET
Tadej
Yuan-Tang
Lecce 
Innsbruck 
Olomouc 
Pisa 
Pavia 



Tadej Novak
(ATLAS)



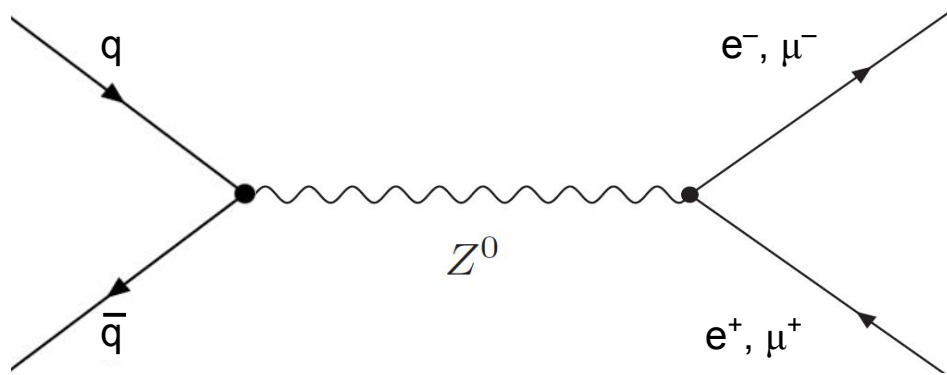
Yuan-Tang
Chou
(ATLAS)

Oggi pomeriggio:
13:00 inizio attività in laboratorio
16:00 videoconferenza

- ♦ Analizzare un insieme di dati raccolti dall'esperimento ATLAS ad LHC
 - Utilizzando un event display
 - 50 eventi ogni persona
- ♦ Selezionare campione di eventi con le caratteristiche di potenziali **candidati**
 - Bosone vettore Z e altre “risonanze” di-leptoniche
 - Bosone di Higgs
- ♦ Analizzare statisticamente il campione per distinguere il segnale dal fondo
 - Cioè, costruzione di un istogramma

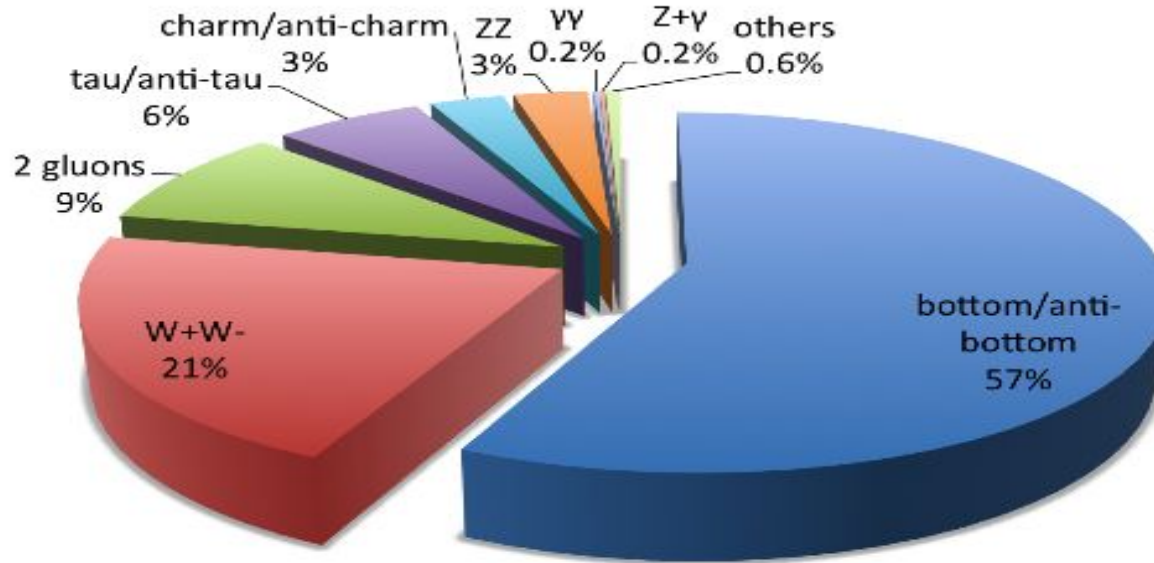


- Molti possibili canali di decadimento
 - Cercheremo il decadimento in coppie di leptoni dello stesso tipo (o elettroni o muoni) di segno opposto



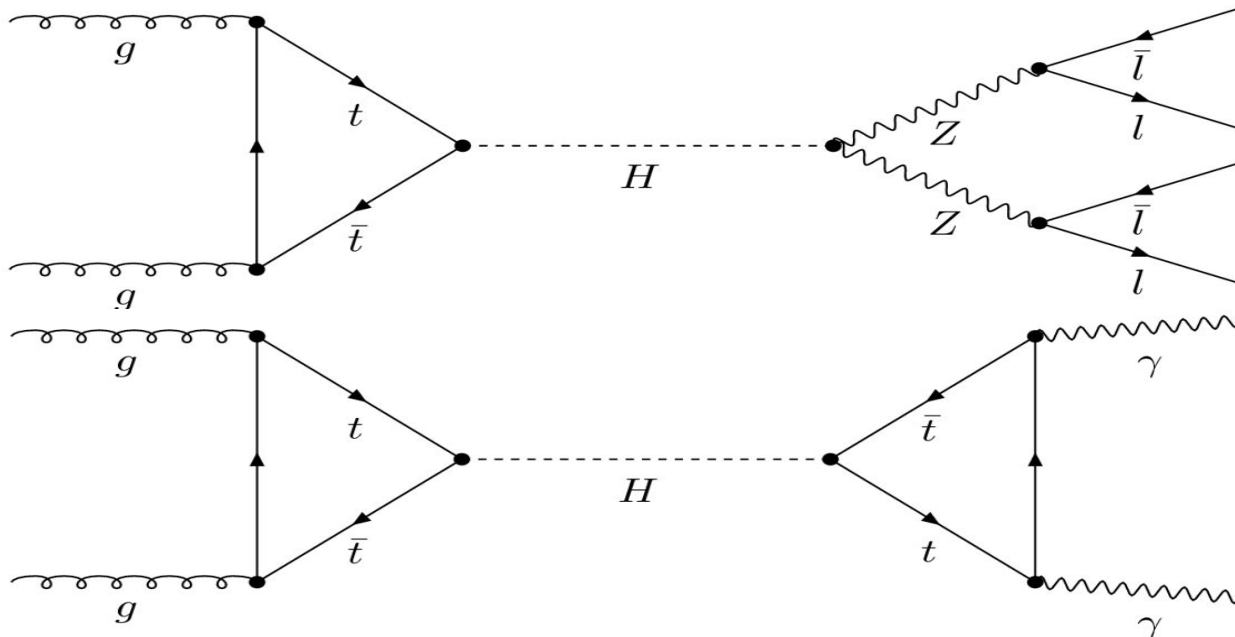
Bosone di Higgs

Quale canale di decadimento sceglieresti?



- A. Bottom/antibottom
- B. ZZ
- C. $\gamma\gamma$
- D. WW

- Cercheremo i canali di decadimento in
 - 4 leptoni (attraverso una coppia di Z)
 - 2 fotoni



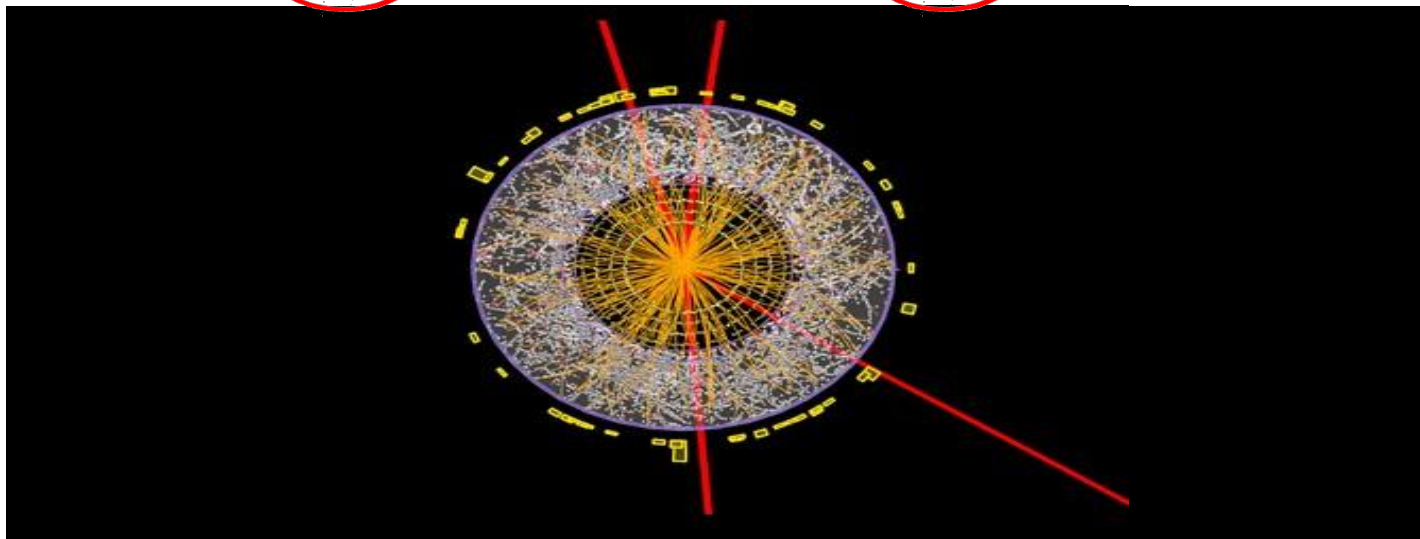
Eventi candidati

Impossibile catalogare univocamente una data collisione (**evento**)

- Il **fondo** può avere stessa segnatura del **segnale**

$qq \rightarrow ZZ \rightarrow \mu\mu\mu\mu$

$qq \rightarrow H \rightarrow \mu\mu\mu\mu$



Come le distinguiamo?

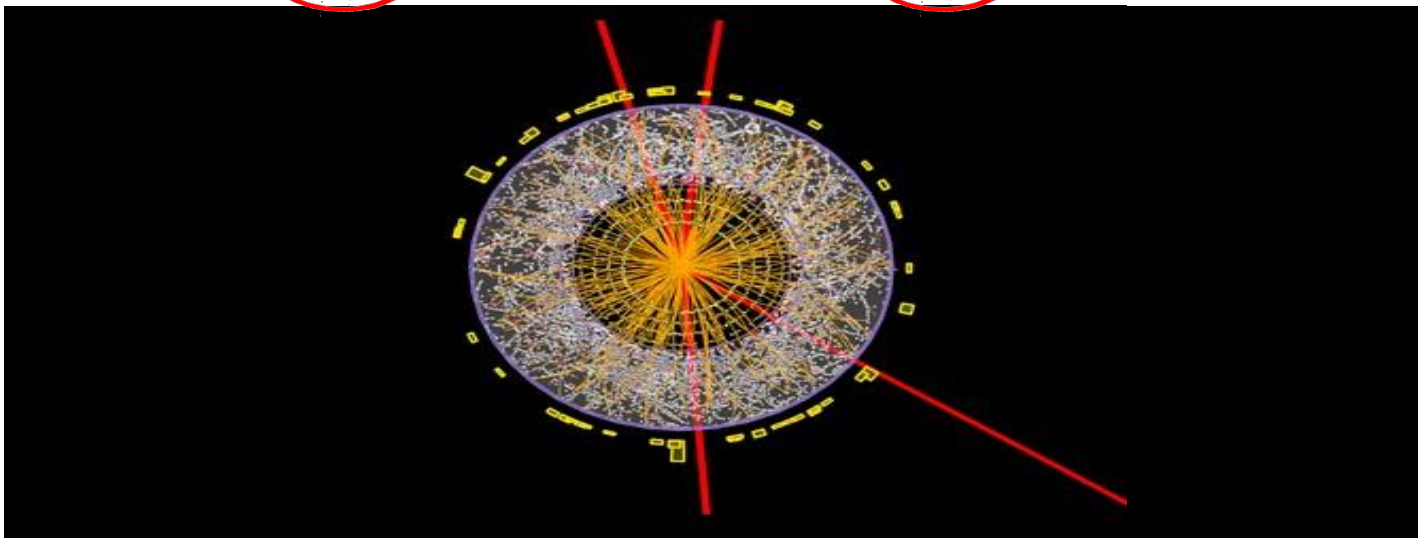
Eventi candidati

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Come le distinguiamo?

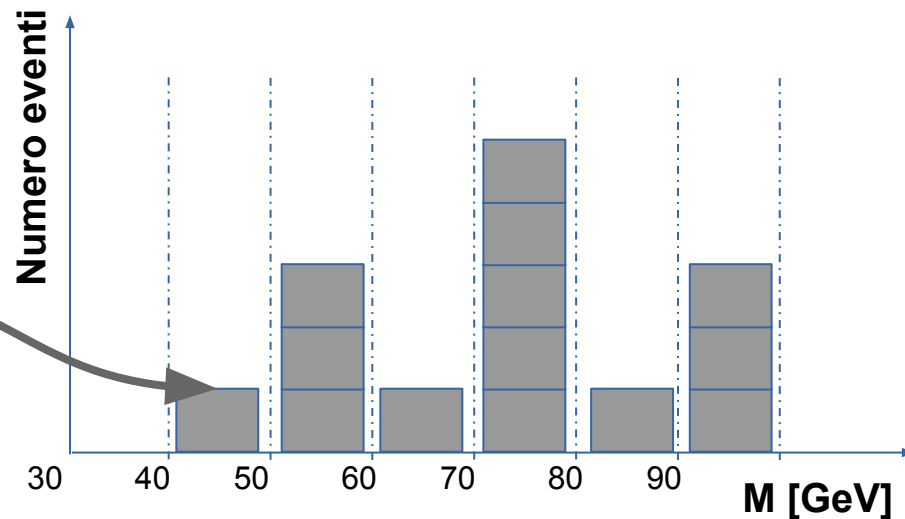
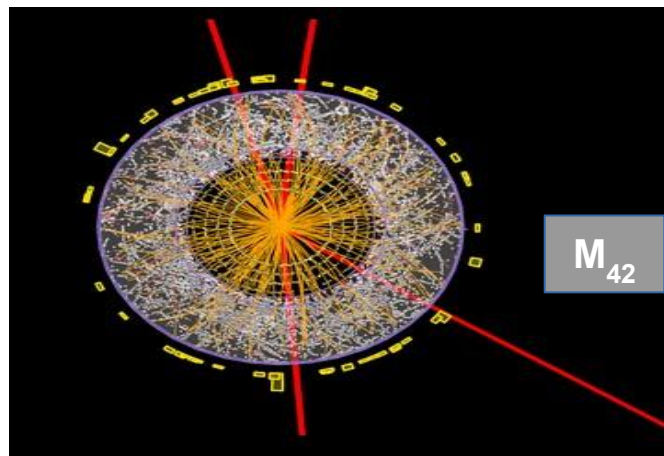
- **Non le distinguiamo.** Necessario approccio statistico

Istogramma: per ogni evento

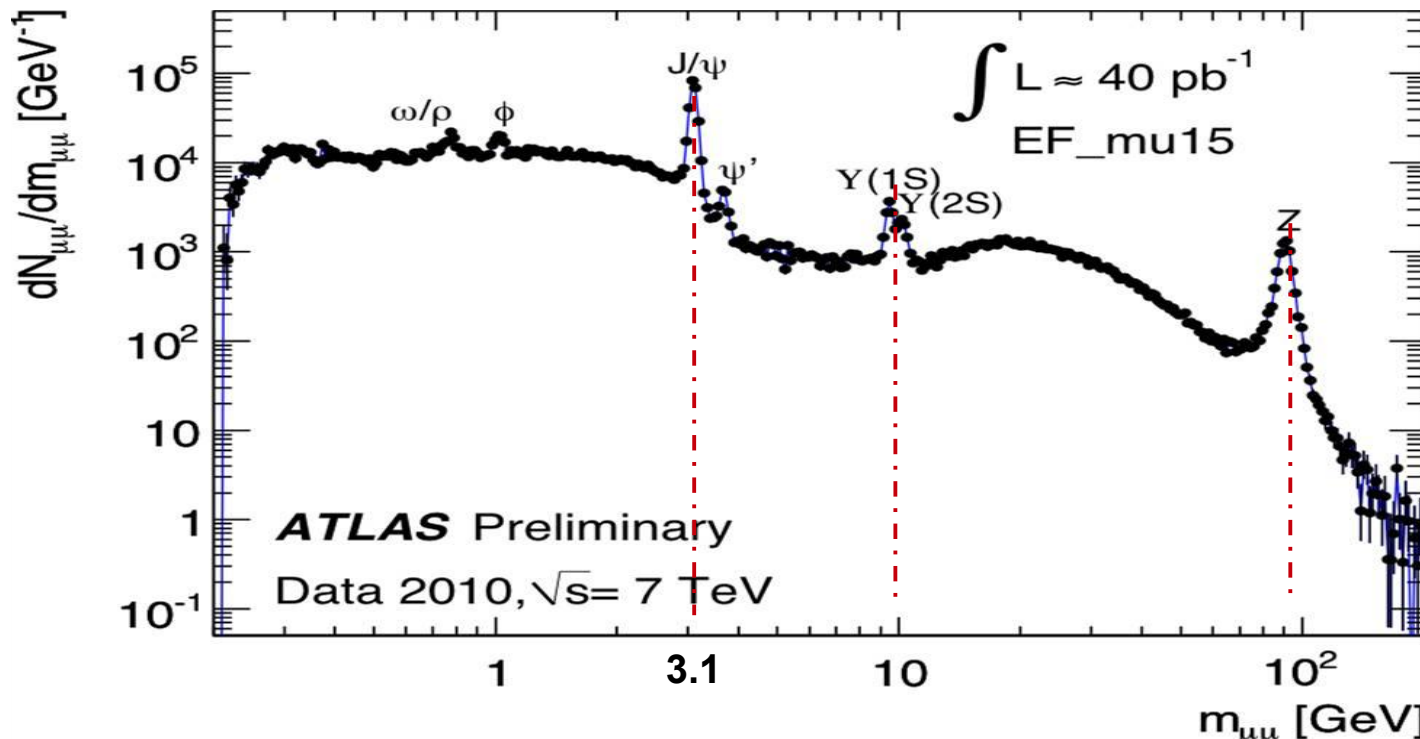
- calcolo la **massa invariante** del sistema finale M_i

$$m_0^{(Z)} = \sqrt{\left(\frac{(E_{e^-} + E_{e^+})}{c^2}\right)^2 - \left(\frac{\vec{p}_{e^-} + \vec{p}_{e^+}}{c}\right)^2}$$

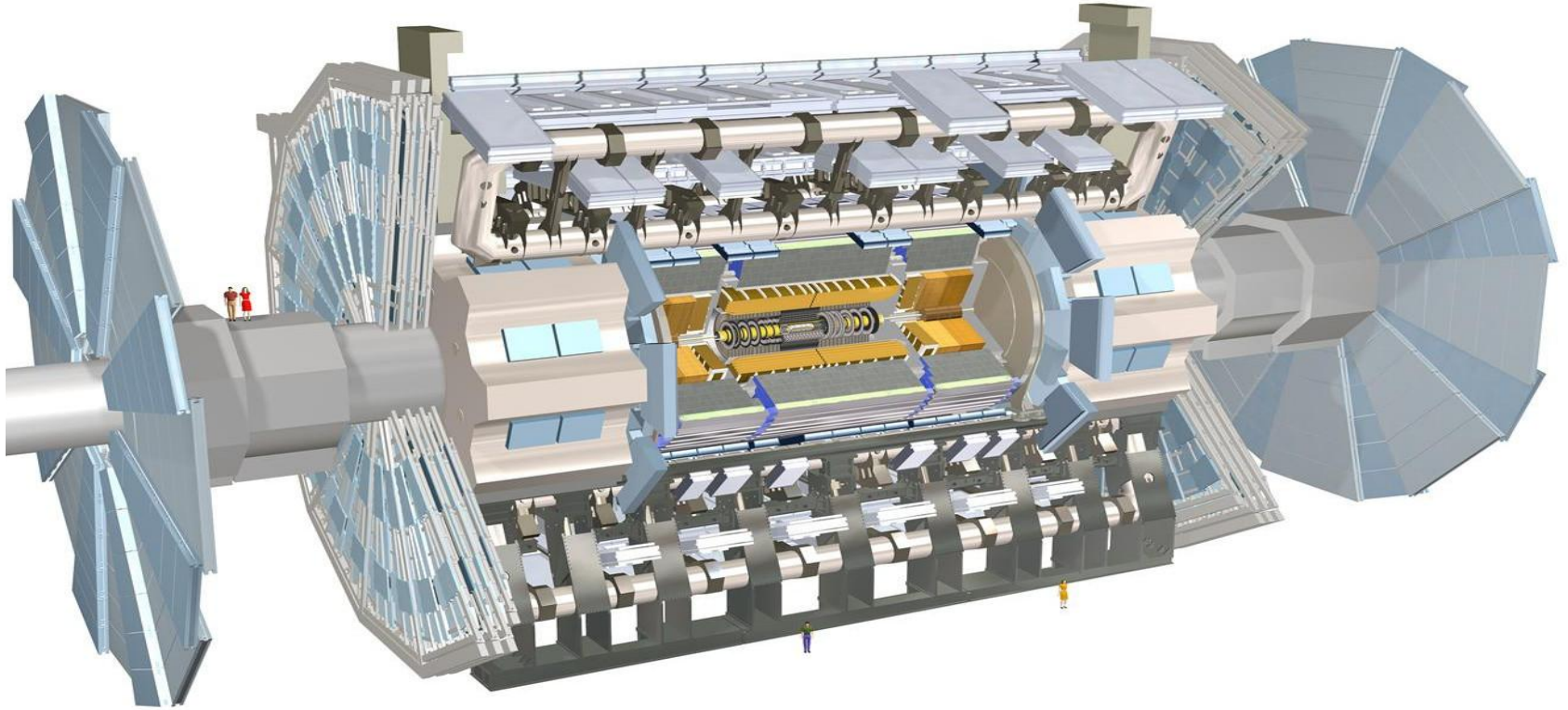
- Aggiungo un conteggio al canale dell'istogramma corrispondente ad M_i



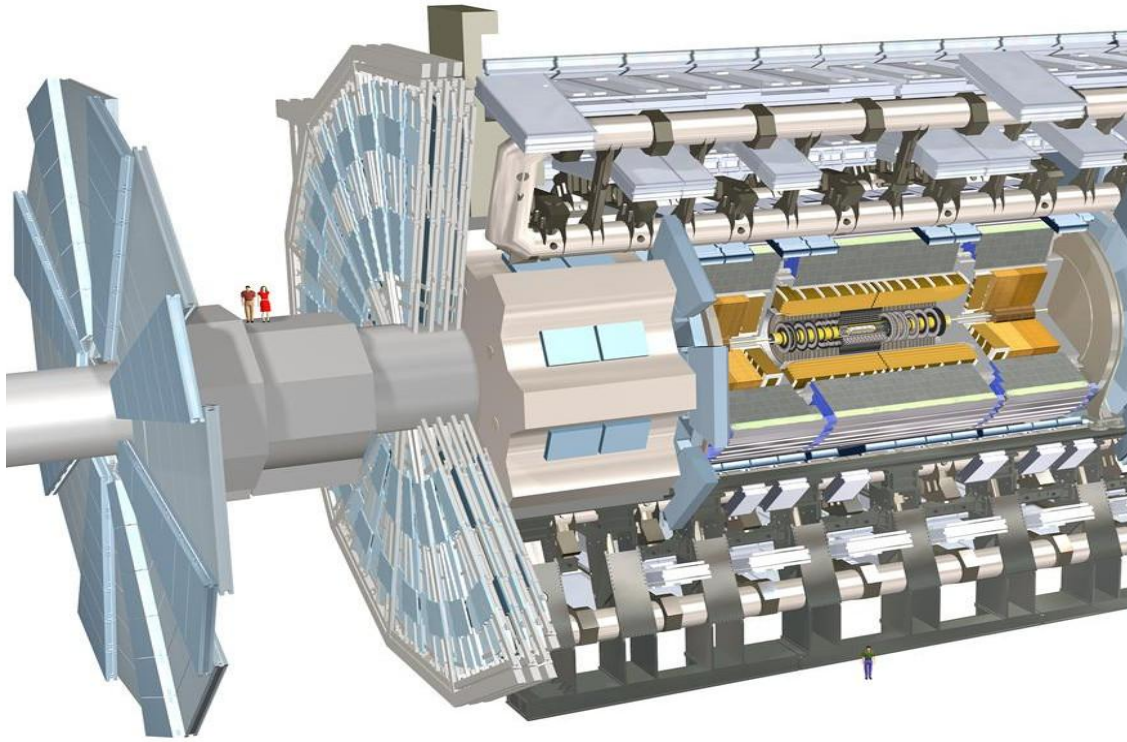
- Massa invariante del sistema dei due leptoni
 - La massa del “potenziale” progenitore



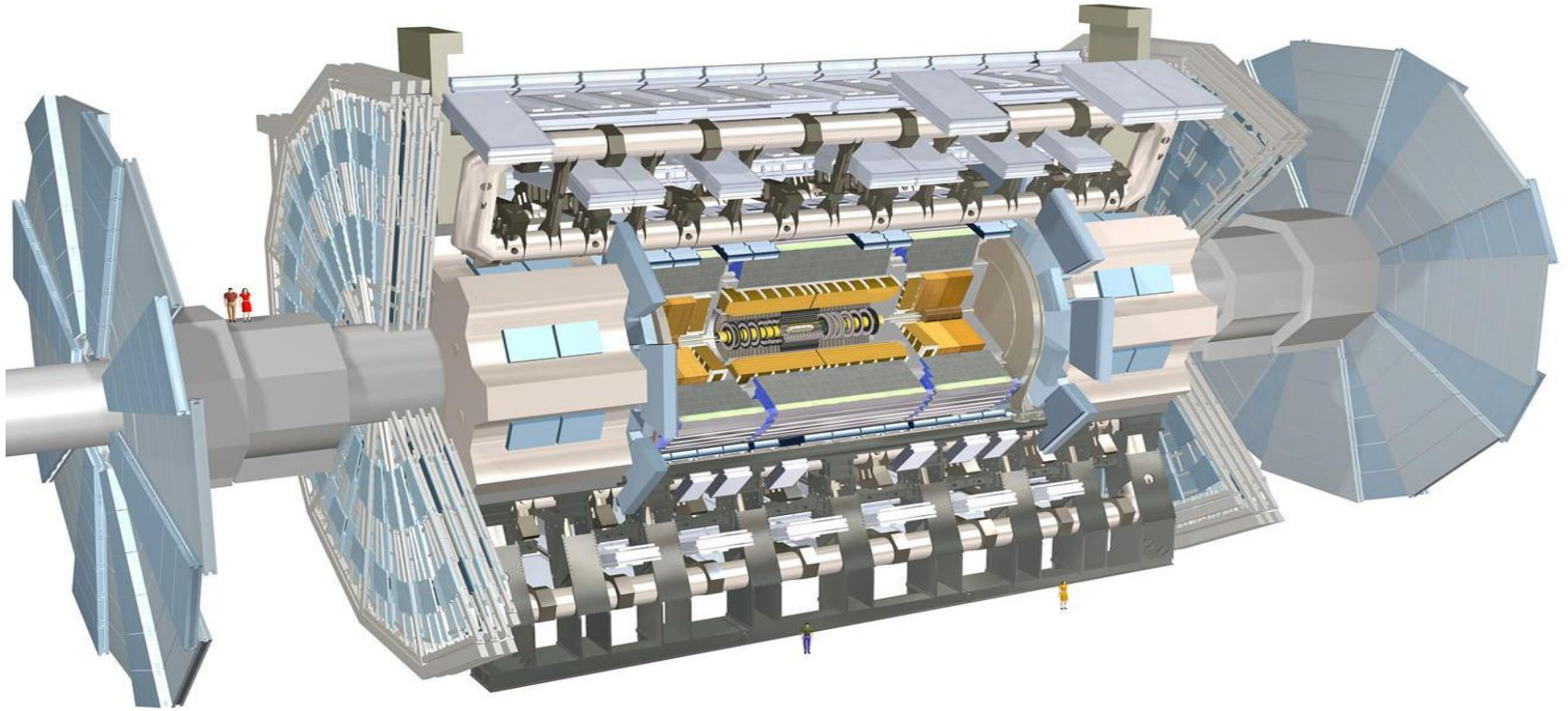
ATLAS



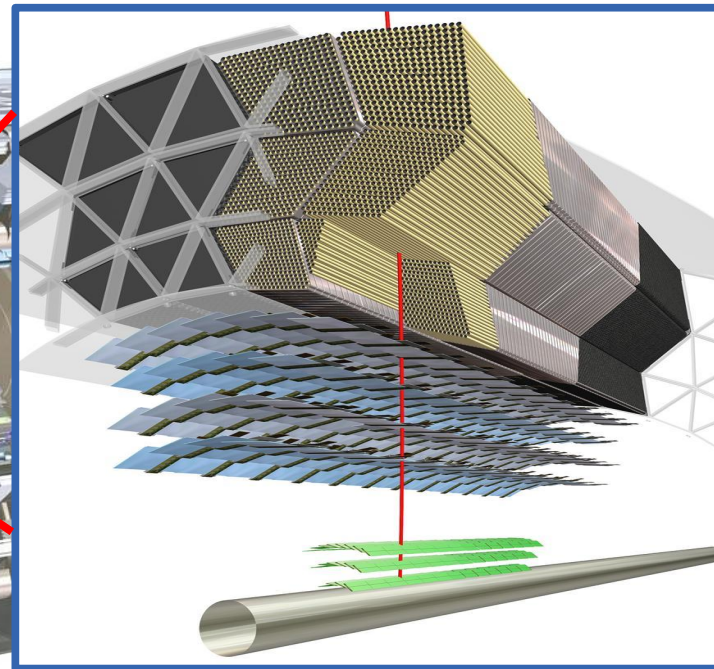
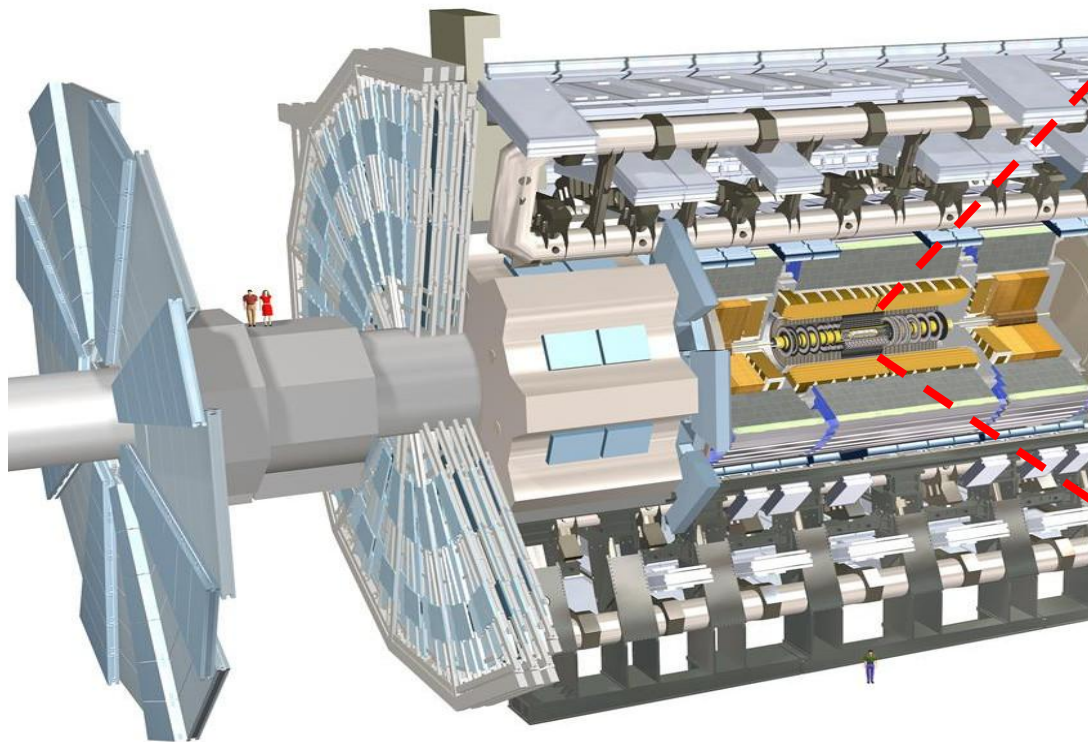
ATLAS



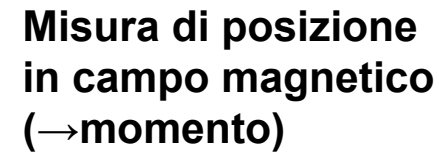
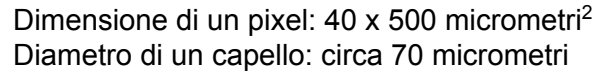
ATLAS



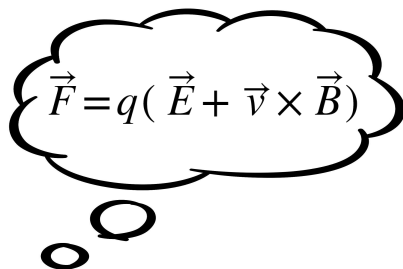
Tracciatore interno



**Misura di posizione
in campo magnetico
($\rightarrow$ momento)**

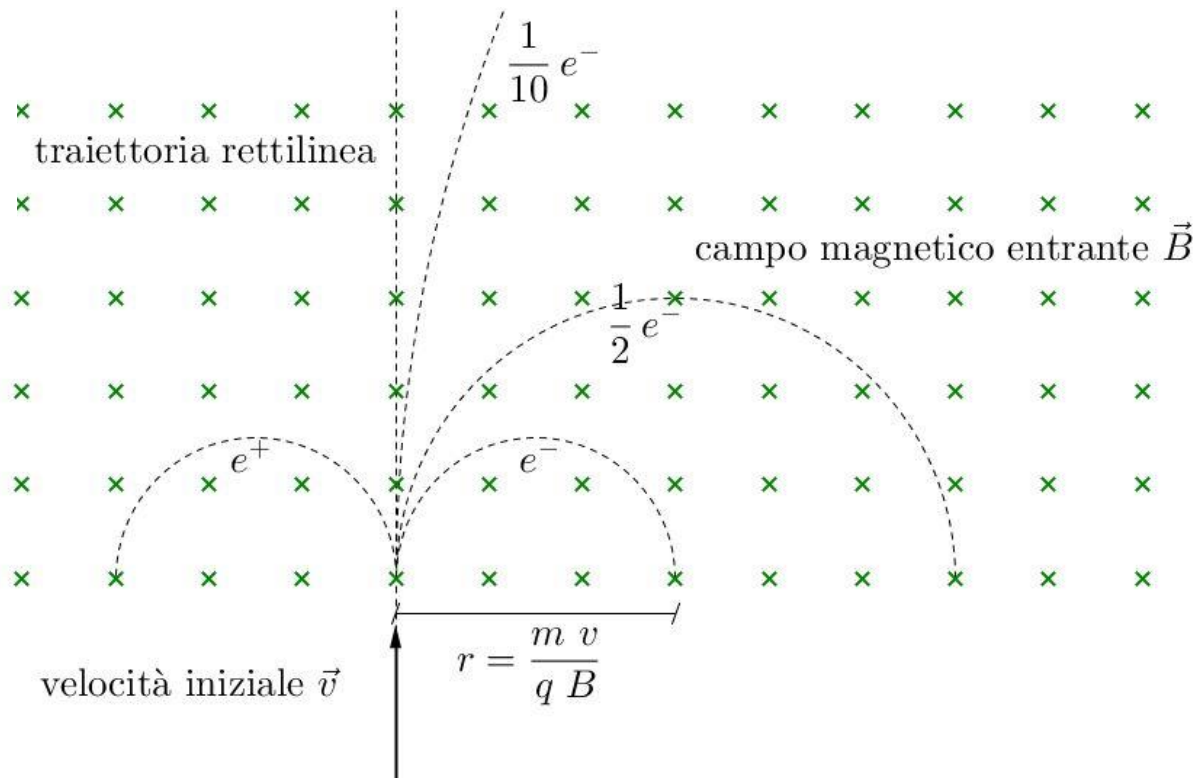


Misura del momento di una particella

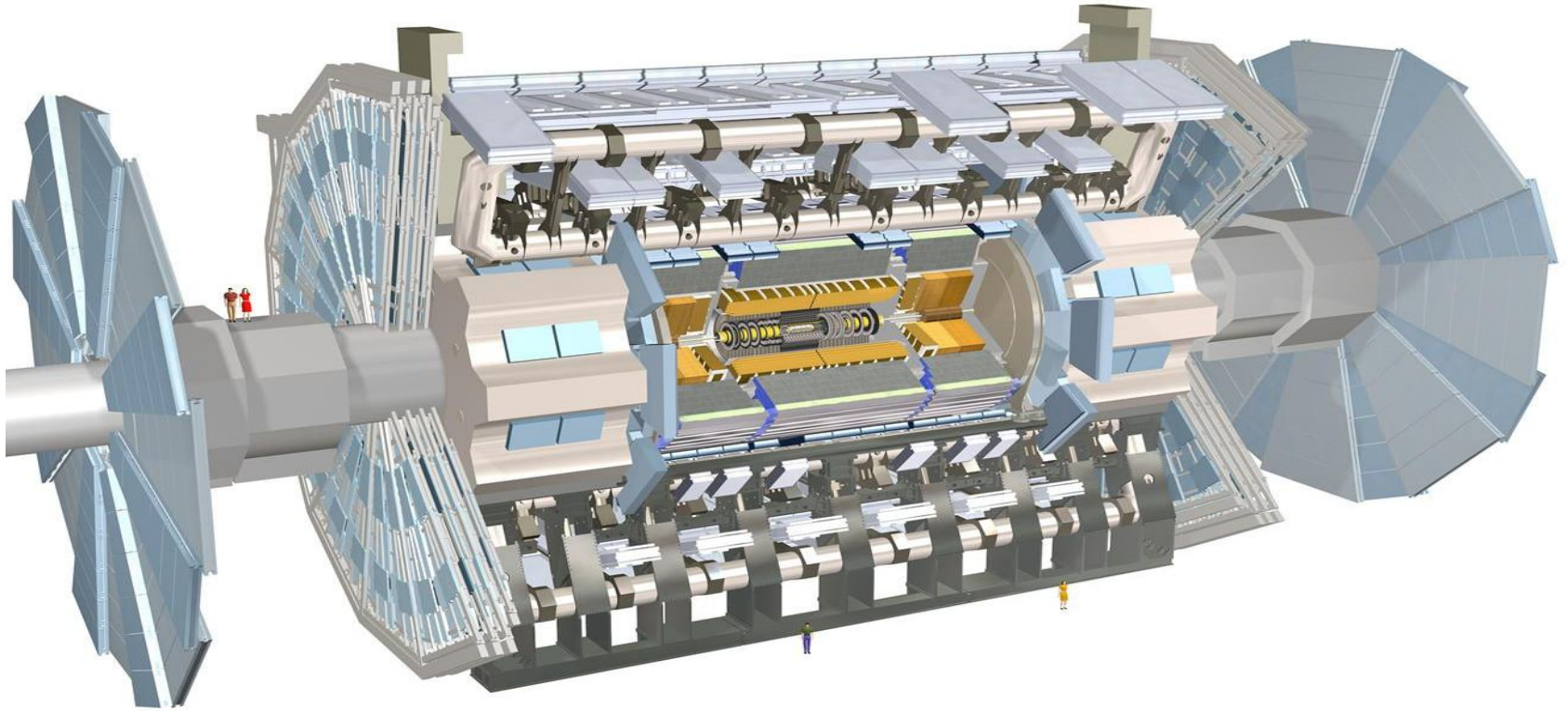

$$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$$



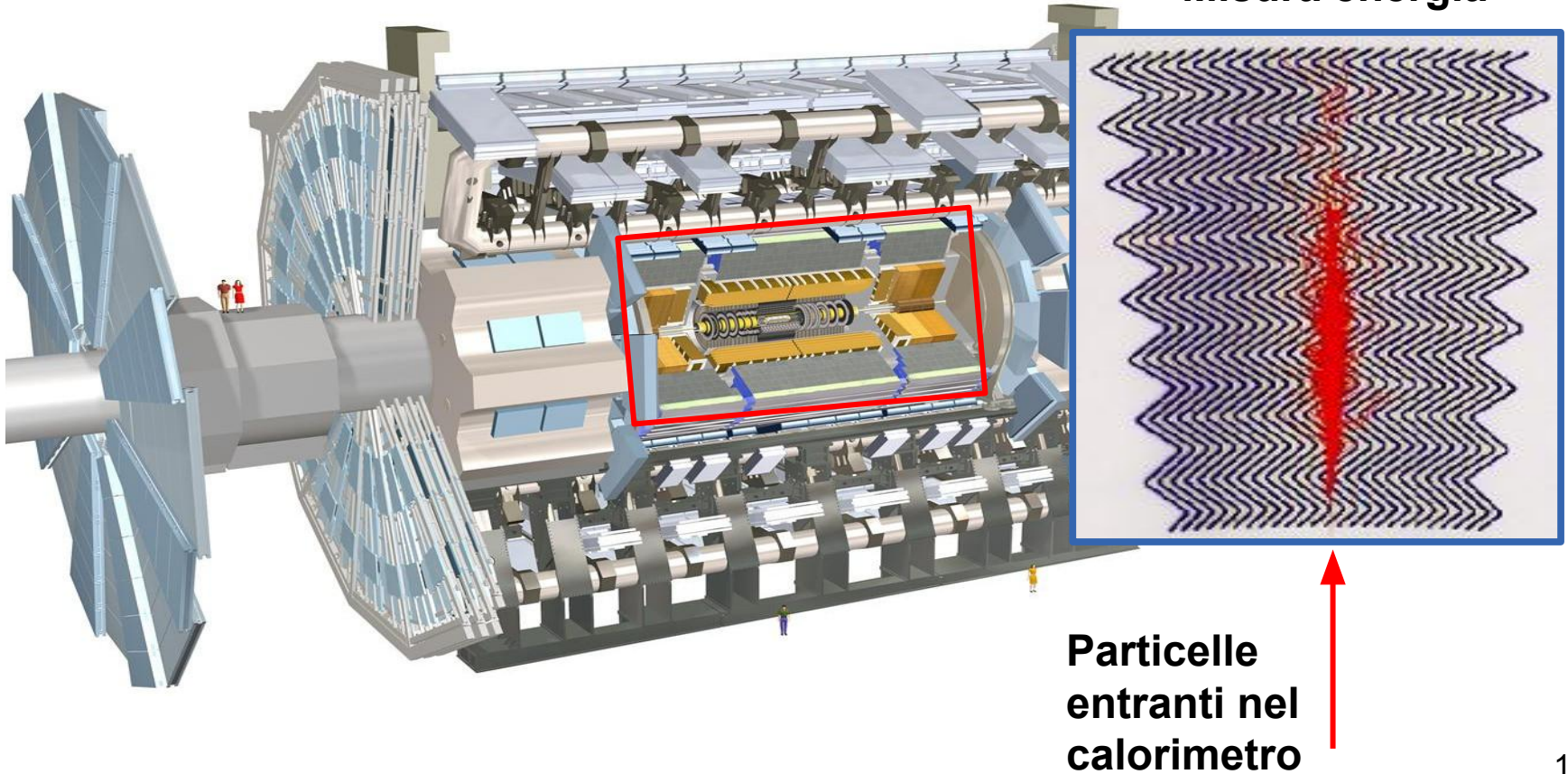
Hendrik Lorentz



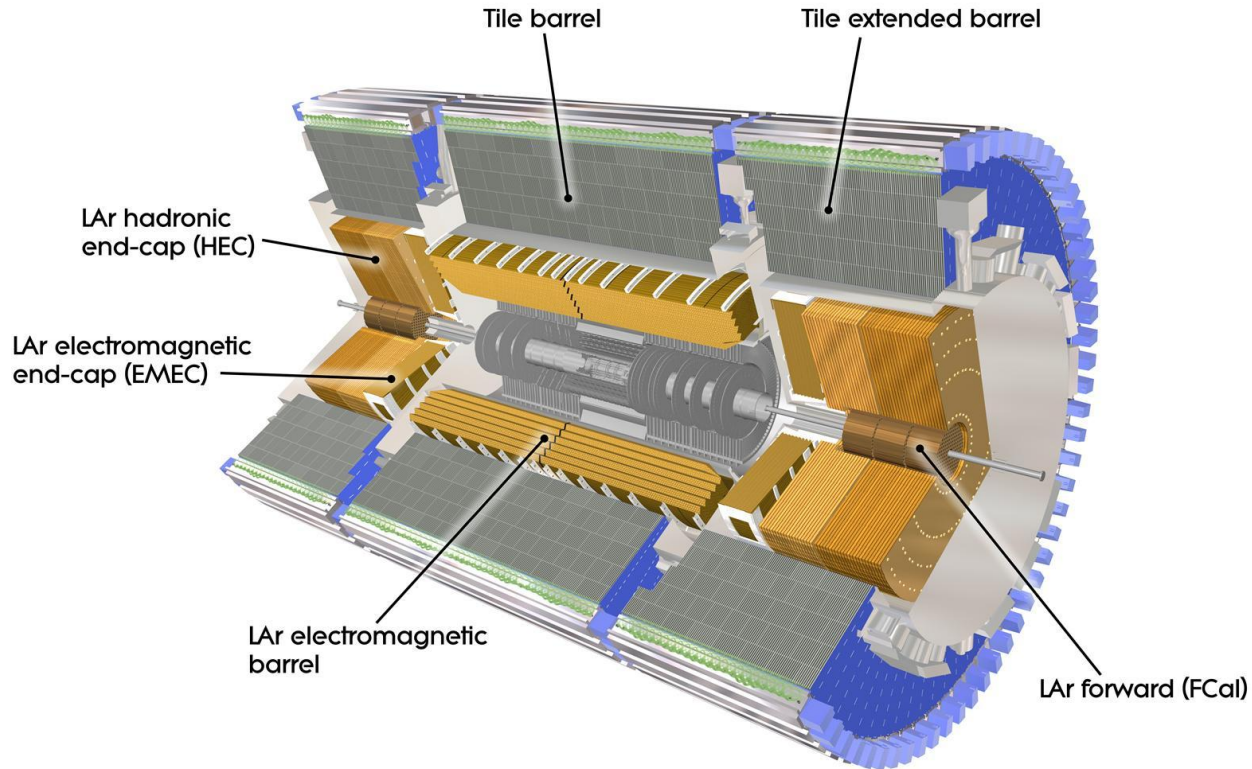
Sistema di calorimetria



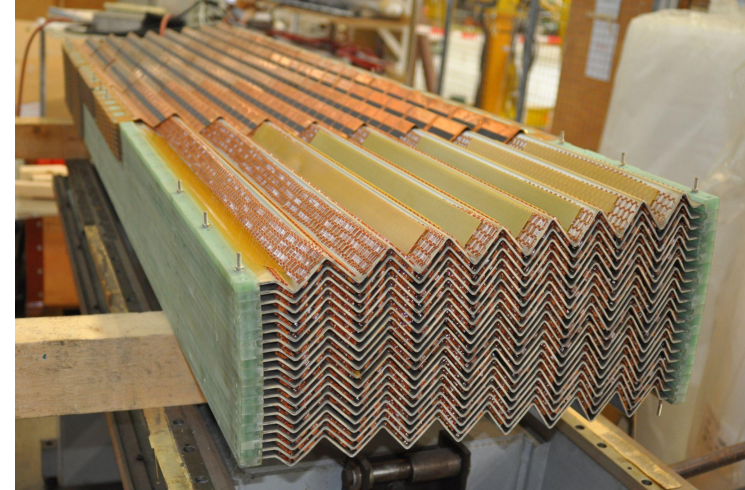
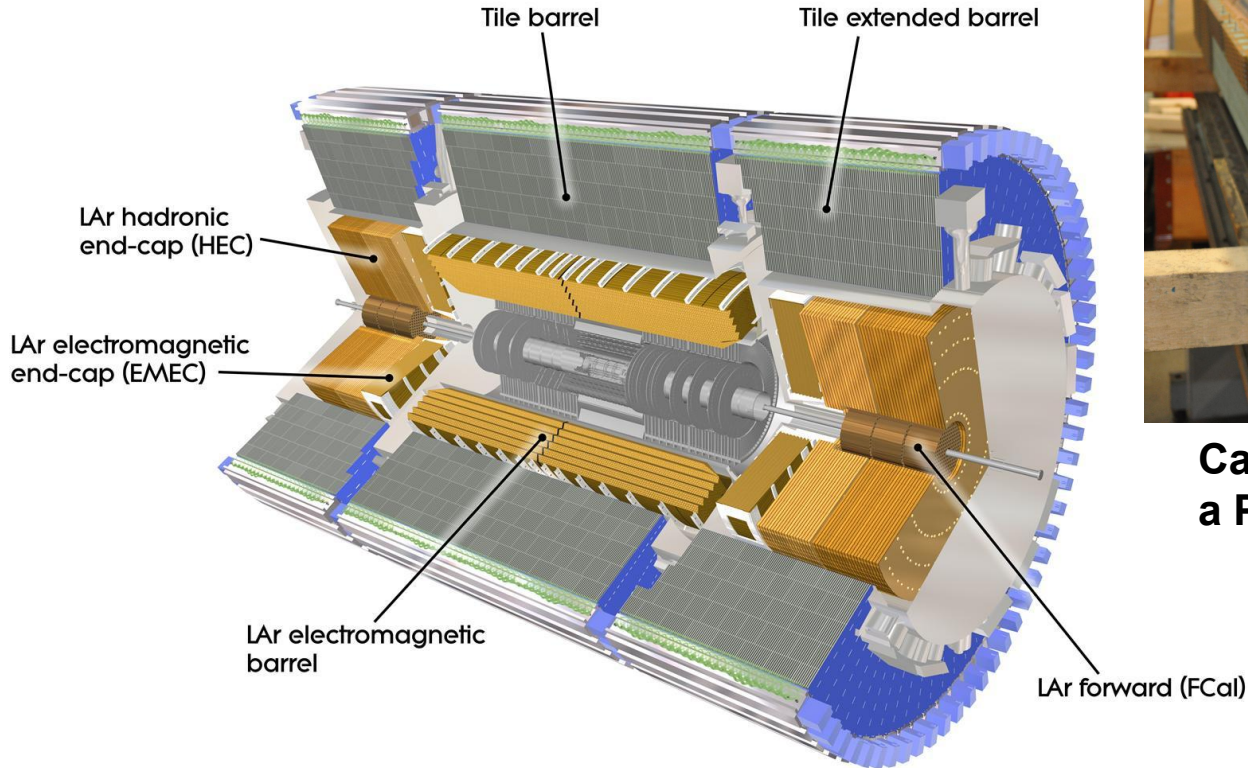
Misura energia



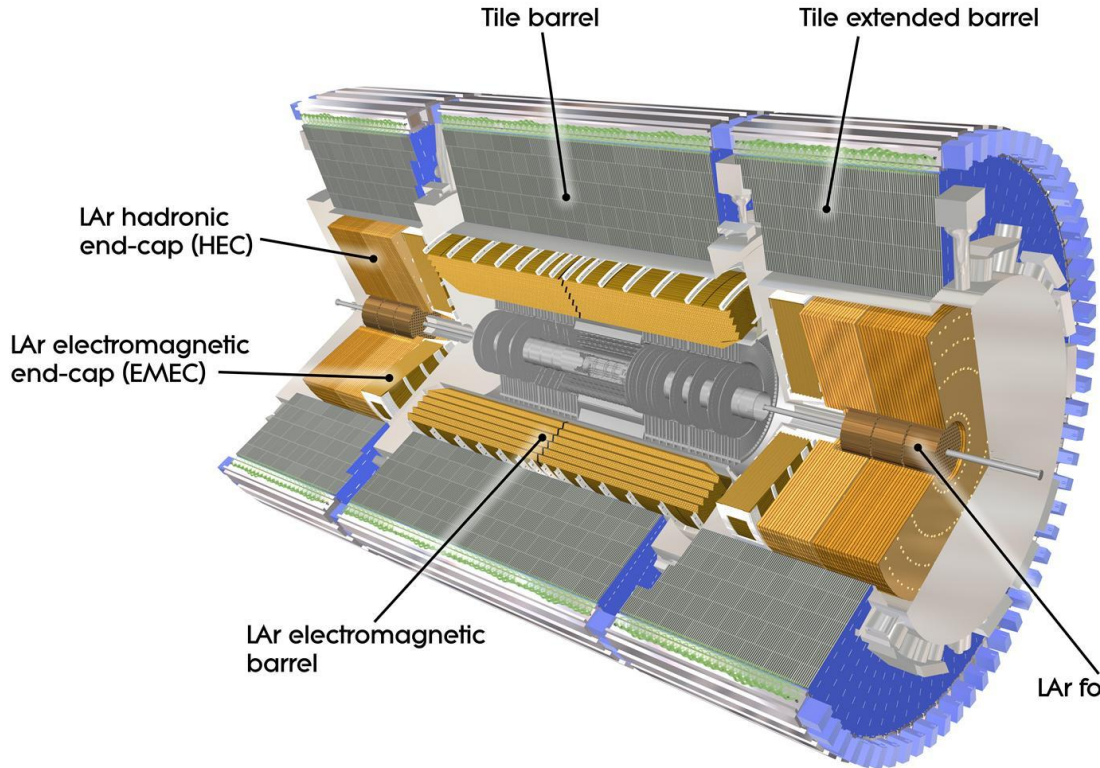
Sistema di calorimetria



Sistema di calorimetria



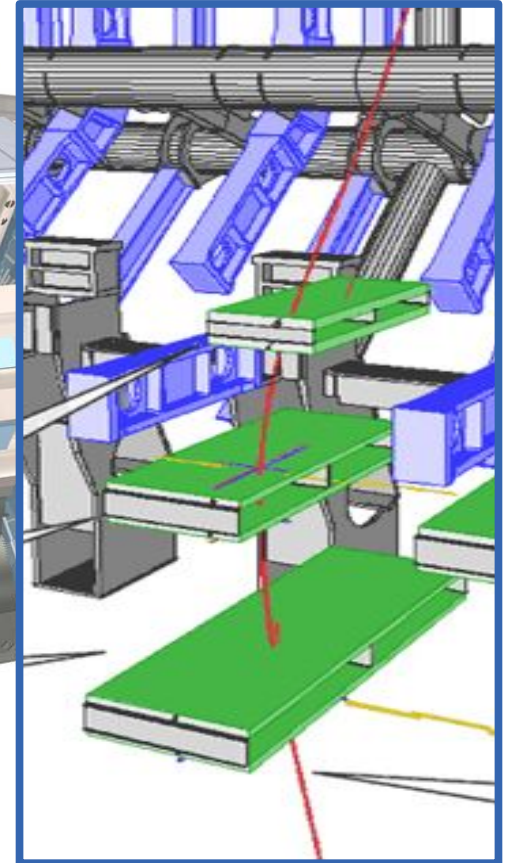
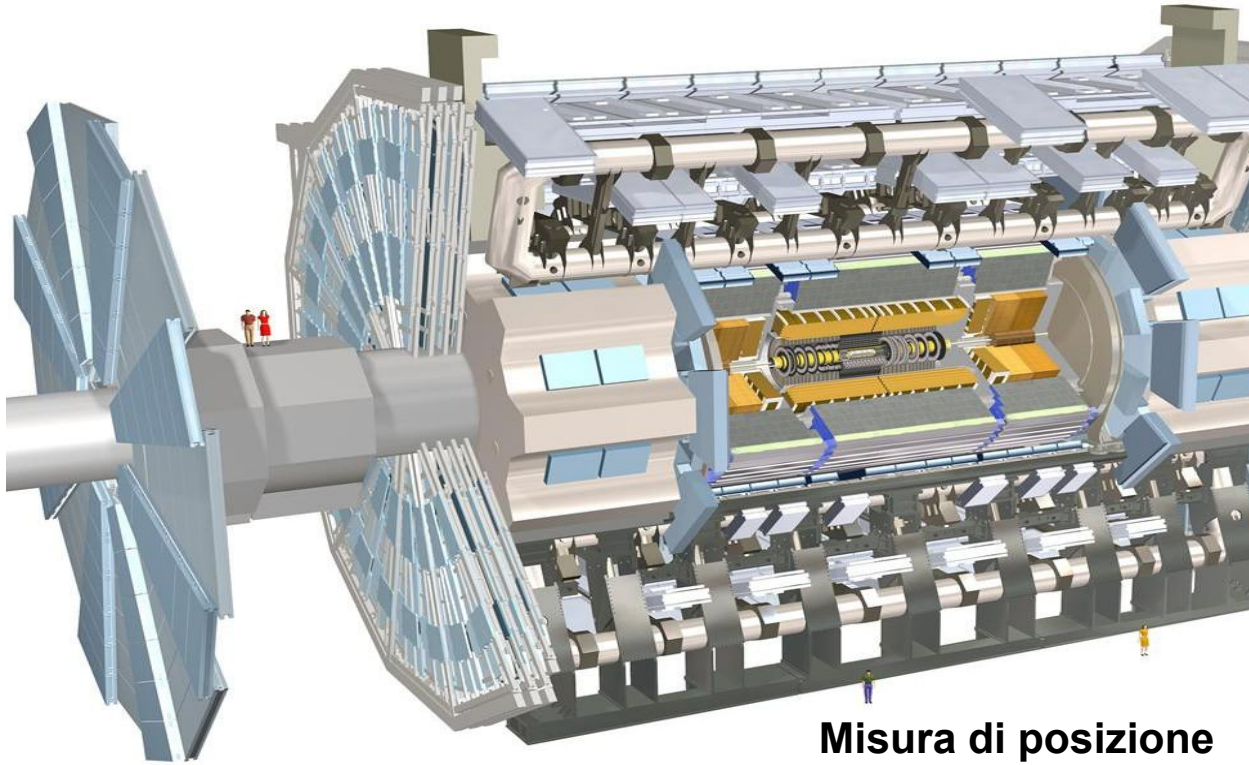
**Calorimetro elettromagnetico
a Piombo-Argon liquido**



Calorimetro adronico
Ferro e plastiche scintillanti

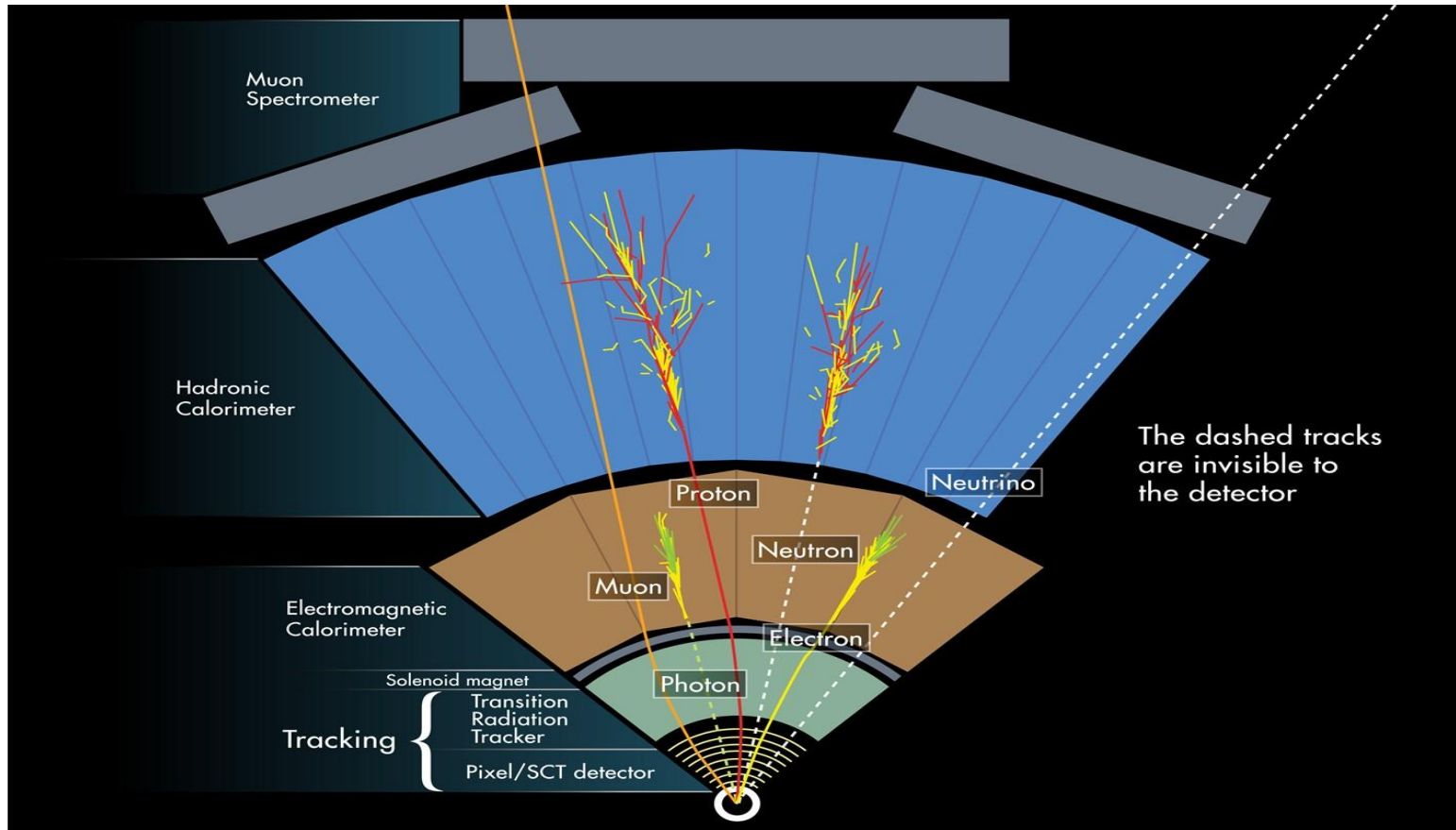


Spettrometro per i muoni



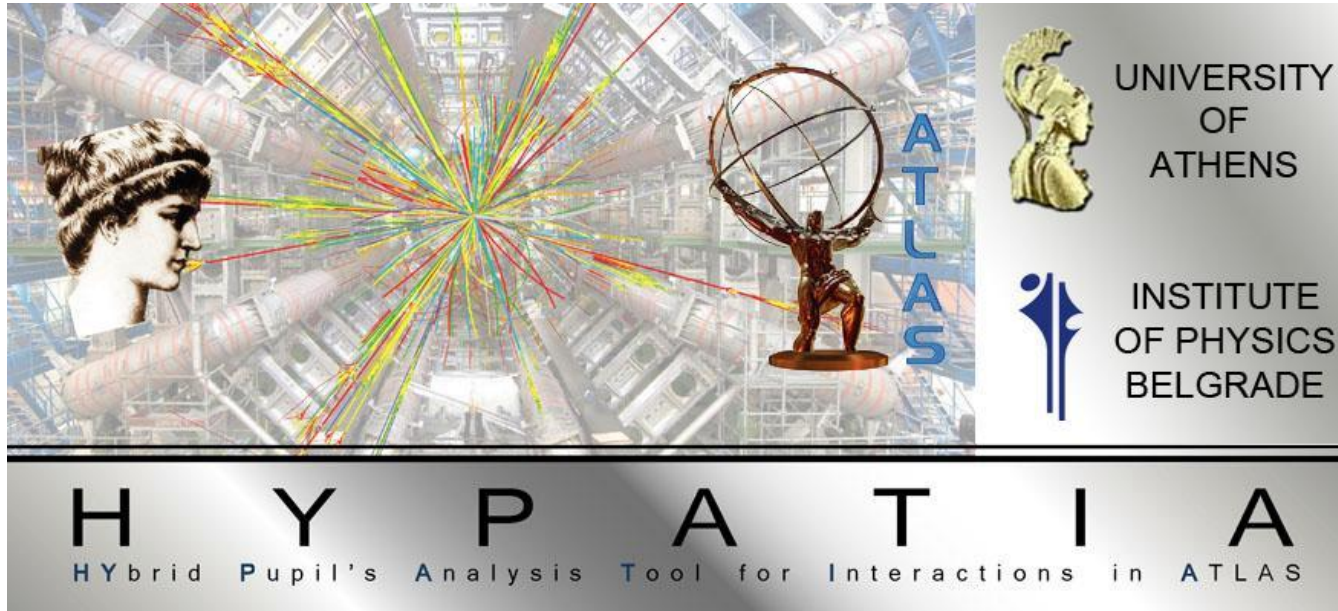
Misura di posizione
in campo magnetico
(→momento)

Identificazione delle particelle

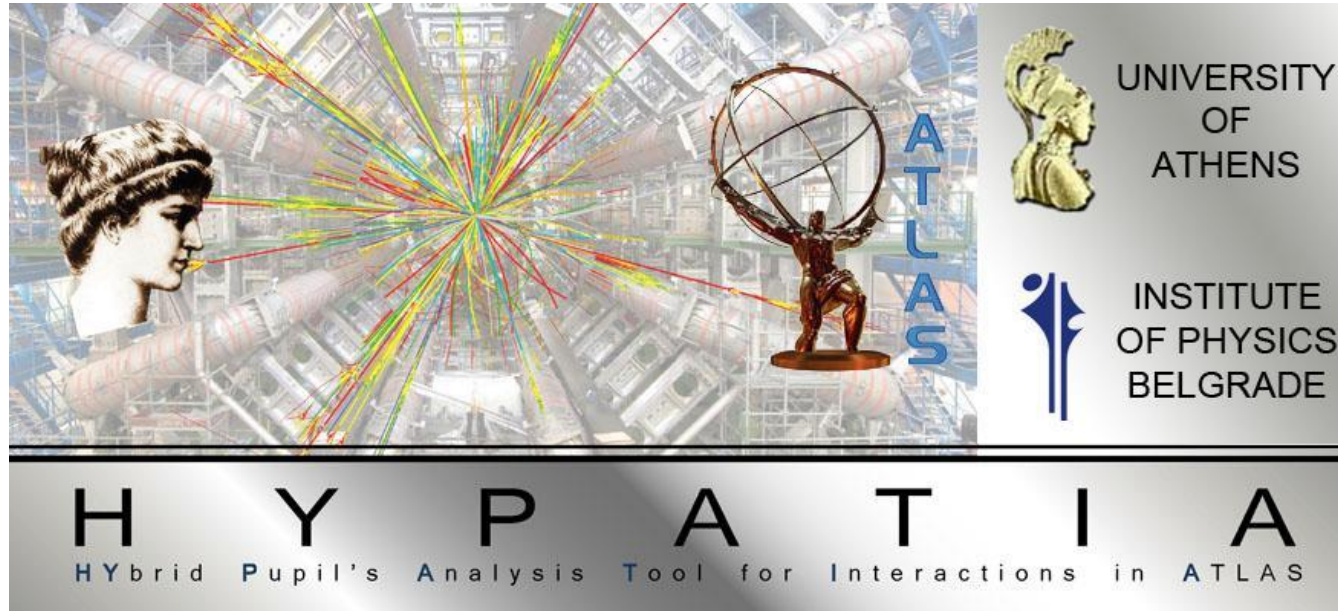


- ❖ Muoni, antimuoni
 - Tracce sia nel rivelatore interno che nello spettrometro
- ❖ Elettroni, positroni
 - Tracce nel rivelatore interno che puntano a depositi di energia nel calorimetro elettromagnetico
- ❖ Fotoni
 - Depositi di energia nel calorimetro senza tracce associate
- ❖ Jet (decadimenti di quark e gluoni)
 - “Fascio” di tracce che puntano a depositi di energia in entrambi i tipi di calorimetri
- ❖ Neutrini
 - Energia mancante nel piano trasverso rispetto al fascio

Hypatia Event Viewer

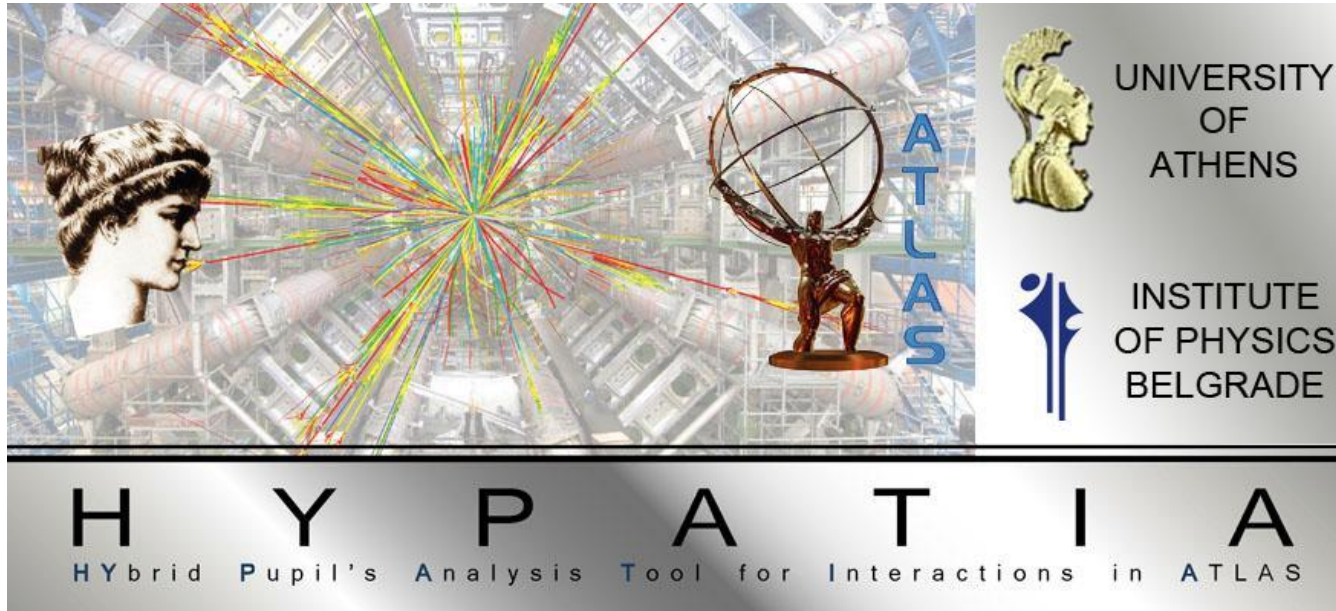


Hypatia Event Viewer



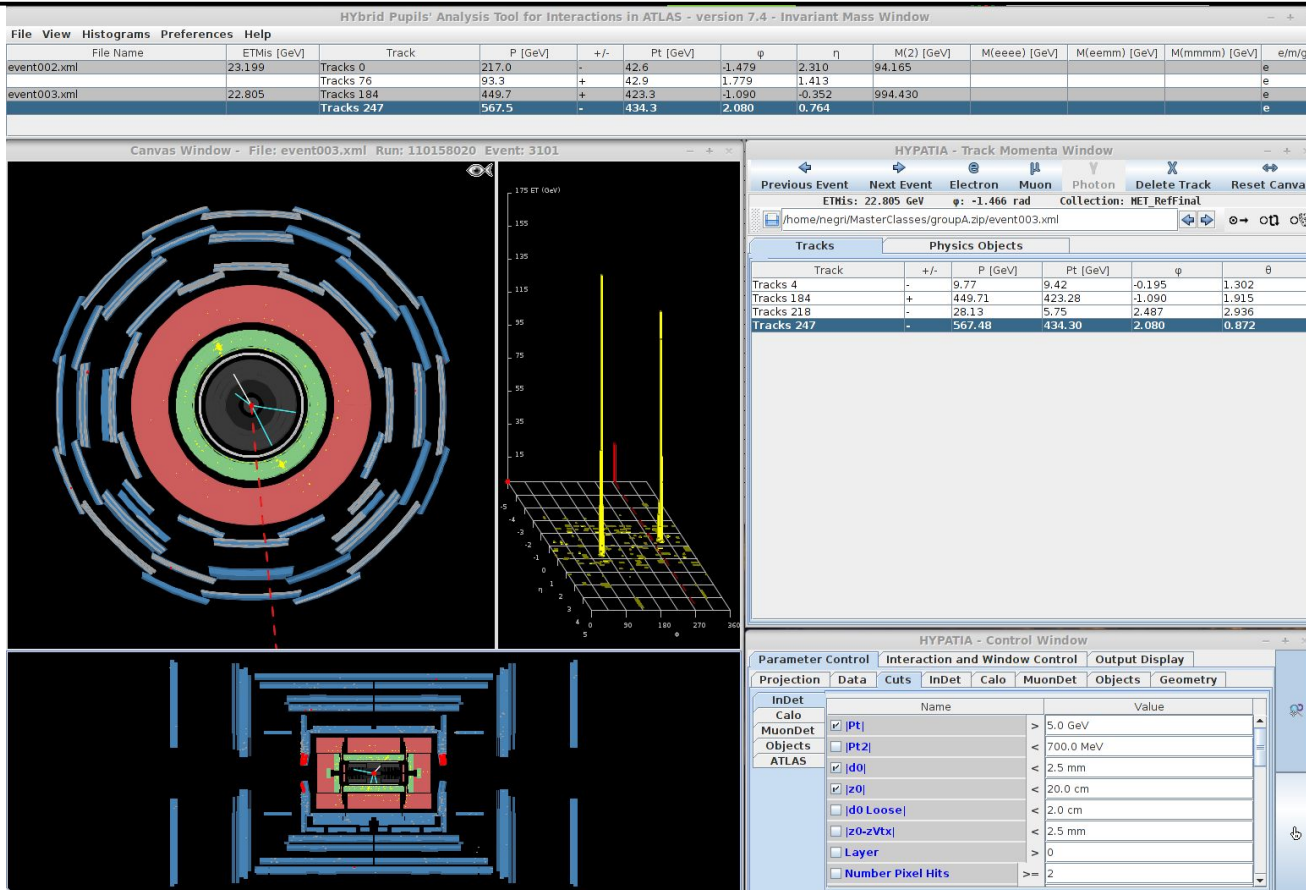
Doppio click sull'icona "MC.desktop" che trovate sullo schermo del laptop

Hypatia Event Viewer

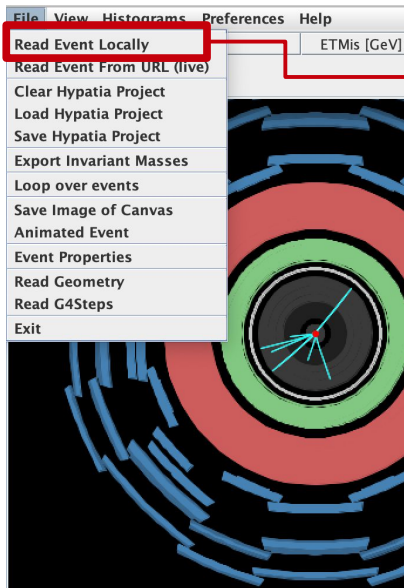


```
java -jar Hypatia_7.4_Masterclass.jar
```

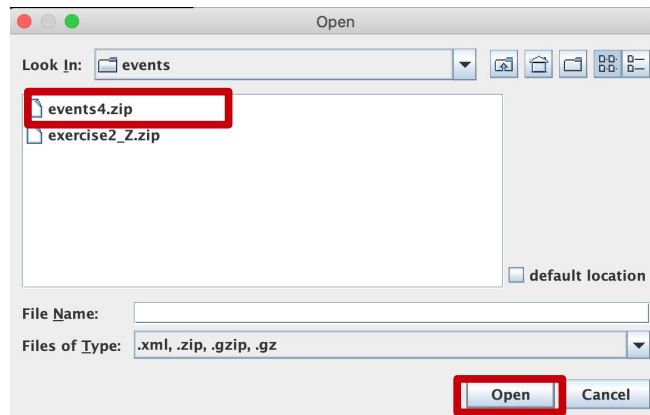
Hypatia Event Viewer



Data Files

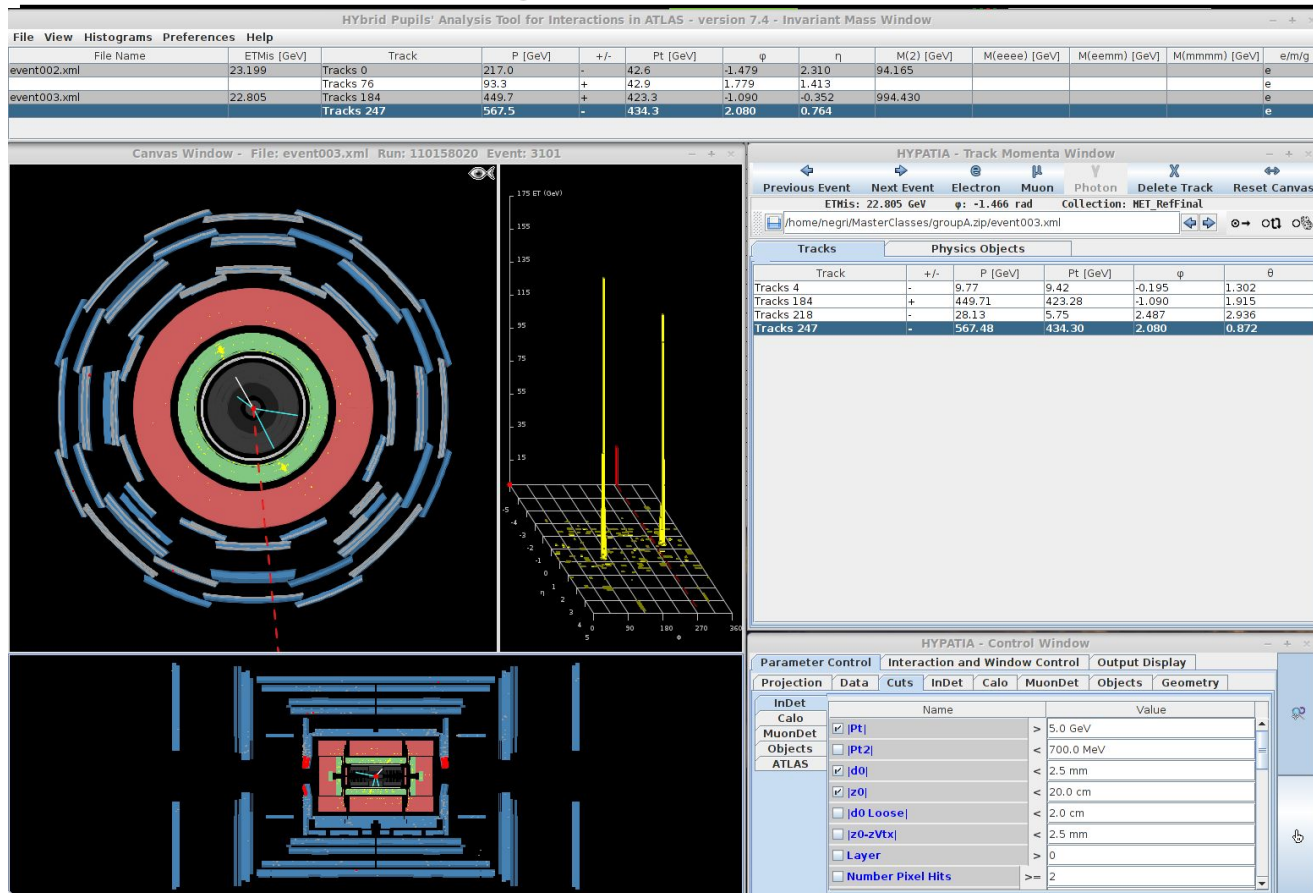


Per selezionare il file
di dati scaricato



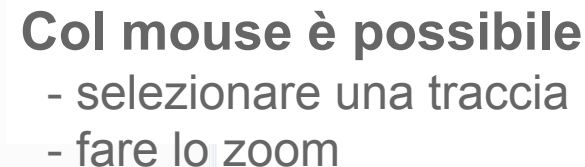
[groupA.zip](#)
[groupB.zip](#)
[groupC.zip](#)
[groupD.zip](#)
[groupE.zip](#)
[groupF.zip](#)
[groupG.zip](#)
[groupH.zip](#)
[groupI.zip](#)
[groupJ.zip](#)
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[groupQ.zip](#)
[groupR.zip](#)
[groupS.zip](#)
[groupT.zip](#)

Hypatia Event Viewer



Finestra grafica

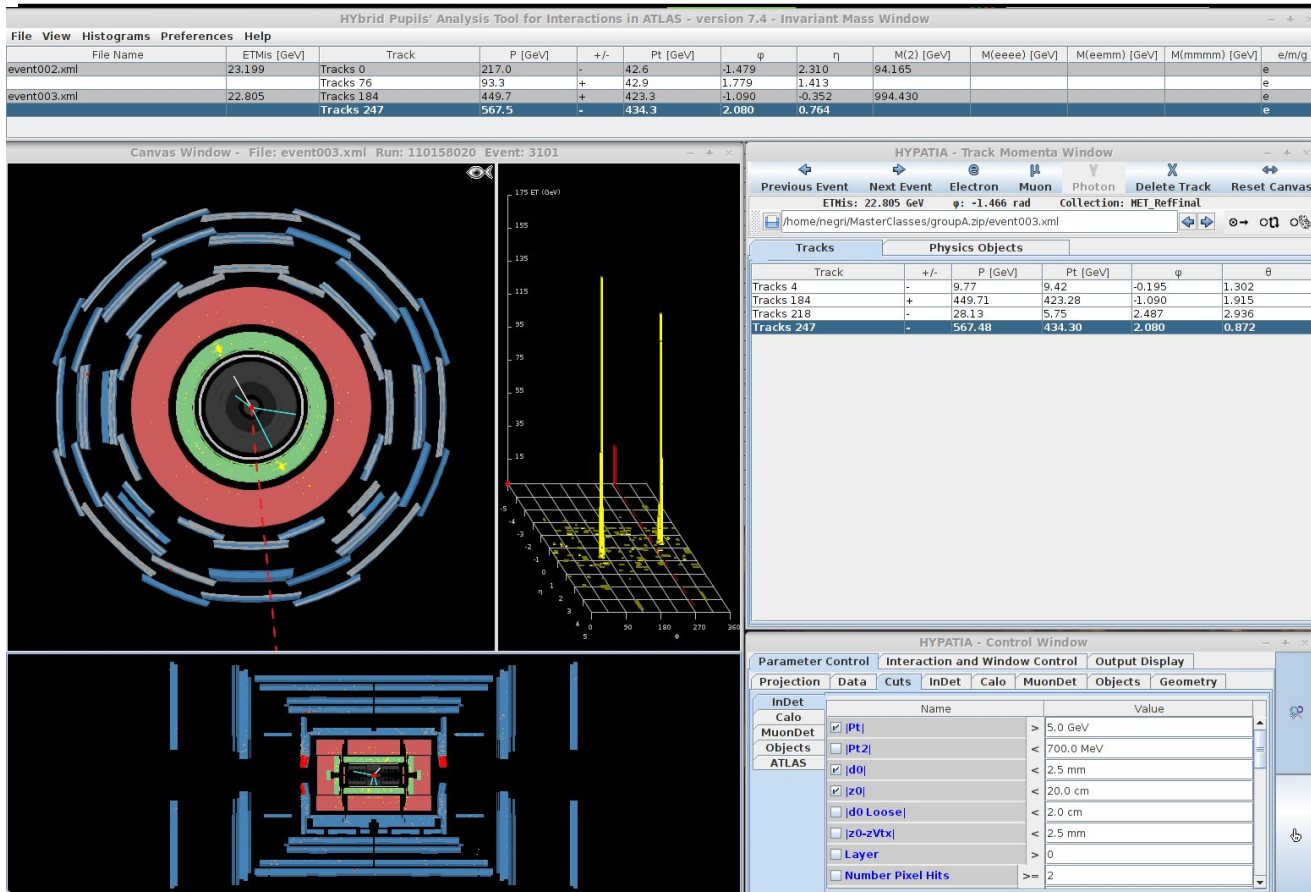




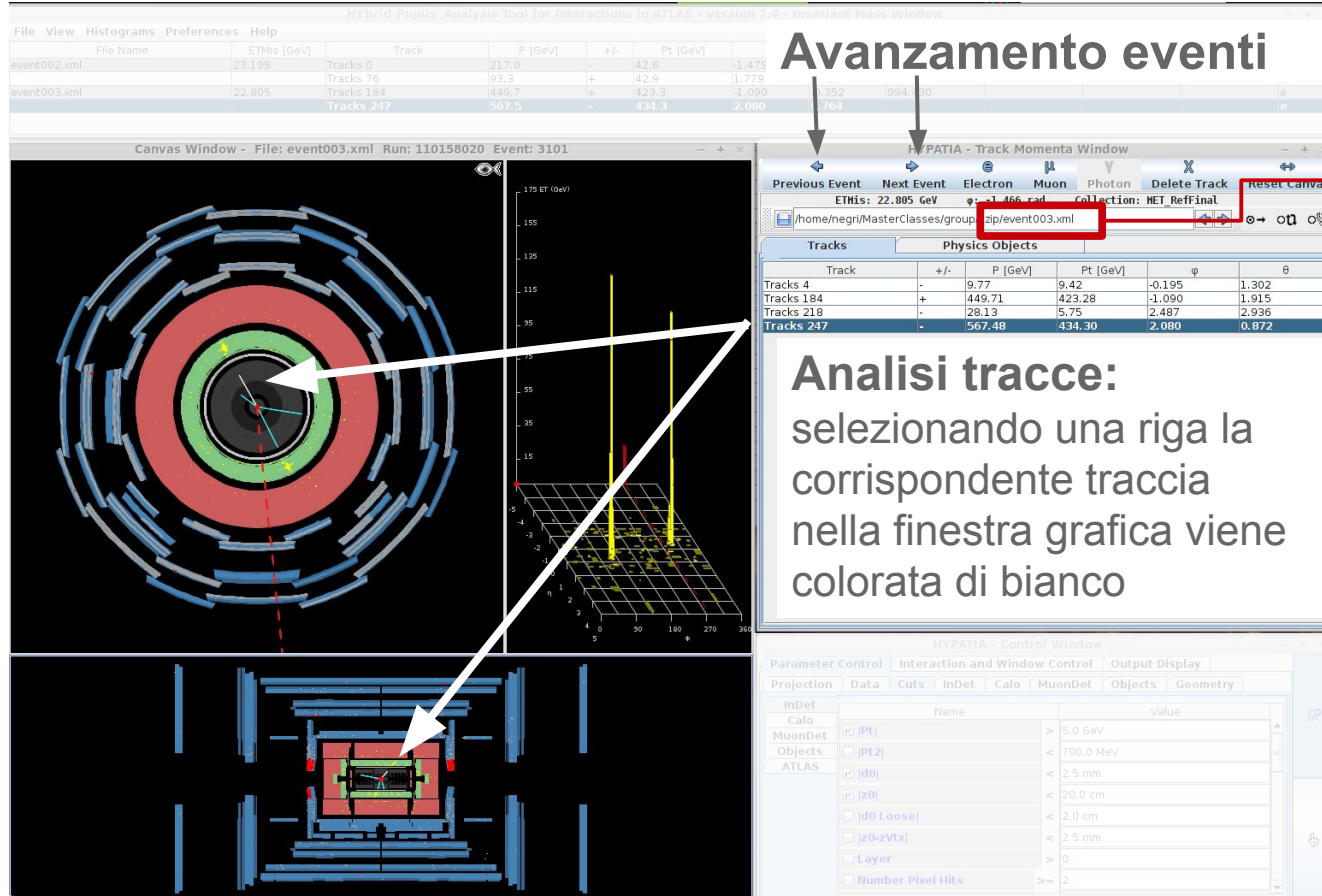
Tasto per modalità zoom

Tasto per modalità selezione

Hypatia Event Viewer



Finestra di controllo



numero evento

Finestra massa invariante

HYBRID Pupils' Analysis Tool for Interactions in ATLAS - version 7.4 - Invariant Mass Window

File Name	ETMis [GeV]	Track	P [GeV]	+/-	Pt [GeV]	ϕ	η	M(2) [GeV]	M(eeee) [GeV]	M(eemm) [GeV]	M(mmmm) [GeV]	e/m/g
event002.xml	23.199	Tracks 0	217.0	-	42.6	-1.479	2.310	94.165				e
		Tracks 76	93.3	+	42.9	1.779	1.413					e
event003.xml	22.805	Tracks 184	449.7	+	423.3	-1.090	-0.352	994.430				e
		Tracks 247	567.5	-	434.3	2.080	0.724					e

Canvas Window - File: event003.xml Run: 110158020 Event: 3101

massa invariante

HYPATIA - Track Momenta Window

Previous Event Next Event Electron Muon Photon Delete Track Reset Canvas

ETMis: 22.805 GeV ϕ : -1.466 rad Collection: MET Refinal

/home/negri/MasterClasses/groupA.zip/event003.xml

Track	+/-	P [GeV]	Pt [GeV]	ϕ	θ
Tracks 4	-	9.77	9.42	-0.195	1.302
Tracks 184	+	449.71	423.28	-1.090	1.915
Tracks 218	-	28.13	5.75	2.487	2.936
Tracks 247	-	567.48	434.30	2.080	0.872

Parameter Con
Projection D

InDet
Calo
MuonDet
Objects
ATLAS

Inserimento tracce

selezionare riga della traccia
premere tasto opportuno

Rimozione tracce

selezionare traccia
premere "delete track"

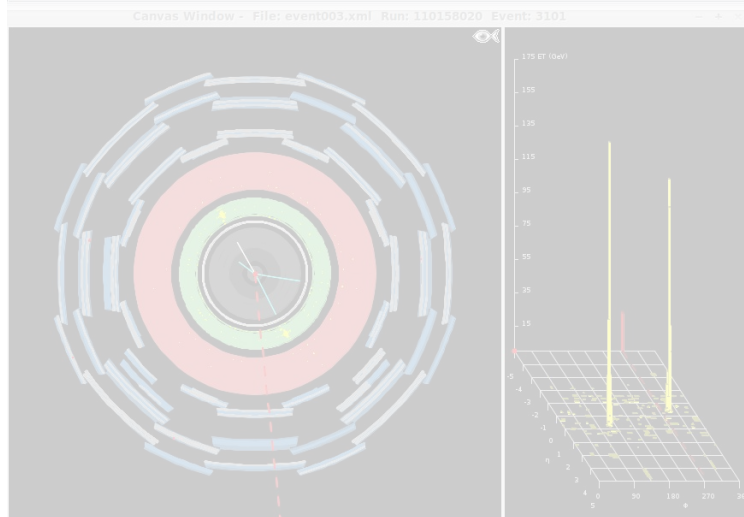
Calcola massa invariante

di ogni coppia di fotoni o
di leptoni di carica opposta

Finestra strumenti

HYbrid Pupile: Analysis Tool for Interactions in ATLAS - version 7.4 - Invariant Mass Window

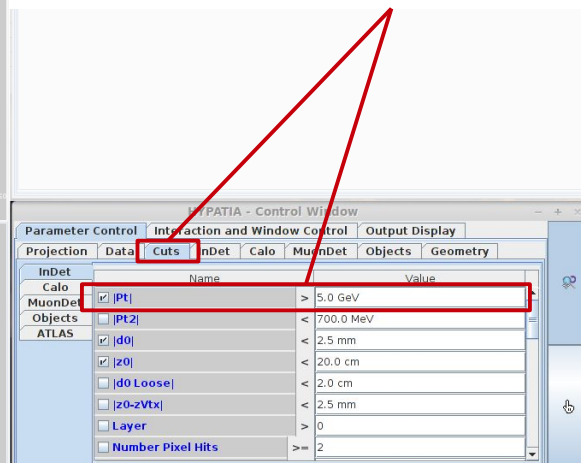
File Name	ETMis [GeV]	Track	P [GeV]	+/-	Pt [GeV]	η	η	M(2) [GeV]	M(eeee) [GeV]	M(eemm) [GeV]	M(mmmm) [GeV]	emig
event002.xml	23.199	Tracks 0	217.0	-	42.6	-1.479	2.310	94.165				e
		Tracks 76	93.3	+	42.9	-1.779	1.413					e
event003.xml	22.805	Tracks 184	449.7	+	423.3	-1.090	-0.352	994.430				e
		Tracks 247	567.5	-	434.3	2.080	0.764					e

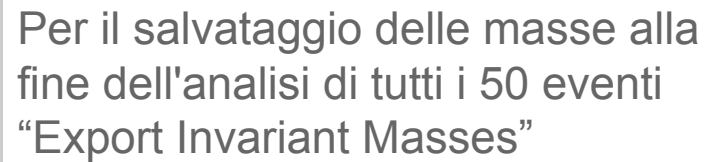


Taglio sulle tracce

Visualizzazione delle sole tracce
con momento superiore ad una
certa soglia

Partire sempre da 5 GeV





Hypatia Event Viewer

Interactions in ATLAS - version 7.4 - Invariant Mass Window

File Name	Tracks	Pt [GeV]	η	ϕ	M(2) [GeV]	M(eeee) [GeV]	M(eemm) [GeV]	M(mmmm) [GeV]	e/m/g
event002.xml	Tracks 0	217.0	-1.479	2.310	94.165				e
event003.xml	Tracks 76	93.3	42.9	1.779	1.413				e
		423.3	-1.090	-0.352					e
		434.3	2.080	0.764	994.430				e

Canvas Window - File: event003.xml, Run: 110158020, Event: 3101

Vista trasversale (dalla linea del fascio)

Sviluppo piano celle calorimetro

Vista longitudinale

Previous Event Next Event Electron Muon Photon Delete Track Reset Canvas

Tracks Physics Objects

Tracks	η	Pt [GeV]	ϕ	θ
Tracks 4	- 9.77	9.42	-0.195	1.302
Tracks 184	+ 449.1	423.28	-1.090	1.915
Tracks 218	- 28.1	5.75	2.487	2.936
Tracks 247	- 567.18	434.30	2.080	0.872

HYPATIA - Control Window

Parameter Control Interaction and Window Control Output Display

Projection Data Cuts InDet Calo MuonDet Objects Geometry

InDet Calo MuonDet Objects ATLAS

Mass

Value

Taglio momento tracce

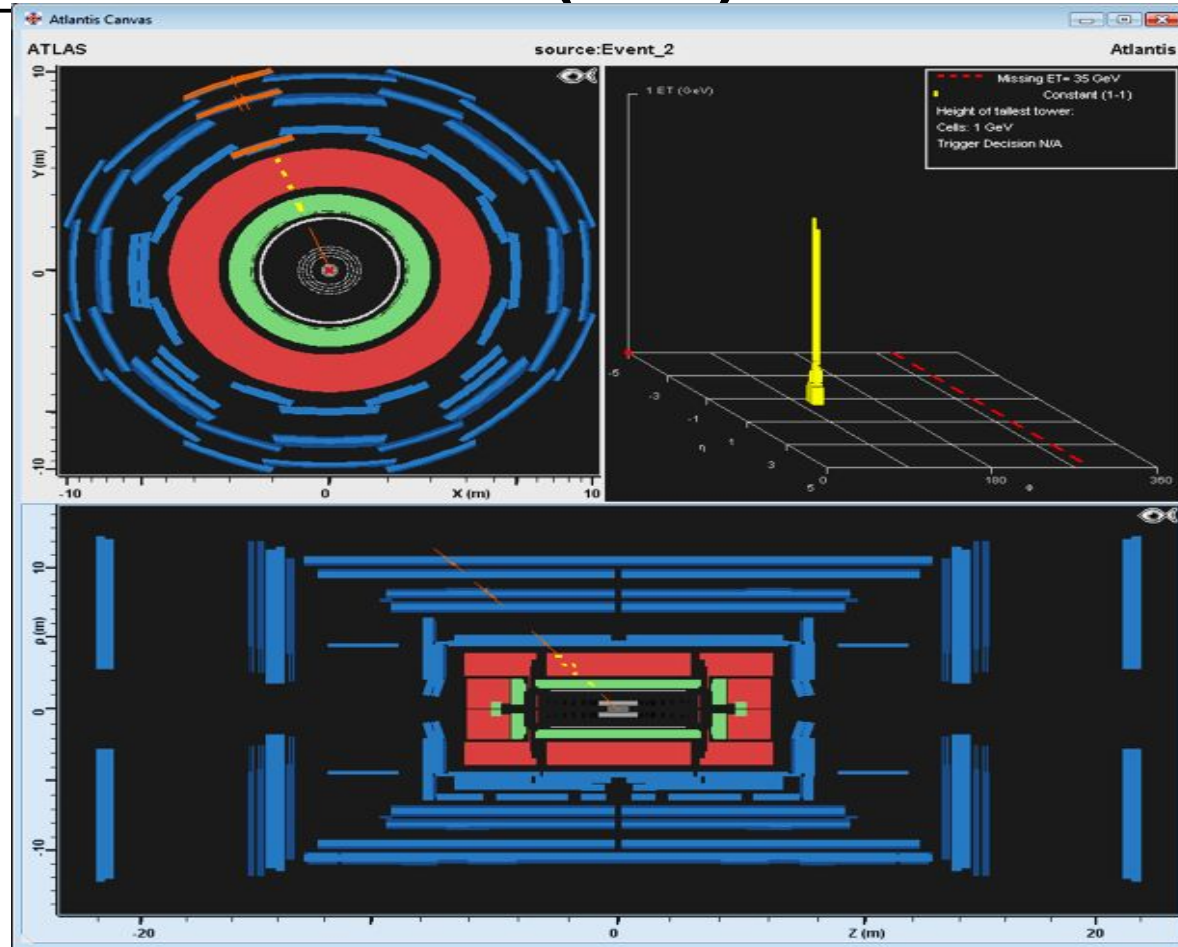
Inserimento tracce per calcolo masse

Scheda oggetti: fotoni

Scheda tracce: elettroni e muoni

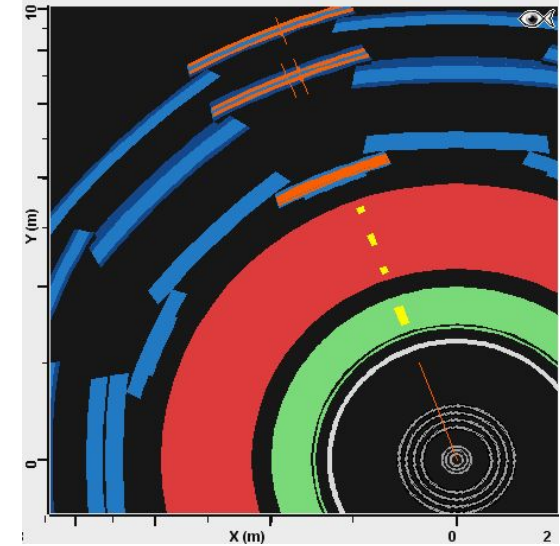
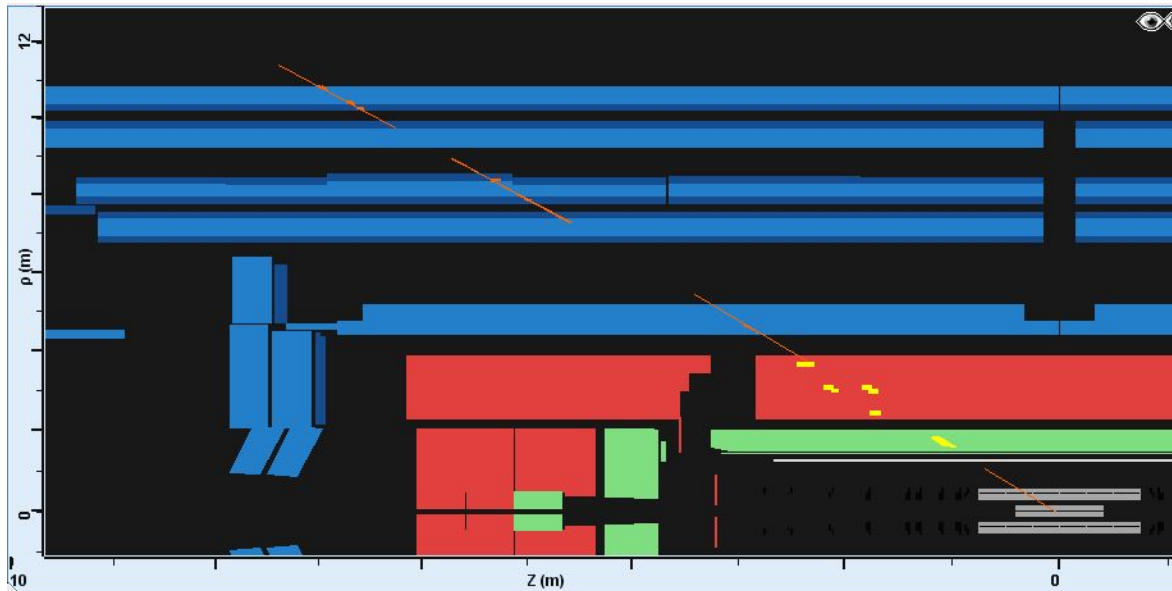
Tasti cambio modalità: zoom / selezione

Identikit: (anti)muoni

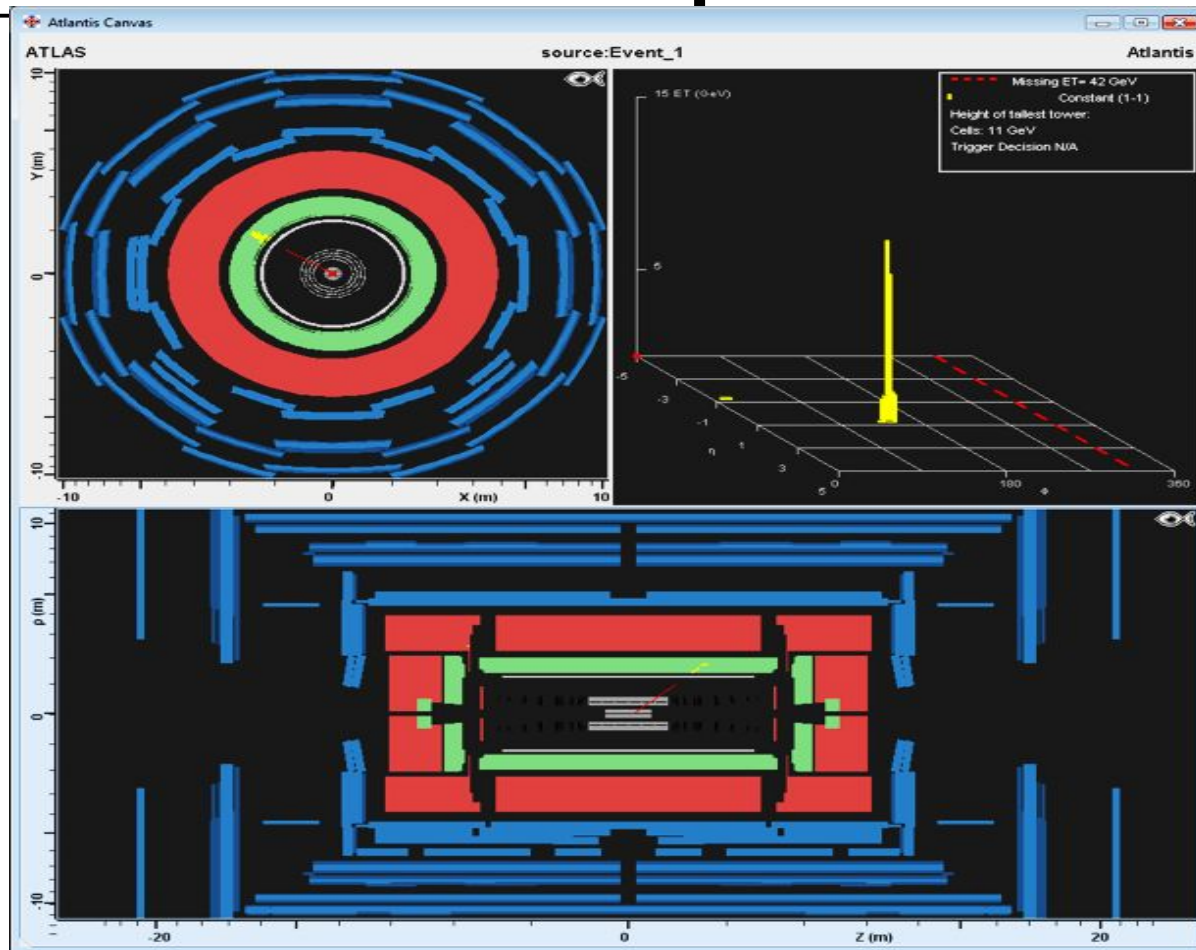


Identikit: (anti)muoni

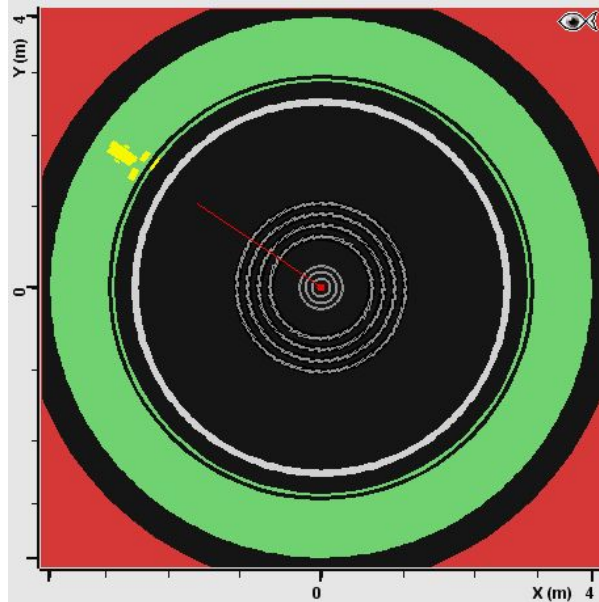
Traccia nel rivelatore interno e nello spettrometro senza significativi depositi di energia nei calorimetri



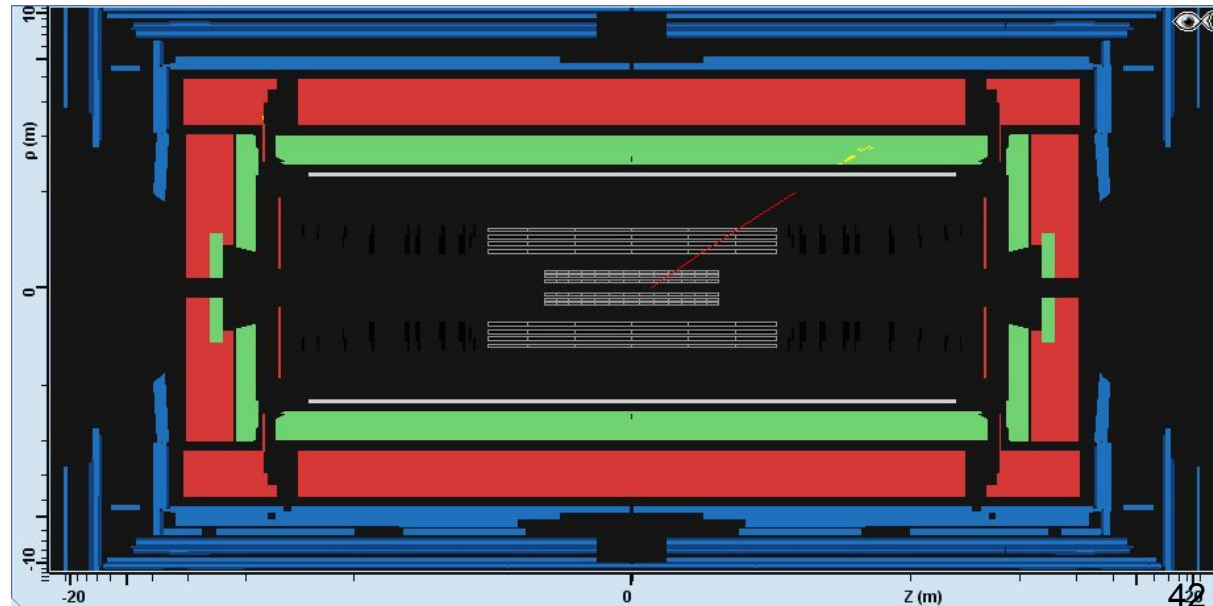
Identikit: elettroni/positroni



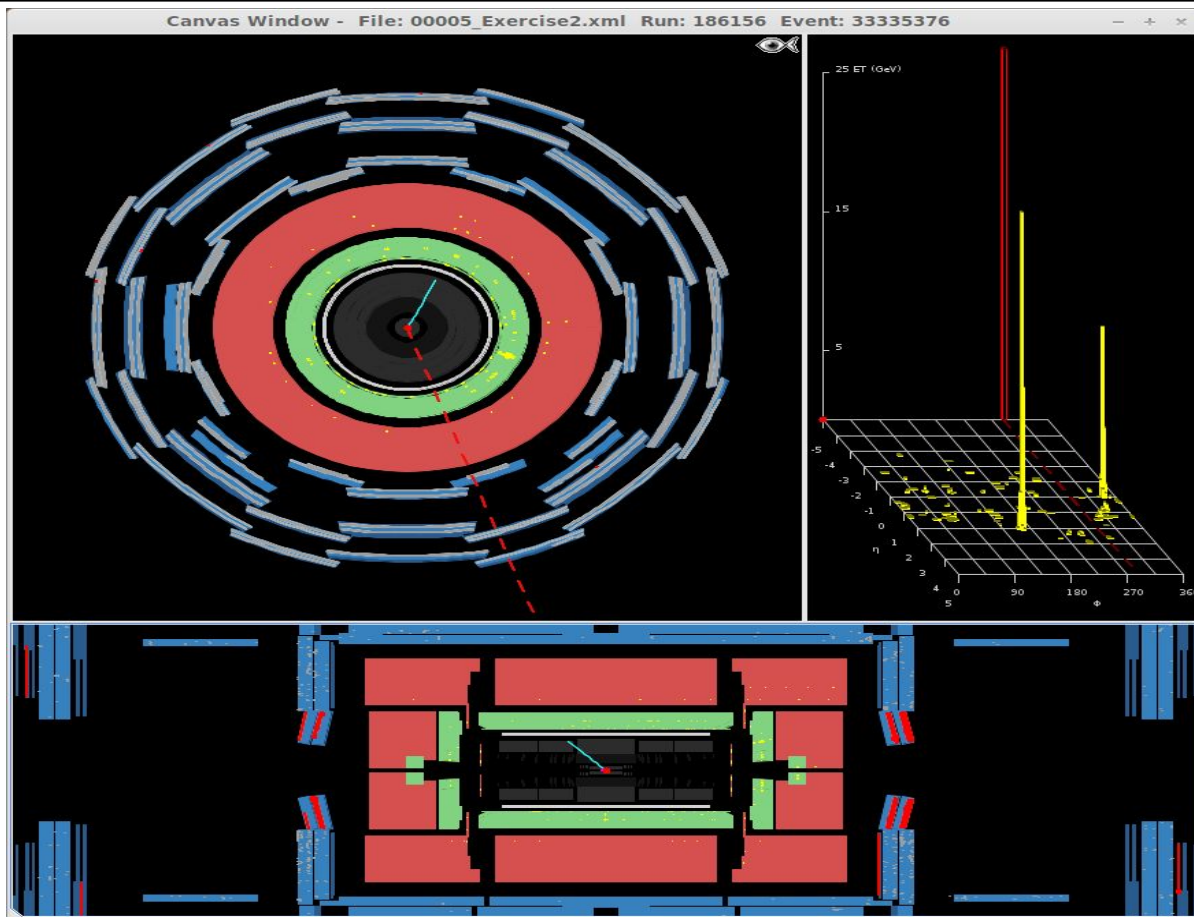
Identikit: elettroni/positroni

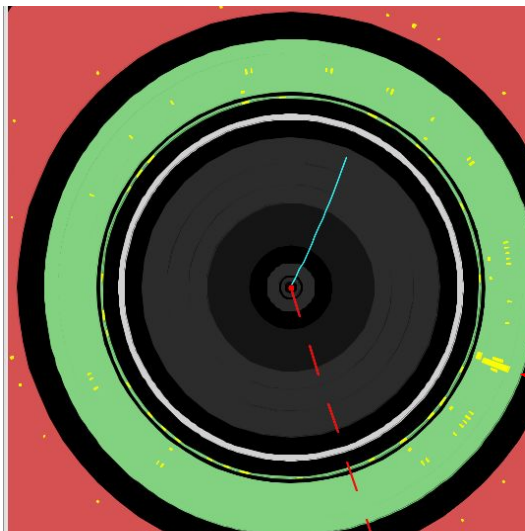


Tracce nel rivelatore interno che puntano a depositi di energia nel calorimetro elettromagnetico

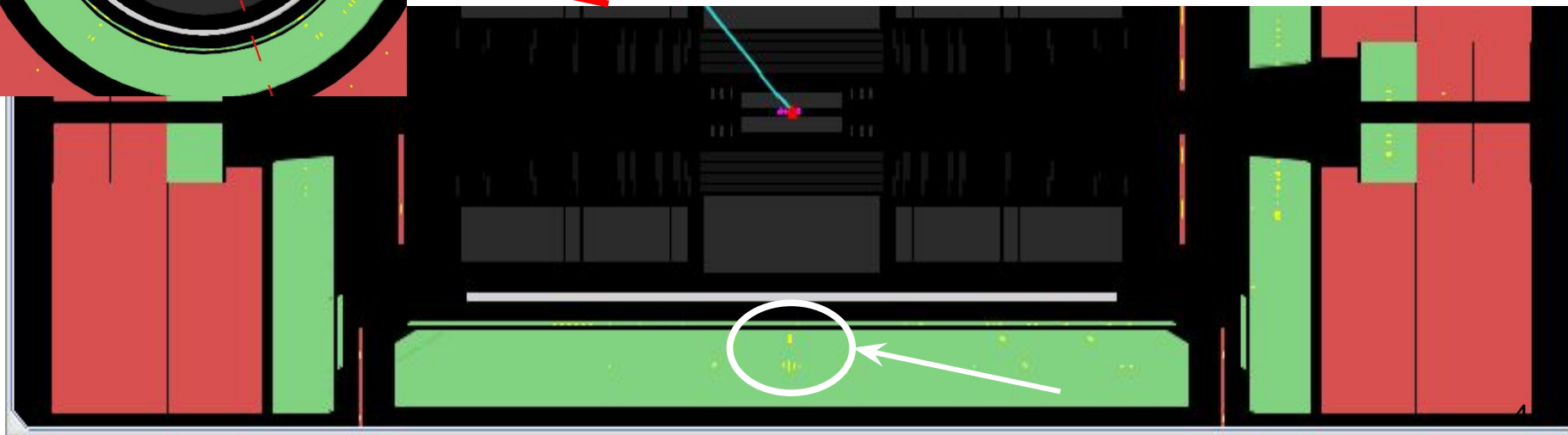


Identikit: fotoni

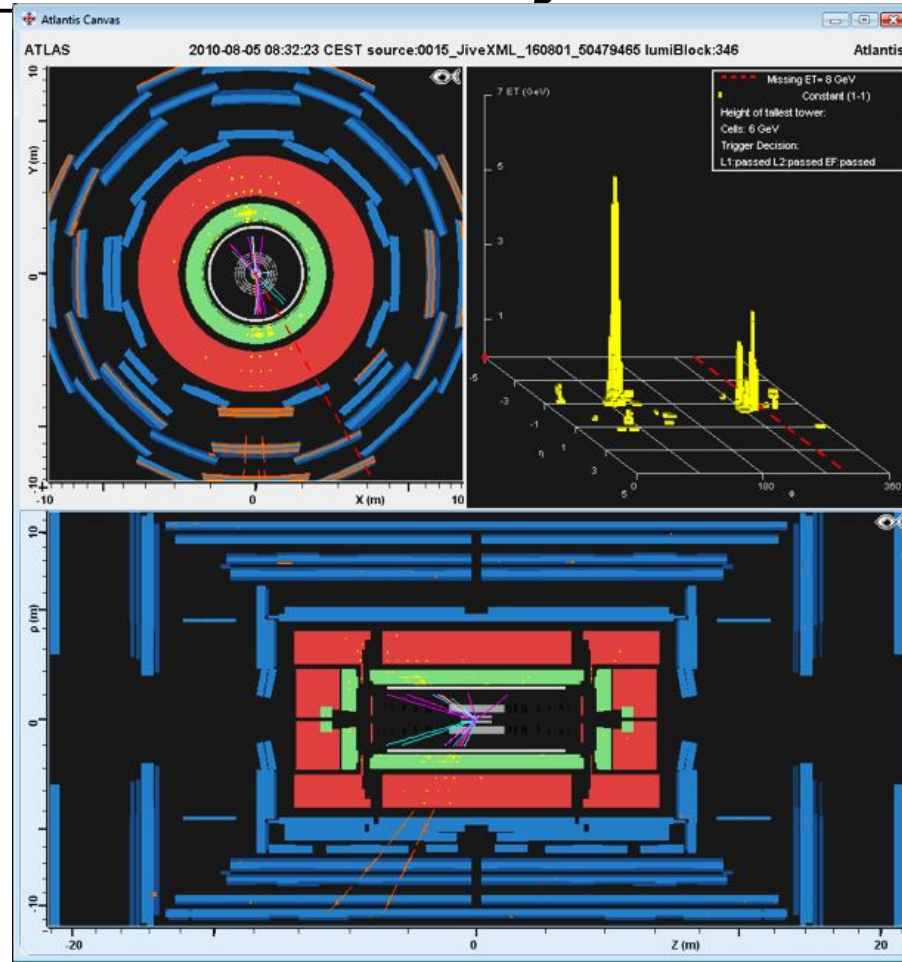


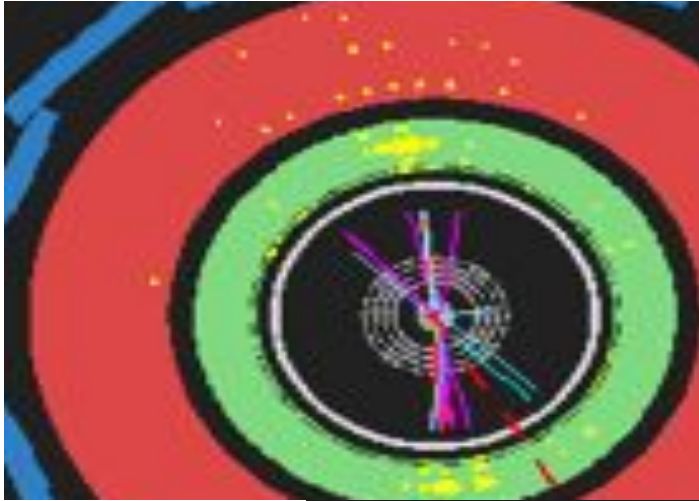


Depositi di energia nel calorimetro
elettromagnetico senza tracce associate

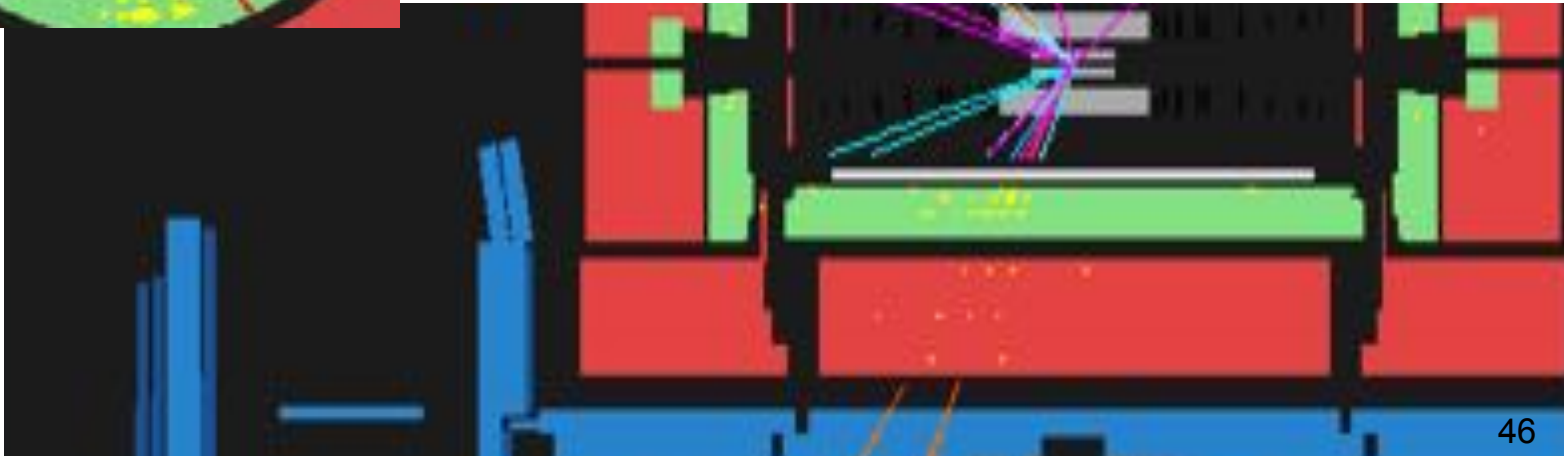


Identikit: jets

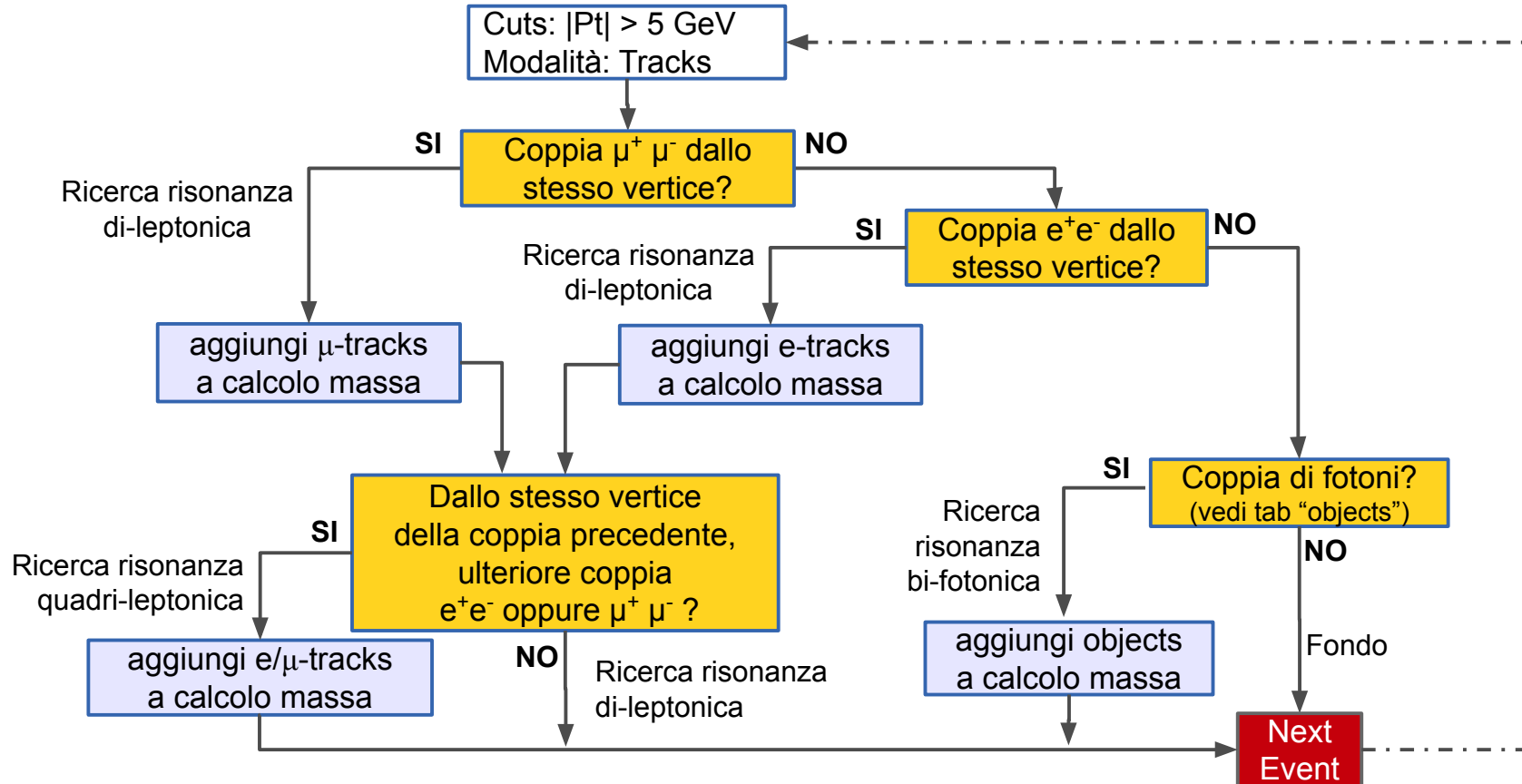




“Fascio” di tracce che puntano a depositi di energia in entrambi i tipi di calorimetri



Piano di lavoro: flow chart





Piano di lavoro: flow chart

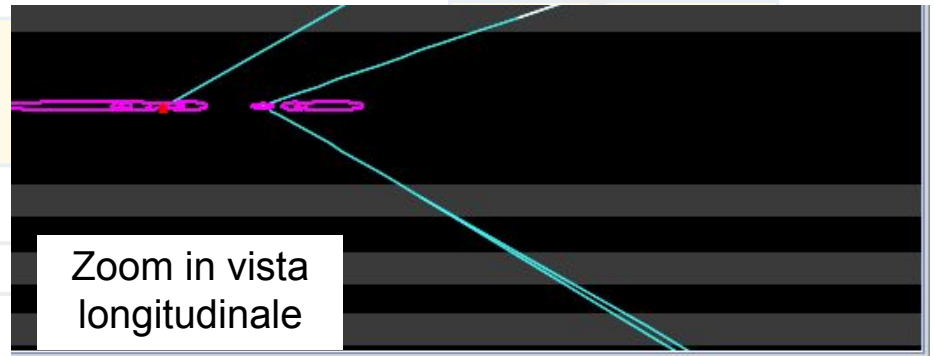
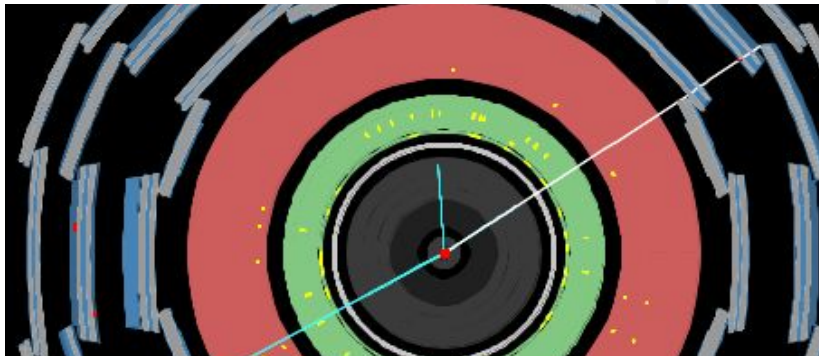
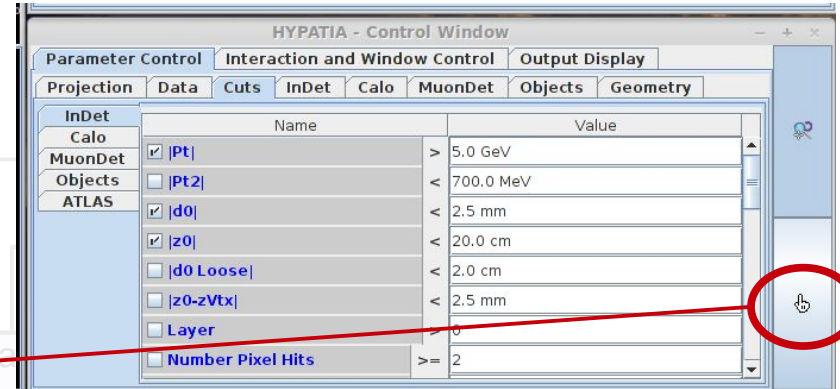
Cuts: $|Pt| > 5$ GeV
Modalità: Tracks

Coppia $\mu^+ \mu^-$ dallo
stesso vertice?

Ricerca
risonanza
di-leptonica

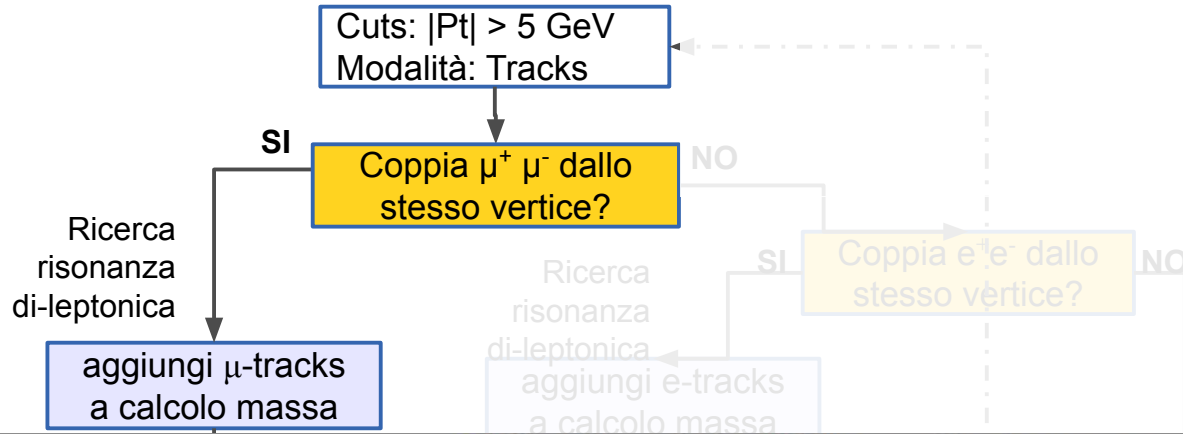
Ricerca
risonanza

Utilizzare il mouse in modalità selezione
per identificare le tracce nelle due viste:
la traccia selezionata viene colorata di bianco



Zoom in vista
longitudinale

Piano di lavoro: flow chart



HYbrid Pupils' Analysis Tool for Interactions in ATLAS - version 7.4 - Invariant Mass Win

File View Histograms Preferences Help

File Name	ETMis [GeV]	Track	P [GeV]	+/-	Pt [GeV]	φ	η	M(2)
event003.xml	22.805	Tracks 184	449.7	+	423.3	-1.090	-0.352	994.43
		Tracks 247	567.5	-	434.3	2.080	0.764	
00007_Exercise2.xml	7.369	Tracks 22	139.5	-	47.7	0.576	1.736	86.854
		Tracks 139	73.7	+	37.7	-2.627	1.201	

Navigation buttons: Previous Event, Next Event, Electron, **Muon**, Photon, Delete Track, Reset Canvas

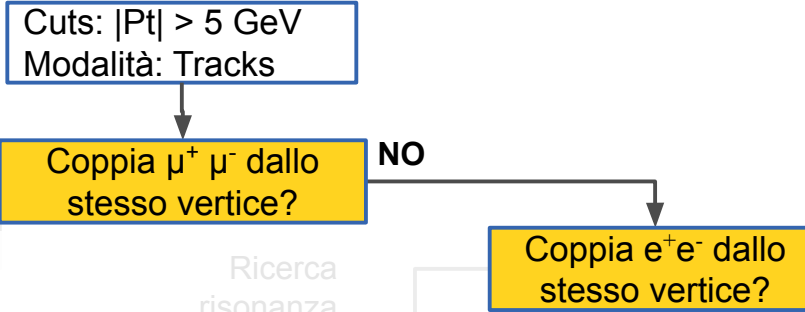
ETMis: 7.369 GeV φ: 2.796 rad Collection: MET_Reffinal

File path: /home/negri/MasterClasses/exercise2_Z.zip/00007_Exercise2.xml

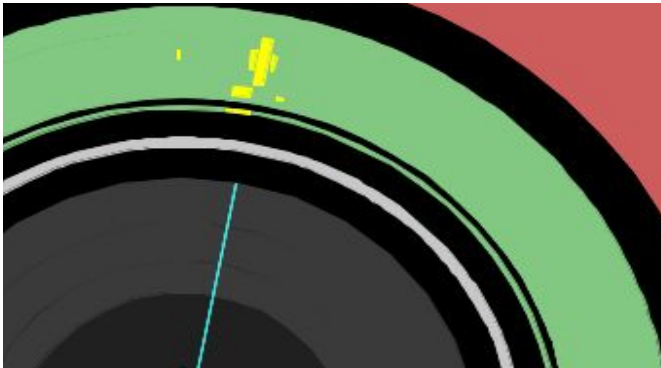
Tracks Physics Objects

Track	+/-	P [GeV]	Pt [GeV]	φ	θ
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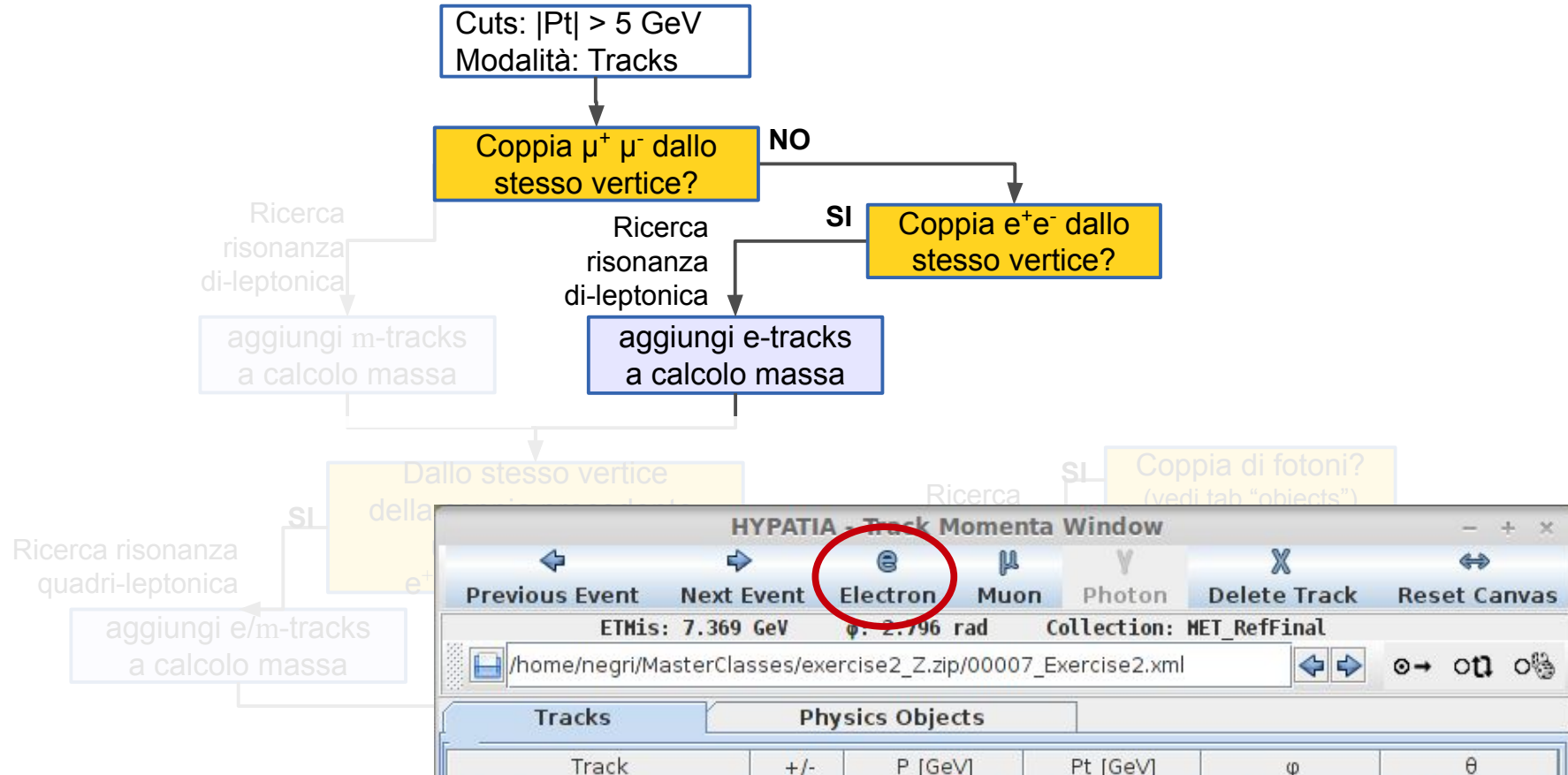
Piano di lavoro: flow chart



- Cercare depositi di energia nel calorimetro
- Verificare la presenza di tracce che puntano ai depositi
- Verificare che puntino allo stesso vertice primario

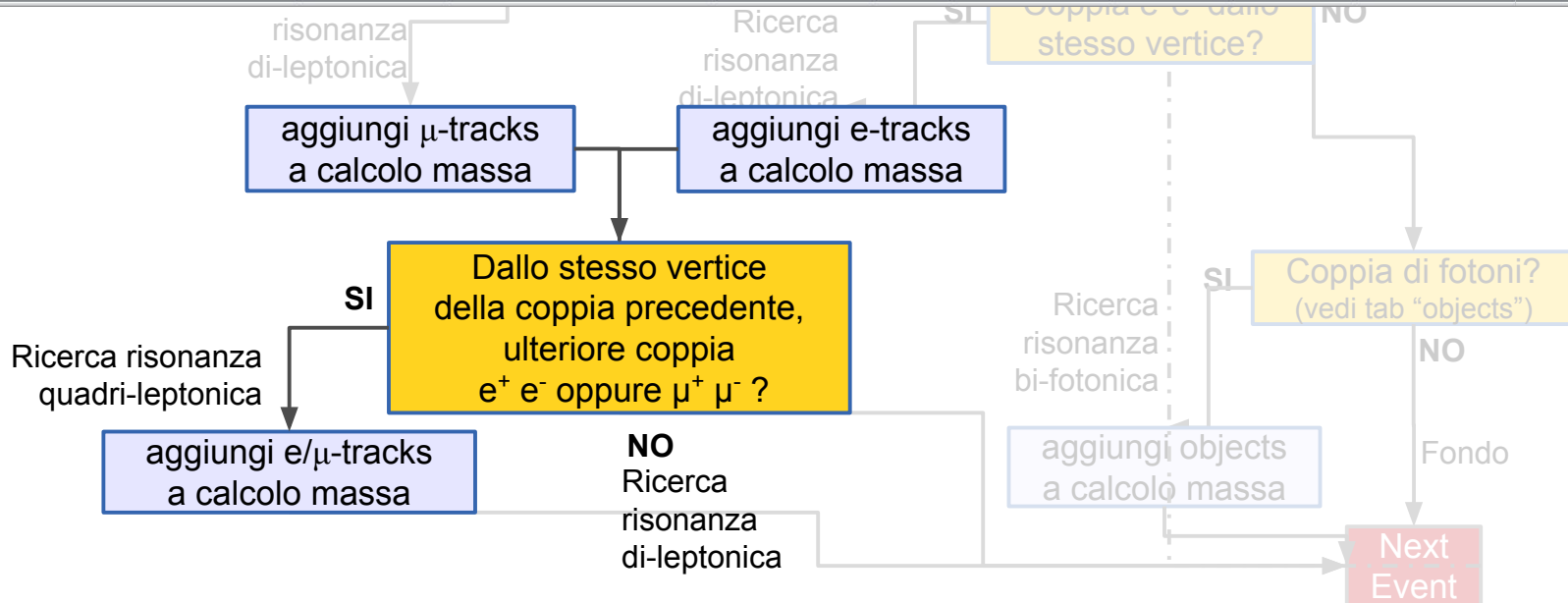


Piano di lavoro: flow chart

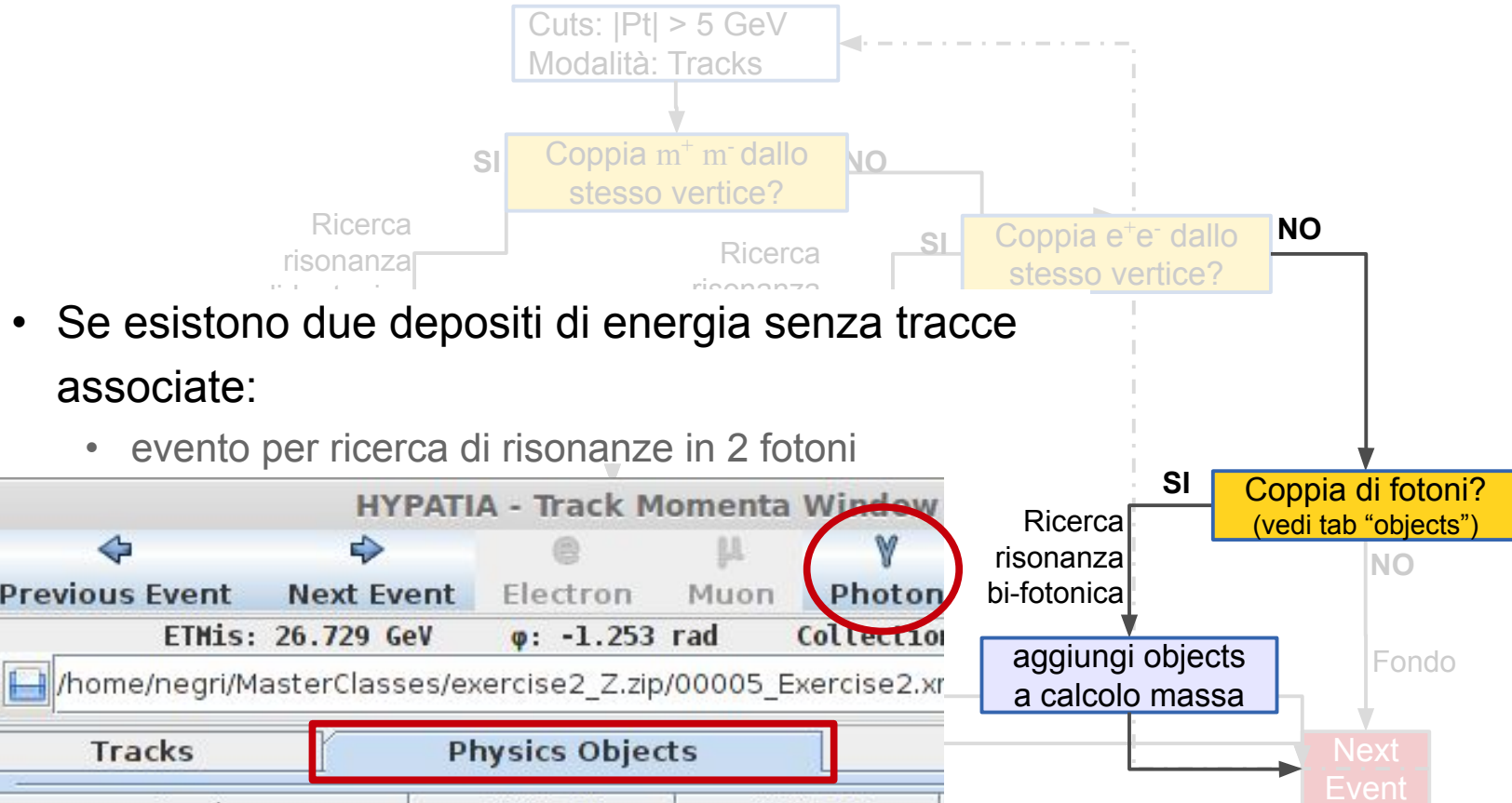


Modalità: Tracks

Hybrid Pupils' Analysis Tool for Interactions in ATLAS - version 7.4 - Invariant Mass Window										More options: help info download FAQ version 7.4 contact the author																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
File View Histograms Preferences Help										Go for Histograms Help																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
File Name	ETMis [GeV]	Track	P [GeV]	+/-	Pt [GeV]	φ	η	M(2) [GeV]	Value	2016b	2016c	2016d	2016e	2016f	2016g	2016h	2016i	2016j	2016k	2016l	2016m	2016n	2016o	2016p	2016q	2016r	2016s	2016t	2016u	2016v	2016w	2016x	2016y	2016z	2016aa	2016ab	2016ac	2016ad	2016ae	2016af	2016ag	2016ah	2016ai	2016aj	2016ak	2016al	2016am	2016an	2016ao	2016ap	2016aq	2016ar	2016as	2016at	2016au	2016av	2016aw	2016ax	2016ay	2016az	2016ba	2016bb	2016bc	2016bd	2016be	2016bf	2016bg	2016bh	2016bi	2016bj	2016bk	2016bl	2016bm	2016bn	2016bo	2016bp	2016bq	2016br	2016bs	2016bt	2016bu	2016bv	2016bw	2016bx	2016by	2016bz	2016ca	2016cb	2016cc	2016cd	2016ce	2016cf	2016cg	2016ch	2016ci	2016cj	2016ck	2016cl	2016cm	2016cn	2016co	2016cp	2016cq	2016cr	2016cs	2016ct	2016cu	2016cv	2016cw	2016cx	2016cy	2016cz	2016da	2016db	2016dc	2016dd	2016de	2016df	2016dg	2016dh	2016di	2016dj	2016dk	2016dl	2016dm	2016dn	2016do	2016dp	2016dq	2016dr	2016ds	2016dt	2016du	2016dv	2016dw	2016dx	2016dy	2016dz	2016ea	2016eb	2016ec	2016ed	2016ee	2016ef	2016eg	2016eh	2016ei	2016ej	2016ek	2016el	2016em	2016en	2016eo	2016ep	2016eq	2016er	2016es	2016et	2016eu	2016ev	2016ew	2016ex	2016ey	2016ez	2016fa	2016fb	2016fc	2016fd	2016fe	2016ff	2016fg	2016fh	2016fi	2016fj	2016fk	2016fl	2016fm	2016fn	2016fo	2016fp	2016fq	2016fr	2016fs	2016ft	2016fu	2016fv	2016fw	2016fx	2016fy	2016fz	2016ga	2016gb	2016gc	2016gd	2016ge	2016gf	2016gg	2016gh	2016gi	2016gj	2016gk	2016gl	2016gm	2016gn	2016go	2016gp	2016gq	2016gr	2016gs	2016gt	2016gu	2016gv	2016gw	2016gx	2016gy	2016gz	2016ha	2016hb	2016hc	2016hd	2016he	2016hf	2016hg	2016hh	2016hi	2016hj	2016hk	2016hl	2016hm	2016hn	2016ho	2016hp	2016hq	2016hr	2016hs	2016ht	2016hu	2016hv	2016hw	2016hx	2016hy	2016hz	2016ia	2016ib	2016ic	2016id	2016ie	2016if	2016ig	2016ih	2016ii	2016ij	2016ik	2016il	2016im	2016in	2016io	2016ip	2016iq	2016ir	2016is	2016it	2016iu	2016iv	2016iw	2016ix	2016iy	2016iz	2016ja	2016jb	2016jc	2016jd	2016je	2016jf	2016jg	2016jh	2016ji	2016jj	2016jk	2016jl	2016jm	2016jn	2016jo	2016jp	2016jq	2016jr	2016js	2016jt	2016ju	2016jv	2016jw	2016jx	2016jy	2016jz	2016ka	2016kb	2016kc	2016kd	2016ke	2016kf	2016kg	2016kh	2016ki	2016kj	2016kk	2016kl	2016km	2016kn	2016ko	2016kp	2016kq	2016kr	2016ks	2016kt	2016ku	2016kv	2016kw	2016kx	2016ky	2016kz	2016la	2016lb	2016lc	2016ld	2016le	2016lf	2016lg	2016lh	2016li	2016lj	2016lk	2016ll	2016lm	2016ln	2016lo	2016lp	2016lq	2016lr	2016ls	2016lt	2016lu	2016lv	2016lw	2016lx	2016ly	2016lz	2016ma	2016mb	2016mc	2016md	2016me	2016mf	2016mg	2016mh	2016mi	2016mj	2016mk	2016ml	2016mm	2016mn	2016mo	2016mp	2016mq	2016mr	2016ms	2016mt	2016mu	2016mv	2016mw	2016mx	2016my	2016mz	2016na	2016nb	2016nc	2016nd	2016ne	2016nf	2016ng	2016nh	2016ni	2016nj	2016nk	2016nl	2016nm	2016nn	2016no	2016np	2016nq	2016nr	2016ns	2016nt	2016nu	2016nv	2016nw	2016nx	2016ny	2016nz	2016oa	2016ob	2016oc	2016od	2016oe	2016of	2016og	2016oh	2016oi	2016oj	2016ok	2016ol	2016om	2016on	2016oo	2016op	2016oq	2016or	2016os	2016ot	2016ou	2016ov	2016ow	2016ox	2016oy	2016oz	2016pa	2016pb	2016pc	2016pd	2016pe	2016pf	2016pg	2016ph	2016pi	2016pj	2016pk	2016pl	2016pm	2016pn	2016po	2016pp	2016pq	2016pr	2016ps	2016pt	2016pu	2016pv	2016pw	2016px	2016py	2016pz	2016qa	2016qb	2016qc	2016qd	2016qe	2016qf	2016qg	2016qh	2016qi	2016qj	2016qk	2016ql	2016qm	2016qn	2016qo	2016qp	2016qq	2016qr	2016qs	2016qt	2016qu	2016qv	2016qw	2016qx	2016qy	2016qz	2016ra	2016rb	2016rc	2016rd	2016re	2016rf	2016rg	2016rh	2016ri	2016rj	2016rk	2016rl	2016rm	2016rn	2016ro	2016rp	2016rq	2016rr	2016rs	2016rt	2016ru	2016rv	2016rw	2016rx	2016ry	2016rz	2016sa	2016sb	2016sc	2016sd	2016se	2016sf	2016sg	2016sh	2016si	2016sj	2016sk	2016sl	2016sm	2016sn	2016so	2016sp	2016sq	2016sr	2016ss	2016st	2016su	2016sv	2016sw	2016sx	2016sy	2016sz	2016ta	2016tb	2016tc	2016td	2016te	2016tf	2016tg	2016th	2016ti	2016tj	2016tk	2016tl	2016tm	2016tn	2016to	2016tp	2016tq	2016tr	2016ts	2016tt	2016tu	2016tv	2016tw	2016tx	2016ty	2016tz	2016ua	2016ub	2016uc	2016ud	2016ue	2016uf	2016ug	2016uh	2016ui	2016uj	2016uk	2016ul	2016um	2016un	2016uo	2016up	2016uq	2016ur	2016us	2016ut	2016uu	2016uv	2016uw	2016ux	2016uy	2016uz	2016va	2016vb	2016vc	2016vd	2016ve	2016vf	2016vg	2016vh	2016vi	2016vj	2016vk	2016vl	2016vm	2016vn	2016vo	2016vp	2016vq	2016vr	2016vs	2016vt	2016vu	2016vv	2016vw	2016vx	2016vy	2016vz	2016wa	2016wb	2016wc	2016wd	2016we	2016wf	2016wg	2016wh	2016wi	2016wj	2016wk	2016wl	2016wm	2016wn	2016wo	2016wp	2016wq	2016wr	2016ws	2016wt	2016wu	2016wv	2016ww	2016wx	2016wy	2016wz	2016xa	2016xb	2016xc	2016xd	2016xe	2016xf	2016xg	2016xh	2016xi	2016xj	2016xk	2016xl	2016xm	2016xn	2016xo	2016xp	2016xq	2016xr	2016xs	2016xt	2016xu	2016xv	2016xw	2016xx	2016xy	2016xz	2016ya	2016yb	2016yc	2016yd	2016ye	2016yf	2016yg	2016yh	2016yi	2016yj	2016yk	2016yl	2016ym	2016yn	2016yo	2016yp	2016yq	2016yr	2016ys	2016yt	2016yu	2016yv	2016yw	2016yx	2016yy	2016yz	2016za	2016zb	2016zc	2016zd	2016ze	2016zf	2016zg	2016zh	2016zi	2016zj	2016zk	2016zl	2016zm	2016zn	2016zo	2016zp	2016zq	2016zr	2016zs	2016zt	2016zu	2016zv	2016zw	2016zx	2016zy	2016zz
event046.xml	37.975	Tracks 2	108.7	-	58.0	1.525	1.242	90.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0																																																																																																																																																																																																																																																																																																																																													



Piano di lavoro: flow chart



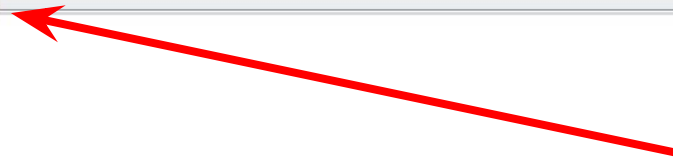
Alla fine dei 50 eventi

Salvare sul desktop il file delle masse
“Invariant_masses.txt”

HYbrid Pupils' Analysis Tool for Interactions in ATLAS - version 7.4 - Invariant Mass Window

File View Histograms Preferences Help

	ETMis [GeV]	Track	P [GeV]	+/-	Pt [GeV]	ϕ	η	M(2) [GeV]	M(eeee) [GeV]	M(eemm) [GeV]	M(mmmm) [GeV]	e/m/g
Read Event Locally	23.199	Tracks 0	217.0	-	42.6	-1.479	2.310	94.165				e
Read Event From URL (live)		Tracks 76	93.3	+	42.9	1.779	1.413					e
Clear Hypatia Project	22.805	Tracks 184	449.7	+	423.3	-1.090	-0.352	994.430				e
Load Hypatia Project		Tracks 247	567.5	-	434.3	2.080	0.764					e
Save Hypatia Project												
Export Invariant Masses												
Loop over events												
Save Image of Canvas												
Animated Event												
Event Properties												
Read Geometry												
Read G4Steps												
Exit												



Alla fine dei 50 eventi

Aprire il link: <https://cernmasterclass.uio.no/OPloT/index.php>
Selezionare “Student” (Username/Password: ippog/imc)

OPloT – MasterClass with CERN – Student page

Start Student Moderator Tutor Administrator

Student Tasks

Please select items from the drop-down boxes to submit your results!



The screenshot shows a form with several drop-down boxes. The first four boxes are labeled '2024', 'February', '29', and 'Pavia'. The fifth box contains the number '3' and the sixth box contains the letter 'H'. Both the '3' and 'H' boxes are circled in red. Two red arrows originate from the bottom of these circles: one points to the text '3 o 4' and the other points to the text 'A-T'.

2024	February	29	Pavia	3	H
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3 o 4 A-T

Alla fine dei 50 eventi



Caricare il file “Invariant_masses.txt”
Choose file → Submit

[OPloT – MasterClass with CERN – Plot for Pavia Group 3E on 2024-02-29](#)

[Start](#) [Student](#) [Moderator](#) [Tutor](#) [Administrator](#)

Tuesday, February 27th 2024 - 21:15:20 UTC

Change date

Change institute

Change group

Upload your file:

Choose File

No file chosen

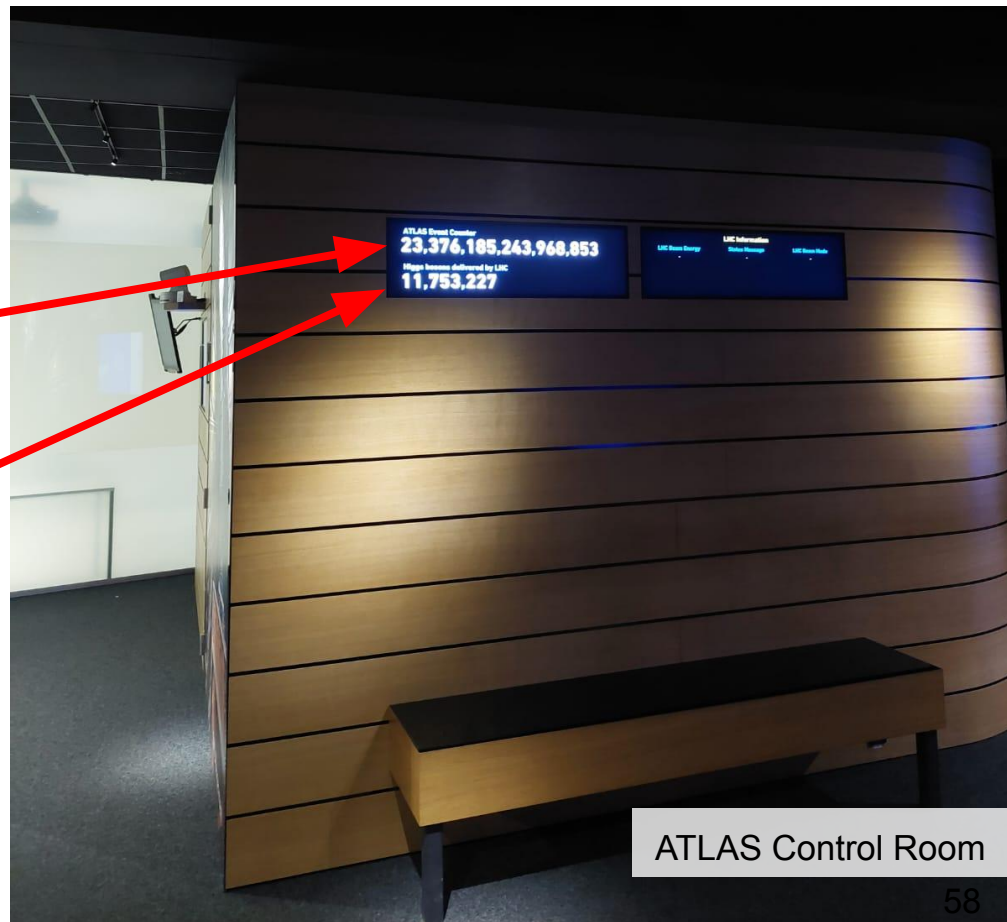
Submit

Alla fine dei 50 eventi

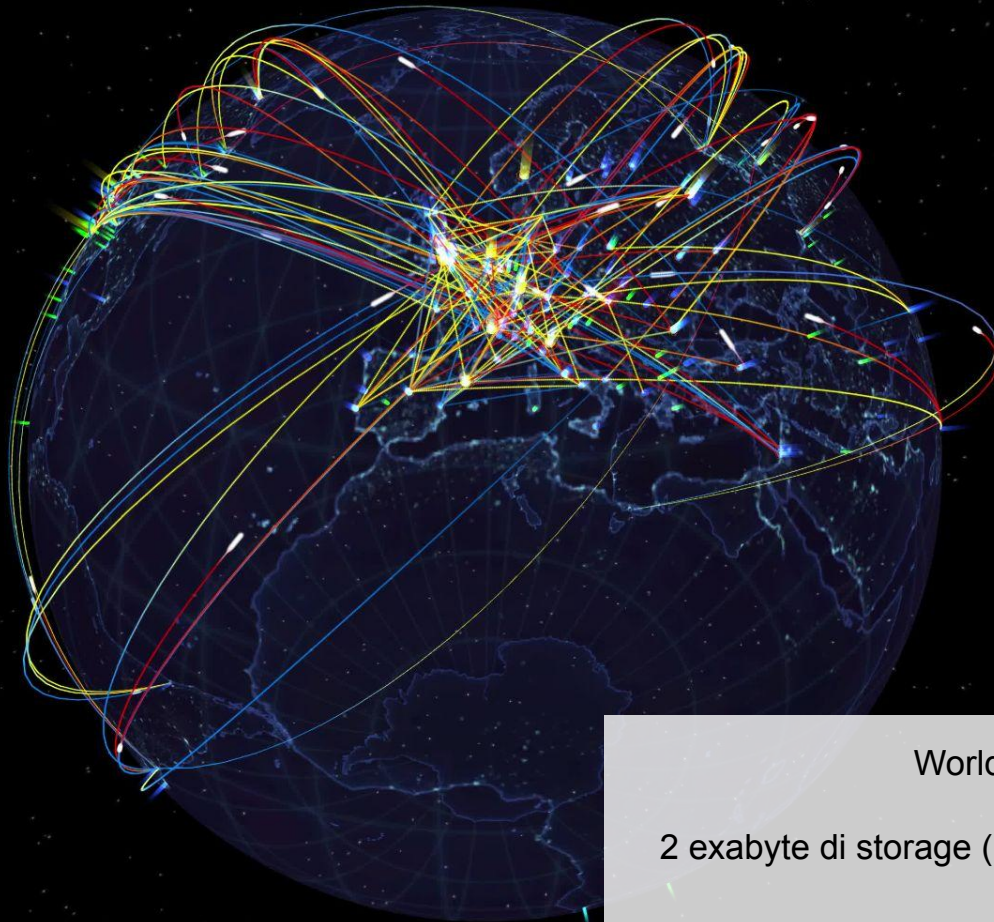
50 eventi vi sembrano tanti?

Numero di eventi osservati in ATLAS

Numero di bosoni di Higgs prodotti da LHC



ATLAS Control Room



Running jobs: 365644
Active CPU cores: 807139
Transfer rate: 21.54 GiB/sec

Worldwide LHC Computing Grid
1.4 milioni di core
2 exabyte di storage (=2000 miliardi di Gigabyte)
42 Paesi
170 centri di computing
59



Running jobs
Active CPU c
Transfer rate