Highlights of users applications

To provide you some ideas how Geant4 would be utilized…

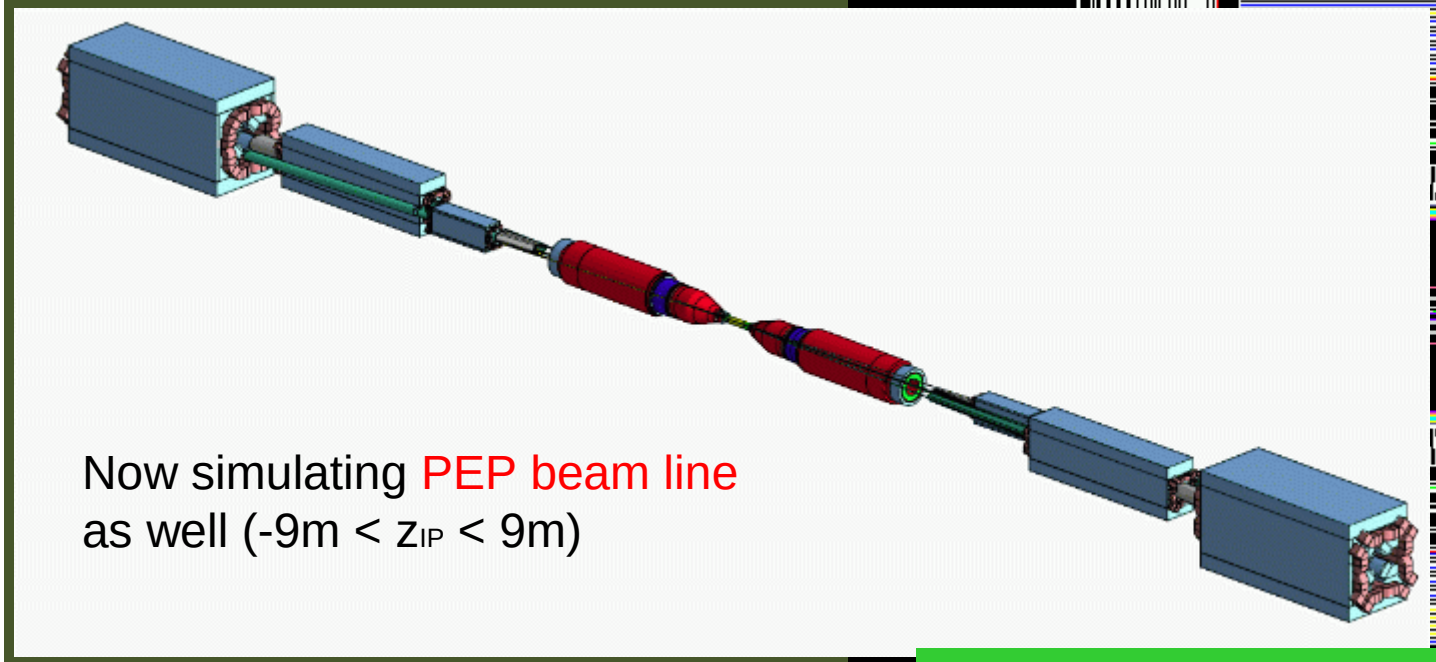
Thanks to Makoto Asai (SLAC)

High Energy Physics

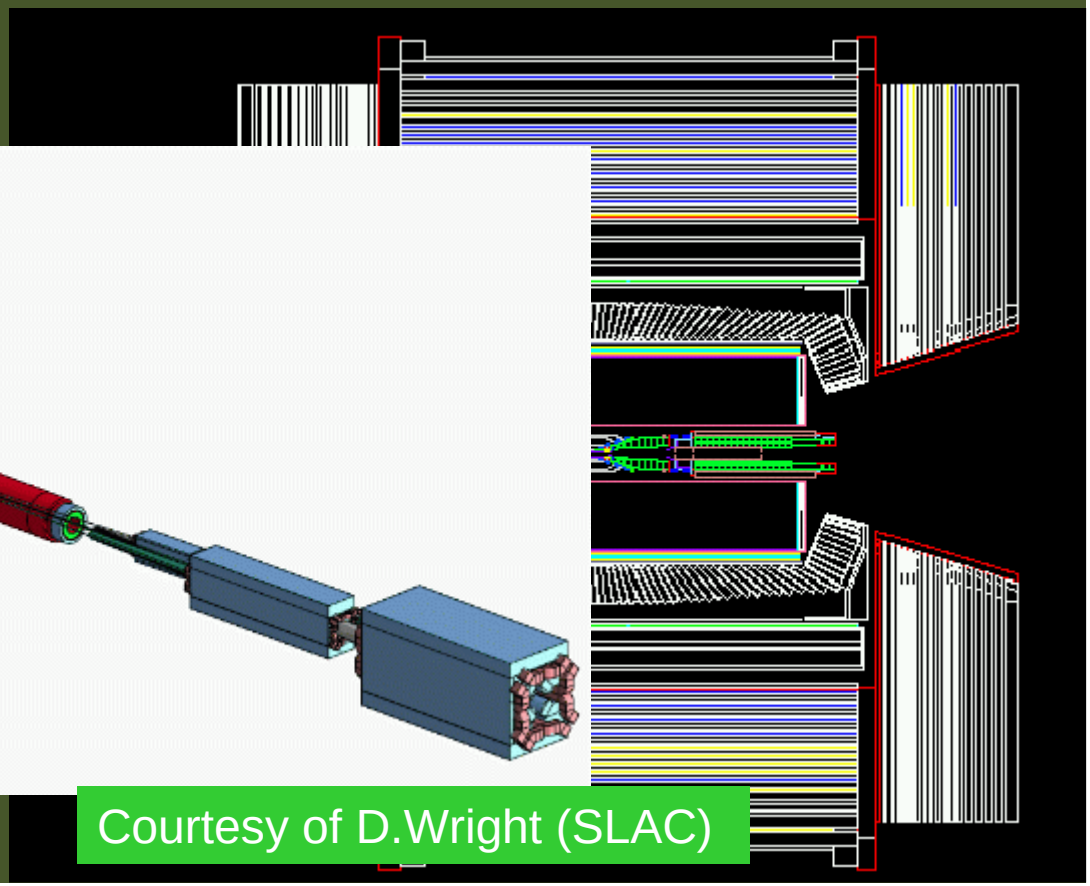
BaBar

BaBar

- BaBar at SLAC is the pioneer experiment in HEP in use of Geant4
  - Started in 2000
  - Simulated $5*10^9$ events so far
  - Produced at 20 sites in North America and Europe
  - Current average production rate 6.1×10^7 events/week



Now simulating PEP beam line
as well ($-9m < z_{IP} < 9m$)



Courtesy of D.Wright (SLAC)

LHC

Geant4 at the LHC Today

Now Geant4 has become the standard simulation for ATLAS, LHCB, and CMS

	ATLAS	CMS	LHCb
Transition to Geant4 (G3 stopped)	DC02 '04	Nov '03	May '04
Produced # of events in DC	12 M	40 M	80 M
CPU time (sec)/ event (2.8 Ghz)	600 (pp→Z→ee) 700 (SUSY)	200 (QCD jets) 60 (min bias)	22-65
Memory used	400 Mb	220 Mb	220 Mb
# of placed volumes	5 M	1.2 M	18 M

No memory leaks!!

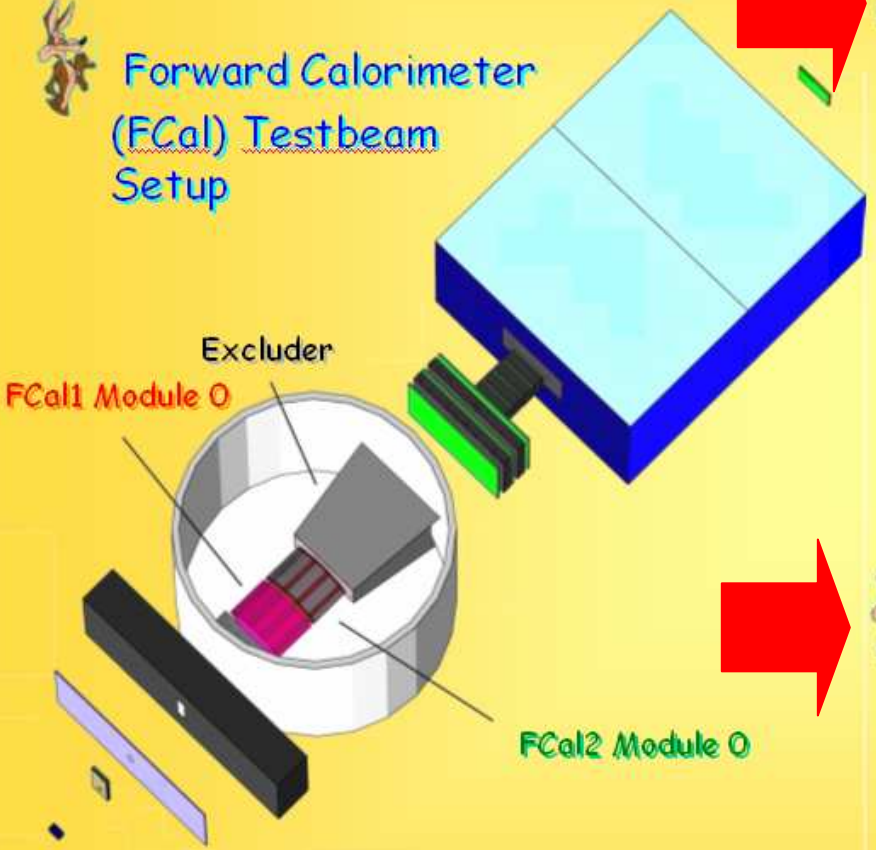
⇒ Observations:

Geant4 in production is running now very stable/very few problems (~ 10^{-5})

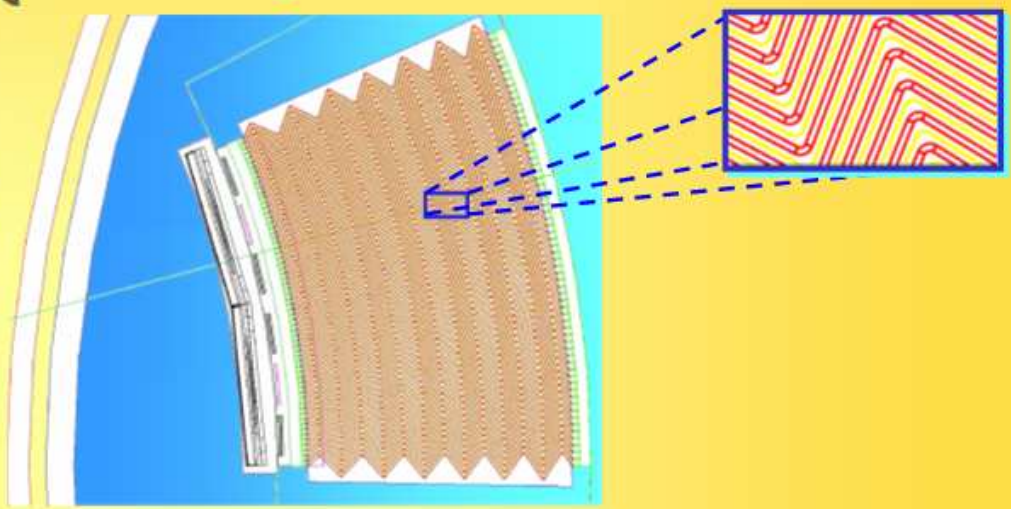
Transition to Geant4 has been a very smooth process for all experiments

Geant4 Setups (2)

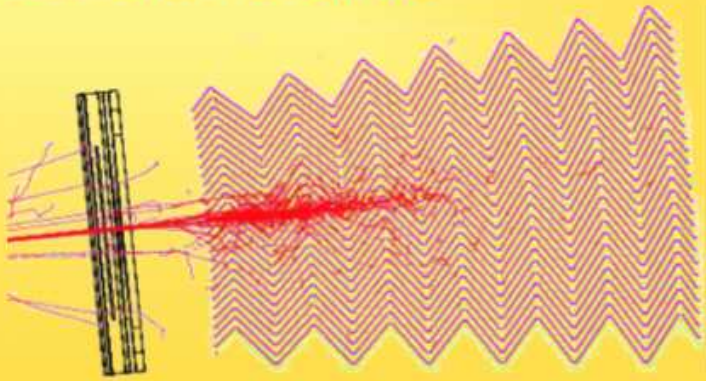
Forward Calorimeter (FCal) Testbeam Setup



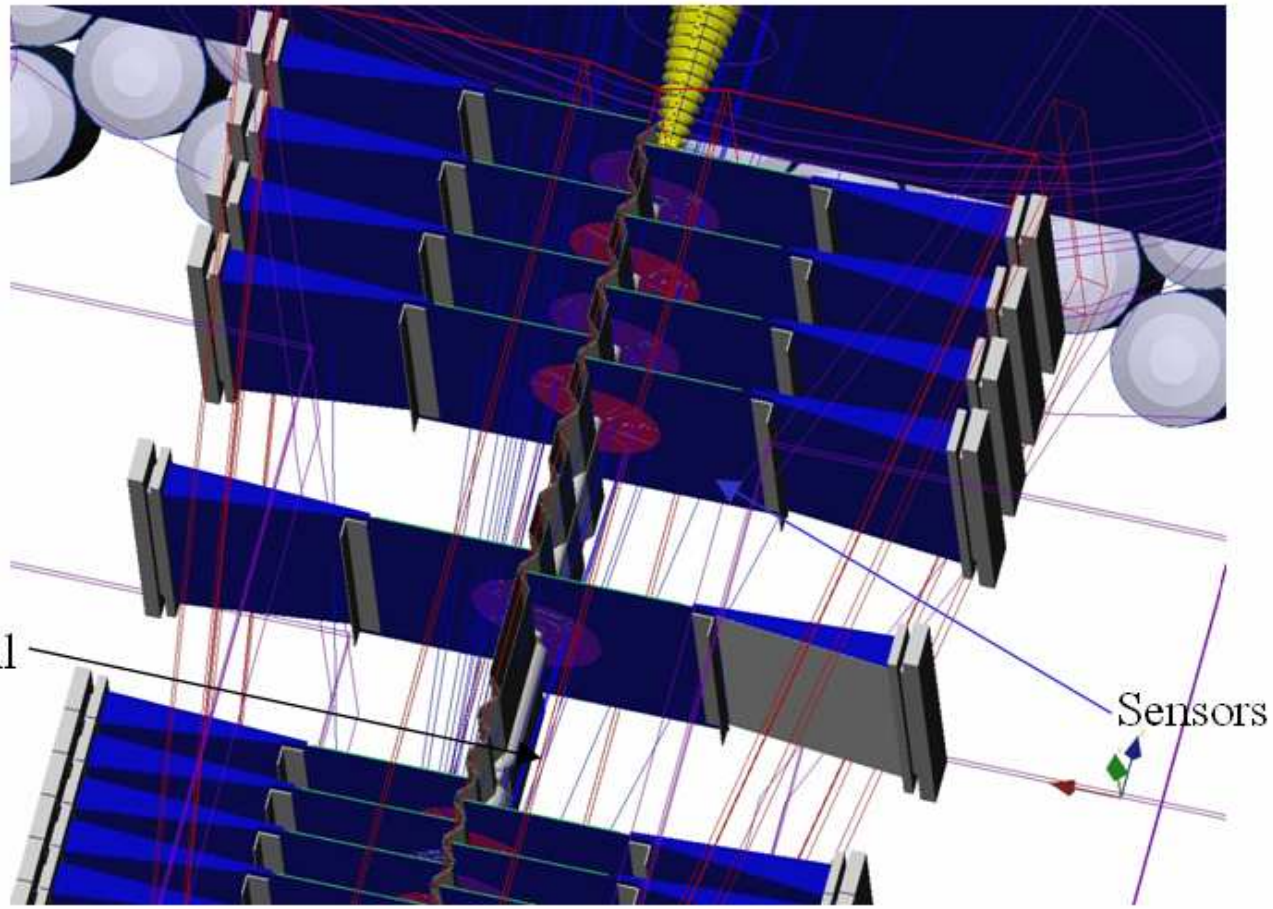
Electromagnetic Barrel Accordion Calorimeter



10 GeV Electron Shower



Geant4 at the LHC Today



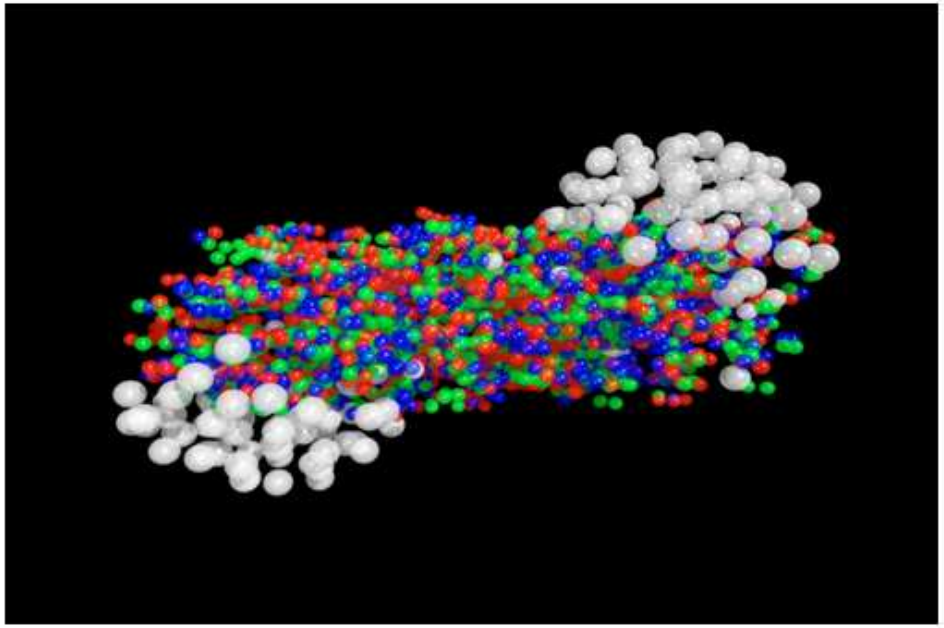
Complicated geometry
Details are very important

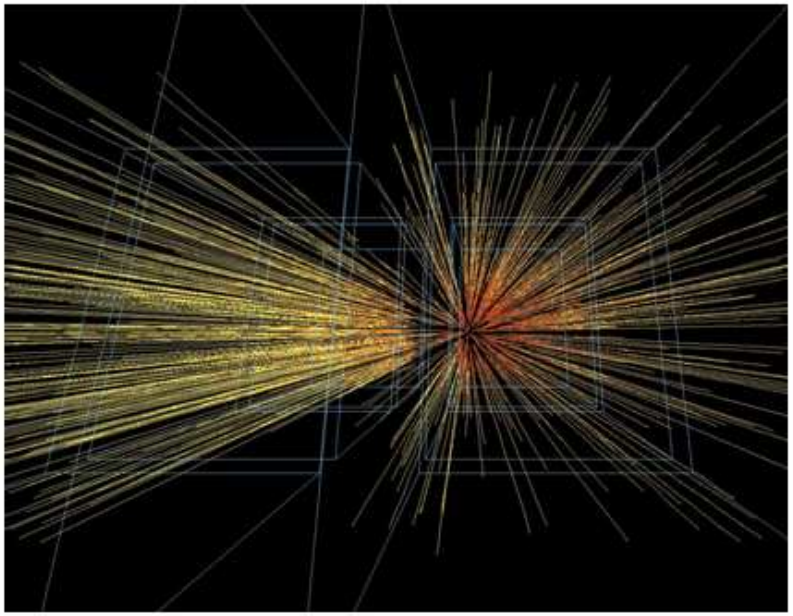
Geant4 can handle it!!

LHCb Vertex Locator description

Geant 4

Pushing G4 to the limits: Heavy Ions





Events with > 50000 particles/event in detector acceptance

CMS

Geant 4

Heavy-Ion Collisions

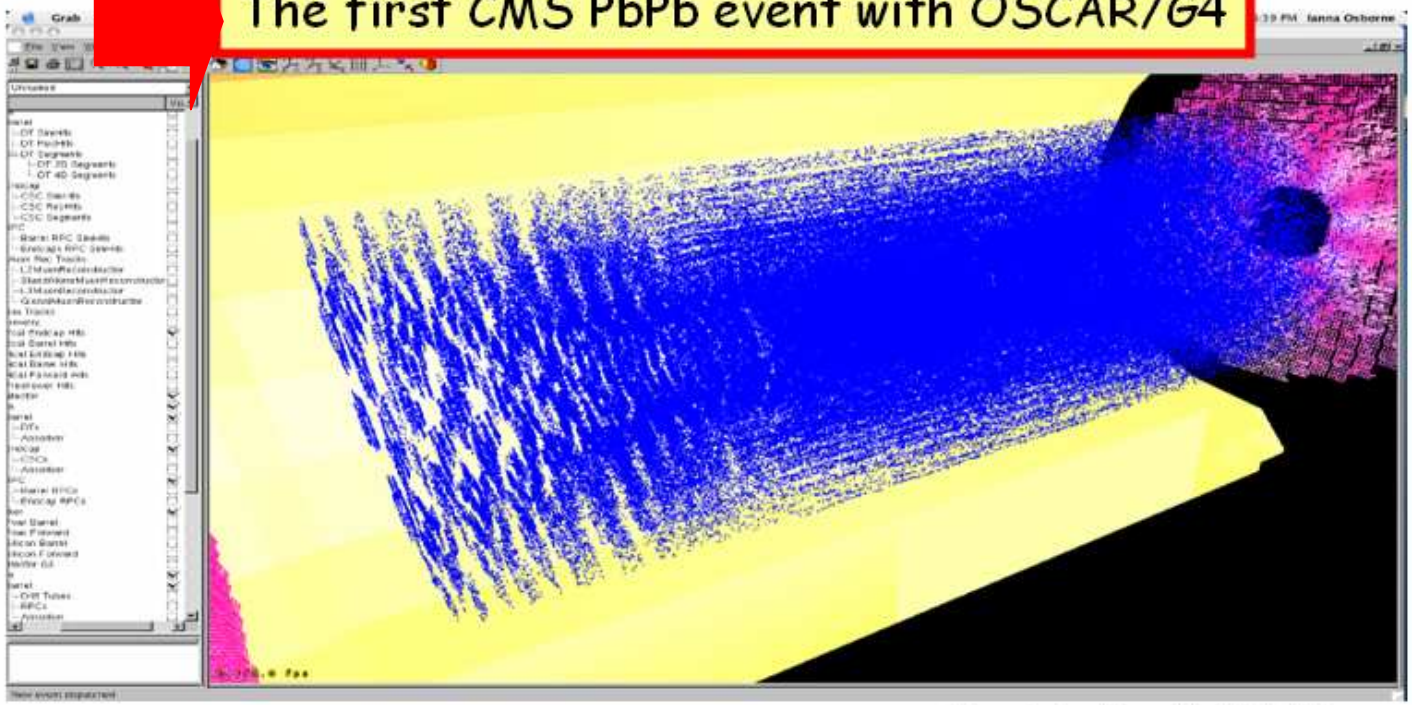
OSCAR/Geant4 can run full heavy ion events.

- Timing is good/Memory > 500 Mbyte (2GB memory machines used)
- Have now run > 100 events without problems

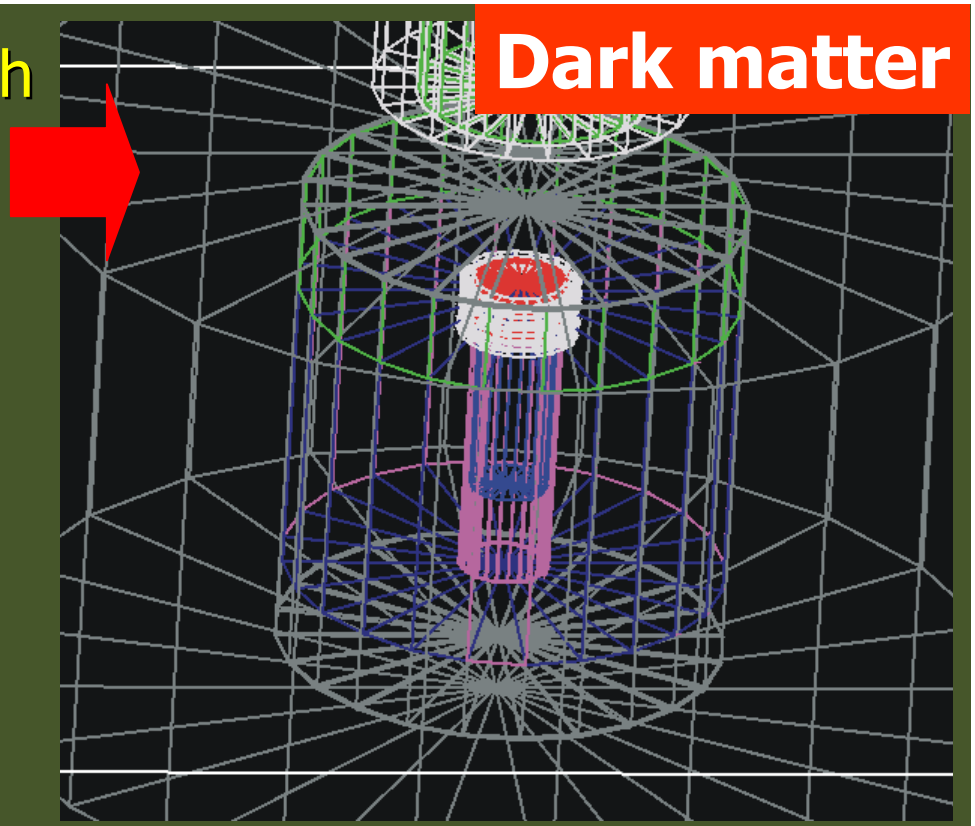
~ Timing for the first event with 55K generator tracks

Program	CPU (2.8GHz) (min)
CMSIM	230
OSCAR 2_4_5	320
OSCAR 3_4_0	180

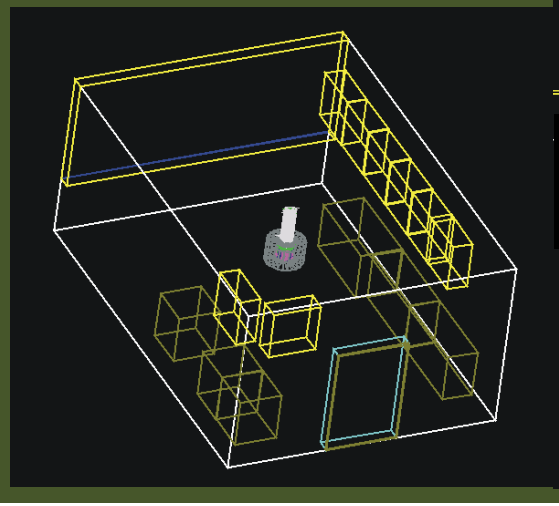
The first CMS PbPb event with OSCAR/G4

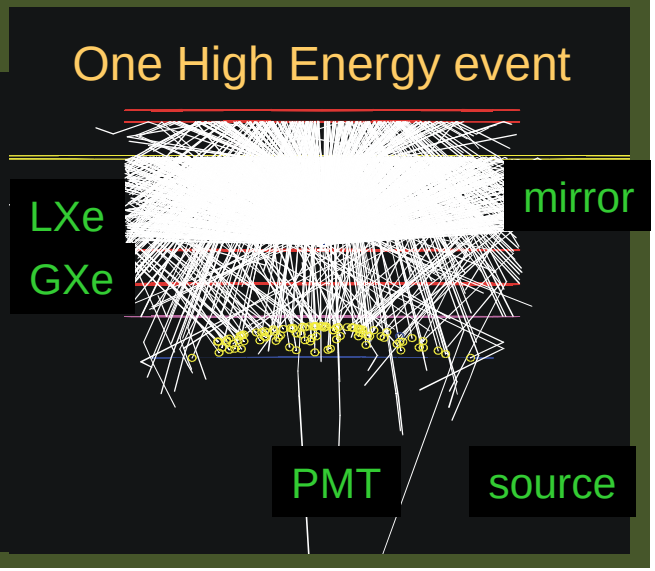


Boulby Mine dark matter search
Prototype Simulation



Courtesy of H. Araujo, A. Howard, IC London





Beam ray-tracing

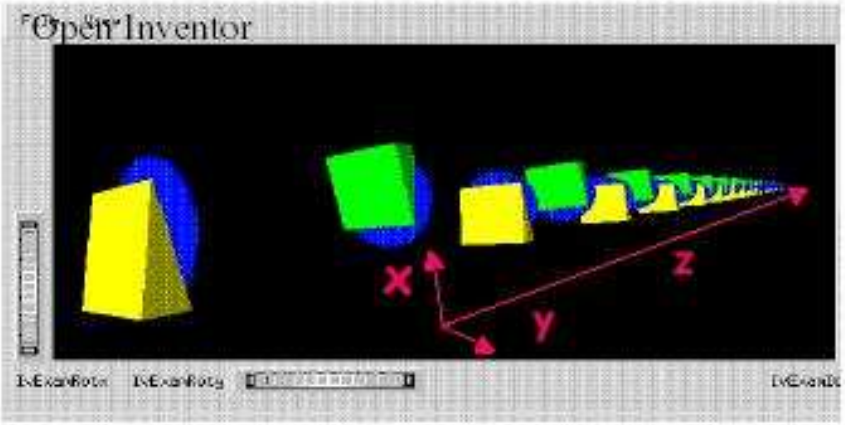
Geant4 for beam transportation

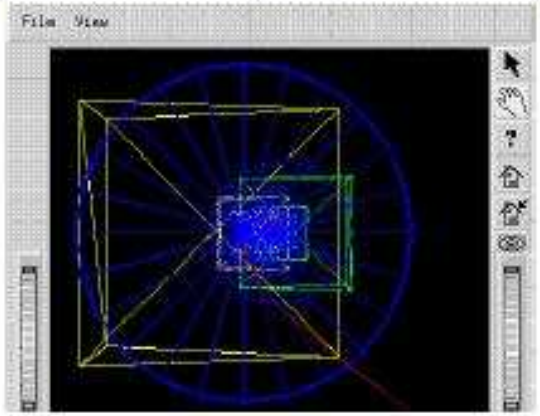
Example: Helical Channel

Published in proc. of PAC 2001
(Fermilab-Conf-01-182-T)

72 m long solenoidal + dipole field with wedge absorbers and thin cavities

$$B_{xy} = B_T \cos,\sin\left(\frac{2p}{L} z\right) \qquad B_z = B_0$$





Other simulations:

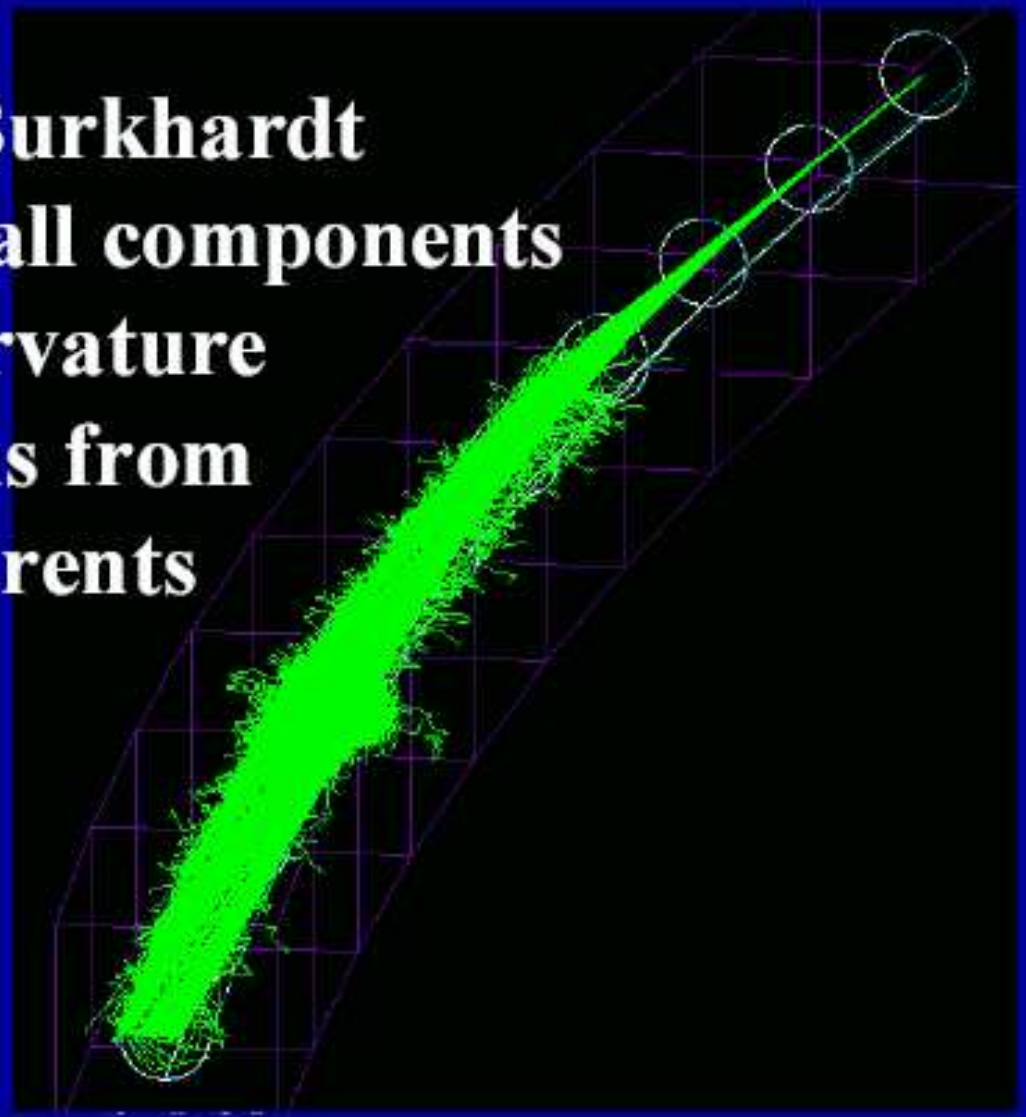
- Alternate Solenoid Channel (sFoFo), published in proceedings of PAC2001 and Feasibility Study II for a Neutrino Factory at BNL (2001)
- Bent Solenoid Channel, presented at Emittance Exchange Workshop, BNL 2000
- Low Frequency r.f. Cooling Channel, presented at International Cooling Experiment Workship, CERN 2001
- Cooling Experiment (MICE) Simulation (in progress)

G4 Users Meeting, February 21st, 2002 — V. Daniel Elvira, Fermilab

Courtesy of V.D.Elvira (FNAL)

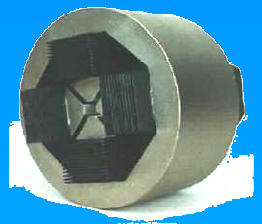
Synchrotron Radiation

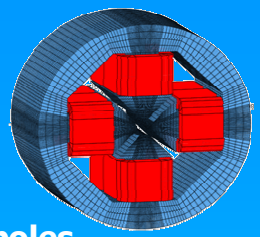
Generator of H. Burkhardt
Implemented for all components
Based on local curvature
Individual photons from
individual parents



Courtesy of G.Blair (CERN)

Sub-micron raytracing @ CENBG : nanobeam line design





OM50 quadrupoles

3D field map

DOUBLET

TRIPLET

Electrostatic deflection

4565

5100

Object collimator

Diaphragm

Diaphragm

3150

400

40

400

40

250

Image plan

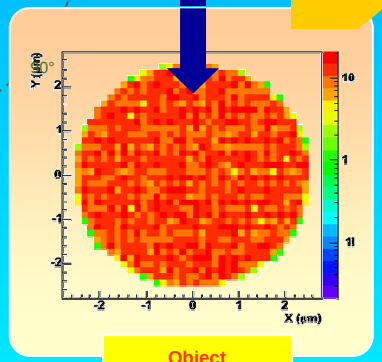
90° analysis magnet

Switching magnet

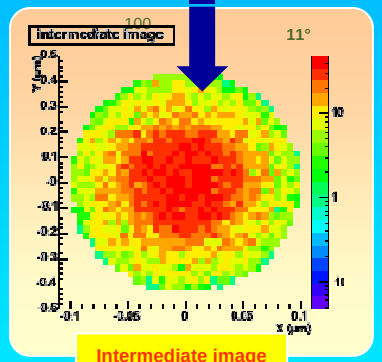
300

100

Singletron incident beam



Object
5 µm in diameter



Intermediate image
60 nm x 80 nm

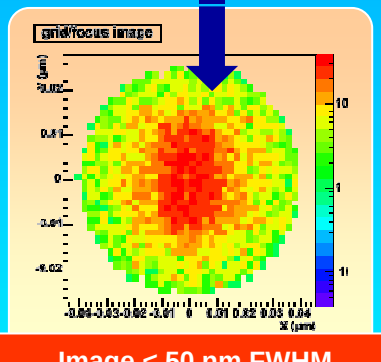
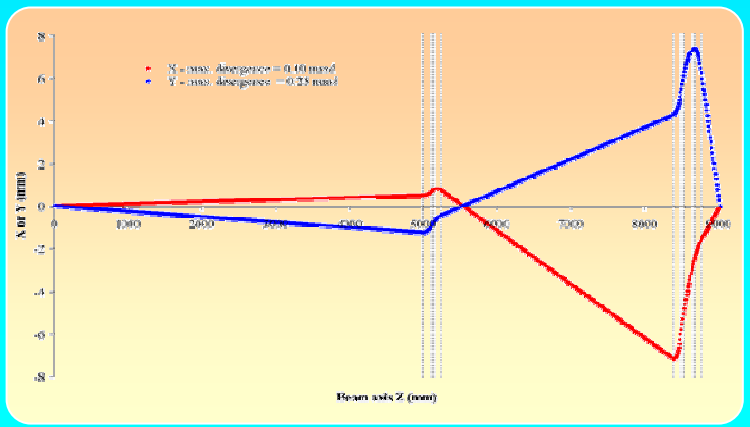
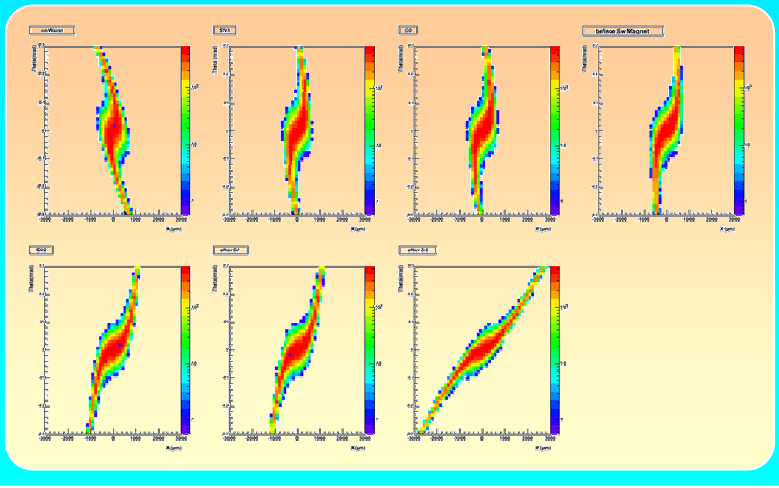


Image < 50 nm FWHM
same prediction as Oxray, Zgoubi…



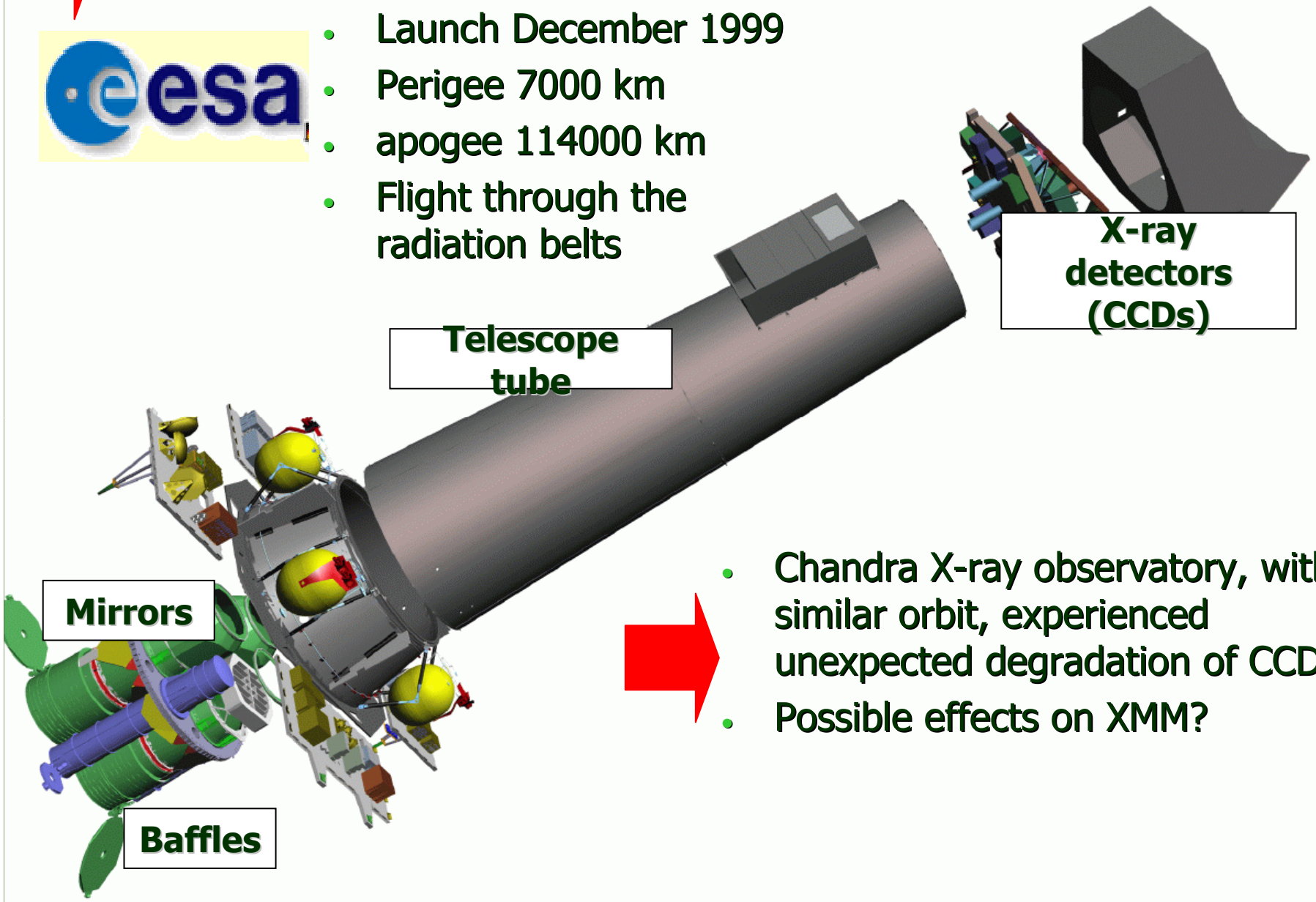


Space science

X-ray Multi-Mirror mission (XMM)

XMM

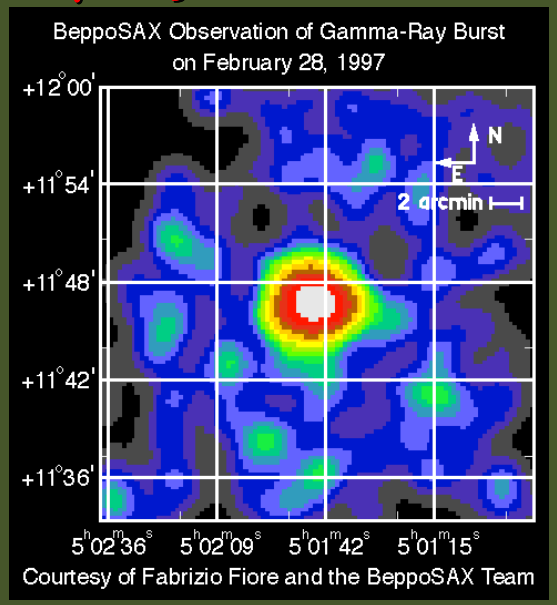
- Launch December 1999
- Perigee 7000 km
- apogee 114000 km
- Flight through the radiation belts

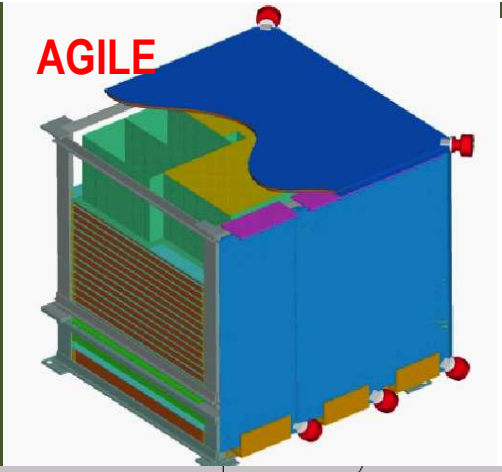


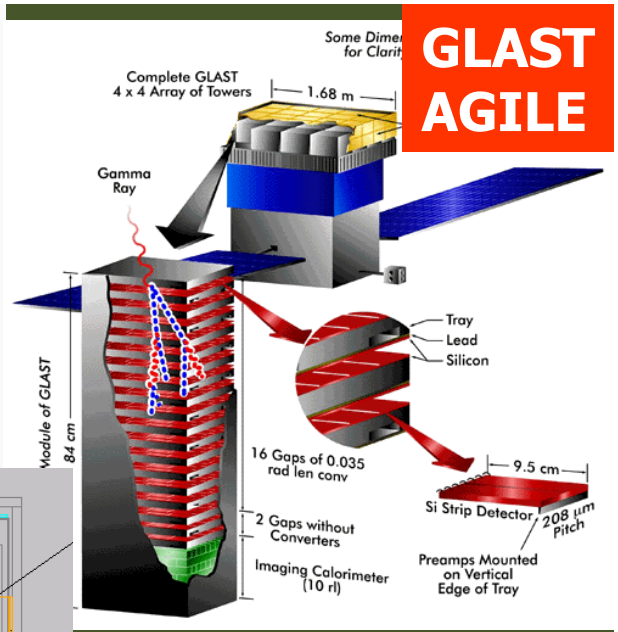
- Chandra X-ray observatory, with similar orbit, experienced unexpected degradation of CCDs
- Possible effects on XMM?

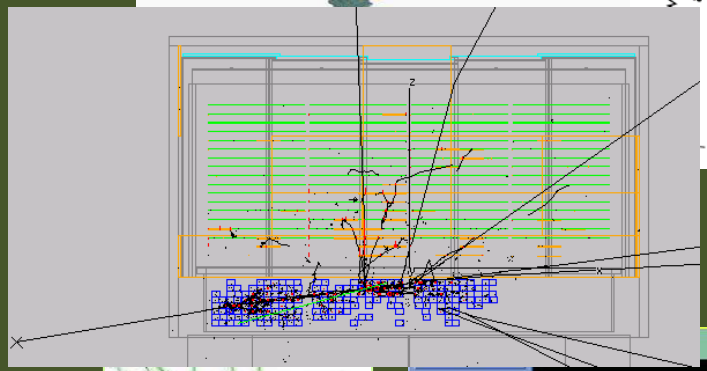
γ astrophysics

γ-ray bursts

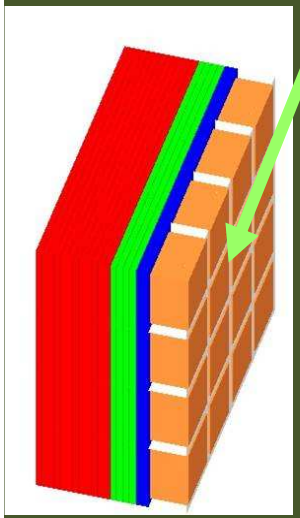






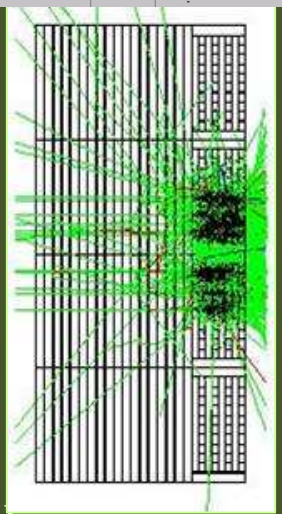


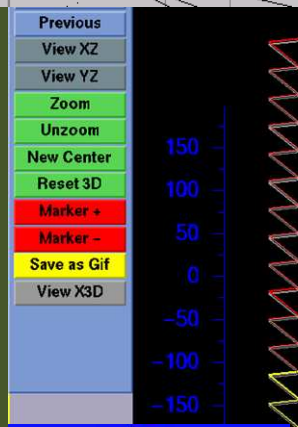
GLAST

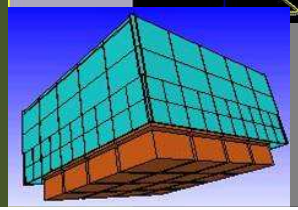


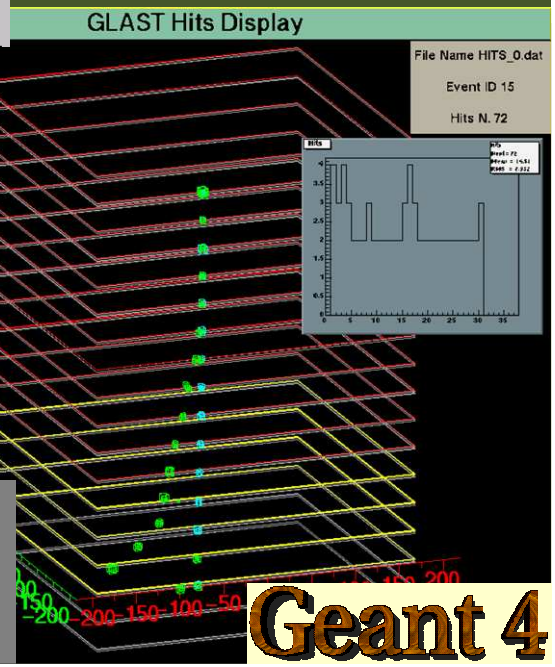
Typical telescope:
Tracker
Calorimeter
Anticoincidence

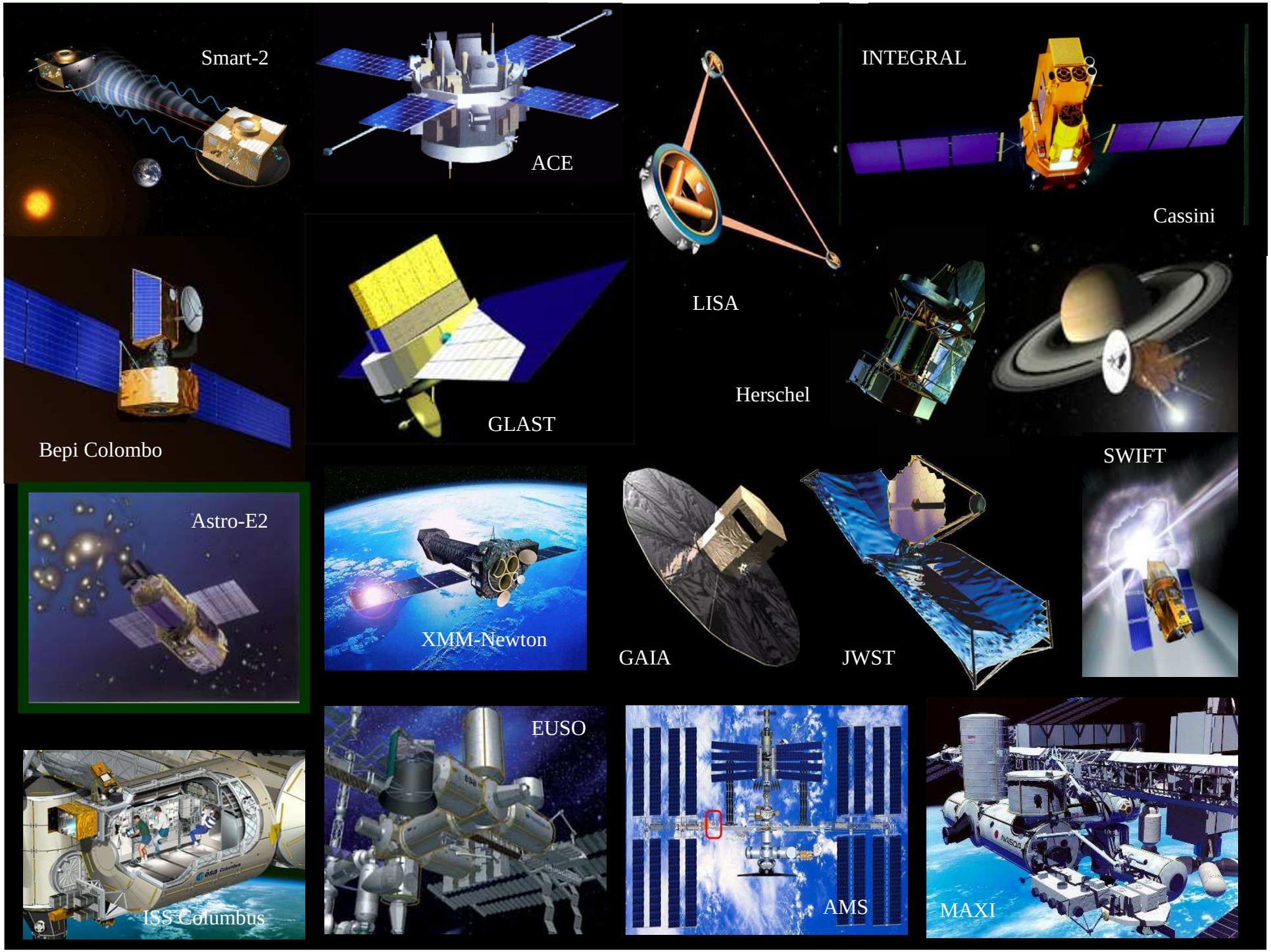
- γ conversion
- electron interactions
- multiple scattering
- δ-ray production
- charged particle tracking










Smart-2
ACE
LISA
INTEGRAL
Cassini
Bepi Colombo
GLAST
Herschel
SWIFT
Astro-E2
XMM-Newton
GAIA
JWST
EUSO
ISS Columbus
AMS
MAXI

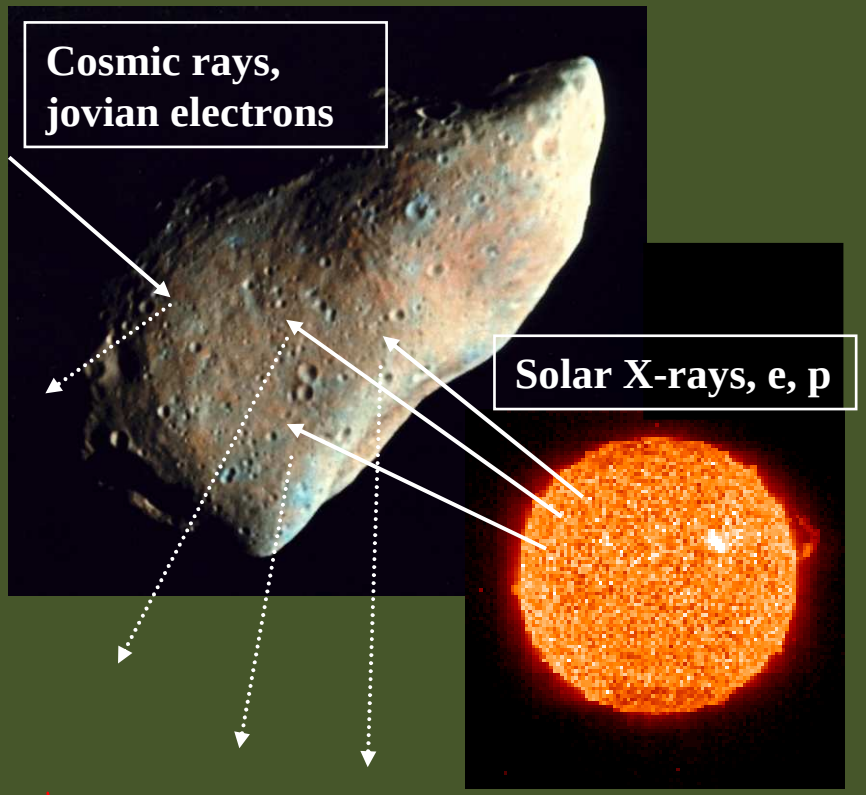
ISS

Courtesy T. Ersmark, KTH Stockholm

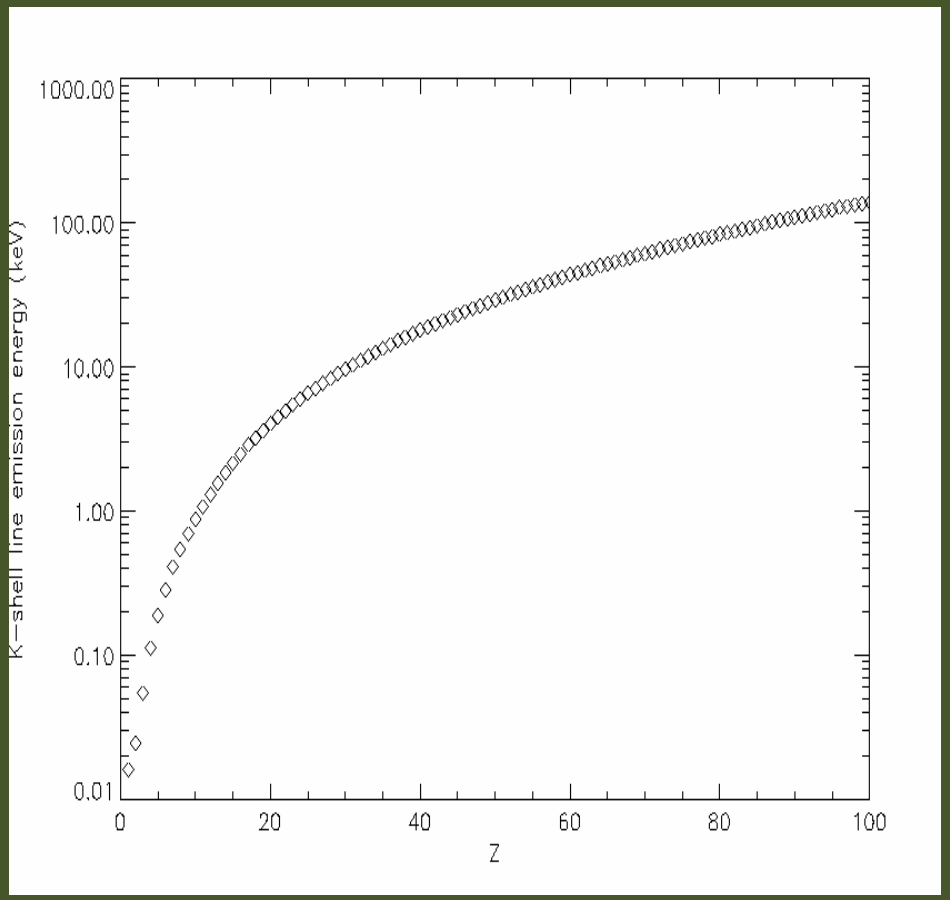
Geant4 in space science

ESA Space Environment & Effects Analysis Section

X-Ray Surveys of Asteroids and Moons



Courtesy SOHO EIT

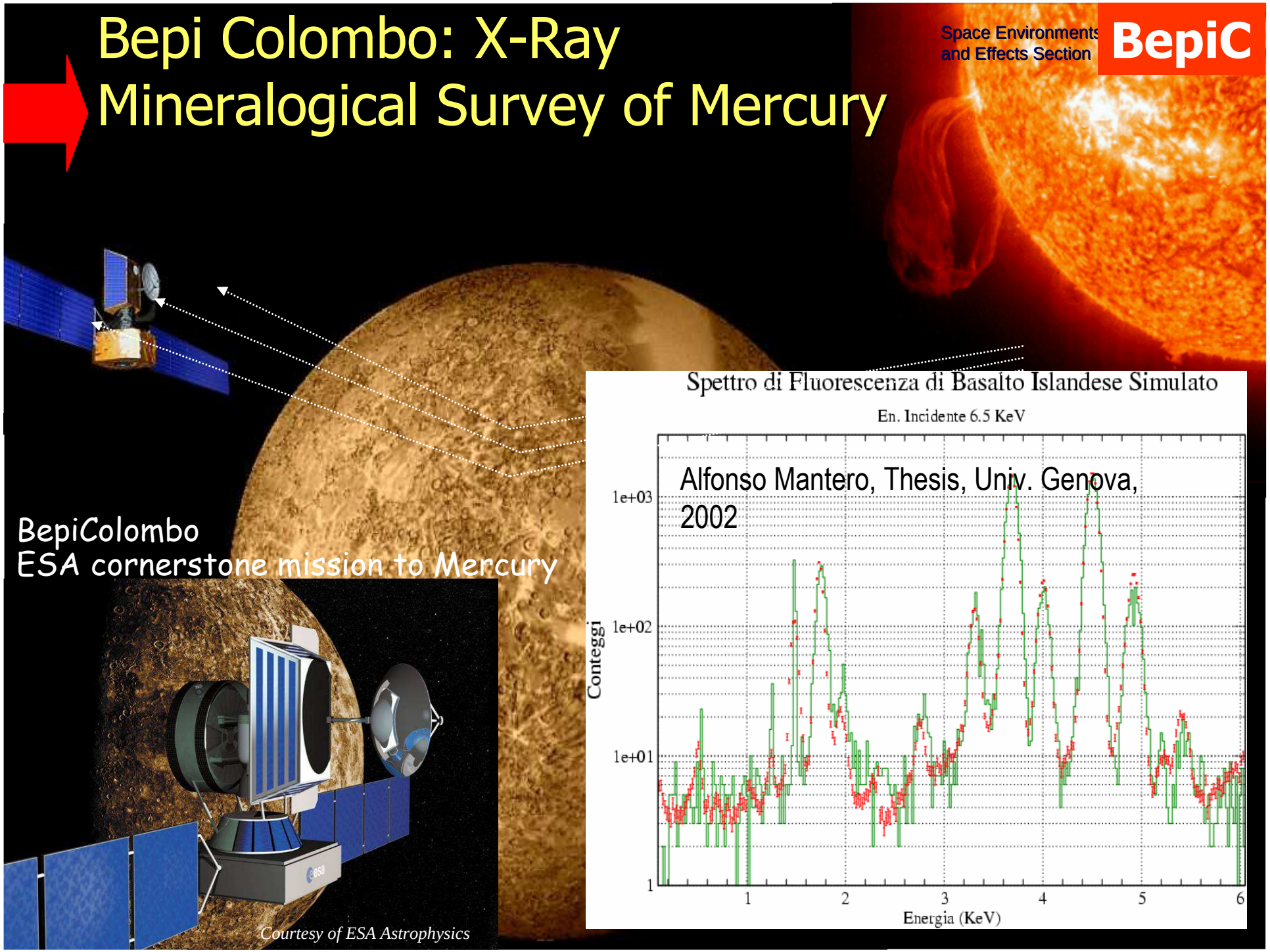


Induced X-ray line emission: indicator of target composition (~100 μm surface layer)

Bepi Colombo: X-Ray Mineralogical Survey of Mercury

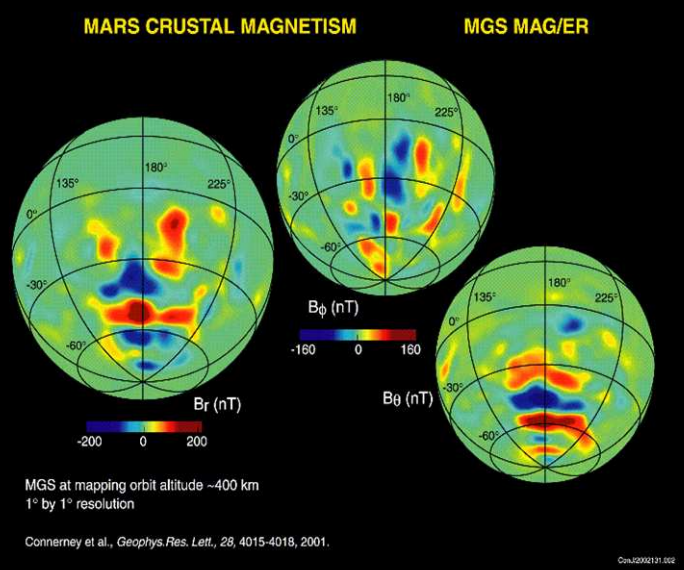
Space Environments and Effects Section

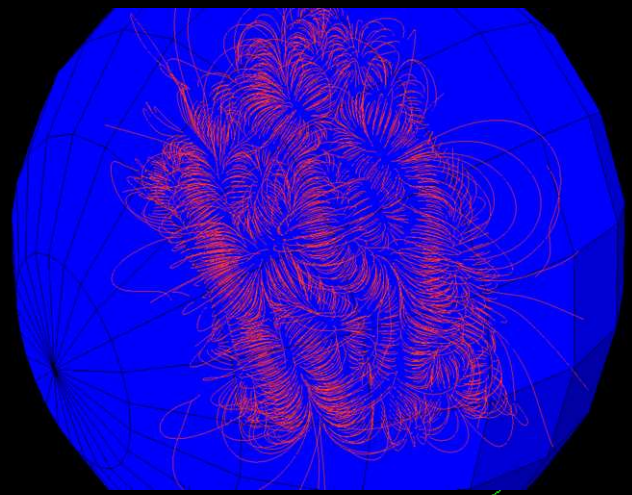
BepiC

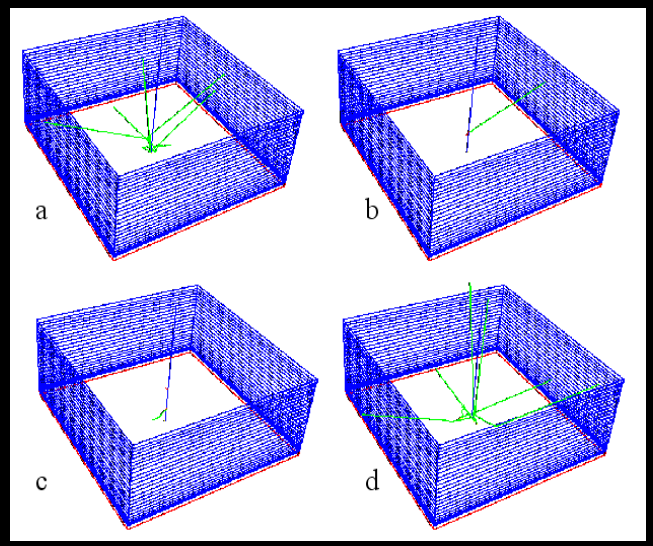


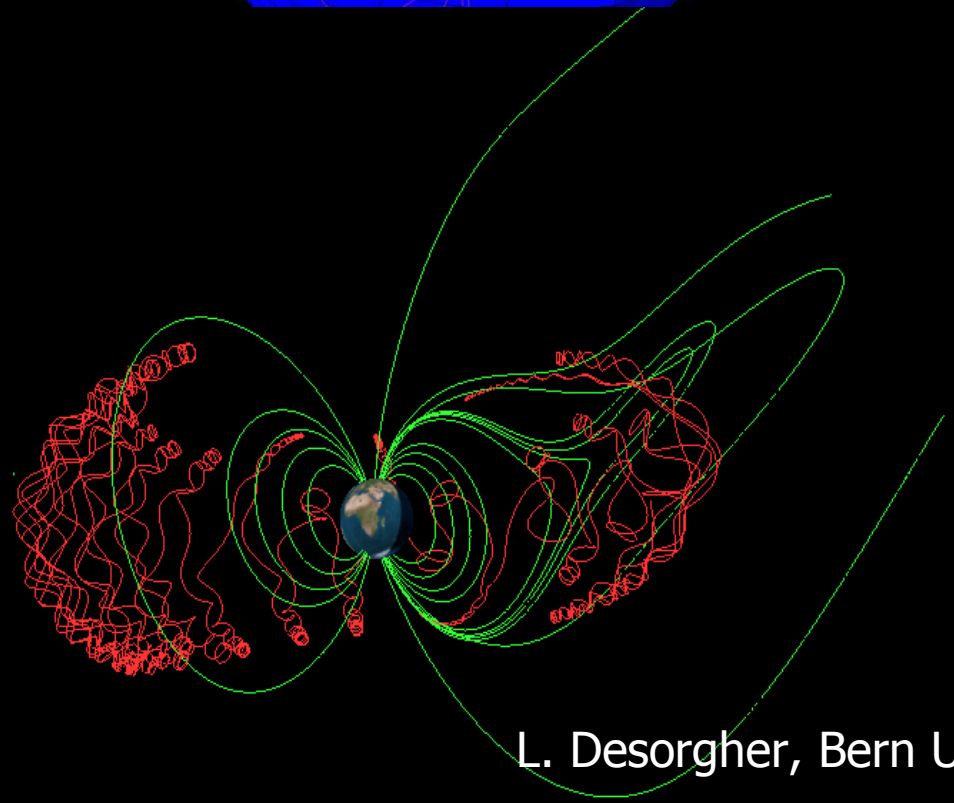
Planetary radiation environments

Planets





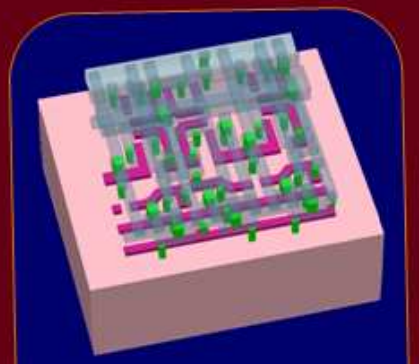




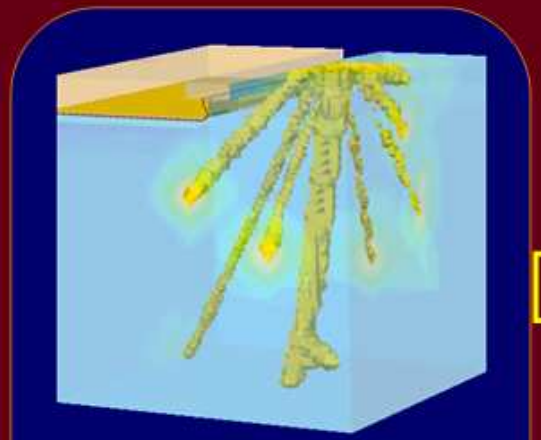
L. Desorgher, Bern U.

RADSAFE on SEE in SRAMs

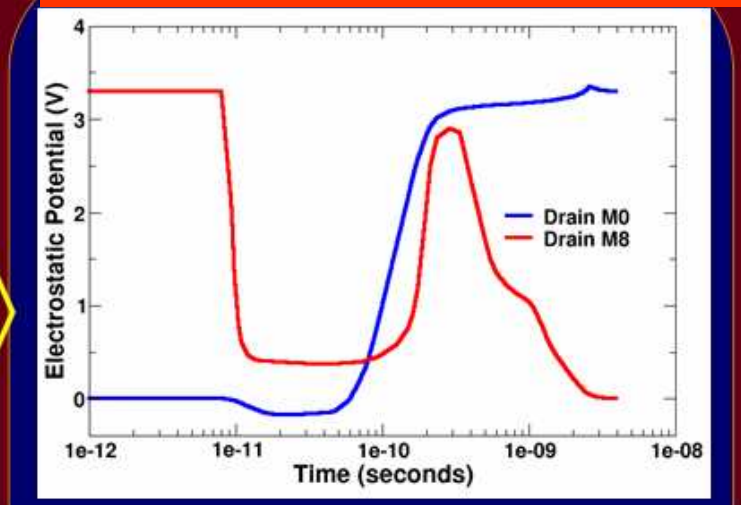
Radiation damage



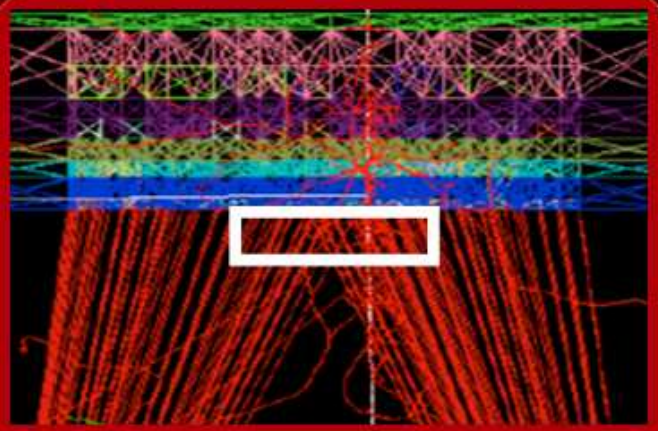
TCAD Cell Structure: SRAM Cell



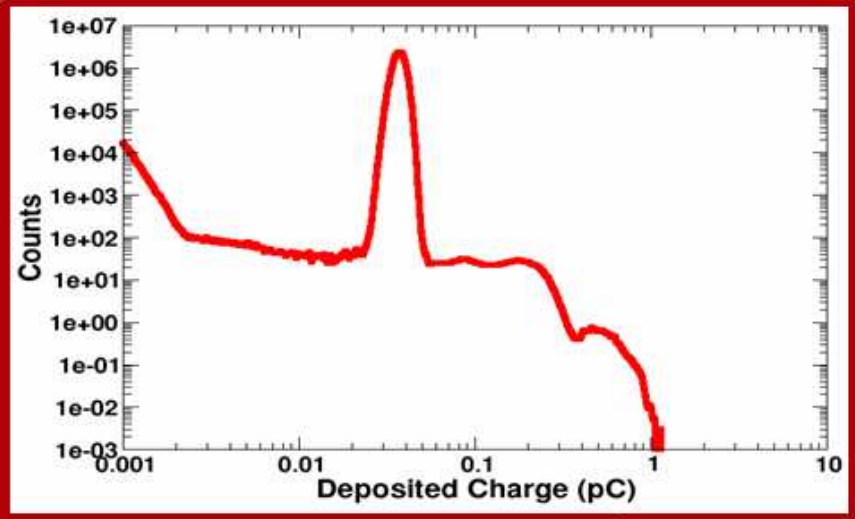
Single Charge Deposition in TCAD: Ne+W Event



SRAM Cell Upset



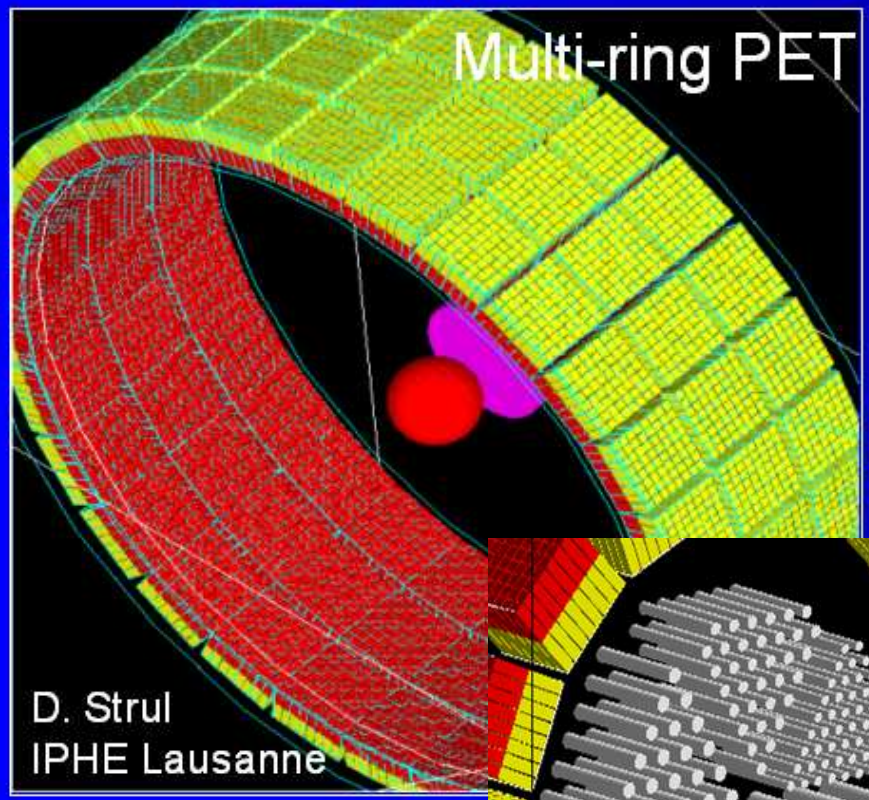
Geant4 Geometry and 523 MeV Neon Event

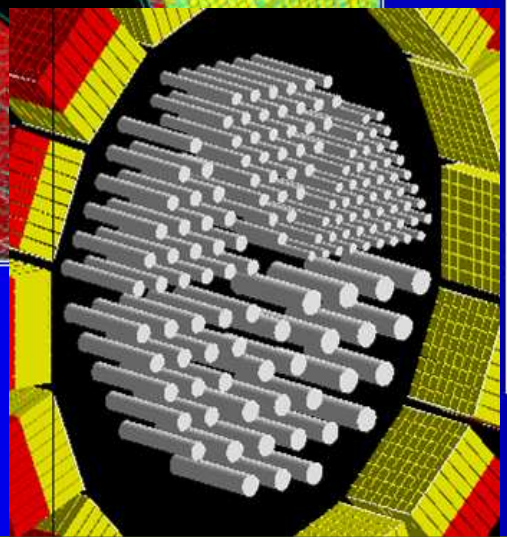


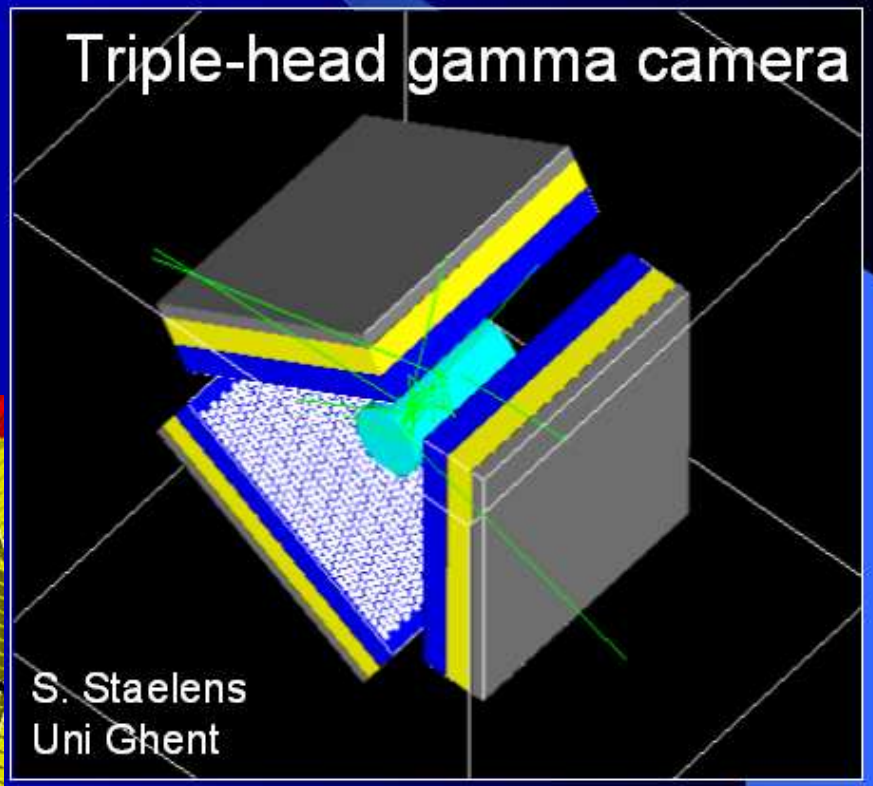
MRED Energy Deposition for 10^8 Events

Medical

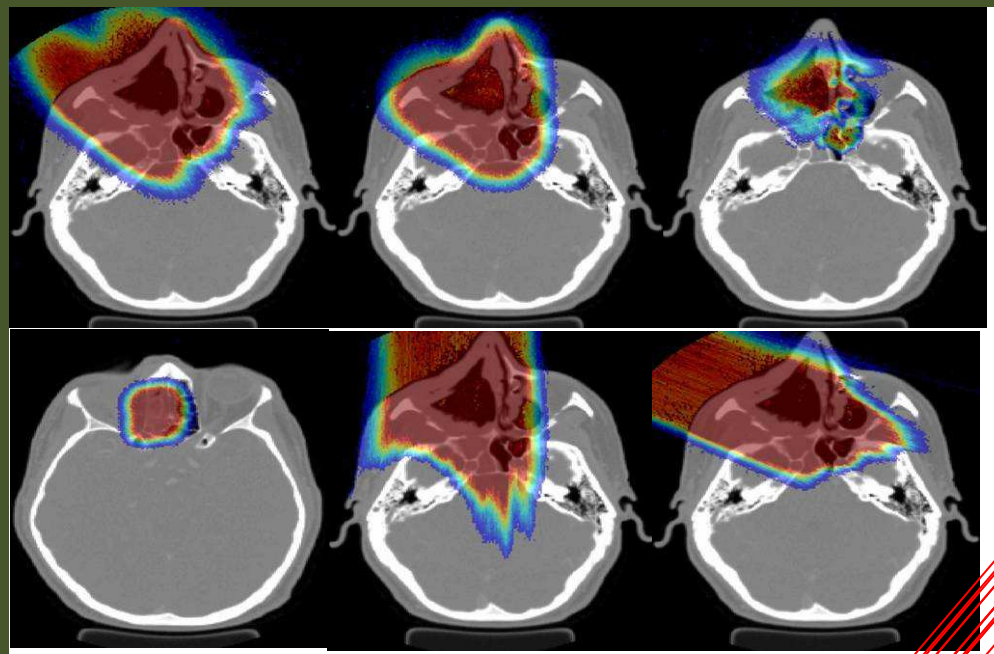
Geometry examples of GATE applications

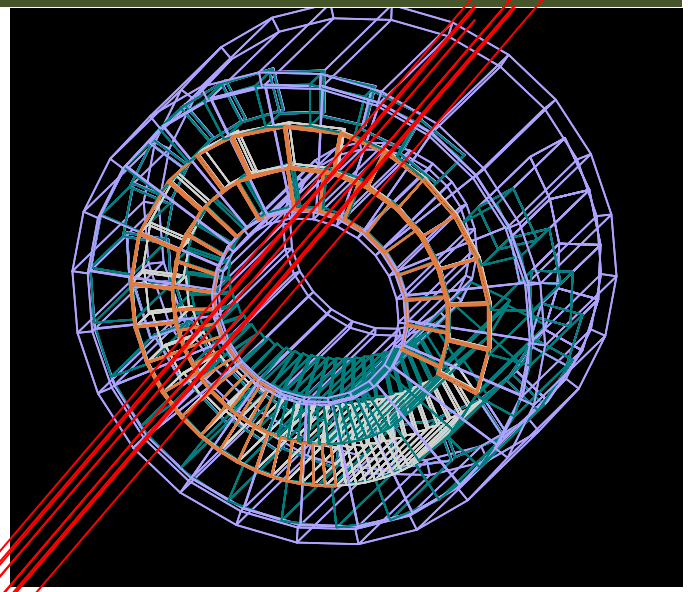


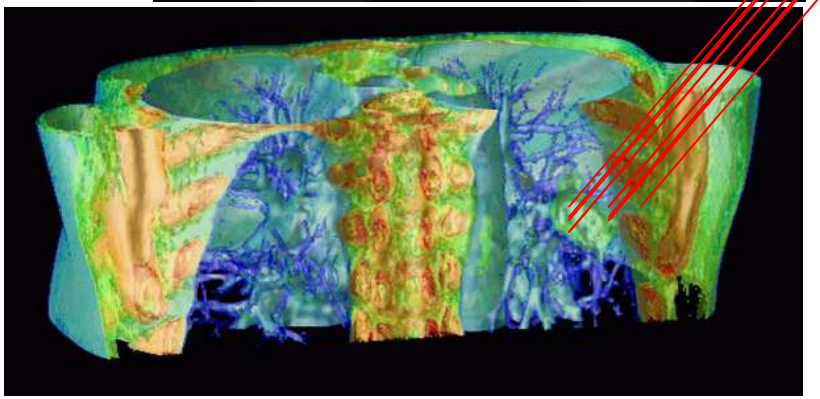




GEANT4 based proton dose calculation in a clinical environment: technical aspects, strategies and challenges





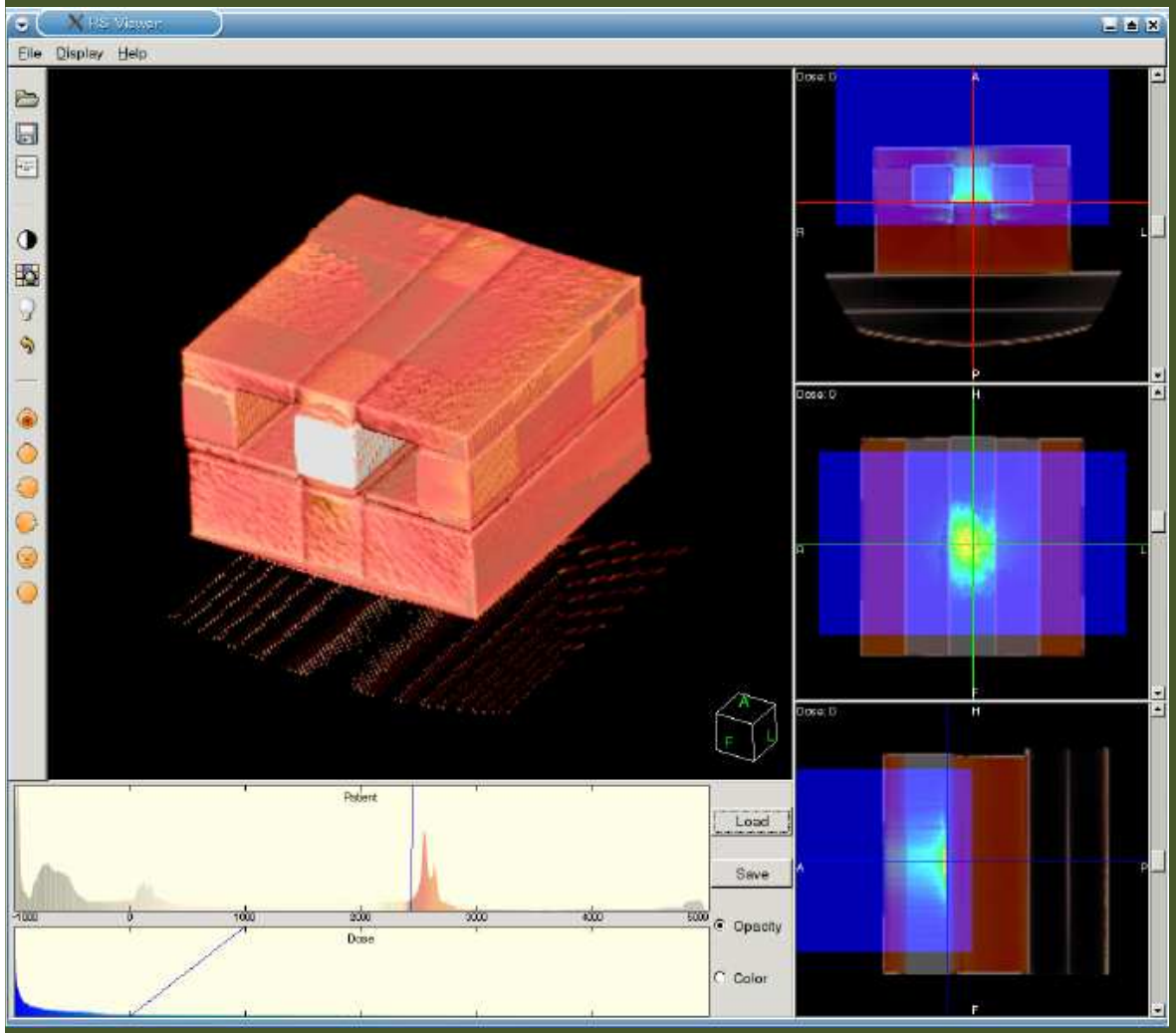


Harald Paganetti

MASSACHUSETTS GENERAL HOSPITAL

HARVARD MEDICAL SCHOOL

Screen shots of gMocren



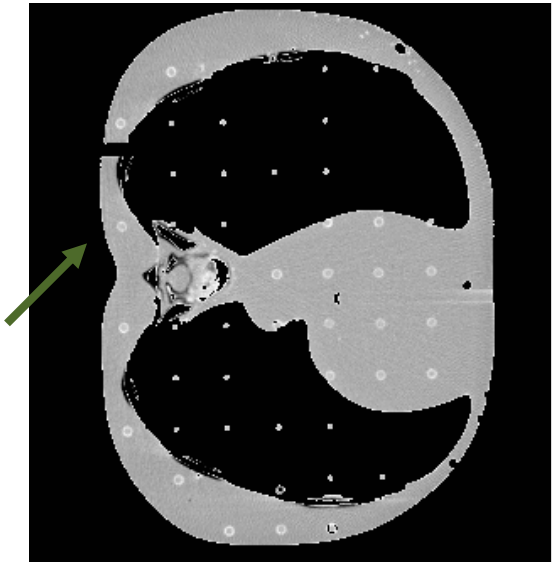
Comparison with commercial treatment planning systems

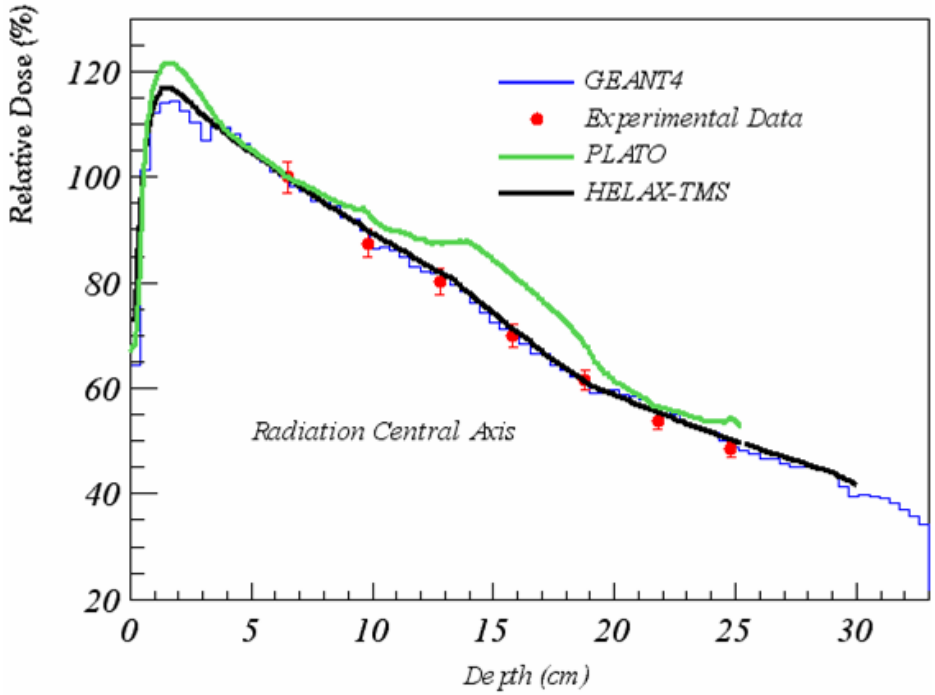
M. C. Lopes [1], L. Peralta [2], P. Rodrigues [2], A. Trindade [2]
[1] IPOFG-CROC Coimbra Oncological Regional Center - [2] LIP - Lisbon

CT-simulation with a Rando phantom
Experimental data obtained with TLD LiF dosimeter

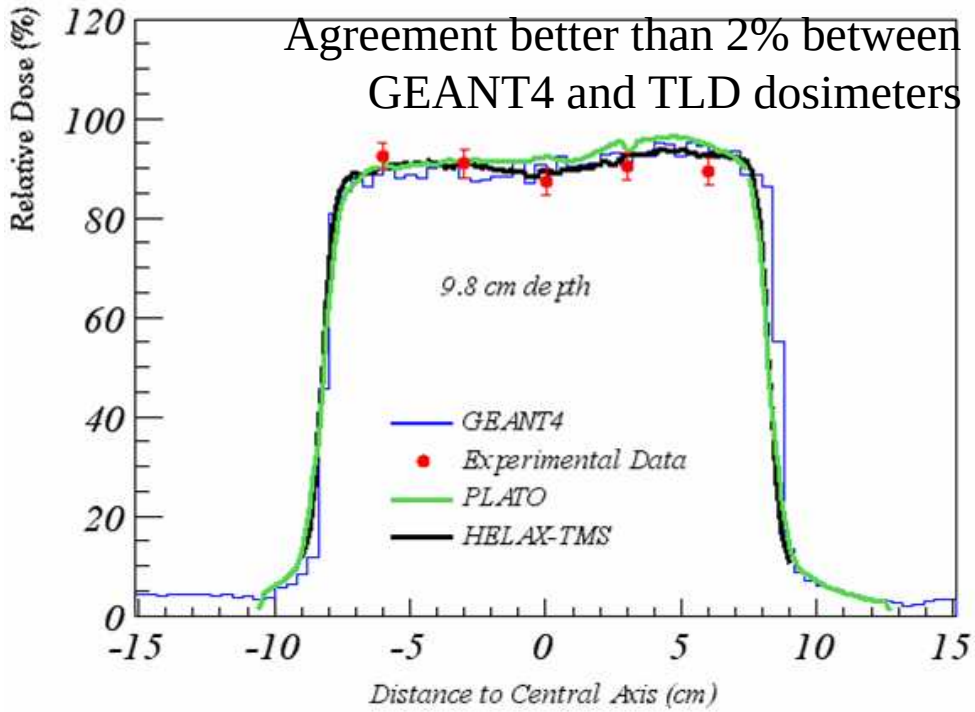
CT images used to define the geometry:

a thorax slice from a Rando anthropomorphic phantom





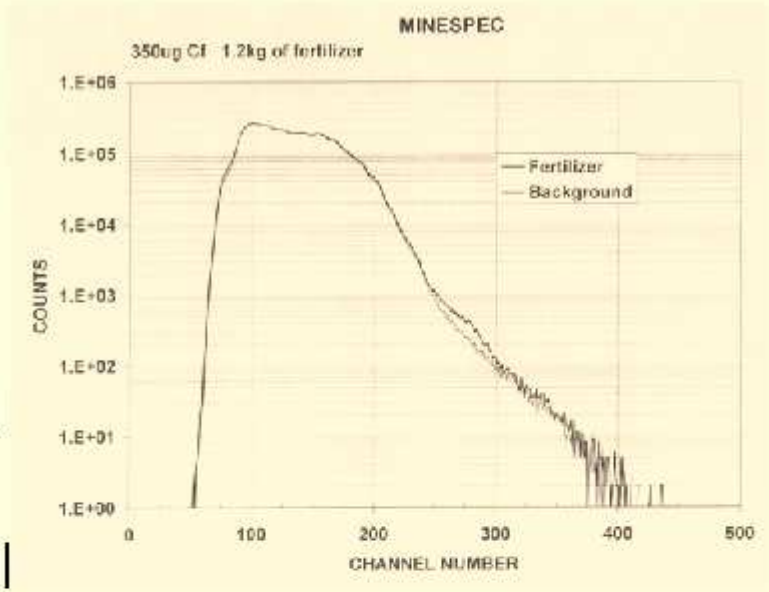
Agreement better than 2% between GEANT4 and TLD dosimeters

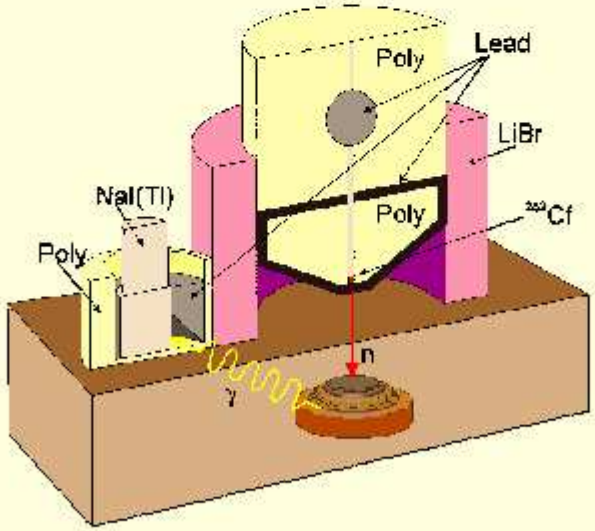


Other

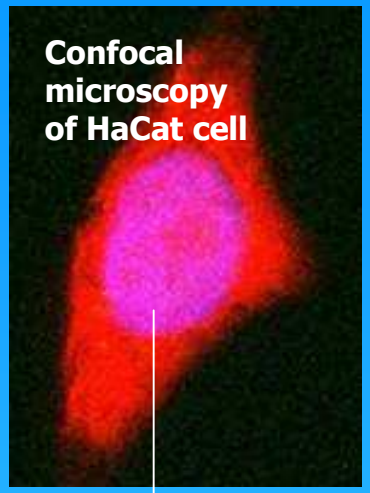
Thermal Neutron Activation

- TNA detects explosive by properties of constituents
  - High concentration of N
  - Does not ID explosive
- Can confirm presence of all surface laid or shallow AT mines in few seconds to 1 minute
- AT up to 20 cm deep and large AP mines in < 5 minutes



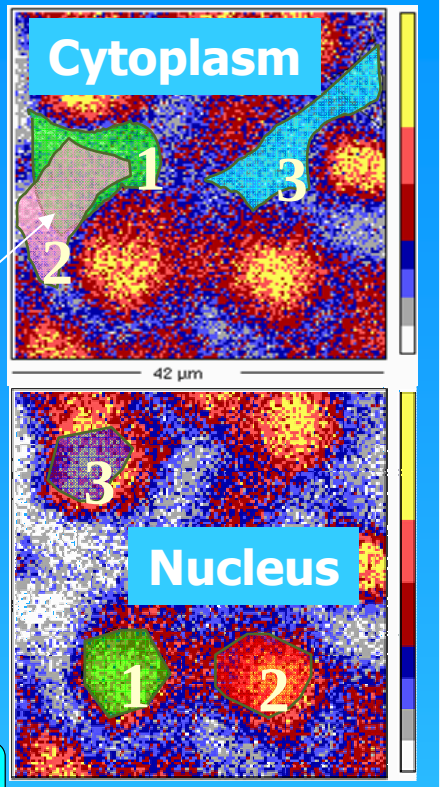


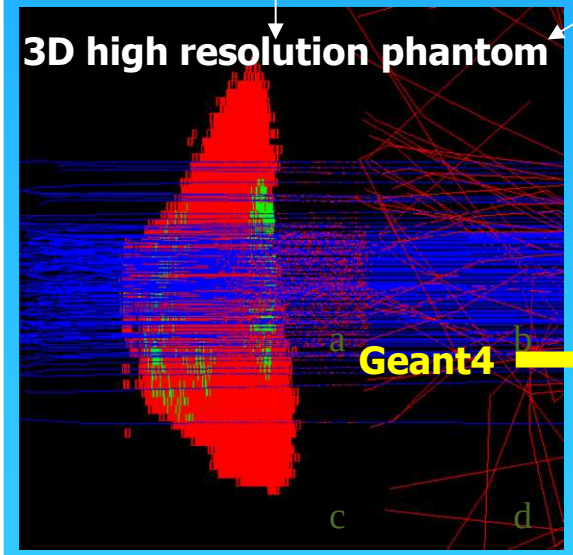
Cellular irradiation @ CENBG



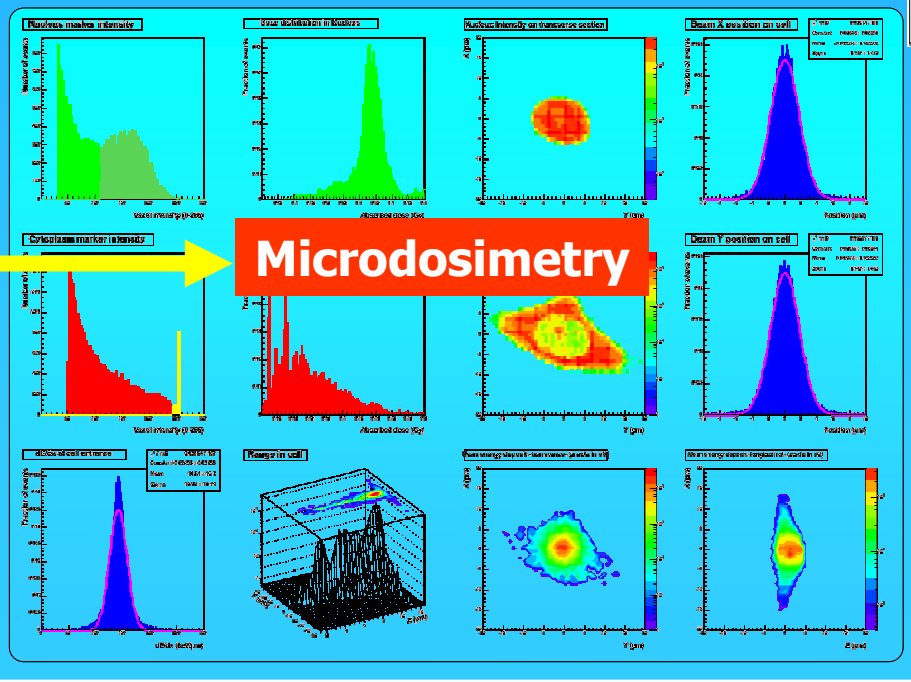
Cellular irradiation 3 MeV alphas

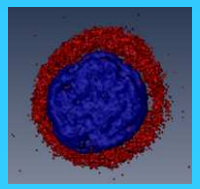
Ion beam analysis with protons (PIXE, RBS)

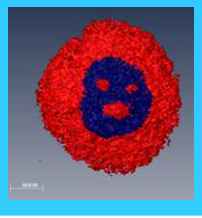


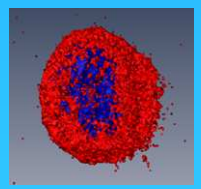


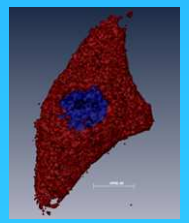
Geant4











Chemical composition	Mean dose in nucleus (Gy)
Liquid water	0.14 ± 0.02
Reference cell (ICRU)	0.32 ± 0.06
CENBG measurements	0.38 ± 0.07

More to come on Friday !

- GATE by S. Jan
- ThIS by L. Guigues
- FASTRAD by T. Beutier & P. Pourrouquet
- GRAS by G. Santin
- PLANETOCOSMICS by L. Deshorger