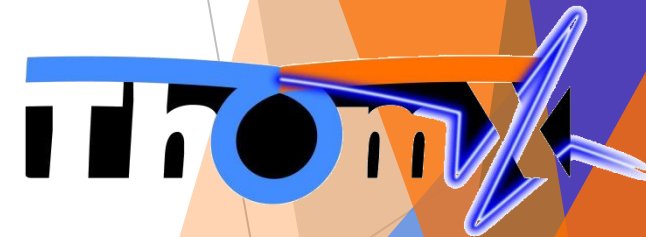


# ThomX Status



Hugues MONARD, project manager

LAL



# Plan

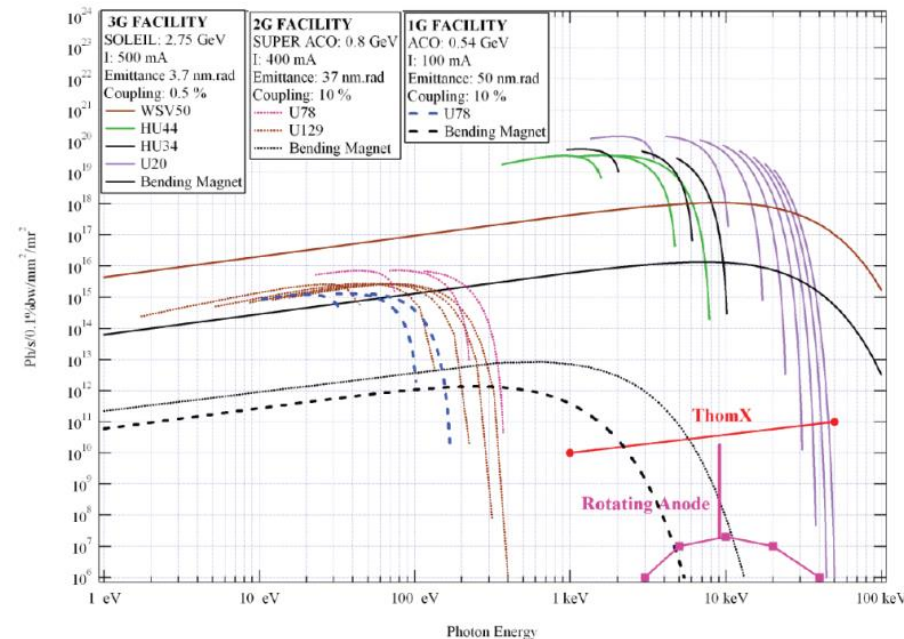
- ▶ About ThomX
- ▶ Finance, partners
- ▶ Accelerator, parameters
- ▶ Xray
- ▶ Building (Igloo)
- ▶ Accelerator block status
- ▶ Impact on Depacc
- ▶ Planning
- ▶ conclusions



# What is ThomX ?

- ▶ ThomX is a « **hard** » X ray source with high flux
- ▶ Xray production based on **Compton effect** : laser - electron interaction
- ▶ ThomX is a demonstrator for a future industrial source (Thales)
- ▶ one goal of ThomX : affordable Xray source for a Laboratory
- ▶ X ray energy : 45 to 90 keV
- ▶ Flux :  $10^{11}$  à  $10^{13}$  ph/s

Flux  $\sim 10^{12} - 10^{13}$  ph/sec  
Brightness  $\sim 10^{11}$  ph/sec/mm<sup>2</sup>/mrad<sup>2</sup>/0.1%bw

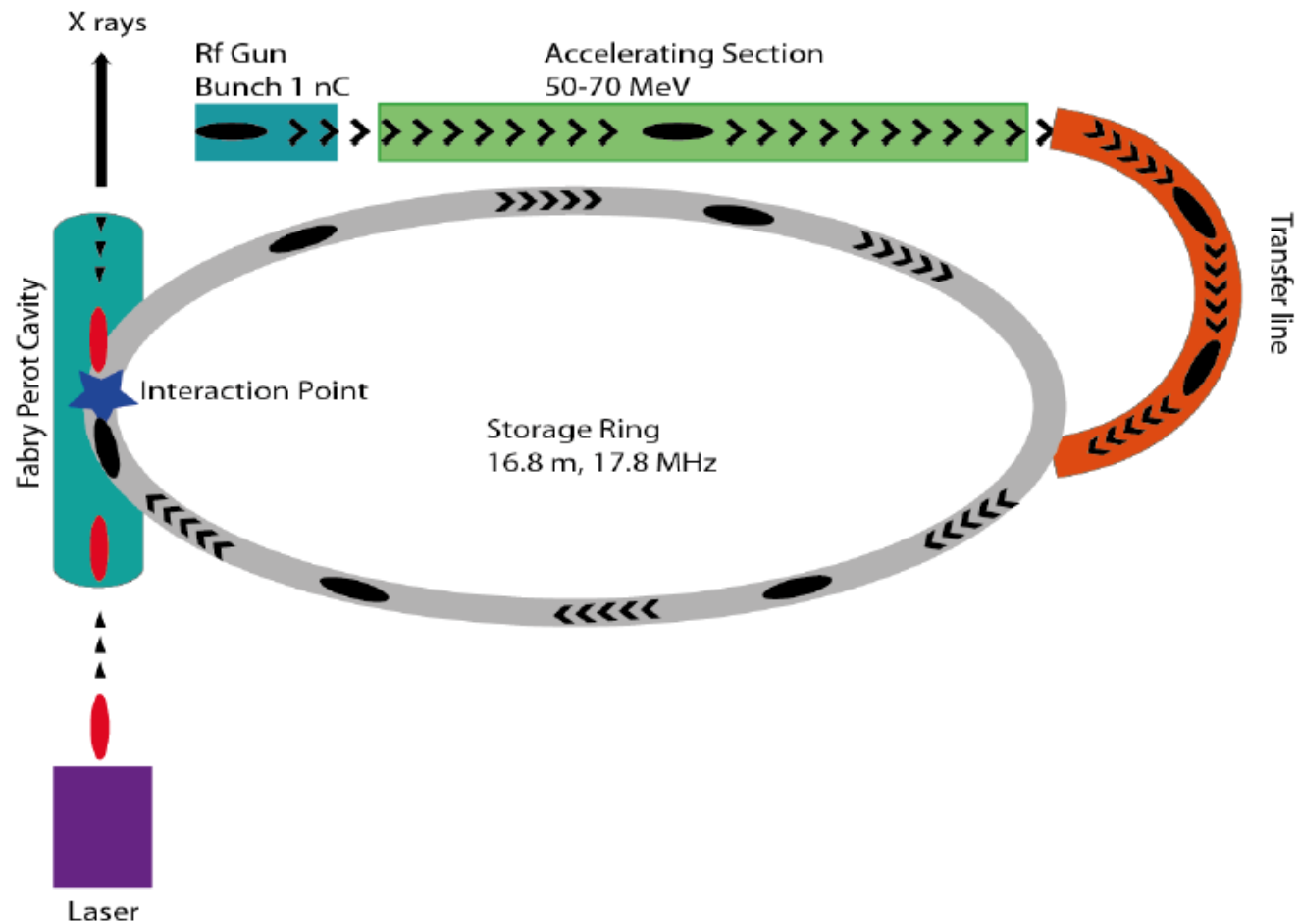


# ThomX finance and partners

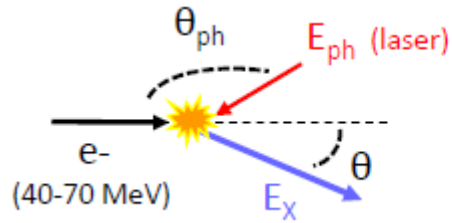
- ▶ Finance obtained in 2010 by A. Variola from the Equipex program of french National Reasearch Agency : **12 M€**
- ▶ Partners of the project :

Name	contribution
Thales TED	Industrialisation
Synchrotron SOLEIL	Ring, magnets, Rf source, ...
Institut NEEL (Grenoble)	Xray line
ESRF	Xray line, cooling rack,...
LAMS	Cultural heritage analysis
GIN(Grenoble Institut Neuroscience)	medical application
CELIA (Talence)	high power laser, laser amplification

# ThomX accelerator layout principle

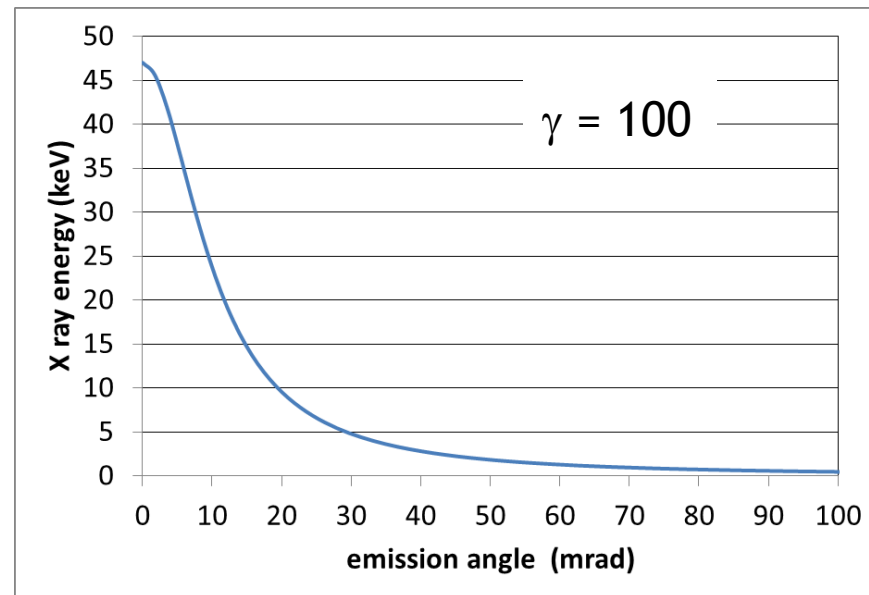


# X ray source characteristics



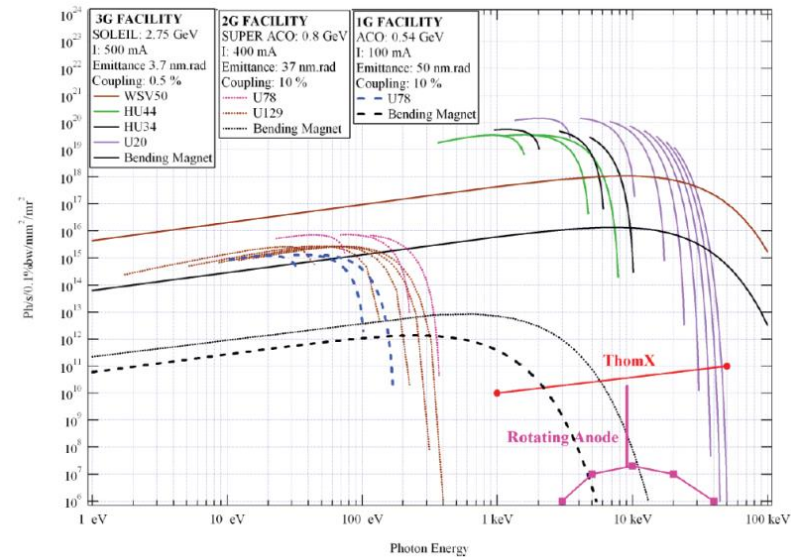
$$E_X \sim \frac{2 \gamma^2 E_{ph} [1 - \cos(\theta_{ph})]}{1 + (\gamma\theta)^2}$$

- ▶ Most efficient frequency amplifier
- ▶ Very weak cross section  $\sim 6.6 \cdot 10^{-25} \text{ cm}^2$  : need many e- and photons
- ▶ Tunability : electron or photon energy
- ▶ Directivity :  $1/\gamma$
- ▶ Energy/angle
- ▶ Collision angle small dependence



# Main parameters

Injector		Ring	
Charge	1 nC	Energy	50 MeV (70 MeV possible)
Laser wavelength and pulse power	266 nm, 100 $\mu$ J	Circumference	16.8 m
Gun Q and Rs	14400, 49 MW/m	Crossing-Angle (full)	2 degrees
Gun accelerating gradient	100 MV/m @ 9.4 MW	$B_{x,y}$ @ IP	0.2 m
Normalized r.m.s emittance	8 $\pi$ mm mrad	Emittance x,y (without IBS and Compton)	3 $10^{-8}$ m
Energy spread	0.36%	Bunch length (@ 20 ms)	30 ps
Bunch length	3.7 ps	Beam current	17.84 mA
Laser and FP cavity		RF frequency	
Laser wavelength	1030 nm	Transverse / longitudinal damping time	1 s / 0.5 s
Laser and FP cavity Frep	36 MHz	RF Voltage	300 kV
Laser Power	50 - 100 W	Revolution frequency	17.8 MHz
FP cavity finesse / gain	30000 / 10000	$\sigma_x$ @ IP (injection)	78 mm
FP waist	70 $\mu$ m	Tune x / y	3.4 / 1.74
Source		Momentum compaction factor $\alpha_c$	0.013
Photon energy cut off	46 keV (@50 MeV), 90 keV (@ 70 MeV)	Final Energy spread	0.6 %
Total Flux	10 <sup>11</sup> -10 <sup>13</sup> ph/sec		
Bandwidth	1 % - 10%		
Divergence	1/ $\gamma$ ~ 10 mrad without diaphragm @ 50 MeV		

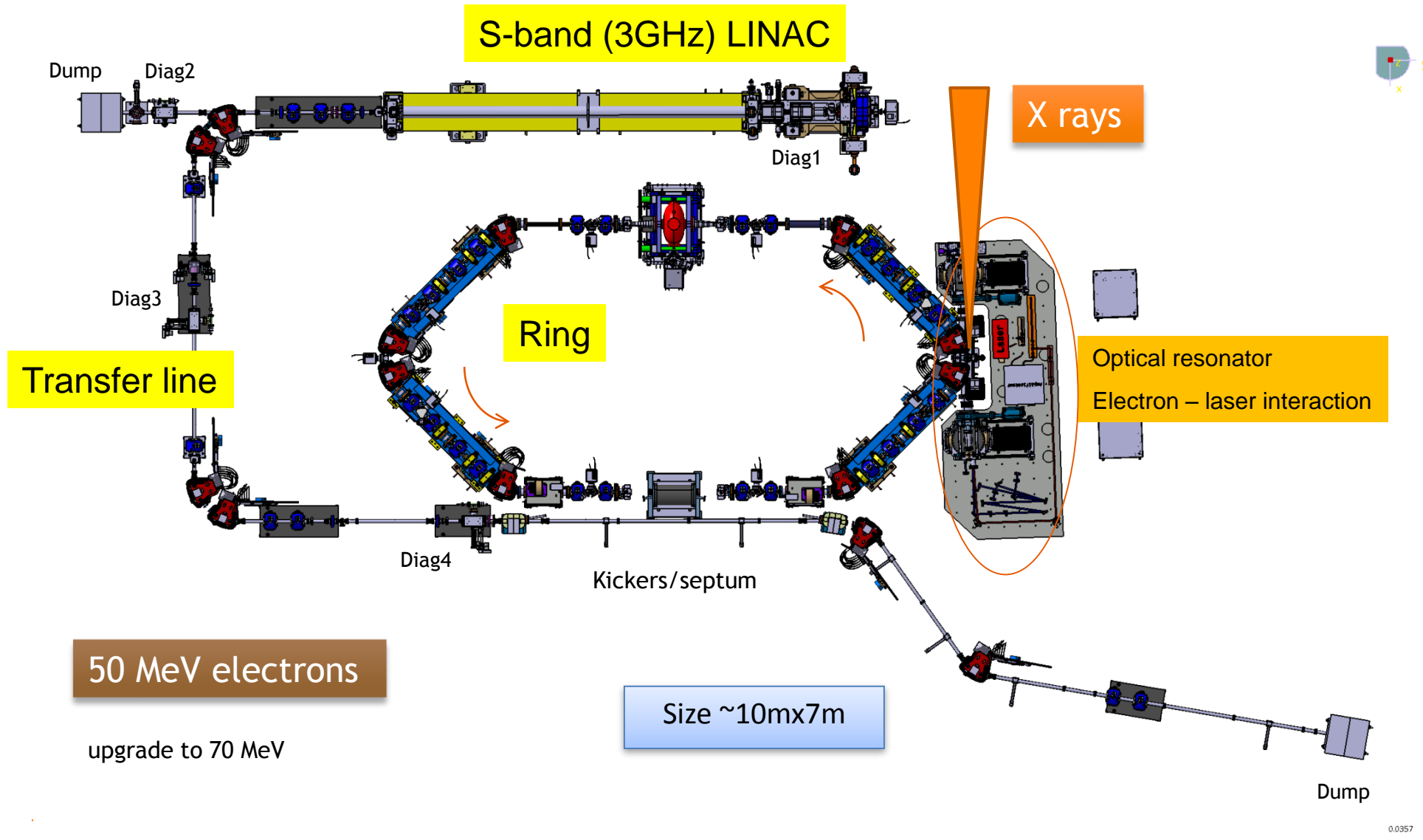


Flux ~ 10<sup>12</sup> - 10<sup>13</sup> ph/sec

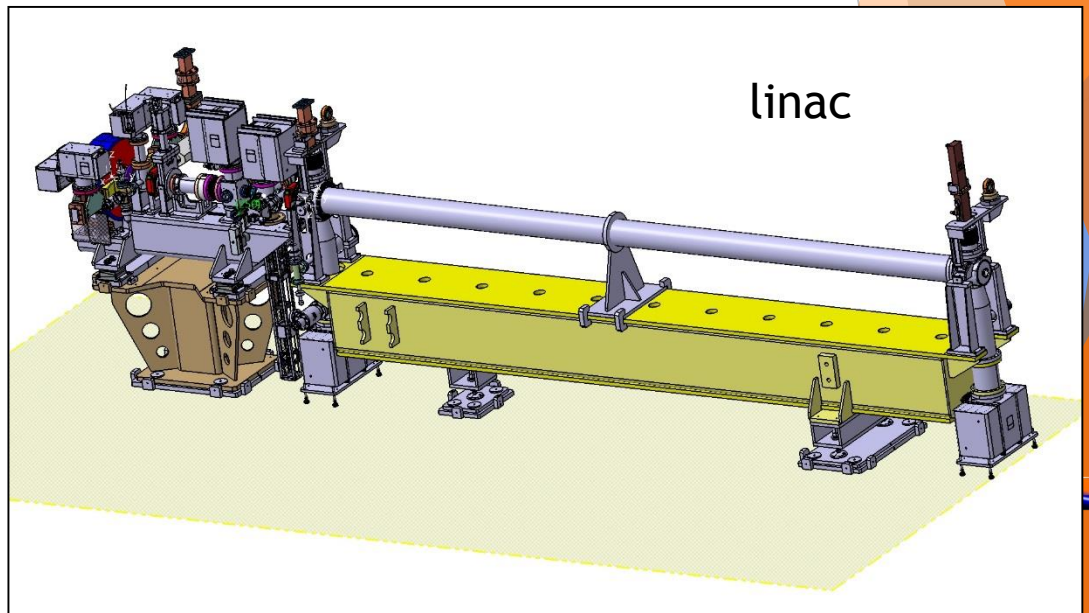
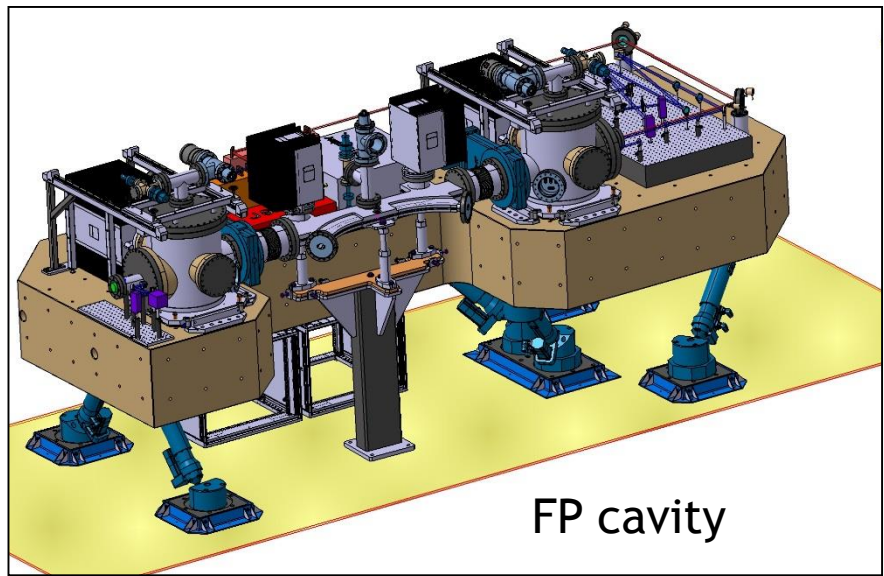
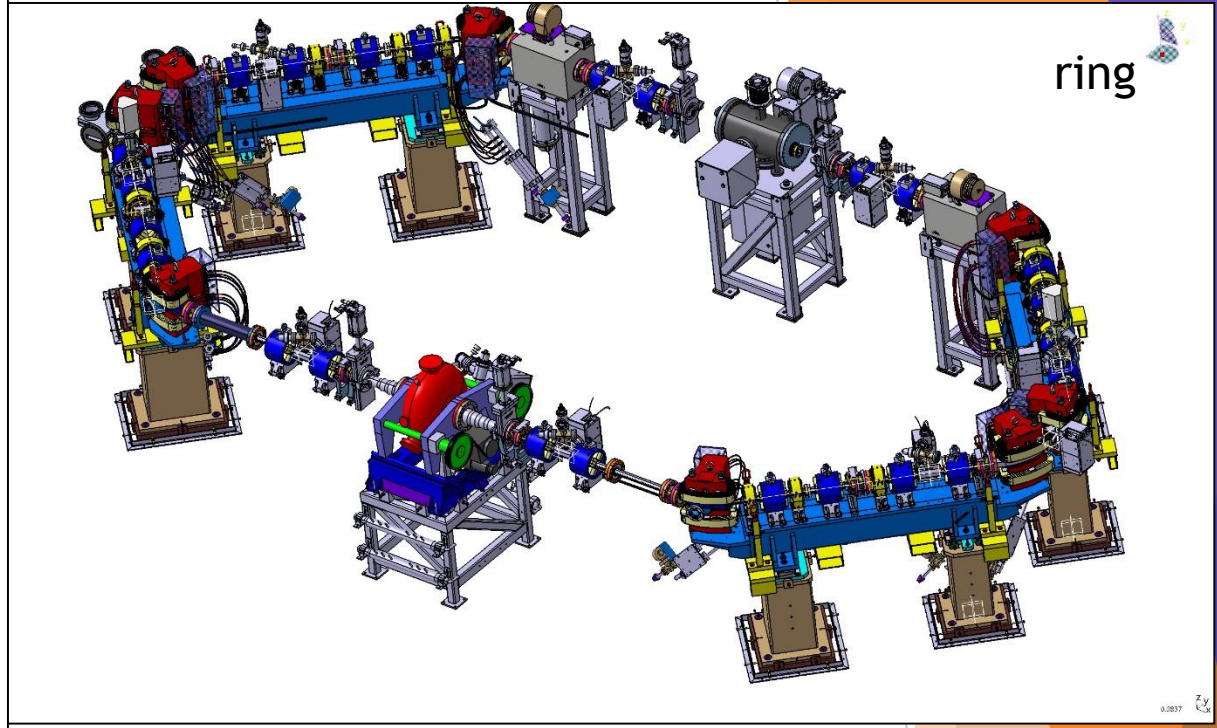
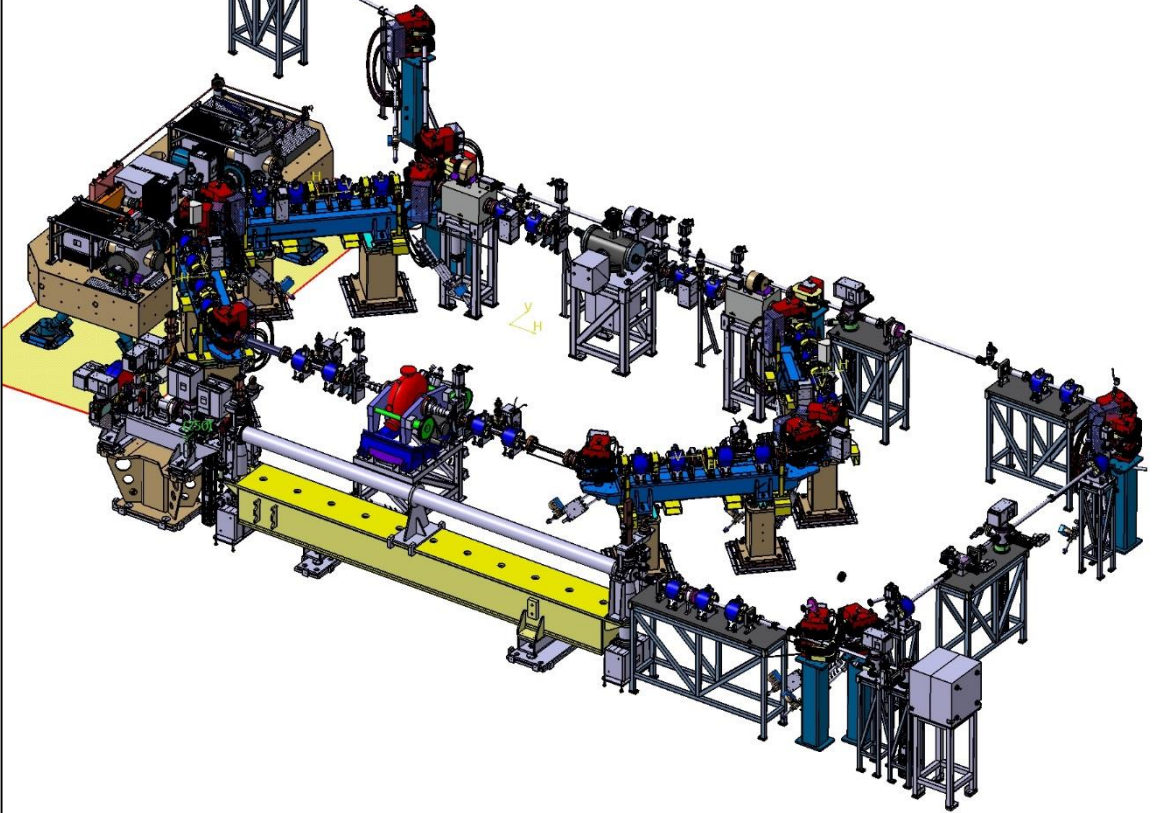
Brightness ~ 10<sup>11</sup> ph/sec/mm<sup>2</sup>/mrad<sup>2</sup>/0.1%bw



# ThomX accelerator

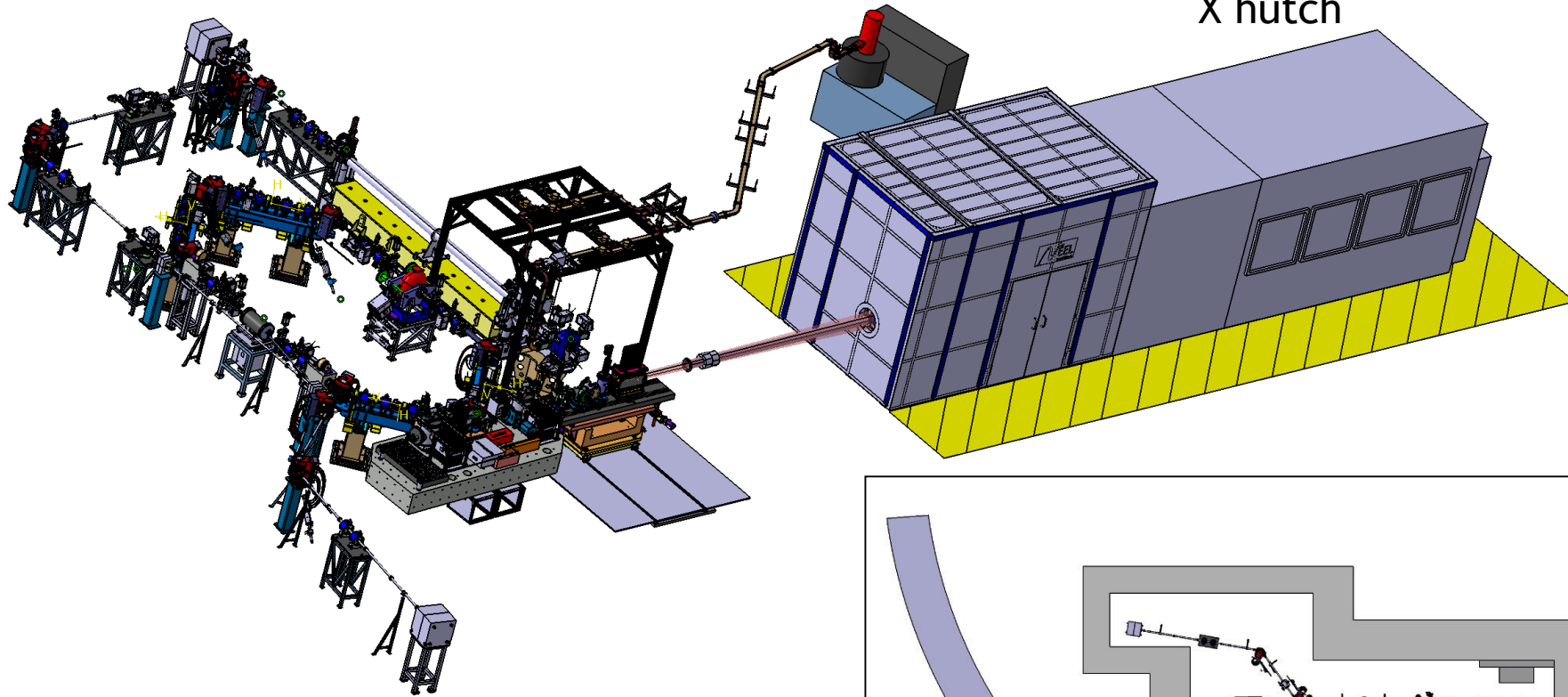






Linac RF source

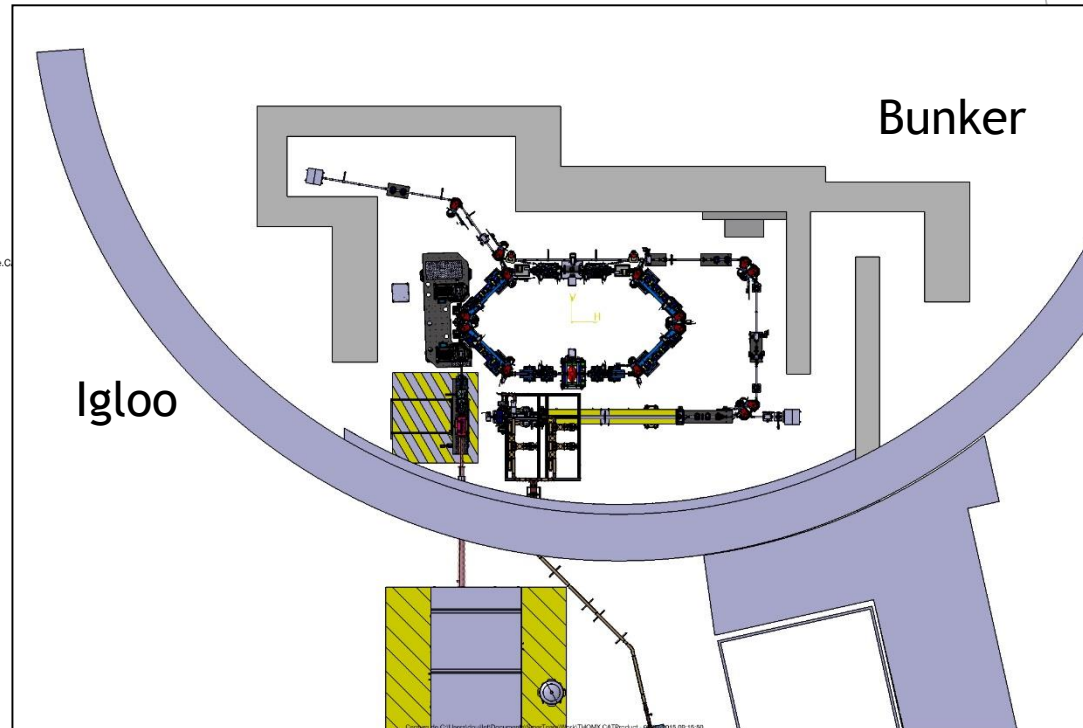
X hutch



Capture de C:\Users\douillet\Documents\SmarTeam\Work\ThomX Machines.C

Bunker

Igloo



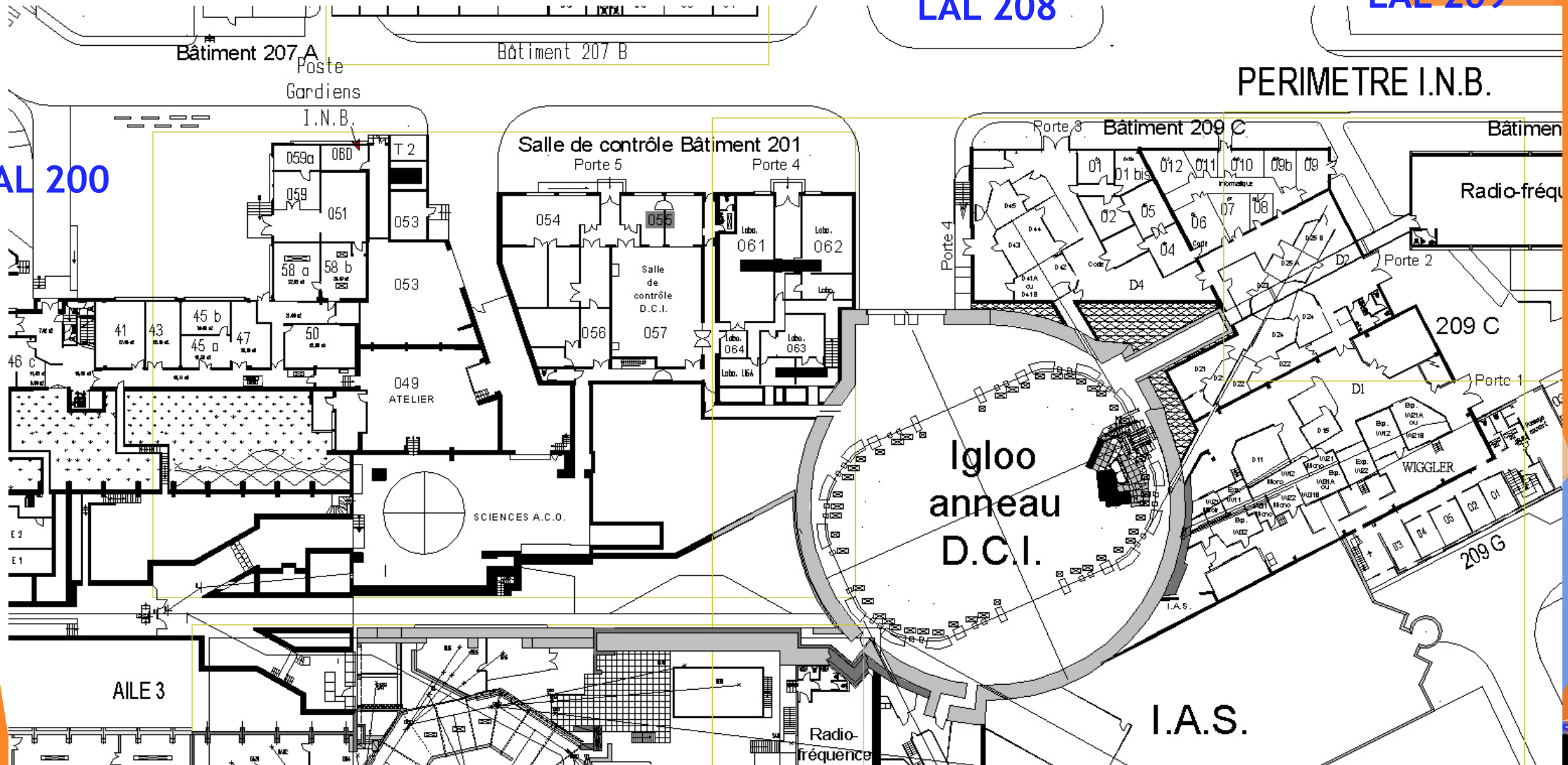


# ThomX civil engineering

LAL 208

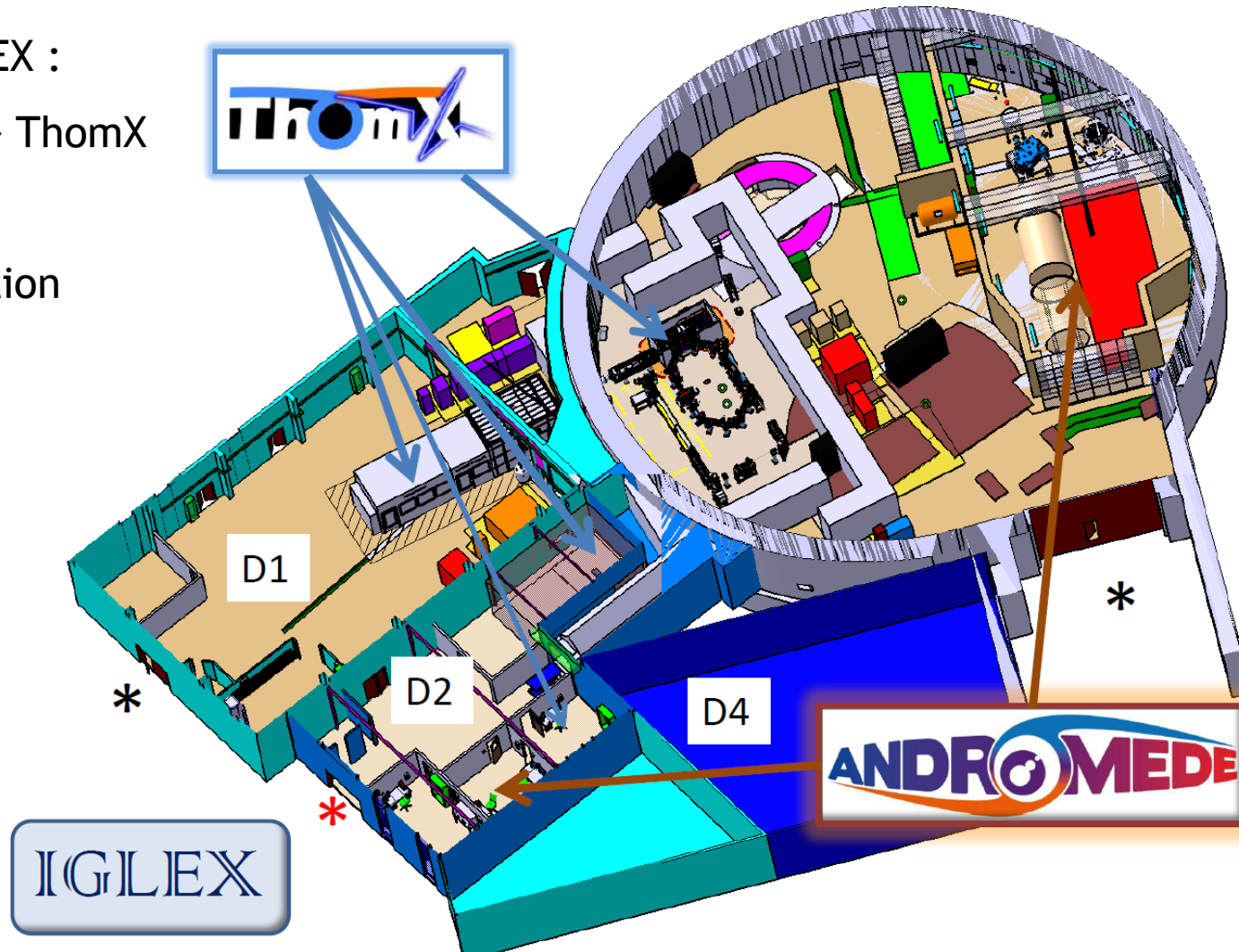
LAL 209

LAL 200



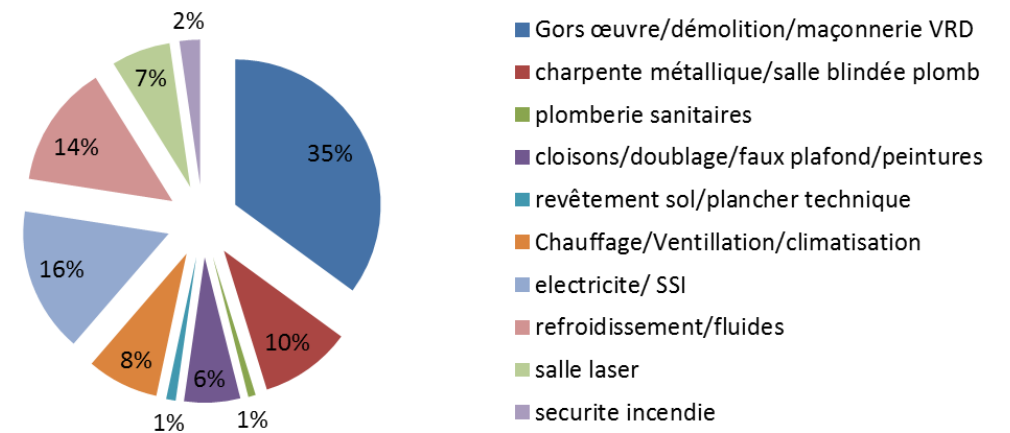
# ThomX civil engineering

- ▶ creation IGLEX :  
Andromède + ThomX
- > ASN authorisation



# ThomX civil engineering

IGLOO Rehabilitation lots :



LOT N°01	GROS ŒUVRE / DEMOLITION / MACONNERIE / VRD	603 169,00 €
LOT N°02	CHARPENTE METALLIQUE - SALLE BLINDEE AU PLOMB	175 000,00 €
LOT N°03	PLOMBERIE SANITAIRES	14 255,00 €
LOT N°04	CLOISONS / DOUBLAGE / FAUX PLAFONDS / PEINTURE / MENUISERIES INT / SERRURERIE	107 273,00 €
LOT N°05	CARRELAGE / FAIENCE / REVETEMENTS SOLS / PLANCHER TECHNIQUE	18 266,00 €
LOT N°06	CVC	137 550,00 €
LOT N°07	ELECTRICITE (COURANTS FORTS / COURANTS FAIBLES) / SSI	277 368,00 €
LOT N°08	REFROIDISSEMENT / FLUIDES	235 500,00 €
LOT N°09	SALLE LASER	113 000,00 €
LOT N°10	SECURITE INCENDIE	39 425,00 €
<b>TOTAL GÉNÉRAL H.T</b>		<b>1 720 806,00 €</b>
<b>TOTAL GÉNÉRAL H.T + TRANCHES CONDITIONNELLES &amp; OPTIONNELLES</b>		<b>1 810 726,00 €</b>

Planning :

- 20/03 publication annonce
- 20/05 date limite réponse
- 08/06 premier rapport choix et négociations
- 22/06 fin négociations
- 30/06 choix final début recours
- 15/07 fin recours notification

Overheads max ~ 10% → +170 k€

# Acquisition status

OBJET	prévu	réel	CCTP	ACTEUR	Resp. technique	COMMENTAIRES ACTUALISÉS JANVIER 2015
RF Linac Circulateur & Atténuateurs Dephaseur	90	68,6	octobre 2013	PUMA LAL	SOLEIL	PUMA n° 44811 publiée, marché avec sté Tech-Inter
RF Linac Network > réseau guide d'ondes	100	84,6	octobre 2013	PUMA LAL	SOLEIL	Marché notifié avec TECH-INTER
RF Source (Modulateurs + 2 klystrons)	1010	1000	avril 2015	DDAI	SOLEIL	<b>candidat choisi, pas encore notifié à ce jour.</b>
RF Cavité (Gratuit) + Cooling rack	400	50	2015	PUMA LAL	SOLEIL	solution type ESRF
Aimants	600	411	2014	DDAI	SOLEIL	Marché notifié avec sté SIGMAPHI
Alims	300	377,5	2014	DR	SOLEIL	Marché notifié avec sté SIGMAPHI
Kicker & Septum	565	565	Fin 2014	DR	SOLEIL	marché négocié (avec Sigmaphi, sans mise en concurrence) en cours à la DR
Laser (s)	450	450	2015	DR	LAL	2 RECAS à faire, en attente CCTP
BPM (Beam Positionnt Monitor)	300	223,3	Fin 2013	DR	SOLEIL	Marché notifié avec sté Instrumentation technologies
Chambres à vide droites	70	70	fin avril 2015	PUMA LAL	LAL	Puma prévue début 2015
Systèmes RF avec soufflets	80	80	fin juin 2015	PUMA LAL	LAL	Puma prévue début 2015
Matériels vide (plusieurs lots + PUMA)	600	550	fin mars 2015	DR	LAL	Faire un AO pour les lots 1-3-4-6-7 et des PUMAS pour les autres lots : 2-5-8-9 (en le précisant dans l'AO)
Poutres mécano-soudées en alu	100	90	fin mars 2015	DR	LAL	
Table motorisée	300	128,5	2014	DR	LAL	<i>Marché notifié avec sté Symétrie</i>
PMB	200	200	2014	DR	LAL	<i>Marché négocié signé (Sté PMB)</i>
câbles	150	150	fin mars 2016	DR	LAL	<i>marché</i>
TCR ThomX	200	150	oct 2015	DR	LAL	<i>IRSD + IGLEX - marché</i>

ThomX Status - march 2015

TOTAL CDES A ENGAGER

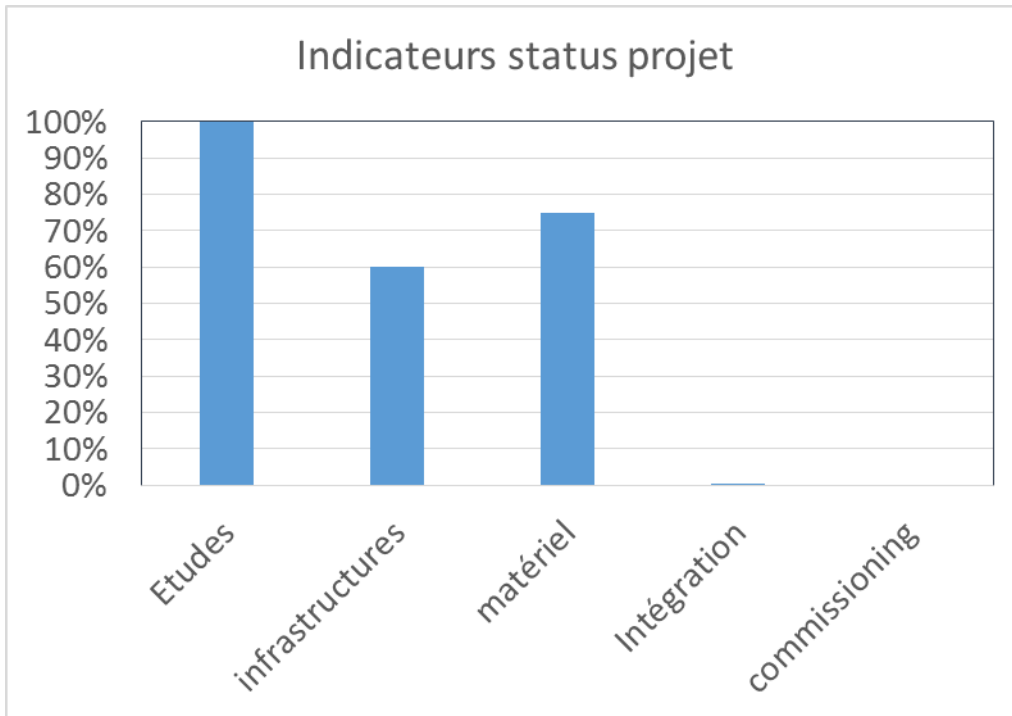
5515

4648,3

14



# Project Status



Etudes : TDR publié fin 2014  
95% des CCTP sont finalisés

Infra : MOE choisi, DCE terminé,  
publication annonce, réhabilitation Igloo

Matériel : presque tous les marchés sont passés

Intégration : démarre en sept 2015 (bât 208)

Commissioning : en 2017



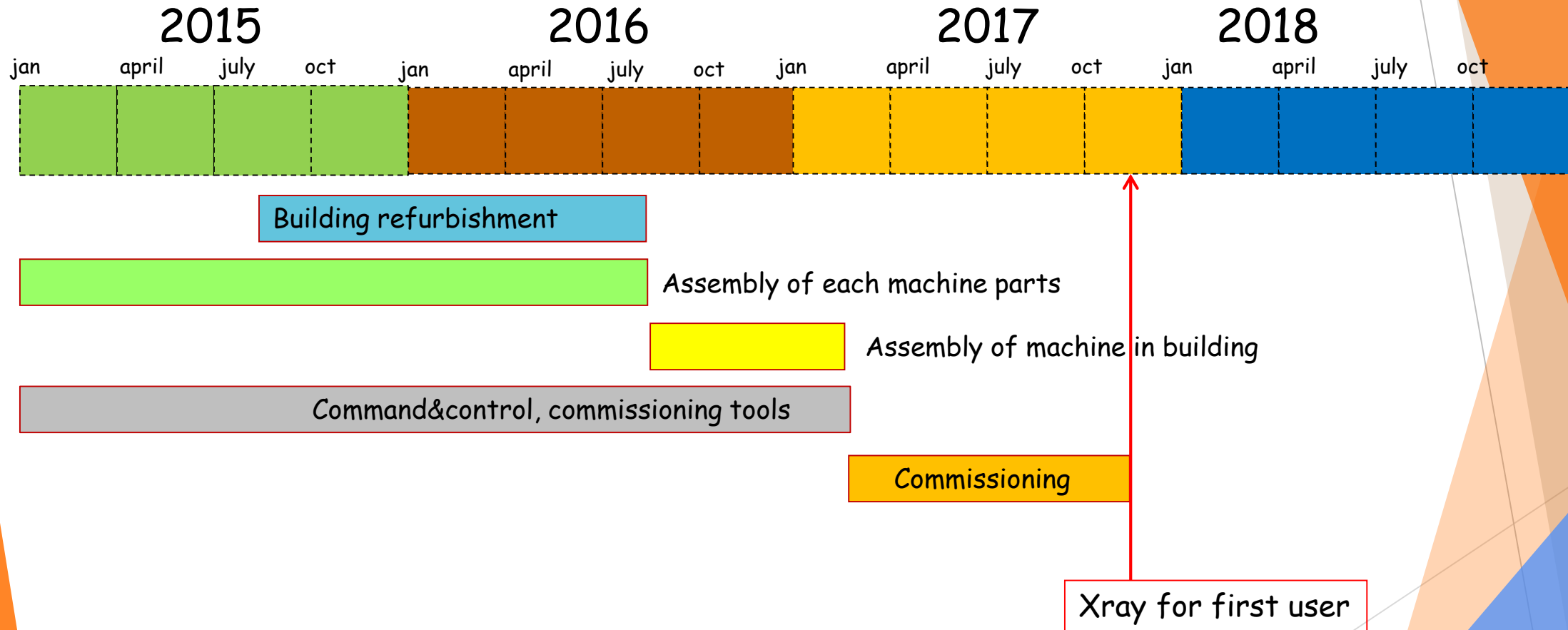
# Impact on Depacc and LAL

- ▶ Priority project of Depacc
- ▶ Bring new knowledge : low energy electron ring, high power laser , large instrument management,...
- ▶ Continuation of LAL know-how for photoinjectors
- ▶ Bring Industrial collaboration
- ▶ User facility to manage
- ▶ Accelerator to run : team of operators + support team + Physicists  
Depacc personnel involved+ ThomX partners

# Commissioning of ThomX

- ▶ Driven by beam characteristics : X ray, electron, laser
- ▶ Separate electrons, laser, X ray
- ▶ Commissioning : 1) Accelerator 2) laser 3) Xray
- ▶ Commissioning imply LAL but also partners : Soleil, CELIA, NEEL, ...
- ▶ 3 teams :
  - 1) operators : run machine
  - 2) support : maintenance + intervention
  - 3) physicists : drive commissioning
- ▶ Impact on Depacc : members in 3 teams
- ▶ Impact on LAL : building ready, control-command ready

# Planning - Scenario 1 : all parts of machine ready



Machine parts : linac, LT/LE, ring, Xline, FP cavity & laser

# Conclusions

- ▶ ThomX is a new local machine @ LAL
- ▶ ThomX is a source of Xray but also of know-how & motivation  
Original machine with technical challenges :  
low energy ring, high power laser...
- ▶ ThomX will help PHIL development and vice-versa
- ▶ Synergy ThomX - ELI NP (transport laser, ...)
- ▶ Organisation to find inside Depacc for running ThomX
- ▶ Possible extension of ThomX in D4 (Sesame)
- ▶ Facility to finance after end of Equipex (2019)