

Collision Avoidance Systems in SOLEIL TUPV042 Poster Session



Collision Avoidance Systems

How to handle collision risks with motorised systems – *violated/overlapping workspaces*



Collision Avoidance Systems

Static-CAS: Proximity- or touch- based sensors (with PLC-controller configurations)

Dynamic-CAS: Combining 3D-models and encoder feedback to avoid collisions

Collision Avoidance Systems in SOLEIL Dynamic-CAS in the MARS Beamline



An aerial photograph of the SOLEIL synchrotron facility, showing a large circular building with a grid-like roof structure, surrounded by other buildings and greenery.

Jean-Luc Giorgetta
Mechanical Engineering

Simon Bouvel
Christer Engblom
ECA (Electronics, Control- &
Acquisition Group)

- Introduction
 - [MARS] 2D Detector Support
 - Control Configuration
- Dynamic-CAS at MARS Beamline
 - Principle & Implementation
- Results

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2018, MARS Beamline

(Extract from 'D. Menut – Jouvence support motorisé CX3 – 05/09/2018')

*« ... Concevoir & Réaliser un système d'axes motorisés codés pour le **support** et le positionnement des **détecteurs 2D** exploités sur le poste d'analyse CX3 de la ligne MARS ... pour la réalisation d'expériences de XRD (poudres et monocristaux), **SAXS** et **GISAXS** ... »*

Incident X-ray beam

SAXS: **S**mall-**A**ngle **X**-ray **S**cattering

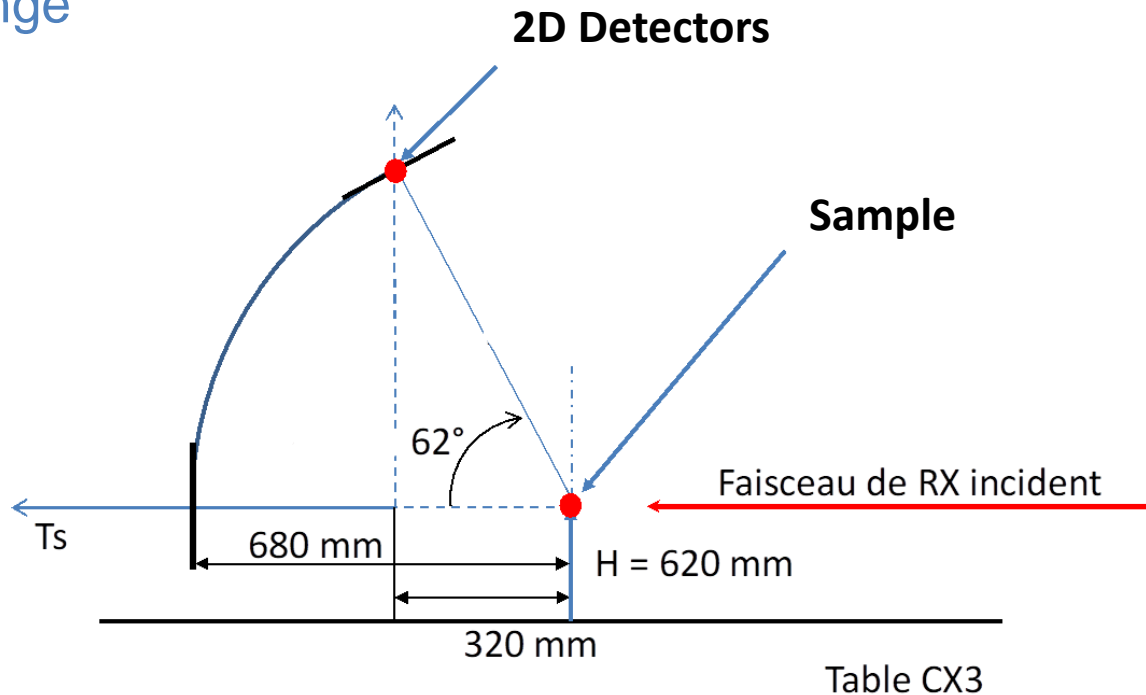
GISAXS: **G**razing-**I**ncidence **X**-ray **S**cattering

GISAXS

SAXS

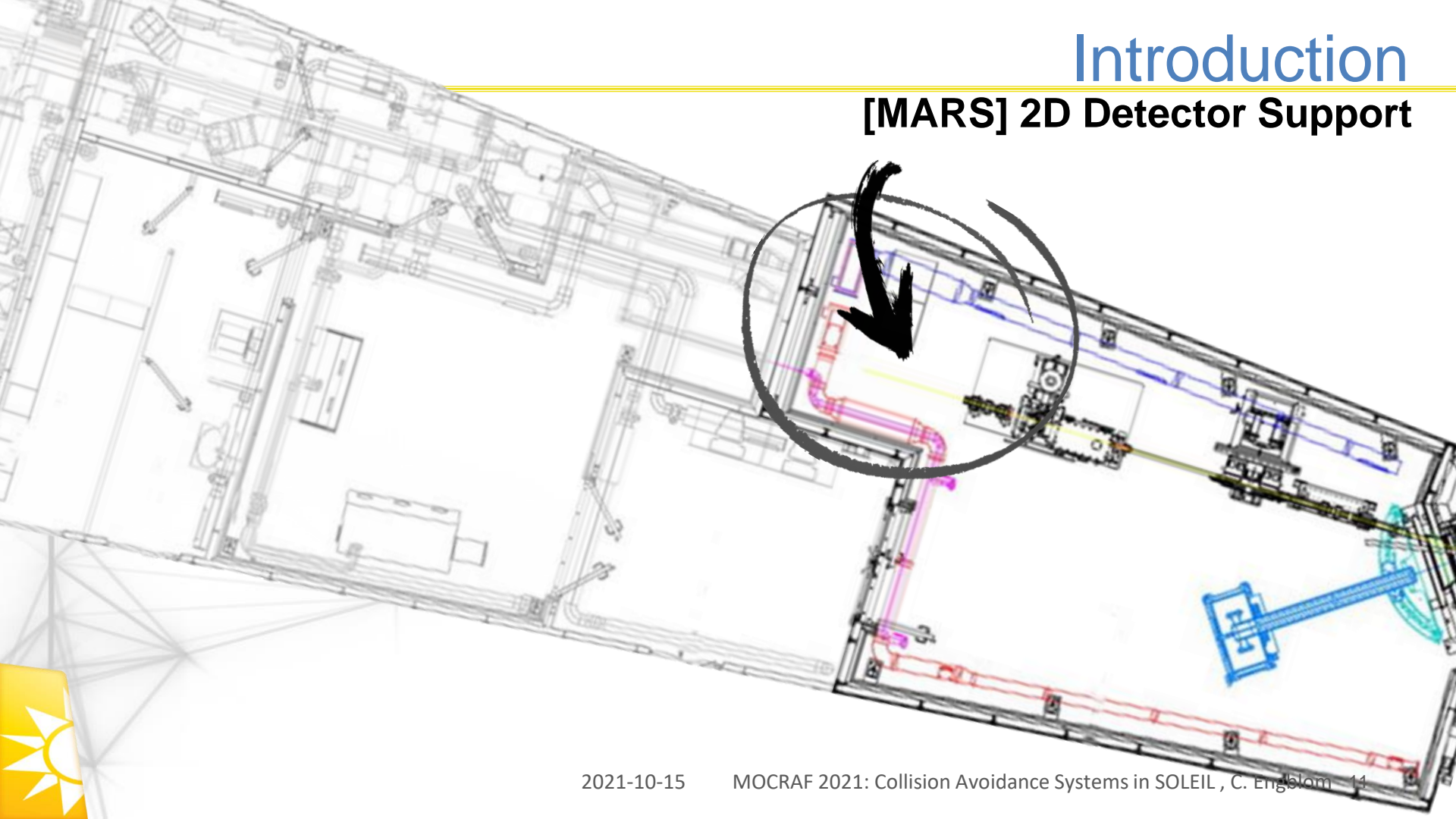
[MARS] 2D Detector Support

- Significant increase in the measured angular range (with 2D detectors)



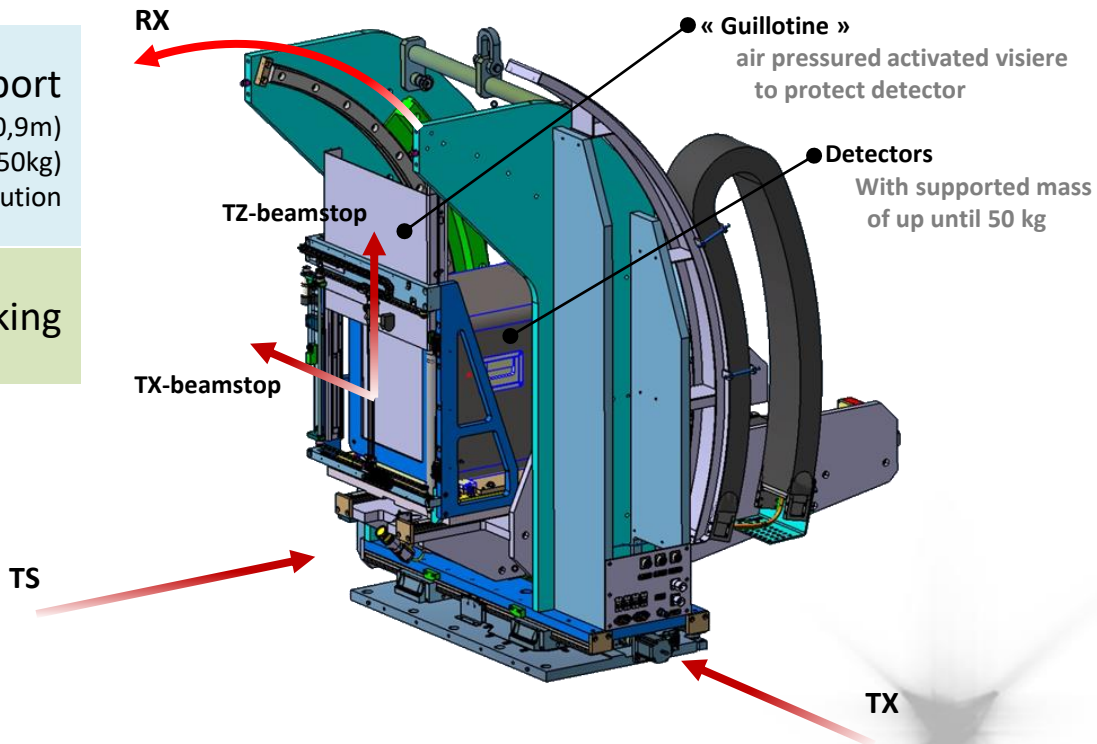
Introduction

[MARS] 2D Detector Support



Motorised Axes

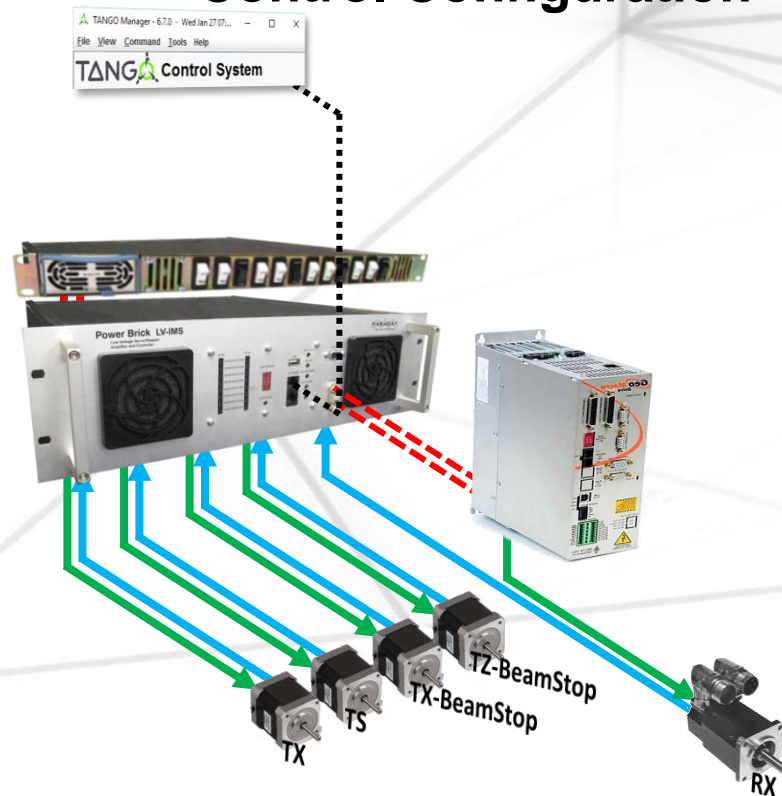
- | | |
|---------------|---|
| • TX | Detector Support
Big movements (→60 deg, →0,9m)
Heavy weight(→ ~50kg)
High resolution |
| • TS | |
| • RX | |
| • TX-Beamstop | Beam-Blocking |
| • TZ-Beamstop | |



- Controller / amplifier selection criteria
 - [TX, TS, TX-Beamstop, TS-Beamstop]
4 stepper motors (standard)
 - [RX] (High-speed, High-torque)
1 brushless motor (Current++, Voltage++)
 - Capable of continuous anti-collision avoidance calculations

Controller: Powerbrick LV

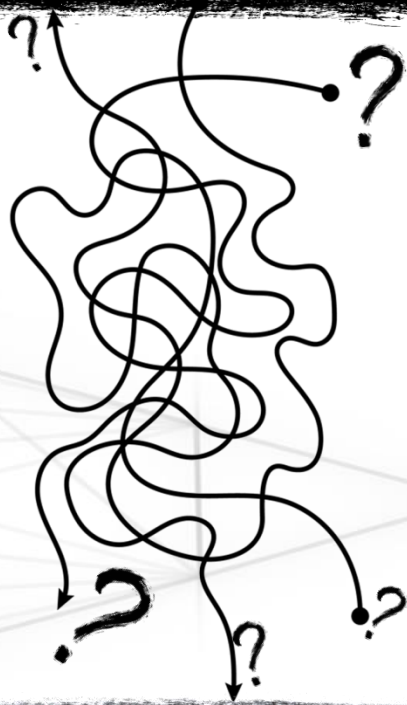
Driver: GeoMACRO



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System 3D-Model



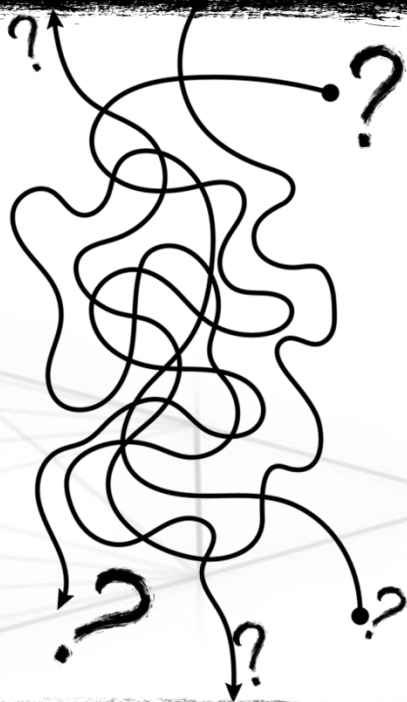
Collision Avoidance System

Principle & Implementation

The Dynamic-CAS project is part of a comprehensive approach to global collision avoidance:

- Static (ex: PUMA, NANOSCOPIUM)
- Dynamic (ex: MARS, ANTARES)

System 3D-Model

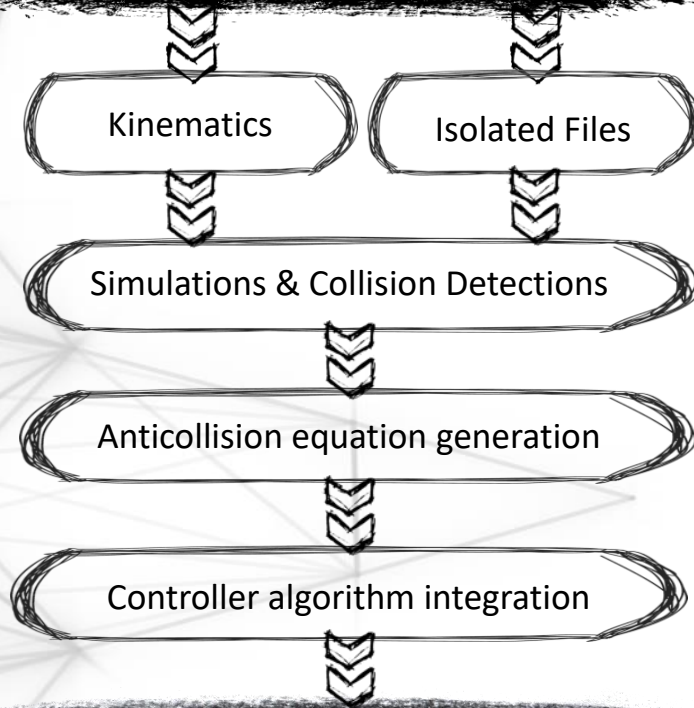


Collision Avoidance System

Mechanical
Engineering

ECA

System 3D-Model



Collision Avoidance System

System 3D-Model

Kinematics

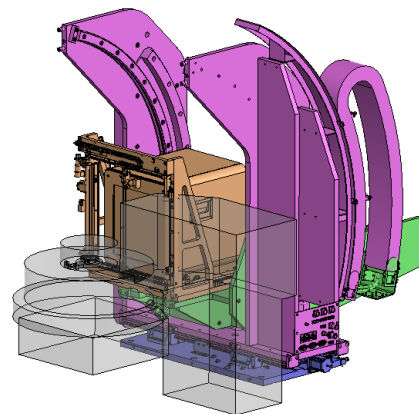
Isolated Files

Simulations & Collision Detections

Anticollision equation generation

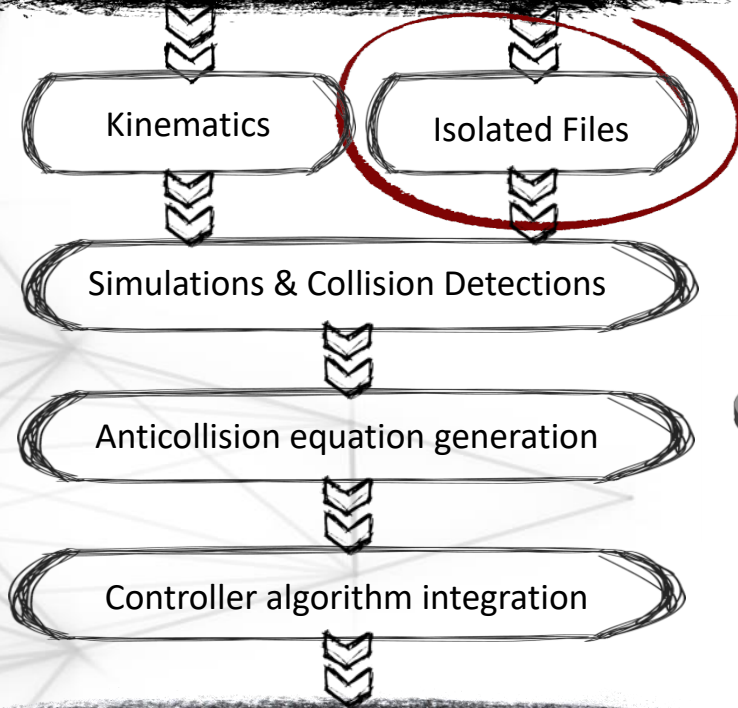
Controller algorithm integration

Collision Avoidance System

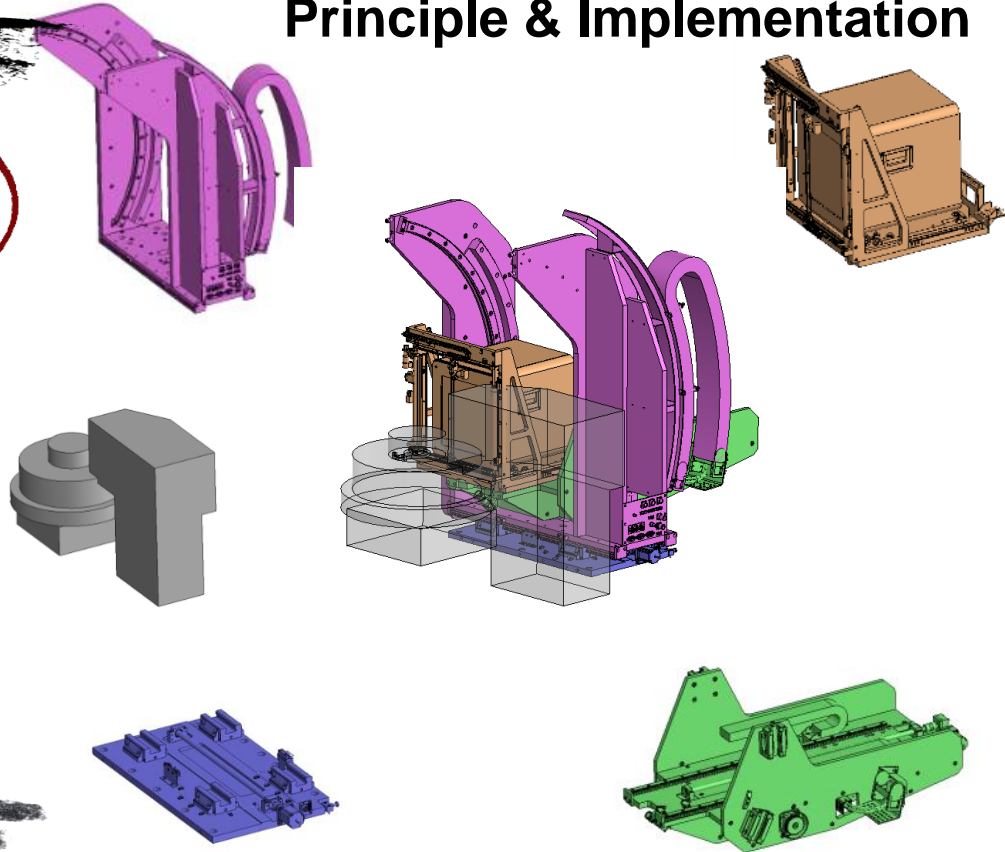


SolidWorks

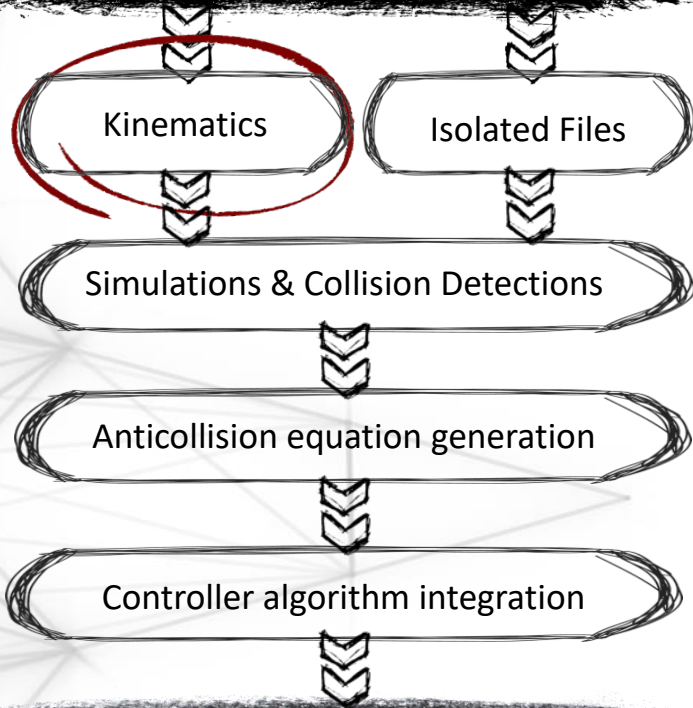
System 3D-Model



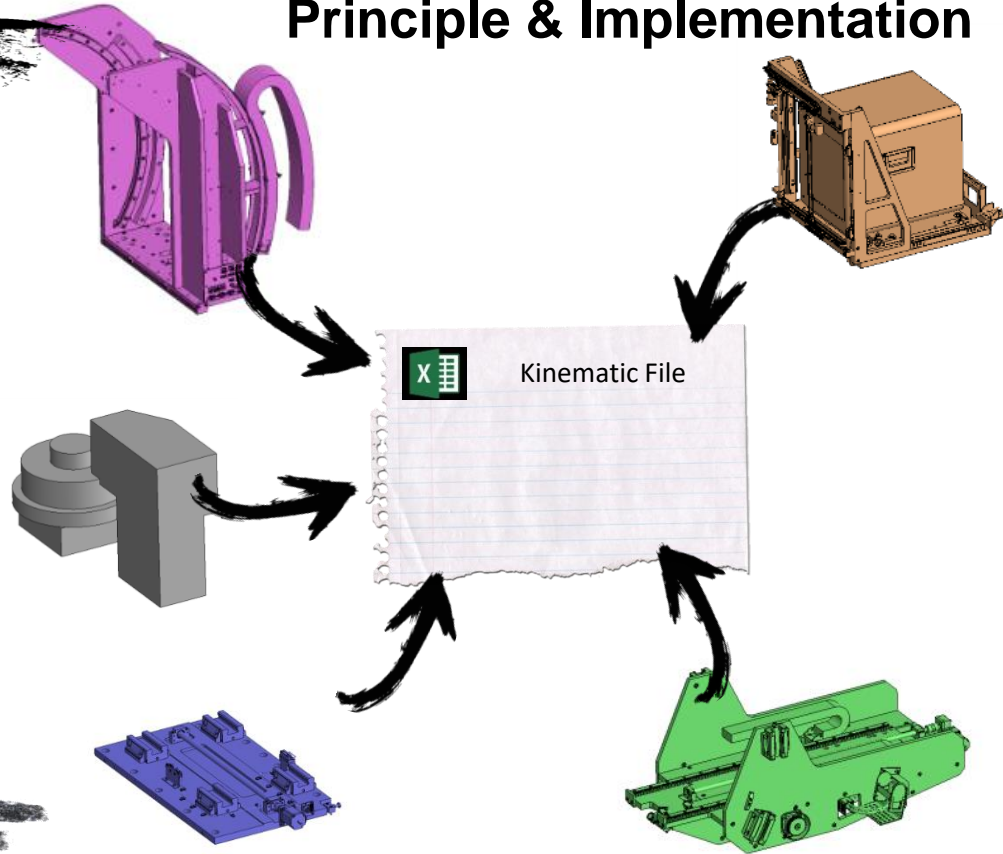
Collision Avoidance System

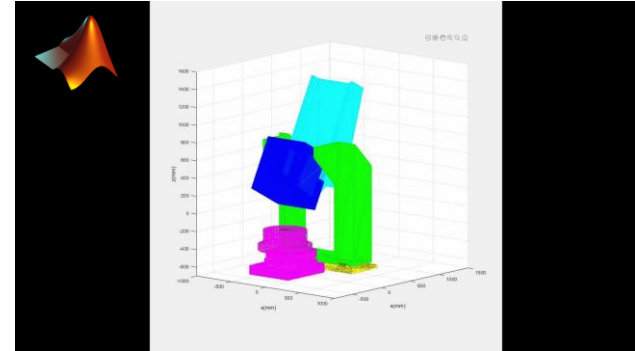
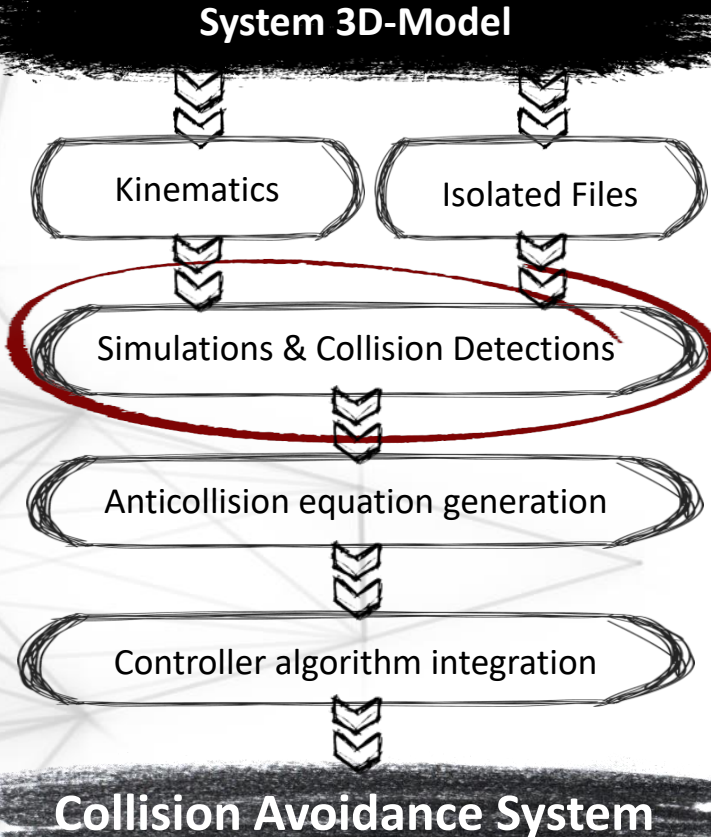


System 3D-Model



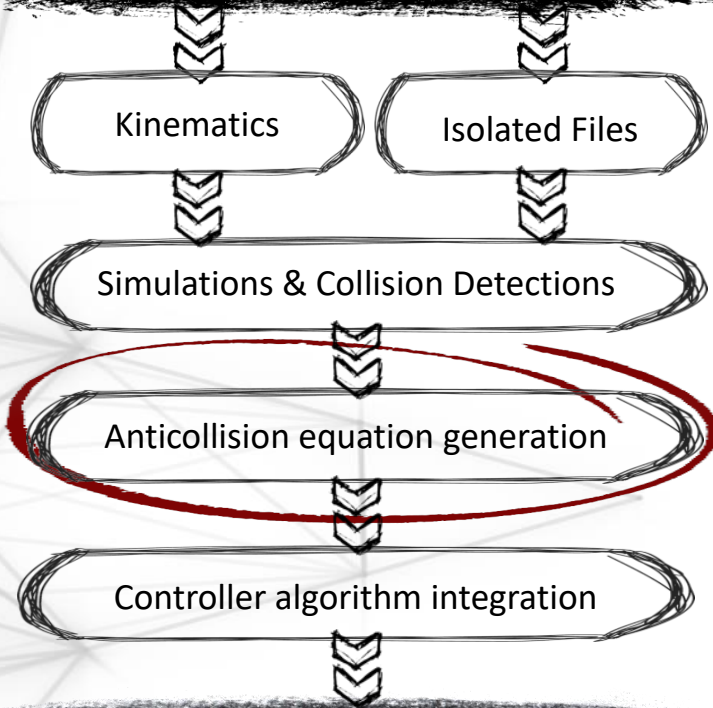
Collision Avoidance System



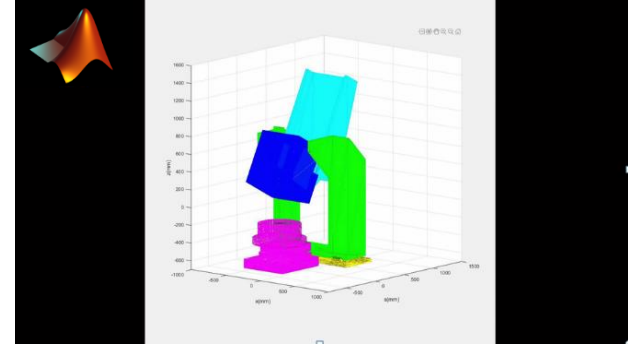


MATLAB: Calculating all collision-points using 3D-Files and kinematics

System 3D-Model



Collision Avoidance System



MATLAB: Calculating collision boundaries from point-cloud data

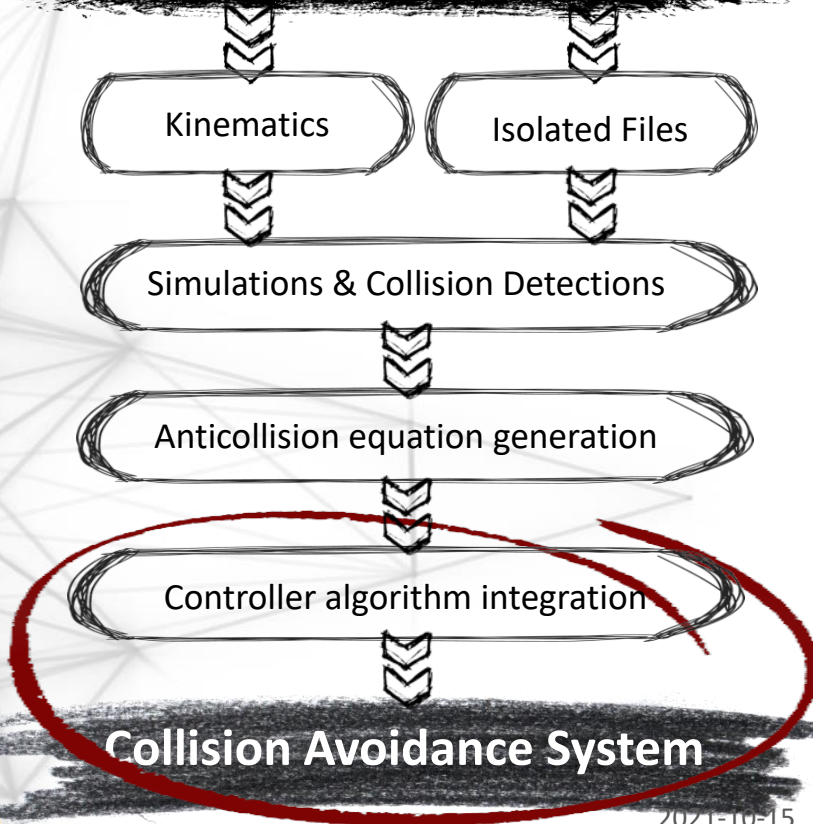
Equations in the form:

$$a_0 + a_1x_1 + a_2x_2 + \dots + a_nx_n < 0$$

$$b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n < 0$$

$$c_0 + c_1x_1 + c_2x_2 + \dots + c_nx_n < 0$$

Modèle 3D du système



Ensemble d'équations de la forme :

$$a_0 + a_1x_1 + a_2x_2 + \dots + a_nx_n < 0$$

$$b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n < 0$$

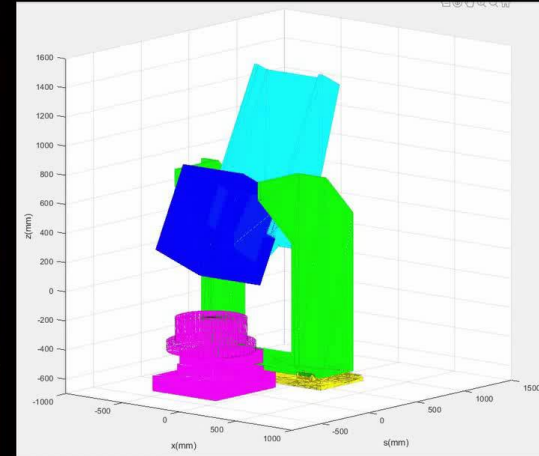
$$c_0 + c_1x_1 + c_2x_2 + \dots + c_nx_n < 0$$



Algorithme intégré au contrôleur

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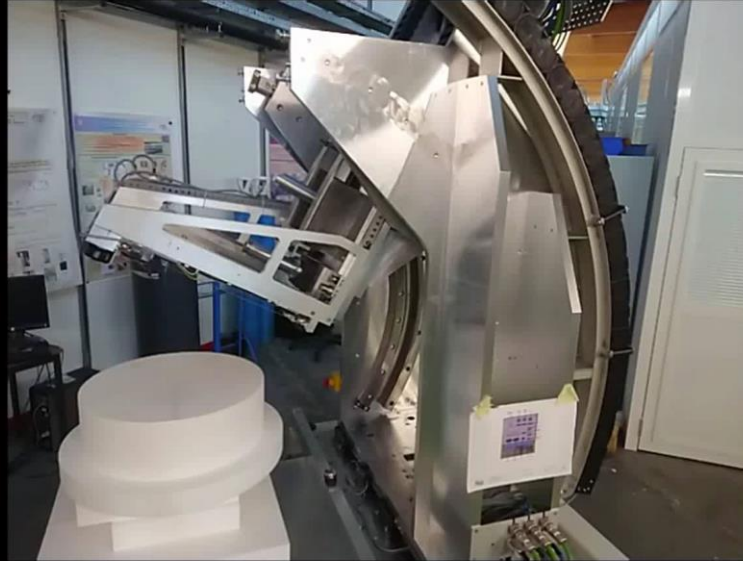
MARS Support Detecteur

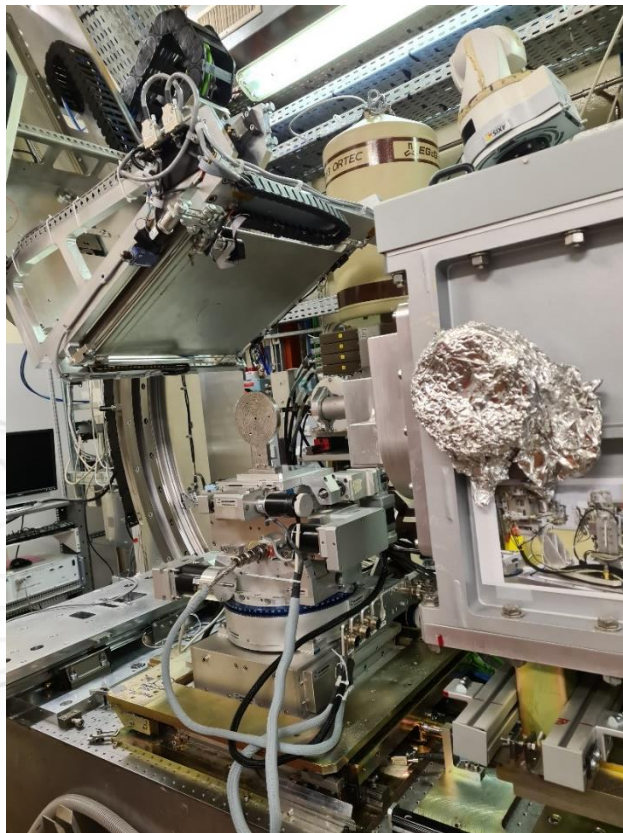
2021-02-12: Tests anti-collision (Video 3X)



MARS Support Detecteur

2021-02-12: Tests anti-collision (Video 40X)





2021-10-15



MOCRAF 2021: Collision Avoidance Systems in SOLEIL , C. Engblom 30

- The MARS Dynamic-CAS is functional, proving consistency from 3D-model environment to real-world controller implementation
 - Complements static-CAS systems (as those which are installed in PUMA and NANOSCOPIUM beamlines)
- Project prompts close collaboration between:
Mechanical Engineering/Motion Control- Engineering
- Areas for improving the method: How to improve collision detection algorithm (and scale it with number of axes), equations simplification, etc...