Development of Mixed Reality Software Applications for the ATLAS Experiment

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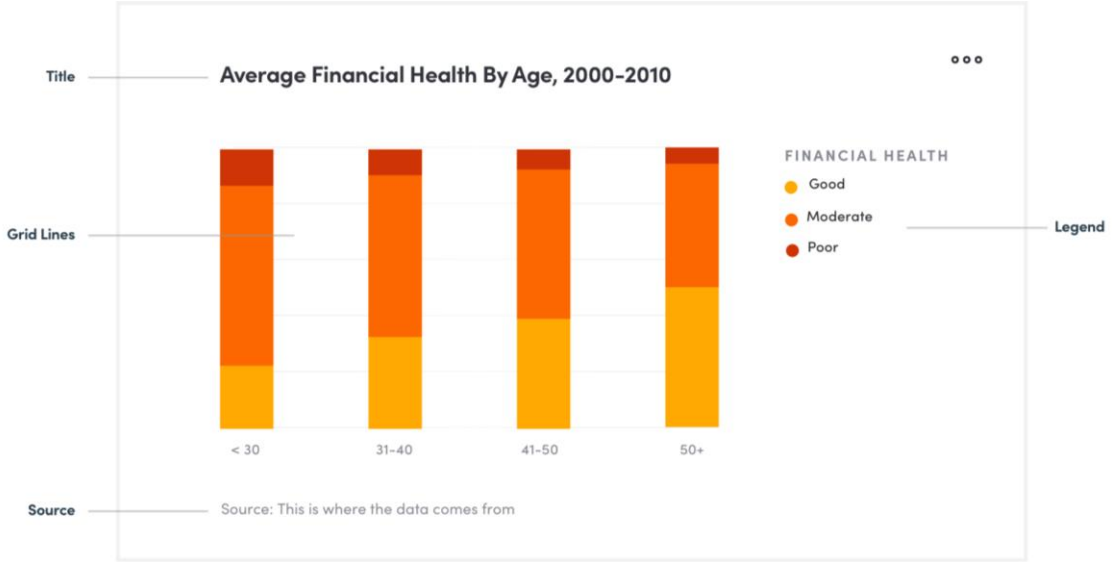
Visualization Technologies



Along with other technologies there is an urgency to develop technologies that will help to involve wider masses into science and technological innovations:
One of these technologies are Visualization Technologies, which convert information into a format that is easily understood and recognizable by the non-scientist person.

Similar visual aids shape important trends such as Augmented and Mixed Reality technology.

- With "Augmented Reality" (AR), virtual content can be used in the real world.
- Mixed Reality Technology synthesize Augmented Reality and Virtual Environment and create an environment where physical and virtual objects can co-exist and interact in real time

CERN Outreach

Wider Masses include students and pupils who are potential future software developers, scientists and innovators.

“**In addition to the scientific mission, scientific organizations also have an educational mission to awaken in young people love and interest towards scientific activities.** “

CERN’s outreach knows the importance of educational mission and hosts and arranges wide number of activities and events for students all over the world.

Cognitive Festival in Georgia

Cognitive Festival in Georgia

“The ATLAS Collaboration recognizes the importance of communicating the scientific goals and achievements of the experiment and has developed an Outreach program to facilitate public engagement.”

ATLAS **Outreach & Education**

IPPOG Masterclasses ,Cognitive Festival in Georgia

The ATLAS Outreach program arranges various of activities and events, including Masterclasses, hosting of local and virtual visits for students, teachers and general public and the development of games, books, applications and other educational tools.

ATLAS Masterclass, Cognitive Festival in Georgia

- IPPOG Masterclasses

  provide an opportunity for 15- to 19-year old students to discover particle physics. Masterclasses take place in more than 220 places in 55 countries with more than 13.000 participants worldwide

- Origin Collaboration

  ORIGIN is a network founded in January 2018 by several high energy and astrophysics collaborations and research centers. It's purpose is to create and support events, exhibits and workshops where public engagement and education are enhanced by both art and science.

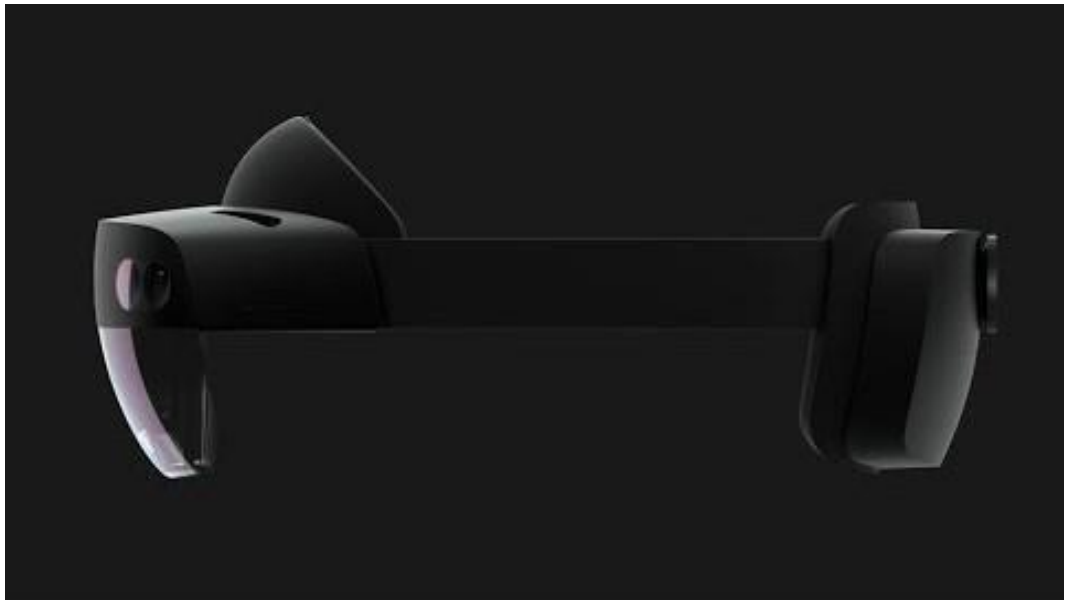
- Cognitive Festival in Georgia

  scientific and educational event based on the CERN scientific research and innovation technologies which took place in Georgian Technical University. Event was organized by Nuclear Engineering Center Georgia

Visualization tools for Educational Events

Augmented and Mixed Reality applications and tools can become great innovational tools used for Masterclasses, Festivals and other educational events held for students and pupils.

One of the example of Mixed Reality Tool is Microsoft HoloLens.



- **Wallpaper Your Room With Webpages**

The HoloLens can run some normal Windows 10 apps, displaying them as glowing windows floating in the air

- **Create a Holographic Diorama**

lets you build, modify, and arrange holograms into entire scenes

- **Video Call Your Friends in Skype and Share Your Holographic Vision**

Video calls appear as floating windows in front of you. Your video feed shows whoever you're talking to your own view, complete with any holograms you've set up around the room.

Implementing These Technologies in Educational and Outreach Purposes

Mixed Reality breaks emotional barriers so students can experience life from new perspectives.

The technology can make it easy for students to work, play and learn together, no matter what their socio-economic background might be, according to Mark Christian — Pearson's Global Director of Immersive Learning – who thinks mixed-reality devices should be made available in schools.

By interacting with content in a mixed reality, learners can comprehend and remember it more effectively than if they simply try to memorize it, that's why it is important to implement such tools in Education and Outreach.

Mixed Reality Applications for ATLAS Experiment

Nuclear Engineering Center Georgia in collaboration with CERN creates innovative technologies such as Augmented and Mixed Reality Applications specially for CERN's Outreach and Education. These applications are:

- TRACER – ART (AR Table)

enables to put detector on table and interactions with it

- TRACER – ARB (AR Book)

3D-extension of the paper printed documents

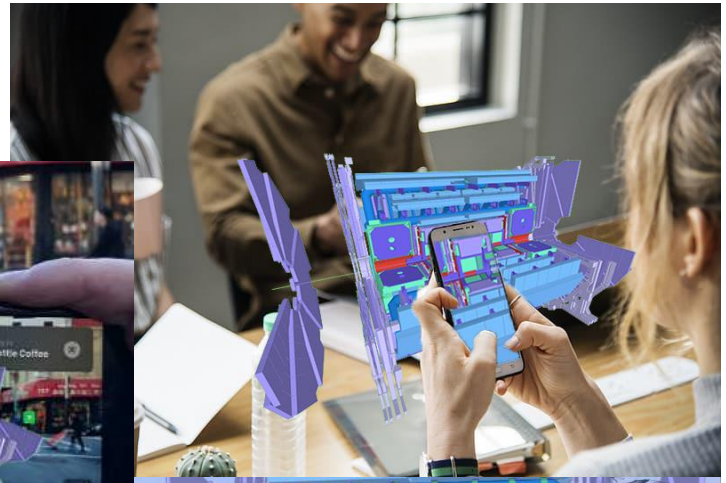
- TRACER – ARD (AR Door)

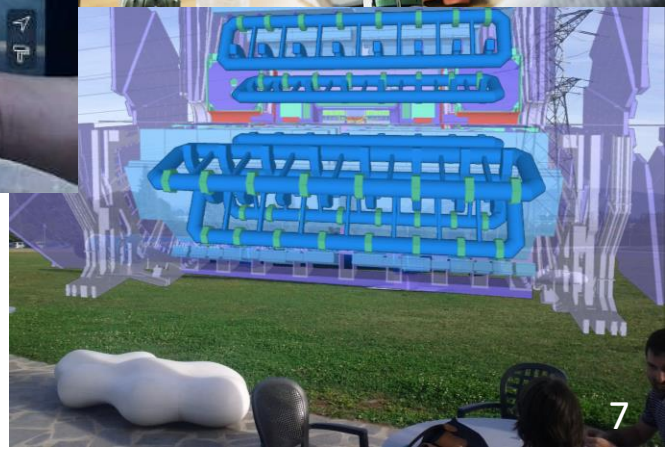
for the navigation inside of the ATLAS detector

- TRACER – LND (Landscape)

visualize the Detector in the actual-size

Tracer-ART and ARB are already developed, whilst others are under development.





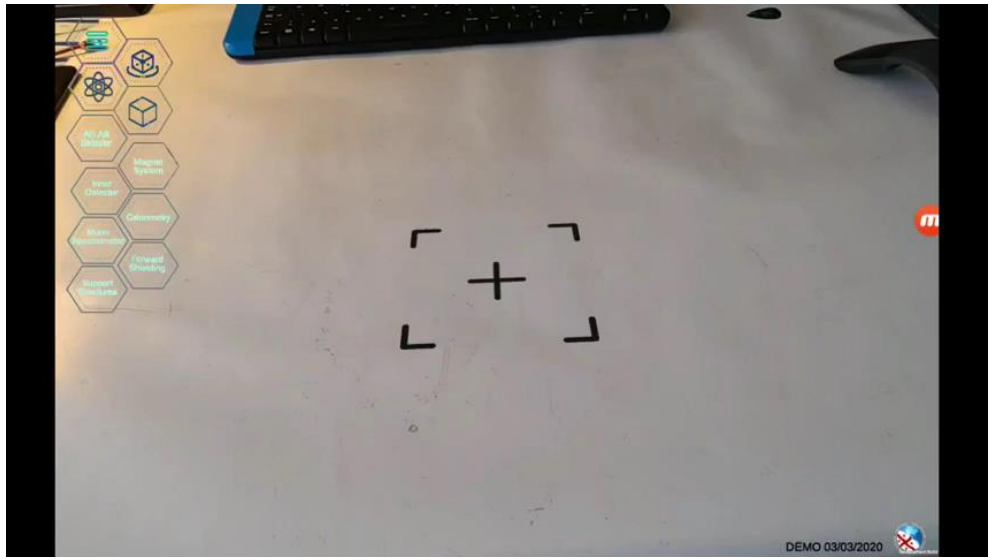
For development of applications we use Unity (real-time development platform).

You can view all of our application on the link: https://tracer.web.cern.ch/tracer/

For Tracer-ART we used AR Foundation framework.
We made special changes and modifications with AR Foundation and also made independent engine for this project, called “TRACER-Core”.
TRACER-Core enables user to scan surfaces, detect user interactions and controls, that are scanning surfaces and putting ATLAS Detector on scanned surface, as well as zooming Detector in and out.

```
private void ZoomOrPan() {

    if(
        (
            (
                Input.GetTouch(0).phase == TouchPhase.Began
                &&
                Input.GetTouch(1).phase == TouchPhase.Began
            )
            ||
            (
                Input.GetTouch(0).phase == TouchPhase.Moved
                &&
                Input.GetTouch(1).phase == TouchPhase.Began)
            ||
            (
                Input.GetTouch(0).phase == TouchPhase.Began
                &&
                Input.GetTouch(1).phase == TouchPhase.Moved
            )
        )
        &&
        (
            Input.GetTouch(0).phase != TouchPhase.Ended
            &&
            Input.GetTouch(1).phase != TouchPhase.Ended
        )
    )
    {
        startingDistance = getDistanc
    }

    if( Input.GetTouch(0).phase == To
        startingDistance = 0.0f;
        TracerCore.Control.resetResiz
        return;
    }
```

```
void Start()
{
    var xs = new float[trackCount * trackPoly];
    var ys = new float[trackCount * trackPoly];
    var zs = new float[trackCount * trackPoly];
    int counter = 0;
    int ii = 0;
    for (var q = 1; q < trackCount; q++) {
        ii = 0;
        float a = UnityEngine.Random.Range(trackRandomMin, trackRandomMax) / trackRandomMulti;
        float b = UnityEngine.Random.Range(trackRandomMin, trackRandomMax) / trackRandomMulti;
        float c = UnityEngine.Random.Range(trackRandomMin, trackRandomMax) / trackRandomMulti;


        for (float i = 0, k = 0, j = 0; ii < trackPoly; i += 0.1f, k += 0.05f, j += 0.075f)
        {
            xs[counter] = gennum(i, a);
            ys[counter] = gennum(j, b);
            zs[counter] = gennum(k, c);
            counter++;
            ii++;
        }
    }


    int nextTrackIndex = trackPoly;

    ii = 0;
    var temp = new Vector3[nextTrackIndex];
    for (int i = 0; i < xs.Length; i++)
    {
        int index = i % nextTrackIndex;
        temp[index] = new Vector3(xs[i] / shrinkSize, ys[i] / shrinkSize, zs[i] / shrinkSize);
        if (i != 0 && index == nextTrackIndex - 1)
        {
```



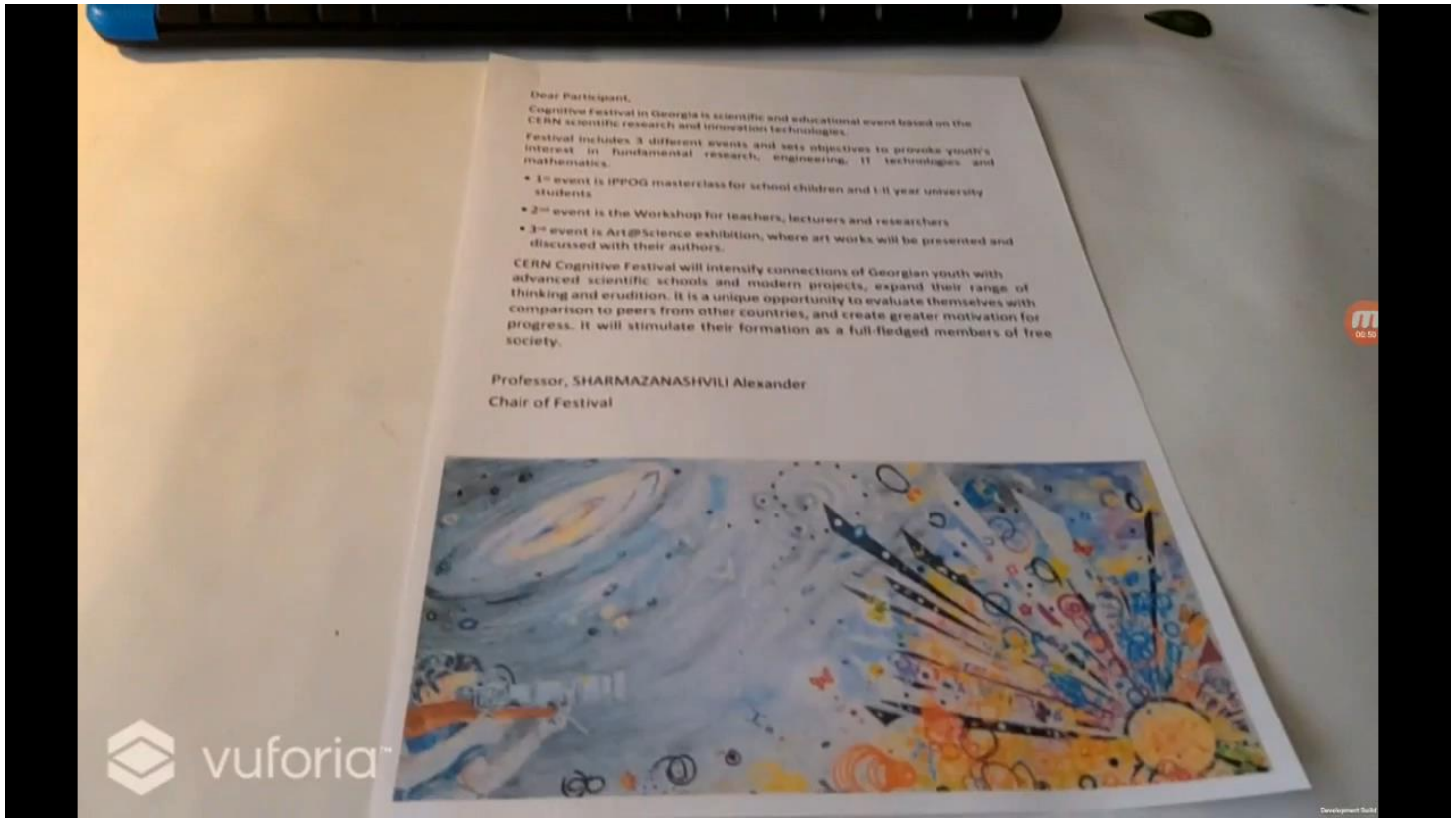

```
try
{

    children = Instantiate(objectToPlace, placementPose.position + TracerCore.MainGeometryParameters.getStartingOffs
    children.transform.parent = GameObject.Find("SceneInteractives").transform;
    children.transform.Rotate(0,250, 0);
    TracerCore.MainGeometryParameters.setSize(children.transform.localScale.x);
}
catch (Exception e)
{
    children = Instantiate(defaultObject, placementPose.position + TracerCore.MainGeometryParameters.getStartingOffs
    children.transform.parent = GameObject.Find("SceneInteractives").transform;
    children.transform.Rotate(0, 250, 0);
    TracerCore.MainGeometryParameters.setSize(children.transform.localScale.x);
}

placementIndicator.SetActive(false);
TracerCore.MainGeometryParameters.isPlaced = true;
TracerCore.MainGeometryParameters.showAll(true);
```

https://tracer.web.cern.ch/tracer/

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using Vuforia;

public class CameraFocusController : MonoBehaviour
{
    // Start is called before the first frame update

    void Start()
    {
        var vuforia = VuforiaARController.Instance;
        vuforia.RegisterVuforiaStartedCallback(OnVuforiaStarted);
        vuforia.RegisterOnPauseCallback(OnPaused);
    }

    private void OnVuforiaStarted()
    {
        CameraDevice.Instance.SetFocusMode(
            CameraDevice.FocusMode.FOCUS_MODE_CONTINUOUSAUTO);
    }

    private void OnPaused(bool paused)
    {
        if (!paused)
        {
            CameraDevice.Instance.SetFocusMode(
                CameraDevice.FocusMode.FOCUS_MODE_CONTINUOUSAUTO);
        }
    }
}
```

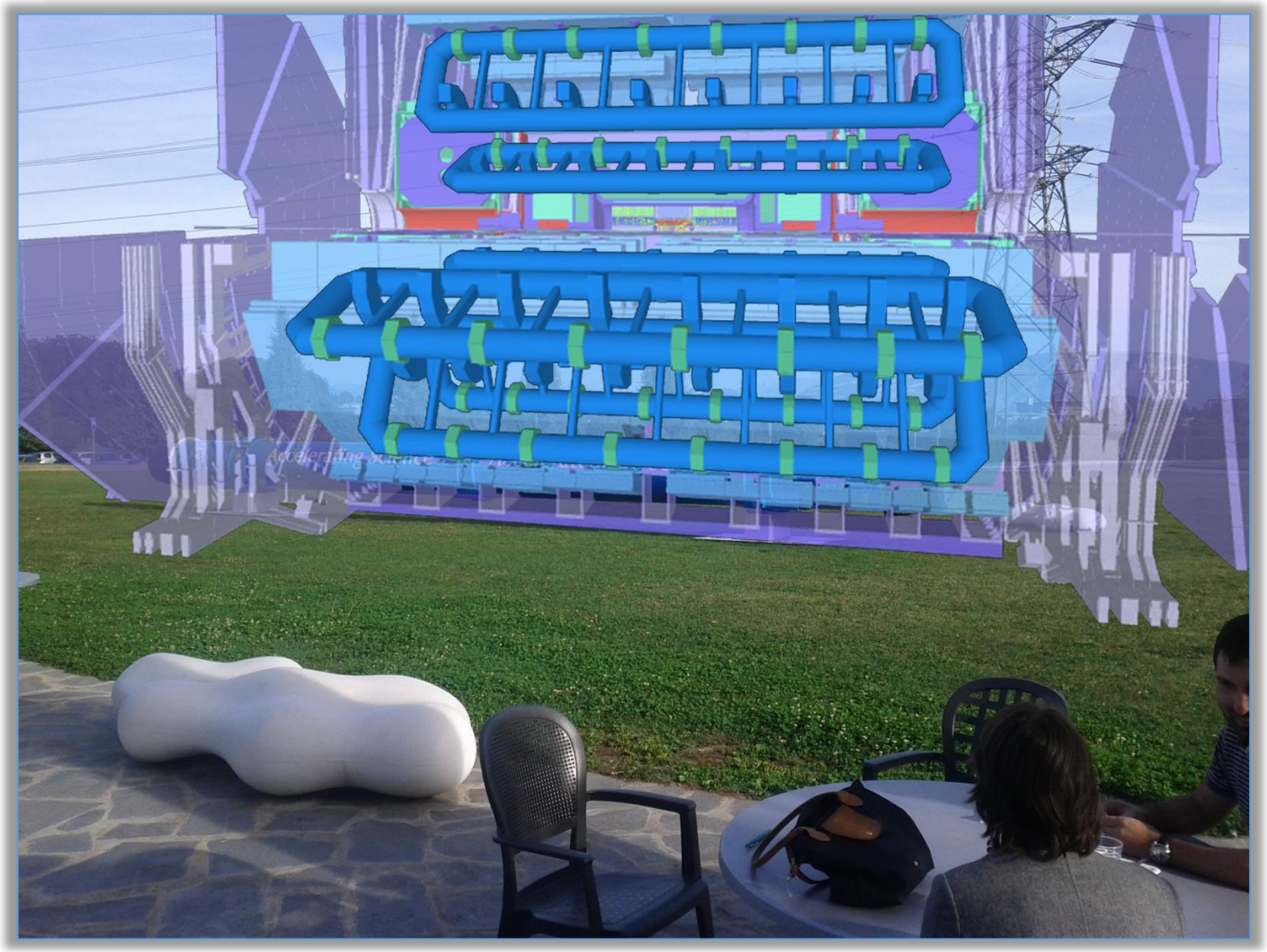
```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

0 references
public class MA_EventController : MonoBehaviour
{
    public static GameObject EventObject;
    private static Transform startingPosition;
    private static GameObject SceneObject;
    private static ParticleSystem tracks;
    private static Animation particleAnimation;
    private static Animator collisionAnimator;
    private static bool collisionChecker = false;
    private static Vector3 StartingPosition;
    private static Pose StartingPose;
    // Start is called before the first frame update
    0 references
    void Start()
    {
    }

    0 references
```

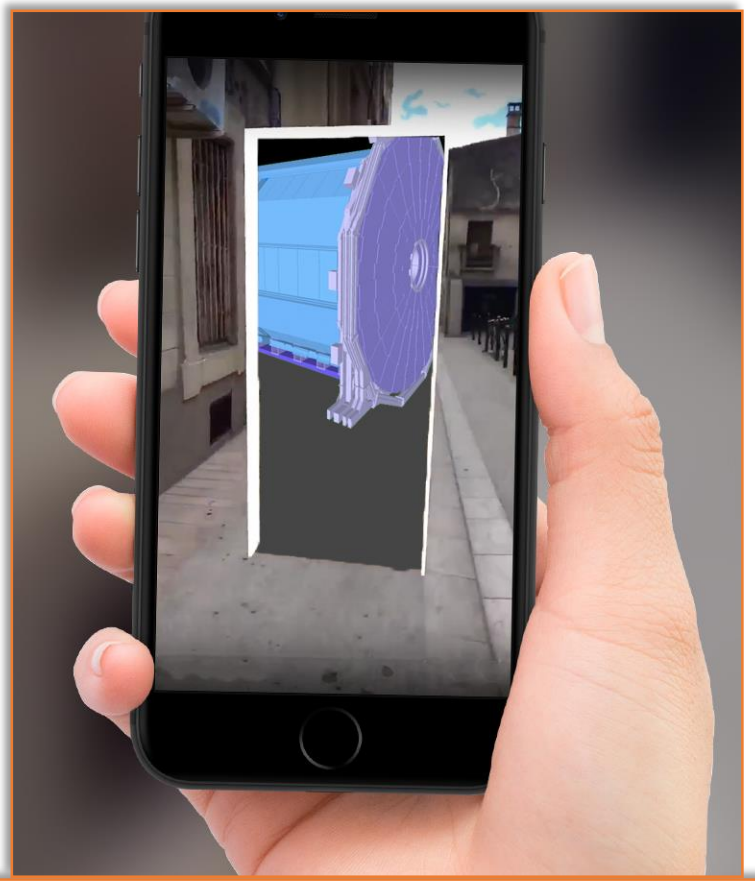
For TRACER – ARB we have used Vuforia Engine.
The application visualize content of the printed documents in 3D and gives additional information about the subject



https://tracer.web.cern.ch/tracer/

TRACER LND
visualizes the facilities in the actual scale in the real-life environment





TRACER-ARD
puts virtual door in the real environment and lets you enter inside the ATLAS detector. It enables to organize virtual tours inside the cavern and learning the detailed detector facilities

Thanks for your attention!